June 22, 1954 M. A. TOWNSEND 2,682,015

GASEOUS DISCHARGE STEPPING DEVICE

Filed Jan. 22, 1953

FIG. 1

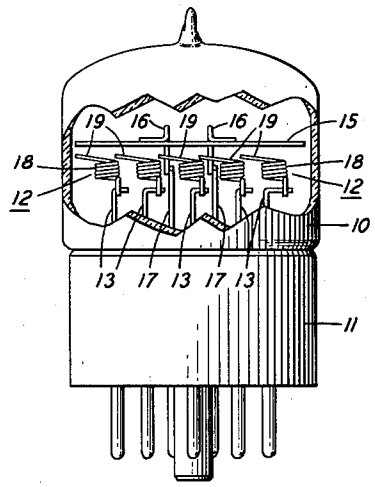


FIG. 2

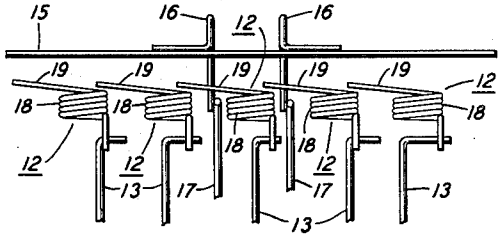
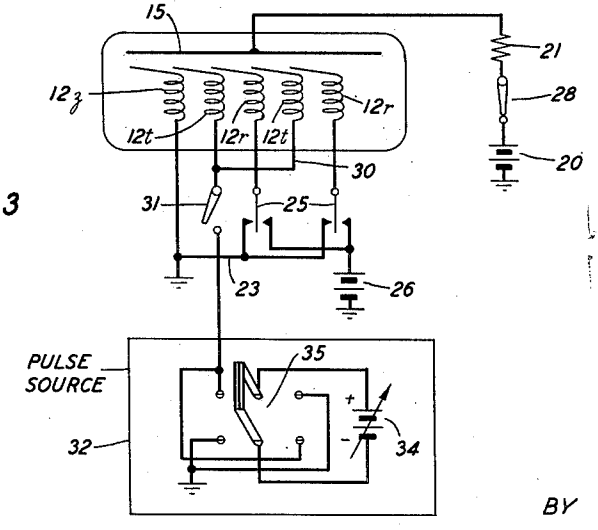


FIG. 3



INVENTOR
M. A. TOWNSEND

BY James W. Falk

ATTORNEY

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GASEOUS DISCHARGE STEPPING DEVICE

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

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3 Claims. (Cl. 315—169)

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This invention relates to cold cathode gaseous discharge devices and more particularly to such devices wherein the gaseous discharge is stepped along a row of cathodes in response to applied pulses.

In such devices, which have become known as stepping tubes and which are described generally in my Patent 2,575,370 of November 20, 1951, the cathodes are generally divided into two groups, designated as rest and transfer cathodes, and cathodes of these groups are arranged alternately in the row of cathodes. These devices have also been referred to as gaseous discharge storage tubes of the glow transfer type. When a discharge has been initiated at one particular rest cathode, application of a pulse to the transfer cathodes, which are advantageously connected together, causes the discharge to step, in a particular direction, from the particular rest cathode to a transfer cathode and thence, on removal of the pulse, to the next adjacent rest cathode.

The direction of the stepping of the discharge is determined by employing cathodes having preference mechanisms, as described in my above-mentioned patent. Such cathodes comprise a portion of high discharge efficiency and a portion of low discharge efficiency. The low discharge efficiency portion is adjacent the high discharge efficiency portion of the preceding cathode. When a discharge is present at a particular cathode, it will tend to concentrate at the high efficiency portion, and thus the low efficiency portion of the next cathode will be adjacent this region of intense ionization. When a pulse is applied to the transfer cathodes, the discharge will transfer to the low discharge efficiency portion of this adjacent transfer cathode due to this ionization adjacent that portion and then will itself migrate from the low efficiency portion to the high efficiency portion. On removal of the pulse, the glow discharge will similarly transfer to the next adjacent rest cathode.

Preference cathodes having these two discharge efficiency portions may be of several types as fully set forth in my above-mentioned patent. One particular cathode structure that it is advantageous to employ due to its simplicity, low cost, and the ease with which it may be fabricated is formed from a single wire, the high efficiency discharge portion being provided by winding the wire into a closed helix or open-ended cylinder, thereby providing a hollow cathode, and the low efficiency portion is provided by one end of the wire extending from the helix

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or cylinder, as set forth in my application Serial No. 254,327, filed November 1, 1951, now Patent No. 2,627,053, issued January 27, 1953.

A general object of this invention is to provide an improved gaseous discharge device of the stepping tube type and more particularly to provide an improved stepping tube employing open-ended cylinders having wire portions extending therefrom as the preference cathodes of the tube.

In accordance with this invention, a number of such preference cathodes are arranged in a glow transfer path with an anode equidistant from the open end of each cathode and the low discharge efficiency wire portion of each cathode extends intermediate the preceding cathode and the anode so that when a transfer pulse is applied, the electric field between the end of the wire portion and the anode will be more intense than that between the anode and the remainder of the cathode, causing a considerable overvoltage, i. e., voltage above that required for breakdown, to be present at the end of the wire portion. By employing this overvoltage in addition to the intense ionization present at the end of the wire portion due to the discharge at the preceding cathode, very rapid pulse rates may be utilized.

It is, therefore, a feature of this invention that the wire portion of each preference cathode of a glow discharge device of the stepping tube type extend intermediate the high efficiency portion of the preceding cathode and the anode to establish the preferential glow transfer path to the cathode when a glow discharge exists between the anode and the preceding cathode.

A complete understanding of this invention and of the various features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a side view of a stepping tube illustrative of one specific embodiment of this invention;

Fig. 2 is a side view of the preference cathodes and anode of the embodiment of Fig. 1; and

Fig. 3 is a schematic representation of the embodiment of Fig. 1 together with a circuit in which it may be employed or tested.

Turning now to the drawing, the specific illustrative embodiment of this invention depicted in Fig. 1 comprises an envelope 10, as of glass, positioned in a base 11, as is known in the art. Positioned within the envelope 10 are a number of preference cathodes 12 arranged in a glow transfer path; these cathodes may advantageously be supported by leads 13 extending

through the base of envelope 10. An anode, which may comprise a single wire 15, is positioned equidistant from the open end of the cathodes 12 and may advantageously be supported by a support wire 16 attached to a lead 17 extending through the envelope 10.

As best seen in Fig. 2, each of the cathodes 12 comprises an open-ended cylinder portion 18 from which a conductive wire portion 19 extends; advantageously, the cylinder portion 18 and wire portion 19 are formed by winding a single wire into a closed helix and leaving an end extending therefrom, as disclosed in my application Serial No. 254,327, filed November 1, 1951, now Patent No. 2,627,053, issued January 27, 1953, so that the wire and cylindrical portions of the cathode are integral.

In accordance with one feature of this invention, the wire portion 19 of a cathode 12 extends towards the hollow cylinder portion 18 of the preceding cathode 12 so as to be positioned not only intermediate the two cathodes but also intermediate the hollow portion 19 of the preceding cathode and the anode 15. The amount of this overlap of the wire portion 19 is not critical, as it is only of importance that the end of the wire 19 be both within a region of intense ionization when the glow is present at the preceding cathode and also be closer to the anode 15 than the remainder of the cathode 12 in order to attain the advantages of this invention. The anode 15 may be offset slightly from the row of cathodes 12. However, as the end of the wire 19 protrudes into the glow discharge so that the glow discharge is along it and is closer to the anode, rapid stepping of the discharge can be attained.

In one specific illustrative embodiment that has been constructed, the cathodes 12 each comprised four turns of .020 inch diameter molybdenum wire closely wound on a mandrel consisting of two other .020 inch diameter wires side by side, i. e., on a .020 x .040 inch mandrel. The conductive wire portion 19 extended 7/64 inch beyond the outer surface of the open cylinder portion 18 and the spacing between the end of the wire portion 19 and the top surface of the preceding open cylinder portion 18 was .015 inch. The distance from the top of the end of the wire portion 19 to the anode 15 was .035 inch, and the anode itself was a .030 inch diameter molybdenum wire. The envelope 10 was filled with neon at 50 millimeters of mercury pressure.

Turning now to Fig. 3, there is shown one particular circuit that may be employed in the utilization of the device of Figs. 1 and 2. A suitable operating voltage is applied to the anode 15 from a voltage source 20 through an anode resistor 21. A common connection is provided for the one group of alternate cathodes 12*r*, which define the rest cathodes, by a lead 23, the initial or zero rest cathode 12*z* being connected directly to the lead 23, which is grounded, and the other rest cathodes being connected to the lead 23 through switches 25.

One advantageous manner for initiating the glow discharge between the one preselected rest cathode 12*z*, which is the first or zero cathode, and the anode 15 is to connect the remaining rest cathodes, through the switches 25, to a positive voltage source 26 before applying the voltage source 20 to the anode 15 by closing switch 28. The discharge will thus be prevented from breakdown to the other rest cathodes and will be initiated only at the first or zero rest cathode; advantageously, during this operation, a positive potential is also applied to the other alternate group of cathodes 12*t* which define the transfer cathodes. The transfer cathodes 12*t* also have a common connection between themselves comprising the wire lead 30 which is connected, through a switch 31, to a pulse source 32.

The pulse source 32 may comprise any of a number of circuits or arrangements for applying two successive voltage changes to the transfer cathodes to cause a transfer of the glow discharge from one rest cathode to the succeeding one. In the specific circuit depicted in Fig. 3, the pulse source 32 comprises a source of voltage 34 connected to the transfer cathodes both through the switch 31 and through a double pole reversal switch 35. Thus, by operating the reversal switch 35, the voltage applied to the transfer cathodes can be changed from a positive value to a negative value, or vice versa thereby to apply two successive voltage changes to the transfer cathodes.

Reference is made to application Serial No. 117,316, filed September 23, 1949, of H. L. von Gugelberg wherein a related invention is disclosed and claimed.

While a specific embodiment of this invention has been illustrated and described above, it is to be understood that it is but illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A gaseous discharge storage tube of the glow transfer type wherein a glow discharge is sequentially transferred from one preselected position within the tube to another to store a given manifestation including a number of cathodes arranged in a glow transfer path and formed as open-ended cylinders; an anode arranged equidistant from the open end of each cathode; means for initiating a glow discharge between one preselected cathode and said anode; a first common connection between alternate ones of said cathodes in the path and a second common connection between the remaining cathodes, thereby providing for the application of different voltage values to the cathodes joined by said first and second common connections; and conductive means intermediate adjacent cathodes in said path and intermediate the first of those two adjacent cathodes and the anode for establishing a preferential glow transfer path to the second of the two adjacent cathodes when a glow discharge exists between said anode and the first of the two adjacent cathodes.

2. A gaseous discharge storage tube of the glow transfer type wherein a glow discharge is sequentially transferred along a path to effect storage including a source of voltage; glow storage position indicating cathodes and one starting cathode arranged in spaced relation along a line; current conductive means including an electrical switch commonly connecting said position cathodes to said source; current conductive means connecting said starting cathode to said source; transfer cathodes, one arranged intermediate each two adjacent position cathodes; an anode arranged equidistant from each of said cathodes; a source of pulses to be stored; pulse responsive voltage changing means commonly connected to said transfer cathodes for applying two successive voltage changes thereto in response to each pulse to be counted; means coupling said source of pulses and said voltage changing means;

a glow transfer wire connected to each transfer cathode and extending intermediate each position cathode and said anode so that each time a glow discharge is present between that position cathode and the anode a glow discharge is present along said wire thereby establishing a preferential glow transfer path from that position cathode to that transfer cathode; a glow transfer wire connected to each position cathode and extending intermediate each transfer cathode and said anode so that each time that a glow discharge is present between that transfer cathode and the anode a glow discharge is present along said wire thereby establishing a preferential glow transfer path from that transfer cathode to that position cathode; and means for rendering said tube operable to sequentially advance the glow discharge from one position cathode to the next in response to each pulse to be stored, said glow discharge first being advanced to the transfer cathode intermediate the position cathodes.

3. A gaseous discharge device comprising a

plurality of cathodes arranged in a glow transfer path and formed as open-ended cylinders, said cathodes being arranged in alternate groups defining rest and transfer cathodes; an anode arranged equidistant from the open end of each cylinder; means for initiating a glow discharge between one of said rest cathodes and said anode; means for applying pulses to each of said transfer cathodes to transfer said discharge from one rest cathode to the next rest cathode in said path; and a wire extending from each of said cylinders and extending intermediate the cylinder of the preceding cathode and the anode so as to be within the region of intense ionization of a glow discharge present at that preceding cathode.

References Cited in the file of this patent

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