Dec. 6, 1966 A. F. CAKE 3,290,551

MEMORY CIRCUIT FOR INDICATOR DEVICES EMPLOYING FOUR-ELECTRODE, FOUR-LAYER SEMICONDUCTOR SWITCH

Filed March 23, 1964

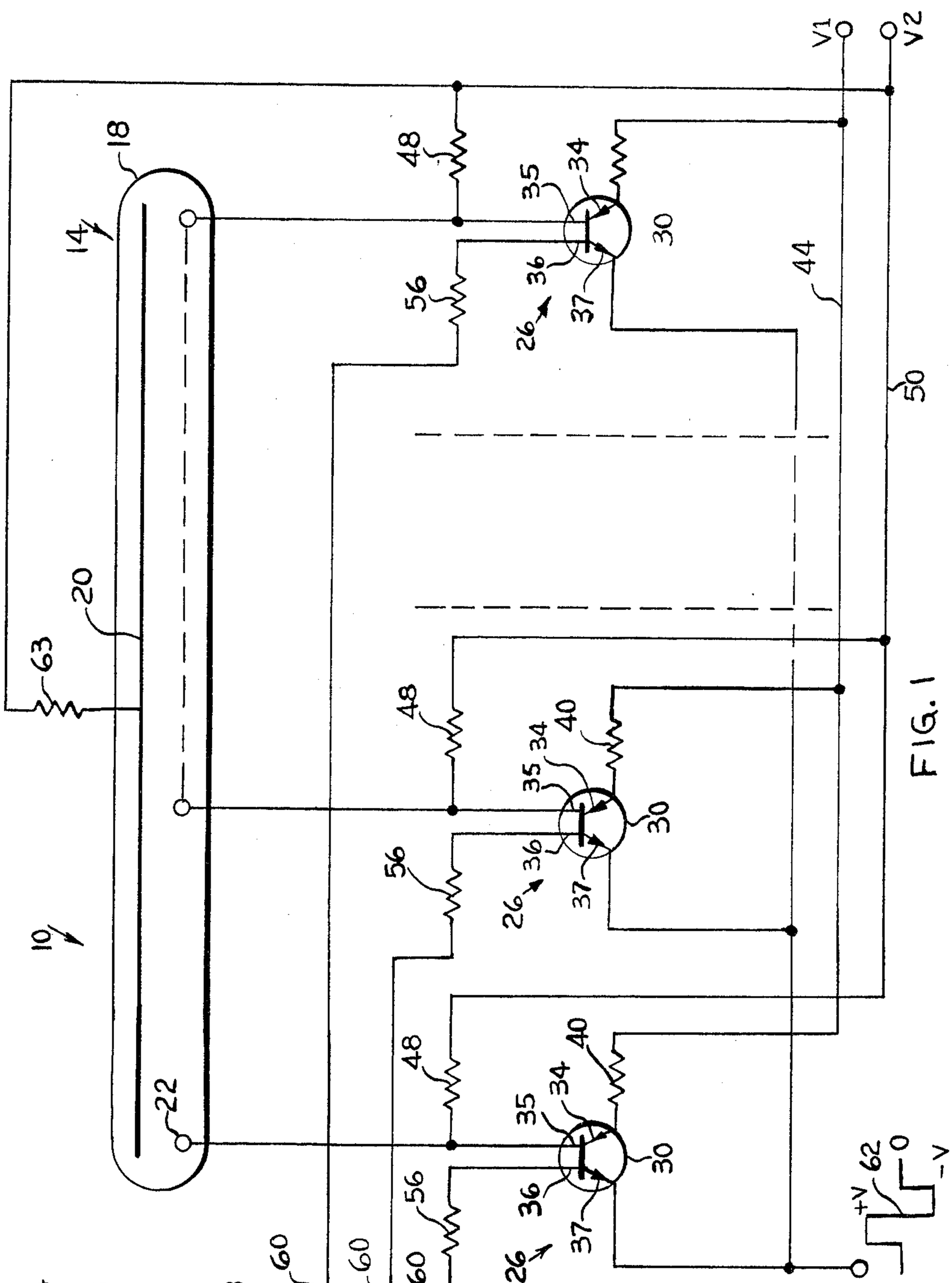



FIG. 1

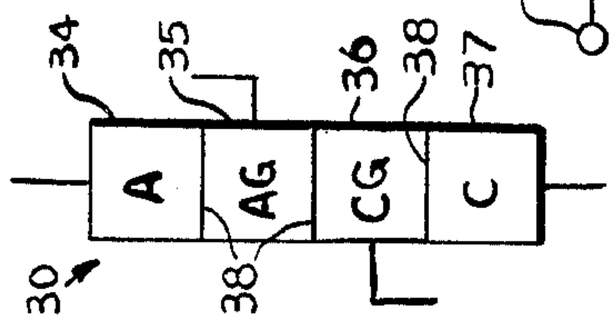



FIG. 2

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3,290,551

Patented Dec. 6, 1966



3,290,551

# MEMORY CIRCUIT FOR INDICATOR DEVICES EMPLOYING FOUR-ELECTRODE, FOUR-LAYER SEMICONDUCTOR SWITCH

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Filed Mar. 23, 1964, Ser. No. 353,960

3 Claims. (Cl. 315—84.6)

This invention relates to indicator devices and to circuits for operating them and, particularly, to such circuits having memory.

Circuits are known for operating indicator or display devices such as neon tubes or glow cathode indicator tubes such as the type 6844A tube, which includes an anode and a plurality of cathode glow elements. Generally, such circuits include a separate switch means such as a tube or transistor for operating each cathode indicator element, and a signal applied to the switch means causes the indicator element to glow and provide a visual display of some intelligence. However, there is no such circuit which is relatively simple in construction and which has "memory." Memory is that ability of the circuit to turn on the indicator device and keep it on even though the applied signal, which caused the device to be turned on, is removed.

Accordingly, the objects of the present invention concern the provision of an improved circuit for operating an indicator device, the circuit having the operating characteristic known as memory.

Briefly, the circuit of the invention comprises an indicator device, for example a gaseous indicator tube, which has one or more indicating or display elements or electrodes, to each of which a switching latch circuit is coupled. Each latch circuit utilizes a four-element semiconductor switch device in a novel circuit arrangement which is relatively simple, utilizes a minimum number of circuit components, and is relatively non-critical and uses low operating current.

The invention particularly relates to the use of the aforementioned semiconductor switch devices, which are considered low voltage devices, in combination with a glow cathode gaseous indicator tube, which is, by comparison, a relatively high voltage device. The combining of two such different devices presents problems for which the prior art provides no satisfactory teaching.

The invention is described in detail below with reference to the drawing wherein:

FIG. 1 is a schematic representation of a circuit embodying the invention; and

FIG. 2 is a schematic representation of a semiconductor switch used in each latch circuit shown in FIG. 2.

A circuit **10** embodying the invention (FIG. 1) includes an indicator device **14** which, for purposes of illustration, is a glow cathode gaseous indicator tube such as the type 6844A tube. Such a tube includes a gas-filled envelope **18** which contains an anode electrode **20** and a plurality of cathode indicator electrodes **22**, only three of which are shown, and which may be in the form of numeral or alphabet characters or the like. The cathodes may also be separate elements which can be combined to represent characters. Each cathode **22** can be caused to glow by the application of a suitable potential between it and the anode **20**. This potential is generally of the order of 170 volts for tubes of this type.

According to the invention, a memory latch circuit **26** is provided for each cathode electrode **22**, and each such circuit includes a multiple zone semiconductor switch device **30** shown as an SCS device. An SCS semiconductor switch **30**, shown in different form in FIG. 1, includes four alternating zones **34**, **35**, **36**, **37** of P-type and N-type semiconductor material, with adjacent zones being separated by a P–N junction **38**. Each zone is provided with a lead for applying signals thereto or extracting signals therefrom. The first zone **34** is known as the anode of the device, and the next adjacent zone **35** is used as a control zone for the anode and is known as the anode gate. The fourth zone **37** is known as the cathode, and the third zone **36** adjacent to the cathode is used as a control for the cathode and is known as the cathode gate.



In each latch circuit **26**, the anode zone **34** is coupled through a suitable resistor **40** to a common lead **44** which is connected to a relatively low voltage power sourve **V1** which may be of the order of 12 volts. The adjacent zone **35**, which is the anode gate, is coupled both to one of the cathode indicator electrodes **22** of the indicator tube and through a resistor **48** to a bus **50** which is connected to a relatively high voltage power source **V2** which may be of the order of 170 volts or higher. The cathode gate zone **36** is coupled through a resistor **56** to a terminal **60** to which input information signals **61** may be applied. The terminals **60** are adapted to carry a negative potential, about —12 volts, to represent the absence of signal information, and a more positive potential, for example zero volts, to represent the presence of signal information. The cathode gate zone is coupled to a source of control signals **62** for operating the semiconductor switch. This control signal includes negative and positive steps of about 12 volts each and is used to turn off and to turn on the semiconductor switch, depending on the presence or absence of signal information at the cathode gate. The control signal **62** can also be used to clear the swtiches **30** at any time in a cycle of operation.

The anode **20** of indicator tube **14** is connected through a resistor **63** to power source **V2**.

In operation of the circuit of the invention **10**, assuming that initially none of the semiconductor switches **30** is on and none of the cathodes **22** is energized, if the input signal applied to one of the terminals is zero, which represents certain intelligence, and the control or command signal **62** is applied to the cathode; then current flows from the cathode gate **36** to the cathode **37**, and the semiconductor switch is turned on. When the switch is turned on, the anode gate **35** assumes approximately zero potential, and the cathode **22** to which it is connected is thereby caused to glow.

At the same time, all of the other input terminals **60** have no intelligence applied thereto, and, as a result, they carry a potential of about —12 volts. When the command or control signal **62** is applied, and it is applied to the cathode zones of the semiconductor switches **30** associated with these terminals, the switches are not turned on and the associated cathodes **22** do not glow.

If the cathodes of the indicator tube are elements which are combined in groups to represent characters, then, to energize a group of such elements, signal information would be applied to more than one terminal **60** and more than one semiconductor switch **30**, and the corresponding indicator cathodes would be turned on at the same time.

One of the important advantages of the circuit of the invention lies in the fact that each latch circuit provides the desired energization and latching of an indicator cathode electrode **22** with a minimum number of circuit components. In addition, the arrangement of each latch circuit **26** is such that the turn-on current flow path from cathode gate to cathode in each semiconductor switch **30** is operated at low potential and low current, even though the circuit in general requires relatively high potential for operating the anode of the indicator tube and to insure that the potentials are proper for achieving full indicator cathode glow.

In FIG. 1, the dash lines represent glow cathodes and latch circuits which might be added to an operating circuit but which are omitted to simplify the drawing.

What is claimed is:

1. A circuit for operating indicator devices comprising

an indicator tube including a gas-filled envelope which contains an anode electrode and a plurality of cathode indicator electrodes, each of which provides a visual character indication,

a multiple junction semiconductor switching device including first, second, third, and fourth zones of P-type and N-type semiconductor material which alternate in conductivity type with a P–N junction between adjacent zones,

said first zone comprising an anode, said second zone comprising an anode gate, said third zone comprising a cathode gate, and said fourth zone comprising a cathode,

said first zone being connected to a source of relatively low bias voltage,

said second zone being connected both to one of said indicator electrodes in said tube and through a resistor to a source of relatively high bias voltage,

said fourth zone being coupled to a source of control signals for turning the semiconductor device off and on, and

said third zone being coupled to a source of signal information, the entry of which in said indicator tube is controlled by said control signals.

2. A circuit for operating indicator devices including

an indicator tube including a gas-filled envelope which contains an anode electrode and a plurality of cathode indicator electrodes, each of which provides a visual character indication,

a multiple junction semiconductor device including first, second, third, and fourth zones of P-type and N-type semiconductor material which alternate in conductivity type with a P–N junction between adjacent zones,

said first zone comprising an anode, said second zone comprising an anode gate, said third zone comprising a cathode gate, and said fourth zone comprising a cathode,

current flow through said semiconductor device being from said first zone to said fourth zone with said second and third zones being operable as current control zones,

said first zone being connected to a source of relatively low bias voltage,

said second zone being connected both to one of said indicator electrodes in said tube and through a resistor to a source of relatively high bias voltage which is also coupled to the anode of said indicator device,

said fourth zone being coupled to a source of erase and write signals for turning the semiconductor device off and on, and

said third zone being coupled to a source of signal information, the entry of which in said indicator device is controlled by said source of erase and write signals.



3. A circuit for operating an indicator device comprising

an indicator tube including a gas-filled envelope which contains an anode electrode and a plurality of cathode indicator electrodes, each of which provides a visual character indication,

a multiple junction semiconductor device including first, second, third, and fourth zones of alternating P-type and N-type semiconductor material having a P–N junction between adjacent zones,

said first zone comprising an anode, said second zone comprising an anode gate, said third zone comprising a cathode gate, and said fourth zone comprising a cathode,

said second zone being coupled to a cathode electrode,

a turn-on current flow path between said third and fourth zones with means for applying information signals to said third zone and means for applying control switching signals to said fourth zone, the combination of information and control signals applied simultaneously causing the semiconductor device to turn on and thereby to cause the cathode electrode to which the second zone is connected to glow.


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