

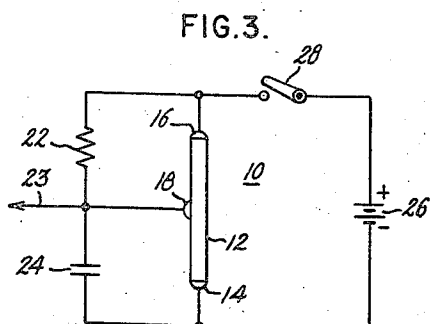
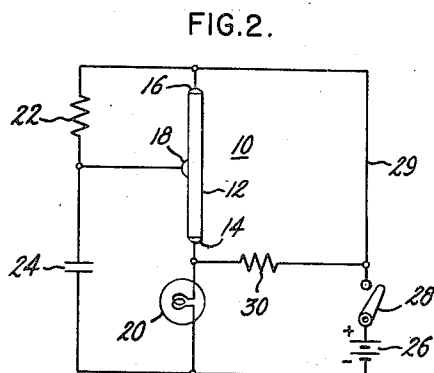
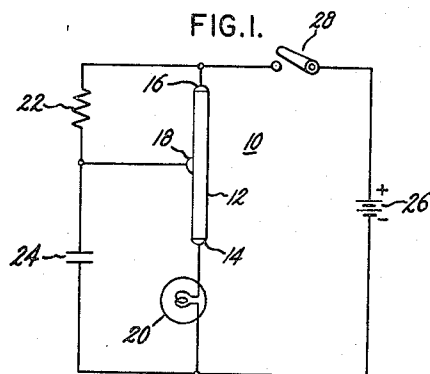
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2,780,752

SEMI-CONDUCTOR NETWORK

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2,780,752

SEMI-CONDUCTOR NETWORK

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10 Claims. (Cl. 315-240)

This invention relates to signaling devices and more particularly to signaling devices employing semi-conductors in connection with their operation.

The conduct of rescue operations, the location of supplies delivered by parachute drop and the summoning of assistance under other emergency conditions is considerably facilitated by the use of a signaling device for drawing the attention of searchers. It is important that such a signaling device be light, compact, and capable of untended operation for extended periods of time. It is a further requirement that such a device be capable of operating satisfactorily over a wide range of ambient conditions, such as extremes of temperature, which may range from the usual atmospheric temperature to far below zero degrees Fahrenheit. There are also many routine everyday control and signaling requirements for a device of such characteristics such as, warning light flashes, illuminated sign control, and a host of others.

Accordingly, it is a primary object of the invention to provide a semi-conductor control network with improved stability in the presence of wide changes in ambient temperature.

It is a further object of the invention to provide a new and novel semi-conductor controlled signalling network.

Still another object of the invention is to provide a system for controlling a light source without the use of moving parts and in such a manner as to be most economical of electrical power requirements.

These, and other objects and advantages of the present invention will become readily apparent in the course of the following description of the invention, as developed in connection with the description of several embodiments illustrating its principles. The features of the invention which are believed to be novel are particularly pointed out in the appended claims.

In the drawings, Figure 1 is a schematic diagram of a light source controlling network according to the principles of the invention;

Figure 2 is a schematic diagram of a modified network for controlling a light source with a single junction semi-conductor; and

Figure 3 illustrates a semi-conductor control network which may be used to govern any desired signaling device.

Referring now to Figure 1, there is indicated generally at 10 a single junction semi-conducting device such as the double-base diode which has been described in "Principles of Transistor Circuits," published by John Wiley & Sons, Inc., New York, edited by Richard F. Shea. The device 10 may comprise a body 12 of N-type germanium to which base contacts or electrodes 14 and 16 are affixed at either end. The contacts 14 and 16 preferably do not exhibit appreciable rectifying properties and may be formed by spraying or otherwise affixing tin to spaced points on the bar 12. A dot of acceptor material 18, such as indium, is suitably associated with and diffused into the bar 12 at 18, which will hereafter be referred to as a junction electrode since it exhibits unilateral conducting properties.

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A source of electric potential 26 has a positive terminal connected with the electrode 16 through switch 28, while its negative pole is connected with the terminal 14 through the filamentary light source 20. The source 26 may have a potential of about six volts, and the light source 20 may be one which produces rated brilliance with a terminal voltage of two volts and a current of sixty milliamperes. A resistance 22, which may be about 350 ohms, is connected between the junction electrode 18 and the line from source 26 which feeds the electrode 16, while a capacitor 24, which may be about 500 microfarads, is connected between the junction electrode 18 and the portion of the circuit exciting the lamp 20 which is fed from the negative pole of the source 26. The separation between the electrode 14 and junction electrode 18 is preferably of the order of the diffusion distance of the minority carriers in the N-type germanium body, while the separation between the junction electrode 18 and other base electrode 16 is not critical.

When the switch 28 is closed, the lamp 20 flashes at a rate which is controlled by the values of the resistor 22, capacitor 24, and the dimensions and properties of the germanium comprising the bar 12. The operation in the circuit is generally along the lines discussed in the aforementioned reference work. The application of a potential gradient along the bar 12 causes the portion of the body adjacent to the junction electrode 18 to become positive with respect to the junction, which remains near the potential of the negative pole of source 26 due to the time required for charging capacitor 24. The capacitor 24 is now charged by the back-current flowing through the junction 18 and the current flowing through the resistor 22 until its potential has increased so that a portion of the junction interface with the body 12 becomes positive with respect thereto. There now results an injection of minority carriers, causing a redistribution of the potential gradient within the body 12, to make the portion thereof adjacent the junction electrode interface at 18 less positive, thereby increasing the injection of minority carriers. The conditions now existing at the junction electrode 18 are favorable to the flow of current, and the capacitor 24 discharges rapidly through the lower portion of the body 12 and the lamp 20, causing it to flash. This discharges the capacitor 24, so that the conditions postulated at the beginning of the operating cycle once more exist. The cycle is repeated again and again so long as the switch 28 remains closed. In the specific embodiment of the apparatus which has been described, the average current drawn from the source 26 was about 20 milliamperes, while the peak currents through the lamp 20 were from 70-80 milliamperes.

It will be noted from the foregoing description, that the junction 18 is biased in its reverse direction during the major portion of the operating cycle. The reverse current characteristics of such junctions are quite dependent upon temperature, and, with the resistor 22 omitted, the flashing rate was found to be significantly temperature-dependent. The introduction of the resistor 22 increases the charging flow of current to the capacitor 24, so that the contribution from back current flow through the junction 18 is greatly reduced and the flashing rate of the lamp 20 is therefore much less dependent upon temperature than would otherwise be the case.

With the further improvement of Figure 2, the amount of power which must be controlled by the semi-conductor is reduced. In the network accomplishing this, the semi-conducting device 10 again comprises a semi-conducting body 12 to which are affixed bilaterally conducting or "ohmic" electrodes 14, 16, with a junction electrode 18 intermediately disposed thereof and formed by the use of any desired acceptor impurities, such as indium or gallium. The lamp 20 has one terminal connected with

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the electrode 14, and its other electrode connected with the negative pole of the source 26 which, as before, may have a potential of six volts. The positive pole of the source 26 is connected through switch 28 with the line 29; the line 29 is connected through resistor 30 with the junction between electrode 14 and the lamp 20, and may be directly connected to the electrode 16. A further branch of the line 29 is connected with the resistor 22 whose other terminal is linked to the junction electrode 18, and the capacitor 24 is electrically disposed between the junction electrode 18 and the negative pole of the source 26.

The operation of the network of Figure 2 is substantially the same as that of the network in Figure 1, save for the fact that the controlled current through the lamp 20 is now supplemented by a continuous current flowing through the resistor 30. The value of resistance 30 is preferably so selected that the steady current flow through the lamp 20 raises it to a temperature just below the threshold of significant luminescence. So long as the switch 28 is closed, this network causes the lamp 20 to flash at a rate of about 75 flashes per minute.

The network of Figure 3 retains the advantages of control action stability in the presence of wide temperature excursions when it is desired to employ a potential-controlled signaling device. This network is substantially the same as that of Figure 1, save for the elimination of the lamp 20. It comprises the semi-conducting device 10 having a semi-conductor body 12 provided with ohmic electrodes 14, 16 and an intermediately-disposed junction electrode 18. The positive pole of the source 26 may be connected with electrode 16 through a switch 28, while the negative pole of the source 26 is connected directly with the electrode 14. The resistor 22 is connected between the electrode 16 and junction electrode 18, while the capacitor 24 joins the junction electrode 18 with the other base electrode 14. A lead 23 brought out from the junction electrode 18 may be applied to any potential-controlled device for the purpose of effecting the desired signaling under the control of this semi-conductor network.

It is to be understood that the component values, potentials and specific type of single junction semi-conductor device shown herein have been employed for purposes of illustration only, and that any of these may be changed or additional elements added to meet varying demands of different classes of service or different environments without departing from the principles of the invention. While germanium has been specifically mentioned, it is also obvious that other semi-conducting materials, such as silicon, may be used. It is further obvious that, while a junction formed by a P-type electrode on an N-type body has been shown, the reverse arrangement will also operate satisfactorily with appropriate modification of the source potentials with respect to the other circuit elements. The appended claims are therefore intended to cover any such modifications within the true spirit and scope of the invention.

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

1. In combination, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, means for applying an electric potential between said bilaterally conducting electrodes, a capacitor connected between said junction electrode and one of said bilaterally conducting electrodes, and an impedance connected between the other of said bilaterally conducting electrodes and said junction electrode.

2. In combination, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region in-

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fluenced by potential applied between said bilaterally conducting electrodes, means for applying an electric potential between said bilaterally conducting electrodes, a capacitor connected between said junction electrode and one of said bilaterally conducting electrodes, and a resistance connected between the other of said bilaterally conducting electrodes and said junction electrode.

3. In combination, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, means for developing an electric potential of predetermined polarity between said bilaterally conducting electrodes, a capacitor connected between said junction electrode and one of said bilaterally conducting electrodes, and impedance including means for applying a potential of like polarity between said junction electrode and said one of said bilaterally conducting electrodes.

4. In electric signaling apparatus, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, an exciting circuit including a current responsive signaling device and a source of electric energy impressing an electric potential between said bilaterally conducting electrodes, a capacitor connected between said junction electrode and one of said bilaterally conducting electrodes, and a resistor connected between the other of said bilaterally conducting electrodes and said junction electrode.

5. In electric signaling apparatus, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, a current responsive signaling device, means connecting one terminal of said current responsive signaling device with one of said bilaterally conducting electrodes, a source of electric energy connected between another terminal of said current responsive signaling device and the other of said bilaterally conducting electrodes, and a capacitor connected between said junction electrodes and said other terminal of said current responsive signaling device.

6. In electric signaling apparatus, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, a current responsive signaling device, means connecting one terminal of said current responsive signaling device with one of said bilaterally conducting electrodes, a source of electric energy connected between another terminal of said current responsive signaling device and the other of said bilaterally conducting electrodes, a capacitor connected between said junction electrode and said other terminal of said current responsive signaling device, and a resistance connected between said junction electrode and the pole of said source associated with said other of said bilaterally conducting electrodes.

7. In electric signaling apparatus, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, a current responsive light source, means connecting one terminal of said light source with one of said bilaterally conducting electrodes, a source of electric energy connected between another terminal of said light source and the other of said bilaterally conducting electrodes, a capacitor connected between said

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junction electrodes and said other terminal of said light source, a resistance connected between said junction electrode and the pole of said electric energy source associated with the other of said bilaterally conducting electrodes, and a resistor connected between said one terminal of said light source and said pole of said electric energy source associated with said other of said bilaterally conducting electrodes.

8. In electric signaling apparatus, a semi-conducting body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having unilateral conducting properties associated with said body in a region influenced by potential applied between said bilaterally conducting electrodes, a filamentary light source, means connecting one end of the light source filament with one of said bilaterally conducting electrodes, a source of electric energy connected between the other end of said filament and the other of said bilaterally conducting electrodes, a capacitor connected between said junction electrode and said other end of said filament, a resistance connected between said junction electrode and the pole of said electric energy source associated with the other of said bilaterally conducting electrodes, and a resistance connected between said one end of said filament and said pole of said electric energy source associated with said other of said bilaterally conducting electrodes.

9. The combination according to claim 8 in which the resistance connected between said one end of said filament

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and said pole of said electric energy source associated with said other of said bilaterally conducting electrodes is proportioned to pass a current through said filament less than that required to bring said filament into a luminous condition.

10. In combination, a semi-conductor device comprising a semi-conductor body provided with spaced predominantly bilaterally conducting electrodes and a junction electrode having asymmetric conducting properties disposed in a region of said body affected by an electric potential between said bilaterally conducting electrodes, a current supply circuit including an electric potential source developing a potential difference between said bilaterally conducting electrodes, an impedance connected between said junction electrodes and a first portion of said current supply circuit, and a capacitor connected between said junction electrode and another electrically distinct portion of said current supply circuit.

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