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RADIATION COUNTER TUBE

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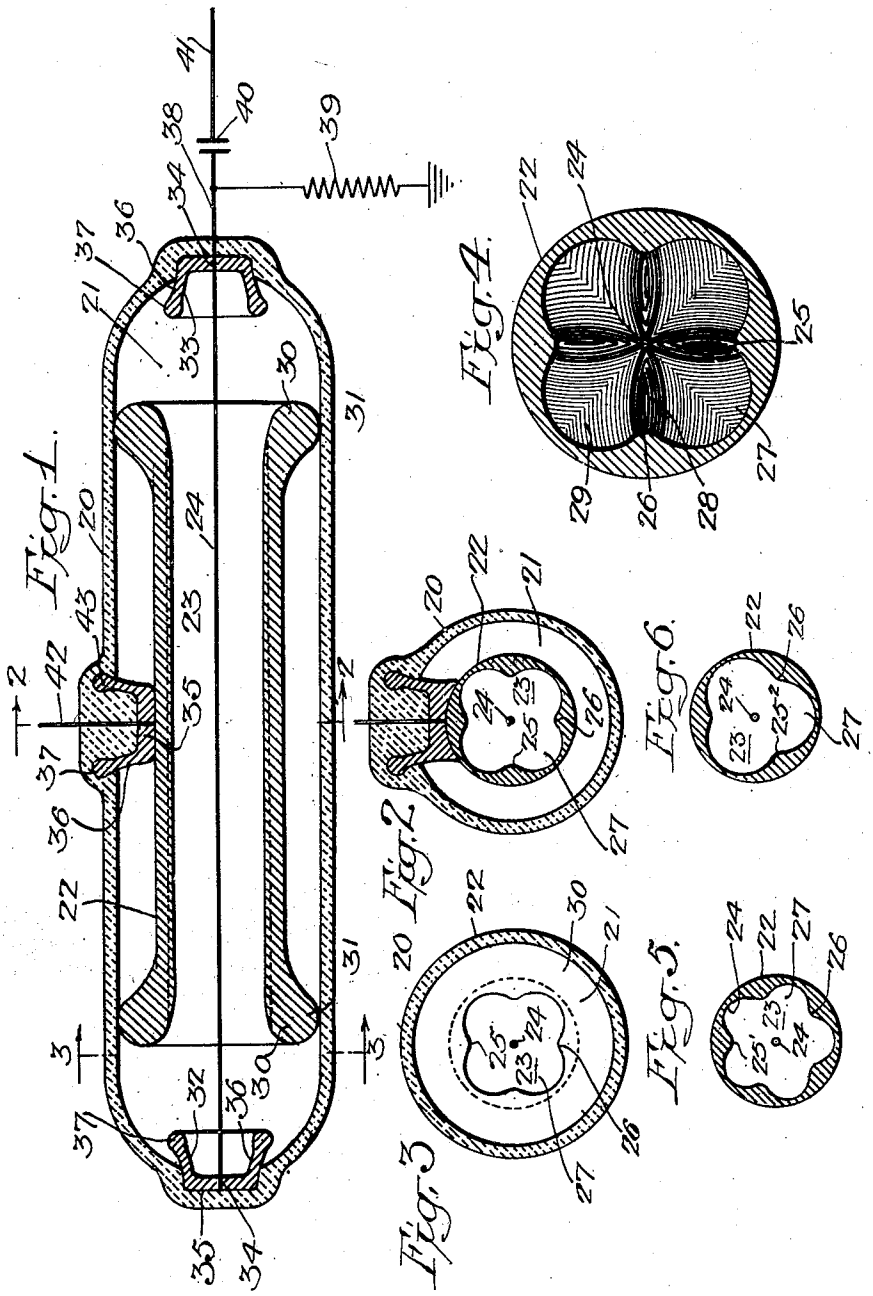


Fig. 1.

Fig. 4.

Fig. 2.

Fig. 6.

Fig. 3.

Fig. 5.

INVENTOR
Frank E. Dudley.
BY
Dalsa and Dalsa
ATTORNEYS

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RADIATION COUNTER TUBE

Frank E. Dudley, Philadelphia, Pa.

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6 Claims. (Cl. 250—27.5)

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My invention relates to radiation counter tubes of the type used for indicating, measuring or counting radiations.

A purpose of my invention is to increase the sensitivity of radiation counter tubes, particularly when operating at moderate voltages.

A further purpose is to reduce the energy losses in radiation counter tubes to a minimum.

A further purpose is to produce equidistant bands or zones of increased intensity, and intermediate and preferably gradating bands of low intensity, in the field of an electron counter tube, desirably due to equidistant internal bands and grooves on a tubular electrode.

A further purpose is to provide, at the ends of the tubular electrode, annular enlargements of arcuate cross section on a radius not less than five times the minimum thickness of the tubular electrode, and preferably outwardly belled.

A further purpose is to provide metalic cup-like bushings where the leads enter the envelope on the inside, and preferably to arcuately thicken the lips of the cups.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, choosing the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a central longitudinal section of a radiation counter tube in accordance with the present invention.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a section on the line 3—3 of Figure 1.

Figure 4 is an enlarged section corresponding in position to Figure 2, omitting the leads and envelope, and showing a diagram of the flux distribution.

Figures 5 and 6 are views corresponding to Figure 2, omitting the leads and envelope and showing variations.

In the drawings like numerals refer to like parts throughout.

In the prior art radiation counter tubes have been widely used for counting, indicating or measuring radiations due to natural or artificial radioactivity. The most common type of such tubes have included an envelope (suitably of glass) containing a gaseous medium at suitable pressure, with leads running through the envelope to electrodes. One electrode (the cathode)

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is ordinarily tubular, while the other electrode (the anode) is ordinarily of rod or wire form extending centrally through the tubular electrode. The gaseous medium in the envelope usually is helium, neon, argon, nitrogen, hydrogen, argon and hydrogen, neon and hydrogen, argon and oxygen or one of these gases with an organic vapor.

For high sensitivity such prior art tubes have normally required a high voltage and heavy auxiliary equipment incident to the high voltage and the necessary associated mechanism. The portability of such equipment has therefore been limited and the device has in every case been a major item of equipment, and not merely an incidental pocket device which could be carried as ordinary equipment by a man in the field the way he carries his watch or pocket knife. The energy losses in such prior art radiation counter tubes have been so great that a portable source such as a battery was not suitable unless it had a considerable energy rating, necessitating rather bulky battery sources.

In accordance with the present invention, the sensitivity of the tube has been greatly increased, particularly when operating at moderate or low voltages, and the energy losses have been reduced so that the tube can operate on a very moderate wattage. By this procedure the weight of the equipment, especially the auxiliary equipment such as batteries, has been greatly reduced without sacrificing sensitivity or service life.

At the same time, important savings are made both in cost of manufacture and in cost of maintaining radiation counter devices.

The radiation counter tube of the invention comprises an envelope 20 suitably of glass, and permissibly having special windows (not shown) as well known in the art for admission of particular radiations. The space 21 inside the tube is occupied by a gas at a suitably low pressure as above referred to in accordance with prior art practice. In many cases the gas pressure will be about one-tenth atmosphere. A tubular electrode (cathode) 22 extends longitudinally of the tube, and has an internal longitudinal passage 23 across which an electrostatic field is applied as later explained. The tubular electrode 22 is conveniently of copper or a copper base alloy as well known. Centrally located within the tubular electrode and extending longitudinally thereof is a wire or rod electrode (anode) 24 insulated from the tubular electrode by the glass or other envelope. The central electrode 24 may conveniently be of tungsten as in the prior art.

An important feature of the invention is the construction of the interior surface and the ends of the tubular electrode. Extending straight (parallel to the axis) and longitudinally from end to end on the interior of the tubular electrode are ribs 25 equidistant from one another around the tube. In the form of Figures 1 to 4, inclusive, four such ribs are shown spaced 90° apart, while in the form of Figure 5 there are five equally spaced ribs 25' and in the form of Figure 6 there are three equally spaced ribs 25^2. It will thus be seen that the number of ribs can vary widely but in any case the ribs should be equally spaced. Each rib in cross section is arcuate as indicated at 26 in Figures 2 to 6, so that there is a gradual and not an abrupt gradation of flux density as the side of each rib is approached. Between the ribs are straight longitudinal grooves 27 which again as shown are arcuate in cross section and which gradually merge into the ribs with imperceptible gradations in a smooth or streamlined curve. The curvature of the ribs and curves may vary widely, but it will be evident that in general the arc of curvature of the rib will be on a smaller radius than the arc of curvature of the curve in most cases. The effect of the ribs and curves as thus arranged is to produce generally radial zones of high flux intensity 28 between the electrode, gradually merging into zones of lower flux intensity 29 between the electrodes corresponding to the curve positions (Figure 4).

No matter what angle a radiation beam may have in passing across the space between the electrode, it is certain at some point to encounter a zone of high field intensity 28 and give rise to a pulse which is comparatively high in magnitude for the impressed voltage between the electrodes because of the high flux intensity zones. Thus the counting is more positive, particularly when moderate or low voltages are used. Even in the unlikely circumstances that the radiation might only encounter one of the lower zones of field intensity 29, however, there is some field intensity available to produce an indication even in these areas of low intensity. Thus it will be seen that an extremely intense field can be built up notwithstanding that the voltage is much lower than has been considered good practice in the prior act. Accordingly there is much less danger of missing a count with a field distribution of the character employed in the present invention than with the uniform distribution of the prior art as obtained from a straight tube, or a complicated irregular field distribution obtained in the prior art where irregularities were employed due to use of a screen mesh or of ribs producing a highly irregular broken up field as due to screw threads on the interior of the tubular electrode.

The gradual gradation from high intensity at the ribs to the lower intensity at the grooves is not adequately suggested by Figure 4, since it is not possible to employ the wide variation in line thicknesses which would indicate the very gradual merging of one zone into another which actually occurs.

It has been common practice to bell the ends of the tubular electrode, but I find that notwithstanding such belling there is in the prior art a very unsatisfactory field distribution at the end of the tubular electrode which is conducive to continuous or corona discharge. Such corona discharge not only increases the occurrence of errors in counting, but also materially

adds to the wattage consumption, and reduces the life of batteries which may be employed. It is important not only to bell the interior of the ends of the tubular electrode at 30 as shown, but also to create annular enlargements 31 on the ends on a radius not less than five times the minimum thickness of the wall of the tubular electrode (the thickness at the base of the grooves). For best results the radius of curvature of the cross section of the enlargements at the ends should be not less than ten times the minimum thickness of the wall of the tubular electrode at the base of the grooves. On both sides the annular enlargement should gradually and progressively merge with the electrode wall so that no sharp zone of demarcation will be produced.

The elimination of corona discharge also aids in obtaining a higher field of intensity between the electrodes for a lower voltage.

Both the tubular electrode and the wire electrode should very desirably be polished to the highest possible degree to eliminate localized stresses or corona concentrations which would tend to unbalance the electrical field or cause waste of energy. On the tubular electrode the inside diameter, the outside diameter and all edges should be smooth and polished to eliminate burrs, tool marks and sharp corners. All surfaces should merge on stream lines.

The wire electrodes should likewise be smooth and should be polished to eliminate irregularities. The diameter of the wire electrode can to advantage be of the order of 0.003 inch.

The wire should also be accurately centralized so that it is at the exact axis of the tube as far as possible.

Further in order to eliminate corona, and to avoid undesired field distortion, bushings preferably of cup form and suitably made from copper, nickel or the like, are arranged joining the envelope at points where the electrodes are connected to leads through the envelope or secured to the envelope. Thus at opposite ends of the wire electrode 24 are cup bushings 32 and 33, each having an opening 34 at the center of the base 35 for passing the wire and suitably silver soldering to the wire, and each having a side wall 36 outwardly flaring toward the lip which carries a beadlike annular enlargement 37 on a radius in cross section at least as great as the thickness of the side wall. There is a gradual merging into the bead on both the inside and the outside of the side wall to give a streamlined effect. Beyond the bushing 33 the wire extends through the envelope to make a lead-in 38 which will be connected to a suitable contact not shown. The bushings are suitably sealed in the glass.

The conventional features of the outside circuit are shown connected to the lead-in, and consisting of a resistor 39 connected across to ground and a condenser 40 in series with a lead 41 extending to the counter circuit, which may be of any suitable type.

The tubular electrode is connected to a lead 42 extending through the envelope secured to the electrode in any suitable way as by silver solder not shown. A bushing 43 of the same general character as the bushing previously referred to surrounds the lead 42 with its base 35 suitably soldered to the outside of the tubular electrode, and has its sides 36 and lip 37 embedded in the glass of the envelope. The bushings have the effect of materially reducing corona and cutting down losses in the tube.

It will be understood that there may be special treatment of the electrode surfaces as well known, and this treatment whether oxidation or otherwise forms no part of the present invention but may be used if desired.

In operation a negative voltage is applied to the tubular electrode or cathode, and the wire electrode or anode is connected to an amplifier through the series condenser, and also to ground through the resistor. The value of the negative voltage is adjustable so that it is almost enough to cause brush discharge between the electrodes. In this sensitive state, any particle passing through the tube and liberating one or more ions from the cathode initiates a small gas discharge between the electrodes. This discharge, recorded by the amplifier and counting device, is normally automatically quenched as a result of the lowering of the voltage across the counter by the drop of potential in the resistor. The counter is then sensitive to another radiation beam.

The polarity of the tube may be reversed, making the wire the cathode and the tubular electrode the anode.

It will be evident that in accordance with the present invention the energy required by the tube is small enough so that small batteries or other energy sources can be used, and the sensitive operating condition can be maintained by a lower voltage than has been common in the prior art. In this way high sensitivity can be maintained on an extremely small portable device.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process and structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a radiation counter tube, a tubular electrode having internal equidistant spaced longitudinal ribs of arcuate cross section, a central electrode extending longitudinally through the tubular electrode and an envelope surrounding the electrodes.

2. In a radiation counter tube, a tubular electrode having a plurality of internal equidistant longitudinal ribs of arcuate cross section spaced by arcuate grooves merging into the ribs, a central electrode extending longitudinally through the tubular electrode and an envelope surrounding the electrodes.

3. In a radiation counter tube, a tubular electrode having an annular enlargement on each end which is curved on a radius of curvature in cross section not less than five times the minimum thickness of the tubular electrode wall, a central electrode extending longitudinally within the tubular electrode and an envelope surrounding the electrodes.

4. In a radiation counter tube, a tubular electrode having an annular enlargement on each end which is curved on a radius of curvature in cross section not less than five times the minimum thickness of the tubular electrode wall, the ends at the enlargements being outwardly belled, a central electrode extending longitudinally within the tubular electrode and an envelope surrounding the electrodes.

5. In a radiation counter tube, a tubular electrode, a central electrode extending longitudinally within the tubular electrode, an envelope surrounding the electrodes, metallic leads extending through the envelope to the electrodes and cup-like metallic bushings surrounding the leads at the inside of the envelope, the leads running longitudinally through the bushings.

6. In a radiation counter tube, a tubular electrode, a central electrode extending longitudinally within the tubular electrode, an envelope surrounding the electrodes, leads extending through the envelope to the electrodes and cup-like metallic bushings having arcuate enlargements at the lips of the cups surrounding the leads at the inside of the envelope.

FRANK E. DUDLEY.

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