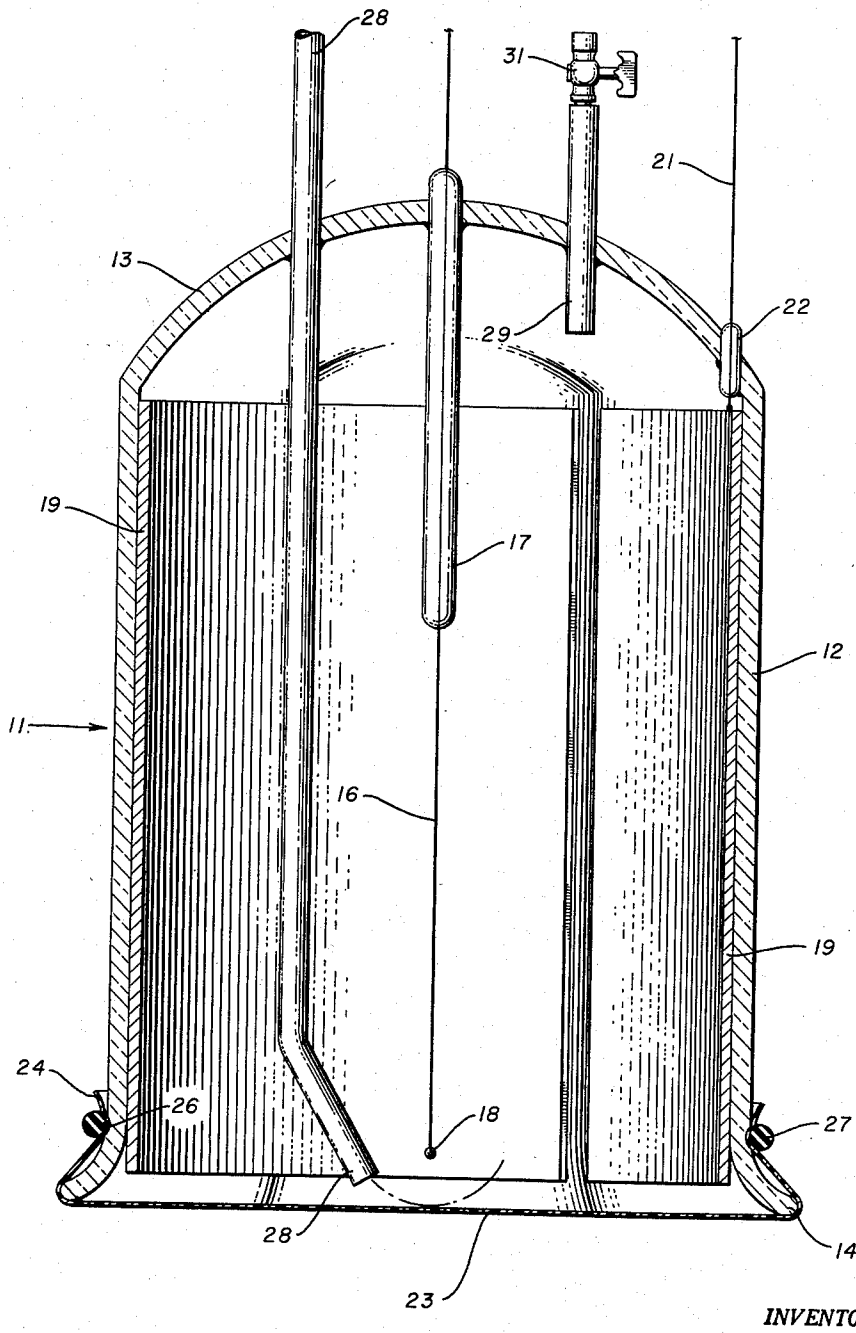
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LOW ENERGY COUNTING CHAMBERS

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LOW ENERGY COUNTING CHAMBERS

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1 Claim. (Cl. 313—93)

This invention relates, in general, to a superior means for introducing low energy beta particles into a counting chamber and, more particularly, to window means for such a chamber which provides for the more efficient counting of low energy beta particles and increased functional reliability.

In conventional practice, diverse types of ionization chambers and counting tubes are employed for the detection and determination of ionizing radiation quantities. These devices generally comprise a closed chamber wherein there is disposed two electrode surfaces of various configurations. Usually, one electrode is suspended centrally within the chamber and the other is arranged to at least partially encircle the first.

For measurement and counting of low energy radiation, especially low energy beta particles (energetic electrons), the structure of the ionization chamber or counter tube (proportional or Geiger Müller) usually is bell-shaped. The walls may be made of metal to serve as one electrode and the central electrode may be supported by a vacuum tight feed-through insulator disposed in the wall. Operating conditions depend on the type of gas filling and a variety of electrical circuits may be employed therewith in accordance with established practice.

To adapt such a chamber for the detection and counting of low energy beta particles, the mouth of the chamber is provided with a covering of a material which has as low as possible absorptivity for beta radiation. Also, the covering is made as thin as possible for the same reason. Thin mica sheets and thin films of various plastics such as cellophane, polyamide and polyethylene resins have been employed heretofore; however, these materials leave much to be desired from the standpoint of durability, ease of mounting and radiation transmission characteristics. Conventionally, these covered openings are termed "windows" to indicate the relatively low absorption characteristic or radiation transparency thereof for beta radiation as compared to the remainder of the chamber walls. It will be understood that these "windows" are a special adaption of counter tubes and chambers to provide for the better measurement and detection of low-energy beta radiation.

It has now been discovered that remarkably superior "windows" for low energy beta radiation counting devices, of the character described, are provided by utilizing thin films of a polyester resin formed by the condensation of ethylene glycol and terephthalic acid. Such resin film can be fabricated in very thin dimensions which, taken together with excellent radiation transparency characteristics of the material, allows a much larger proportion of low energy beta particles to pass therethrough as compared with previous materials. Moreover, the excellent mechanical characteristics of the film permits improvements in the structure, durability and ease of repair of the counting chamber.

Accordingly, it is an object of the invention to provide an ionization chamber which is superior for the detection and counting of low energy ionizing radiation.

Another object of the invention is to provide a more durable beta radiation transparent window for an ionization chamber used for detecting and counting low energy beta radiation.

Still another object of the invention is to utilize films prepared from polyester resins of the ethylene glycol-terephthalate type for fabricating the windows of ionization chambers.

A further object of the invention is to provide a window for ionization chambers which is thin and of low absorptive density and is thereby of relatively high transparency to low energy beta radiation.

A still further object of the invention is to provide a high radiation transparency window for ionization chambers which is relatively rugged and resistant to perforation or abrasive contact with radiation emitting surfaces.

One other object of the invention is to provide an ionization chamber structure in which the window may be easily and economically mounted or replaced.

Other objects and advantages will be apparent from the following description taken in conjunction with the accompanying drawing of which the single figure is a sectional view of an ionization chamber constructed in accordance with the invention.

Basically, the ionization chamber of the invention is provided as a cup-like enclosure having a centrally disposed anode and a radially disposed cathode element which is similar to those customarily employed in the art. However, there is herein provided a novel covering for the end window opening of such enclosure including novel means for mounting and other details of construction providing advantageous operational features.

Constructional details of a practical embodiment of the invention will now be described with reference to the single figure of the drawing. As illustrated therein, the ionization chamber is provided with a cup-like enclosure **11** having an elongated generally cylindrical central section **12**, closed at the upper end with a concave closure cap **13** and having the lower end flared outwardly to provide an enlarged rounded rim section **14**. The enclosure **11** may be constructed of an appropriate dielectric material such as glass. Ordinarily the enclosure walls will be of sufficient thickness to be effectively opaque to beta radiation.

An anode wire **16** is supported coaxially within the enclosure section **12** by means of a glass stem **17** which encases a portion thereof, said glass stem **17** being fused to the inner wall of cap **13**. The upper end of anode wire **16** is lead exteriorly of the cap **13** for attachment to an external counter circuit (not shown). The lower end of anode **16** which terminates near the terminal plane of the rim section **14** of the enclosure **11** is encased in a fused glass bead **18** to prevent spurious discharges and corona effects. Accordingly, a substantial length of anode **16** extends coaxially within the lower length of enclosure section **12**. A cylinder **19** formed of copper sheet and split lengthwise is disposed in proximity to the walls within enclosure section **12** and extending coextensively therewith to serve as the cathode element noted above. A conductor **21** is attached to the upper edge of the cathode cylinder **19** and lead exteriorly through a seal **22** for attachment to the external counting circuit as noted above.

To provide the window for the chamber, a thin film **23** of the aforesaid polyester resin is stretched over the enlarged rim section **14** of the enclosure with the excess edge portions **24** folded back over the lower outer surface of the enclosure section **12**. The film **23** may be secured by clamping the folded portion **24** of the film to the outer surface of the enclosure section **12** by appropriate means. A preferred method of securing the

film is provided by forming a peripheral groove 26 in the exterior surface of the enclosure 11 in the region of the juncture of the flared rim 14 and the enclosure portion 12, whereby the folded portion 24 of the film extends thereover. An elastic member such as the O-ring 27 is disposed to clamp the film portion 24 tightly into the groove 26 and thereby effect an efficient seal.

Under certain circumstances the ionization chamber may utilize ordinary air or nitrogen gas fillings; however, in order to allow operation with lower voltages, it is preferred to employ a rare gas such as helium or argon therein. Alternatively, it is preferred to operate in the Geiger-Müller region and to employ a self-quenching gas mixture therein as in conventional practice. In this case appropriate gas mixture such as helium or argon with various organic vapors including low molecular weight aliphatic hydrocarbons, alcohols, chlorinated hydrocarbons or halogens are employed as the filling material.

To obtain maximum sensitivity, the film is made as thin as possible and films of as thin as 0.00025 inch are available commercially under the trade name "Mylar" of the Du Pont Company. Mylar film is prepared from a polyester resin which is produced by the condensation of ethylene glycol with terephthalic acid and is known by the chemical name, polyethylene terephthalate. A counterpart of this material is supplied, also by a British concern. Several analogous materials may be made by condensing various other polyhydric alcohols with terephthalic acid and should yield comparable results.

When a self-quenching gas mixture is employed in the chamber and when the film 23 is of the thinnest practical dimensions (ca. 0.25 mil.), it has been found that air diffuses through the film 23 in sufficient quantities to disturb the operating characteristics of the chamber. Accordingly, there is provided an outwardly extending conduit tube 28 sealed into the chamber cap 13 so as to terminate near the inner surface of film 23, whereby a flushing current of the selected filling gas mixture may be directed to impinge upon the inner surface of film 23 in the region beneath the beaded tip 18 of the anode wire 16. A stub conduit tube 29 is sealed into the cap 13 to provide exit means for the flushing gas and a stopcock 31 may be affixed to the tube 29 for closure purposes in the event that intermittent flushing is employed. Sufficient positive gas pressure is supplied by an external source (not shown) to effect flushing but insufficient to distort or rupture the film 23.

In an operating embodiment employing a sheet of Mylar resin 0.00025 inch in thickness as the window film 23 and with appropriate anode voltages applied between anode wire 16 and cathode cylinder 19 to effect operation in the Geiger region, counting efficiencies of above 20% of the beta particles emitted by carbon 14 have been obtained. Under comparable conditions the best available mica window chambers yielded a maximum of 14% mounting efficiency. Other advantages also were obtained including durability in services requiring rubbing and scraping contact with rough surfaces being monitored or scanned as in paper chromatography tracer applications in which there is inadvertent but frequent contact with sharp edges, corners, etc. A gas mixture of helium and butane was used in a ratio of about 100:1 and conventional electronic counting circuits were employed. Moreover, the essentially plane configuration of the window construction permits the closest possible contact with plane surfaces thereby permitting the best counting geometry. In the event of contamination the window film 23 is quickly and economically replaced.

While there has been described in the foregoing what may be considered to be preferred embodiments of the invention, various modifications may be made therein without departing from the teachings of the invention and it is therefore intended to cover all such as fall within the scope of the appended claim.

What is claimed is:

An ionization chamber for use in counting low energy beta radiation comprising a cup-like enclosure having a cylindrical central section, being closed at one end by a cap, having a flared rim at the other extremity defining a planar terminal opening with exterior surfaces of said enclosure being grooved radially, a conductive cylindrical cathode sheath disposed in said central enclosure section, an anode wire sealed into said enclosure caps and disposed coaxially within said cathode sheath, a film of polyethylene terephthalate stretched over said planar enclosure opening and overlapping the groove in said exterior enclosure surface, a bond of extensible material clamping said film into said groove, tubular conduit means for directing an ionizable gas on inner surfaces of said film, and means for exhausting gas from said enclosure.

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