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Amqvist et al.

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[54] **DEVICE FOR SPARK DISCHARGE CHAMBER EMPLOYING SEGMENTED CATHODE**

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[52] **U.S. Cl.** **250/385,** 313/93

[51] **Int. Cl.** **G01t 1/18**

[58] **Field of Search** ..... 250/83.6 R; 313/93

[56] **References Cited**

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Assistant Examiner—Davis L. Willis
Attorney, Agent, or Firm—Larson, Taylor & Hinds

[57] **ABSTRACT**

A spark discharge chamber for detailed study of gamma and beta radiation comprising a plane cathode, a lattice-shaped auxiliary electrode and an anode, said cathode being divided into at least two cathode sections which are electrically insulatable from one another.

2 Claims, 5 Drawing Figures

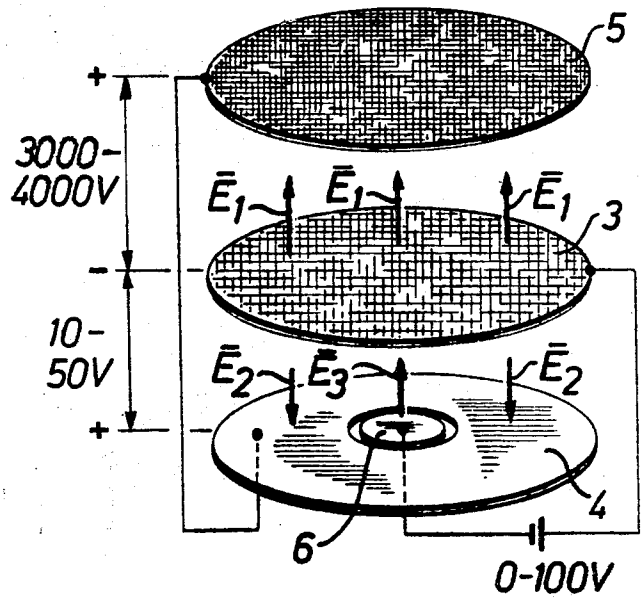


Fig. 1

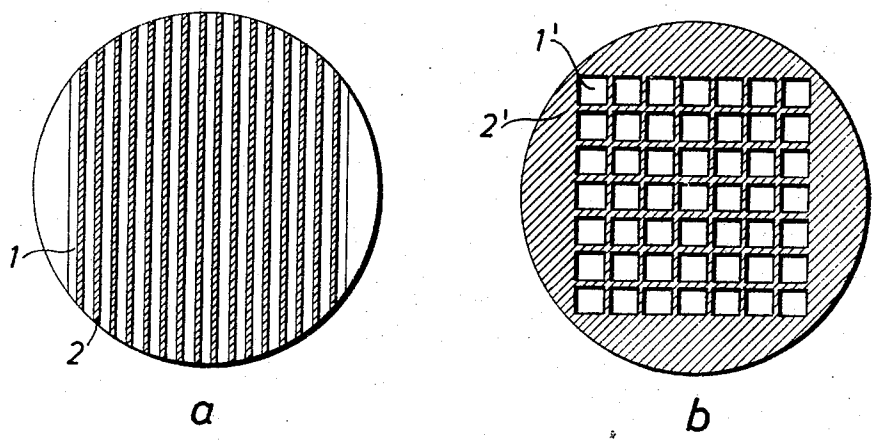

1
2
a
1'
2'
b
1"
2"
c

Fig. 2

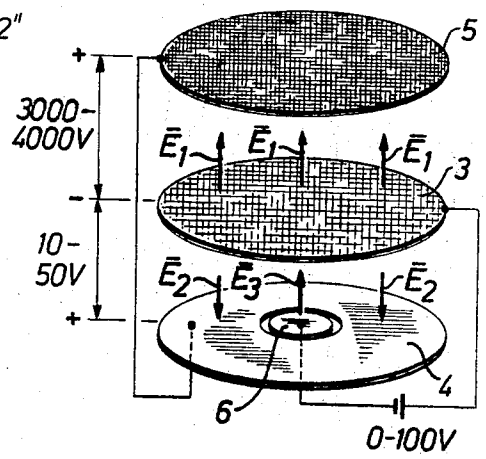

5
3000-
4000V
$\bar{E}_1$
$\bar{E}_1$
$\bar{E}_1$
3
10-
50V
$\bar{E}_2$
$\bar{E}_3$
$\bar{E}_2$
4
6
0-100V

Fig. 3

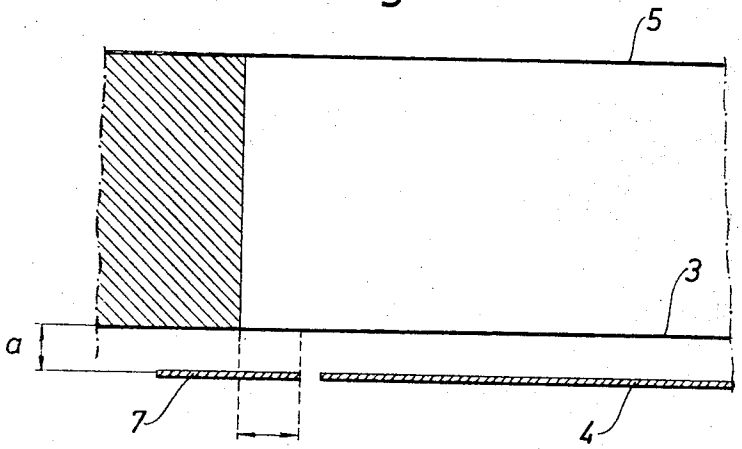


Fig. 4

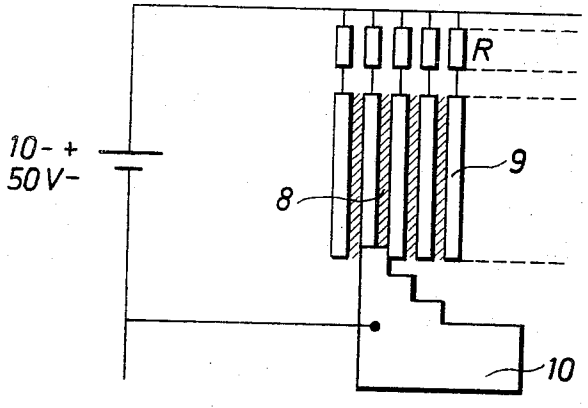
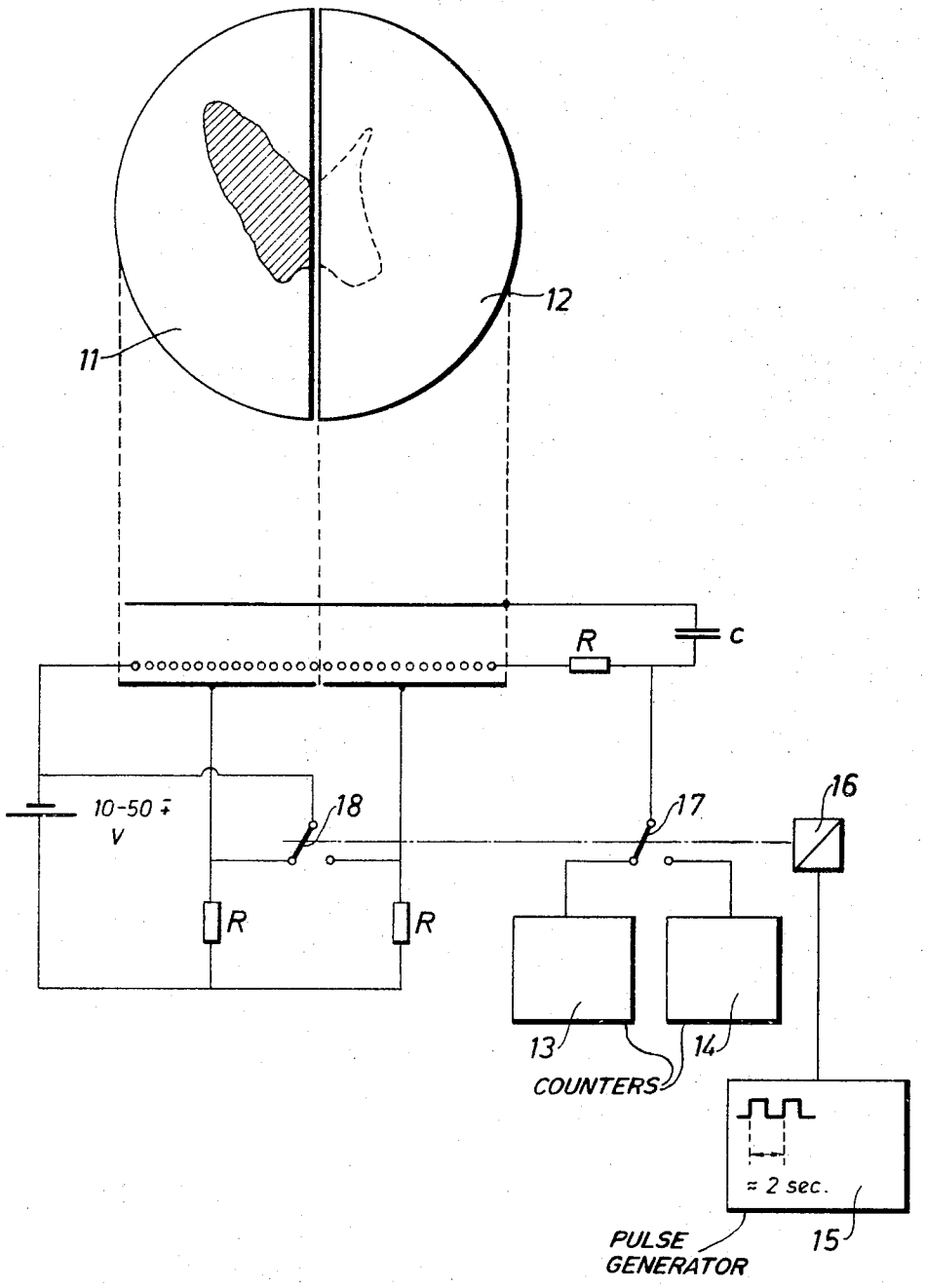


Fig. 5


11
12
R
C
10-50 ∓
V
18
17
16
R
R
13
14
COUNTERS
≈ 2 sec.
PULSE
GENERATOR
15

DEVICE FOR SPARK DISCHARGE CHAMBER EMPLOYING SEGMENTED CATHODE

The invention relates to a device for spark discharge chambers to permit a detailed study of beta or gamma radiation.

For the study of flux density in beta or gamma radiation use is often made of a spark discharge chamber with a plane cathode, a reticulate auxiliary electrode parallel thereto, and a likewise reticulate anode.

The radiation incident on the cathode gives rise to an electron cloud which accelerates, in the direction towards the anode. When the electron cloud has penetrated into the spark gap between the auxiliary electrode and the anode, this gives rise to visible sparks at the anode. The spark density provides a representation of the flux density in the radiation entering the cathode and this picture can thereafter be reproduced digitally for study of the original radiation.

For this study of beta or gamma radiation, accordingly, a total picture is obtained which corresponds to the entire anode surface studied. There is often a need, however, to select a part of the surface for special study. This may be the case, for example, in the study of human or animal organs, e.g., for the presence of tumors. For this purpose a radioactive isotope is injected into the organ to be examined, after which the radiation emitted from the organ is studied with the aid of a spark discharge chamber. If the organ contains a tumor, a larger or smaller quantity of the isotope is absorbed by its tissue in relation to the quantity absorbed by normal tissue. A tumor may be benign (cold) or malignant (warm), i.e., contain dead tissue or tissue which grows more quickly than normal tissue. In both cases the tumor tissue yields a flux density of radiation which differs from the flux density for normal tissue and the tumor can therefore be detected.

A further example of a case in which there is a special interest in studying only a part of the radiation emitted from a dissected organ is the study of symmetrical organs. In this case it may be of special interest to study the symmetrical parts separately in order thereafter to make a direct comparison of the results to decide whether the different parts have similar properties.

The object of the present invention, accordingly, is to permit a detailed study of gamma or beta radiation, the spark discharge chamber comprising a plane cathode, a lattice-shaped auxiliary electrode and an anode, and the invention is chiefly characterized in that the cathode is divided into at least two cathodes electrically insulatable from one another.

The cathode sections can, as described below in conjunction with the attached drawings, be given an arbitrary form and size. They may thus consist of several squares or rectangles with parallel longitudinal bands, concentric circular rings, and so on.

According to an advantageous further development of the invention the cathode sections are arranged to be electrically connected to a voltage source via a sliding contact, multipole switch or the like. This provides the means of successively studying one part after another of the radiation. The results of the study of these various parts can thereafter be combined, so yielding a complete picture with a precision of detail which is dependent on the number of parts into which the cathode is divided.

It is appropriate also to arrange around the cathode divided into cathode sections an electrode situated on the plane of the cathode and with positive potential in relation to the auxiliary electrode. This greatly reduces the background count caused by interference discharges along the electrode separation ring.

A spark chamber according to the present invention can accordingly be used, for example, for radiochromatography, all cathode sections first being given the same potential as or a negative potential in relation to the auxiliary electrode so as to yield a complete picture of the radiation. The parts of this radiation which are of special interest can then be studied in greater detail, and purely numerical results can be obtained from such parts by giving only one or some of the cathode sections the same potential as or a negative potential in relation to the auxiliary electrode, while other cathode sections are given a positive potential.

Some embodiments of the invention will now be described with reference to the attached drawings, in which

FIG. **1** shows three cathodes divided in different ways,

FIG. **2** a spark chamber with associated cathode divided into a circular cathode section and an annular cathode section surrounding the latter,

FIG. **3** an extra electrode in the plane of the cathode, surrounding all cathode sections,

FIG. **4** a schematic diagram of the connection of the cathode sections to a voltage source, and

FIG. **5** a schematic diagram of a coupling for counting of sparks over different parts of a divided cathode in a spark chamber.

FIG. **1***a* shows how a cathode according to the invention can be divided into a number of parallel bands **1** separated by insulating portions **2.**

In FIG. **1***b* the cathode is instead divided into several small square sections **1'**, and FIG. **1***c* shows another possibility of dividing the cathode.

The principle of this invention is most clearly illustrated in FIG. **2.** This shows a spark chamber comprising a cathode **4,6,** an auxiliary electrode **3,** and an anode **5.** The cathode is divided into two parts, a central circular portion **6** and an annular portion **4** surrounding the latter. The central portion **6** of the cathode is given a negative potential in relation to the auxiliary electrode or may be kept at the same potential as the latter. The potential on the anodes should amount to about 3,000–4,000 V in relation to the auxiliary electrode. In the space between the auxiliary electrode **3** and the anode **5** accordingly, there is an electric field, directed towards the anode, above both cathode sections, while in the space between the cathode and the auxiliary electrode the electric field above the central portion **6** of the cathode is directed towards the anode and the field above the outer annular portion **4** of the cathode is directed from the auxiliary electrode to the cathode. Radiation incident on the cathode, e.g., gamma radiation, thus gives rise over the whole cathode to primary electrons which are accelerated by the electric field prevailing between the cathode and the auxiliary electrode **3.** As, however, above the annular portion **4** of the cathode this field is directed towards the cathode, no transport of electrons takes place from the cathode towards the auxiliary electrode **3,** while on the other hand the electrons generated at the central portion **6** of the cathode are accelerated towards the

auxiliary electrode. These electrons are accelerated into the gas discharge chamber and, at the anode **5,** within the zone immediately above the central portion **6** of the cathode, give rise to sparks. At other parts of the anode **5** no sparks arise.

Division of the cathode into several cathode sections according to the invention results in reduction of the background. Thus, if the cathode has a diameter of 20 cm, and the cathode sections an area corresponding to a diameter of 1 cm, the background is reduced 0.0025 times. Other undesirable effects derive from interference electrons generated at the electrode separation ring. FIG. **3** shows a part of a device for elimination of this interference effect. The cathode **4** is here surrounded by an extra electrode **7** situated on the plane of the cathode and held to a positive voltage, preferably 10–50 V in relation to the auxiliary electrode.

This electrode results in the fact that no electrons are generated in the critical zone adjoining the electrode separation ring, so that no interference discharges can arise within this zone.

FIG. **4** shows an appropriate device for connection of the cathode sections **9** to a voltage source. One of the cathode section terminations is connected across resistor R to one pole of a voltage source, while the other pole of the voltage source is connected to a sliding contact **10.** With this sliding contact the cathode sections **9** can be successively connected to the voltage source for study of different parts of the radiation.

In the schematically represented device in FIG. **5** for counting of sparks above different parts of the cathode, the cathode in the spark chamber is divided into two semicircular parts **11, 12.** By means of a switch **18** one of these two parts **11, 12** can be given the same potential as the auxiliary electrode, while the other part of the cathode can at the same time be given a positive potential. The switch **18** is mechanically connected to another switch **17,** which connects one of two counters **13, 14** for counting of the sparks at the anode over the cathode section **11,** which is temporarily at the same potential as the auxiliary electrode. On switching between these counters **13, 14** the voltages on the cathode sections are automatically changed in such a way that the section which has just been on the same voltage as the auxiliary electrode receives a positive voltage in relation to the auxiliary electrode, while the positive voltage on the other cathode section disappears and the latter is connected to the same voltage as the auxiliary electrode. Switching between the counters can take place automatically, for example by means of a relay **16** controlled by a pulse generator **15.**

Although the invention has been described with reference to some of its embodiments, it can nevertheless be arbitrarily varied within the scope of the subsequent claims.

What is claimed is:

1. In a spark discharge chamber for a detailed study of nuclear radiation, such as beta or gamma radiation, comprising a planar cathode, a reticulate anode and a reticulate auxiliary electrode, the improvement wherein the cathode comprises a plurality of separate, mutually insulated sections and means are provided for connecting predetermined sections of the cathode to a potential source which is positive in relation to the auxiliary electrode and for connecting other sections of the cathode to a potential source which is not positive in relation to the auxiliary electrode.

2. A spark discharge chamber according to claim **1** further comprising a further electrode located in the plane of the cathode and means for connecting said further electrode to a potential source which is positive in relation to the auxiliary electrode.

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