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METHYLAL QUENCH PROPORTIONAL COUNTER GAS FILLING

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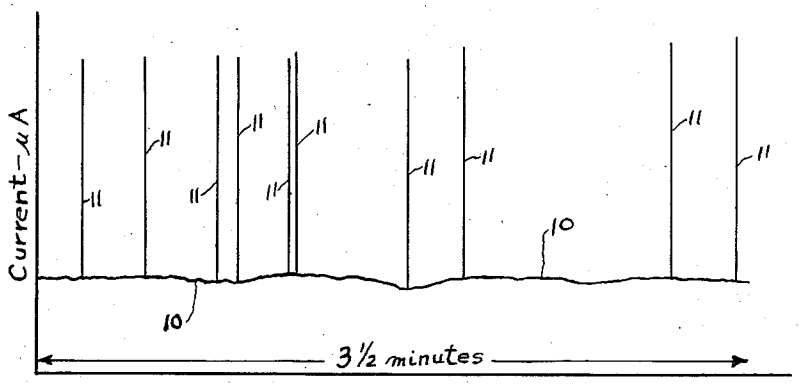


FIG. 1

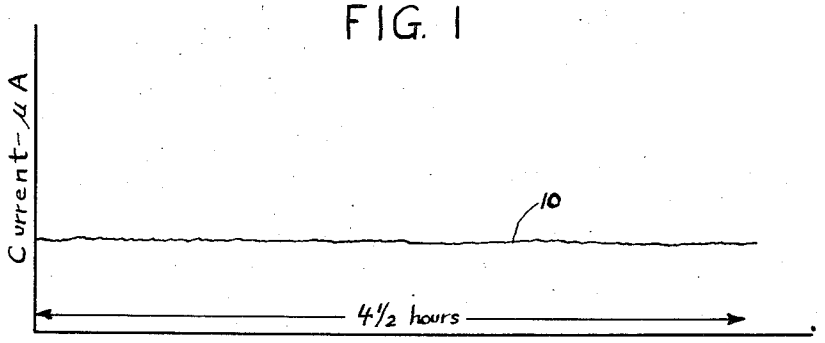


FIG. 2

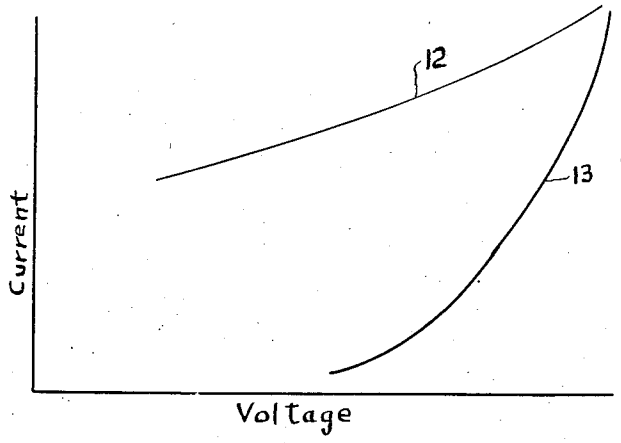


FIG. 3

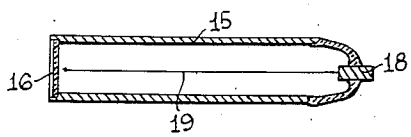


FIG. 4

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METHYLAL QUENCH PROPORTIONAL COUNTER GAS FILLING

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7 Claims. (Cl. 313—93)

This invention relates to gas fillings for proportional counters and in particular to low pressure, methylal-quench, gas fillings for radiation detectors whose output current is an indication of the radiation intensity.

The characteristics required of such a proportional counter are a linear relationship between the current produced at the output of the counter and the intensity of the exciting radiation, a large change in counter current per unit change in radiation intensity, i. e., high sensitivity, a small change in counter current per unit change in applied counter potentials, i. e., a low dI/dV characteristic, and stability. The combination of these features cannot be found in the known proportional counters.

In particular, methylal-quench, rare-gas-filled, proportional counters can be obtained exhibiting all but one of the above characteristics. That is, such counters normall exhibit rather good linearity and sensitivity, and also have excellent dI/dV characteristics. However, they suffer from the drawback of extremely poor stability. Counter tubes filled with methylal-rare-gas fillings are subject to so-called spurious discharges, large erratic current pulses which bear no relationship to the radiation being detected. These spurious discharges cause rapid and violent deflections of the ammeter-indicating-element and render it practically impossible to obtain accurate readings. The frequency of the spurious discharges appears to be quite random. In some tubes, they occur at the rate of one per second. In other tubes, they might occur at the rate of one per hour.

The chief object of the invention is to provide a proportional counter of the methylal-quench-gas filling type which is free of spurious discharges and still exhibits a good dI/dV characteristic.

This and other objects of the invention will be best understood from the following description.

According to the invention, a trace of a halogen or organic halide is added to a gas filling for a proportional counter consisting of a rare gas and methylal. It has been found that this small but significant amount of the halogen or organic halide renders the thus-filled counter tube completely free from spurious discharges without substantially affecting any of its other valuable characteristics.

The amount of the halogen or organic halide added should lie in the range between $\frac{1}{1000}$ mm. and $\frac{1}{10}$ mm. of Hg pressure. Amounts added below the lower limit have been found to have little effect on the spurious discharges produced by the counter; whereas, amounts added above the upper limit causes a significant change in the dI/dV characteristic of the tube with the result that it becomes less suited for most practical applications.

The quantities of the rare gas and the methylal of the tube may be varied over a rather wide range, depending upon the characteristics required of the proportional counter. Thus, mixtures such as argon and methylal, in the range of 90 to 97% of argon to 10 to 3% of

methylal are suitable for detecting X-radiation. In this connection, an especially useful filling in accordance with the invention, which gave excellent results over a long period of time and was easily reproducible, consists of about 97% argon and 3% methylal at a combined pressure of about 313 mm. of Hg, and about $\frac{1}{30}$ mm. of methylene bromide. The total pressure of the gas-filling within the tube for most applications should lie in the range of 200 to 400 mms. of Hg.

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

Figs. 1 and 2 depict, respectively, the output current of a counter containing only argon and methylal and one containing argon, methylal and methylene bromide;

Fig. 3 shows current-voltage curves for a proportional counter containing a gas-filling of the invention, compared to the characteristic of a similar counter containing a gas-filling not in accordance with the invention;

Fig. 4 is a cross-sectional view of a radiation detector or counter containing the gas-filling of the invention.

Figs. 1 and 2 show the effect on the characteristics of a counter upon adding a trace of a halogen or organic halide, in this particular case methylene bromide, to the gas-filling contained therein. Fig. 1 is a curve of the variation with time of the output current of a conventional proportional counter filled only with argon and a methylal quench, excited by a low energy X-ray source. It will be noted that the wavy line 10 at the bottom of the curve represents the average current produced by the counter in response to the X-radiation excitation. The randomly-distributed current pulses 11 represent the spurious discharges occurring within the tube. Each of these pulses 11 are many orders of magnitude larger than the average current 10. Consequently, each of them causes a violent deflection of the microammeter needle.

Fig. 2 illustrates the effect of adding a halogen or organic halide to the tube. All of the spurious discharges were completely eliminated. For purposes of comparison, the curve in Fig. 1 was taken in three and one-half minutes, whereas the curve in Fig. 2 represents a time interval of four and one-half hours.

Fig. 3 shows a graph of proportional counter output current along the ordinate and cathode-anode potential of that counter along the abscissa, curve 12 representing the dI/dV characteristic of a proportional counter containing argon, methylal and methylene bromide at a pressure between $\frac{1}{1000}$ and $\frac{1}{10}$ of a mm. of Hg. The tube containing the aforesaid gas-filling consisted of a conventional, end-window, cylindrical type of proportional counter (Fig. 4) and was excited by a low energy X-ray source. The curve 12, it should be noted, exhibits an excellent dI/dV characteristic. By this is meant that the characteristic is substantially linear and has a rather small slope. This is of advantage from a practical point of view since it places less stringent conditions of regulation on commercially available power supplies for such counters. This follows from the fact that fluctuations in the applied voltage to a tube having a characteristic such as the curve 12 in Fig. 3 of the drawing will have little effect on the output current of that counter. Since a trace of methylene bromide was present within the counter, that tube exhibited absolutely no current fluctuations, thereby indicating the absence of spurious discharges.

Curve 13 is the characteristic produced by the identical tube; however, in this case, the amount of the added halogen or organic halide was above the upper limit of $\frac{1}{10}$ of a mm. of Hg pressure. This tube also exhibited an absence of spurious discharges. However, the slope of 13, the dI/dV characteristic, has sharply increased. Consequently, such a type of tube is strongly voltage-

dependent, and cannot be relied on in commercial equipment to give accurate and reproducible results due to voltage fluctuations in the power supply as a result of line surges or poor filter design, etc.

The rare gases that may be employed in the gas-filling of the invention are the conventional gases, such as neon, argon, krypton and xenon. As for the halogen and organic halides, the only requirement is that they be in a gaseous state at the temperature at which the counter is operated. Such materials would include halogens, such as chlorine and bromine, and organic halides such as aliphatic halides as methylene bromide (CH_2—Br_2) and alkyl chlorides and bromides. The formula of methylal is $CH_2(OCH_3)_2$.

The proportional counter tube of the invention has particular utility as an X-ray detector in connection wtih X-ray spectroscopic and diffraction equipment. The tube is very sensitive and is responsive to copper K-α radiation without requiring extremely sensitive amplifying equipment. The tube is also very stable, and a current-indicating device responsive to currents of the order of microamperes is sufficient to indicate the X-radiation intensity for most purposes. The tube of the invention is also suitable for measuring types of radiation other than X-radiation. Fig. 4 shows a typical tube of the end-window type. It comprises a cylindrical, metal shell **15**, serving as the cathode, sealed off at one end by a radiation-transparent window **16**, such as mica, and by a glass member **17** and metal conductor **18** at the opposite end. A central, anode wire **19** extends through the center of the shell **15** and is supported by the conductor **18**, which constitutes its external terminal. The tube is filled with the gas-filling of the invention described above.

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 claims.

What is claimed is:

1. A gas-filling for a proportional counter discharge tube consisting essentially of a rare gas, methylal, and a trace of a gaseous member selected from the group consisting of halogens and organic halides.

2. A gas-filling for a proportional counter discharge tube consisting essentially of a rare gas, methylal, and a member selected from the group consisting of halogens and organic halides at a pressure between about $\frac{1}{1000}$ and $\frac{1}{10}$ mm. of Hg.

3. A gas-filling for a proportional counter discharge tube consisting essentially of about 90 to 97% of a rare gas, about 10 to 3% of methylal, and methylene bromide at a pressure between about $\frac{1}{1000}$ and $\frac{1}{10}$ of mm. of Hg.

4. A gas-filling for a proportional counter discharge tube consisting essentially of about 90 to 97% of argon, about 10 to 3% of methylal, and methylene bromide at a pressure between about $\frac{1}{1000}$ and $\frac{1}{10}$ of a mm. of Hg.

5. A gas-filling for a proportional counter discharge tube consisting essentially of about 97% of argon, about 3% of methylal, and methylene bromide at a pressure between about $\frac{1}{1000}$ and $\frac{1}{10}$ of a mm. of Hg.

6. A gas-filling as claimed in claim 5 in which the total gas pressure within the tube is in the range of 200 to 400 mms. of Hg.

7. A proportional counter discharge tube comprising a tubular envelope having a conductive surface serving as a cathode, an anode wire disposed within said tubular envelope, and an ionizable gas-filling within said envelope, said gas-filling consisting essentially of a rare gas, methylal, and a trace of a gaseous member selected from the group consisting of halogens and organic halides.

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