March 29, 1949. R. SMOLUCHOWSKI 2,465,821

THIN-WALLED GEIGER-MULLER COUNTER

Filed May 31, 1946

Fig. 1.

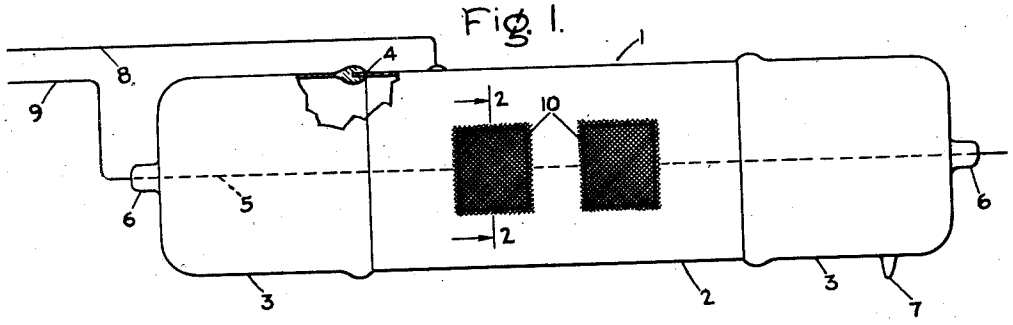


Fig. 3.

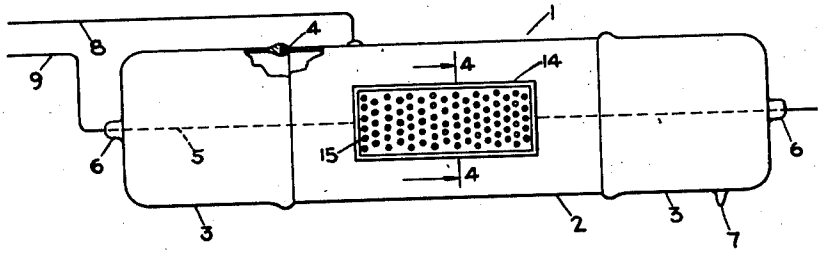


Fig. 2.

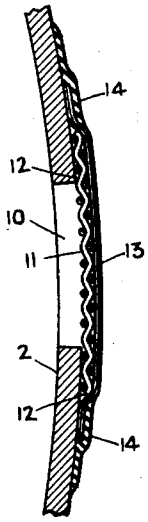
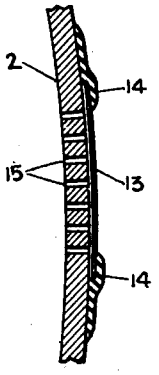


Fig. 4.



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2,465,821

THIN-WALLED GEIGER-MÜLLER COUNTER

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Application May 31, 1946, Serial No. 673,419

3 Claims. (Cl. 250—83.6)

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My invention relates to an improved apparatus for measuring radioactivity and more particularly to an improved Geiger-Müller counter for use through a greatly extended range of energies.

The alpha, beta, and gamma particles emitted by radioactive substances possess energy respectively to an extent dependent upon the radioactive characteristics of the substance from which they are emitted. This energy is usually expressed in terms of electron volts. For example, beta particles emitted from one isotope of sulphur possess an energy of 107,000 electron volts while beta particles emitted from one isotope of argon possess an energy of 4,400,000 electron volts.

Since this energy is absorbed by the medium through which the particles travel, the length of travel depends upon the initial energy and the nature of the medium traversed. The energy which a beta particle at the surface of a material must possess in order to penetrate a given thickness of the material may be determined by considering the molecular densities of the material and of aluminum and the known absorption values in the latter. If measurement of beta particles of low energy is to be made, the total absorption along the path from the radioactive substance to the measuring device must be low.

The enclosing walls of a Geiger-Müller counter must be structurally sufficient to withstand the pressure differential between atmospheric pressure and the pressure within the partially evacuated interior. To render it operative, however, the enclosing wall must include a portion thin enough to allow the radiations from radioactive substances to penetrate it. In the past, Geiger-Müller counters have been provided with such windows but the windows themselves have been too thick to allow the low energy level radiations to penetrate even though the high energy level radiations may. Many radioactive substances such as sulphur, calcium and others emit low energy radiations and in cases such as measuring the diffusion rate of sulphur along grain boundaries and surfaces of metals, it is important that these low energy radiations may be detected and counted. Heretofore, this has been made possible only by placing the material under study directly within the enclosure of the Geiger counter after which evacuation must take place before the instrument is again operative. Disadvantages of such a method are evident. Accordingly, it is an object of my invention to provide an improved Geiger-Müller counter possessing windows through which low level radiations may penetrate.

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It is a further object of my invention to provide an improved Geiger-Müller counter which responds to radiations of a wider range of energies than heretofore provided.

It is a still further object of my invention to provide a compact and easily movable instrument for detecting low energy radiations which may easily be placed very close to the subject being studied. This advantage is particularly valuable in the study of low energy radiations since they are dissipated within very short distances through air.

The features of the invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of the invention, reference is made in the following description to the accompanying drawings in which Fig. 1 is a partially cutaway front view of a Geiger-Müller counter provided with a plurality of windows constructed in accordance with my invention, Fig. 2 is an enlarged cross-sectional view along the line 2—2 of Fig. 1 showing in detail the structure of the windows, Fig. 3 is a front view of a Geiger-Müller counter provided with another embodiment of my invention, and Fig. 4 is an enlarged cross-sectional view along the line 4—4 of Fig. 3.

The objects of my invention may be carried out by providing a plurality of windows in the enclosing wall of a Geiger-Müller counter, each window being of such small area that sufficient support is offered to allow the use of extremely thin material for rendering the windows gastight.

Referring now to the drawing, Figs. 1 and 3 show a Geiger-Müller counter 1 with a cylindrical cathode 2, preferably of an iron nickel cobalt alloy commonly known as fernico, forming a substantial part of the enclosure casing and to which glass end bells 3 are attached as by a gastight glass to metal joint 4. The anode 5 is a straight wire through the axis of the cathode cylinder and supported by the glass seals 6. An opening at 7 is provided whereby the enclosure may be evacuated to the proper amount and then sealed, or it may remain connected to a vacuum pump, not shown, by which the degree of evacuation can be controlled or evacuated from time to time in case of slow leaks. Leads 8 and 9 to a registering device, not shown, are attached to the cathode 2 and anode 5 respectively.

In Fig. 1 a plurality of rectangular openings 10 are provided in the wall of the cylindrical cathode 2 over which are placed the window structures shown in enlarged detail in Fig. 2 and described by reference thereto. The number,

spacing, and arrangement of these openings may obviously be varied in any desired fashion as long as sufficient supporting cathode structure remains between adjacent openings.

The details of the window structure may be described by reference to Fig. 2 wherein a cross-sectional portion of the cathode 2 is taken through the opening 10 along the line 2—2 of Fig. 1. A metal net or screen 11, preferably of copper, covers the opening 10 and is soft soldered to the cathode structure around the edges of opening 10. Screen 11 may have a large enough area to cover all of the plurality of openings provided in the cathode 2. In any case, it is desirable to attach it to the cathode external surface along the edges of each opening which it covers. The soft solder bond as at 12 should be smooth with no sharply irregular surfaces. The external side of net 11 is covered by extremely thin gastight sheets 13 of material prepared in a manner to be described. The edges of these sheets extend beyond the net 11 and are attached to the cathode surface by rubber cement 14 or other suitable bonding material. Thus an essentially gastight enclosure for the Geiger-Müller counter results which possesses a multiplicity of small areas wherein the exterior and interior are separated by an extremely thin sheet of material easily traversed by low energy radiations from radioactive substances. The number of sheets or their total thickness will be determined by the size of openings in net 11 and by the degree of evacuation to be used. I have employed a 500 mesh copper net and sheets totaling 1 to 1½ microns in thickness with satisfactory results while using an internal pressure of 4 to 5 cm. of mercury.

A multiplicity of windows covered only by the extremely thin sheets may also be obtained by utilizing the structure shown in Figs. 3 and 4. Referring to Fig. 3, a Geiger-Müller counter is shown with its principal parts numbered as in Fig. 1. A multiplicity of small holes 15 in the cathode wall are separated only sufficiently to retain structural rigidity of the cathode wall. Extremely thin sheets 13 are placed over the area covered by the holes and rubber cement 14 or other suitable bonding agent used along the edges. This structure is more clearly shown in Fig. 4 in which the various portions retain the same numbers as in Fig. 3. If a structure of this type is utilized, I have found that sheets as thin as .5 micron may be used with holes of 40 mils diameter.

Preferably, I employ the substance polyvinylformal in extremely thin sheets in the construction of a thin-walled Geiger-Müller counter. Polyvinylformal is easily formed into thin sheets and its beta radiation energy absorption is low, being only about 2,000 electron volts per micron at 30,000 to 50,000 electron volts energy radiations or one micron is essentially equivalent in absorption to .6 millimeter of air. These sheets were obtained in the following manner. Polyvinylformal was dissolved in ethylene dichloride to form a solution of approximately one per cent concentration. A clean glass plate was covered

by the solution and allowed to dry. When dry, the thin coating was cut along a line near one edge of the plate. If the plate is slowly immersed into water with its coated side up and if the edge near which the coating was cut is the first to be immersed, the coating will be freed from the glass plate and will float as a sheet upon the surface of the water. This was done and the sheet transferred to the proper portion of the cathode structure by allowing contact of one edge of the sheet with the cathode structure to which it will adhere and then essentially rolling the counter tube over the floating sheet thereby picking it up in proper position over the cathode window structure. Each sheet is similarly obtained and transferred to its proper position upon the window area of the cathode.

As will occur to those skilled in the art, various different arrangements and combinations of the principles described above may be employed without departing from the true spirit and scope of the invention and I therefore do not wish to limit my invention to the particular arrangement described.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a Geiger-Müller counter, a tubular cathode, an anode wire extending along the axis of said cathode, members hermetically closing the ends of said cathode and supporting said anode wire, and at least one window in said cathode, said window being covered by a sheet of polyvinylformal having a thickness not exceeding 1½ microns.

2. In a Geiger-Müller counter, a cathode, an anode, an envelope hermetically enclosing said electrodes, and a plurality of radiation permeable windows comprising a portion of said envelope, said windows comprising a reinforcing mesh covered by a sheet of polyvinylformal having a thickness not exceeding 1½ microns.

3. In a Geiger-Müller counter, a tubular cathode having at least one small opening in a portion of the wall thereof, an anode wire extending along the axis of said cathode, members hermetically closing the ends of said cathode and supporting said anode wire, and a thin sheet of polyvinylformal totaling ½ to 1½ microns in thickness affixed to the exterior surface of said cathode and covering said opening therein and in gastight relation thereto.

ROMAN SMOLUCHOWSKI.

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