United States Patent

Perlman

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[54] **PARAMETRIC INTEGRATOR FOR CONDITION-RESPONSIVE SYSTEMS**

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[52] **U.S. Cl.** ....**340/258 B,** 328/127, 307/233, 250/221

[51] **Int. Cl.** **G08b 13/00**

[58] **Field of Search**...............340/258 B; 250/221; 328/127, 328/165, 167; 307/233, 246, 295

[56] **References Cited**

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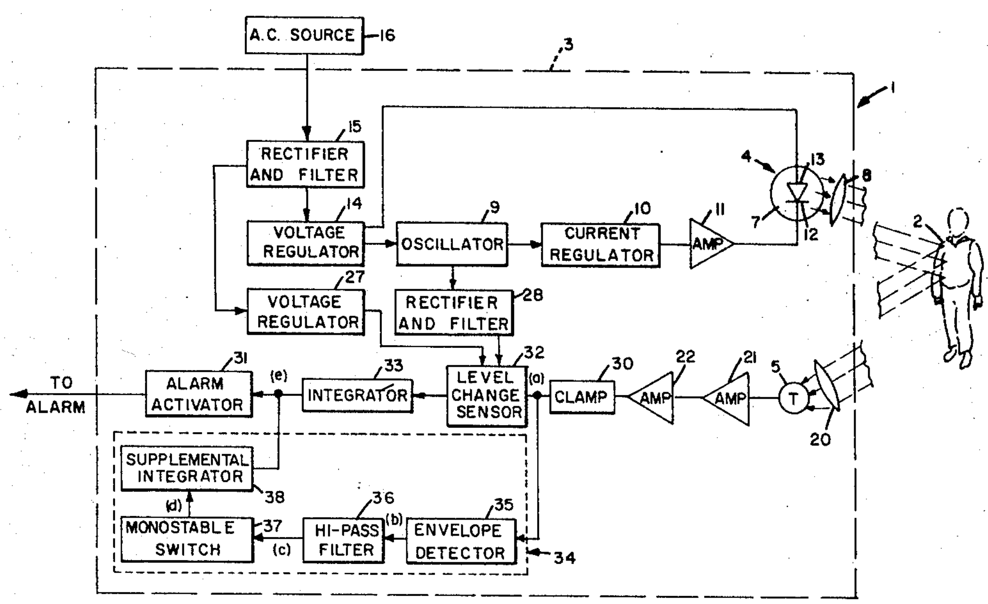
[57] **ABSTRACT**

A parametric integrator adapted for use in condition-responsive systems such as intruder detection devices. The integrator is normally inactive until a transient signal, uncharacteristic of a change in the condition being monitored, is received at the system input. The integrator is then rapidly switched into system circuitry for a predetermined time interval to reduce system sensitivity and thereby avoid the possibility of false alarming in response to the transient.

2 Claims, 3 Drawing Figures



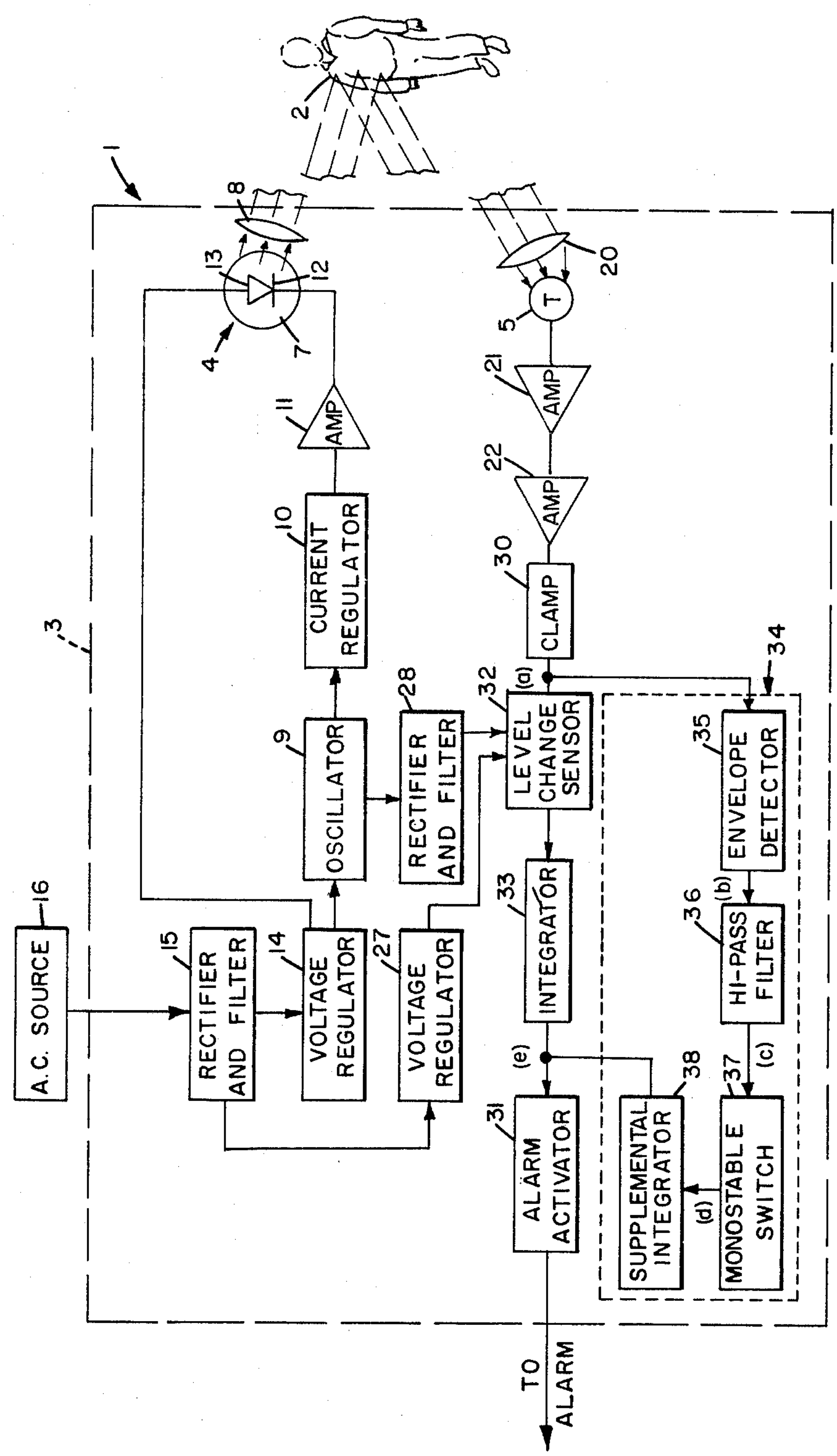


FIG. 1

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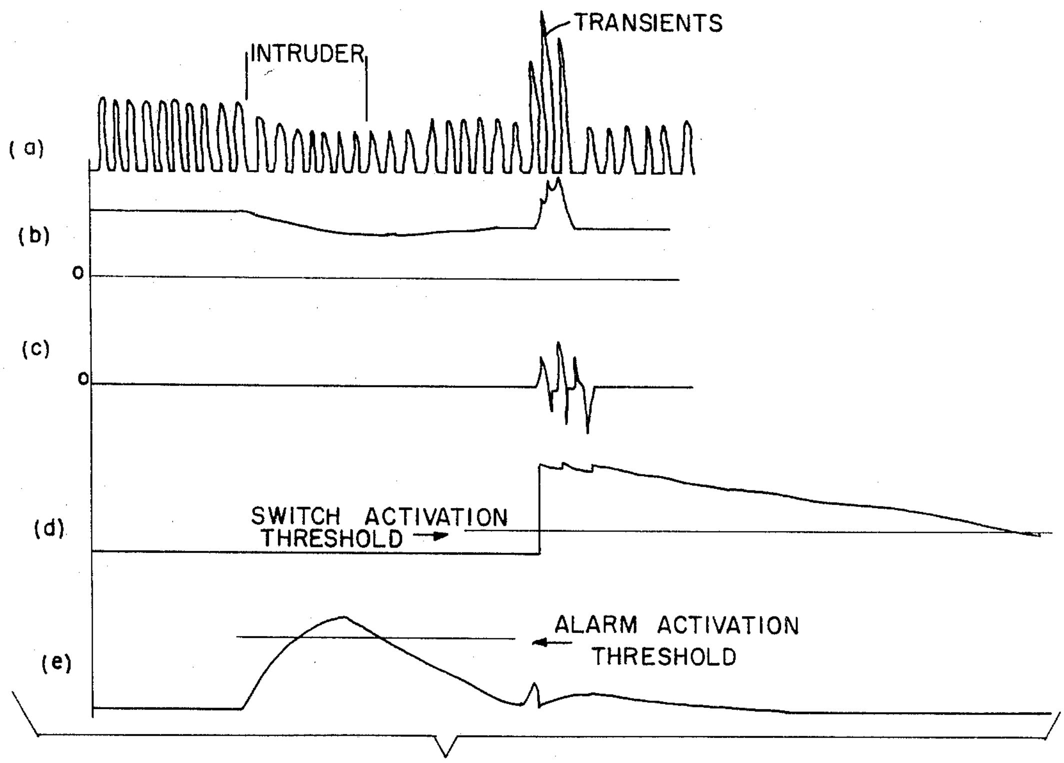

FIG. 2

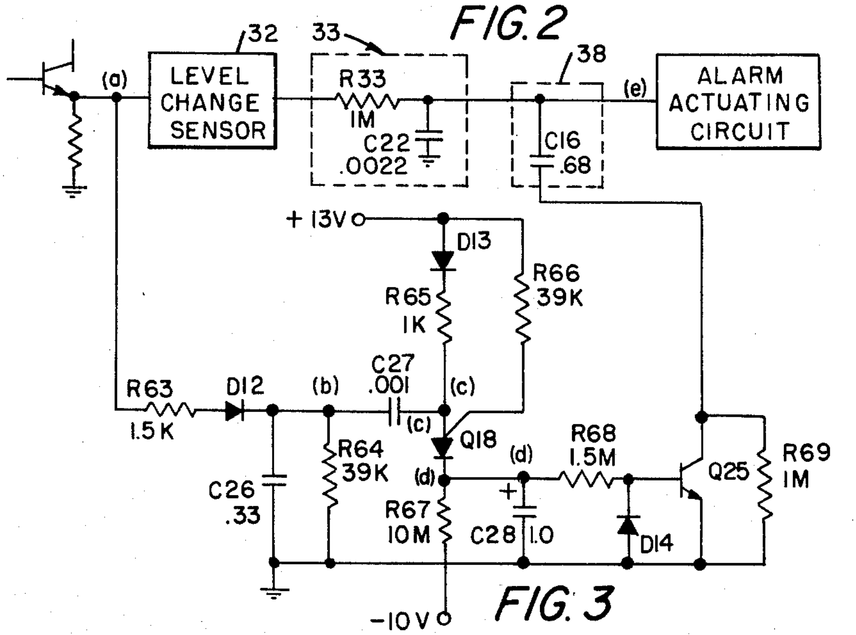

FIG. 3

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PARAMETRIC INTEGRATOR FOR CONDITION-RESPONSIVE SYSTEMS

The present invention relates to condition-responsive devices such as intruder detection devices.

In my co-pending commonly assigned patent application Ser. No. 858,927, filed Sept. 18, 1969, there is disclosed a single terminal photoelectric intruder detection system which detects intrusion by detecting the increase or decrease in received signal caused by the presense of an intruder in a beam of optical energy transmitted by the system. In this system, an RC integrator is used to prevent false alarming from common transient disturbances, such as flickering lights, moderate electrical noise disturbances, and other relatively minor disruptive inputs. In this system, like other known conventional systems, the RC integrator reduces the system sensitivity by a fixed amount, dependent upon the specific time constant chosen. Because of the undesirability of false alarms, there is a tendency to use integrators having exceptionally long time constants so as to avoid alarm activation in response to all conceivable sources of false alarming. The problem, of course, with using an integrator having a long time constant is that relatively weak variations in reflected energy caused by the presence of an intruder in the beam will go undetected. Ideally, no integration at all would be desirable since the system would respond to fast moving and low contrast targets much more readily. However, this sensitivity would lead to the danger of false alarming from relatively minor optical and electrical disturbances of the type mentioned above.

In accordance with the present invention, high sensitivity and immunity to transient disturbances are both achieved in a single condition-responsive device by the use of a parametric integrator. The parametric integrator of the present invention varies the sensitivity of the system in accordance with the type of signal received. When there are no disturbances, little or no integration is present and maximum sensitivity is achieved. In the presence of electrical transients, flickering lights or other disturbances, however, integration is switched in fast enough to cancel the disturbance before its effect is transmitted to the alarm activating circuit. By providing a monostable function to this switch, the increased integration is kept in effect for several seconds following the receipt of a disturbance, thereby permitting the detection circuits to reach equilibrium before the integration is removed. It should be recognized that adding integration only when required is far superior to cancelling or deactivating the system for a period of time following the occurrence of a disturbance since the former merely decreases sensitivity to some degree while the latter totally disables the device during the presence of a disturbance and for several seconds thereafter.

It is the primary object of the present invention to provide an improved intruder detection device of high sensitivity and reliability.

Another object of the present invention is to provide a detection system which is capable of distinguishing minor signal variations produced by the presence of an intruder from minor signal variations caused by the occurrence of unrelated transient events and for preventing the latter from producing false alarms.

Still another object of the invention is to provide a parametric integrating circuit which is adapted for use in all condition-responsive systems.

These and other objects of the invention will become immediately apparent to those skilled in the art from the ensuing detailed description of a preferred embodiment, reference being made to the accompanying drawings in which:

FIG. 1 is a block diagram and partial electrical schematic of a detection system incorporating a preferred embodiment of the invention.

FIG. 2 is a series of waveforms illustrating the outputs of various system components as a function of time; and

FIG. 3 is an electrical schematic of a parametric integrator according to a preferred embodiment.

Referring now to FIG. 1, a single terminal photoelectric detection system 1 for detecting the presence of an intruder 2 in a space under surveillance by such system is shown embodying the invention. The system comprises a housing 3 having disposed therein a transmitter 4 of electromagnetic radiation, a transducer 5 which is sensitive to the radiation provided by transmitter 4 and capable of producing an electrical signal having an amplitude proportional to the intensity of such radiation incident upon the sensitive surface thereof, and circuitry for activating an alarm in response to predetermined rate of change in energy incident upon the transducer 5.

Preferably, the transmitter comprises a luminous or light-emitting diode 7 (e.g., the gallium-arsenide or silicon carbide types) and a lens 8 which serves to direct energy from the source outwardly from the housing 3 through a space wherein intrusion is to be detected. Luminous diodes are ideal for use in such systems because of their relatively small size and ability to be modulated at electronic speeds. Gallium arsenide luminous diodes are particularly preferable because of their ability to emit infrared radiation which is, of course, undetectable by the intruder; therefore, he would be unable to determine the direction in which the system is directed even if he were aware of its presence. Luminous diode 7 is energized and sine wave modulated at a frequency whereby room lighting and other background noise may be discriminated against. Diode energization and modulation is accomplished by conventional circuitry comprising a multivibrator oscillator 9, a current regulator 10, and a power amplifier 11 which are connected in series with the cathode 12 of the luminous diode. Regulated voltage is provided to the diode energizing and modulating circuit and on to the anode 13 of the luminous diode by a voltage regulator 14 which receives the direct current output of the rectifyting and filtering circuit 15 which, in turn, is connected with a conventional alternating current source 16.

Transducer 5 preferably comprises a silicon photodiode which is arranged in the housing 3 in such a manner as to receive radiant energy which has been transmitted by transmitter 4 and reflected by objects in the space under surveillance. A lens 20 serves to provide optical gain by condensing reflected energy upon the radiation sensitive surface of the transducer. The output of the transducer is then amplified by preamplifier 21 and the output thereof is then passed through a sharply tuned amplifier 22 which is tuned to the frequency of modulation provided by oscillator 9. The output of tuned amplifier 22 is fed to a conventional clamping circuit 30, commonly referred to as a "d.c. restorer" whereby the sine wave output of the tuned amplifier may be clamped to zero volts so that the full peak-to-peak amplitude can be detected. Because of the normal distortion associated with clamping circuits, the lower portion of the sine wave input is clipped off by clamping circuit 30 and its output will be as shown in FIG. 2(a). Variations in the AC output of clamping circuit 30 are detected by a level change sensor 32 which is provided with regulated voltage from voltage regulator 27 and is provided with a negative reference voltage from oscillator 9 through the rectifying and filtering circuit 28, the negative voltage serving to enhance the output of level change sensor 32 when the input decreases from a pre-existing low value. The output of level change sensor 32 would normally be at a constant d.c. voltage when the input thereto is at a steady state value. When the input to sensor 32 varies, however, a positive-going d.c. signal will appear on its output until the input signal stabilizes at a new steady state value. This d.c. signal is proportional to the magnitude of variation in its input. Circuitry for this sensor is disclosed in my aforementioned co-pending application.

If an object moves into the beam and its reflectivity is less than that of background, a decrease in the input to sensor 32 will occur. Conversely, if an object whose reflectivity exceeds that of background enters the beam, the input to sensor 32 will increase. Assuming that the change in input is greater than the detecting threshold of the sensor 32, an output signal would be transmitted to the alarm activator 31. Before being fed to the alarm activator, however, the output signal of sensor **32** is integrated by a RC integrator **33** having a relatively fast response time. Integrator **33** merely serves to desensitize the system to high frequency disturbances due to random noise which is always present. This integration, however, is not sufficient to prevent alarms due to flickering fluorescent lights and other optical and electrical disturbances. To desensitize the system to such disturbances, a parametric integrator **34** is incorporated as shown. Parametric integrator **34** comprises envelope detector **35**, high pass filter **36**, monostable switch **37** and a supplemental integrating circuit **38**.

The operation of the parametric integrator **34** may be best understood by referring to FIG. **2** wherein the outputs of the various elements comprising the parametric integrator are shown as a function of time. A single pulsed disturbance typical of a fluorescent light flicker is shown in the right hand portion of the waveform in FIG. 2(a). This is typical of an optical transient and may be found to occur singly, as shown, or in sustained bursts. The latter type of disturbance is characteristic of shot noise due to very high illumination levels and electrical disturbances arising from nearby machinery such as motors with arching brushes. In order for the circuit to work properly, the average peak value of the modulated signal is obtained in an envelope detector having a frequency response fast enough to preserve transients which must be suppressed. The high pass filter blocks all signal changes characteristic of targets or intruders and passes only fast disturbances which are usually at least an order of magnitude shorter in duration than the signal produced by fast moving intruders through the beam. The output of the envelope detector and the high pass filter are shown as waveforms (b) and (c), respectively, in FIG. 2. The output of the high pass filter activates a regenerative monostable switch which turns on very rapidly and then remains on for several seconds following the removal of the disturbance. This switch connects the supplemental integrator **38** into the signal processing circuit. Since the capacitive element of the supplemental integrator **38** is considerably larger than that of integrator **33** and is initially uncharged, it acts as an initial short circuit across the output of integrator **33**, instantly removing charge which has begun to build up across the capacitive element of integrator **33** in response to the transient. Response time of the integrator switching must be fast enough so that the capacitive element of integrator **33** is dumped before its voltage can rise to the alarm activating threshhold value required to trigger alarm activator **31**.

In FIG. 2(e) the input to the alarm activator is shown. Notice that as the output of clamping circuit **30** varies relatively slowly, such variation being attributable to the presence of an intruder, the parametric integrator has no effect on the input to alarm activator **31**, the input being effected solely by integrator **33**. Integrator **33** will continue to receive a signal from sensor **32** until the sensor input has stabilized. Thus, the alarm activator input or the output of integrator **33** will appear as shown in the left portion of the waveform in FIG. 2(e). Upon the occurrence of a high intensity transient, as shown in the right portion of the waveforms in FIG. 2, the output of integrator **33** will increase in accordance with its time constant, until the parametric integrator is triggered and dumps the accumulated charge on the capacitive element of integrator **33** following which the signal at (e) will increase much more slowly in accordance with the greatly increased time constant associated with supplemental integrator **38**.

Circuitry for the parametric integrator is illustrated in FIG. 3. Integrator **33** is comprised of the resistor **R33** and capacitor **C22**. The envelope detector comprises resistor **R63** and **R64**, diode **D12**, and capacitor **C26**. The tie constants of the circuit are chosen so as to filter out the modulated signal (2–2.5 KHZ in the present embodiment) while maintaining adequate speed of response to respond to the transient disturbances which must be sensed in order for the parametric integrator to function properly. Coupling capacitor **C27** serves as the high pass filter to block signal changes of the type resulting from intrusion. The heart of the monostable switch is a programmable unijunction transistor **Q18** which is a three terminal semiconductor device which switches rapidly from a non-conducting to a conducting state when its gate lead becomes approximately 0.6 of a volt negative with respect to its anode lead. Once switched on, the unijunction transistor will remain in conduction as long as the current flowing through it exceeds a threshhold value called the holding current and its conduction, once initiated, will continue after the withdrawal of turn-on voltage between anode and gate. In the circuitry shown, the programmable unijunction transistor is non-conducting because its anode and gate leads are both connected to the positive supply via **R65** and **R66**, respectively. Therefore, since there is no current flow through transistor **Q18**, the cathode voltage at point (d) is at minus 10 volts, keeping switching transistor **Q25** in the off condition. Diode **D14** prevents excessive negative voltage from appearing across the base-emitter junction of transistor **Q25**. In this condition, capacitor **C16**, comprising supplemental integrator **38**, is essentially removed from the circuit.

Upon receipt of a suitably fast transient, both a positive and negative spike will appear at the anode (c) of transistor **Q18**. Whereas the negative portion of this transient has no effect, the positive portion, if it exceeds 0.6 volt, causes transistor **Q18** to switch on. Capacitor **C28** charges rapidly via resistor **R65** and the conducting programmable unijunction transistor from an initial small negative voltage to plus **13** volts. Resistor **R65** serves to limit this charging current to a safe value. Diode **D13** steers the positive trigger pulses from anode to gate rather than to positive supply via **R65**. It is important that resistors **R67** and **R68** be large enough so that it is impossible for the steady state current through transistor **Q18** to reach the holding current level. Therefore, as soon as capacitor **C28** approaches full charge, the programmable unijunction transistor ceases conduction until retriggered by a succeeding transient. Once released, capacitor **C28** discharges through resistor **R68** and the base emitter junction of transistor **Q25**. So long as this discharge is sufficiently high, transistor **Q25** will remain saturated, effectively switching capacitor **C16** in parallel with capacitor **C22**, thereby increasing the integrator time constant and suppressing the circuit's response to the disruptive transient. Resistor **R69** provides a discharge path for capacitor **C16** after transistor **Q25** ceases conduction.

The parametric integrator described herein is capable of suppressing a considerable amount of severe signal fluctuations, this amount being determined primarily by the value of capacitor **C16** and the average value of the disturbance. It should be clear, that even if **C16** is made very large, a sustained disturbance having a sufficiently high average value will eventually cause an alarm condition to exist. The existance of such a disturbance, however, is highly improbable so long as the device is not exposed to very high illumination levels as might be obtained in pointing it directly at a light bulb. Further protection against false alarms is provided by the intense transient cancelling circuit described in my copending application Ser. No. 98,355 filed Dec. 15, 1970, and entitled "Photoelectric Intruder Detection device," which totally disables the signal processing circuit when excessively large and/or high speed disruptive transients occur. Since the threshhold of the intense transient cancelling circuit is set quite high compared to that of the parametric integrator, it should be considered as a secondary or emergency defense against transients of the most severe character that one would anticipate in any normal installation.

While the present invention has been described with particular reference to a single terminal photoelectric intruder detection circuit, it should be quite apparent that the parametric integrator has utility in any condition-responsive system in which integration is desirable. While only one embodiment of the invention has been here disclosed, it should be apparent that the apparatus and particularly the particular circuit elements comprising such apparatus may all be varied widely without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A parametric integrator for suppressing the effect of transient occurrences in a condition-responsive circuit, said integrator comprising in series a high pass filter adapted to pass signals having a substantially higher frequency than the frequency of the condition to be sensed, a normally nonconductive monostable switch adapted to switch to a conducting state for a predetermined time in response to the passage of a signal by said filter, and an RC integrator adapted to be connected to said circuit when said switch is in a conducting state.

2. For use in a photoelectric intruder detection device comprising transmitting means for directing a beam of electromagnetic radiation into a space wherein the intrusion is to be sensed, transducing means positioned to receive radiation from said transmitting means as modified or reflected by objects in said beam for providing an electrical output signal having an amplitude proportional to the intensity of received radiation, signal level sensing means operably coupled with said transducing means output for providing a signal whenever said transducing means output varies with a magnitude and at a rate in excess of a predetermined value, first integrating means, operably coupled with said signal level sensing means output for integrating said sensing means output, and means for activating an alarm whenever the integrated signal exceeds a predetermined threshhold value, the improvement comprising a second integrating means having a time constant substantially longer than said first integrating means and being normally disassociated with said device, and means for connecting said second integrating means in parallel with said first integrating means for a predetermined period following a transient signal on the output of said sensing means, said transient signal having a frequency substantially greater than that normally encountered by the passage of an intruder through said beam.

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