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CIRCUIT FOR SOUNDING AN ALARM WHEN THE INCOMING SIGNAL EXCEEDS A GIVEN AMPLITUDE

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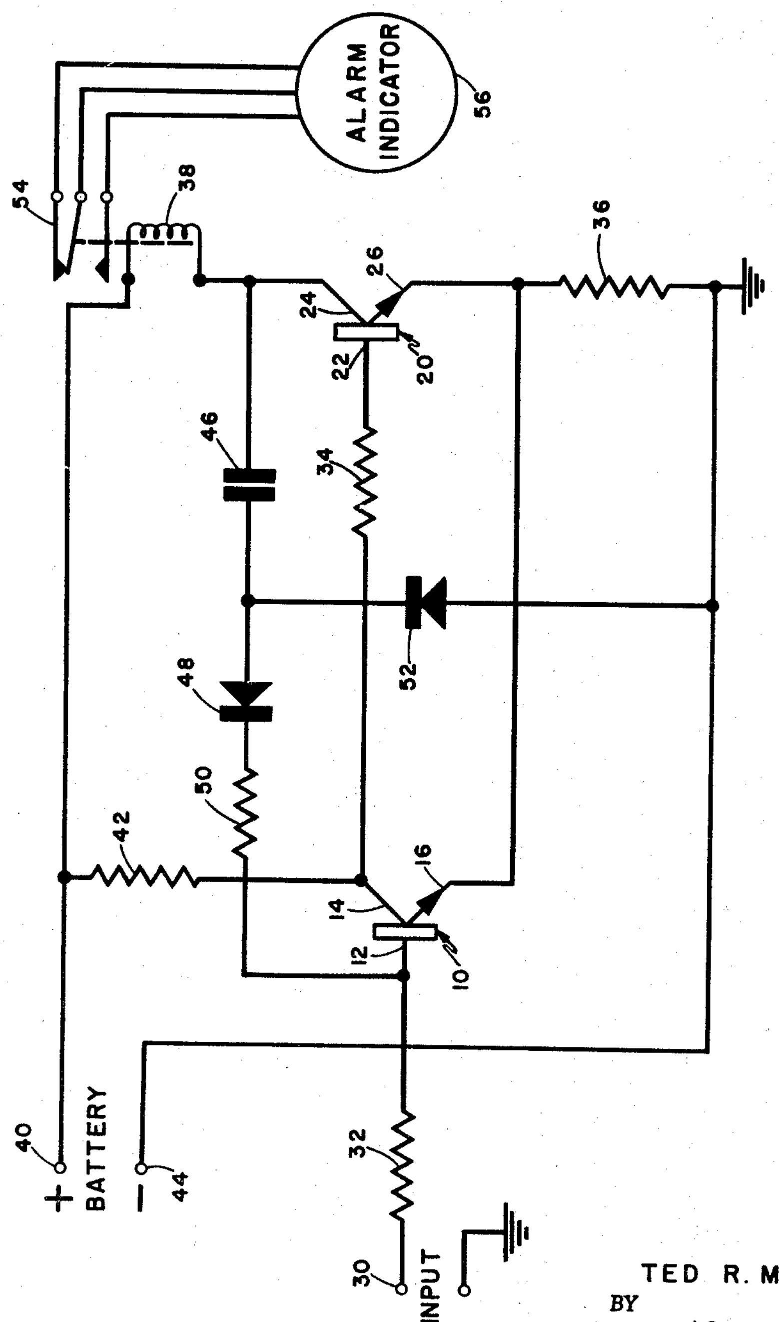

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CIRCUIT FOR SOUNDING AN ALARM WHEN THE INCOMING SIGNAL EXCEEDS A GIVEN AMPLITUDE

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The present invention relates generally to radar and more particularly to a radar alarm.

The primary object of this invention is to provide an alarm which is actuated by a radar echo signal whose effective strength is above a predetermined threshold, the alarm being self-resetting after the signal strength drops below the threshold.

Another object of this invention is to provide an alarm suitable for use with pulse type radar and which sustains an alarm indication for a period of time considerably in excess of the pulse duration.

Still another object of this invention is to provide an alarm circuit which, without modification, may be used with continuous wave radar and will sustain an alarm indication from the time a signal threshold is reached until the signal strength drops below the threshold.

A further object of this invention is to provide an alarm having a minimum recovery time after an alarm has been given.

Finally, it is an object to provide a radar alarm of the aforementioned character which is simple to construct and which will give generally efficient and durable service.

With these and other objects definitely in view, this invention consists in the novel construction, combination and arrangement of elements and portions, as will be hereinafter fully described in the specification, particularly pointed out in the claims, and illustrated in the drawing which forms a material part of this disclosure, and in which the single figure is a schematic wiring diagram of the alarm circuit.

Referring now to the circuitry shown in the drawing, the alarm comprises basically a two-stage D.C. amplifier using a first transistor 10 and a second transistor 20. The first transistor 10 has a base electrode 12, a collector electrode 14 and an emitter electrode 16, the second transistor 20 similarly having a base electrode 22, a collector electrode 24 and an emitter electrode 26, the term "electrode" being omitted hereinafter. The input 30 is connected directly to the base 12 through a resistor 32, while the collector 14 is connected to the base 22 through a coupling resistor 34. The emitter 16 is connected to the emitter 26 and thence to ground through a resistor 36. The collector 24 is connected to one end of a relay coil 38, the other end of the coil being connected to the positive terminal 40 of a battery, or similar source of D.C. voltage. The positive terminal 40 also provides voltage, through a load resistor 42, to the collector 14 of transistor 10, the negative terminal 44 of the battery being connected to ground. The collector 24 is connected back to the base 12 through a feedback circuit comprising, in series, a coupling capacitor 46, a decoupling diode 48 and a resistor 50, the feedback circuit being coupled to ground through a bypass diode 52 connected between the capacitor 46 and diode 48. The relay contacts 54 are wired in a suitable manner to an alarm indicator 56, which is actuated by the relay. The alarm indicator 56 may be of any suitable type such as an audible or visual indicator.

The D.C. amplifier comprising the transistors 10 and 20, maintains a constant current in the circuit and through the relay coil 38 and resistor 36. This current is sufficient to operate the relay contacts 54 and is necessary to es-

tablish a threshold bias for the input transistor 10. It is understood that the word threshold will refer to the magnitude of the voltage required at the input 30 to just overcome the bias applied to emitter 16 by current flow through resistor 36, resulting in the turning on of transistor 10. When a positive pulse type signal is received at the input 30, that portion of the signal, which is greater in amplitude than the threshold bias voltage, is amplified and causes a considerable drop in current through the relay coil 38, sufficient to cause the relay contacts 54 to operate, so actuating the alarm indicator 56. Since the normal radar signal pulse is of extremely short duration, it is necessary to sustain the alarm condition sufficiently long to obtain a useful indication. This is accomplished by the positive feedback circuit which feeds amplified signal current from the output collector 24 back to the input base 12 through capacitor 46, diode 48, and resistor 50, and maintains an effective signal for a considerably longer period than the actual pulse, as hereinafter described in detail. The capacitor 46 passes the A.C. feedback but prevents the D.C. circuit voltage from feeding the input sufficiently to cause a false alarm indication. The diode 48 is a silicon diode which is an open circuit for small signals, so that there is normally no feedback, said diode being a relatively high impedance for low voltages, less than 0.6 volt, in the forward direction, thus decoupling the feedback for small disturbances and preventing feedback or oscillation due to noise. With the advent of a large amplified signal voltage appearing on the collector 24, the diode 48 conducts and allows feedback to the input base 12. The bypass diode 52 provides a quick discharge to ground for the capacitor 46, thereby resetting the circuit and reducing the recovery time of the circuit. The cathode of diode 52 is positive with respect to the anode thereof when the first transistor 10 is conducting, due to an incoming signal. As soon as the capacitor 46 is charged, the first transistor 10 stops conducting, or is turned off, and the second transistor 20 is turned on. Diode 52 is now biased in the forward direction by the negative pulse from the collector 24 of transistor 20, which is turning on, so allowing current to flow through said diode and furnishing a low impedance discharge path. This resetting action is automatic as soon as the signal strength drops below the threshold and is thus effective for true alarm indications or for false alarm indications caused by noise or interference. The feedback is sustained as long as the second transistor 20 is turned off, the time being governed by the charging time of capacitor 46.

Initially, when there is insufficient or no input signal at input 30, the current through relay coil 38 is high enough to energize the relay and close contacts 54 in one direction so that the indictor 56 indicates no signal. When sufficient signal is received at input 30, the amplified portion is added to the current in the relay coil, the summation actually causing the current in the coil to drop and release contacts 54, which return to the other position and actuate indicator 56 to denote an alarm condition. When a steady or continuous wave signal with amplitude greater than the threshold voltage established by resistor 36 is received at the input 30, the relay contacts 54 are immediately actuated to operate the alarm indicator 56 and the alarm condition is sustained until the input signal voltage drops below the threshold. Thus a steady alarm indication is provided during the entire time that a signal of sufficient intensity is being received. Without diode 48, if the circuit is operating above the threshold for any length of time, an undesirable oscillation is likely to occur. However, the diode 48 decouples the feedback circuit before any undesirable oscillation can build up. Again, the bypass diode 52 provides a quick discharge for capacitor 46, so that the circuit can recover for a further signal.

In the feedback circuit, the initial state is as follows: input voltage at 30 is zero, emitter 16 and collector 14 currents are zero, base 22 current through resistors 42 and 34 is at maximum, collector 24 current through relay coil 38 is at maximum, emitter 26 current through resistor 36 is at maximum, capacitor 46 is uncharged and the voltage drop developed by resistor 36 constitutes negative bias for transistor 10. When a positive signal is applied to input 30 and is of sufficient amplitude to overcome the negative bias on emitter 16, collector 14 conducts, causing a large drop in voltage at said collector and reducing base 22 current and collector 24 current to zero. Capacitor 46 now charges through diode 48, resistor 50, relay coil 38 and base 12, thus providing sufficient current to said base to maintain transistor 10 in its on or conducting state. The current at base 12 is present until capacitor 46 has charged and is independent of any signal current at input 30. If a signal current continues at input 30, the circuit remains in the same state with transistor 10 on and transistor 20 off. However, if the input signal ceases while capacitor 46 is charging, the current at base 12 gradually drops until it is insufficient to hold the collector 14 current, which returns to its initial value and permits transistor 20 to be turned on again. This last condition initiates discharge of capacitor 46 through diode 52 and completes a cycle of operation.

The circuit may be adjusted so that the normal input noise voltage, present on terminal 30 in the absence of a radar echo signal, is below the selected threshold. In this manner, the alarm indicates only objects or targets which may be of interest and which cause an echo signal of sufficient intensity to pass the circuit threshold. It is emphasized that the circuit is sensitive to pulse or continous wave inputs and to A.C. or slowly changing D.C., the amplitude and duration being the important factors rather than specific signal characteristics.

The operation of this invention will be clearly comprehended from a consideration of the foregoing description of the mechanical details thereof, taken in connection with the drawing and the above recited objects. It will be obvious that all said objects are amply achieved by this invention.

It is understood that minor variation from the form of the invention disclosed herein may be made without departure from the spirit and scope of the invention, and that the specification and drawing are to be considered as merely illustrative rather than limiting.

I claim:

1. A two-transistor circuit having an alarm state when an input signal exceeds a predetermined amplitude, and having a non-alarm state in the absence of an input signal that exceeds said predetermined amplitude, said circuit maintaining said alarm in its alarm state for a selected interval of time, comprising: a first transistor having an input terminal; a second transistor having an output terminal; a source of potential having a negative terminal; means, comprising connections between said source and said first transistor, for causing said transistor to be non-conductive in said non-alarm state; means, comprising connections between said source and said second transistor, for causing said second transistor to be conductive in said non-alarm state; a load circuit connected to said output terminal of said second transistor, said load circuit comprising the coil of an alarm relay, whereby when said second transistor is conductive it maintains a current flow through said load circuit, said current flow maintains said alarm relay in said circuit's non-alarm state; means for causing said first transistor to become conductive and for simultaneously causing said second transistor to become non-conductive in the presence of a positive-going input signal that exceeds said predetermined amplitude, the circuit thus switching to its alarm state; a positive feedback circuit connected between said output terminal of said second transistor and said input terminal of first transistor, said feedback circuit comprising a series-connected capacitance, and a decoupling diode poled to transmit a positive feedback signal to said first transistor, whereby feedback signal tends to maintain said abnormal state; means for discharging said capacitance when the normal state is restored, said discharging means comprising a diode connected between said negative terminal and said capacitance for transmitting a signal through said capacitance in a direction opposite that of the feedback signal.

2. A two-transistor circuit for energizing an alarm when an incoming signal comprising a single incoming radar pulse, a train of pulses, or a radar wave exceeds a predetermined amplitude, said circuit maintaining said alarm in its energized state for a selected interval of time, comprising: a first transistor having an input terminal; a second transistor having an output terminal; a source of potential having a negative terminal; means, comprising connections between said source and said first transistor, for causing said transistor to be non-conductive in said non-alarm state; means, comprising connections between said source and said second transistor, for causing said second transistor to be conductive in said non-alarm state; a load circuit connected to said output terminal of said second transistor, said load circuit comprising the winding of an alarm relay and a load resistance; biasing means, activated by said load circuit, for controlling the bias of said first transistor; means for activating said first transistor and cutting off said second transistor in the presence of said input signal; a positive feedback circuit connected between said output terminal of said second transistor and said input terminal of said first transistor, said feedback circuit comprising a series-connected capacitance, and a decoupling diode poled to transmit a positive feedback signal to said first transistor; and means for discharging said capacitance, said discharging means comprising a diode connected between said negative terminal and said capacitance, said discharging diode being poled to transmit a signal through said capacitance in a direction opposite that of the feedback signal.

3. A two-transistor circuit for energizing an alarm and maintaining said alarm in its energized state for a selected interval of time, when an input comprising a single incoming radar pulse, a train of radar pulses, or a radar wave exceeds a predetermined amplitude, said circuit comprising: a first normally non-conductive transistor having a base, a collector, and an emitter; a second normally conductive transistor having a base, a collector, and an emitter; a source of potential having a positive terminal and a negative terminal; a load circuit comprising the winding of an alarm relay connected between said positive terminal and said collector of said second transistor, and a load resistance connected between said emitter of said second transistor and said negative terminal; a biasing direct connection between said emitter of said first transistor and said emitter of said second transistor, whereby when said normally conductive second transistor maintains a current flow through said load circuit, said current flow maintains said alarm relay in a normal non-alarm state, and biases said first transistor to its non-conductive state; a load resistance connected between said positive terminal and said collector of said first transistor; a biasing resistance connected between said collector of said first transistor and said base of said second transistor, whereby the presence of said input produces an abnormal state wherein said first transistor is conductive, said biasing resistance cuts off said second transistor, and said biasing connection removes the bias from said first transistor and permits it to remain conductive; a positive feedback circuit connected between the collector of said second transistor and the base of said first transistor, said feedback circuit comprising a series-connected capacitance, a decoupling diode poled to transmit a positive feedback signal to said base of

said first transistor, and a resistance, whereby the nonconductive state of said second transistor causes said positive feedback circuit to charge said capacitance and maintain said abnormal state; means for discharging said capacitance upon the return of said circuit to its normal state, said discharging means comprising a diode connected between said negative terminal and the juncture between said decoupling diode and said capacitance, said discharging diode being poled to transmit a signal through said capacitance in a direction opposite that of the feedback signal, whereby when said circuit returns to its normal state, said capacitance may be discharged.

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