Oct. 10, 1967 N. R. STEWART 3,346,770

LAMP DRIVER CIRCUITS

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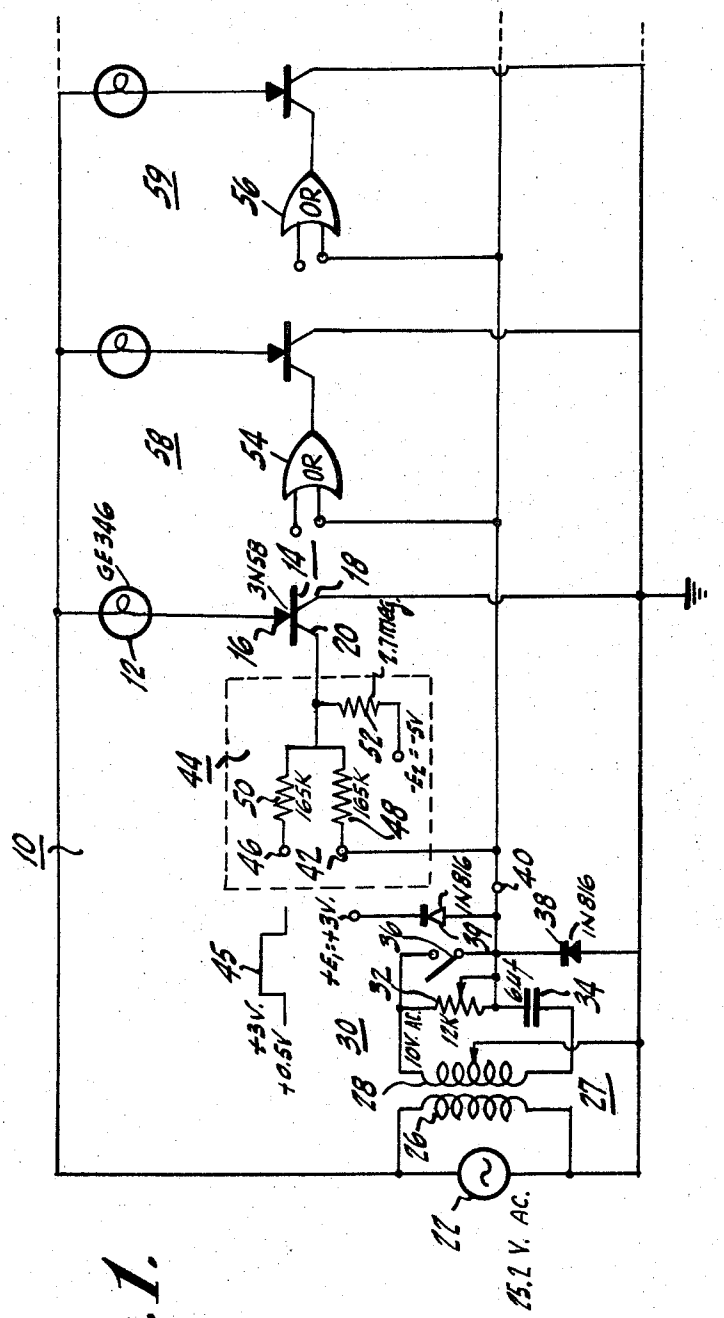


Fig. 1.

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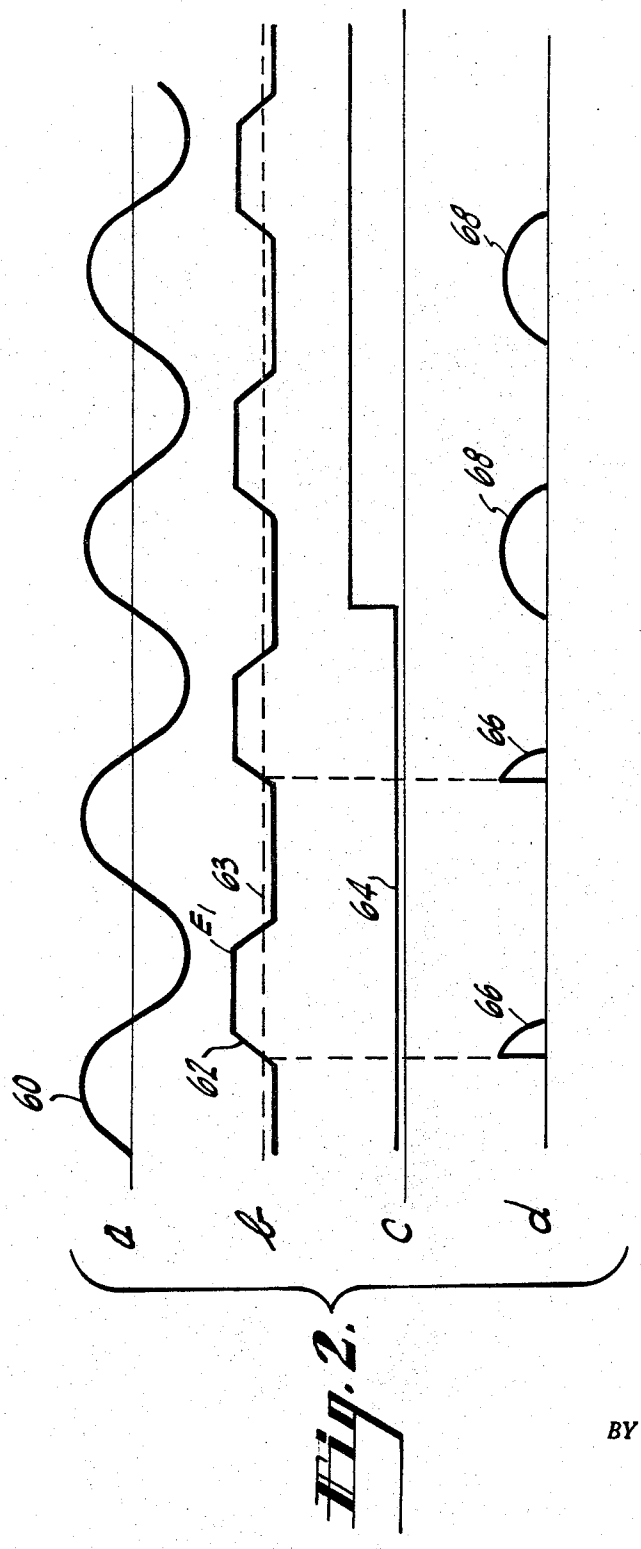


Fig. 2.

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LAMP DRIVER CIRCUITS

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ABSTRACT OF THE DISCLOSURE

A lamp driver circuit includes a controlled rectifier that is connected in series with an indicator lamp across a source of alternating signals. A trickle current is permitted to flow in the indicator lamp by first phase shifting and then rectifying the original alternating signals from the source of alternating signals to apply positive pulses through an OR gate to the gate electrode of the controlled rectifier to activate the controlled rectifier for short periods of time. The trickle current is selected to maintain the lamp filament hot but unilluminated. An overriding signal is applied through the OR gate to activate the controlled rectifier to pass substantially greater amounts of current then the trickle current to illuminate the indicator lamp. The trickle current maintains the lamp filament hot so that the filament exhibits a high resistance to prevent surge currents from developing when the indicator lamp is illuminated.

Background of the invention

Indicating lamps, such as incandescent lamps having tungsten filaments, are utilized in electronic data processing systems to monitor the operation of the various circuits in the system. These lamps are normally turned on and off by semiconductor switches, such as transistors or silicon controlled rectifiers. The indicator lamps exhibit a much greater resistance when hot than when cold. Consequently, when the lamp is first turned on, a surge of current flows through the semiconductor switch because of the low resistance of the cold filament. Such a current tends to damage the semiconductor switch.

One solution heretofore utilized to prevent damage to the switch was to connect a leakage resistor across the terminals of the switch to permit a low trickle current to flow through the indicator lamp when the switch was not activated. The trickle current was selected to be of a value low enough to prevent the lamp filament from lighting but high enough to keep the lamp filament hot. In large data processing systems a large number of lamp circuits are usually used. Consequently, a serious power drain is present in such prior art circuits.

Accordingly, it is an object of this invention to provide a new and improved lamp driver circuit.

It is another object of this invention to provide a lamp driver circuit that eliminates surge currents and also exhibits a low standby power dissipation.

A lamp driver circuit in accordance with the invention includes a semiconductor switch such as a controlled rectifier having anode and cathode electrodes that define a conductive path through the switch and a gate electrode for activating the switch. The controlled rectifier is connected in series with an indicator lamp to control the illumination of the lamp. A source of alternating signals is coupled across the serial combination of the rectifier and lamp to provide a current flow through the lamp when the rectifier is activated. A phase shifter is also coupled to the alternating signal source to shift the phase of the initial alternating signals to provide a resultant signal of a different phase. The resultant signal is applied to the gate electrode of the rectifier to turn on the rectifier when both the initial alternating signal and the resultant alternating signals are of the same predetermined polarity. The rectifier is rendered nonconductive when the initial alternating signal reverses polarity on each cycle. The time of conduction of the rectifier is selected to be appreciably less than a half cycle of the initial alternating signals to keep the lamp hot but unilluminated. This is accomplished by the proper selection of the phase shift. An overriding signal is applied to the gate electrode of the controlled rectifier when it is desired to maintain the switch activated to light the lamp.

In the drawings:

FIGURE 1 is a detailed schematic circuit diagram of a lamp driver circuit in accordance with the invention; and,

FIGURE 2 is a series of graphs illustrating the waveforms occurring at various points in the lamp driver circuit of FIGURE 1.

Referring now to FIGURE 1, a lamp driver circuit **10** includes an indicator lamp **12** and a semiconductor switch **14**. The semiconductor switch **14** is a silicon controlled rectifier having a first or anode electrode **16**, a second or cathode electrode **18**, and a third control or gate electrode **20**. The anode and cathode electrodes **16** and **18**, respectively, define a conductive path through the rectifier **14** that is rendered conductive when both the anode **16** and the gate electrode **20** are positive with respect to the cathode **18** and the gate electrode **20** goes above its firing potential. The conductive path remains conducting even though the gate electrode **20** falls below its firing potential so long as the anode electrode **16** remains positive with respect to the cathode electrode **18**. However, once the anode electrode **16** becomes negative, with respect to the cathode electrode **18**, the rectifier **14** is rendered nonconductive regardless of the potential of the gate electrode **20**.

The anode-cathode conductive path of the rectifier **14** is connected in series with the indicator lamp **12** across a source of bipolar or alternating signals **22**. The signal source **22** may, for example, comprise a sinewave signal generator or any other suitable alternating signal generator. The signal source **22** is also coupled to the primary winding **26** of a transformer **27** of a phase shifter circuit **30**. The phase shifter **30** provides a phase shifted or resultant alternating signal for application to the gate electrode **20** of the rectifier **14**. The transformer **27** also includes a secondary winding **28** that has a centertap which is connected to a point of reference potential or circuit ground. The end terminals of the secondary winding **28** of the transformer **27** are connected across an R-C serial combination comprising a variable resistor **32** and a fixed capacitor **34**. The transformer **27** provides an alternating signal of a desired level to the R-C combination and the R-C combination shifts the phase of this signal a desired amount depending upon the setting of the resistor **32**. At single-pole, single-throw switch **36** is directly connected across the variable resistor **32** so that the signal at the output terminal **40** is in phase with the alternating signal **22** when the switch **36** is closed. A diode **38**, having an anode coupled to ground and a cathode connected to the junction of the variable resistor **32** and capacitor **34**, rectifies the phase shifted alternating signal and the rectified signal appears at the output terminal **40** of the phase shifter **30**. The anode of a diode **39** is connected to the junction of the variable resistor **32** and capacitor **34** while the cathode thereof is connected to a positive voltage $+E_1$ to clip the output signal at the E_1 level. This provides a well defined upper voltage signal level and also a faster voltage rise time that gives better control over the ON time of the rectifier **14**. The output terminal **40** is connected to one input terminal **42** of a gate **44**. The other input terminal **46** of the gate **44**, which operates as an OR gate, has applied thereto an overriding signal, such as the signal **45** in FIGURE 1, when a circuit in a com-

puter (not shown) is operating and is to be monitored. The terminals **42** and **46** of the OR gate **44** are coupled through resistors **48** and **50**, respectively, to the gate electrode **20** of the controlled rectifier **14**. Additionally, the gate electrode **20** is also connected to a source of negative voltage $-E_2$ by means of a resistor **52**. This provides compatibility between the voltage levels at the input terminals of the OR gate **44** and the firing potential of the control gate **20**. The output terminal **40** is also connected to apply phase shifted signals to the OR gates **54** and **56** that are identical to the OR gate **44** and that control indicator lamps in other branches **58** and **59** of the electronic data processing system. The phase shifter **30** is capable of providing signals to a multiple number of gates **44**, **54**, **56**, etc. The values and types of components used in the circuit **10** are shown in FIGURE 1.

An initial alternating signal **60** as derived from the source **22** is shown in line *a* of FIGURE 2. Such an alternating signal is applied to the series combination of the lamp **12** and rectifier **14** in FIGURE 1. The waveform **60** is also applied to the phase shifter **30** which shifts the phase of the initial wave **60** to provide a resultant phase shifted, rectified, and clipped wave **62**, as shown in line *b* of FIGURE 2. During a period of time in each cycle, both of the waves **60** and **62** are coincidentally positive and the waveform **62** exceeds the firing potential of the gate electrode of the rectifier **14**. When the data processing circuit being monitored by the lamp circuit **10** is not active, a low signal level **64**, as shown in line *c* of FIGURE 2, is applied to the input terminal **46** of the OR gate **44**. The coincidentally positive portions of the signals **60** and **62** make the gate **20** and anode **16** of the rectifier **14** positive with respect to the cathode **18** thereof and the rectifier **14** is triggered to conduct when the gate electrode goes above its firing potential **63**. The rectifier **14** conducts only during the remaining time before the initial wave **60** goes negative. The current through the rectifier **14** is shown by the pulses **66** in line *d* of FIGURE 2. The pulses of current **66** through the rectifier **14** are sufficient to maintain the tungsten filament of the lamp **12** hot but do not illuminate the lamp. These pulses **66** flow through the low resistance of the rectifier **14** and produce substantially no power loss therein as contrasted to prior art circuits. The exact amount of standby current is selected by adjusting the variable resistor **32** in the phase shifter **30**.

When the data processing circuit being monitored is activated, the signal **64** applied to the terminal **46** of the OR gate **44** goes high and overrides the phase shifted signal **62** applied to the gate electrode **20**. This overriding positive signal **64** maintains the gate electrode **20** positive during the entire half cycle that the initial wave **60** is positive. Consequently, the controlled rectifier **14** rectifies the wave **60** to produce the rectified pulses **68** in line *d* of FIGURE 2. The pulses **68** illuminate the lamp **12**.

Thus, in accordance with the invention, a lamp driver circuit is provided which periodically pulses an incandescent lamp to maintain the filament of the lamp hot but unilluminated. The periodic pulses flow through the essentially zero resistance of a controlled rectifier and consequently cause little power drain in the circuit. In addition, the current required at the gate electrode of the controlled rectifier is negligible and therefore the loading on the computer circuit being monitored is very small. Furthermore, the gate **44** is designed to exhibit negligible heat dissipation.

What is claimed is:

1. A surge protection circuit for controlling a current through an indicator lamp having a filament that exhibits substantially less resistance when cold than hot, comprising in combination,

means providing a source of alternating signals having a half period of a predetermined duration,

a controlled rectifier having an anode electrode and a cathode electrode that defines a unidirectional current conductive path through said rectifier, and a gate electrode that controls the activation of said conductive path,

means for applying said alternating signals to said indicator lamp solely through said controlled rectifier by coupling the filament of said indicator lamp in series with the conductive path of said controlled rectifier and said source of alternating signals,

a phase shifter circuit coupled to said source of alternating signals to shift the phase of the initial alternating signals from said source so that said phase shifted and initial alternating signals are coincidentally positive for a period of time less than said predetermined half period,

rectifying means coupled to said phase shifter circuit for rectifying said phase shifted alternating signals to provide positive phase shifted pulses,

an OR gate having an output terminal coupled to the gate electrode of said controlled rectifier, and having a pair of input terminals,

means for coupling said rectifying means to one of said input terminals of said OR gate for applying said positive phase shifted pulses to said gate electrode to activate the conductive path of said controlled rectifier to pass current pulses through said indicator lamp when both said original alternating signals and said pulses exhibit a positive phase,

means coupled to said phase shifter circuit for varying the phase of said phase shifted signals to shape said current pulses to exhibit a duration substantially less than said predetermined half period to produce a trickle current that maintains said indicator lamp hot but unilluminated, and

means for applying an overriding signal to the other input terminal of said OR gate to maintain said gate electrode of said controlled rectifier positive with respect to said cathode electrode so as to pass through said controlled rectifier a current that is substantially greater than said trickle current so as to illuminate said indicator lamp,

whereby the filament of said indicator lamp is maintained hot so that said indicator lamp is illuminated by said overriding signal without surge currents developing.

2. A surge protection circuit in accordance with claim **1** that further includes a plurality of said connected pairs of indicator lamps and controlled rectifiers all connected in parallel across said source,

a plurality of OR gates each having an output terminal coupled to a different gate electrode of said controlled rectifiers, and each having a pair of input terminals,

means for applying said pulses from said rectifying means to one input terminal of each of said OR gates, and

means for applying separate overriding signals to the other input terminal of each of said OR gates so that each indicator lamp is illuminated by separate overriding signals without surge currents developing.

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