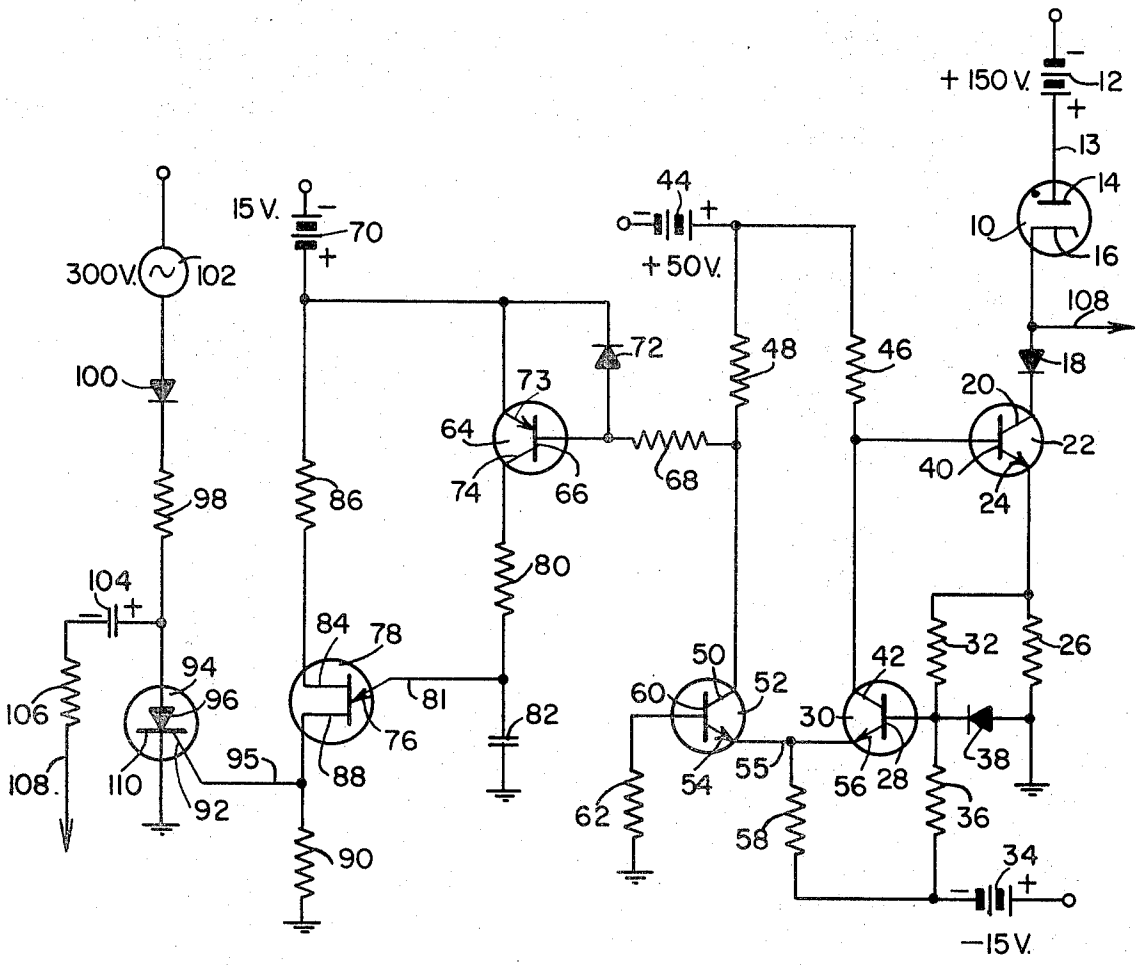
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AUTOMATIC IGNITION AND IONIZATION DETECTION CIRCUIT FOR GAS TUBES

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AUTOMATIC IGNITION AND IONIZATION DETECTION CIRCUIT FOR GAS TUBES

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ABSTRACT OF THE DISCLOSURE

A detecting circuit comprising a detecting switch in combination with a charging circuit and a gas tube. The detecting circuit also is responsive to ionization of the tube and is so disposed as to either maintain electrical pulses from the charging circuit to the tube or to inhibit the transmission of the pulses to the tube. The detecting switch comprises a switching device, an oscillator, and a control rectifier all acting in response to ignition or non-ignition of the tube. If the tube ignites, detection occurs, adn the electrical pulses cease. If the tube fails to ignite, the electrical pulses will continue being applied to the tube until ignition occurs.

This invention relates to the igniting of gas tubes as used in spectrophotometers and other commercial devices utilizing gas tubes and in particular to the automatic ignition of the tube by incorporating an ionization detection circuit responsive to ionization of the gas tube.

Ignition of gas tubes as used in spectrophotometers and the like require the application of a charge or pulse of electrical energy across the igniting terminals of the tube. Generally, the electrical potential required to ignite the tube is greater than the potential required to keep the tube in an operational state. The practice in igniting these tubes has been to apply the electrical pulse or charge by manually turning a switch on and to visually observe the lamp or the instrument which the lamp forms a part thereof, to see if ignition and therefore ionization has occurred. If ignition has indeed not occurred, which is very common, it was required to repeat the procedure again until ignition occurred. This procedure is inefficient and very cumbersome depending upon the particular device in which the tube is utilized and results in a loss of man hours which is expensive.

The purpose of this invention is to provide an ionization detecting circuit in which the charging circuit to the tube automatically continues to transmit starting electrical pulses to the gas tube until ignition and therefor ionization has occurred. When an electrical pulse to the tube has ignited it and ionization has occurred, the detecting circuit inhibits the further transmission of starting electrical pulses to the gas tube so that only the necessary holding potential to keep the tube operating is applied.

This invention therfore replaces the existing inefficient manner in igniting the devices utilizing gas tubes with a time saving, efficient apparatus.

In the prior use of gas tubes, which are constant voltage devices, it has been known to employ constant current circuits. More specifically, a resistive voltage divider circuit coupled to a differential amplifier has been found to provide good current control for gas tubes. The present invention employs such a current regulation circuit in a

unique manner such that its input, which is a series coupling to one electrode of the gas tube, controls a switch interposed between the current regulation circuit and a charging circuit for the gas tube. In this manner, prior to ignition of the gas tube, the combination coacts as a plural switched pulsing system and repeatedly applies ignition charges or pulses to the gas tube. Once the gas tube ignites, the current regulation circuit not only functions normally ,but also coacts with the remainder of the circuitry to disable the charging circuit.

Accordingly, it is a primary object of this invention to provide an automatic circuit for detection of ionization of gas tubes.

It is a further object of this invention to provide a circuit for the automatic firing of an electrical charge to the terminals of a gas tube until ionization occurs.

It is still a further objective of this invention to provide a circuit which, upon ionization of a gas tube, inhibits further ignition charges to be transmitted to the gas tube.

Yet another object of this invention is to employ the input of a conventional current regulation circuit for automatically detecting the ignition state of a gas tube and for controlling an ignition charging circuit.

Other objects and advantages of the invention will become apparent from a consideration of the following specification, taken together with the accompanying drawing which is a circuit diagram of the preferred embodiment of the invention.

The illustrated circuit will be discussed herein when a gas tube **10**, is in a non-ionized state.

A positive potential **12** is applied to the plate **14** by lead **13** of the lamp **10**. This potential is suitable to maintain ignition of the tube **10**, once its ignition has occurred. In the preferred embodiment, the potential **12** of +150 volts is adequate to maintain ignition of tube **10**, which is a deuterium lamp.

The cathode **16**, of the tube **10** is connected through a forward poled diode **18** to the collector **20**, of a detecting transistor **22**. The emitter **24** of the transistor **22** is connected to a grounded resistor **26** and to the base **28** of a transistor **30** through a resistor **32**. The base **28** is also connected to a negative bias voltage **34** through a resistor **36** and to a grounded diode **38**. The transistor **22** has a base **40** which is connected to the collector **42** of the transistor **30**, and is also connected to a positive bias voltage **44**, through a resistor **46**. A resistor **48** is also connected to the bias voltage **44** and in turn is connected to the collector **50** of a transistor **52**. The emitter **54** of the transistor **52** is connected by a lead **55** to the emitter **56** of the transistor **30** which are in turn connected to the bias voltage **34** through a resistor **58**. The base **60** of the transistor **52** is connected to a grounded resistor **62**.

A transistor **64** has a base **66** which is connected to the collector **50** of the transistor **52** through a resistor **68** and is also connected to a positive bias voltage **70** through a forwardly poled diode **72**. The emitter **73** of the transistor **64** is also connected to the bias voltage **70**. The collector **74** of the transistor **64** is connected to the control electrode **76** of a double base diode **78**, through a resistor **80** and a lead **81**. A grounded capacitor **82**, is also connected to the control electrode **76** of the double base diode **78** by lead **81** and to the resistor **80**. The base **84** of the double base diode **78** is also connected to the bias voltage **70** through a resistor **86**. The base **88** of the double base diode **78** is connected to a grounded resistor **90** and to the control

gate **92** of a control rectifier **94** by a lead **95**. The control rectifier **94** having an anode **96**, and a grounded cathode **110**. The anode **96** of the control rectifier **94** is connected through a resistor **98** and forwardly poled diode **100** to a potential source **102** which in this embodiment is 300 volts. The potential source **102** when combined with the potential source **12** between the anode **14** and the cathode **16** of lamp **10**, is sufficient to ignite the lamp **10**. However, because of the inherent characteristics of this type of lamp, which are well known in the art, ignition will not always occur, necessitating repeated application of the potential source **102** in combination with potential source **12**, to the lamp **10**, until ignition occurs. The anode **96** of the control rectifier **94** is connected to the cathode **16** of the lamp **10** through a capacitor **104** and a resistor **106** by the common lead **108**.

The elements of the illustrated circuit combined as herein described establish an automatic igniting and ionization detection circuit which operates in the manner next described.

The double base diode **78**, as is well known in the art, has a high impedance between its base **88** and its control electrode **76** and will retain such high impedance until a predetermined potential is applied to the control electrode **76**, whereupon, the high impedance drops to a low value. The double base diode **78**, connected to the capacitor **82** by the lead **81**, forms an oscillator **78/82**, as is well known in the art.

The transistors **52** and **30** are connected together to form a switching circuit **30/52**, whereby when one transistor is on the other transistor is off. In its normal state, that is when the lamp **10** is not ionized and there is no current flow from the cathode **16** of the lamp **10** to the collector **20** of the detecting transistor **22**, the transistor **30** is off and the transistor **52** is on. With the transistor **52** of the switching circuit **30/52** in the on condition, current flows from its collector **50** through the resistor **68** to the base **66** of the transistor **64**, which turns that transistor on. The transistor **64** is an on-off relay switch for the oscillator **78/82**, which in the on condition causes a current to flow from its collector **74** to the capacitor **82** through the resistor **80**. Thereupon, the capacitor **82** charges to the firing point of the double base diode **78**. This firing point represents the predetermined value at which the high impedance between the control electrode **76** and the base **88** breaks down, as discussed above. When the oscillator's double base diode **78** fires, the resulting electrical pulse turns the control rectifier **94** on and forces its anode **96** to ground. The anode **96** being forced to ground through the cathode **110** of the control rectifier **94** forces the charge on the charging capacitor **104** to the cathode **16** of the lamp **10**. The charge transmitted from the charging capacitor **104**, to the cathode of the lamp **10** is a negative 300 volts and when combined with the potential **12**, which is a positive 150 volts, results in a potential of 450 volts between the anode **14** and the cathode **16** of the lamp **10**. The potential source **102**, the diode **100**, the resistor **98** and the capacitor **104** are connected together to form a charging circuit.

If the lamp **10** ignites, a current will flow from its cathode **16** to the collector **20** of the detecting transistor **22**. This current will in turn flow through transistor **22** and will turn off the transistor **52** and will turn on the transistor **30** of the switching circuit **30/52**. When the transistor **52** is off, there no longer is a current from the collector **50** to the base **66** of the transistor **64**, thereby turning off the transistor **64**. The capacitor **82** of the oscillator **78/82** will no longer charge when the transistor **64** is off and this in turn stops the oscillator **78/82**, which therefore prevents any further charge on the capacitor **104** from being transmitted to the cathode **16** of the lamp **10**.

If the lamp **10** did not ignite when the minus 300 volt charge was transmitted from the charging capacitor **104** to its cathode **16**, the control rectifier **94** will turn off at the end of the pulse from the double base diode **78** which will be in the order of 10 to 20 microseconds. The value of the resistor **98** has been selected so as not to provide a holding current for the control rectifier **94**. The transistor **52** of the switching circuit **30/52** will remain on, as will the transistor **64**, thereby allowing the capacitor **82** to charge. The transmitting of the minus 300 volt signals from the capacitor **104** to the cathode **16** of the lamp **10** will continue until the lamp **10** is ignited.

The following values for the elements of the illustrated circuit set forth an operable apparatus as described above:

Element:	Value or type
Gas tube **10**	Deuterium lamp.
Potential **12**	+150 volts.
Diode **18**	600 volt, 500 mil.
Transistor **22**	DTS 423.
Resistor **26**	40 ohms, 25 watts.
Transistor **30**	2N3569.
Resistor **32**	1.1K ohms.
Potential **34**	−15 volts.
Resistor **36**	1.47K ohms.
Diode **38**	600 volt, 500 mil.
Potential **44**	+50 volts.
Resistor **46**	1.8K ohms.
Resistor **48**	1.8K ohms.
Transistor **52**	2N3569.
Resistor **58**	6.8K ohms.
Resistor **62**	470 ohms.
Transistor **64**	2N3638A.
Resistor **68**	3.3K ohms.
Potential **70**	+15 volts.
Diode **72**	600 volt, 500 mil.
Double base diode **78**	2N1671.
Resistor **80**	120K ohms.
Capacitor **82**	22 microfarads.
Resistor **86**	100K ohms.
Resistor **90**	47 ohms.
Control rectifier **94**	2N3529.
Resistor **98**	22K ohms, 1 watt.
Diode **100**	600 volt, 500 mil.
Potential **102**	+300 volts.
Capacitor **104**	2 microfarads, 200 volt.
Resistor **106**	15 ohms.

Ignition of the lamp **10** is maintained by a constant current regulating circuit which is disposed between the cathode **16** of the lamp **10**, and the transistor **64** which acts as an on-off switch for the oscillator **78/82** and the charging circuit as described above. The transistor **22** upon ignition of the lamp **10** acts as a constant current supply. The emitter **24** of the transistor **22** is directly connected to a resistive voltage divider comprising resistors **26** and **32**. The collector **20** of the transistor **22** is connected to the cathode **16** of the lamp **10**. Transistors **30** and **52**, after ionization of the lamp **10**, act as a differential amplifier with an output connected to transistor **64**.

The constant current supply, the resistive voltage divider and the differential amplifier are connected together to form the constant current regulating circuit between the cathode **16** of lamp **10** and transistor **64**, to provide current control for the lamp **10**, after lamp **10** ionizes.

Although a specific embodiment of the invention has been described and illustrated for use in a certain environment, it will be apparent to those skilled in the art that the invention is capable of various modifications without departing from its spirit and scope.

What is sought to be secured by Letters Patent of the United States is:

1. An automatic ionization detecting circuit for a gas tube having at least an anode and a cathode electrode comprising:

an ionization detecting switch including a transistor, having an input serially coupled to one electrode of

said gas tube, and transistor enabling bias means,
a switching circuit connected to the output of said detecting switch,
an oscillator connected to be driven through said switching circuit,
an ionization charging circuit connected to one electrode of said gas tube, and
a control rectifier connected between said charging circuit and said oscillator and also connected to a source of ionizing potential,
said detecting circuit coacting to apply ionizing potential to one electrode of said gas tube until tube ionization is detected, to cause said bias means to enable said transistor to inhibit said oscillator, and thereupon disconnecting the ionizing potential from said tube.

2. An ionization detecting circuit as set forth in claim 1 wherein said oscillator comprises a capacitor and a diode, connected to receive an electrical signal from said switching circuit and to transmit a gating pulse to said control rectifier.

3. An ionization detecting circuit as set forth in claim 1, wherein said charging circuit comprises in series combination
a connection to a voltage source, a diode, a resistor, a capacitor, and means to transmit a stored electrical charge from said capacitor to one electrode of said gas tube for initiating ionization thereof.

4. An ionization detecting circuit as set forth in claim 1 wherein said control rectifier comprises an anode coupled to said charging circuit,
a grounded cathode and
a control gate,
said control gate being so disposed as to receive periodic control signals from said oscillator until ionization of said gas tube is detected.

5. An automatic ionization detecting circuit for a gas tube having at least an anode and a cathode electrode comprising:
an ionization detecting switch having an input serially coupled to one electrode of said gas tube,
a switching circuit connected to the output of said detecting switch and including two switches so connected and biased that when one is on the other is off, and output means in the form of a relay switch responsive to one of said two switches,
an oscillator connected to be driven and controlled through the output means of said switching circuit,
an ionization charging circuit connected to one electrode of said gas tube, and
a control rectifier connected between said charging circuit and said oscillator and also connected to a source of ionizing potential,
said detecting circuit coacting to apply ionizing potential to said gas tube until tube ionization is detected and thereupon disconnecting the ionizing potential from said tube.

6. An automatic ionization detecting circuit as set forth in claim 5 wherein
a resistive voltage dividing circuit is coupled between said detecting switch and said switching circuit,
the combination thereof forming a current regulation circuit operative subsequent to ionization and influencing said relay switch and thereupon said oscillator for inhibiting said charging circuit from applying said ionizing potential to said gas tube.

7. An automatic ionization detecting circuit as set forth in claim 6 wherein said two switches comprise
two transistors having their respective emitters commonly connected and negatively biased,
one of said transistors has its collector connected to an input of said relay switch, and
a source of operating potential is coupled to the anode of said gas tube and provides, only with said ionizing potential, sufficient potential to ionize said tube.

8. An automatic ignition and ionization detection circuit comprising:
a gas diode tube having an anode and a cathode,
a first voltage source connected to the anode of said tube, said source being of sufficient potential to maintain ionization of said gas diode, but insufficient for ignition thereof,
a detecting transistor connected to the cathode of said tube,
a switching circuit comprising two transistors, one of said transistors being connected to said detecting transistor,
an oscillator comprising a capacitor and a double base diode, said capacitor being connected to the second of said transistors of said switching circuit,
a control rectifier connected in firing relation to one base electrode of said double base diode, and
a charging circuit connected to said gas diode tube and comprising a second voltage source of potential insufficient by itself to ignite said gas diode, and a capacitor resistively connected to both said second source and to the cathode of said gas diode and also connected to the anode of said control rectifier, the firing of said control rectifier by said oscillator enabling both said voltage sources to be applied to said tube for ignition purposes.

9. An automatic ignition and ionization detection circuit as set forth in claim 8 wherein
circuit elements are connected to said detecting transistor to inhibit its conduction prior to and during ignition of said gas tube and to enable said detecting transistor upon ionization of said gas tube to inhibit the firing of said control rectifier.

10. In a gas tube ignition system having
a charging circuit for applying potential of a first magnitude to the gas tube,
a source for applying a lower operating potential during and subsequent to ignition, and
an ignition detector coupled between said tube and charging circuit and responsive to tube ignition for decoupling said charging circuit from said tube, the improvement which comprises:
the series combination of a switching circuit, a relay switch, an oscillator, and a control rectifier coupled between said ignition detector and said charging circuit,
said control rectifier coupling to said charging circuit the potential difference between said ignition and operating potentials and,
said difference being coupled to the cathode of said gas tube.

11. A system as defined in claim 10 further comprising:
a resistive voltage dividing circuit coupled between said ignition detector and said switching circuit,
the combination of said ignition detector, said voltage dividing circuit, and said switching circuit forming a current regulation circuit operative subsequent to ignition,
the operation of said current regulation circuit causing the operation of said relay switch for influencing said relay switch and thereupon said oscillator for inhibiting said charging circuit from applying said potential of a first magnitude to said gas tube.

12. An automatic ionization detecting circuit for a gas tube having at least an anode and a cathode comprising:
an ionization detecting switch having an input serially coupled to a unidirectional conduit from said gas tube cathode for receiving an enabling signal in response to ionization of said tube,
a switching circuit connected to the output of said detecting switch,
an oscillator connected to be driven through said switching circuit,
an ionization charging circuit connected to said gas tube cathode, and

a control rectifier connected between said charging circuit and said oscillator and also connected to a source of ionizing potential,

said detecting circuit coacting to apply ionizing potential to said cathode until tube ionization is detected and thereupon disconnecting the ionizing potential from said tube.

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