

[54] **ULTRASONIC INTRUSION ALARM**

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[51] Int. Cl. **G08b 19/00**

[58] Field of Search **340/258 A, 258 R; 343/7.7, 343/8**

3,432,855 3/1969 Kalmus.....343/7.7

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[57]

ABSTRACT

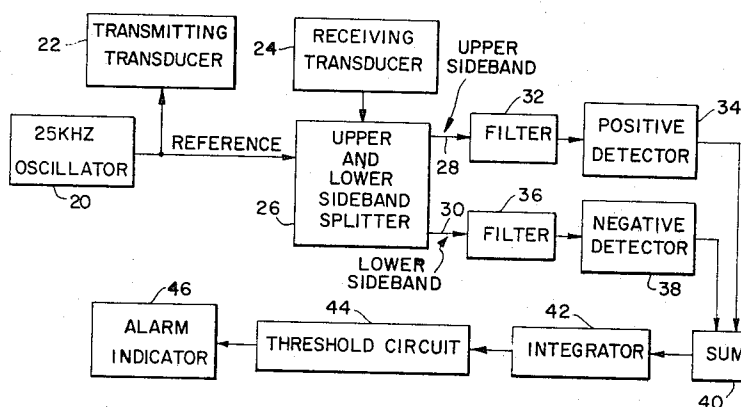
An ultrasonic intrusion alarm system for detecting moving targets in a manner which effectively discriminates against interfering phenomena which could otherwise cause false alarm indications. The alarm system is operative to discriminate against signals attributable to spurious conditions and to process those signals attributable to true moving targets, thereby to substantially lessen the false alarm rate.

References Cited

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14 Claims, 9 Drawing Figures



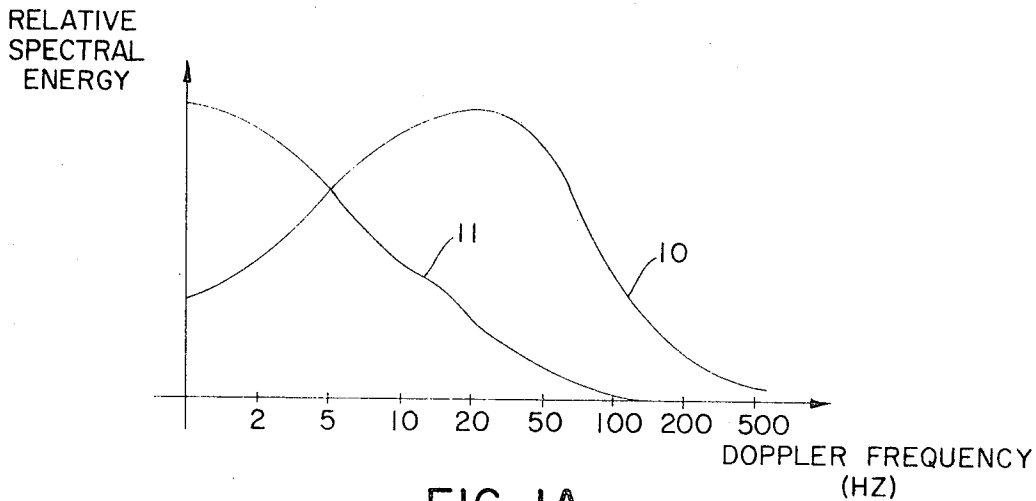


FIG. 1A

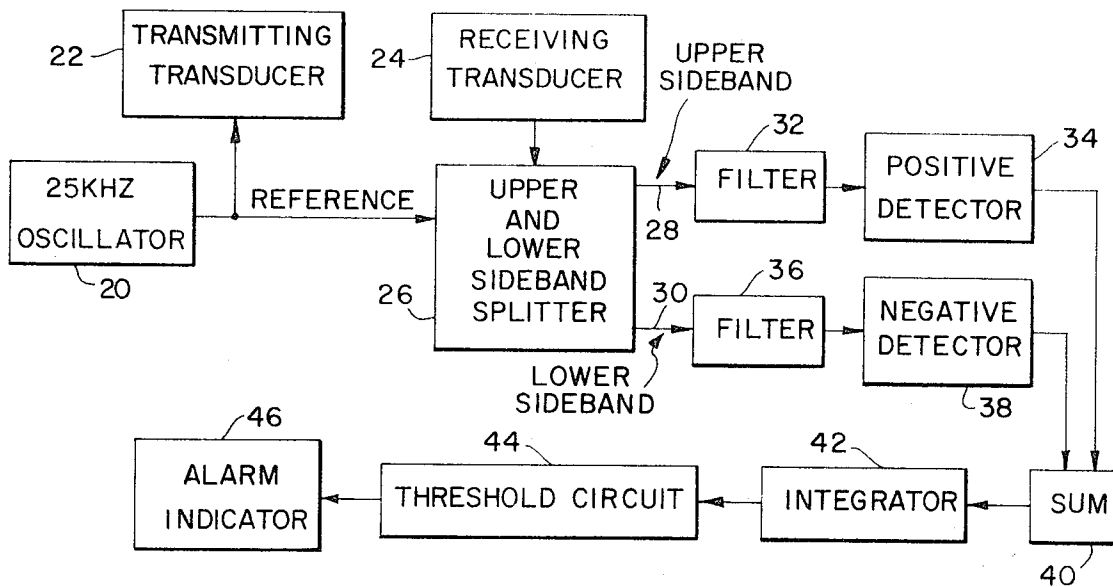


FIG. 2

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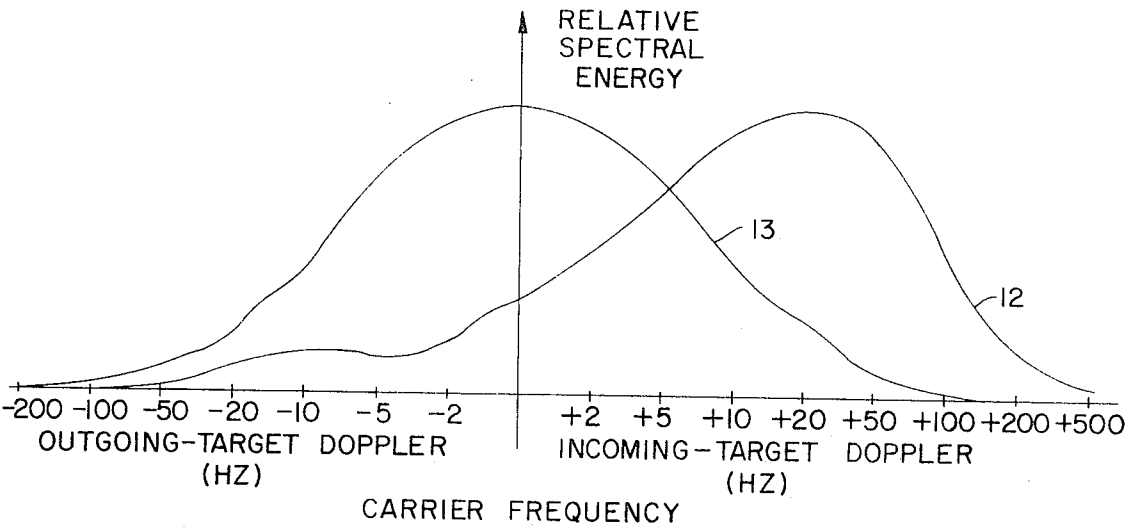


FIG. 1B

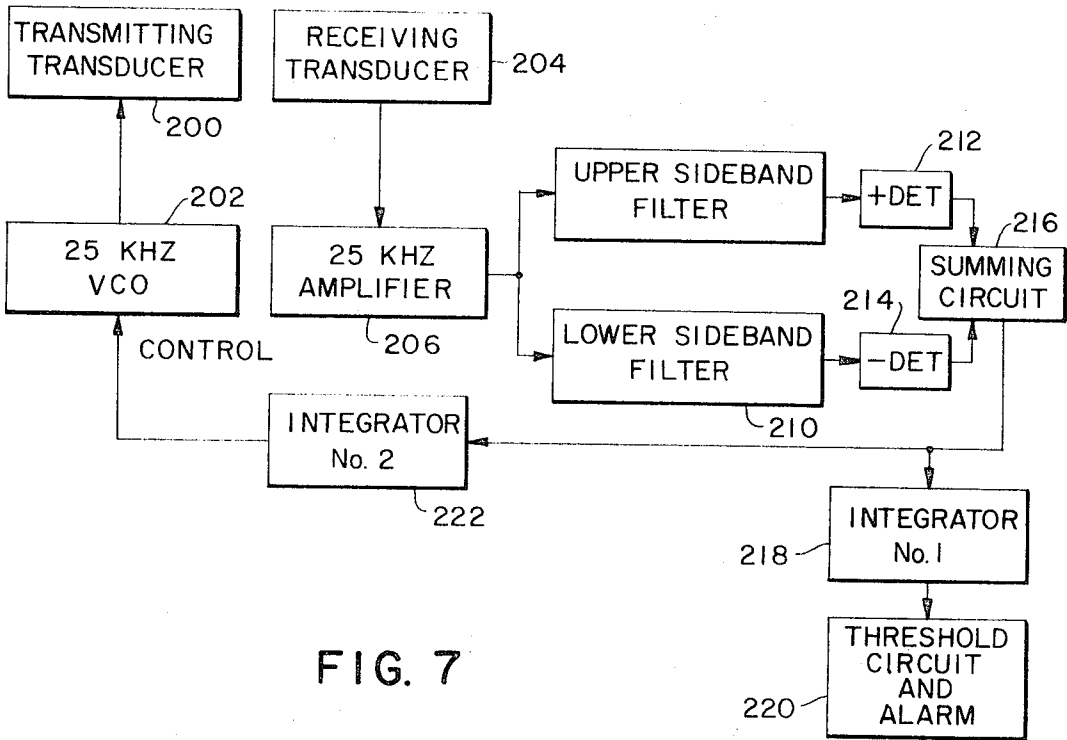


FIG. 7

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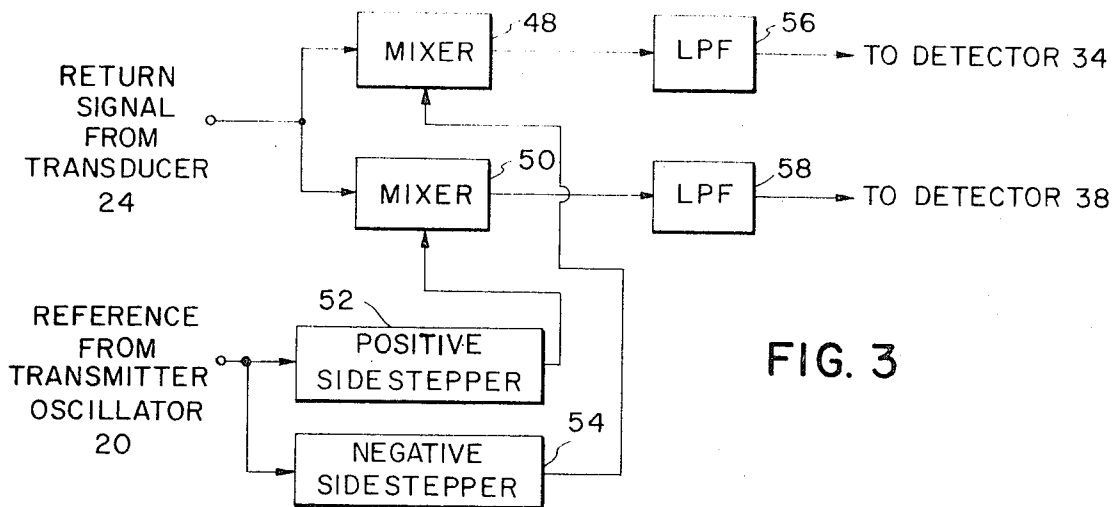


FIG. 3

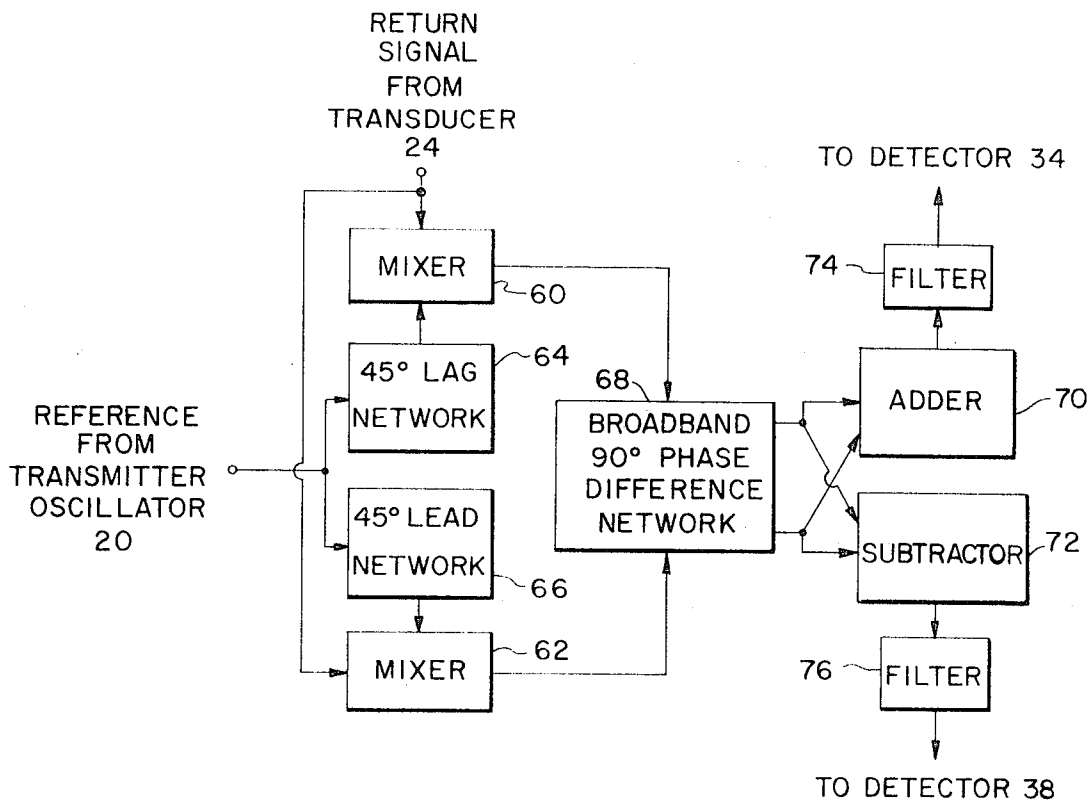


FIG. 4

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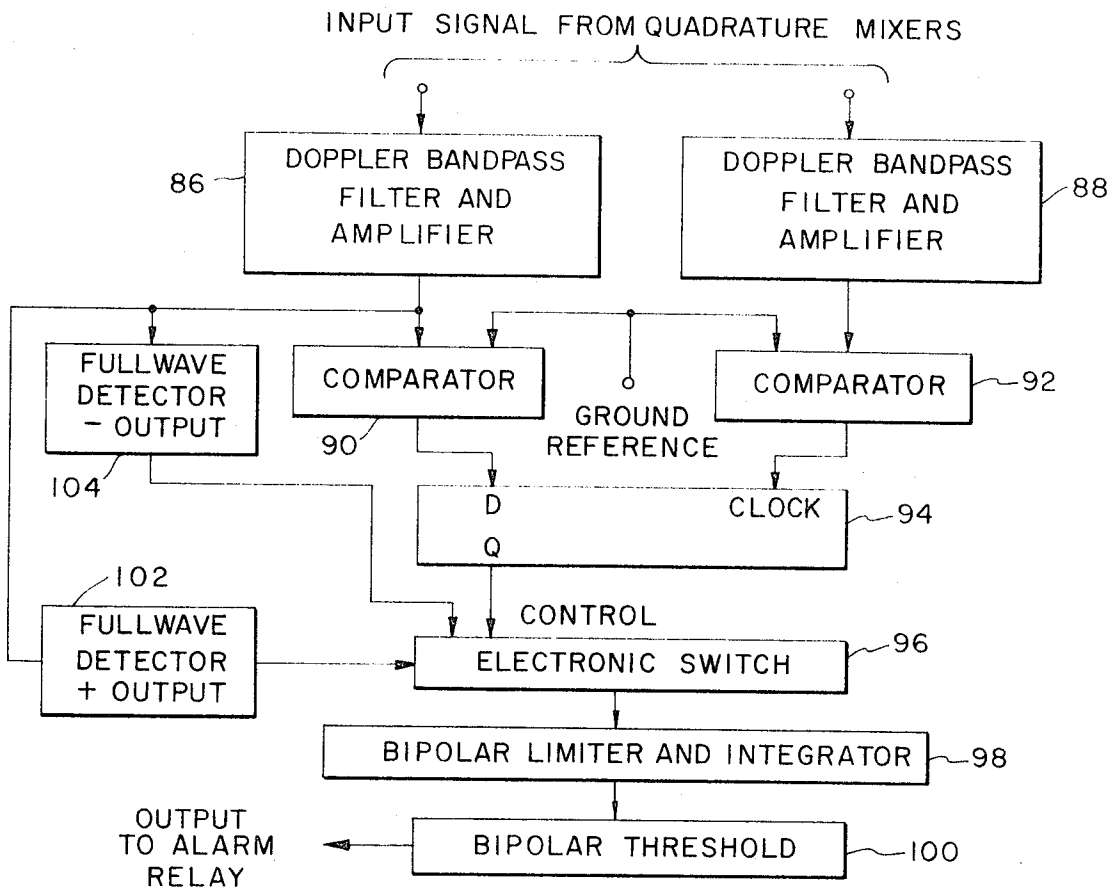
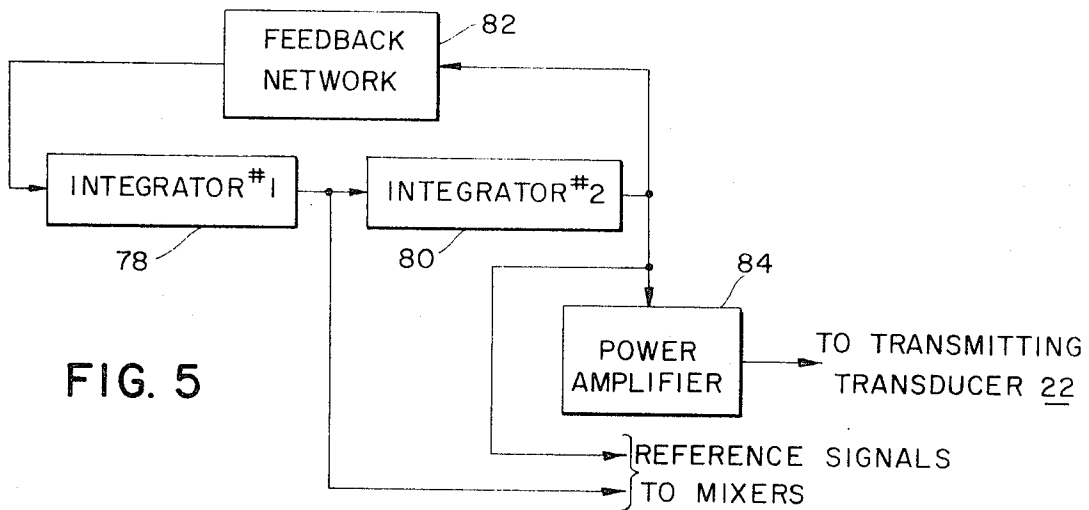


FIG. 6

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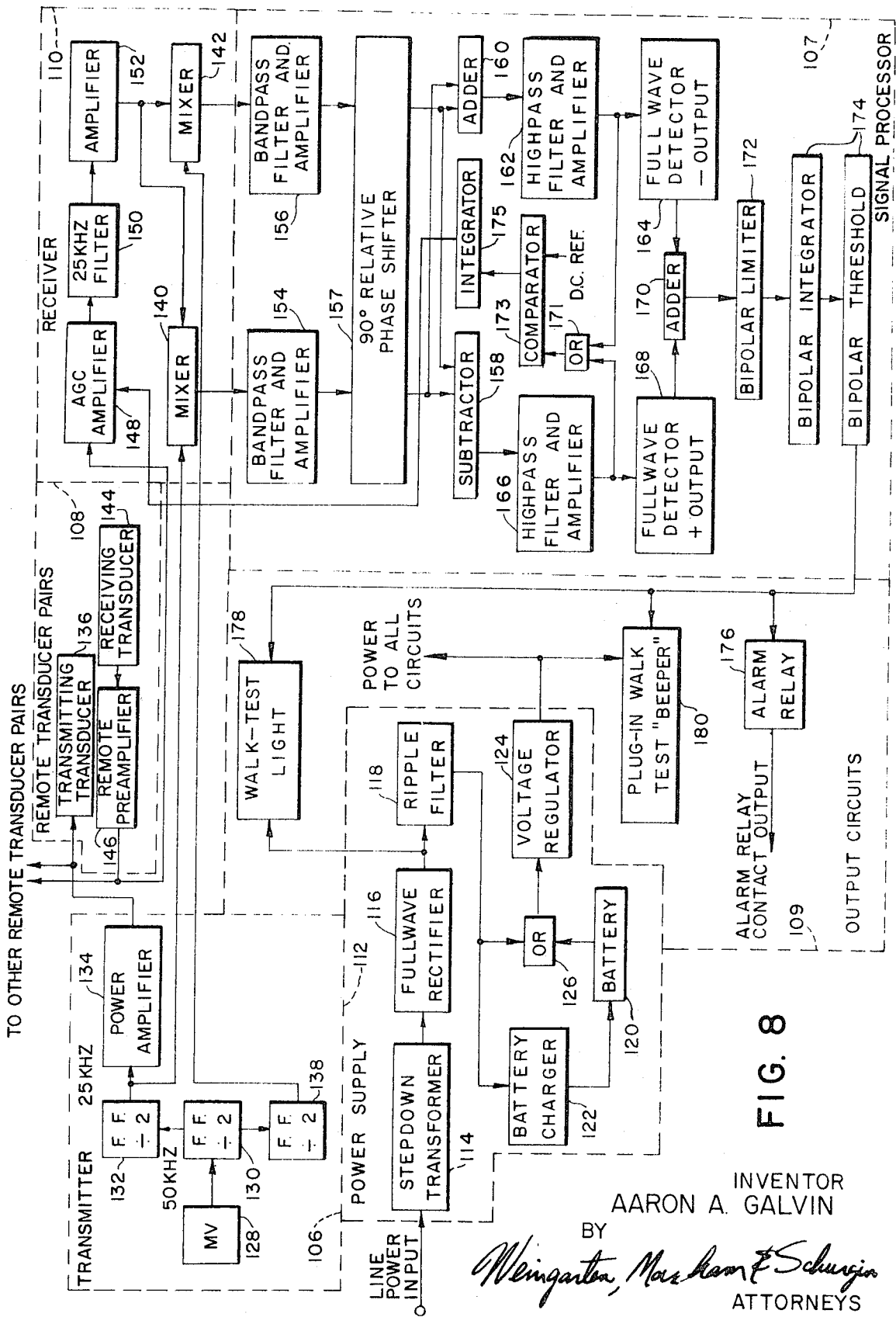


FIG. 8

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ULTRASONIC INTRUSION ALARM

FIELD OF THE INVENTION

This invention relates to intrusion detection systems and more particularly to ultrasonic systems for the detection of a moving target within an area of coverage.

BACKGROUND OF THE INVENTION

Ultrasonic intrusion alarms are known for detecting the presence of a moving target within an area of coverage and for providing an alarm indication of target presence. In general, a continuous ultrasonic tone is transmitted into a zone under surveillance and the back-scattered signal from the stationary objects and moving target in the zone is returned to the receiver and mixed with a portion of the transmitted tone. The return from the moving target produces a low beat frequency which is sensed by a filter and used to trigger an alarm. A major problem in the design of such alarm systems is the tendency of the system to provide false alarm indications caused by various spurious conditions present within the surveillance zone. Such false alarms can be produced, for example, by moving currents of air caused by normal temperature gradients, air conditioning or heating systems, or by the movement of drapes or window shades. False alarms can also be caused by vibrating walls and light fixtures resulting, for example, from passing vehicles, sonic booms, or earth tremors. In addition, high ultrasonic levels caused by lightning or corona discharge can also trigger false alarms in an ultrasonic alarm system. Various techniques have been proposed for reducing the occasion of false alarms but heretofore false alarm reduction has been at the expense of detection sensitivity to true moving targets, particularly those moving at low velocities.

One known approach which has been suggested for reducing the sensitivity of an alarm system to spurious conditions has been to vary the gain or the alarm threshold of the system based on a measurement of background noise or clutter averaged over some period of time. This type of gain or threshold variation is effective only if the interfering phenomena has a gradual onset, over a period of tens of seconds, such as would be caused by slow variations in room air temperature or gradual starting of motion of objects within the room. In actuality, however, the interfering phenomena usually does not exhibit a gradual onset; rather, such phenomena are usually abrupt, such as caused by the starting and stopping of air conditioners, heaters and objects which spuriously move or vibrate. Thus, gain or threshold compensation is generally not very effective against those spurious conditions most often encountered in a working environment. Moreover, variation of the gain also causes a variable detection sensitivity which also results in variable target detection range.

Another technique for discriminating true moving targets from interfering phenomena has employed selective filtering techniques in an attempt to eliminate a major portion of Doppler noise energy caused by moving air currents while retaining sensitivity against a moving target moving at a relatively high radial velocity. While these systems offer some discrimination against false alarms for targets moving at relatively high velocities, these systems are not very effective for low velocity targets since for such low velocity targets the Doppler frequencies attributable to interference phenomena are generally the same as the Doppler frequencies attributable to a true target. Low radial velocities can occur when a target is purposely trying to defeat a detection system or when a target is moving at a normal rate but in a direction that is nearly perpendicular to the radiated beam.

A known intrusion alarm system is disclosed in U.S. Pat. No. 2,794,974 which describes a turbulence compensation scheme in which the overall system threshold level is a voltage derived from a measurement of the background energy at low Doppler frequencies, the purpose being to raise the system threshold and lower the false alarm probability when the Doppler noise level increases due to an increase in air turbulence.

While this technique is somewhat effective in reducing the false alarm rate, it does so only at severe cost in terms of reduced target detection performance for targets which are moving at low radial velocities. The sensitivity of this system to low radial velocity targets is poor because the cutoff frequency of the Doppler filter in the detection channel is set to high Doppler frequencies and also because the energy from a low radial velocity target causes an increase in the threshold level which requires the presence of an even higher processed target return amplitude to cause an alarm.

SUMMARY OF THE INVENTION

In accordance with the present invention, an ultrasonic intrusion alarm system is provided in which certain spectral characteristics of moving targets and interfering phenomena are employed to achieve markedly improved discrimination of moving targets in the presence of such interfering phenomena. Applicant has appreciated that the spectrum caused by interfering phenomena, such as air turbulence, is symmetrically arranged about the carrier frequency of the transmitted signal, symmetrically the spectrum of a signal attributable to an actual target is asymmetrical with respect to the carrier frequency. The present invention makes use of these different spectral characteristics to provide an alarm system having greatly improved target discrimination.

Briefly, the invention comprises means for producing an alarm in response to a received signal, the spectrum of which is unbalanced by a predetermined amount with respect to the carrier, and not producing an alarm in response to a received signal, the spectrum of which is balanced with respect to the transmitted carrier.

DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIGS. 1A and 1B are plots of the spectra attributable to a moving target and to interfering phenomena and useful in explaining operation of the invention;

FIG. 2 is a block diagram of an ultrasonic alarm system according to the invention;

FIG. 3 is a block diagram of an alternative embodiment of the invention;

FIG. 4 is a block diagram of a further embodiment of the invention;

FIG. 5 is a block diagram of a transmitter circuit useful in the invention;

FIG. 6 is a block diagram of an alternative signal processor useful in the invention;

FIG. 7 is a block diagram of yet another embodiment of the invention; and

FIG. 8 is a block diagram of a more detailed embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1A there is shown the spectral characteristics of a signal caused by a moving target and of a signal caused by interfering phenomena such as air turbulence. The curve 10 is the spectrum of a moving target moving at a 1 foot per second radial velocity, while curve 11 depicts the spectrum of background clutter caused by turbulent air conditions. This spectral diagram is shown after conversion of the ultrasonic return signals to baseband frequencies which is a conventional way of depicting such spectra. However, such conversion to baseband frequencies causes foldover of frequencies below the transmitted carrier on top of frequencies above the carrier and hence provides a spectral representation which is different from that which applicant has discovered occurs in actuality.

If the same spectrum is measured at the transmitted carrier frequency, for example with a high resolution spectrum analyzer, the spectrum appears as shown in FIG. 1B. It will be

appreciated that the spectrum 12 caused by a moving target is substantially non-symmetrical with respect to the carrier, while the curve 13 attributable to turbulent air or other interfering phenomena is substantially symmetrical or balanced with respect to the carrier frequency. Applicant has appreciated that the spectra attributable to interfering phenomena and to actual moving targets are distinguishable and that such moving targets are detectable in the presence of such interfering phenomena by novel means to be described herein. Investigation by applicant has shown that the spectrum caused by air turbulence arises generally from three causes. The first cause is the presence of moving air density gradients which cause the summed return from all of the objects in a field of view of an ultrasonic system to vary in amplitude and phase in a random manner. This cause appears to be the most dominant false-alarm-producing component and is fundamentally a balanced sideband phenomena relative to the transmitted carrier frequency.

The second cause is occasioned by slow changes in the average propagation velocity within the back-scattered beam as the result of average air temperature and/or humidity changes. This second cause results in a lower amplitude and generally lower frequency unbalanced spectrum; however, this latter effect has been found to be substantially lower in amplitude and frequency content than the first cause, and is not found to be of serious consequence in an operative system. The third cause which contributes to the spectrum of interfering phenomena is occasioned by returns from the differing temperature interfaces in the air which produces both balanced and unbalanced spectral components. The balanced component is caused by small eddy currents, while the unbalanced component is caused by unidirectional motion of the warm/cold air interface. At ultrasonic carrier frequencies of about 25 KHz this third cause is not usually of sufficient effect to present a problem.

The spectrum of ultrasonic noise caused by lightning and corona tends to be rather broadband and well balanced in terms of energy within the Doppler band of interest.

From extensive investigation applicant has shown that substantially all of the spurious signals received by an ultrasonic alarm are essentially of balanced spectral content such that such balanced returns can be discriminated from unbalanced returns from true moving targets. Unbalanced returns occur by reason of the radial component of motion of an intruder moving toward or away from the alarm system. A target moving away from the system causes return energy lower than the carrier frequency, while return energy higher than the carrier is caused by a target moving toward the system.

A system constructed and operative according to the invention is illustrated in FIG. 2. An oscillator 20 typically operative at a frequency of 25 KHz drives a transmitting ultrasonic transducer 22 which illuminates a predetermined detection zone with ultrasonic energy. A receiving ultrasonic transducer 24 receives back-scattered energy from the detection zone and provides a signal to a sideband splitter 26 which also receives a signal from oscillator 20. The sideband splitter 26 provides two outputs, one output 28 providing energy if a return signal contains components above the carrier frequency, while the other output 30 provides energy if the return signal appears below the carrier frequency. In essence, sideband splitter 26 provides two output signals representative of the upper and lower sidebands, respectively, of a return signal from transducer 24. Output 28 is coupled to a filter 32 which in turn is coupled to a detector 34. Output 30 is coupled to a filter 36 which is coupled to a detector 38. Detector 34 is operative to produce a positive full wave rectified output representation of the input signal from filter 32, while detector 38 is operative to produce a negative full wave rectified output representation of the input signal from filter 36. The positive and negative output signals from respective detectors 34 and 38 are applied to a summing circuit 40, the output of which is coupled to an integrator 42. Integrator 42 is operative to drive a threshold circuit 44 for triggering a suitable alarm indicator 46.

One or the other of detectors 34 and 38 will provide an output signal in the presence of a moving target. Detector 34 will provide a positive rectified output signal in the presence of a target having a component of motion moving toward the transmitter, while detector 38 will provide a negative rectified output signal in the presence of a target having a component of motion moving away from the transmitter. By reason of the substantially balanced spectrum caused by interfering phenomena in contrast to the unbalanced spectrum caused by a moving target, detectors 34 and 38 will both provide output signals in the presence of such interfering phenomena and such signals will substantially cancel in the combination of summing circuit 40 and integrator 42.

Thus, in the presence of interfering phenomena a substantially zero output signal is provided by integrator circuit 42 and no alarm condition is sensed. When however a moving target is detected, integrator circuit 42 will provide a positive or negative output signal to threshold circuit 44 which is operative to energize an alarm indicator 46 in the presence of an input signal which exceeds the predetermined threshold level. It will be appreciated that an alarm indication is provided for a moving target while interfering phenomena which but for the invention could cause an erroneous alarm indication, are not detected by reason of the novel signal processing provided by the invention.

The filters 32 and 36 in the embodiment of FIG. 2 are of narrow bandwidth and in practice such filters are difficult to implement at a 25 KHz carrier frequency by reason of high Q and stability requirements. The requisite filtering can be synthesized in the manner illustrated in FIG. 3. The return signal from receiving transducer 24 is applied to a pair of mixers 48 and 50. Mixer 48 also receives a local oscillator signal from a 25 KHz positive sidestepper which is a frequency offsetting circuit capable of small offsets such as a Serrodyne circuit 52 driven by a reference signal from oscillator 20 and which provides an output signal 200 Hz above the transmitted frequency. Mixer 50 also receives a signal from 24.8 KHz negative sidestepper 54 also driven by a reference signal from oscillator 20 and which provides a local oscillator signal 200 Hz below the transmitted frequency.

The outputs of mixers 48 and 50 are applied to respective low pass filters 56 and 58, each of which contains a notch at 200 Hz to reject the transmitted carrier. The output signals from filters 56 and 58 are applied to respective detectors 34 and 38 (FIG. 2) and the processing continues as described above.

An alternative technique for sideband splitting and providing the requisite filtering is shown in FIG. 4. A return signal from transducer 24 is applied to mixers 60 and 62 which also receive respective signals from lag network 64 and lead network 66. Networks 64 and 66 are driven by a reference signal from transmitter oscillator 20 and provide quadrature driving of mixers 60 and 62. The mixer output signals are therefore quadrature representations ($A \sin \theta$ and $A \cos \theta$) of the received signal vector. The mixer outputs are phase shifted by 90° in a broadband phase difference network 68.

The two output signals from network 68 are added in network 70, while the difference of the two signals from network 68 is provided by network 72. The difference is provided for example by inverting one of the output signals from network 68 and adding this phase shifted signal to the other signal. The output signals from summing networks 70 and 72 respectively represent targets at frequencies above the carrier and targets at frequencies below the carrier. These signals are applied to respective Doppler bandpass filters 74 and 76 and are processed as described above in connection with FIG. 2.

A useful transmitter configuration is illustrated in FIG. 5 and includes a pair of operational amplifier integrators 78 and 80 series connected, with the output of integrator 80 fed back through network 82 to the input of integrator 78. It will be recognized that the illustrated feedback arrangement provides an oscillator for producing an intended sinusoidal output signal typically at a frequency of 25 KHz. The output of integrator 80 is applied to a power amplifier 84 which drives the

transmitting transducer 22 (FIG. 2). The output of integrator 78 is in phase quadrature with respect to the output of integrator 80, and the quadrature output signals provided by the integrators are employed as reference signals in the quadrature mixers described hereinbelow.

An alternative signal processor for providing upper and lower sideband processing is depicted in FIG. 6 and employs a mixed analog and digital circuit configuration. It should be noted that this represents another technique for examining the two input signals to see if a 90° leading or lagging relationship exists between them for a certain minimum interval of time and, if this condition is met at a certain minimum signal amplitude, causing an alarm condition. It is appreciated that there are many possible variations of this general scheme. Signals provided by the quadrature mixers of the embodiments of FIG. 3 or FIG. 4 are applied to respective Doppler bandpass filters 86 and 88 and the amplified output of these filters is applied to respective comparators 90 and 92. The comparators are also coupled to a reference potential such as ground and are respectively operative to produce a positive detector level when an input exceeds ground level.

The output signals from comparators 90 and 92 are applied to the input and clock terminals of a flip-flop 94. The "Q" output of flip-flop 94 is coupled to an electronic switch 96, the output of which is applied to a bipolar limiter and integrator 98 which, in turn, drives a bipolar threshold circuit 100. Flip-flop 94 provides an output level at output terminal "Q" which is the same as the signal level at input terminal "D" at the time of the positive transition of the clock pulse, and retains that level until the next positive transition of the clock pulse. The "Q" terminal will therefore remain positive at all times that the "D" input signal lags behind the clock signal by 90°. If the "D" signal leads the clock signal by 90°, the "Q" terminal will remain negative.

The electronic switch 96 functions as a single-pole double-throw switch and is operative to receive an input from detector 102 when the "Q" terminal is at positive potential, and a signal from detector 104 when the "Q" terminal is at negative potential. The detectors 102 and 104 provide a measure of the actual clutter level present and switch 96 permits a detected sample of the signal from Doppler filter 86 to be applied to limiter and integrator 98, of either positive or negative polarity depending upon the instantaneous position of switch 96. When the signal from limiter and integrator 98 exceeds the threshold provided by circuit 100 an input signal is provided to an alarm indicator.

A further embodiment of the invention is illustrated in FIG. 7 which utilizes a pair of narrowband filters in a feedback controlled loop. A transmitting transponder 200 is coupled to a voltage controlled oscillator 202 typically operative at 25 KHz. Transponder 200 is operative as in the embodiments described above to illuminate an intended surveillance zone with ultrasonic energy. A receiving transponder 204 is adapted to receive energy returned from the zone and to apply a signal in response thereto to an amplifier 206, the output of which is applied to a pair of narrowband filters 208 and 210.

Filter 208 is operative to detect only those frequencies within the upper sideband structure of the received signal, while filter 210 is operative to detect only those frequencies within the lower sideband structure. The filters are coupled to respective detectors 212 and 214 the outputs of which are applied to a summing circuit 216. Detector 212 provides a positive direct current output signal in the presence of a target moving toward the transmitter, while detector 214 provides a negative direct current output signal in the presence of a target receding from the transmitter. Output signals are provided by both detectors 212 and 214 in the presence of interfering phenomena, by reason of the balanced spectra thereof, in contrast to the unbalanced spectra provided by true moving targets.

The output of summing circuit 216 is applied to an integrator 218 which in turn drives a threshold circuit and associated alarm indicator 220. The presence of an unbalanced energy

spectrum caused by a moving target permits the application of a signal to integrator 218, the output signal of which causes alarm actuation if the threshold level is exceeded. If however, a substantially balanced spectral condition exists, detectors 212 and 214 will both provide signals to summing circuit 216 the signal cancellation of the positive and negative signals from the detectors.

The output signal from summing circuit 216 is also applied to a second integrator 222 the output of which is fed back to voltage controlled oscillator 202. Integrator 222 is operative to derive a control signal from the output signal from summing circuit 216 for maintaining the output frequency of oscillator 202 at the center of the filter bands defined by narrowband filters 208 and 210. By use of this embodiment there is no requirement for upper and lower sideband splitting for purposes of quadrature mixing; rather, fixed filters are employed for separating the upper and lower sidebands from the received signal complex while the feedback controlled oscillator 202 is maintained at a frequency at the center of the filter band to permit proper sideband discrimination.

A more detailed implementation of a typical embodiment of the invention is shown in FIG. 8 and includes a transmitter 106, a transducer section 108, a receiver 110, a signal processor 107, an output circuit 109, and a power supply 112. The power supply includes a step-down transformer 114 energized by AC line power from a suitable source and operative to drive a full wave rectifier 116 and filter 118. Standby power is provided by a battery 120 which is maintained in a charged state by a battery charger 122. The rectified and filtered voltage from filter 118 and the voltage from battery 120 are each coupled to a voltage regulator 124 by way of an OR network 126. When line power is present, voltage regulator 124 receives power from filter 118. When, however, line power is removed, battery 120 is automatically coupled to regulator 124 to provide standby power to the system.

The transmitter 106 includes a free running multivibrator 128 which typically operates at a frequency of 100 KHz. The output signal from multivibrator 128 is divided by a factor of four with two series connected flip-flops 130 and 132. The output of flip-flop 132, which is at a frequency of 25 KHz, is amplified by power amplifier 134 and applied to the transmitting transducer 136, and can also drive other like transducers which may be remotely located from the processor. The complementary output of flip-flop 130 is applied to a flip-flop 138 which provides a square wave output having a fundamental frequency component shifted by 90° from the fundamental component of the square wave from flip-flop 132. The output signals from flip-flops 132 and 138 are therefore in phase quadrature and provide the quadrature reference signals for sideband processing, as described above.

It will be appreciated that the transmitter is digital in nature and provides a stable and precisely 90° phase shifted output independent of the basic clock frequency and independent of the symmetry of the wave form provided by multivibrator 128. The quadrature reference signals from flip-flops 132 and 138 are applied to respective mixers 140 and 142. The return signal received by receiving transducer 144 is amplified in preamplifier 146 which is usually located proximate with the receiving transducer. The return signal is further amplified in an AGC amplifier 148 which can also receive additional return signals from other remote transducers.

The output of amplifier 148 is applied to a 25 KHz bandpass filter 150, and after further amplification in amplifier 152, is applied to respective mixers 140 and 142. The output signals from the mixers are quadrature baseband audio frequency versions of the received signal vector. These audio components from mixers 140 and 142 are bandpass filtered in respective filters-amplifiers 154 and 156. The outputs from filters 154 and 156 are applied to respective inputs of a 90° relative phase shifter 157, which maintains a 90° phase difference between its output signals. The outputs from phase shifter 157 are each applied to a subtractor 158 and an adder 160. The output signals from the adding and subtracting circuits

represent information from targets incoming toward and outgoing from the transducers.

Adder 160 is coupled to a high pass filter and amplifier 162, which, in turn, is coupled to a full wave detector 164. Similarly, the output from subtractor 158 is coupled to a high pass filter and amplifier 166 which, in turn, is coupled to a full wave detector 168. The highpass filters in 166 and 162 are both for low Doppler frequency signal rejection and to eliminate D.C. offsets which would otherwise affect balance. Detectors 164 and 168, which respectively provide negative and positive outputs, are coupled to an adder 170, the output of which is applied to a bipolar limiter 172. Limiter 172 is coupled to a bipolar integrator and threshold detector 174 which is operative to drive an alarm relay circuit 176. Output signals from filter and amplifier 162 and 166 are each applied to an OR circuit 171, the output of which is applied to a comparator 173. Comparator 173 in turn provides a signal to a rapidly acting integrator 175 the output of which is a control signal for AGC amplifier 148. The gain of amplifier 148 is adjusted by this rapidly acting gain control circuitry to provide a maximum contrast between the respective energy in the sidebands of a received signal. Any limiting in the system would reduce this contrast. The control signal provided by integrator 175 typically reaches full value in about 1 second and has a decay time of the order of 10 seconds. If a signal detected at filter and amplifier 162 or 166 exceeds a reference level provided by a suitable reference source, the automatic gain control becomes operative and adjusts the signal level within a predetermined range to permit optimum target detection by preventing signal limiting.

This fast-acting automatic gain control is useful to minimize the effects of multipath noise caused for example by energy returning from the target to the receiving transducer after reflections off the walls and objects within a surveillance zone. Such multipath signal returns can cause unexpectedly high energy to appear at the receiving transducer which causes signal limiting or in some cases this multipath signal can produce energy in the other sideband, both of which cause a corresponding lowering of contrast between the signals sensed by the respective signal-processing channels. By operation of the AGC circuitry, such signal limiting is prevented and a relatively high energy difference is maintained between the upper and lower sidebands. The automatic gain control is operative to adjust the signal level in amplifier 148 near the saturation level thereof to permit optimum target detection. The output signal from adder 170 is of positive polarity for incoming targets and of negative polarity for outgoing targets. The adder output will fluctuate both positively and negatively around a zero level for an input condition caused by ultrasonic noise or an object which is swaying back and forth or vibrating. The limiter 172 prevents the integrator 174 from charging too rapidly on either the return from a swinging object or the signal caused by high-level ultrasonic noise, and the parameters of the integrator are chosen such that a unidirectional target must move for a time duration of at least one second before the threshold of detector 174 can be exceeded.

A signal which exceeds the bipolar threshold level of circuit 174 causes an alarm relay 176 to actuate, in turn signalling an alarm condition on a suitable indicator such as an audible or visual alarm. An indicator light 178 and an audible indicator 180 are provided for respective visual and aural indication of an alarm condition and such indicators are also useful for system testing.

Various modifications and alternative implementations of the invention will occur to those versed in the art without departing from the spirit and true scope of the invention. Accordingly it is not intended to limit the invention by what has been particularly shown and described except as indicated in the appended claims.

What is claimed is:

1. An ultrasonic intrusion alarm system comprising:
means for transmitting an ultrasonic signal into a zone under surveillance;
means for receiving signals returned from said zone;

detection means operative in response to said received signals to provide either a first or a second output signal in the presence of a valid moving target and in accordance with the sense of target motion, and to provide both first and second output signals in the presence of interfering phenomena; and

means for processing said output signals to provide an alarm indication only in the presence of either of said first or second output signals.

2. A system according to claim 1 wherein said detection means is operative in response to a received signal, the spectrum of which is unbalanced with respect to the transmitted signal to provide said first or second output signals.

3. A system according to claim 1 wherein said detection means is operative in response to a received signal, the spectrum of which is unbalanced with respect to the transmitted signal to provide either said first or second output signals, and operative in response to a received signal, the spectrum of which is balanced with respect to the transmitted signal to simultaneously provide said first and second output signals.

4. A system according to claim 1 wherein said detection means includes:

a sideband splitter having first and second outputs and operative to provide an upper sideband or a lower sideband signal on only one of said first and second outputs in the presence of a moving target and to provide both upper and lower sideband signals on respective ones of said first and second outputs in the presence of interfering phenomena.

5. A system according to claim 4 wherein said detection means further includes:

first filter means coupled to said first output for receiving said first output signal;

second filter means coupled to said second output for receiving said second output signal;

first detector means coupled to said first filter means;

second detector means coupled to said second filter means; and

means for combining the output signals from said first and second detector means and operative to provide an output signal only in the presence of either a signal from said first detector means or said second detector means.

6. A system according to claim 1 wherein said detection means includes:

a pair of quadrature mixers operative to receive said return signals from said zone and to provide a pair of quadrature output signals;

means for providing a reference signal derived from said transmitted signal to said pair of quadrature mixers; and

means operative in response to said quadrature output signals to provide said first or second output signal.

7. A system according to claim 3 wherein said receiving means includes a variable gain amplifier;

and further including:

means for providing a reference signal of predetermined threshold level; and

means for comparing the amplitude of said first and second output signals with that of said reference signal and for providing an error signal in response to such comparison when the amplitude of said first or said second output signal exceeds said threshold level; and

an integrator operative in response to said error signal to provide a control signal to said variable gain amplifier to vary the gain thereof to provide maximum contrast between the energy in respective sidebands of said received signal and to maintain a predetermined low false alarm rate under varying levels of interfering phenomena.

8. A system according to claim 3 wherein said alarm indicating means includes:

means operative in response to either said first or said second output signal to provide an alarm indication only after a target is detected for a predetermined duration of time.

9. A system according to claim 8 wherein said alarm operating means includes:

a limiter for receiving either said first or said second output signal; and
 integrator means operative in response to the output signal of said limiter and having a threshold level the exceedance of which causes an alarm indication.

10. A system according to claim 6 wherein said reference signal providing means includes:

frequency offsetting means operative in response to a signal from said transmitter to provide a first local oscillator signal to one of said mixers above the transmitter frequency and a second local oscillator signal to the other of said mixer below said transmitter frequency; and
 filter means for receiving said quadrature signals and for respectively providing upper and lower sideband signal components thereof.

11. A system according to claim 1 wherein said detection means includes:

a pair of mixers operative to receive said return signals;
 a phase shift network coupled to said transmitter and operative to provide quadrature mixing signals to said pair of mixers whereby said mixers provide a pair of quadrature output signals;

a quadrature phase difference network operative in response to said quadrature output signals to provide a pair of sinusoidal quadrature phased signals;
 means for summing the signals from said phase difference network to provide a first output signal; and
 means for subtracting the signals from said phase difference network to provide a second output signal.

12. A system according to claim 1 wherein said transmitter comprises:

a pair of serially connected integrators;
 a feedback network connecting the output of one integrator

to the input of the other integrator to provide feedback oscillation;

a power amplifier coupled to the output of one of said integrators for providing energy for transmission in said zone; and

means coupled to the output of said first and second integrators to provide quadrature signals.

13. A system according to claim 1 wherein said receiving means includes a broadband amplifier; said detection means includes:

a pair of narrowband filters operative to detect frequencies in the upper and lower sidebands of said received signals, respectively; and

control means for adjusting the frequency of said transmitting means to a value at the center of the filter band of said narrowband filter.

14. A system according to claim 1 wherein said detection means includes:

a pair of quadrature mixers operative to receive a return signal from said zone and to produce a pair of quadrature output signals;

a pair of bandpass filters operative to respectively receive said quadrature output signals;

a pair of comparators each operative to receive a signal from respective ones of said bandpass filters and to produce a signal upon exceedance of a received signal above a predetermined reference level;

detector means for providing signals representative of noise clutter level; and

digital means operative in response to signals from said comparators and from said detector means to provide an output signal representative of an alarm indication.

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