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2,876,387

INDICATOR CIRCUIT

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Fig. 1

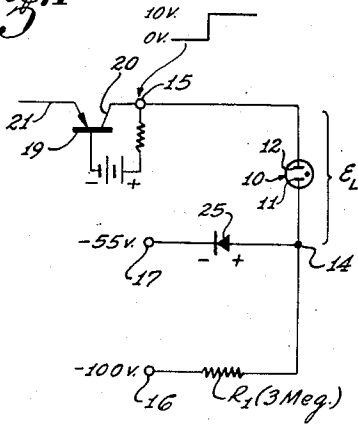


Fig. 2

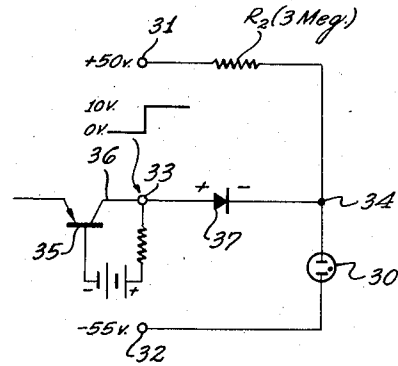


Fig. 4

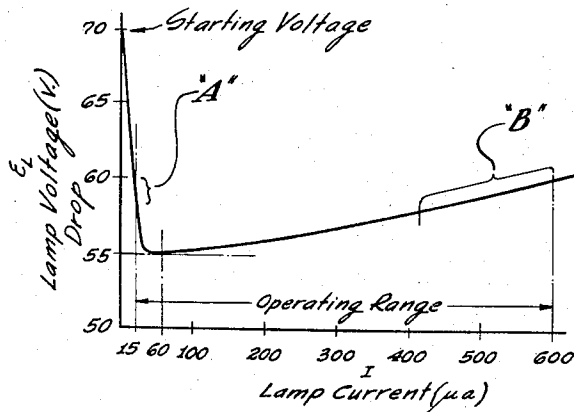
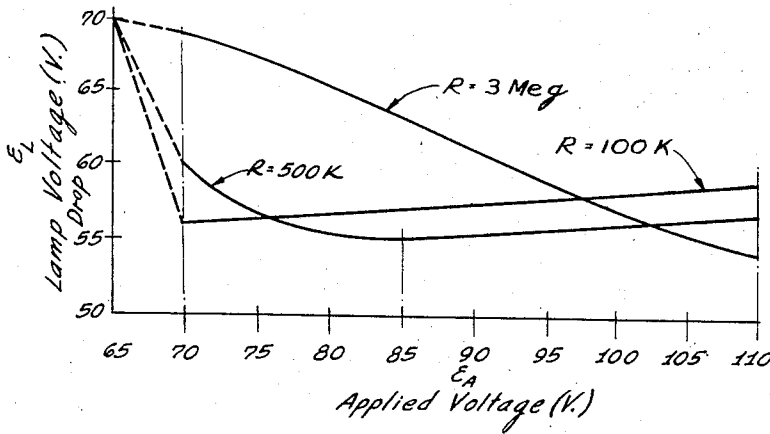


Fig. 3



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INDICATOR CIRCUIT

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7 Claims. (Cl. 315—171)

This invention relates to gaseous conduction indicator lighting circuits and more particularly to a neon lamp circuit adapted for indicating the conduction status of switching circuits having output voltages that swing over a narrow range.

When utilizing lamps of the neon type, for example, in indicator lighting circuits, it is customary to arrange the circuits so that the lamp can be provided with a high starting or firing voltage for initially ionizing the gas. At the instant of firing, a voltage drop is produced across a current limiting resistor in the supply line, thus providing a lower steady state operating voltage across the lamp for safely maintaining it in an illuminated condition. In order to extinguish the lamp, it is then customary to sufficiently reduce the voltage across the lamp below its steady state operating voltage until it is no longer ionized.

From the above it should be clear that in order to reliably control a neon lamp operated in this manner, it must be used with a switching circuit providing a control voltage swing equal to the maximum potential difference between the firing and extinguishing voltage that the lamp is likely to require. Certain switching circuits, however, such as transistor circuits, for example, operate with maximum voltage swings which are less than that required to reliably operate the neon lamp in this conventional manner, and thus it is a primary object of this invention to provide a circuit arrangement which enables the neon indicator lamp to be operated in response to a voltage swing which is appreciably less than the characteristic potential difference between the firing and extinguishing voltage of the neon lamp.

Another object of this invention is to provide a circuit arrangement whereby a neon lamp can be controlled with a small voltage swing while being maintained in an ionized state such that the degree of illumination readily distinguishes between the on and off condition of the circuit.

Another object of this invention is to provide a neon lamp indicator circuit arrangement especially adapted for operating with transistor switching circuits or conventional vacuum tube circuits having an output control signal which swings over a narrow voltage range.

Still another object of this invention is to provide a switching circuit arrangement for an indicator lamp which is highly efficient, simple in construction, and whose operation is not critically dependent on maintaining the supply voltage at fixed values.

In the drawings:

Fig. 1 is a circuit diagram of one preferred form of the present invention.

Fig. 2 is a circuit diagram of a modification of the circuit of Fig. 1.

Fig. 3 is a graph showing how the lamp voltage varies with applied voltage for different size limiting resistors, and

Fig. 4 is a graph explaining the overall operation of the circuit of Fig. 1.

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Reference will first be made to Fig. 1 showing a circuit comprised of a neon lamp 10 connected in series with a limiting resistor R_1 . One electrode 12 of neon lamp 10 is connected to a first terminal 15 and the other electrode 11 is connected by way of limiting resistor R_1 to a second terminal 16 supplied with a negative voltage of -100 v. A p-n-p transistor switching circuit 19, for example, whose conducting status is to be indicated by neon lamp 10, has the collector 20 thereof connected to first terminal 15. The electrode 11 of lamp 10 is further connected at point 14 to the anode of a diode 25 whose cathode is connected to an intermediate terminal 17 supplied with a fixed bias voltage of -55 v. Transistor 19 is operated with its collector 20 either at ground or a positive voltage of 10 v. dependent on the voltage signal connected to its emitter 21. When the circuit of Fig. 1 is initially energized with the applied voltage E_A , i. e., with the first terminal 15 at zero volts and the second terminal 16 at -100 v., the gas in the lamp 10 becomes ionized. At the instant of firing, the current flow through the lamp is limited by the resistor R_1 which has a value of 3 megohms in the preferred embodiment. The voltage drop across the resistor R_1 results in the voltage E_L across the lamp 10 being maintained at the operating level of approximately -58 v. as represented by region A of a curve in Fig. 4 showing the typical operating characteristics of the circuit in Fig. 1. This region A is in the low conducting operating range of the lamp, just to the left of the minimum E_L point of the curve, as shown. It should be noted that the applied voltage E_A , as defined by the potential between the terminals 15 and 16, is much higher than that conventionally applied across a neon lamp circuit, but the resistor R_1 having a value of 3 megohms limits the current through the lamp 10 so that the glow produced therein is barely visible. In other words, the operating region A of the curve of Fig. 4 is sufficient to maintain the gas in the lamp 10 in an ionized state, but because of the high value of resistance R_1 a current of only about 15 microamps flows through the lamp 10 resulting in the illumination of the lamp being too feeble to be considered as a lit condition thereof.

The series circuit comprising the lamp 10 and the resistor R_1 is now operating in a stable condition with a feeble glow in the lamp and the circuit is unaffected in any way by the bias voltage of -55 v. connected to point 14 by way of diode 25 inasmuch as diode 25 is connected with its anode at approximately -58 v. and its cathode at -55 v., which provides a sufficient back-bias voltage to prevent any current flow therethrough.

As above described, the initial firing of the lamp 10 is accomplished with the transistor collector 20 at ground. Now, if while in this operating condition, the emitter 21 of transistor 19 is impressed a positive voltage signal of 2 v., the collector 20 provides a voltage of 10 v. on terminal 15 such that the series circuit comprising the lamp 10 and resistor R_1 now has an increased applied voltage E_A across its terminals 15 and 16. The result of this increased applied voltage is that the potential at point 14 rises inasmuch as the voltage drop E_L across the lamp is actually slightly less than it was before. With point 14 now more positive in potential than intermediate terminal 17, diode 25 has a forward voltage applied which causes it to conduct. Thus an additional amount of current is permitted to pass from supply terminal 15 through lamp 10 and to intermediate terminal 17. The net result of this action is that the current flow through the lamp 10 increases to approximately 500 microamps, such that it is now operating in region B of the operating curve shown in Fig. 4, characterized by a highly illuminating glow in the lamp 10.

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It should be clearly understood now that the small voltage swing on the collector output 20 of the transistor 19, as provided at terminal 15, controls the amplitude of current through the lamp 10 such that the glow therein is either very feeble or very bright.

The operation of the circuit of Fig. 1 may be further understood by referring to the curves of Fig. 3 showing the variation of lamp voltage E_L with applied voltage E_A for various values of limiting resistors R in series with the neon lamp. These curves indicate that by increasing the value of the limiting resistor from 100k to 3 megohms, the path and the slope of the characteristic curve becomes such as to ensure that the current through the lamp can be limited to a predetermined low value, and an increase in the applied voltage E_A is accompanied by a decrease of the lamp voltage E_L . This latter feature aids in ensuring that by increasing the applied voltage E_A across the circuit in Fig. 1, the lamp voltage E_L will decrease so as to raise the voltage at point 14 which determines the back-bias across the diode 25. Thus, when the applied voltage E_A increases due to the swing of collector 20 of transistor 19 to 10 v., a larger current of approximately 500 microamps. is caused to flow through the lamp 10, thereby shifting the operation of the lamp 10 to region B of the curve of Fig. 4 which provides the highly illuminating "on" condition of the indicator circuit.

It should now be clearly understood that the circuit shown in Fig. 1 is operated with current continually flowing through the resistor R_1 to maintain the lamp 10 in an ionized state at all times. The cathode of diode 25 is held at a fixed negative voltage of -55 v. which is so related to the voltage at point 14 that when the transistor collector 20 switches from 0 v. to 10 v. the voltage on electrode 11 of lamp 10 is changed so that the diode 25 connected thereto has a forward voltage applied to enable an increased amount of current to flow through the lamp 10, over and above what is normally flowing through the resistor R_1 , thus switching the circuit into its brightly illuminating operating condition.

Referring next to Fig. 2, a modification of the circuit in Fig. 1 is shown. Here a positive voltage of 50 v. is applied to the resistor terminal 31 of the series circuit comprised of resistor R_2 and neon lamp 30, and a negative voltage of -55 v. is applied to the other terminal 32 connected to the neon lamp 30. In this embodiment of the invention, the applied voltage E_A across terminals 31 and 32 is held constant. The transistor switch 35 is connected to intermediate terminal 33 which connects to the point 34 of the circuit by way of diode 37, as in Fig. 1. Here, however, the diode 37 is connected such that when its cathode connected to point 34 is at +3 volts and the collector 36 of transistor 35 connected to its anode is at 0 volts the diode 37 is backbiased such that no current flows from terminal 33 through the neon lamp 30 to the -55 v. terminal 32. For these conditions, the lamp is operated in its feeble glow indicative of the "off" condition of the switching circuit. However, when the collector output 36 of transistor 35 swings at +10 v., the diode 37 conducts increasing the current flow through the lamp 30 to cause it to have a bright glow indicative of the "on" condition of the switching circuit. It should be noted that the forward resistance of the diode 37 functions as a limiting resistance to prevent the current increase in the neon lamp 34 derived from terminal 33 from being too high, thus maintaining the lamp 30 in a safe operating condition.

The circuit arrangement of the present invention is highly desirable since the values of the series limiting resistor and the supply voltages are not critical. Furthermore, the arrangement does not draw excessive current when the neon lamp is glowing brightly, thus making the circuit compatible with the low current operating characteristics of transistor switches.

The circuit of the present invention has been described in language more or less specific as to structural features,

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in order to comply with the statutes. It is to be understood, however, that the invention is not limited to the specific features shown and described but that the means and construction herein disclosed comprise only the preferred forms of putting the invention into effect and the invention is obviously susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages. The invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

What is claimed is:

1. A two-state visual indicating device comprising: a first and second terminal; a series circuit comprising a glow discharge lamp and a resistor connected across said first and second terminals; a source of potential connected across said first and second terminals to operate said lamp in the negative slope region of its characteristic voltage vs. current curve; an intermediate terminal provided with a source of potential shiftable between a high and low level; and a diode interconnecting said intermediate terminal and the junction of said lamp and said resistor, said diode oriented to conduct current through said lamp only when the potential on said intermediate terminal has shifted to said high level to thereby cause said lamp to operate in the positive slope region of its curve.

2. A two-state visual signal indicating device including: a circuit comprising a gaseous conduction lamp connected in series with a limiting resistor, said lamp having a voltage vs. current operating curve characterized by a negative and positive slope; a source of potential applied across said circuit to operate said lamp in an ionized condition on the negative slope of its curve with a small current conduction therethrough, thereby causing said lamp to have a feeble glow therein; a unidirectional conductor connected to the junction of said lamp and said resistor; and a source of control signals having a first or second potential level connected to the circuit to enable said unidirectional conductor in response to one of said potential levels to increase the current conduction through said lamp to shift the operation of said lamp to the positive slope of its curve, thereby causing said lamp to have a bright glow therein.

3. A visual indicator device for indicating the electrical condition of a two-state switching circuit comprising: a circuit having a gaseous conduction lamp connected in series with a resistor, said series circuit connected to a source of voltage capable of causing said lamp to operate in the negative slope of its voltage vs. current curve with a small current conduction; a unidirectional conductor connecting the junction of said lamp and said resistor to an intermediate source of voltage, said unidirectional conductor connected such that the voltage at said junction is not sufficient to cause conduction there-through when said series circuit has a small current conduction; and means including a signal potential indicating one of the electrical conditions of said switching circuit for applying an increased voltage across said circuit to increase the voltage at said junction to cause said unidirectional conductor to conduct, thereby causing said lamp to operate on the positive slope of its voltage vs. current curve with a high current conduction.

4. An indicator circuit comprising: a gaseous conduction lamp having a characteristic voltage vs. current operating curve with a negative and positive slope region, said lamp having a pair of electrodes, one of said electrodes connected to a transistor switching device having a voltage output swing substantially less than the difference between the ignition and extinction voltages of said lamp, an impedance connecting the other electrode to a low voltage supply, and a unidirectional conductor for further connecting said other electrode to an intermediate potential, said intermediate potential having such a value that when said switching device has a low

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voltage output said unidirectional conductor is non-conducting and said lamp operates on the negative slope of its curve in an ionized state which produces a weak luminous phenomena, and when said switching device has a high voltage output said unidirectional conductor conducts and said lamp operates on the positive slope of its curve in an ionized state which produces a bright luminous phenomenon.

5. Apparatus for visually indicating the status of a two state electrical device, comprising: a glow discharge lamp having a characteristic voltage vs. current operating curve with a negative and a positive resistance slope corresponding to a low and a high current conductive state, respectively; an energizing circuit for said lamp including a resistor and a source of unidirectional electrical energy in series, said source having a potential greater than the ignition potential of the lamp and said resistor having a value sufficiently high to limit the current through the lamp such that it operates on the negative resistance slope of its voltage vs. current curve as represented by a feeble glow; a unidirectional conductor connecting the junction of said lamp and said resistor to a source of potential having such a value that the potential at said junction is not sufficient to cause conduction through said unidirectional conductor when said lamp is energized by said energizing circuit; and means responsive to a signal representing one of the states of said electrical device for impressing across said series circuit a signal potential effective to adjust the potential at said junction to enable said unidirectional conductor to conduct to thereby increase the current passing through said lamp such that the lamp switches to the positive slope of its voltage vs. current curve as represented by a bright glow.

6. Apparatus for visually indicating an electrical on-off condition of a switching device providing an output signal having either a high potential level or a low potential level, comprising: a glow discharge lamp having a characteristic voltage vs. current operating curve with a negative and a positive resistance region corresponding to a low and a high current conductive state, respectively; an energizing circuit for said lamp including a resistor and a source of unidirectional electrical energy in series, said source having a potential greater than the ignition potential of said lamp and said resistor having a value sufficiently limiting the current through said lamp such that it operates in the negative resistance region of its voltage vs. current curve as characterized by a feeble glow; a connection to said energizing circuit effective in response to one of the potential levels of the output signal provided by said switching device to increase the potential of said source to thereby adjust the potential level at the junction of said lamp and said resistor; and

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a unidirectional conductor connecting the junction of said lamp and said resistor to a source of intermediate potential, said latter source having such a value that the potential level at said junction is not sufficient to cause conduction through said unidirectional conductor when said lamp is energized by said energizing circuit alone but is sufficient to cause conduction through said unidirectional conductor when the potential level at said junction is adjusted by the output signal provided by said switching device, to thereby increase the current through said lamp such that it operates in the positive resistance region of its voltage vs. current curve as characterized by a bright glow.

7. Apparatus for visually indicating an electrical on-off condition of a switching device providing an output signal having either a first or a second potential level which level differs by a selected difference value, comprising: a glow discharge lamp having an ignition and extinction voltage difference which is substantially greater than the difference value of the output signal from said switching device, and said lamp having a characteristic voltage vs. current operating curve with a negative and a positive slope corresponding to a low and a high current conductive state, respectively; an energizing circuit for said lamp including a resistor and a source of unidirectional electrical energy in series, said source having a potential greater than the ignition potential of said lamp and said resistor having a value sufficiently limiting the current through said lamp such that it operates on the negative slope of its voltage vs. current curve characterized by a feeble glow; a unidirectional conductor connecting the junction of said lamp and said resistor to a source of intermediate potential having such a value that the potential at said junction is not sufficient to cause conduction through said unidirectional inductor when said lamp is energized by said energizing circuit; and connecting means responsive to the output signal provided by said switching device and connected in series with a circuit including said lamp and said unidirectional conductor to cause said unidirectional conductor to conduct in response to one of the potential levels of said output signal, thereby increasing the conduction through said lamp such that the lamp switches to operate on the positive slope of its voltage vs. current curve characterized by a bright glow.

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