Jan. 22, 1963 T. P. J. BOTDEN ETAL 3,075,119

GLOW-DISCHARGE INDICATOR TUBE

Filed July 15, 1960

2 Sheets-Sheet 1

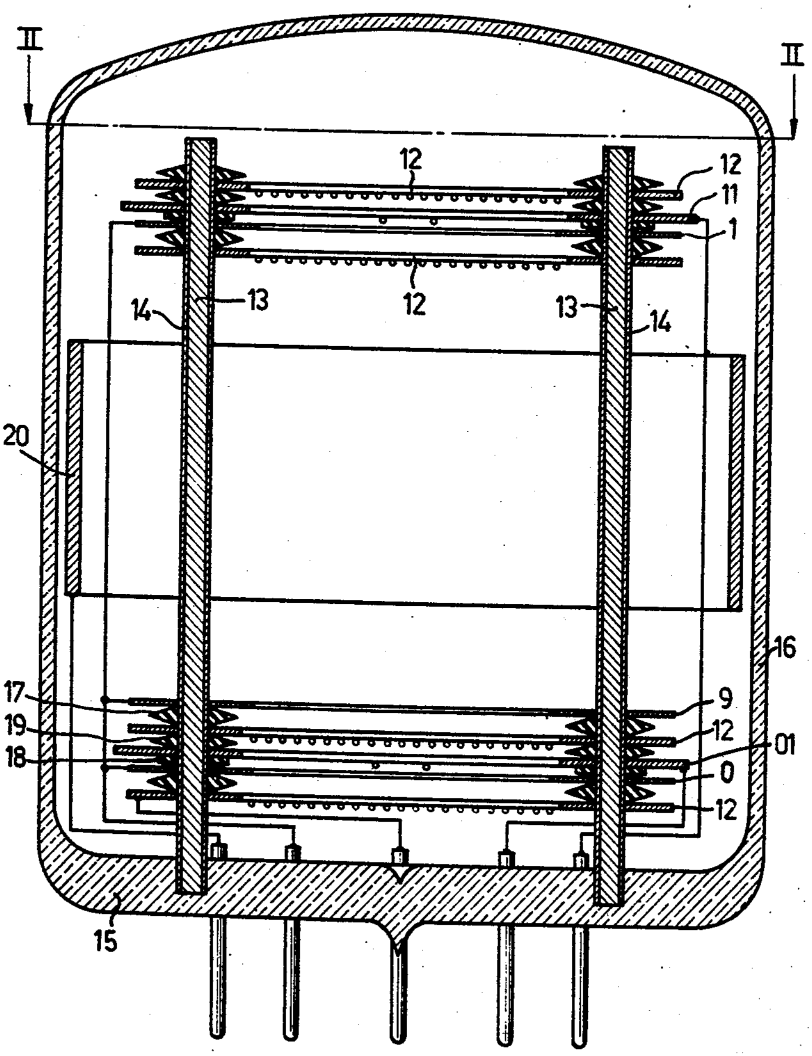

FIG.1

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2 Sheets-Sheet 2

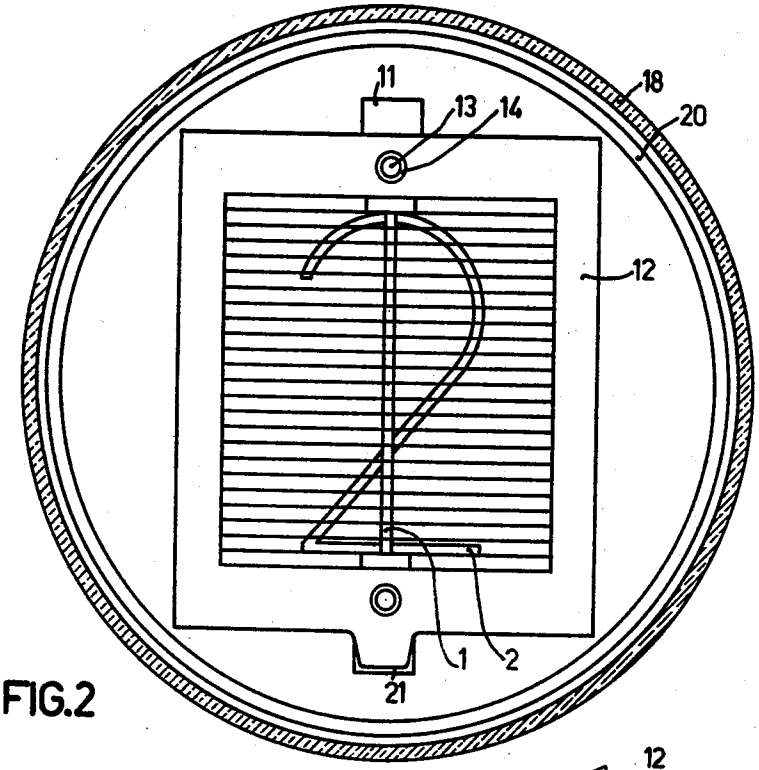

FIG.2

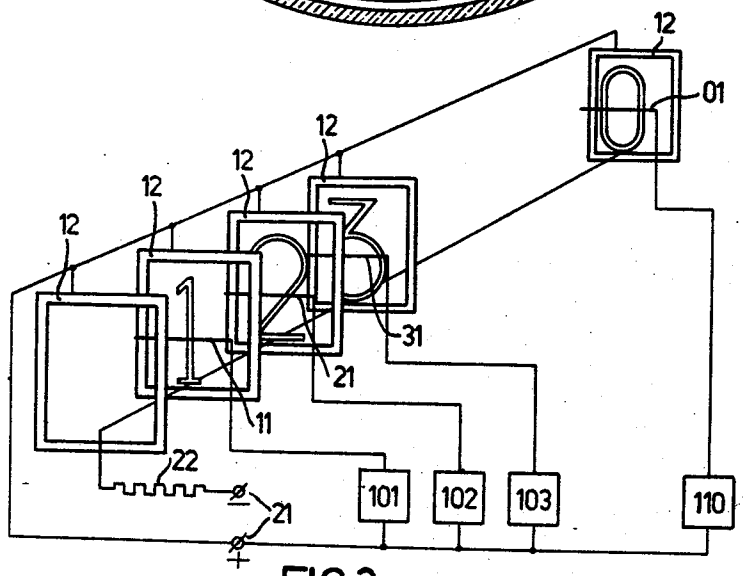

FIG.3

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GLOW-DISCHARGE INDICATOR TUBE

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5 Claims. (Cl. 313—109.5)

The invention relates to glow-discharge indicator tubes in which the position of the glowlight is determined by a voltage applied to an auxiliary electrode and which contains, in addition to a main cathode and a main anode, at least one auxiliary anode. The invention also relates to devices comprising such gaseous glow-discharge tubes.

In a prior co-pending patent application there is described a glow-discharge indicator tube in which a plurality of auxiliary anodes is arranged near the main cathode so that, upon applying the anode voltage, the glow-discharge is ignited and keeps burning near that auxiliary anode which has a low positive potential with respect to the anodes.

An object of the invention is to provide a modification of the specified glow-discharge indicator tube which permits obtaining attractive properties.

According to the invention, in a glow-discharge indicator tube in which the position of the glow light is determined by a voltage applied to an auxiliary electrode and which contains, in addition to a main anode and a main cathode, at least one auxiliary anode, the cathode comprises a plurality of digits positioned in parallel planes one after another between grid-like interconnected anodes, one auxiliary anode being arranged adjacent each digit so that, upon applying a positive potential between the parallel-connected anodes and the parallel-connected digits, the discharge is ignited towards that digit the associated auxiliary anode of which has a low positive potential with respect to the anode.

With a tube according to the invention it is ensured that, if the auxiliary anodes are included in the circuit through a sufficiently large resistor, the position of, for example, a transistorized counting circuit can be indicated in the form of a luminescent digit with the expenditure of only very little energy. The currents flowing to the auxiliary anodes need by only a few tens of microamps. and a potential difference of, say, from 10 to 12 volts between the main anode and the auxiliary anode suffices.

In order to ensure that the discharge keeps burning on the digit to be indicated and, upon variation thereof, passes to the other digit, it is necessary to apply an intermittent anode voltage. This may be effected in different ways, namely by means of a half-wave or full-wave rectified alternating voltage. If desired, use may be made of an alternating voltage of a frequency which is not unduly high and having a voltage peak which is sharply defined. As an alternative, the circuit may be fed from a direct-current source and chosen to be such that the discharge is intermittent.

According to the invention, in order to ensure that the digit to be indicated is unambiguous, it is desirable that an important difference in igniting voltage and burning voltage exists between each of the cathodes and the associated auxiliary anode. A difference of 10% of the igniting voltage usually suffices.

According to the invention, in order to ensure that the auxiliary anodes actually determine the ignition, the product of the pressure of the gas and of the distance between a digit and the nearest anode must preferably be equal to a multiple of the product of the pressure and of the distance between an auxiliary anode and the

associated digit. This pressure usually has the value corresponding to the minimum of Paschen for the relevant gas and the relevant cathode material, since it is so chosen to permit working with as low voltages as possible.

Glow-discharge digit indicator tubes in which the cathode digits are present between grid-like anodes are already known. Auxiliary anodes are not present in such tubes and the digit to be indicated must be chosen, for example, by changing-over a switch so that in each case the full cathode current must be delivered, which implies that it cannot be taken, for example, from a transistor countering circuit.

It is known to build up a glow-discharge digit tube by positioning cathode digits and associated anodes between a plurality of thin glass plates. The digits are ignited by temporarily increasing the anode voltage and applying a lower negative potential to a grid electrode present in front of the anode. Since the grids associated with the digits which are not chosen must convey comparatively high negative voltages such a circuit requires the use of high control voltages, whereas control might be possible with comparatively small energy. However, due to the arrangement of the digits between the glass plates, it is difficult to obtain those favourable discharge-technical properties which are possible if the insulating material is present substantially on the wall of the tube which is covered with an atomised metal coating. Apart therefrom, the structure of the tube seems difficult to realize and the glass plates soon become black. Properly speaking, the tube may be regarded as ten separate units in one bulb.

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

FIGURES 1 and 2 show two cross-sections of a glow-discharge indicator tube according to the invention and

FIGURE 3 shows a simple circuit.

Referring now to FIGURES 1 and 2, each digit consists of molybdenum sheet of 0.125 mm. thick having a tongue for mounting at its upper and lower ends. The digits are indicated by 1 to 0. Above each digit and at a distance of 0.3 mm. therefrom is one of the auxiliary anodes 11, 21, etc. to 01, consisting a square chrome-nickel frame of 0.25 mm. thick on which about at the centre two molybdenum wires of 0.05 mm. thick are welded with a spacing of 2 mms. Above each auxiliary anode and at a distance of 0.6 mm. therefrom is a square frame which constitutes an anode 12 likewise of chrome-nickel of 0.25 mm. thick, on which molybdenum wires of 0.04 mm. thick are welded with a spacing of 0.5 mm.

Again another digit is present above each anode at a distance of 0.8 mm. therefrom, except above that anode which lies above the cathode 1 and the auxiliary anode 11. The digits, the main anode and the auxiliary anodes are slipped onto two rods 13 sealed into a base 15 of the tube and covered with a thin glaze layer 14. The correct spacings are guaranteed by rings 17, 18 and 19 having thicknesses of 0.8 mm., 0.3 mm. and 0.6 mm. respectively. The rings 17 and 19 are of ceramic material and bevelled. The rings 18 are punched mica rings. The total depth per digit is 2.325 mms. so that the deepest digit lies at a distance a little less than 21 mms. from the anode which closes the upper side of the stack, while the whole stack has a thickness of about 22 mms. Consequently, it has been found that the digit indicated can be observed unambiguously over a very usable space angle despite the large number of electrodes.

Since in a tube of this kind constant discharge technical properties are desirable, the stack of electrodes is surrounded, in addition, by a molydenum ring 20 which is thoroughly atomised in preparing the tube.

All of the anodes **12** and all of the cathodes **1** to **0** are connected in parallel. The auxiliary anodes **11, 31**, etc. are led out at the top of the digits and the auxiliary anodes **21, 41** are led out at the foot thereof. The tube is filled with neon and 1% of argon at a pressure between 15 and 20 mms. of mercury. For a certain indication and a cathode current of from 6 to 7 milliamps., the auxiliary-anode current at the digit to be indicated need be no more than 50 microamps. The potential difference required between the main anode and the auxiliary anode is then less than 12 volts.

In FIGURE 3, the anodes are shown as frames and the interposed digits are shown in their natural shape in a somewhat exploded view. A single wire is shown as the auxiliary anode with each digit, these wires being connected to elements **101, 102**, etc., which represent the units of a decade of a transistor counting circuit. When the counting circuit has reached a state associated with one of the units, such a unit may have taken from it a positive voltage of 12 volts relative to the parallel-connected other outlets, which voltage is applied to the relevant auxilary anode. The intermittent anode voltage is applied via terminals **21** to the anode **12** and through a resistor **22** to the cathode.

What is claimed is:

1. An indicating tube of the glow-lamp type comprising an envelope having a transparent viewing portion, and within the envelope in viewable position a plurality of character-like cathodes positioned in parallel planes, a grid-like anode positioned between each pair of successive cathodes, an ionizable medium, means to connect the cathodes and the anodes, respectively, in parallel, and an auxiliary anode positioned adjacent each cathode a distance at which with a small positive potential applied thereto relative to the anode a discharge is initiated between the cathode and anode associated therewith.

2. A glow-discharge indicator tube as claimed in claim 1, in which the main anode comprises parallel wires and the auxiliary anodes comprise a small number of parallel wires parallel to the wires of the main anode.

3. A glow-discharge indicator tube as claimed in claim 1, in which the distances between a cathode and the associated auxiliary anode, thence to the anode, and thence to the next cathode are approximately in the proportion of 1:2:3.

4. A glow-discharge indicator tube as claimed in claim 1, in which the difference in igniting voltage and burning voltage between each cathode and the associated auxiliary anode is more than 10% of the igniting voltage between these electrodes.

5. A glow-discharge indicator tube as claimed in claim 1, in which the product of the gas pressure and of the distance between a cathode and the nearest anode is equal to a multiple of the product of the pressure and of the distance between an auxiliary anode and the associated cathode.

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