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G. O. CROWTHER

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CIRCUIT ARRANGEMENT FOR ELECTRIC DISCHARGE TUBE

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FIG. 1

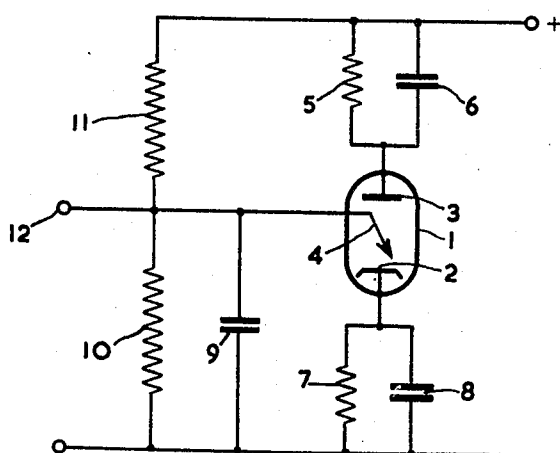
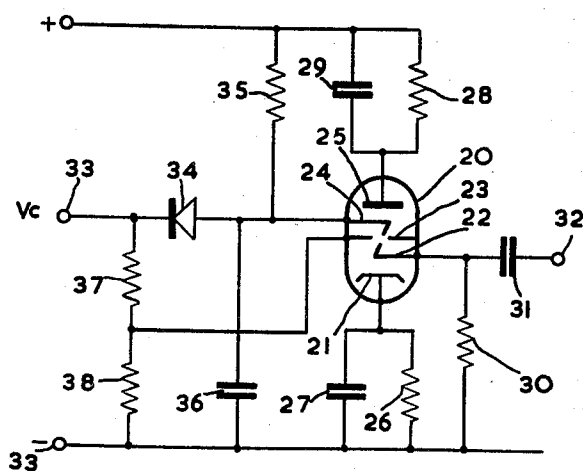


FIG. 2



INVENTOR
GERALD OFFLEY CROWTHER

BY

Gerald M. Crowther
AGENT

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2,907,922

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Gerald Offley Crowther, New Malden, England, assignor, by mesne assignments, to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Application December 20, 1955, Serial No. 554,345

Claims priority, application Great Britain December 21, 1954

6 Claims. (Cl. 315—234)

This invention relates to circuit arrangements comprising a glow discharge tube having a cold cathode and an ignition anode.

In many such circuit arrangements, for example those comprising Geiger-Müller counting tubes for radiation measurements and dynamic stabilizers, it is highly desirable that the time interval which elapses between the extinction of the discharge and the instant when the discharge can again be ignited should be a minimum.

During a discharge the potential of the ignition anode is coupled via the burning voltage with that of the cathode, so that this potential is lower than that required for maximum sensitivity. Such is the case more particularly, if the ignition anode also constitutes the anode of an auxiliary discharge for suppressing ignition delays. Consequently, the potential of the ignition anode must increase after each discharge, which takes up much time due to the high time-constant of the circuit of the ignition anode. The high time-constant of the ignition anode is due to the high input resistance which, if necessary, must also limit the auxiliary discharge current, and due to the high capacity, which is required for rapid development of the discharge upon occurrence of an ignition pulse. The consequence of the slow restoration of the potential of the ignition anode is that the tube may be insensitive during a period which is many times longer than the deionization time.

The object of the invention is to provide a circuit arrangement in which the potential of the ignition electrode can acquire comparatively rapidly the value required for a subsequent ignition despite the high time-constant of the circuit of the ignition anode.

According to the invention, in a circuit arrangement comprising a glow discharge tube having a cold cathode and an ignition anode, the load resistance of the tube is included wholly or in part in the cathode circuit, so that immediately before extinction of the discharge, the cathode and the main discharge maintain the ignition anode at a potential as required for re-ignition, the time-constant of the cathode circuit being considerably less than that of the ignition anode circuit.

When a discharge is initiated, the potential of the ignition anode first decreases as a result of the series resistor, but the potential of the main cathode increases as a result of the resistor in the cathode circuit. Subsequently, the potential of the ignition anode also increases due to the discharge, it being possible for the different magnitudes to be so chosen that the ignition anode acquires the desired potential precisely before the extinction of the main discharge. The circuit arrangement is preferably of the self-extinguishing type, the cathode circuit including the parallel combination of a resistor and a capacitor, and having a time-constant which is less than $\frac{1}{2}$ of that of the ignition anode circuit.

The lead of the ignition anode preferably includes a rectifier which is connected to a constant voltage, so that the ignition anode cannot assume so high a voltage that spontaneous re-ignition is possible.

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The circuit arrangement according to the invention may advantageously be used with a tube of the type described in copending patent application, Serial No. 554,343, filed December 20, 1955, in which the anode and the cathode are separated by a de-ionizing screen, to which more than half of the discharge extends in parallel. This screen may be so connected that at the moment of extinction it is the most negative electrode, due to the increase in cathode potential.

In order that the invention may be readily carried into effect, it will now be described by way of example, with reference to the accompanying drawing, in which:

Fig. 1 is a schematic diagram of an embodiment of the circuit arrangement of the present invention; and

Fig. 2 is a schematic diagram of another embodiment of the circuit arrangement of the present invention.

Referring to the pulse amplifying circuit arrangement of Fig. 1, a glow discharge tube is indicated by reference numeral 1. The anode 3 of tube 1 is connected to the positive terminal of a voltage source via a parallel combination of a resistor 5 and a capacitor 6. The cathode 2 of tube 1 is connected to the negative terminal of the voltage source via a parallel combination of a resistor 7 and a capacitor 8. The ignition anode 4 of tube 1 is connected via a capacitor 9 to the negative terminal of the voltage source. A potentiometer, constituted by resistors 10 and 11, which is connected across the voltage source, provides for the electrode 4 a potential with respect to the cathode 2 such that breakdown still does not occur.

The various circuit elements are so chosen that the discharge extinguishes of its own accord, so that in the absence of ignition pulses the anode potential and the cathode potential are equal to those of the positive and negative terminals, respectively, of the voltage source. When a positive ignition pulse appears at terminal 12, the ignition voltage between the electrodes 2 and 4 is exceeded, so that at first the auxiliary discharge and then the main discharge is initiated. The capacitor 9 discharges to the breakdown voltage between the cathode and the ignition anode.

In the absence of a load in the cathode lead, the ignition electrode 4, upon extinction of the main discharge, would have to assume its initial potential in the time interval determined by the resistors 10 and 11 and the capacitor 9, which is necessarily long. The maximum sensitivity is reached only, if the ignition electrode has assumed its initial potential.

The presence of the cathode load according to the invention causes the cathode potential to increase during the main discharge, the capacitor 8 then being charged. The voltage of the ignition anode increases with that of the cathode and the value of the various elements may readily be so chosen that the ignition anode acquires its bias potential. When the discharge extinguishes, the cathode voltage rapidly decreases, since the time-constant of the combination constituted by resistor 7 and capacitor 8 is small with respect to that of capacitor 9 and its associated resistors. The tube thus reaches the condition of maximum sensitivity more rapidly.

In Fig. 2, the glow discharge tube 20 comprises a main cathode 21, an ignition cathode 22, an apertured deionizing screen 23, an ignition anode 24 and a main anode 25.

The main cathode 21 is connected to the negative terminal of a voltage source via a parallel combination of a resistor 26 and a capacitor 27. The anode 25 is connected to the positive terminal of the voltage source via a parallel combination of a resistor 28 and a capacitor 29.

The ignition cathode is connected to the negative terminal of the voltage source via a resistor 30 and is con-

nected via a capacitor 31 to a terminal 32, to which negative ignition pulses may be supplied, as described in U.S. Patent No. 2,768,330, issued on October 23, 1956, to Goulding et al. The ignition anode 24 is connected via a resistor 35 to the positive terminal of the voltage source and is connected via a capacitor 36 to the negative terminal of said voltage source. Furthermore, the ignition anode 24 is connected via a rectifier 34 to a terminal 33, to which a constant voltage V_c is applied. The rectifier 34 prevents the voltage of the ignition anode 24 from rising above that of terminal 33 during the main discharge.

A potentiometer, comprising resistors 37 and 38, serves to apply voltage to the screen 23, which voltage is preferably substantially equal to that of the equipotential surface, in which the screen lies, or the mean voltage of such surfaces. This voltage is usually about 100 volts.

In the absence of input pulse at the ignition cathode 22, a small constant priming current flows between the ignition anode 24 and the ignition cathode 22, the ignition anode taking up a potential slightly less than the voltage V_c . The arrival of a negative pulse at the ignition cathode 22 causes the capacitor 36 to discharge to the main cathode 21 and thus causes anode to cathode breakdown to follow. Due to the parallel combination of resistor and capacitor in both the anode circuit and the cathode circuit, the discharge reduces the potential difference between the anode and the cathode to a considerable extent, until the extinction voltage is reached and the discharge extinguishes automatically. The values of capacitor 27 and resistor 26 are so chosen that, at the instant of ignition, the screen 23 is negative with respect to the main cathode 21. This has a favorable effect upon the deionization because of the higher speed of the ions and the shorter paths to be covered.

Due to the rise in cathode potential, the potential of the ignition anode 24 remains comparatively high, since it is coupled by the discharge with that of the cathode. However, the potential of the ignition anode 24, due to the presence of rectifier 34, can never become higher than the voltage V_c .

The advantage is, however, that after extinction of the discharge, the ignition anode 24 immediately has the proper potential for re-initiating a discharge, even when the voltage difference between anode and cathode is still insufficient for ignition of a new main discharge. The time constant of the circuit of the ignition cathode is less than that of the main cathode circuit, whereas that of the ignition anode circuit is higher than that of the main cathode circuit.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A circuit arrangement comprising a glow type electron discharge tube having a cold cathode, an anode forming an output circuit with said cathode, a first ignition electrode forming an ignition circuit with said cathode and a second ignition electrode, means for applying an ignition pulse to said first ignition electrode thereby to initiate a discharge between said cathode and said anode, said discharge being self-extinguishing after a predetermined period of time, a rectifier, means for applying a constant voltage to said second ignition electrode through said rectifier thereby imposing said constant voltage as a maximum limit on the voltage of said second ignition electrode, circuit means having a given time constant connected to said second ignition electrode, and said output circuit comprising a portion connected in said ignition circuit, said portion comprising a resistor and a capacitor connected in parallel combination with

said resistor and having a time constant substantially less than that of said circuit means.

2. A circuit arrangement comprising a glow type electron discharge tube having a cold cathode, an anode forming an output circuit with said cathode, a first ignition electrode forming an ignition circuit with said cathode, a second ignition electrode and a de-ionizing screen, said screen being positioned between said cathode and said anode at a point substantially close to said anode and having an aperture whereby any discharge in said tube runs substantially parallel to said screen for a considerable portion of its length, means for applying an ignition pulse to said first ignition electrode thereby to initiate a discharge between said cathode and said anode, said discharge being self-extinguishing after a predetermined period of time, means for maintaining said screen at a negative voltage of greater magnitude than that of any other element of said tube during said predetermined period of time, a rectifier, means for applying a constant voltage to said second ignition electrode through said rectifier thereby imposing said constant voltage as a maximum limit on the voltage of said second ignition electrode, circuit means having a given time constant connected to said second ignition electrode, and said output circuit comprising a portion connected in said ignition circuit, said portion comprising a resistor and a capacitor connected in parallel combination with said resistor and having a time constant substantially less than that of said circuit means.

3. A circuit arrangement comprising a glow type electron discharge tube having an anode, a cold cathode, a first ignition electrode, a second ignition electrode and a de-ionizing screen, said screen being positioned between said cathode and said anode at a point substantially close to said anode and having an aperture whereby any discharge in said tube runs substantially parallel to said screen for a considerable portion of its length, means for applying a supply voltage to said tube, means for applying an ignition pulse to said first ignition electrode thereby to initiate a discharge between said cathode and said anode comprising a resistance-capacitance circuit having a given time constant, said discharge being self-extinguishing after a predetermined period of time, means for maintaining said screen at a negative voltage of greater magnitude than that of any other element of said tube during said predetermined period of time, an anode circuit comprising a resistor and a capacitor connected in parallel combination with said resistor, said last-mentioned parallel combination being connected between said anode and the positive terminal of said voltage applying means, circuit means comprising a rectifier, means for applying a constant voltage to said second ignition electrode through said rectifier thereby imposing said constant voltage as a maximum limit on the voltage of said second ignition electrode, a potentiometer connected between said last-mentioned voltage applying means and the negative terminal of said first-mentioned voltage applying means and a capacitor connected between the said negative terminal and said second ignition electrode, said circuit means having a predetermined time constant, and a cathode circuit comprising a resistor and a capacitor connected in parallel combination with said resistor, said last-mentioned parallel combination being connected between said cathode and the said negative terminal and having a time constant substantially less than that of said circuit means and substantially greater than that of the resistance-capacitance circuit of said ignition pulse applying means whereby said second ignition electrode acquires a potential required for re-ignition within said predetermined period of time.

4. A circuit arrangement comprising a glow type electron discharge tube having a cold cathode, an anode forming an output circuit with said cathode and an ignition electrode forming an ignition circuit with said cathode, said ignition circuit having a given time constant,

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said ignition electrode being at a given potential relative to a given reference point of said ignition circuit and normally undergoing changes in potential relative to said reference point upon initiation of discharge between said cathode and said anode, means comprising said ignition electrode for initiating a discharge between said cathode and said anode, and means operative during said discharge to counteract changes in the potential of said ignition electrode relative to said reference point comprising means coupled to said cathode to vary during the said discharge the potential of the said cathode in the direction of the said given potential, said last-mentioned means having a time constant substantially less than that of said ignition circuit.

5. A circuit arrangement comprising a glow type electron discharge tube having a cold cathode, an anode forming an output circuit with said cathode and an ignition electrode forming an ignition circuit with said cathode, said ignition circuit having a given time constant, said ignition electrode being at a given potential relative to a given reference point of said ignition circuit and normally undergoing changes in potential relative to said reference point upon initiation of discharge between said cathode and said anode, means for initiating a discharge between said cathode and said anode, said discharge being self-extinguishing after a predetermined period of time, and means operative during said discharge to counteract changes in the potential of said ignition electrode relative to said reference point comprising means coupled to said cathode to vary during the said discharge the potential of the said cathode in the direction of the said given potential, said last-mentioned means comprising a resistor and a capacitor connected in parallel combination, said parallel combination having a time constant substantially less than one-fifth that of said ignition circuit.

6. A circuit arrangement comprising a glow type electron discharge tube having an anode, a cold cathode and an ignition electrode forming an ignition circuit with said cathode, said ignition circuit having a given time constant,

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said ignition electrode being at a given potential relative to a given reference point of said ignition circuit and normally undergoing changes in potential relative to said reference point upon initiation of discharge between said cathode and said anode, said ignition circuit including means having a given time constant for applying an ignition pulse to said ignition electrode thereby to initiate a discharge between said cathode and said anode, said discharge being self-extinguishing after a predetermined period of time, means for applying a supply voltage to said tube, said voltage applying means having a positive polarity terminal and a negative polarity terminal, an anode circuit comprising a resistor and a capacitor connected in parallel combination with said resistor, said last-mentioned parallel combination being connected between said anode and the positive terminal of said voltage applying means, said ignition circuit further including a potentiometer connected across the terminals of said voltage applying means and a capacitor connected between a point on said potentiometer and the negative terminal of said voltage applying means, said point on said potentiometer being connected to said ignition electrode, and means operative during said discharge to counteract changes in the potential of said ignition electrode relative to said reference point comprising means coupled to said cathode to vary during the said discharge the potential of the said cathode in the direction of the said given potential, said last-mentioned means comprising a resistor and a capacitor connected in parallel combination with said resistor, said last-mentioned parallel combination being connected between said cathode and the negative terminal of said voltage applying means and having a time constant substantially less than the time constant of said ignition circuit means.

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