June 7, 1960 E. F. DE HAAN 2,940,003

COUNTING TUBE ARRANGEMENT

Filed Aug. 5, 1957

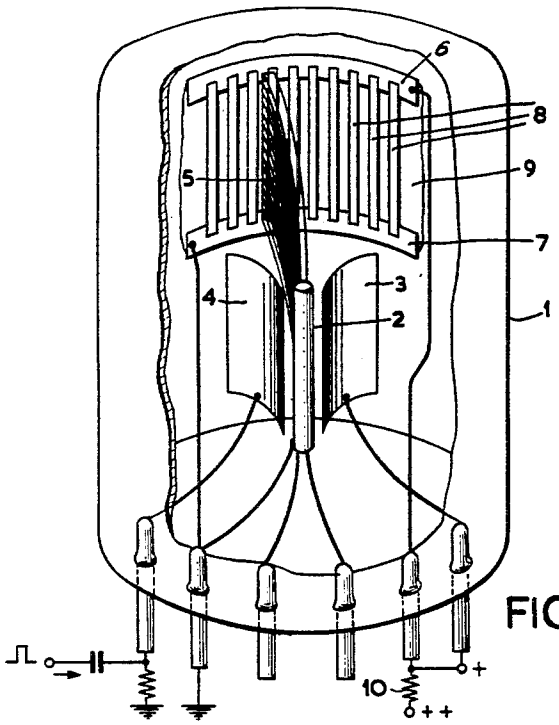

FIG.1

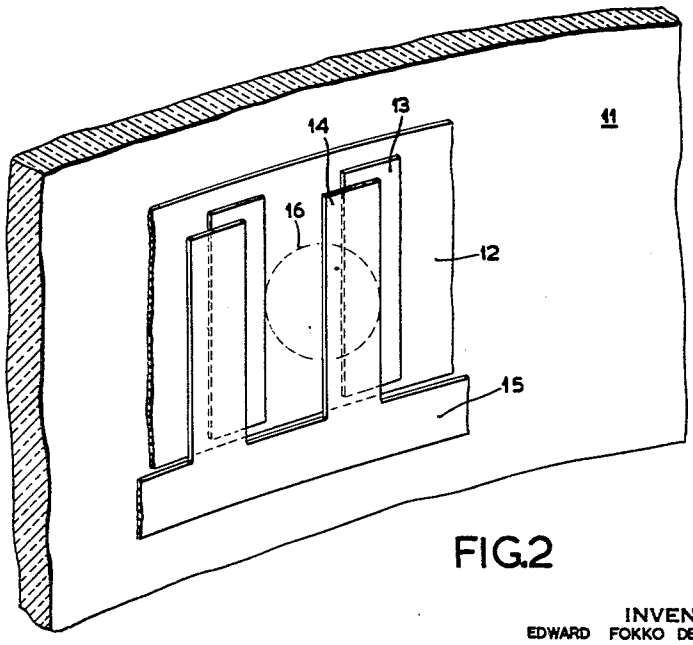

FIG.2

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United States Patent Office 2,940,003 Patented June 7, 1960

2,940,003

COUNTING TUBE ARRANGEMENT

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Filed Aug. 5, 1957, Ser. No. 676,216

Claims priority, application Netherlands Aug. 14, 1956

1 Claim. (Cl. 315—8.6)

The invention relates to an arrangement comprising a counting tube producing an electron beam which can be deflected and held in different positions, and to a counting tube intended for use in such a device. The invention relates particularly to the collecting electrode for the electron beam.

In a known device of this kind, the beam is held in given positions in that the beam current in these positions is distributed among two electrodes. One of these electrodes is shaped in the form of a slotted screen, behind which is arranged a second collecting electrode to collect the electrons passing through the slots. This second collecting electrode is also provided with windows or apertures, so that part of the electrons pass through them to the tube wall. At the areas concerned the tube wall is coated with a phosphor to permit a visual indication of the beam position.

This system of collecting electrodes, however, is comparatively complicated. In accordance with the invention, a simple construction is possible by collecting, in such a device, the electrons of the beam on a collecting electrode which is preferably applied to the tube wall and which consists of two strips of good conductivity extending parallel to the deflection direction of the beam and connected to one another by a series of straps of a material of which the electrical conductivity varies strongly upon electron impact, to which straps the beam can be directed, while between the strips of good conductivity a voltage difference is applied, while one of the strips may be connected to one of the deflection plates and via a resistor to a terminal of the voltage source. The straps are preferably made of a substance which does not only exhibit the aforesaid property of electron bombardment induced conductively, but also luminescence upon electron impact. The strips and straps may be applied directly to the bulb of the tube, for example by vaporization or by brushing. The strips may be made of silver, whereas the straps may be made of metal sulphides, for example, cadmium sulphide, zinc sulphide and the like. Such substances and the fact that their electrical conductivity increases materially upon electron impact are known per se. The invention provides a very simple arrangement. It is advisable to coat the tube wall previously with a slightly conductive layer in order to permit collection of the electrons of the beam not striking the said straps. This layer may be connected to one of the silver strips. However, as an alternative, these strips may be applied without using further means to the said wall, in which case the resistance of the wall layer must be so high that the current remains low with respect to the current passing through the straps, when the latter are struck by electrons.

The conductive strips may be arranged in one plane, but as an alternative, they may be arranged one behind the other, these conductive strips being separated by the substance of which the conductivity varies upon electron impact. The electrons must then pass the first conductive layer in order to reach this substance. One

conductive strip may then be made of tin oxide and be applied directly to the tube wall; it may be coated with the straps of cadmium sulphide, which may, in turn, be covered with straps of aluminum. The aluminum layer must be so thin that the electrons can penetrate it.

The invention will now be described more fully with reference to the accompanying drawing in which Figs. 1 and 2 show different embodiments of a tube for use in a device according to the invention, in a diagrammatical view.

Referring to Fig. 1, reference numeral **1** designates the bulb or transparent envelope of the tube, in which a cathode **2** and deflection plates **3** and **4** are housed, which electrodes produce a ribbon-shaped electron beam **5**. The beam **5** strikes a collecting electrode consisting of strips **6** and **7** of good conductivity, which are connected to one another by straps **8** of a substance, for example zinc sulphide, of which the conductivity increases strongly upon electron impact. A current which is 100 to 1000-times the incident electron current can be readily obtained. The strips and straps may be arranged on a slightly conductive wall layer **9**, which serves to conduct away electrons falling at the side of the straps **8**. The strip **6** is connected via a resistor **10** to a positive voltage of a few 100 v.; the strip **7** is connected to the cathode. In the position shown the beam **5** indicates the number **7**, if there are ten straps **8**. The deflection plate **3** is connected to the strip **6**. The beam partly bypasses the left-hand side of the said strap and lands partly on this strap. Consequently, this strap exhibits a low resistance, so that the current from the strip **6** to the strip **7** increases strongly, and the voltage of the strip **6** drops owing to the voltage drop across the resistor **10**. The beam is held in this position, since, if the beam moves slightly to the right, the voltage of the strip **6** and hence that of the deflection plate **3** drops, as the beam strikes a larger part of the strap, so that it is again deflected to the left-hand side, whereas the reverse takes place when the beam moves further to the left, i.e. away from the strap. Only by supplying a positive pulse to the plate **4** can the beam be moved to the next following strap.

The strips **6** and **7** may be made of silver and be provided by vaporization of metal, or by brushing on of a paste, similarly for the straps **8**. For the strips use may then be made of a known silver paste; for the straps use may be made of a paste of cadmium sulphide or zinc sulphide. The latter substance has the advantage that it luminesces so that it may serve as an indicator for the beam position. The slightly conductive substratum **9**, whose resistance may be approximately equal to that of the unbombarded straps, may be constituted by a very thin metal layer or a tin oxide layer, by which the inner side of the bulb **1** may be covered. Between the deflection plates **3** and **4** and the collecting electrode provision may be made of one or more grid or screen electrodes in order to obtain a sharp definition of the beam and to withhold secondary electrons from the collecting electrode.

With the tube modification shown in Fig. 2, the strips and straps are arranged one behind the other, viewed in the direction of travel of the electrons.

To the glass wall **11**, of which only part is shown in the drawing, is applied a layer **12** of tin oxide. On this layer are arranged straps **13**, for example, of cadmium sulphide, which are covered by a thin aluminum layer **14**. The layers **13** and **14** may be applied for example by means of a mask, for example by vaporization. The aluminum straps are connected to the strip **15**, which may be connected via a resistor to a positive voltage. The layer **12** may be connected to a higher positive voltage. However, the reverse is also possible. In this

case a beam 16 of circular section is used, which falls partly on the strap 14 and partly on the layer 12, where it is held since the strap 15 is also connected to a deflection plate. The electrons penetrate the thin aluminum layer 14 and produce an increase in conductivity of the straps 13, so that the current from the layer 12 to the strap 14 increases.

The advantage of this embodiment of the invention consists in the possibility of a simple arrangement of the electrodes, while a high amplification can be obtained, since a comparatively great current variation can be obtained in the straps by means of a slight beam current. Therefore, use may be made of a rod-shaped beam.

Although two embodiments are described, it will be obvious that further embodiments are possible within the scope of the invention. For example, as a rule means will be provided to move the beam from the last strap back to the first, but these means are known to those skilled in the art in view of the means used in known counting tubes.

What is claimed is:

An arrangement including an electron-beam counting tube comprising beam-producing means and deflection means for directing the beam along plural paths, a collecting electrode for receiving said beam and controlling the position of said beam along said plural paths, said collecting electrode comprising plural, spaced, electron-receiving portions constituted of a material whose electrical conductivity is a function of the extent of electron bombardment and each mounted to receive electrons when the beam occupies one of its plural paths, terminal connections to spaced points of each of said spaced electron-receiving portions, means for applying a difference of potential across said terminal connection, a direct electrical connection between the deflection means and one of the terminal connections, and an impedance connecting said direct electrical connection to a source of potential.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,940,003 June 7, 1960

Edward Fokko de Haan

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 48, for "conductively" read -- conductivity --

Signed and sealed this 4th day of April 1961.

(SEAL)
Attest: ERNEST W. SWIDER
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents