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A. L. SAMUEL
GLOW TRANSFER TRIGGER

2,741,699

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2 Sheets-Sheet 1

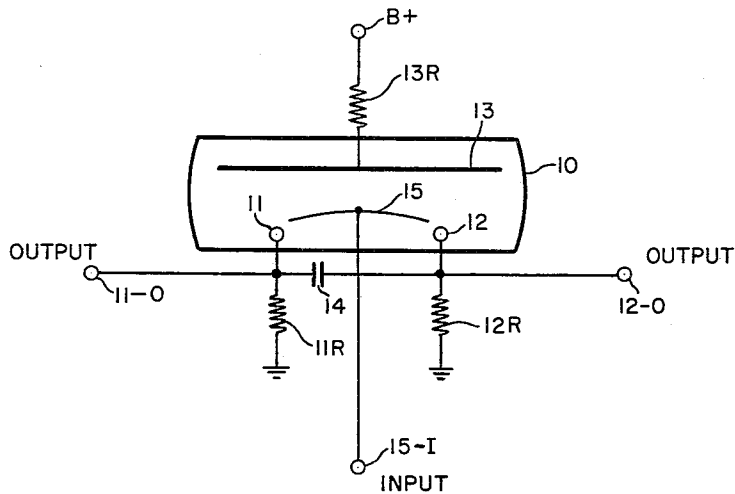


FIG 1

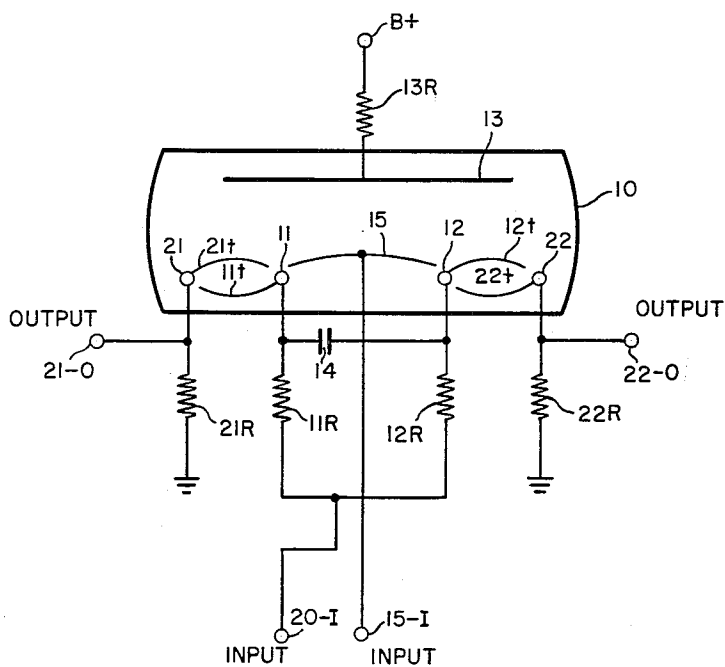


FIG 2

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FIG. 1a

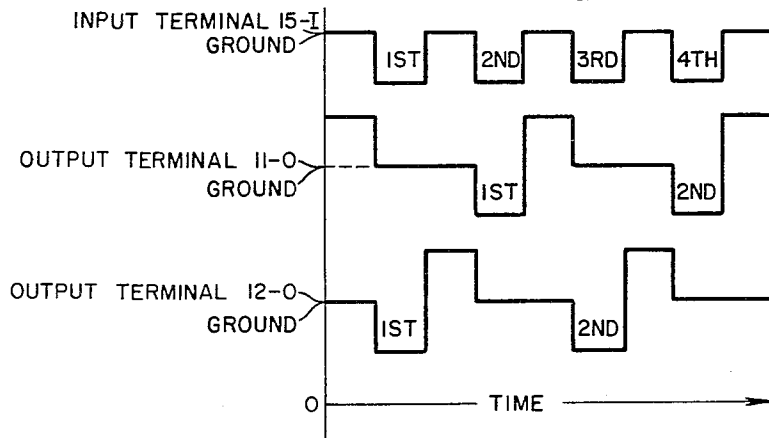
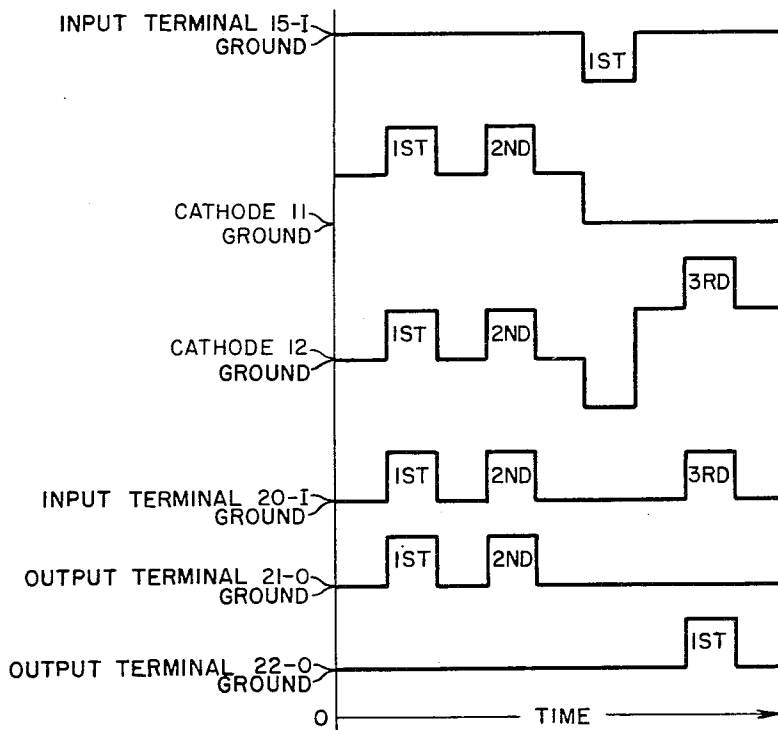


FIG. 2a



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1

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GLOW TRANSFER TRIGGER

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Application April 16, 1952, Serial No. 282,657

4 Claims. (Cl. 250—27)

This invention relates to gaseous discharge tubes and more particularly to a novel discharge tube of the glow transfer type operable as a trigger having two stable conditions alternately assumed and having further switching means associated with each stable condition.

A conventional gaseous discharge switch of the glow transfer type provides two capacitively coupled cathodes and an anode common thereto. A glow discharge is established between one cathode and the anode. Each input pulse applied to the cathodes causes the glow discharge to be extinguished and another glow discharge to be created between the other cathode and the anode. Such is disadvantageous in that it requires both a de-ionization and ionization of the gaseous atmosphere within the tube in response to each input pulse.

Accordingly, it is a principal object of the invention to provide a trigger circuit of the glow transfer type wherein the above disadvantages are avoided.

Another object is to provide a trigger circuit of the glow transfer type having two cathodes, an anode common thereto, and glow transfer means intermediate the cathodes to effect glow transfer therebetween in response to each input pulse applied to the trigger circuit.

Another object is to provide a gaseous switch tube of the glow transfer type wherein means are provided intermediate two cathodes to effect a physical transfer of a glow discharge therebetween and to receive an input voltage for initiating such transfer.

A further object is to provide a novel gaseous switch tube of the glow transfer type having one anode, two cathodes providing a trigger having two stable conditions alternately assumed and an additional cathode in glow transfer relation with each of the said two cathodes to provide two switches.

A still further object is to provide a gaseous discharge tube of the glow transfer type wherein a first glow transfer cycle is completed in response to each two consecutive input pulses from a first input and a second glow transfer cycle is completed in response to each input pulse from a second input.

Still another object is to provide a gaseous discharge tube of the glow transfer type wherein a single glow discharge is transferred therein in accordance with the time and amplitude relation of pulses from two separate input sources.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a diagrammatic representation of one embodiment of the invention,

Fig. 1a shows wave forms indicating the operation of the embodiment shown in Fig. 1,

Fig. 2 is a diagrammatic representation of another embodiment of the invention, and

2

Fig. 2a shows wave forms indicating the operation of the embodiment shown in Fig. 2.

Briefly, one embodiment of the invention comprises two cathodes, an anode common thereto, and a glow transfer wire positioned intermediate the two cathodes to effect glow transfer from either cathode to the other in response to an electrical manifestation or pulse applied to the glow transfer wire. The two cathodes, transfer wire and anode are placed in a suitable gaseous atmosphere contained within a single envelope. Output connections are provided at each cathode in response to alternate negative pulses applied to the transfer wire. At all times during operation a single glow discharge exists within the tubes between one of the cathodes and the common anode.

The type of cathode used and the general principle utilized by a transfer wire intermediate two cathodes to effect glow transfer are explained in detail in the application of Richard K. Steinberg, Serial No. 192,199 filed October 26, 1950, and entitled "Glow Transfer Storage Device," now Patent No. 2,621,313.

In another embodiment of the invention additional cathodes are connected in glow transfer relation to the cathodes to provide a trigger switch. The principles of operation of such a switch are described in detail in the application of Arthur L. Samuel, Serial No. 282,658 filed April 16, 1952, entitled "Glow Transfer Trigger Switch."

Referring more particularly to Fig. 1 the elements of the gaseous discharge trigger circuit are contained within the envelope 10. The cathodes 11 and 12 of the type described in the application of Richard K. Steinberg referred to herein, are connected through resistors 11R and 12R respectively to ground and an anode 13 is connected through a load resistor 13R to a terminal designated B+ which is connected to a suitable source of positive voltage. Output terminals 11-O and 12-O are connected to the cathodes 11 and 12 respectively. Capacitor 14 is connected between the cathodes 11 and 12. A glow transfer wire 15 is positioned intermediate the cathodes 11 and 12 but out of physical contact with either. One end of glow transfer wire 15 is positioned intermediate the cathode 11 and the anode 13 and the other end is positioned intermediate the cathode 12 and the anode 13. Transfer wire 15 is connected to an input terminal 15-I.

When the positive voltage is applied at B+ a glow discharge will be created between one of the cathodes 11 and 12 and the anode 13. The cathode to which the glow discharge will exist will be determined by the slight difference in the electrical characteristics of the two cathodes. If a glow discharge is desired at one particular cathode any suitable means such as a switch may be provided to open the connection of the other cathode to ground. When this glow discharge is thus established the ground connection may be re-established without altering the stable condition of the glow discharge.

For purposes of explanation it is assumed that a glow discharge exists initially between the cathode 11 and the anode 13 and description will be undertaken by conjoint reference to Figs. 1 and 1a. It follows if a glow discharge exists at the cathode 11 that the voltage at the cathode 11 is more positive than that at the cathode 12 because of the voltage drop across the resistor 11R caused by current flow through the cathode 11.

The first negative input pulse (Fig. 1a) applied to the input terminal 15-I causes a similar negative voltage to exist at the transfer wire 15. This voltage is more negative than the voltage at the cathode 11. Hence, a greater voltage difference is present between the transfer wire 15 and the anode 13 than is present between the cathode 11 and the anode 13. The glow discharge is accordingly transferred from the cathode 11 to the transfer wire 15 and exists between the transfer wire 15 and the anode 13.

The voltage at the cathode 11 is thus decreased (Fig. 1a) and the negative pulse so developed is transferred through the capacitor 14 to the cathode 12. The cathode 12 is now negative with respect to ground (Fig. 1a). The voltage difference between the cathode 12 and anode 13 is therefore greater than that between cathode 11 and anode 13. As a result, when the first negative voltage pulse ends the glow discharge is transferred from the transfer wire 15 to the cathode 12 and exists between the cathode 12 and the anode 13. Hence, the first negative input pulse produced a first negative output pulse at terminal 12-O.

The second negative input pulse applied to the input terminal 15-I causes a similar sequence of voltage changes to transfer the glow discharge back to the cathode 11. The glow discharge is transferred from the cathode 12 to the transfer wire 15 and the voltage at cathode 12 decreases. This decreased voltage is transferred through the capacitor 14 to the cathode 11 to decrease the voltage at the cathode 11 (Fig. 1a). When the second negative pulse ends the glow discharge is transferred from the transfer wire 15 to the cathode 11 thereby causing a sharp voltage increase at the cathode 11 (Fig. 1a). Hence, the second input pulse applied to the terminal 15-I causes a first negative output pulse to be produced at the output terminal 11-O.

From the above description of a cycle of trigger operation and reference to Fig. 1a, it is readily seen that the third input pulse applied to the input terminal 15-I caused a second negative pulse to be produced at the output terminal 12-O. Also that the fourth input pulse applied to the input pulse 12-I causes a second negative output pulse to be produced at the output pulse 11-O. Hence, a negative output pulse appears at each output terminal in response to alternate negative input pulses applied to the terminal 15-I. These negative output pulses are all identical.

From inspection of Fig. 1a, it is seen that positive output pulses are produced in response to the input terminal going positive immediately following the end of each negative input pulse.

It is immediately seen from Fig. 1a and the above description that the glow discharge exists between the transfer wire 15 and the anode 13 during the time an input pulse is actually applied, glow transfer from and to the cathodes taking place when the input goes negative and positive, respectively. Such provides a uniform output faithfully following the input pulses while effecting glow transfer from each cathode to the other and making unnecessary the repeated ionization and de-ionization of the gaseous atmosphere within the envelope 10.

Referring to Fig. 2, parts similar to those shown in Fig. 1 are similarly designated. The cathode resistors 11R and 12R are connected together and to a common input terminal 20-I. Additional cathodes 21 and 22 are connected to ground through the resistors 21R and 22R respectively and to the output terminals 21-O and 22-O. A glow discharge may be transferred from the cathode 12 to the cathode 22 via the transfer wire 22t and from the cathode 22 to the cathode 12 via the transfer wire 12t. Similarly, a glow discharge may be transferred from the cathode 11 to the cathode 21 via the transfer wire 21t and from the cathode 22 to the cathode 11 via the transfer wire 11t.

Operation of the embodiment shown in Fig. 2 will be described by conjoint reference to Figs. 2 and 2a. If a glow discharge exists to the cathode 11 and a first positive input pulse is applied to the terminal 20-I the voltage difference between the cathode 21 and the anode 13 is greater than that between the cathode 11 and anode 13 and the glow discharge is transferred over the transfer wire 21t to exist between the cathode 21 and the anode 13. There is no tendency to transfer the glow discharge via transfer wire 15 to the cathode 12 because the voltage difference between cathode 12 and anode 13 is also decreased

by the positive input pulse applied to the input terminal 20-I.

When the glow discharge arrives at cathode 21 the voltage thereat increases and a positive voltage appears at the output terminal 21-O. This positive voltage continues at the cathode 21 until the first positive input pulse goes negative, at which time the voltage difference between the cathode 11 and the anode 13 becomes greater than that between the cathode 21 and the anode 13 and the glow discharge is transferred via the transfer wire 11t to the cathode 11. Hence, this first positive input pulse applied to the terminal 20-I caused a first positive output pulse to appear at the output terminal 21-O and a first positive pulse to appear at the cathodes 11 and 12. A second input pulse from the terminal 20-I will cause a repetition of the operation caused by the first input pulse. If a first negative input pulse is now applied to the input terminal 15-I, it will effect a transfer of the glow discharge via the transfer wire 15 from the cathode 11 to the cathode 12 in the manner described in connection with Fig. 1 and appreciated from Fig. 2a.

If a third positive input pulse is now applied to the input terminal 20-I the glow discharge will be transferred from the cathode 12 to the cathode 22 when this input pulse goes positive and from the cathode 22 to the cathode 12 when it goes negative. As a result a third and more positive pulse is produced at the cathode 12 and a first positive output pulse is produced at the output terminal 22-O. As seen from Fig. 2a two input pulses have been applied to the input terminal 20-I, one input pulse has been applied to the input terminal 15-I and one output pulse has been produced at the output terminal 22-O.

Subsequent input pulses applied to the terminal 20-I will produce an output pulse in response to each input pulse applied. It is understood that each two input pulses applied to the input terminal 15-I cause glow transfer from the cathode 11 to the cathode 12 and back again to the cathode 11. It is seen, therefore, that the cathodes 11 and 21 function as a switch when pulses are applied to the input terminal 20-I as do the cathodes 12 and 22 and that the cathodes 11 and 12 function as a trigger when pulses are applied to the input terminal 15-I. When input pulses are applied simultaneously to the input terminals 15-I and 20-I the voltage difference caused by each compensates for that caused by the other and there is no transfer of the glow discharge. However, if there is sufficient difference in the amplitude of the input pulses then glow transfer may be effected.

From the operation of Fig. 2 as demonstrated by Fig. 2a it is seen that by the preselected choice of the time relationship of the pulses applied to the input terminals 15-I and 20-I numerous predetermined outputs may be obtained.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. A gaseous discharge trigger circuit of the glow transfer type wherein the physical position of a glow discharge within a gaseous atmosphere indicates two stable conditions alternately assumed in response to successive impulses including; two cathodes and an anode common thereto; glow transfer means intermediate said cathodes and intermediate each cathode and said anode; voltage means for establishing a glow discharge between said anode and one of said cathodes; coupling means connected to said cathodes and responsive to said glow discharge; electrical input means connected to said glow

5

transfer means for effecting a transfer, along said transfer means, of said glow discharge from one cathode to another; an additional cathode connected in glow transfer relation to each of said two cathodes so that said glow discharge is selectively transferable between either of said additional cathodes and the related one of said two cathodes; second electrical input means commonly connected to said two cathodes; and output means connected to said additional cathodes.

2. A gaseous discharge tube of the glow transfer type wherein a single glow discharge is established within said tube between an anode and a first cathode; a second cathode, first glow transfer means suspended within said tube for effecting glow transfer between said first and second cathodes; first input means connected to apply a voltage change to said first transfer means to attract said glow discharge thereto and therealong to the other of said first and second cathodes; a third cathode; second glow transfer means intermediate said first cathode and said third cathode and arranged to permit cycling of the glow discharge therebetween; and second input means for applying a voltage change to said first cathode to transfer said glow discharge between said first and third cathodes.

3. In a gaseous discharge tube of the glow transfer type wherein two stable glow discharge positions represented respectively by glow discharge between an anode and either of two cathodes; voltage receiving means within said tube for transferring glow discharge along a single glow transfer path from each cathode to the other in response to each pulse from a first input source applied to said means; an additional glow transfer path associated with each of said two cathodes for cycling said glow discharge and each said path including at least one additional cathode connected in glow transfer to the

6

corresponding one of said two cathodes; a second input source connected to apply a pulse to one of the cathodes of each said additional glow transfer path; and output means connected to the other cathode of one of the additional glow transfer paths to provide an output thereat dependent upon the pulse applied from said first and second sources.

4. A gaseous glow transfer tube including first electrode means establishing a path of stable step-by-step glow transfer therein in response to pulses; second electrode means in glow transfer relation to said first electrode means for establishing at least one path of unstable glow transfer; pulse means connected to said electrode means for applying a pulse to transfer the glow discharge from a preselected position in said path of stable step-by-step glow transfer to a path of unstable glow transfer and returning said glow discharge to the same position in said path of stable step-by-step glow transfer; and output means for deriving a predetermined output from said tube.

References Cited in the file of this patent

UNITED STATES PATENTS

2,575,516	Hagen	Nov. 20, 1951
2,598,677	Depp	June 3, 1952
2,638,564	Williams and Hagen	May 12, 1953

FOREIGN PATENTS

486,752	Canada	Sept. 23, 1952
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OTHER REFERENCES

"Cold Cathode Glow Discharge Tube," by G. H. Hough and D. S. Ridler, *Electronic Engineering*, pages 152-157, April 1952; pages 230-235, May 1952; and pages 272-276, May 1952. (Copy in Div. 54.)