

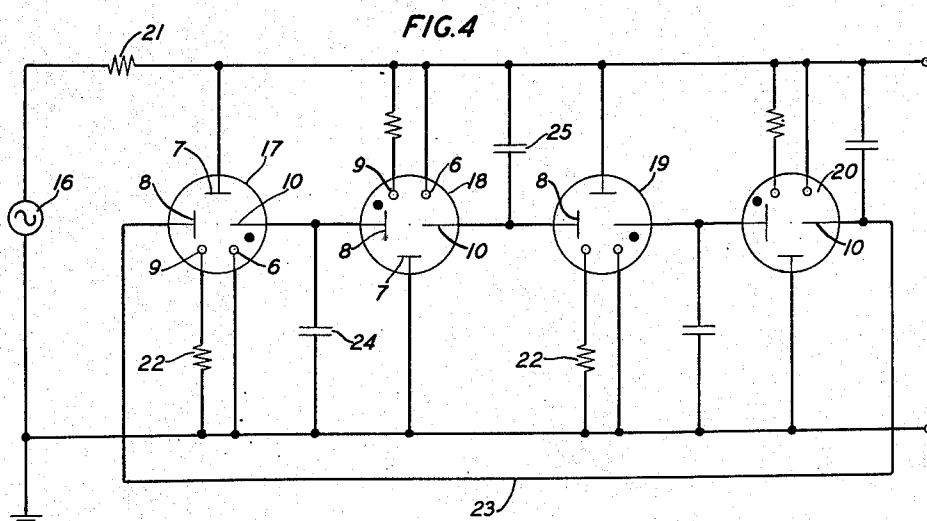
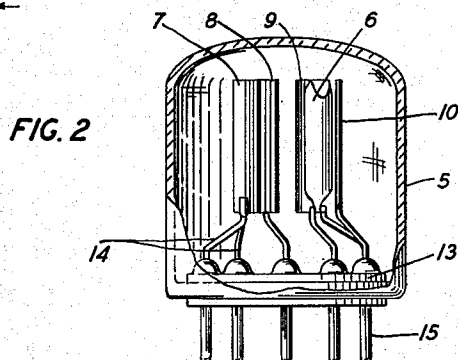
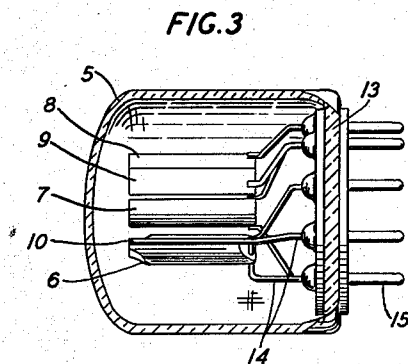
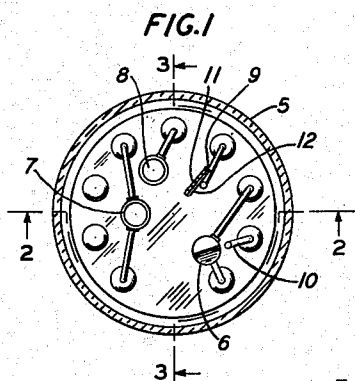
April 15, 1952

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2,593,109

COLD CATHODE GASEOUS DISCHARGE DEVICE

Filed March 24, 1950



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## UNITED STATES PATENT OFFICE

2,593,109

COLD CATHODE GASEOUS DISCHARGE  
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Application March 24, 1950, Serial No. 151,696

6 Claims. (Cl. 313-188)

1

This invention relates generally to gaseous discharge devices and more particularly to cold cathode gaseous discharge devices especially suitable for use in counting ring circuits.

Devices of the type to which this invention pertains comprise a plurality of electrodes in a hermetically sealed, gas containing envelope. In one construction, the electrodes include a starter cathode and a starter anode which define a starter glow discharge gap, and a main cathode and a main anode which define a main glow discharge gap. Another electrode, designated as the probe electrode, is positioned in the device in the main cathode-main anode gap.

In certain types of counting ring circuits, glow discharge tubes are connected in parallel and have a common voltage applied across certain electrodes therein. It is usually desired that the devices ionize individually and in a predetermined sequence. One way to accomplish this is to have the probe electrode of an ionized tube electrically connected to a starter electrode of another tube. This will bias the latter tube so that it will ionize in preference to any other tube upon the application of a next voltage signal to be registered. A high probe voltage is desirable since it will effect a greater preference for the tube being biased.

One difficulty encountered in counting ring circuits utilizing this type of tube lies in the fact that although it is desirable to have the starter gap breakdown voltage as small as possible it cannot be less than the sum of the probe electrode voltage plus the voltage necessary to transfer the glow discharge to the main anode. If the starter gap breakdown voltage is less than this sum, upon breakdown of the starter gap the probe voltage is immediately dissipated leaving only the line voltage impressed upon the main anode which would be insufficient to cause transfer of the glow discharge to the main anode. The upper limit of a starter gap breakdown voltage is determined by the voltage available in the circuit.

The glow discharge tube, therefore, should have starter gap breakdown voltage characteristics which lie between these two limits. From a design standpoint and from a manufacturing viewpoint, it is desirable to have these limits as far apart as is possible in order to mitigate the possibility of faulty operation. It can be seen that by reducing the main anode transfer voltage the minimum starter gap breakdown voltage can also be reduced proportionally, thus increasing the voltage difference between the two limits.

One object of the invention is to provide a glow

2

discharge gas tube having a small main anode transfer voltage and a relatively large probe electrode output voltage.

A further object of the invention is to improve gaseous discharge devices especially suitable for use in counting ring circuits.

Another object of the invention is the improvement of glow discharge devices generally.

A cold cathode gas tube illustrative of one embodiment of this invention comprises a main anode, a starter anode, a probe electrode, and a main cathode of a metal such as molybdenum or nickel, and features a starter cathode element of a material such as activated barium oxide on a nickel plate which has lower main anode transfer and sustaining voltages than the corresponding voltages characteristic of the material of the main cathode. The use of barium compound starter cathode element allows these low transfer and sustaining voltages with respect to the gap between the main anode and the starter cathode, while at the same time obtaining a relatively high sustaining voltage between the main cathode and the main anode. Because of the low main anode transfer voltage there is permitted a wider range of allowable starter gap breakdown voltages than would be possible with a higher main anode transfer voltage.

A further feature of the invention is the positioning of the barium compound starter cathode element with respect to the main cathode in such a manner that the main cathode material cannot spatter onto the active face of the barium compound element.

The above-mentioned and other objects and features of the invention will be more clearly understood from the drawing and the detailed description thereof. In the drawing:

Fig. 1 is a top view of a discharge device illustrative of one embodiment of the invention, a portion of the enclosing being broken away;

Figs. 2 and 3 are side views in section of the device taken along lines 2-2 and 3-3 respectively of Fig. 1; and

Fig. 4 illustrates a counting ring which is an example of a type of circuit in which the gas tube described herein can be advantageously employed.

The gaseous discharge device illustrated in Figs. 1, 2 and 3 comprises an envelope 5 enclosing a main cathode 6, main anode 7, starter anode 8, and starter cathode 9. In this embodiment of the invention, probe 10 has also been included within the tube as one of the elements. Main anode 7 and starter anode 8 may be of nickel.

3

However, it is to be noted that other metals such as molybdenum or tantalum can be used. Main cathode 6 is preferably of molybdenum, since molybdenum is characterized by a high sustaining voltage. If desired, however, metals other than molybdenum, such as nickel, tantalum, or columbium, may be used according to the sustaining voltage required by the application to which the gas tube is to be put. The front surface 11 of starter cathode 9 in the preferred embodiment described herein is composed of a barium compound, such as activated barium oxide which has a sustaining voltage of the order of 70 volts. The other surface 12 of starter cathode 9 may be of nickel, although other metals may be used since its primary purpose is to provide a base for the barium compound surface and to shield the activated barium oxide from material sputtered off the main cathode 6. The probe 10 can be of any suitable metal, for example molybdenum or nickel, which will not contaminate the other elements of the tube.

To prepare a starter cathode of activated barium oxide, the carbonates of barium and strontium are deposited on a nickel base. Next the starter cathode element is installed in the envelope which is then evacuated. The element is then heated in the evacuated envelope at a temperature of 900° C. which will release carbon dioxide. The tube is then filled with about 15 millimeters (of mercury) pressure of argon and hermetically sealed. It is to be noted that gases other than argon may be used. Finally, the barium surface is activated by conducting high current pulses through the surface.

The various elements in the tube are mounted from the base 13 by support wires 14, which, in turn, are connected to individual terminal pins 15. The base of the tube can be constructed in one of many conventional manners well known in the art.

The operation of the tube is essentially as follows: A voltage of approximately 175 volts is applied across starter anode 8 and starter cathode 9. A breakdown will occur between these two elements and a sustaining voltage of approximately 70 volts will be required to maintain the discharge between these two electrodes. This discharge will then transfer to the gap between the starter cathode 9 and the main anode 7, since the main anode 7 has been placed at a higher potential than starter anode 8 by appropriate circuit means. Since the starter cathode is involved in this transfer of the discharge is activated barium oxide coated surface 9, the sustaining voltage remains approximately 70 volts. If main cathode 6 is then placed at a lower potential than starter cathode 9, the discharge will transfer to the gap between main anode 7 and main cathode 6. The main cathode 6 transfer voltage required to effect this transfer to the main anode 7-main cathode 6 gap is approximately 150 volts for this particular embodiment of the invention. The said 150 volts is measured across the main anode 7-main cathode 6 gap. Because the main cathode 6 is of molybdenum in this embodiment of the invention, the sustaining voltage of 100 volts is higher for a discharge existing between main cathode 6 and main anode 7 than it was for a discharge existing between two elements one of which was activated barium oxide coated starter cathode 9.

This cold cathode gas tube described herein and characterized by a low main anode transfer voltage and a high probe output voltage may be used advantageously in a counting ring circuit,

4

such as is shown in Fig. 4, wherein the elements in the gas tubes are numbered to correspond to those in Fig. 1. A 165 peak voltage alternating voltage source 16 is connected to the main anode of every odd gas tube 17, 19, numbering from left to right in the drawing, and to the main cathode of every even numbered gas tube 18, 20, through 5000-ohm resistance 21. In the odd tubes 17 and 19 the main cathode is connected directly to ground, and the starter cathode is connected to ground through resistance 22; and in the even tubes 18 and 20 the main anodes are connected directly to ground. The probe electrode 10 of any given tube is connected directly to the starter anode of the succeeding tube. Accordingly, the probe of tube 17 is connected to the starter anode of tube 18, the probe of tube 18 is connected to the starter anode of tube 19 and the probe of tube 19 is connected to the starter anode of tube 20. The chain is completed by having the probe of tube 20 connected through lead 23 to the starter anode 8 of tube 17.

Assume that the voltage source 16 is in the positive half of its cycle and that tube 17 has been ionized so that the main anode-main cathode gap has an electron discharge therein. The sustaining voltage is approximately 100 volts, as discussed hereinbefore. Since the probe 10 of tube 17 is placed close to the main anode 7, its potential is about 90 volts, which means that .01 microfarad condenser 24 has a charge of 90 volts thereon and also that starter anode 8 of tube 18 has a potential of 90 volts. When the alternating voltage source 16 decreases to a value of 100 volts, tube 17 will extinguish, since a potential of 100 volts is required to sustain the discharge in the main cathode main anode gap. The source voltage will then continue to decrease and will pass through zero and begin to apply a negative voltage to the resistance 21. During this interval of time, starter anode 8 of tube 18 has maintained a positive potential of 90 volts due to the charge on condenser 24. Since the minimum breakdown voltage of starter anode 8-starter cathode 9 gap of tube 18 is 175 volts, and since the starter anode 8 already has a positive 90 volts potential thereon, the line voltage must become 85 volts negative in order to produce the necessary 175-volt difference between the starter anode 8-starter cathode 9 gap. The starter cathode gap will thereupon break down, and a transfer of the discharge to the starter cathode 9-main anode 7 gap of tube 18 will immediately take place. When the alternating voltage source reaches a potential of minus 150 volts, the discharge will transfer to the main cathode 6-main anode 7 gap of tube 18, which will have a sustaining voltage of about 100 volts, thus placing the probe 10 of tube 18 at 90 volts as soon as condenser 25 charges.

It is to be noted that the probe voltage plus the difference of potential between the main anode 7 and the starter cathode 9 necessary to cause a transfer of the electron discharge from the starter anode 8-starter cathode 9 gap to the main anode 7-starter cathode 9 gap must be less than the minimum voltage required to break down the gap between the starter anode 8 and the starter cathode 9; otherwise the gas tube would be extinguished, since the difference of potential between the starter cathode 9 and the main anode 7 would be insufficient to transfer the discharge therebetween. Tube 18 will remain ionized until the alternating voltage source reaches the peak of its negative value and returns to a value of minus 100 volts, at which

5

time tube 18 will be extinguished leaving a potential of minus 90 volts on starter anode 8 of tube 18, wherein the cycle repeats itself when the next positive half-cycle of the alternating voltage source occurs.

The purpose of the 100,000-ohm resistances 22 in the circuit is to insure that a transfer will take place from the main anode 7-starter cathode 9 gap to the main anode 7-main cathode 6 gap. When a discharge exists between the main anode 7 and starter cathode 9, starter cathode 9 will be at a positive potential with respect to main cathode 6 because of the voltage drop across resistance 22. This difference of potential between starter cathode 9 and main cathode 6 will result in a transfer of the discharge to the gap between main anode 7 and main cathode 6 when the difference of potential between main anode 7 and main cathode 6 becomes sufficiently large.

It is to be understood that the form of this invention herein shown and described, is to be taken as a preferred example of the same and that various changes in the shape, size, materials used, and arrangement of parts may be resorted to without departing from the scope or spirit of the invention.

What is claimed is:

1. A gaseous discharge device comprising a main anode and a main cathode opposite thereto, a starter anode and a starter cathode opposite thereto, said starter cathode being of a material having a lower discharge sustaining voltage than said main cathode, and means for deriving a voltage from the main anode-main cathode discharge comprising a probe electrode positioned adjacent said main cathode.

2. A gaseous discharge device comprising a main anode, a main cathode positioned opposite said main anode, a starter cathode opposite said main anode and facing away from said main cathode, a starter anode opposite said starter cathode, and means for deriving a voltage from the main anode-main cathode discharge comprising probe means adjacent said main cathode, said starter cathode being of a material having a lower discharge sustaining voltage than said main cathode.

3. A gaseous discharge device comprising a main anode, a main cathode, a starter cathode opposite said main anode but shielded from said main cathode, a starter anode opposite said starter cathode and facing away from said main

6

cathode, and a probe electrode positioned adjacent said main cathode, said starter cathode being of a material having a lower discharge sustaining voltage than said main cathode.

4. A gaseous discharge device in accordance with claim 3 wherein said main cathode is of molybdenum and said starter cathode is of barium oxide.

5. A cold cathode gas tube comprising a hermetically sealed envelope having a base and filled with argon at about 15 millimeters of mercury pressure, a plurality of electrodes mounted from said base and within said envelope, said plurality of electrodes comprising a probe, a main anode, a starter anode, a main cathode of molybdenum, and a starter cathode having one surface composed of activated barium oxide and the other surface being of nickel, said activated barium oxide surface being positioned with respect to said main cathode so that any material sputtered off the main cathode will not come to rest on the said activated barium oxide surface.

6. An electron discharge device comprising a hermetically sealed vitreous envelope having a base, said envelope containing about 15 millimeters of mercury pressure of argon, a plurality of electrodes mounted on said base and within said envelope, said plurality of electrodes comprising a probe, a main anode, a starter anode, a main cathode of refractory metal and a starter cathode having one surface thereof composed of activated barium oxide and the other surface of nickel, said starter cathode electrode being so positioned with respect to said main cathode that material sputtered from said main cathode will not collect on said activated barium oxide surface.

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