

Aug. 12, 1952

M. A. TOWNSEND

2,607,015

MULTICATHODE GLOW DISCHARGE DEVICE

Filed Dec. 22, 1950

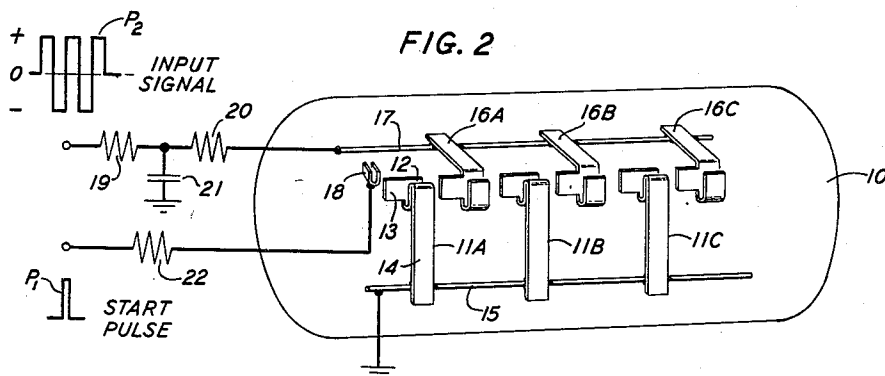
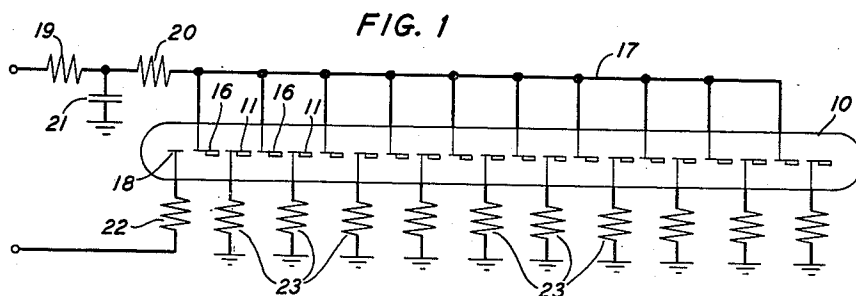
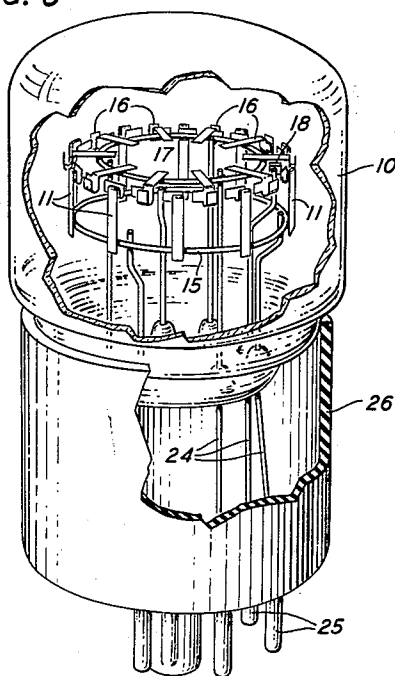


FIG. 3



INVENTOR
M. A. TOWNSEND
BY *[Signature]*
ATTORNEY

UNITED STATES PATENT OFFICE

2,607,015

MULTICATHODE GLOW DISCHARGE DEVICE

Mark A. Townsend, Berkeley Heights, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 22, 1950, Serial No. 202,284

5 Claims. (Cl. 313-188)

1

This invention relates to gaseous discharge devices and more particularly to multicathode glow discharge devices, such as of the general type disclosed in the application Serial No. 101,322 filed June 25, 1949 of M. A. Townsend, now Patent 2,575,370, granted November 20, 1951.

Devices of the type disclosed in the above-identified application comprise, in general, two groups of cathodes mounted in alternate relation and in cooperative relation with a common anode. The several cathodes are constructed and arranged to provide what has been termed a preference mechanism whereby in response to direct-current signal pulses applied between the two groups of cathodes the discharge is stepped or shifted in one direction from one cathode-anode gap to the next adjacent one, the number of steps being in accordance with the number of pulses applied.

One general object of this invention is to improve gaseous discharge devices of the type above described. More specific objects of this invention are to enable stepping of the discharge from cathode to cathode in such devices, directly in accordance with alternating-current signals, and to simplify the structure of multicathode, glow discharge, stepping and counting devices.

In one illustrative embodiment of this invention, a discharge device comprises an array of electrodes each capable of acting as a glow cathode. Each electrode is constructed to have two portions of different efficiencies as glow discharge sustaining elements and the several electrodes are mounted with the portion of higher efficiency of each in juxtaposition to the lower efficiency portion of a next adjacent electrode. An output circuit may be connected to one or more of the electrodes or a plurality of output circuits may be connected individually to several respective electrodes.

In accordance with one feature of this invention, the electrodes in the array are electrically grouped and energized in accordance with alternating-current signals so that each electrode acts alternately as a cathode and an anode, whereby in response to such signals a discharge, sustaining between any two adjacent electrodes, is stepped along the array, advancing two gaps for each cycle of the applied signals.

More specifically, in accordance with one feature of this invention, alternate electrodes are connected electrically in two groups and the alternating-current input signals, of amplitude sufficient to sustain a discharge between adjacent electrodes, are impressed between the two groups.

2

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is in part a diagram and in part a circuit schematic illustrating the principal elements and the organization thereof in a gaseous discharge device constructed in accordance with this invention;

Fig. 2 is a diagram showing a multistage discharge device illustrative of one embodiment of this invention, wherein a plurality of output circuits individual to alternate electrodes are provided; and

Fig. 3 is a perspective view showing details of construction of a discharge device illustrative of this invention.

Referring now to the drawing the discharge device illustrated in Figs. 1 and 2 comprises an enclosing vessel 10 having therein an ionizable atmosphere, such as a rare gas or a mixture of rare gases. Mounted within the vessel is a group of electrodes 11A, 11B and 11C each of which has a hollow or channel-shaped portion 12, a tail portion 13 and a stem or support portion 14. The several cathodes constituting this group are connected together electrically by a tie wire 15. Also mounted within the vessel and in alignment and in alternate relation with the electrodes 11 are a plurality of electrodes 16A, 16B and 16C. Each of the electrodes 16, like the electrodes 11, includes a hollow or channel-shaped portion, a tail portion and a stem or support portion. The electrodes 16 are connected together electrically by a tie wire 17.

The electrodes 11 and 16 advantageously are formed of sheet refractory metal, such as molybdenum or tantalum. As shown clearly in Fig. 1, each of the electrodes 16 is mounted with its hollow or channel-shaped portion in juxtaposition to the tail portion to the next succeeding electrode 11 and with its own tail in juxtaposition to the hollow or channel-shaped portion of the next preceding electrode 11. When a discharge sustains at any of the electrodes, the discharge will concentrate and highest ionization will obtain at the channel-shaped portion of that electrode because of the greater efficiency of this portion than the tail portion 13 as a discharge sustaining element. Thus, there is provided a preference mechanism whereby as explained hereinafter when one group of cathodes is pulsed relative to the other group transfer is effected in a prescribed direction; for example, if the discharge is

sustaining at electrode 11B and the electrodes 16 are pulsed positive relative to the electrodes 11 the tail portion of the electrode 16B will be adjacent a region of high ionization density whereas the electrode 16A will be adjacent a region of low ionization density. Consequently, the discharge will be shifted from electrode 11B to electrode 16B rather than in the opposite direction. Thus, by virtue of the preference mechanism noted, stepping or shifting of the discharge occurs to the right in Fig. 1.

Adjacent the electrode 11A is an auxiliary electrode 18 which may be connected to a pulse source not shown by way of resistor 22. The electrodes 16 are connected to a source of alternating-current input signals through series connected resistors 19 and 20 having associated therewith a condenser 21 as shown.

In the operation of the device, a positive starter pulse, indicated at P₁, is applied to the auxiliary electrode 18 whereby a discharge is initiated between the electrodes 11A and 18, the electrode 11A acting as a cathode. On the first positive half cycle of the input signal, indicated at P₂, a discharge is established between electrodes 11A and 16A with the electrode 11A acting as a cathode and the electrode 16A as an anode. On the succeeding negative half cycle of the input signal the polarity of the electrode 16 relative to the electrodes 11 is reversed and breakdown occurs to the electrode 16A acting as a cathode. At first because of residual ionization from the first positive half cycle of the input signal, electrode 11A will act as an anode. However, because of the construction of the electrode 16A as above described, ionization will be high or intense in the region between the electrodes 16A and 11B and the discharge obtains between electrode 16A acting as a cathode and electrode 11B acting as an anode. On the next succeeding positive half cycle of the input signal, electrode 16A becomes an anode and electrode 11B acts as a cathode. On the next succeeding negative half cycle of the input signal electrode 11B becomes the cathode and electrode 16B functions as an anode.

Thus for each half cycle of the input signal the discharge is moved one position along the row of electrodes advancing in effect from one cathode to the next succeeding one.

Although in the construction illustrated in Fig. 2 six discharge sustaining electrodes are shown, it will be understood, of course, that a greater number may be employed. For example, as shown in Fig. 1, the device may comprise twenty such electrodes and be capable of counting ten complete or twenty half cycles. Each of the electrodes 11 may have associated therewith a suitable output or indicating circuit indicated generally by resistors 23 whereby when a discharge sustains at any of these electrodes a pulse is produced across the respective resistor. These pulses may be recorded, for example in the manner described in the application of M. A. Townsend heretofore identified.

It will be understood, of course, that the input signal should be of amplitude sufficient to sustain a discharge between adjacent electrodes 11 and 16; for example, in a typical device wherein the vessel 10 had therein a filling of neon at a pressure of 50 millimeters of mercury, the peak amplitude of the input signal was approximately 200 volts.

The resistors 19 and 20 together with the capacitance 21 determine the rate of reapplication of the voltage on each half cycle of the input sig-

nal. Specifically, the parameters of these impedances are correlated so that with a neon filled tube a delay of the order of 50 to 200 microseconds occurs in the process of reversing the voltage across the tube. The delay must of course be less than the deionization time of the gas involved.

One physical embodiment of a discharge device constructed in accordance with this invention is illustrated in Fig. 3. As there shown, the several electrodes 11 and 16 in alternate relation are mounted in a circle, the electrodes 11 and electrodes 16 being interconnected electrically by respective tie rings 15 and 17. These tie rings in turn are connected to leading-in conductors 24, in turn connected to terminal prongs 25 upon a base 26 to which the enclosing vessel 10 is affixed. It will be understood, of course, that if in the device illustrated in Fig. 3 individual outputs for the several electrodes 16 are desired, respective leading-in conductors for these electrodes will be provided as in the manner indicated in Fig. 2.

It will be appreciated that inasmuch as in the device illustrated in Fig. 3 the several electrodes 11 and 16 are mounted in circular array, frequency dividing may be obtained one output pulse being realized at one electrode for each ten complete cycles of an alternating-current input signal.

Although specific embodiments of this invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention.

What is claimed is:

1. A gaseous discharge device comprising an array of similar electrodes each capable of functioning as a glow cathode, means electrically connecting said electrodes in two groups with the electrodes of the two groups in alternate relation, said electrodes including means defining a directional preference mechanism, and means for impressing between said two groups alternating-current signals of amplitude sufficient to sustain a glow discharge between adjacent electrodes.

2. A gaseous discharge device comprising an array of electrodes each having two portions of different efficiencies as glow discharge elements, said electrodes being mounted with the higher efficiency portion of each in juxtaposition to the lower efficiency portion of the next succeeding electrode in the array, means electrically connecting one group of alternate electrodes together, means electrically connecting the other alternate electrodes together, and means for driving said other alternate electrodes alternately positive and negative relative to said one group sufficiently to sustain a discharge between adjacent electrodes.

3. A gaseous discharge device in accordance with claim 2 comprising load circuits individual to the electrodes in said one group.

4. A gaseous discharge device comprising a plurality of refractory metal electrodes each having a channel portion and a tail portion, said electrodes being mounted in a row with the channel portion of each adjacent the tail portion of the next succeeding electrode, means electrically connecting said electrodes in two groups with the electrodes of the two groups in alternate relation, and means for impressing between said two groups alternating-current signals of amplitude sufficient to sustain a glow discharge between any two adjacent electrodes.

5. A gaseous discharge device comprising a plurality of refractory metal electrodes each having

5

a channel portion and a tail portion, said electrodes being mounted in a row with the channel portion of each adjacent the tail portion of the next succeeding electrode, an auxiliary electrode adjacent one of said first electrodes, means electrically connecting said electrodes in two groups with the electrodes of the two groups in alternate relation, means for establishing a discharge between said auxiliary electrode and said one electrode, and means for stepping the discharge along

5

10

6

said row comprising means for applying alternating-current signals between said two groups.
MARK A. TOWNSEND.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,524,213	Wales	Oct. 3, 1950