Oct. 27, 1953 L. GOLDSTEIN 2,657,315

HIGH-ENERGY RADIATION COUNTER

Filed April 8, 1950

Fig. 1.

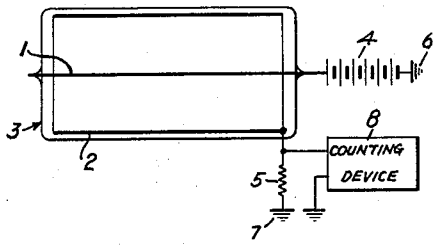


Fig. 3.

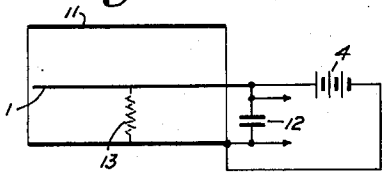


Fig. 2.

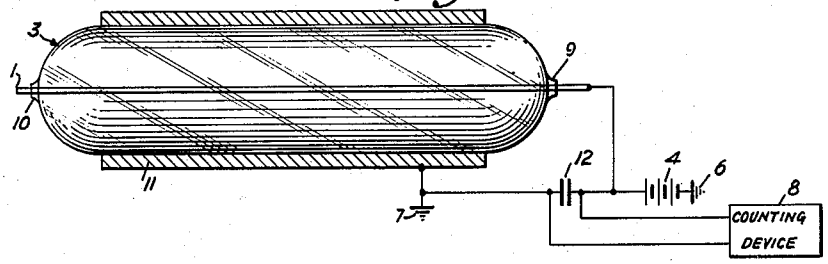


Fig. 4.

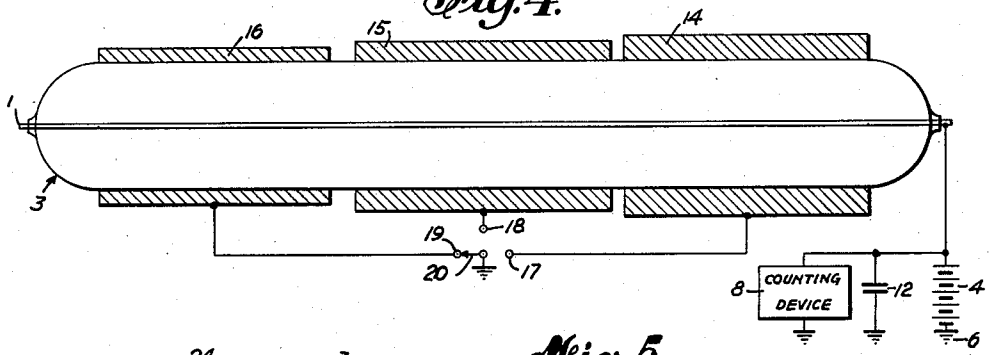
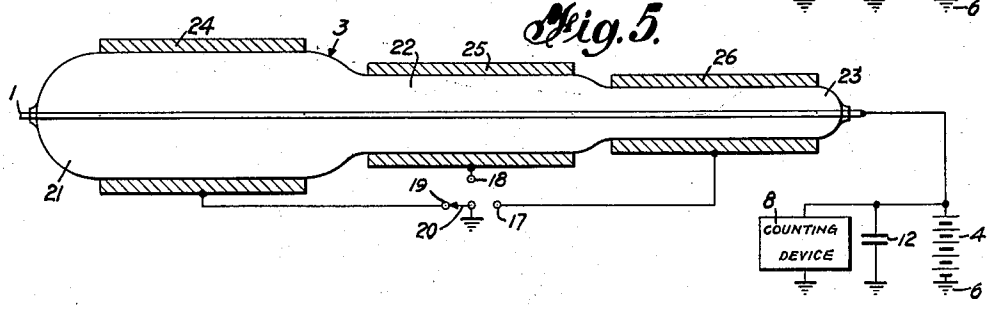


Fig. 5.



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Patented Oct. 27, 1953

2,657,315

UNITED STATES PATENT OFFICE

2,657,315

HIGH-ENERGY RADIATION COUNTER

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Application April 8, 1950, Serial No. 154,825

2 Claims. (Cl. 250—83.6)

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This invention relates to high energy radiation counters and more particularly to the type of counters known generally as Geiger-Muller counters.

Various constructions have been proposed for counting high energy radiations such as cosmic rays, alpha rays, gamma rays, beta rays, etc. These generally comprise an envelope containing an ionisible gas at low pressure. An electrode is arranged extending along the envelope and a second electrode is generally provided concentric with the first electrode. Between these electrodes is applied a polarising potential in series with a high resistance load. The high energy radiations or high energy particles penetrate the first electrode and directly or through secondary radiators cause ionisation of the gas, thus producing pulses in the circuit which includes this gaseous path between the two electrodes, the pulses thus produced being registered on a counting device. This general type of counter is known in the art as a Geiger-Muller counter. Such counters have been constructed with the second electrode formed as a coating on the inside of a glass envelope or as a metallic shell forming a part of the envelope itself. In non self quenching counters a very high resistance is included in series with the potential source which may be, for example, in the order of 1000 megohms or higher.

It is an object of this invention to provide a high energy radiation counter of the type generally used in the art wherein the second electrode is mounted externally of the gas-tight envelope, the envelope forming a high resistance in the counter circuit.

It is a further object of this invention to provide a high energy radiation counter having a first electrode of the conventional form and a plurality of other electrodes associated with this first electrode and presenting therewith different sensitivity with respect to high energy radiations.

In accordance with a feature of my invention the counter may comprise an elongated substantially cylindrical envelope having a first electrode conductor mounted concentrically of the envelope, the envelope containing an ionisible gas. On the outer surface of the envelope is mounted a substantially cylindrical second electrode or electrodes concentric with the first electrode and extending along an appreciable portion thereof. Between the electrodes is connected a source of energizing or biasing potential, the entire circuit including the high internal resistance presented by the envelope. The output energy may be taken across a condenser coupled between said electrodes, effectively in shunt with this high resistance circuit, the counting device being coupled across the said condenser.

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If a plurality of second electrodes is provided these may be made of different thicknesses or of different materials so as to present different absorption characteristics for high energy radiations so that the respective sections will be differently sensitive to radiations of different energy or particle velocity. A switching device may be provided selectively to couple any desired one of these electrodes into the circuit. Alternatively the envelope may be comprised of different cylindrical sections having different diameters and the second electrodes may then be of the same radiation absorption properties; however, the different parts of the tube will have different sensitivities since the polarising battery will provide different voltage gradients across the gaps between the second electrodes and the first electrode dependent upon the diameter of the envelope. It will of course be clear that the multiple electrode arrangement may be used with counters of the type wherein the second electrodes are not mounted externally of the envelope.

The above mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of some embodiments of the invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic circuit diagram illustrating the operation of the known Geiger counter arrangement;

Fig. 2 is a view, partly in section, illustrating my invention applied to a simple high energy radiation counter;

Fig. 3 is a schematic circuit diagram of the counter of Fig. 2;

Fig. 4 is an alternative embodiment of my invention illustrating a multiple electrode counter circuit; and

Fig. 5 is a still further modification of my invention illustrating another form of multiple electrode counter.

Turning first to Fig. 1, the counter for high energy radiation of the conventional form is shown comprising a first electrode 1 and a second electrode 2 generally formed as a cylinder concentric with electrode 1. The entire unit is enclosed usually in a glass envelope as indicated at 3. A source of potential shown at 4 is coupled in series with a resistor 5 between electrodes 1 and 2, as indicated by the ground connections 6

and 7. Across resistor 5 is coupled the counting device 8 which serves to provide the ultimate counting of the discharge effected in the gaseous medium between electrodes 1 and 2 by the radiation through electrode 2 of high energy radiations.

In the embodiment of my invention as shown in Fig. 2 the counter tube itself may comprise a first electrode 1 arranged within a dielectric gas-tight envelope 3. This envelope is generally made of glass and electrode 1 extends through the glass envelope at seal 9 and may be supported at its other end by the glass envelope at 10. Mounted on the outer surface of envelope 3 is provided the second electrode 11 which is preferably cylindrical and concentric with electrode 1. A potential source 4 may be directly connected between electrodes 1 and 11 by way of ground as shown at 6 and 7. Between electrode 11 and electrode 1 is provided a condenser 12 which serves as a blocking condenser for the potential from source 4 and also as an output condenser for the discharge occurring between the electrodes 1 and 2. A counting device 8 may be coupled across condenser 12 for producing indication of the discharge initiated by the high energy particle penetration through electrode 1 in the tube. It will be appreciated that the glass envelope 3 presents a high resistance in the circuit including electrode 1, potential source 4 and electrode 2.

In Fig. 3 the equivalent circuit of Fig. 2 is shown wherein the two electrodes 1 and 11 are shown interconnected by a potential source 4 and by condenser 12. The high resistance presented by the glass envelope 3 is indicated by dotted line resistor shown at 13. It will be clear that this resistor 13 includes also any resistance present in the discharge gas but this will be of such a small value that it can be neglected.

It will be appreciated that the construction of counter of the high energy radiation kind as shown in Fig. 2 is much simpler than prior art systems. In the first place the second electrode is entirely external of the envelope and therefore there will be no problem of occluded gas to be taken care of in evacuating the envelope. This outer electrode may be applied by coating the outer surface of the tube. Alternatively, the electrode may be arranged to be closely fitted to the outside of the envelope and removably positioned thereon so that cylinders presenting different absorption characteristics may be substituted, providing different sensitivities of the circuit for different types of radiation. The resistance presented by the glass or other material of the envelope will depend on the nature of the glass or the other material used. This resistance may be considerably higher than the resistance conventionally used but as this value is not critical to the operation of the system the counter operates as well as the more conventional types.

Turning now to Fig. 4, there is illustrated a modification of my invention wherein a plurality of second or outer electrodes is used. This counter may comprise a first electrode 1 extending throughout the length of a cylindrical envelope 3. As in Fig. 2 a source of potential 4 is connected with its positive terminal to electrode 1. Externally of the envelope are provided the second electrodes 14, 15 and 16 each presenting different absorption characteristics in high energy radiation. As illustrated electrodes 14, 15 and 16 are made of different thicknesses of the same metal so that penetration of the high energy rays will be different for the different electrodes.

Instead of using different thickness of the same metal, metals of different inherent penetration characteristics may be used. Connected respectively to electrodes 14, 15 and 16 are terminals 17, 18 and 19 arranged to be selectively included in circuit with electrode 1 and source 4, by means of a movable switch arm 20. The output condenser 12 and counting device 8 are coupled between electrode 1 and selected ones of electrodes 14, 15 and 16 along with potential source 4. It will be apparent that with this arrangement radiation particles of varying velocities can be measured independently and thus a spectrum analysis of high energy radiation can be achieved. It will be clear that more than the three separate electrodes shown may be provided as desired.

In Fig. 5 is shown an alternate counting tube structure comprising again a first electrode 1 extending through the length of an envelope 3. Envelope 3 however is made in a plurality of sections having different diameters as indicated by portions 21, 22 and 23. Associated with the respective sections 21, 22 and 23 are second electrodes 24, 25 and 26, respectively. These electrodes may be of the same material and the same thickness. However since the radial spacing between electrode 1 and the respective electrodes 24, 25 and 26 is different there will be a different potential presented thereto from the same voltage source connected thereacross. This tube may be connected in circuit in the same manner as shown in Fig. 4. As the switch 20 is in contact with the different terminals 17, 18 and 19 the different sensitivity of resistance in the counting device 8 will occur.

It will be clear that the different sensitivities can similarly be achieved with a structure similar to Fig. 4 wherein the electrodes all have the same penetration resistance but wherein the switch connects a different potential selectively across the electrode pairs. It will furthermore be clear that the principles of varying sensitivity or variable penetration effects outlined in Figs. 4 and 5 are also applicable to high radiation counters of the conventional type wherein the electrodes are mounted within the envelope or form a portion of the envelope itself.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. A Geiger-Muller type counter comprising a gas-tight tubular envelope of dielectric material containing an ionizable gas, a first electrode comprising a linear conductor within said envelope and extending outside thereof, a second electrode comprising a metal cylinder having a given absorption characteristic for particle rays, disposed about the outer surface of said envelope concentric with said first electrode and in contact with the outer wall of said envelope, one of said electrodes being a cathode and the other an anode, said second electrode being removably mounted whereby electrodes of different absorption characteristics may be substituted, and an operating circuit therefor consisting essentially of a source of potential connected directly between said first and second electrodes, said first and second electrodes and the wall of said envelope being part of said circuit, and a counting device coupled between said electrodes.

2. A counter according to claim 1, wherein said envelope is relatively long, said first electrode extending substantially along the entire length thereof, and said second electrode is short in length relative to said envelope, further comprising a third electrode of different absorption characteristics similarly mounted on the outer surface of said envelope in spaced relation to said second electrode and means for coupling said third electrode into said circuit.

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