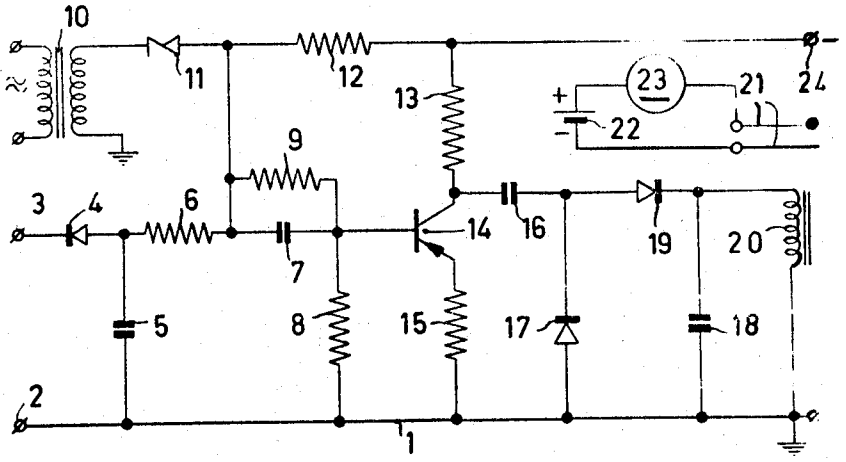
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FAIL-SAFE MONITOR ALARM CIRCUIT

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FAIL-SAFE MONITOR ALARM CIRCUIT

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This invention relates to a fail-safe monitor circuit for signalling the presence or absence of a monitor signal input. The circuit is provided with an alarm or indicator device for use in conjunction with a monitoring device which produces a signal representative of the condition of operation of an apparatus. The invention finds particular use in conjunction with a modulated electromagnetic wave signal receiver wherein it is desired to signal the absence of a modulation signal when it disappears for more than a predetermined time.

In a monitoring and alarm system of this type, it may be desirable to provide a sharp transition between the normal operating condition and the abnormal or alarm condition, so as to prevent uncertain action in this area.

The invention may be used in a monitoring-alarm device working in conjunction with a radio-guidance beacon wherein the failure of the beacon transmission signal must be made known and wherein a false alarm signal should not be given when the beacon is operating on a time-pulse code basis, i.e. where the transmitter is quiescent for several seconds between pulses. When such a beacon is unattended, reliability and power consumption are important considerations, especially for remote locations.

It is, therefore, an object of my invention to provide an alarm or indicator circuit which is reliable in operation and the power consumption of which is small.

It is a further object of this invention to provide an alarm circuit which is positive in its action at the transition point between normal and abnormal conditions of operation of the apparatus under surveillance.

It is a further object of my invention to provide an alarm circuit which is substantially fail safe.

The invention will now be described with reference to the single figure of the drawing showing a preferred embodiment thereof.

Referring to the drawing, an alternating current signal, whose amplitude is representative of the condition of operation of an apparatus, is applied between terminals 2 and 3. Terminal 3 is coupled to one electrode of a diode 4. The other electrode of the diode is coupled to conductor 1 by means of a capacitor 5. A direct current connection is provided from diode 4 to a second capacitor 7 by means of a resistor 6. The junction between resistor 6 and capacitor 7 is connected through a Zener diode 11 and the secondary of a transformer 10 to ground. Conductor 1 is also grounded. An alternating current signal of constant amplitude is applied to the primary winding of transformer 10.

The combination of capacitor 7 and resistor 9 connected in shunt therewith, provides both direct-current and alternating current coupling the junction of resistor 6 and capacitor 7 and the base electrode of a P-N-P transistor 14. The base and emitter electrodes of transistor 14 are returned to conductor 1 through resistors 8 and 15 respectively. The collector electrode of transistor 14 is connected by a resistor 13 to a voltage supply terminal 24 which is negative with respect to conductor 1. Terminal 24 is also connected by resistor 12 to the junction of resistor 6 and capacitor 7.

The collector electrode of transistor 14 is coupled by a capacitor 16 to a rectifier system comprising diodes 17, 19 and a load circuit consisting of a relay actuating coil 20 in parallel with a capacitor 18.

Relay contacts 21, which are closed in the unenergized condition of relay coil 20, control the application of voltage from battery 22 to an indicating device 23.

The operation of the circuit is as follows:

A signal, for example, supplied by a monitoring receiver (not shown) is applied between input terminals 2 and 3 across diode 4 and capacitor 5. Diode 4 is back biased by the negative voltage applied thereto by resistor dividing network 8, 9, 12 connected between line 1 and terminal 24 and isolating resistor 6. As a result, the amplitude of the monitor signal must be greater than a predetermined minimum value in order to open diode 4. When such a signal is present, a negative voltage, in addition to that supplied by the network, is applied to capacitor 5. Zener diode 11 is poled so that a predetermined negative voltage at the junction of diode 11 and resistor 12 is required to produce breakdown or reverse conduction of diode 11. The breakdown voltage of Zener diode 11 is selected to ensure that a predetermined minimum monitor signal level, or negative voltage on capacitor 5, is present before such action occurs. The time constant for the discharge of capacitor 5, when the monitor signal disappears, after normal operation, is such that several seconds elapse before Zener diode 11 closes or becomes non-conducting.

A low level alternating current signal, for instance a 60 cycle signal, is applied through transformer 10, Zener diode 11 in its reverse current conduction, and capacitor 7 to the base electrode of transistor 14 which is the active element of the amplifier circuit. The amplifier is quite conventional in design. Transistor 14 operates in the grounded emitter mode and a negative bias, with respect to the emitter, is applied to the base electrode by the resistor network 8, 9, 12. Since the base-emitter impedance is low, resistor 6, of high value, is inserted between capacitor 5 and the base electrode in order to obtain the necessary long time-constant for the discharge of capacitor 5. The base bias voltage could be supplied by a separate network. However, in the embodiment shown, if Zener diode 11 were to become short-circuited, the base electrode then assumes the potential of line 1 and transistor 14 is thereby rendered inoperative and the circuit is fail safe as to such a short-circuit.

The alternating current supplied by transformer 10 is amplified by transistor 14 and the voltage appearing across resistor 13 is applied through capacitor 16 to diodes 17, 19 and produces a voltage across capacitor 18 which energizes relay coil 20 and maintains contacts 21 open and the indicator 23 unenergized.

The alternating current signal supplied by transformer 10 is of small amplitude so that clipping normally does not occur when Zener diode 11 is so biased that it is conductive in the reverse direction, so that erratic operation on low monitor signal 11 is largely eliminated.

The fail-safe features of the circuit are as follows:

If diode 4 shorts or opens, the required additional negative voltage on capacitor 5 is removed. The indicator then is energized since the alternating current signal is no longer supplied to transistor 14 because Zener diode 11 is non-conducting. If capacitor 5 fails the same action is achieved.

If Zener diode 11 opens, this removes the alternating current from the amplifier and the relay contacts close to energize the indicator.

It will be readily seen that failure of transistor 14 or its associated circuitry, capacitors 16, 18, diodes 17, 19 or relay 20 provides for the alarm indication.

Lesser degrees of fail-safe operation can be achieved while still using the basic concept of the invention which is the utilization of a monitor signal to control the appli-

cation of an auxiliary signal to an amplifier-control system. For instance, relay **20** could be energized directly by the amplified alternating current signal, thus eliminating the rectifier circuitry. Although only one stage of amplification is shown, further stages may be employed. Zener diode **11** can be replaced by an electromagnetic relay. It should be realized that the operation of the circuit may be reversed, that is, the Zener diode may be biased to be normally in its reverse current conduction state and the amplified voltage output of the amplifier be indicative of abnormal operation. In this mode of operation, the monitor signal would be rectified to produce a voltage reducing the back bias on the Zener diode.

Further modifications may be made which do not depart from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A fail-safe monitor circuit for indicating the operating condition of a system comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage, a Zener diode gating element having a conductive state and a nonconductive state, means connecting said voltage source, said Zener diode and said amplifier input circuit in a series circuit, means responsive to the condition of said system for producing a monitor voltage indicative thereof, means for applying said monitor voltage across said Zener diode to control the state of conduction thereof thereby to control the application of said AC voltage to the input circuit of said amplifier means, and indicator means coupled to said amplifier output circuit and arranged to produce an indication in the absence of said AC voltage at the input circuit of said amplifier means or upon the malfunction of one or more of said circuit elements.

2. A circuit for monitoring the operating condition of a device comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage, a Zener diode, a capacitor, a resistive voltage divider, first and second circuit terminals, means connecting said voltage source and said Zener diode in series across said first and second circuit terminals, means connecting said capacitor across said terminals, means connecting said voltage divider across said terminals, means connecting the input circuit of said amplifier means across a portion of said voltage divider, a source of DC voltage, means for applying said DC voltage across said terminals, a pair of input terminals for receiving an AC monitor signal indicative of the operating condition of the device to be monitored, a diode, means connecting one of said input terminals directly to said first circuit terminal, means serially connecting the other input terminal and said diode to said second circuit terminal, the polarity of said diode and said DC voltage source being relatively arranged so that said diode is reverse biased, said diode and capacitor being operative to effectively control the passage of said monitor signal to said Zener diode thereby to control the state of conduction thereof, which in turn controls the passage of said AC voltage to the input circuit of said amplifier means, and indicator means coupled to said amplifier output circuit and arranged to produce an indication of the presence or absence of said AC voltage at the input circuit of said amplifier means.

3. A monitor circuit for indicating the operating condition of a system comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage of a given frequency, a zener diode gating element having a conductive state and a non-conductive state, means connecting said gating element in series circuit with said voltage source and the input circuit of said amplifier means, said voltage source having a voltage amplitude below the breakdown voltage of said zener diode, a pair of input terminals for receiving a monitor signal voltage indicative of the system condition to be monitored, circuit means responsive to said signal voltage and interconnecting said input terminals with said gating element for applying a control voltage across said Zener diode that is proportional to said monitor signal and which controls the state of conduction of said gating element thereby to control the passage of said AC voltage to said amplifier input circuit, and indicator means coupled to said amplifier output circuit and arranged to produce an indication of the presence or absence of said AC voltage at the input circuit of said amplifier means.

4. A monitor circuit for indicating the operating condition of a system comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage of a given frequency, a voltage sensitive gating element having a conductive state and a non-conductive state, means connecting said gating element in series between the output of said voltage source and the input circuit of said amplifier means, a pair of input terminals for receiving a monitor signal voltage indicative of the system condition to be monitored, said monitor signal comprising an AC voltage having a frequency that is unrelated to the frequency of said AC voltage source, circuit means interconnecting said input terminals with said gating element for applying thereto a control voltage that is proportional to said monitor signal and which controls the state of conduction of said gating element thereby to control the passage of said AC voltage to said amplifier input circuit, said interconnecting circuit means including an electric energy storage element arranged to trigger said gating element from one state to the other state upon the absence of said monitor signal at said input terminals for a given period of time, and a discharge path for the energy of said storage element which is arranged to have a time constant that is shorter than said given time period, and indicator means coupled to said amplifier output circuit and arranged to produce an indication of the presence or absence of said AC voltage at the input circuit of said amplifier means.

5. A monitor circuit for indicating the operating condition of a system comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage of a given frequency, a voltage sensitive gating element having a conductive state and a non-conductive state, means connecting said gating element in series between the output of said voltage source and the input circuit of said amplifier means, a pair of input terminals for receiving a monitor signal voltage indicative of the system condition to be monitored, said monitor signal comprising, during normal operation of the system monitored, pulses of AC voltage separated in time by a given interval, circuit means interconnecting said input terminals with said gating element for applying thereto a control voltage that is proportional to said monitor signal and which controls the state of conduction of said gating element thereby to control the passage of said AC voltage to said amplifier input circuit, said interconnecting circuit means comprising, a diode, a capacitor, means connecting said diode and said capacitor in series across said input terminals thereby to charge said capacitor to a DC voltage level determined by the amplitude of said monitor voltage, means for applying said DC voltage to said gating element to control the state thereof, and means providing a discharge path for said capacitor, and indicator means coupled to said amplifier output circuit and arranged to produce an indication of the presence or absence of said AC voltage at the input circuit of said amplifier means.

6. A circuit as described in claim **5** wherein said discharge path includes a resistor which produces a discharge time constant for said capacitor that is longer than said given time interval of the monitor signal.

7. A circuit as described in claim **5** wherein said gating element comprises a Zener diode, said circuit further comprising a source of DC bias voltage, first means for applying said DC bias voltage across said Zener diode to bias same at a level below its Zener breakdown voltage, and second means for applying said DC bias voltage across said capacitor so as to reverse bias said diode and estab-

lish a minimum input threshold voltage which said monitor signal must exceed in order to produce an effect upon said circuit.

8. A monitoring circuit for indicating the operating condition of a system comprising, amplifier means having an input circuit and an output circuit, a source of AC voltage of a given frequency, a Zener diode gating element having a conductive state and a non-conductive state, means connecting said gating element in series between the output of said voltage source and the input circuit of said amplifier means, a pair of input terminals for receiving a monitor signal voltage indicative of the system condition to be monitored, said monitor signal comprising an AC voltage having a frequency that is unrelated to the frequency of said AC voltage source, circuit means interconnecting said input terminals with said gating element for applying thereto a control voltage that is proportional to said monitor signal and which controls the state of conduction of said gating element thereby to control the passage of said AC voltage to said amplifier input circuit, said interconnecting circuit means comprising, a diode, a capacitor, means connecting said diode and said capacitor in series across said input terminals thereby to charge said capacitor to a DC voltage level determined by said monitor voltage, means for applying the capacitor voltage across said Zener diode to control the state of conduction thereof, and a discharge circuit for said capacitor which provides a given time delay for the discharge of said capacitor in the absence of said monitor signal, and indicator means coupled to said amplifier output circuit and arragned to produce an indication of the presence or absence of said AC voltage at the input circuit of said amplifier means.

9. A circuit as described in claim 8 wherein said interconnecting circuit means further comprises means for applying a reverse biasing DC voltage to said diode thereby to establish a predetermined minimum input threshold level which said monitor signal must exceed in order to pass said diode and charge said capacitor.

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