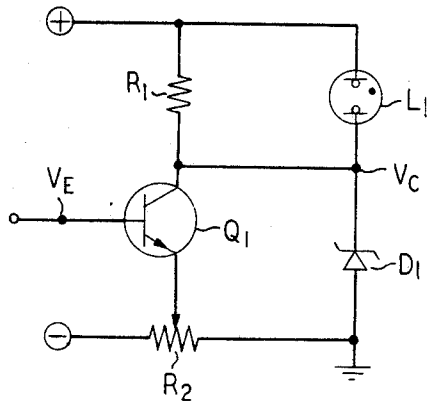
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LEVEL DETECTOR HAVING VISUAL INDICATOR LOCK-UP MEANS

Filed Nov. 15, 1967

FIG. 1



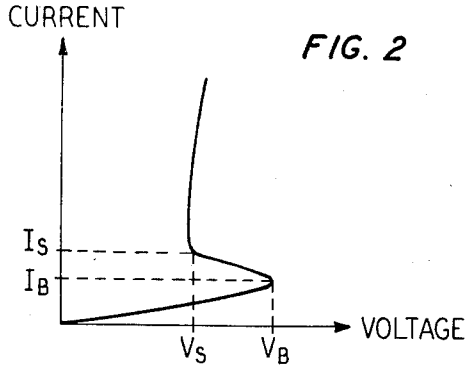
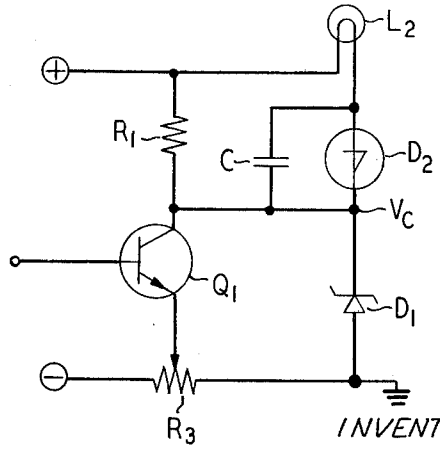


FIG. 2

FIG. 3



INVENTORS M. L. EMBREE
W. L. LANE

BY David P. Kelley

ATTORNEY

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LEVEL DETECTOR HAVING VISUAL INDICATOR LOCK-UP MEANS

Milton L. Embree, Laureldale, and William L. Lane, Reading, Pa., assignors to Bell Telephone Laboratories, Incorporated, Murray Hill, N.J., a corporation of New York

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U.S. Cl. 324—122 1 Claim

ABSTRACT OF THE DISCLOSURE

A level detector includes a neon bulb in parallel with a resistor connected between the collector of a transistor and a source supply voltage. A voltage regulator diode, connected between the collector and ground, has a breakdown voltage such that when reverse-biased into breakdown the collector voltage lies between the breakdown and sustain voltages of the neon bulb. The neon bulb is on, in an excited discharge state, when the base of the transistor has applied thereto a sufficiently high voltage signal. The bulb then remains on in the absence of that signal because the diode clamps the collector potential above the sustain voltage of the neon bulb.

BACKGROUND OF THE INVENTION

This invention pertains to level detector circuits and more particularly to such circuits having visual indicator lock-up means.

In the prior art, level detectors generally include a transistor which is biased just below some threshold value. The transistor is turned ON by a current or voltage signal applied at its base, the magnitude of the signal being sufficient to exceed the threshold. In many cases it is desirable to provide a visual indication that the threshold value has been exceeded. This function is commonly performed by a lamp connected between the collector of the transistor and the supply voltage. When a signal turns ON the transistor the collector potential drops and the lamp turns ON. This type of level detector is particularly useful in instruments having a visual read-out such as a digital voltmeter, for example. In such applications it may be desirable to maintain the visual indication after the detected signal is no longer present. The prior art has resorted generally to two circuit configurations which accomplish this end. In one circuit a transistor switch is connected to the collector of the level detector and is synchronized with the input signal to hold the collector at ground potential after the signal is removed, thereby maintaining the lamp in the ON state. This transistorized switch, however, add to the complexity of the detector and results in unnecessary expense. In a second circuit a resistive voltage divider is connected between the supply and ground, the junction point of the divider being connected to the collector of the level detector transisitor. The value of the resistors is chosen to produce the lamp lock-up condition. Generally large currents are required, however, which of course results in excessive power consumption.

SUMMARY OF THE INVENTION

A level detector in accordance with one embodiment of the invention includes a grounded emitter transistor, the base of which is responsive to the voltage level to be detected. A neon bulb and a resistor are each connected between the collector and the supply voltage. A voltage reference device, typically a voltage regulator diode, is connected between the collector and ground, and is such that when reverse-biased into a breakdown the collector voltage lies between the breakdown and sustain voltages of the neon bulb.

When the transistor is OFF its collector potential is at the breakdown voltage of the diode and thus the potential across the neon bulb is below its breakdown voltage. The neon bulb is therefore OFF. When, however, the transistor is turned ON, the collector potential falls and the voltage across the neon bulb exceeds its breakdown voltage producing a visual indication. Now, when the transistor turns OFF the reference diode clamps the potential across the neon bulb at a point above the sustain voltage, thereby maintaining the visual indication even though the detected signal is no longer present.

As is evident, the present invention performs the lock-up function without the use of an expensive external switch and without the use of a high power consumption voltage divider.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with its various features and advantages, can be easily understood from the following more detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a circuit schematic of one embodiment of the invention;

FIG. 2 is a graph of the current-voltage characteristic of a visual indicator used in accordance with the invention; and

FIG. 3 is a circuit schematic of a second embodiment of the invention.

DETAILED DESCRIPTION

Turning now to FIG. 1, there is shown a level detector comprising an NPN transistor Q1 having its emitter connected through the tap of a potentiometer R2. One side of R2 is connected to a source of negative voltage B_1^- and the other side is grounded. A resistor R1 and a visual indicator, depicted as the neon bulb L1, are connected in parallel between a source of positive voltage B_1^+ and the collector of Q1. A voltage reference diode D1 is connected between the collector and ground and the anode of the diode is grounded. The base of Q1 is connected to a source of signals to be detected.

Before discussing the operation of the level detector, consider the current voltage characteristic of the neon bulb L1 as shown in FIG. 2. As the current through the neon bulb L1 is increased, the voltage across the bulb also increases until the breakdown voltage V_B is reached, at which point a further increase in current results in a decrease in voltage and therefore a negative resistance characteristic. As current is still further increased the voltage across the bulb remains substantially constant at the sustain voltage V_S. When the breakdown voltage V_B is exceeded, the neon bulb turns ON, and is maintained ON until the voltage across it is reduced below the sustain voltage V_B. For purposes that will become evident, the voltage reference diode D1 is chosen to have a breakdown voltage V_{BD} such that when it is reverse-biased into breakdown the collector voltage V_C lies between the neon bulb sustain voltage V_S and the neon bulb breakdown voltage V_B.

The operation of the level detector is as follows. The transistor Q1 is biased just below some threshold value V_E (e.g., 0.45 volts) which may be exceeded when a signal (e.g., 0.1 volt) to be detected is applied at its base. When no such signal is present, Q1 is OFF, its collector potential V_C is at the breakdown voltage V_{BD} of the regulator diode D1. The current from B_1^+ which flows through R1 and D1 is sufficient to bias D1 into breakdown. In this state the collector voltage V_C is approximately equal to $B_1^+ - V_{BD}$ which, by appropriate choice of the diode

D1, is made to be less than V_B the breakdown voltage of the neon bulb L1. When a signal is now applied to the base of Q1, the threshold V_E is exceeded turning Q1 ON and reducing its collector voltage V_C to nearly ground. In this state Q1 represents a low impedance and therefore the current supplied by B_1^+ flows through R1 and Q1 to ground. In this state the collector voltage V_C approaches ground potential and therefore substantially the total supply voltage B_1^+ is available across the neon bulb L1. Since the supply voltage B_1^+ is chosen to be greater than the breakdown voltage V_B of the neon bulb, the bulb turns ON giving a visual indication that a signal has been detected. When the signal that was detected is no longer present, however, the transistor Q1 turns OFF raising the collector potential V_C back to $B_1^+ - V_{BD}$. By choosing the potential $B_1^- - V_{BD}$ to be greater than V_S, the sustain voltage of the neon bulb, the neon bulb L1 is maintained ON even in the absence of the detected signal. Thus the level detector is said to have visual lock-up means in that the visual indication that a signal was detected is maintained even in the absence of the detected signal. The lock-up condition may be removed, for example, by simply disconnecting the supply voltage B_1^+ or lowering the voltage across L1 to below V_S. The following Table 1 lists typical component values for the level detector as shown in FIG. 1. The values are illustrative only and are not to be intended as limitations on the scope of the invention:

TABLE 1

R1—1MΩ
R2—500 Ω
B_1^+—+80 volts
B_1^-— —1 volt
V_E—0.45 volt
Q1—2N3391A
D1 (1N3524):
V_{BD}—18 volts
L1 (NE-52):
V_B—65 volts
V_S—56 volts

An alternative embodiment of the present invention is shown in FIG. 3. The level detector is substantially identical to the circuit shown in FIG. 1 with the exception that the visual indicator herein comprises the series combination of a conventional lamp L2 and a PNPN diode D2. The PNPN diode D2 has a current-voltage characteristic very similar to that of the neon bulb L1 as shown in FIG. 2 in that it is characterized by a breakover voltage and a holding voltage analogous to the breakdown voltage V_B and sustain voltage V_S of the neon bulb. Again, by appropriate choice of the breakdown voltage of the reference diode D1, the collector potential V_C, when Q1 is OFF, is made to be less than the breakover voltage of the PNPN diode D2 but greater than its holding voltage. With this choice of circuit parameters the operation of the circuit is substantially identical to that described with respect to the level detector of FIG. 1. The addition of the capacitor C connected in parallel with the PNPN diode D2 enhances the firing of the PNPN but is not required for all tyeps of PNPN diodes. The level detector of FIG. 3 possesses several advantages over the level detector of FIG. 1. Namely, because the PNPN has significantly lower breakover and holding voltages than the neon bulb L1, a lower supply potential B_2^+ may be utilized. Furthermore, the PNPN diode D2 allows the use of a conventional lamp L2 which produces significantly brighter illumination than the neon bulb L1. Typical component values for the level detector of FIG. 3 are shown in Table 2:

TABLE 2

R1—1MΩ
R2—500 Ω
B_2^+—+40 volts
B_2^-— —1 volt
V_E—0.43 volt
Q1—2N3391A
D1 (1N3522):
V_{BD}—15 volts
D2 (1N3303):
V_B—30 volts
V_S—1.5 volts
L2 (20 ma at 20 volts)—J2 or A1

The transistors, resistors and capacitors utilized in the several embodiments of the present invention can, of course, be readily fabricated in integrated circuit form.

It is to be understood that the above-described arrangements are merely illustrative of the many possible specific embodiments which can be devised to represent application of the principles of the invention. Numerous and varied other arrangements can be devised in accordance with these principles by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A D.C. level detector having visual indicator lock-up means comprising

a transistor having emitter, base, and collector regions, said base region being D.C. coupled to a source of signals to be detected, said signals being applied between said base region and ground,

bias means connected to said emitter region for establishing a D.C. voltage threshold of signals to be detected, said bias means comprising a first source of voltage, a first resistor connected in series between said first source and said emitter region,

a pnpn diode having a breakover voltage level and a holding voltage level,

a capacitor connected in parallel with said pnpn diode,

a second source of voltage having a voltage level at least as great as said breakover voltage of said pnpn diode,

a second resistor connected between said second source and said collector region,

a lamp connected to said second source,

the parallel combination of said pnpn diode and said capacitor being connected in series between said lamp and said collector region,

a voltage reference diode having a constant voltage operation region and having its cathode connected to said collector region and its anode connected to said first resistor and to ground, said reference diode having a reference voltage such that the voltage across said pnpn diode lies between its breakover and holding voltages when said reference diode is operating in its constant voltage region.

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RUDOLPH V. ROLINEC, Primary Examiner

E. F. KARLSEN, Assistant Examiner

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