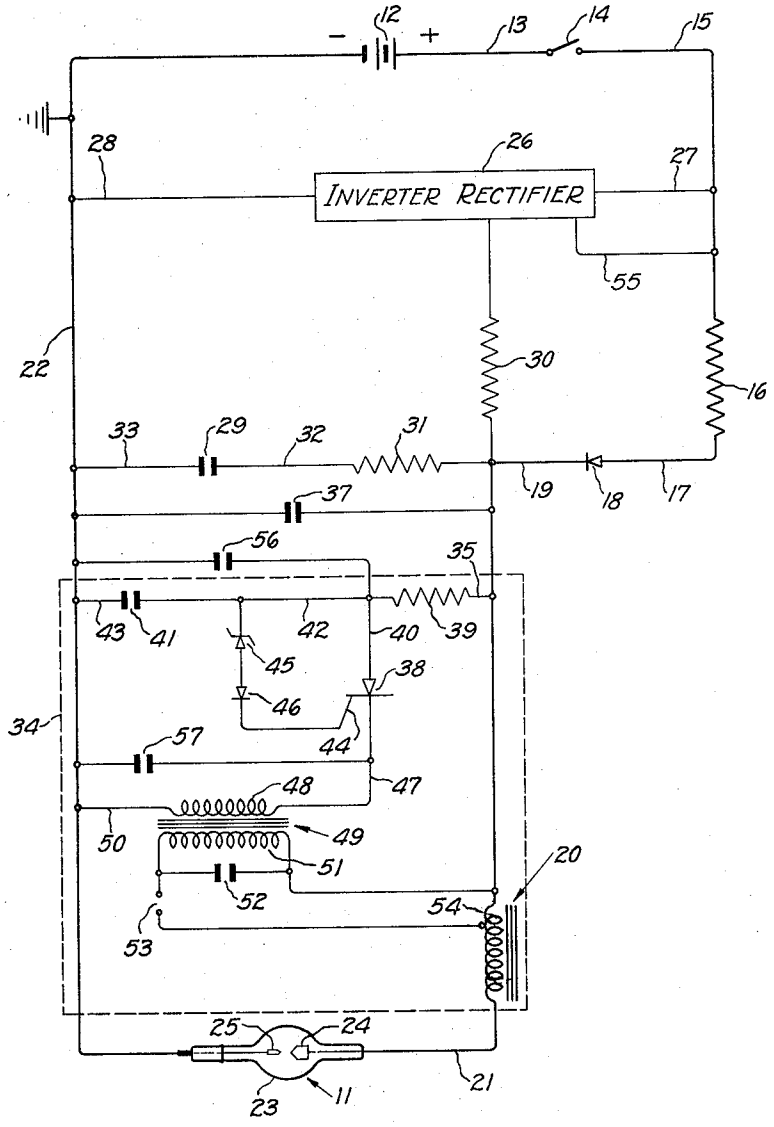
June 15, 1965 E. K. HOWELL 3,189,789

IGNITION CIRCUIT FOR A DISCHARGE LAMP

Filed July 2, 1962



Inventor:
Edward Keith Howell
by Henry T. Olsen
His Attorney

United States Patent Office 3,189,789 Patented June 15, 1965

3,189,789

IGNITION CIRCUIT FOR A DISCHARGE LAMP

Edward Keith Howell, Hendersonville, N.C., assignor to General Electric Company, a corporation of New York

Filed July 2, 1962, Ser. No. 206,597
5 Claims. (Cl. 315—241)

This invention relates in general to circuits for discharge lamps and, more particularly, to a high voltage pulse generating circuit for the starting of a high intensity discharge lamp.

The high intensity discharge lamp to be started is a xenon arc discharge lamp. This lamp is rated to operate at 100 amperes, 20 volt D.C. and thus is well within the range of a battery energy output. The lamp is a two electrode polarized arc lamp with a thoriated tungsten cathode and tungsten anode. Initially a high voltage pulse of 30–50 kv. must be applied across the terminal to form a conduction path within the lamp. This must be immediately followed by a high current discharge from a source of at least 65 volt D.C. to form a cathode hot spot for electron emission. Upon emission and starting of the lamp, the arc drops well below the range of the power supply and the normal operation follows at 100 amps, 20 volt. An example of the above lamp is disclosed in U.S. Patent 2,965,790—Ittig et al., issued December 20, 1960.

It is an object of this invention to provide an improved pulse generating circuit for the above lamp and similar discharge lamps which develops a series of high voltage pulses for initiating conduction in the lamp from a source of pulsating current.

It is a further object of this invention to provide such a pulse generating circuit which utilizes an electron control device having a predetermined voltage breakdown level and ceases operation when the lamp becomes conductive.

It is a further object of this invention to provide an improved pulse generating circuit utilizing a silicon controlled rectifier and other semi-conductor devices which are of small size so that the lamp starting mechanism may be easily portable.

In accordance with the above-mentioned objects, this invention provides a pulse generating circuit for a discharge lamp requiring a very high voltage for initiating conduction therein which comprises a controlled rectifier connected to a source of pulsating current and having a controlled electrode, means for rendering the controlled rectifier conductive including a zener diode conected to the gate of the controlled rectifier, and means for delivering a high voltage pulse to the lamp when the gate of the silicon controlled rectifier is rendered conductive including an operating capacitor connected to the controlled rectifier and the lamp.

Further objects and advantages of the invention will appear from the following specification.

A preferred embodiment of the invention is shown in the drawing.

In the drawing, an operating circuit for discharge lamp 11 includes a low voltage direct current source, such as a battery 12, conductor 13, a control switch 14, conductor 15, a current-limiting impedance 16, conductor 17, high current rectifier 18, conductor 19, autotransformer coil 20, conductor 21 and conductor 22 to ground.

The discharge lamp 11, as shown, is a xenon arc discharge lamp comprising an envelope 23 filled with xenon gas and provided with a thoriated tungsten anode 24 and tungsten cathode 25. The lamp operates 100 amps at 20 volt D.C.; hence, the source 12 can be a 27.5 volt storage battery as is customarily provided on certain vehicles. However, to ignite the lamp, a 30–50,000 volt pulse must be applied across the lamp electrode to initially ionize the gas.

For starting the lamp there is provided a step-up inverter rectifier 26, having a pulsating intermediate voltage output, connected between conductors 15 and 22 by conductors 27 and 28. The output from the inverter rectifier 26 is directed to storage capacitor 29 through a resistor 30, resistor 31, conductor 32, and which storage capacitor bank is connected to ground by conductor 33 so that the capacitor is charged at the intermediate voltage. The starting circuit further includes pulse generating circuit, shown within the dotted lines, 34, the output of which is applied to anode 24 of the lamp 11 through autotransformer coil 20. The inverter rectifier circuit 26 may be of the type described in co-pending application of Joe A. Nuckolls, Serial No. 206,613, filed July 2, 1962, and assigned to the same assignee.

The pulse generating circuit 34 is provided with a silicon controlled rectifier 38 connected to input conductor 35 through a resistance 39 by conductor 40. An operating capacitor 41 is connected to resistance 39 by conductor 42 and to ground by conductor 43 to form a charging circuit across storage capacitor 29. The operating capacitor 41 provides the triggering action for the control gate 44 of the controlled rectifier 38 through zener diode 45 and diode 46. The zener diode 45, being a substantially constant voltage electron control device, becomes conductive when the charge on the capacitor 41 reaches a predetermined zener voltage level. When said level is reached, the diode 45 become conductive, triggering the silicon controlled rectifier 38 which draws energy from the capacitor 41 and discharges a high current pulse through conductor 47, through primary 48 of a ringing transformer 49 and conductor 50 connecting the coil to ground. The series connection of operating capacitor 41, silicon controlled rectifier 38 and the primary 48 thereby forms a discharge loop.

The secondary 51 of ringing transformer 49 is applied to a pulse transformer circuit including the transformer 20, capacitor 52 and spark gap 53 thereby forming an oscillatory circuit with primary 54 of transformer 20 which induces a damped oscillatory train of high voltage pulses in the pulse transformer circuit. The high voltage pulse from transformer 49 charges the capacitor 52 to the breakdown point of spark gap 53 whereby the high voltage pulse is applied to the effective primary 54 of autotransformer 20 which delivers a higher voltage pulse to the lamp through conductor 21. The inverter rectifier circuit 26 continues to run at a high repetition rate, delivering high voltage pulses to the lamp until the lamp becomes conductive; when this condition occurs, the lamp draws on the energy in the storage capacitor 29 as a source of intermediate voltage necessary for cathode warm up. When the voltage drop across the lamp falls below a predetermined level, the inverter rectifier 26 is turned off through conductor 55 as described in the above-mentioned co-pending application. Capacitors 56, 57 and 37 provide radio frequency bypassing.

By way of specific example, the various components above referred to may be the following:

High current rectifier 18	4JA60B.
Autotransformer 20	Turns ratio 1:5.
Capacitor bank 29	2000 microfarads; 100 volt.
Resistor 31	1 ohm; 5 watt.
Resistor 39	100 ohm; 5 watt.
Capacitor 41	100 microfarads; 150 volt.
Zener diode 45	1N1375A (100 volt).
Transformer 49	Turns ratio 1:200.
Capacitor 52	.002 microfarads; 20 kv.
Spark gap 53	10 kv.
Silicon controlled rectifier 38	C35B.
Diode 46	1N538.

The output of inverter rectifier 26 is approximately 170 volts at 300 cycles per second. As the output of the inverter rectifier 26 is applied to storage capacitor 29, and also to operating capacitor 41 of the pulse generating circuit, energy is stored therein. The zener diode 45 is a substantially constant voltage device which conducts when the voltage rises to 100 volts (this voltage may be varied to suit the lamp starting requirements); thus, at 100 volts, approximately 10 joules of energy are stored in capacitor bank 29 and 0.5 joule in operating capacitor 41. At 100 volts, the zener current applied to gate 44 of silicon controlled rectifier 38 is sufficient to make silicon controlled rectifier 38 conductive, extracting approximately 0.5 joule from operating capacitor 41 and delivering it through transformer 49. When the voltage drops below 100 volts, the zener diode becomes non-conductive and silicon controlled rectifier 38 is turned off by the tendency of the inductance of ringing transformer 49 and capacitor 41 to oscillate and reverse the current flow through silicon controlled rectifier 38. Capacitors 56 and 57 serve also to limit the rate or rise of the voltage reapplied to the controlled rectifier 38 to assure turn off of that device. The 100 volt pulse is stepped up by the turns ratio 1:200 of transformer 49 and the voltage on the capacitor 52 rises toward 20,000 volts. The spark gap 53 breaks down when the voltage reaches 10,000 volts and the pulse is delivered into effective primary 54 of the autotransformer 20. The step-up ratio of the autotransformer 20 being 1:5, a 50 kv., high frequency pulse is provided to the lamp. The negative coefficient of resistance of the lamp after starting causes the arc drop across the lamp to fall below 100 volts after ignition, thus stopping the operation of the pulse generating circuit, since zener diode 45 does not trigger the gate of silicon controlled rectifier 38. The 10 joules of energy stored in the storage capacitor 29 serves to maintain operation of the lamp and develop a hot spot on the cathode until the voltage drop across the lamp falls below the source voltage. At this point the source voltage takes over operation of the lamp through current limiting resistor ballast 16 and high current rectifier 18. The effect of conductor 55 is such that when the current drawn by the lamp 11 rises to approximately 60 amperes the operation of the inverter rectifier 26 ceases and no further charging of the storage capacitor 29 takes place during operation of the lamp.

While the invention has been specifically disclosed and the preferred embodiment thereof shown, it should be understood that the invention may be widely modified within the spirit and scope of the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A pulse generating circuit for a discharge lamp requiring a high voltage pulse for initiating conduction therein comprising, a discharge lamp, a controlled rectifier connected to a pulsating current source and having a control electrode, means for rendering said controlled rectifier conductive including a zener diode connected to the source and to the control electrode and means including an operating capacitor responsive to the controlled rectifier when it is rendered conductive for delivering a high voltage pulse to the lamp.

2. A pulse generating circuit for a discharge lamp requiring a high voltage pulse for initiating conduction therein comprising, a discharge lamp, a silicon controlled rectifier connected to a pulsating current source and having a control electrode, means for rendering said controlled rectifier conductive including an electron control device which becomes conductive upon the application of a predetermined voltage level connected to the source and to the control electrode of the silicon controlled rectifier and means including an operating capacitor and a step-up transformer responsive to the controlled rectifier when it is rendered conductive for delivering a high voltage pulse to the lamp.

3. A pulse generating circuit for a discharge lamp requiring a high voltage pulse for initiating conduction therein comprising, a discharge lamp, a silicon controlled rectifier connected to a pulsating current source and having a control electrode, means for rendering said controlled rectifier conductive including an electron control device which becomes conductive upon the application of a predetermined voltage level connected to the source and to the control electrode of the silicon controlled rectifier and means for delivering a high voltage pulse to the lamp when the controlled rectifier is rendered conductive including an operating capacitor, a step-up transformer connected to the output of said silicon controlled rectifier, a spark gap and a second capacitor connected to said transformer, said second capacitor being charged from the operating capacitor prior to the breakdown of said spark gap.

4. A pulse generating circuit for a discharge lamp comprising, a discharge lamp, a controlled rectifier connected to a pulsating current source and having a control electrode, means for rendering said controlled rectifier conductive including a zener diode connected to the source and to the electrode of the controlled rectifier, an oscillating circuit for rendering said controlled rectifier non-conductive including an operating capacitor and a ringing transformer connected across the controlled rectifier and means for delivering a high voltage pulse to the lamp when the controlled rectifier is rendered conductive.

5. A pulse generating circuit for a discharge lamp comprising, a discharge lamp, a controlled rectifier connected to a pulsating current source and having a control electrode, means for rendering said controlled rectifier conductive connected to the source and to the control electrode of the controlled rectifier and means including a charging capacitor and a spark gap connected to the controlled rectifier and lamp and responsive to the controlled rectifier when conductive for delivering a high voltage pulse to the lamp, said capacitor being charged to a predetermined voltage level prior to the breakdown of said spark gap.

References Cited by the Examiner

UNITED STATES PATENTS

2,946,924	7/60	Gerlach et al.	315—241
2,975,331	3/61	Diaz et al.	315—289 X
3,049,642	8/62	Quinn	315—206

DAVID J. GALVIN, *Primary Examiner.*

JAMES D. KALLAM, *Examiner.*