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PROPORTIONAL COUNTER TUBE

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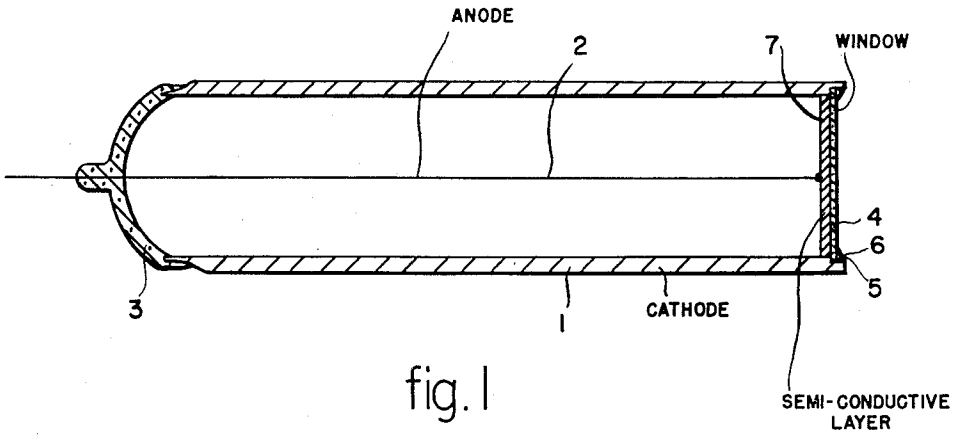


fig. 1

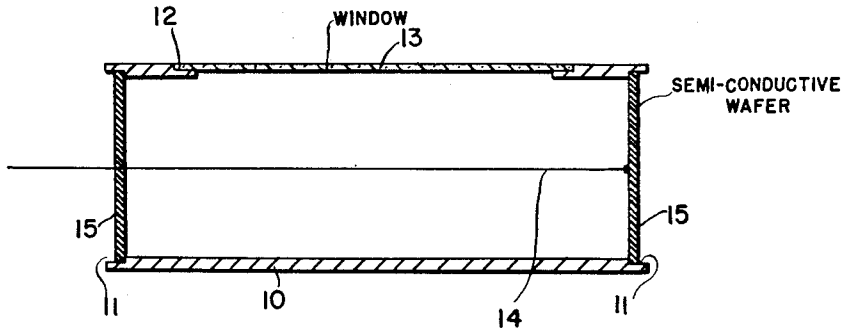


fig. 2

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PROPORTIONAL COUNTER TUBE

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6 Claims. (Cl. 313—93)

This invention relates to proportional counters.

Known counter tubes, which may function quite well as Geiger counters, are generally not useful in the proportional region of their discharge characteristic because of the strong electric field distortion in the region adjacent their window, through which radiation enters the tube. Due to this distortion, absorption events occurring in that region are not subject to the same amplification as events occurring elsewhere, with the consequence that the tube will exhibit a broadened, i. e., smeared, pulse height distribution for monochromatic incident radiation.

The chief object of the invention is to reduce the distortion of the electric field in the region adjacent the window of a proportional counter, and thereby improve the operation of the counter.

In accordance with one aspect of the invention, a thin, radiation-transparent, semi-conductive film is provided on the inside surface of an end window of a counter tube, and electrical contact is effected between the periphery of the film and the cathode, and between the center of the film and the anode, whereby the electric field in the region of the window is made to approximate that existing in the interior of the tube.

In accordance with a further aspect of the invention, the electric field distortion in the vicinity of a relatively short, side-window, proportional counter is reduced by constructing the end walls of the counter from thin, semi-conductive wafers electrically connected to the anode and cathode of the counter.

The invention will now be described in connection with the accompanying drawing, wherein:

Figure 1 is a cross-sectional view of an end-window proportional counter in accordance with the invention;

Fig. 2 is a cross-sectional view of a side-window proportional counter in accordance with the invention.

Referring now to Fig. 1 of the drawing, an end-window counter of the invention comprises a cylindrical metal shell **1**, serving as a cathode, surrounding a central anode wire **2**. One end of the shell **1** is sealed-off by a glass member **3** which also serves to support the anode wire in position. The other end of the shell **1** is closed off by a thin, X-ray transparent window **4**, e. g., mica, seated in a recess **5** formed in the end of the shell **1** and glass-sealed thereto at **6**. The interior of the tube is filled with any one of many well-known gas fillings for such tubes, for example, a rare gas and an organic quench, such as 90% of argon and 10% methane at a combined pressure of about 300 mm. of Hg. By reason of the window and gas filling, the tube is made responsive to low-energy X-radiation.

The inside surface of the window **4** is coated with a thin film **7** of a semi-conductor material. The film **7**, whose thickness is exaggerated for clarity, is electrically connected to the cathode **1** at its periphery, and to the anode **2** at its center. The former connection is obtained by merely effecting contact engagement between the film **7** and the shell **1**, whereas the latter connection may be

effected by soldering the end of the anode wire **2** to the center of the film **7**.

The film **7** may be constituted of any one of the well-known semi-conductor materials. A material is preferably chosen which exhibits the minimal absorption of X-radiation. The film **7** is made as thin as possible for the same reason. The resistance, thickness and shape of the film are chosen so as to obtain an electric field distribution along the film surface which corresponds to that existing between the cathode and anode in the interior of the tube. To that end, it has been found that such a distribution is obtained when the film is uniformly thick throughout its area and is electrically connected to the anode wire and the entire surface of the surrounding cathode shell. The overall resistance of the film between cathode an anode connections should be maintained high, inasmuch as relatively high potentials of the order of 1000 volts or more are commonly impressed between the cathode and anode, and the leakage current through the film should be maintained as small as possible to reduce the drain on the power supply in order not to affect its stability. On the other hand, the overall resistance should not be too high as the noise inherent in this film resistor might produce voltages whose magnitude would obliterate or otherwise interfere with signal voltages produced upon the absorption of the incident radiation. A compromise between these two contradictory requirements is obtained with resistance values between about 10^6 and 10^{10} ohms. As long as the overall resistance of the semi-conductor between the anode and cathode is maintained in this range, the noise voltages will not be excessive, nor will the drain on the power supply exceed the capabilities of commercially-available supplies.

As one illustrative example, a very thin film of a tin oxide semi-conductor is uniformly vapor-deposited on the mica window until the overall resistance in the film between the cathode and anode is about 10^8 ohms. With such a film, the voltage gradient along the surface thereof substantially corresponds to that existing in the interior of the tube between the cathode and anode. Other suitable materials for this purpose are the nickel oxide system, nickel oxide and lithium system, germanium thin films, etc.

Fig. 2 illustrates another embodiment of the invention utilizing the principles set forth above in a side-window proportional counter. In such counters, though most of the absorption events occur in the vicinity of the window, the length of the counter is usually chosen at least three times the length of the window in order to reduce the effects of the electric field distortion existing at the ends of the counter in the absorption or active region. However, by constructing the ends of the counter of semi-conducting wafers in accordance with the invention, the electric field along the surface thereof can be made to approximate that existing at the window, and thus the ends of the counter may be placed closer to the window, thereby effecting a material reduction in the overall length thereof.

Such a construction is illustrated in Fig. 2 and comprises a cylindrical metal shell **10** having recesses **11** at opposite ends and a recess **12** at the center thereof. In the center recess **12** is sealed a mica window **13**, the underside of which may be coated with a conductive layer (not shown) electrically connected to the shell **10**, which serves as the cathode. A central anode wire **14** extends through the shell **10**.

In the recesses **11** at opposite ends of the shell **10**, there is provided a pair of semi-conductive wafers **15** which are vacuum-tight sealed to the shell **10**. The wafer at the right is electrically connected at its periphery to the shell **10** and at its center to wire **14**. The wafer at the left is similarly electrically connected to the shell **10** and the

wire 14, though the wire 14 extends in this case through the wafer. The aperture in the wafer through which the wire passes is sealed-off in an air-tight manner. In a manner similar to that described in connection with Fig. 1, the overall resistance of both of the wafers from the anode to the cathode is chosen in the range of 10^6 to 10^{10} ohms, and the wafers may be uniform in thickness. With such a construction, the electric field distribution along the inner surface of the wafers will approximately correspond to that existing between the cathode and anode in the vicinity of the window; hence, the wafers may be positioned rather close to the window without affecting the desired operation of the counter, to thereby effect a material reduction in the overall length of the counter. The counter may be filled with a conventional gas filling of argon and an organic quench.

While we have described our invention in connection with specific embodiments and applications, other modifications thereof will be readily apparent to those skilled in this art without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A proportional counter comprising a central anode wire, a cylindrical cathode surrounding said anode wire, a radiation-transparent window in said counter, and a thin semi-conductive member in the vicinity of said window, said member being electrically connected at its periphery to the cathode and at its center to the anode, said member having an overall resistance between its center and periphery of between about 10^6 and 10^{10} ohms.

2. A counter as claimed in claim 1 wherein the anode wire is soldered to the center of the semi-conductive member, and the member has a uniform thickness.

3. A proportional counter comprising a cylindrical cathode member, a central anode wire within said cathode, an X-ray transparent window at one end of said counter, and a thin X-ray transparent semi-conductive film on the inside surface of said window, said film being electrically connected at its periphery to the cathode and at its center to the anode, said film being of uniform thickness and having an overall resistance between its center and periphery of between about 10^6 and 10^{10} ohms.

4. A proportional counter comprising a cylindrical cathode member, a central anode wire disposed within said cathode, an X-ray transparent side window disposed in a side wall of said cathode, and a semi-conductive wafer sealing off one end of said counter, said wafer being electrically connected at its periphery to said cathode and at its center to said anode, the overall resistance of the wafer from its center to its periphery being between about 10^6 and 10^{10} ohms, and the wafer being uniformly thick.

5. A counter as claimed in claim 4 wherein a pair of semi-conductive wafers seal off opposite ends of the counter.

6. An X-ray-responsive proportional counter tube comprising an envelope containing an X-radiation-absorbing gaseous medium, concentric cathode and anode electrodes between which a potential is applied to establish an electric field therebetween, a radiation-transparent window portion in the envelope to permit radiation to enter the counter, and a thin, semi-conductive member in the vicinity of said window portion and electrically connected to the cathode and anode electrodes and exhibiting between these connections a resistance between 10^6 and 10^{10} ohms, thereby to minimize any distortion of the electric field in the vicinity of the window portion.

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