

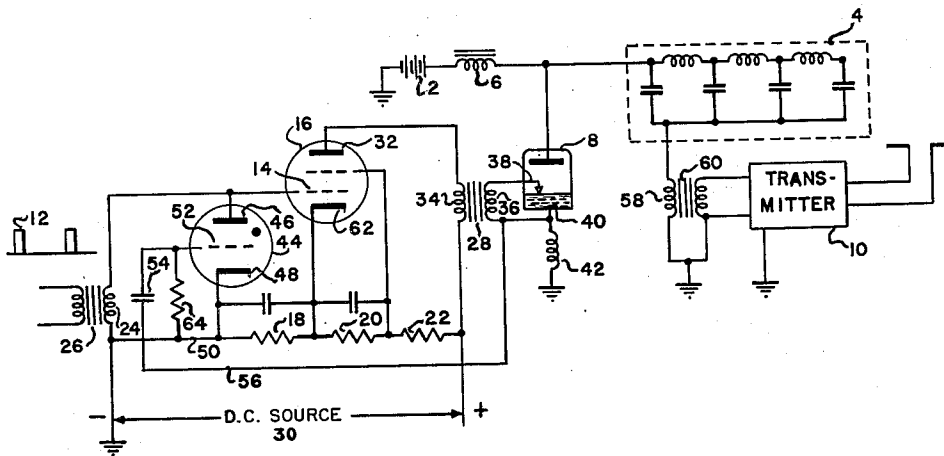
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I. SAGER

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GAS TUBE PROTECTOR CIRCUIT

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## UNITED STATES PATENT OFFICE

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## GAS TUBE PROTECTOR CIRCUIT

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sec. 266)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This application is a division of my application for patent on improvements in Line Pulse Modulator, Serial Number 543,741, filed July 6, 1944.

The present invention relates to a gas tube protector circuit and more particularly but not exclusively to such a circuit adapted to protect the igniting element of a gas tube circuit, particularly of the ignitron type, that periodically keys a pulse transmitter such as used in pulse-echo radio object locating systems.

In such radio object locating systems, the transmitted exploratory pulses are of extremely short duration and high power, the effective operation of the system depending to a very large extent on the power of the transmitted exploratory pulse. This type of operation requires very large concentrations of power during extremely short periods of time, and the task of delivering this power to the transmitter, as a rule, evolves upon the keyer, since plate modulation is assuming a more and more dominant position in the transmitter circuits of radio object locating systems.

In the parent application referred to above, use is made of simple pulse generator circuits which include one or more mercury pool type tubes, generally known as ignitrons. A D. C. source is used for periodically charging an artificial line which, upon the line being fully charged, is discharged very quickly through one or more low impedance ignitrons.

Actual operation of ignitrons in keying circuits has disclosed the fact that the most sensitive element in the entire circuit is the ignitor electrode used for establishing the hot spot in the mercury pool of the ignitron. As is well known in the art, radio object locators as a rule operate continuously over long periods of time, this type of operation being especially common in connection with radio locators assigned for continuous routine surveillance of assigned areas. Since the establishment of ignition must take place in an extremely short period of time and a very powerful pulse must be delivered to the ignitor electrode, the cumulative effect of this type of operation eventually results in the premature burning out of the ignitor electrode. It has also been discovered that the life of the ignitor electrode and, as a consequence, of the entire keyer, may be increased many fold if positive precautions are taken to prevent the ignitor electrode from

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carrying any current immediately upon the establishment of the main cathode-anode circuit.

It is therefore the main object of my invention to provide an ignition circuit for an arc-discharge tube, wherein the discharge control electrode is protected from any possible exposure to excessive current, thus prolonging the operating life of the tube and enabling it to be operated continuously for long periods of time. More specifically, the object of my invention is to provide a circuit which accomplishes the result of prolonging the life of an ignitron by means of a circuit for preventing the continuance of any current in the ignitor circuit immediately upon the establishment of full ionization in the ignitron.

Other objects will become apparent in the ensuing description.

The sole figure of the drawing is a schematic diagram of a keying circuit using only one ignitron, the ignitor element being protected from any injurious excessive currents.

A series resonant circuit consisting of a source of D.-C. potential 2, an inductance 6, a Guillemín artificial line 4, and the primary winding 58 of a pulse transformer 60, is used for periodically charging the Guillemín line. Due to the series resonance of the charging circuit, a maximum voltage of twice that of source 2 is attained. The Guillemín line is then discharged through an arc-discharge tube such as an ignitron 8, delivering the necessary keying pulse to the primary winding 58 of the transformer 60 and thence to a pulse transmitter 10.

Full ionization of ignitron 8, which then discharges the line 4, is accomplished by an input circuit in the following manner: positive rectangular pulses 12 are impressed on the control grid 14 of a tetrode 16 through a pulse transformer 26, said tetrode being normally biased so as to be non-conductive by means of a voltage divider consisting of resistors 18, 20 and 22 connected across a source of D.-C. potential 30. The control grid 14 of the tetrode 16 is connected to the cathode 62 of the tetrode through secondary winding 24 of transformer 26, and biasing resistor 18. The anode 32 of tetrode 16 is connected to the primary winding 34 of a pulse transformer 28 and thence to the positive terminal of the source of potential 30, resistors 20 and 22 completing the cathode-anode circuit. The rectangular pulse 12 is thus amplified in tetrode 16 and impressed on the primary winding 34 of pulse transformer 28, the secondary winding 36 of this transformer being connected on one side to the ignitor electrode 38 of ignitron 8, and on the

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other side to the mercury pool cathode 40 of the ignitron. The cathode 40 is grounded through a small inductance coil 42. The rectangular pulse impressed on the ignitor electrode 38 establishes an arc between the mercury pool and the ignitor 38, which at once produces full ionization of the ignitron, and the Guillemin line 4 discharges to ground.

The grid-cathode circuit of tetrode 16 is shunted by a normally nonconductive gas-filled control tube 44, the anode 46 of this tube being connected to the grid 14 of tetrode 16, while the cathode 48 of tube 44 is connected to a conductor 50 joining resistor 18 to secondary winding 24 of transformer 26. The grid 52 of the gas-filled tube 44 is connected to the same conductor 50 through a grid resistor 64, and through a coupling condenser 54 and a conductor 56 to the cathode terminal 40 of the ignitron 8. It is this gas-filled tube, connected across the input circuit of tetrode 16 and having its grid 52 coupled to the ignitron 8 through the condenser 54, that is used to prevent the continuance of current in the ignitor electrode upon ionization of the ignitron.

If the ignition of ignitron 8 actually took place after the maximum duration of the igniting pulse, and if the pulse ceased immediately upon the full ionization of the ignitron, the ignitor electrode would carry only the current absolutely necessary to produce full ionization of the ignitron. Frequently however, when the establishment of the arc between the mercury pool and the ignitor takes place some time before the cessation of the ignition pulse, a relatively large voltage is still impressed on the ignitor electrode-cathode circuit even after the establishment of the necessary arc and, as a consequence, the ignitor electrode will carry very large parasitic currents which are many times larger than the normal ignition currents. These parasitic currents cause premature burning out of the ignitor electrodes and the failure of keying circuits. The feed-back circuit, consisting of conductor 56 and condenser 54, and the gas-filled tube 44, are used to arrest any continued supply of voltage to the ignitor electrode circuit immediately upon the full ionization of the ignitron. When a large cathode-anode current appears in the ignitron, the inductance coil 42 impresses a high positive potential upon condenser 54 which produces immediate ionization of the gas-filled tube 44. Since this tube 44 is connected directly across the secondary winding 24 of transformer 26, the remaining portion of the rectangular pulse 12 is shorted by the low impedance of the gas-filled tube, and the control grid 14 of tetrode 16 becomes once more connected to the negative terminal of D.-C. source of potential 30. Accordingly, tetrode 16 is at once disabled, and the voltage impressed on the ignitor circuit is removed immediately upon the closing of the main cathode-anode circuit in ignitron 8.

The circuit disclosed above offers a high degree of protection to the ignitor electrode and results in prolonging the life of this element which otherwise is the weakest point in keying systems. This circuit is of course equally useful with keying circuits using more than one ignitron, as shown in parent application referred to above, or when used to protect the control electrode of one or more gas thyratrons in a keyer.

It is believed that the construction and operation of my new protector circuit, as well as the many advantages thereof, will be apparent from the foregoing description. It will, therefore, be

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apparent that while I have shown and described my invention in its preferred form, many changes and modifications may be made without departing from the spirit of my invention as sought to be defined in the following claims.

I claim:

1. A circuit comprising in combination: at least one arc-discharge tube having a cathode, an anode coupled to a potential that is positive relative to said cathode, and a discharge control electrode; an input circuit for impressing triggering pulses between said disabling electrode and said cathode; and control means responsive to the conduction of said tube, for disabling said input circuit only until the cessation of each input pulse.

2. The circuit of claim 1, wherein said disabling means includes a normally non-conductive gas-filled tube coupled across said input circuit and adapted to be rendered conductive upon the conduction of said arc-discharge tube.

3. The circuit of claim 2, wherein said arc-discharge tube is an ignitron.

4. A circuit comprising in combination: at least one arc-discharge tube having an anode coupled to the positive terminal of a source of potential having a negative, grounded terminal, a cathode coupled through an inductance to ground, and a discharge control electrode; a pulse transformer having a secondary winding connected between said control electrode and said cathode; a normally non-conductive vacuum tube amplifier having at least one control grid receptive of a series of input pulses to render said vacuum tube conductive, an anode connected to one end of the primary winding of said transformer, and a cathode coupled to the other end of said primary winding; and disabling means responsive to the conduction of said arc-discharge tube, for short-circuiting the input to said vacuum tube amplifier only until the cessation of each input pulse.

5. The circuit of claim 4, wherein said disabling means includes a normally non-conductive gas-filled tube coupled across the input to said vacuum tube amplifier and adapted to be rendered conductive upon the conduction of said arc-discharge tube.

6. The circuit of claim 5, wherein said disabling means further includes coupling means connecting the control electrode of said gas-filled tube and the cathode of said arc-discharge tube, said gas-filled tube having a grounded cathode.

7. The circuit of claim 6, wherein said arc-discharge tube is an ignitron.

8. The circuit of claim 7, further including an artificial line adapted to be charged by said source of potential, said line being connected in shunt with said ignitron and being discharged by the triggering thereof, and a utilization circuit coupled to said line.

9. A circuit comprising in combination: at least one ignitron having an anode coupled to the positive terminal of a source of potential having a negative, grounded terminal, a cathode coupled through an inductance to ground, and an ignitor electrode; a series resonant charging circuit including an artificial line connected in shunt with said ignitron for charging from said source of potential; a pulse transformer having a primary winding, and a secondary winding connected between said ignitor and said cathode of said ignitron; a normally non-conductive vacuum tube amplifier having at least one control grid receptive of a series of input pulses for ren-

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dering said amplifier conductive, an anode connected to one end of said primary winding and a cathode coupled to the other end of said primary winding; and a gas-filled tube having its anode connected to the control grid of said amplifier, its cathode connected to ground, and its discharge electrode coupled to the cathode of said ignitron, whereby, upon the firing of said ignitron, said artificial line will be discharged through said ignitron and will produce a potential across said inductance which will discharge said gas tube and short-circuit the input pulses applied to said amplifier, thereby preventing said

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ignitor from drawing current during the application of said pulses thereto and after said ignitron has been fired.

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