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[56]

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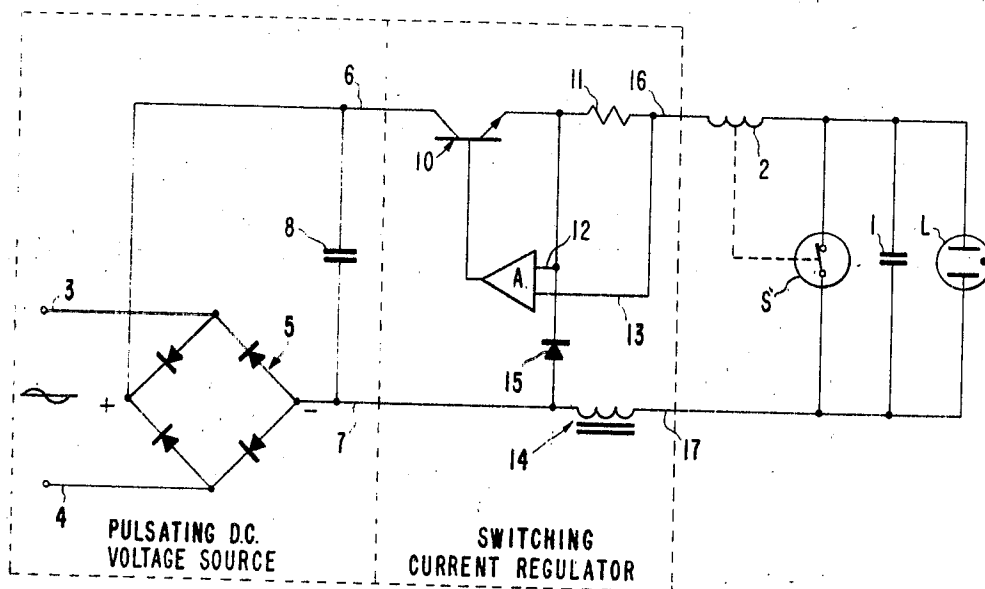
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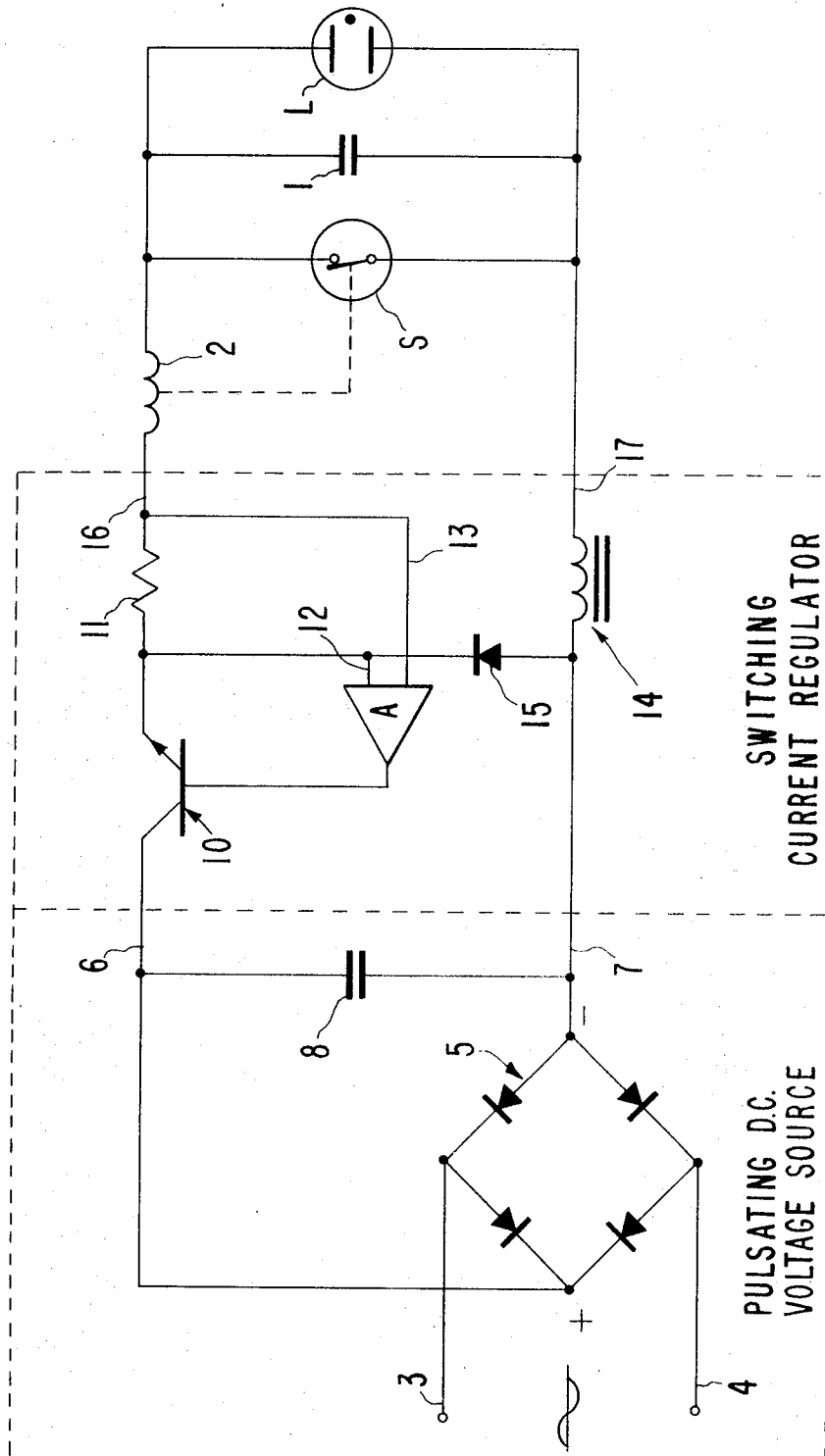
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[54] **STARTING AND OPERATING CIRCUIT FOR GAS DISCHARGE LAMPS**
5 Claims, 1 Drawing Fig.

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ABSTRACT: A starting and operating circuit for a gas discharge lamp is disclosed as comprising a vacuum switch adapted to be connected across a gas discharge lamp, a unidirectional conductor adapted to be connected across a direct current source, and an inductor, the vacuum switch, unidirectional conductor and inductor being connected in series circuit.





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STARTING AND OPERATING CIRCUIT FOR GAS DISCHARGE LAMPS

BACKGROUND OF THE INVENTION

This invention relates generally to power supply circuits for gas discharge lamps, and particularly to circuits for starting and operating high intensity short arc lamps.

High intensity short arc lamps typically comprise two electrodes spaced apart some 4 to 10 mm. from each other to form an arc gap therebetween. The arc gap is located in a vacuum-tight envelope which confines an ionizable gas under pressure. To ionize the gas and breakdown the gap requires the impression of high voltage thereacross such as in the range of 5 to 30 kv. Once breakdown occurs, however, the arc gap impedance drops from infinity to a low value such as in the order of a few ohms. At this point only a relatively low voltage is required to cause sufficient current to flow across the arc gap to flash the lamp or to produce continuous luminescence. The ultimate goal here is to provide a power supply which most efficiently delivers these required voltages to the lamp.

Heretofore power supplies for gas discharge lamps have most frequently employed a spark gap to generate a high voltage pulse in breaking down the lamp. Representative examples of such are disclosed in U.S. Pat. Nos. 3,189,789, 3,250,953 and 3,323,015. Though capable of delivering a large quantity of pulse energy, such pulse is of radio frequency. This often creates electromagnetic interferences and interface problems between the lamp and power supply. Too fast a pulse rise time, for example, may lead to excessive voltage buildup between conductive elements of the lamps other than the starting electrodes. This may in turn lead to internal arcing between the anode and reflector or between external envelope members. Furthermore, the repeated impression of high voltage RF energy between the cathode and anode rapidly causes them to erode.

It therefore is a general object of the present invention to provide an improved circuit for starting a gas discharge lamp, and to provide improved, combined circuits for both starting and operating such lamps.

Another object of the invention is to provide a starting circuit for a gas discharge lamp which does not require the use of high voltage RF energy.

Another object of the invention is to provide a small, lightweight power supply for a gas discharge lamp which does not require the use of relatively heavy electronic components such as transformers.

A more specific object of the invention is to provide an operating circuit for a gas discharge lamp which steps down the voltage delivered to the lamp without the use of stepdown transformers.

SUMMARY OF THE INVENTION

Briefly described, the present invention is a starting and operating circuit for a gas discharge lamp comprising a vacuum switch, means for opening the vacuum switch, an inductor and a unidirectional conductor, the vacuum switch, inductor and unidirectional conductor being connected in series circuit. The vacuum switch is adapted to be connected across a gas discharge lamp. The unidirectional conductor is adapted to be connected across a direct current source without discharging the source therethrough. When the vacuum switch is closed and connected across the lamp, and the unidirectional conductor is connected across the direct current source, the inductor becomes charged. When the vacuum switch is opened the charged inductor impresses a starting voltage across the lamp. After starting the inductor may serve to integrate the continuous, direct lamp-operating current.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a schematic diagram of the preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in detail to the drawing, there is schematically illustrated a high intensity short arc lamp L such as the 150X8P xenon short arc lamp sold by the Eimac Division of Varian Associates. The lamp is connected across capacitor 1 and a vacuum switch S such as the VS-8-type which likewise is manufactured and sold by Eimac. Switch S is in turn connected through switch actuating coil 2 and the switching current regulator indicated in block form across the pulsating direct current voltage source which likewise is indicated in block form.

The pulsating direct current voltage source consists of a pair of input terminal leads 3 and 4 which are connectable to a source of alternating current which is schematically illustrated as being sinusoidal in waveform. Input terminal leads 3 and 4 are respectively connected to the input terminals of bridge rectifier 5. The bridge rectifier provides full wave rectified, pulsating DC voltage across output terminal leads 6 and 7 of the source which voltage is smoothed by capacitor 8 which is connected across the output terminal leads.

The switching current regulator comprises switching transistor 10, the collector of which is connected to output terminal lead 6 of the pulsating direct current voltage source. The emitter of the switching transistor is connected through current sampling resistor 11 to regulator output lead 16 which in turn is connected to switch S. The base of the switching transistor is connected to the output of feedback amplifier A which has two input leads 12 and 13 connected across resistor 11. For sake of clarity, the power supply for amplifier A has not been shown.

Output terminal lead 7 of the pulsating direct current source is connected through inductor 14 to regulator output lead 17 which in turn is connected to switch S. Output terminal lead 7 is also connected through diode 15 to feedback amplifier input lead 12.

When input terminal leads 3 and 4 are connected to a source of alternating current with switch S closed, the source current is converted by full wave bridge rectifier 5 into pulsating direct current which pulses are smoothed by capacitor 8 and delivered to the switching current regulator. Current flows through switching transistor 10, resistor 11, closed switch S, and inductor 14 of the regulator which thereby becomes charged with energy through the establishment of a strong magnetic field generated by the current in the induction windings. When current through current sampling resistor 11 of the switching current regulator reaches a predetermined upper level, feedback amplifier A, in sensing voltages across input leads 12 and 13, amplifies the voltage drop across the resistor to a level sufficient to send a cutoff signal to switching transistor 10. With switching transistor 10 now open, inductor 14 discharges through the loop consisting of inductor 14, diode 15, resistor 11, switch actuating coil 2 and vacuum switch S. The current through actuating coil 2 is sufficient to cause the vacuum switch to open. When the contacts of the vacuum switch S have separated to such a degree that the current through the contacts is interrupted, the current is diverted to charging capacitor 1. The voltage across parallel elements capacitor 1, switch S and lamp L increases with time directly with current and inversely with the value of the capacitance being charged. With switch S open, the voltage induced by inductor 14 across lamp L rises rapidly to that required for lamp gas breakdown to occur. When the gas in lamp L breaks down the resistance between the two lamp electrodes drops drastically. Arcing then occurs between the lamp electrodes and the lamp goes into continuous conduction. Capacitor 1, although not required, has been connected across the lamp to control the rise time of the voltage impressed across the lamp.

It should be appreciated that the illustrated circuit is one of a complete though basic power supply. Thus inductor 14 in the switching current regulator serves the described role of

storing and discharging lamp starting energy and also of integrating the lamp operating current. Nevertheless, it also should be understood that the scope of the invention is limited solely by the concluding claim herein, and not to conjunctive use with the disclosed or any other switching current regulator. Where the invention is used solely as a starter or pulser without a complete switching current regulator, a small ballasting resistor, having a value such as 1 ohm, may be required in series with the DC source and lamp. Furthermore, though vacuum switch S has been actuated by means of coil 2 in the described embodiment, alternative switch actuating means may be used, such as those types which are manually actuated.

The actual value of components used in the illustrated embodiment are listed below in Table 1:

TABLE 1

Current Source	Value in Volts
	115
Bridge Rectifier	Type
5	Motorola MDA-952-3
Switching Transister	Type
10	(3) Delco DTS-430
Diode	Type
15	1N 3891
Inductor	Value in millihenries
14	5
Capacitor	Value in microfarads
1 8	0.0005 430
Resistor	Value in Ohms
11	0.2
Vacuum Switch	Type
S	Eimac VS-8

Arc Lamp	Type
L	Eimac 150X 8P

I claim:

1. A current regulating and starting circuit for connection between a source of direct current and an arc discharge device to be supplied with energy from said source, comprising in combination: a first current gating means having first, second and third terminals, said first gating means providing a low impedance between said first and second terminals in response to current from said second to said third terminal when said current is below a first preselected level, and providing a high impedance between said first and second terminals when said current exceeds said preselected level; a second current gating means having fourth, fifth and sixth terminals, said second gating means providing a low impedance between said fifth and sixth terminals in response to current between said fourth and fifth terminals below a second preselected level and a high impedance between said fifth and sixth terminals in response to current between said fourth and fifth terminals above said second preselected level, said second preselected current level being higher than said first level; an inductor; and a unidirectional conductor means having seventh and eighth terminals and providing a low impedance to currents from said seventh to eighth terminals and a high impedance to currents from said eighth to seventh terminals; said third terminal being connected to said fourth terminal, said inductor being connected between said sixth and seventh terminals, said eighth terminal being connected to said second terminal, said first and seventh terminals being input terminals for connection to said source of direct current, and said fifth and sixth terminals being output terminals for connection to said arc discharge device.

2. The circuit of claim 1 wherein said first current gating means comprises a transistor having its collector connected to said first terminal and its emitter connected to said second terminal, a sampling resistor interconnecting said second and third terminals and a feedback amplifier having its input connected across said resistor and its output connected to the base of said transistor.

3. The circuit of claim 1 wherein said second current gating means comprises a switch connected between said fifth and sixth terminals, and actuating means for operating said switch connected between said fourth and fifth terminals said actuating means causing said switch to open in response to currents in said actuating means exceeding said second preselected level.

4. The circuit of claim 1 further including capacitor means connected between said fifth and sixth terminals for lessening the rate of change of voltage between said fifth and sixth terminals.

5. The circuit of claim 1 further including a full wave bridge-type rectifier circuit having a pair of DC output terminals connected between said first and seventh terminals and having a pair of AC input terminals for connection to a source of alternating current.