

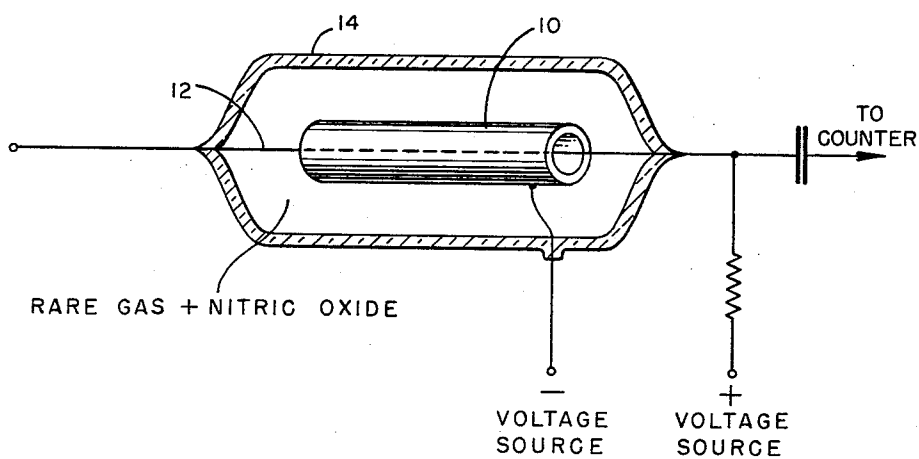
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NITRIC OXIDE COUNTER

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NITRIC OXIDE COUNTER

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This invention relates to Geiger-Mueller tubes and in particular to a Geiger-Mueller tube having extremely long life.

A Geiger-Mueller tube is a diode gas filled tube operated in the region of the unstable corona discharge. There are, in general, two types of Geiger-Mueller tubes. These types are characterized by their filling gases. One type of Geiger-Mueller tube uses simple monatomic or diatomic gases such as hydrogen, air, the rare gases, or mixtures of these gases and is known as a non-self-quenching type tube. The second type of Geiger-Mueller tube is a tube having mixtures of simple gases and small percentages of polyatomic gas "quenching" admixtures. This type of Geiger-Mueller tube is known as a self-quenching tube. It is an object of this invention to provide a novel Geiger-Mueller tube of the self-quenching type which will be characterized by high efficiency, extreme ruggedness and stability and which will have unusually long life.

It is a further object of this invention to provide a novel self-quenching Geiger-Mueller tube having a "quenching" admixture which can be used with any of the well-known cathode structures.

It is a further object of this invention to provide a novel Geiger-Mueller tube whose operation is not affected by long periods of storage and inaction.

It is a further object of this invention to provide a novel self-quenching Geiger-Mueller tube having regenerative qualities whereby the tube after being used for as many as 10^{10} counts may be stored for a period of time and then returned to operation for additional counting operations.

It is a further object of this invention to provide a novel Geiger-Mueller tube having a quenching admixture whose freezing point is low enough so that the novel tube may be immersed in a liquid air bath and still operated successfully.

It is a further object of this invention to provide a novel self-quenching Geiger-Mueller tube which produces wide, flat plateaus.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

The figure is a diagrammatic view of a conventional Geiger-Mueller tube containing the novel quenching admixture.

Referring to the figure, there is shown a conventional Geiger-Mueller counter tube consisting of a thin walled, metal tube or cylinder 10

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which forms the cathode of the Geiger-Mueller tube. Spanning axially and insulated from the cathode cylinder 10 is a thin wire 12 which forms the anode of the tube. These electrodes are disposed in an envelope 14, commonly a glass tube, which forms the outside shell of the Geiger-Mueller tube.

In the conventional and well-known Geiger-Mueller self-quenching type of tube, alcohol vapor and a rare vehicular gas, such as, argon, neon, or helium all of which have a higher ionization potential than the polyatomic admixture are used as the quenching admixture.

The value of using an admixture of this type can be more readily understood by considering the ionization process by which a pulse is registered in the Geiger-Mueller tube. Normally, the potential difference between the cathode 10 and the anode wire 12 is nearly, but not quite, high enough to cause an electrical discharge to take place. Now if an ionizing ray is passed into the tube, electrons are removed from neutral gas atoms by the action of the ionizing ray passing near or through the atom. The negative ions or electrons commence to move towards the anode wire 12. The positive ions begin to move towards the cathode cylinder or tube 10. The electrons proceed to form an avalanche in such a manner that the majority of the ions are produced very near the anode 12. This process, which occurs very quickly, results in the collection of electrons on the anode 12. Also, it is known that the ionization is propagated throughout the length of the anode 12 by action of the ultraviolet radiation emitted during the recombination of ions occurring in a sheath formed by the positive ions which begin to move towards the cathode 10. In this area between the anode 12 and the sheath of positive ions, no new electron avalanche could be formed since the electrical field in this region is reduced below the point at which electrons acquire sufficient energy to produce ions. This condition will continue until the positive ion sheath has moved out to some position near the barrel of the cathode 10.

Now if a tube is filled only with a permanent gas, the positive ions in the sheath can eject secondary electrons from the metal wall of the cathode 10 and thus initiate additional electron avalanches which quickly form a continuous discharge. The presence of these secondary electrons which cause the discharge to continue indefinitely are, of course, objectionable.

Therefore in the prior art, polyatomic mole-

cules, such as, alcohol at a total pressure of 10 cms., Hg, are admixed with the vehicular gas, i. e. argon. The use of such an admixture results in a sheath of positive alcohol ions reaching the cathode rather than a sheath of positive argon ions. The impact of a polyatomic ion with the cathode has a very low probability of producing a secondary electron. As a result no new avalanches are ignited. This is true because all that is required, energetically, is that the ionization potential of the quenching gas be lower than that of argon. When this condition is met, no secondary electrons are emitted from the cathode and the quenching requirement is satisfied.

Other counters have been built using as a vehicular gas, xenon, krypton or neon with alcohol as the admixture. These fillings, while found satisfactory, allow only a limited life for the tube.

My experiments have shown that where Geiger-Mueller tubes of the type now known in the prior art have a quenching admixture of nitric oxide from about 0.5% to about 5.0% combined with a vehicular rare gas, the life time of the tube is substantially unlimited. It was found that the nitric oxide admixture in a Geiger-Mueller tube increased the useful life of the tube from 10^8 counts to 10^{10} counts. It was further found that the nitric oxide Geiger-Mueller tube possessed regenerative features. That is, the tube after being used for 10^{10} counts could then be placed in storage and rested. After which time, the tube would again be capable of being used for a life of 10^{10} counts. This apparently is due to the recombination of the quenching constituent which may have decomposed in the act of quenching.

It was also found that the nitric oxide admixture could be used with any commonly used cathode material, such as copper, or 446 alloy, in a Geiger-Mueller tube without ill effects.

It was further found that since nitric oxide has an extremely low freezing point, a Geiger-Mueller tube containing nitric oxide in its admixture can successfully operate immersed in a liquid air bath.

While fillings of nitric oxide between about 0.5% and about 5.0% were found to result in satisfactory operation, in the preferred embodiment a low striking voltage mixture of spectroscopically pure Ne and .25% A constituted the vehicular gas at a total pressure between $\frac{1}{2}$ and 1 atmosphere with an admixture of between 1% and 2% NO to provide quenching action. This mixture appears to give the best results.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A Geiger-Mueller tube comprising a sealed casing, a cathode member and an anode member within said casing, means for connecting

said cathode and said anode to a source of potential, a gaseous filling within said casing, said filling consisting essentially of a rare gas selected from the group consisting of argon, xenon, neon, helium and krypton, and from about 0.5% to about 5.0% of nitric oxide.

2. A Geiger-Mueller tube comprising a sealed casing, a cathode member and an anode member within said casing, means for connecting said cathode and said anode to a source of potential, a gaseous filling within said casing, said filling comprising a mixture of substantially 1.5% nitric oxide and 98.5% of a rare gas selected from the group consisting of argon, helium, xenon, neon and krypton, said mixture being at a pressure not exceeding atmospheric.

3. A Geiger-Mueller tube comprising a sealed casing, a cathode member and an anode member within said casing, means for connecting said cathode and said anode to a source of potential, a gaseous filling within said casing, said filling comprising a mixture of substantially 1.5% nitric oxide and 98.5% of a rare gas selected from the group consisting of argon, helium, xenon, neon and krypton.

4. A Geiger-Mueller tube comprising a sealed housing, a cylinder within said housing forming a cathode, an anode wire extending through said cylinder, and a gaseous filling in said housing, said filling consisting essentially of spectroscopically pure neon containing from about 0.5% to about 5.0% nitric oxide.

5. A Geiger-Mueller tube comprising a closed housing, a metallic cylinder within said housing forming a cathode, an anode wire spanning axially and insulated from said metallic cylinder, means connecting said metallic cylinder and said anode wire to a source of potential, and a gaseous filling within said housing, said filling consisting essentially of argon ($\frac{1}{4}$ %), neon (98.25%) and nitric oxide (1.5%) at a pressure of 60 cm. of mercury.

6. A gas mixture consisting essentially of a rare gas selected from the group consisting of argon, xenon, neon, helium and krypton in admixture with from about 0.5 to about 5% by volume of nitric oxide.

7. A gas mixture consisting essentially of a rare gas selected from the group consisting of argon, xenon, neon, helium and krypton in admixture with from about 1 to 2% by volume of nitric oxide.

8. A gas mixture consisting essentially of neon and argon in a volume ratio of 4 to 1 in admixture with from about 1 to 2% by volume of nitric oxide.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,503,302	Shore	Apr. 11, 1950
2,519,864	Weisz	Aug. 22, 1950
2,590,108	Liebson	Mar. 25, 1952