

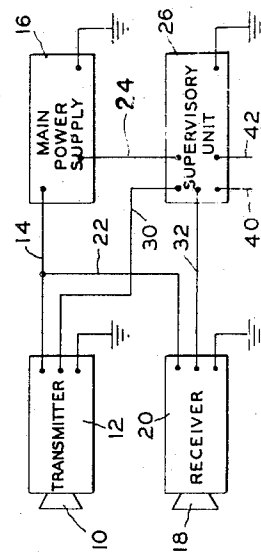
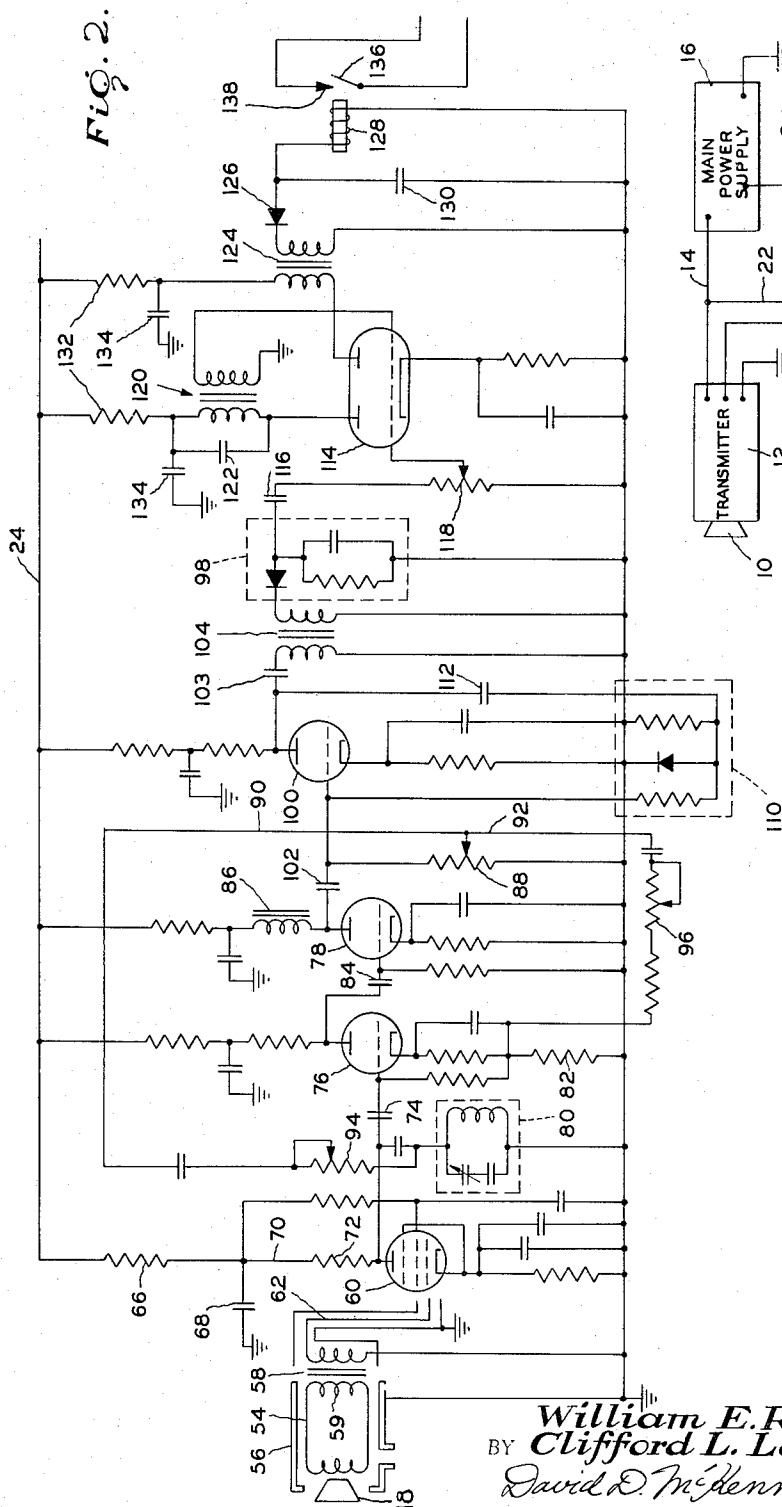
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DEVICE FOR DETECTING MOTION IN A CONFINED SPACE

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2,749,537

DEVICE FOR DETECTING MOTION IN A CONFINED SPACE

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13 Claims. (Cl. 340—258)

The present invention relates to a receiver for a burglar alarm system and more particularly to an improved receiver for use with a burglar alarm system which detects the presence of an intruder within the protected area by means of a disturbance in a complex pattern of ultrasonic waves.

When ultrasonic waves at a fixed frequency are propagated in an enclosure to be protected, a standing wave pattern is established, and a microphone receiver installed within the enclosure will pick up these waves after they have undergone a complex process of reflection and absorption. If an intruder then enters the enclosure, his movements therein have two effects on the ultrasonic wave energy picked up by the microphone receiver. First of all, the frequency of those received waves which are reflected from the moving intruder will differ from the propagation frequency by an amount dependent on the speed of the intruder's movements. This phenomenon has been termed the Doppler Effect. It amounts to frequency modulation of those particular received waves. Secondly, the amount of mechanical energy acting upon the microphone receiver will vary with any shift in the standing wave pattern. This amounts to amplitude modulation. Systems of this general type are known as space type burglar alarm systems.

In systems of this type an appreciable signal-to-noise ratio must be maintained and, therefore, it is desirable to have a system which utilizes both of the above phenomena to detect the presence of the intruder so as to have a large signal available for actuation of the alarm system.

It is, therefore, an object of the present invention to provide a receiver for a burglar alarm system which is responsive to both the frequency modulation and amplitude modulation of a standing pattern of ultrasonic waves due to the presence of an intruder.

It is another object of the present invention to provide a receiver for a burglar alarm system which is responsive to the rate of change of the characteristics of an ultrasonic standing wave pattern, which system as a result can be made insensitive to the effects of slow drift in the pattern.

It is another object of the present invention to provide a receiver for a space type burglar alarm system which includes circuitry which provides for additional gain in the signal-to-noise ratio.

It is another object of the present invention to provide a receiver for a space type burglar alarm system which is not responsive to short duration random noises.

In accordance with the present invention there is provided a receiver which converts the frequency modulated signals due to the presence of an intruder into amplitude modulated signals; the same circuit which performs this conversion combining this signal with an amplitude modulated signal also caused by the presence of an intruder in the protected enclosure. The utilization of

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both the AM and FM signals gives a comparatively large signal thereby providing for a large signal-to-noise ratio. The circuit which converts the FM to an AM signal utilizes a highly selective tank circuit thereby further increasing the signal-to-noise ratio. After the two signals have been combined and amplified they are detected by means of a standard radio-type second detector and the low frequency signal is further amplified. This signal is then rectified and filtered to produce a direct current which is used to operate a direct current relay to actuate the alarm. The filter condenser in the rectifier circuit has an excessively large capacitance to provide a short time delay in the actuation of the relay. This is done so that a random short lived disturbance will not actuate the alarm but will merely partially charge the filter condenser.

Various other objects and advantages will become apparent from the detailed description to follow.

The best form in which we have contemplated applying our invention is clearly illustrated in the accompanying drawings wherein:

Fig. 1 is a block diagram of the system in which the present invention may be used;

Fig. 2 is a circuit diagram of the receiver unit of the present invention;

Referring to Fig. 1 of the drawings, ultrasonic waves at a frequency of about 17,000 cycles per second are propagated in the room or enclosure to be protected by using a standard commercial loud speaker 10 of the high frequency type. This loud speaker has a useful frequency range from 2000 to approximately 18,000 cycles per second and forms a part of transmitter unit 12. The frequency control in this transmitter unit may be a standard constant frequency, phase shift oscillator incorporating negative feed back for stabilization of the output. The transmitter unit obtains A. C. power over lines 14 from the main power supply unit 16.

A loud speaker 18 preferably identical to that associated with the transmitter 12 is used as a microphone to perform the mechanical to electrical energy transformation at a receiver unit 20. A line 22 supplies power to the receiver unit from the main power supply unit 16, and line 24 leads power from unit 16 to a supervisory unit 26. Line 30 connects the supervisory unit to the transmitter unit. Line 32 connects the supervisory unit to the receiver unit and lines 40 and 42 connect the supervisory unit to the central office (not shown).

When an intruder enters the enclosure the standing wave pattern of ultrasonic waves reaching the speaker 18 is disrupted producing frequency modulation and amplitude modulation thereof. These modulated waves represent a signal which is converted by the receiver unit into a direct current which actuates the alarm. The alarm signal is transmitted to the central office over the lines 40 and 42.

The supervisory unit provides for periodic testing of the proper operation of the entire unit by causing the oscillator in the transmitter to emit a signal which simulates the presence of an intruder. The supervisory unit forms no part of the present invention but is the subject matter of copending application Serial No. 495,486, filed by Loudon et al. on March 21, 1955.

Referring to Fig. 2, the speaker 18 serves as a microphone for converting the ultrasonic energy into electrical energy. The output of the speaker 18 is connected to the primary winding 59 of the impedance matching transformer 58. The secondary of the transformer is connected to the control grid of the pentode 60. Electrostatic and magnetic shielding of the input line 54 from the microphone to the transformer is necessary and therefore a two conductor shielded cable is used for this purpose.

It is also necessary to electrostatically shield the control grid lead 62 and the transformer 58 to maintain a signal-to-noise ratio at an acceptable value. A resistor 66 and decoupling capacitor 68 are also used in the plate supply feed 70 of the tube 60 to reduce the possibility of undesirable feed back from later portions of the receiver unit circuit. The output of this tube 60 is obtained across a plate circuit resistance 72 and is capacitively coupled through condenser 74 to the succeeding circuits. The tube 60 should be a pentode since high gain is required at this point in the circuit, and also because of the high impedance used in the plate circuit of pentodes. This high impedance is desirable since the variable selectivity circuit which follows operates best when coupled to a high impedance source. Also the variable selectivity circuit should be independent of the conditions at the input of the receiver unit and a pentode provides for a high degree of isolation between its input and output circuits.

As previously pointed out, it is necessary in circuits of this type to maintain a high signal-to-noise ratio since if this were not done, random noises introduced by the tubes and other circuit parameters might actuate the alarm. Therefore it is highly desirable to have a circuit having a relatively narrow band pass which will eliminate most random noise. The circuit employed in the present invention consists of the tubes 76 and 78 and their associated circuits. The first tube 76 is capacitively coupled to the output of the tube 60 and has connected between its grid and ground a high-Q tank circuit 80 having a band width of approximately 400 cycles. The cathode of the tube 76 has an unbypassed resistor 82 connected in its cathode circuit. Except for these two modifications, the tube acts essentially as a class A-1 self biased, resistance-capacitance coupled amplifier. The input to the tube 78 is capacitively coupled through capacitor 84 to the output of the tube 76. This tube also operates as a class A-1 amplifier and is necessary for the selectivity function. However, an inductance 86 is used as the plate load to obtain a high plate voltage but still retain a high impedance load at the operating frequencies. The output of the tube 78 is capacitively coupled through condenser 102 to the grid of the tube 100. Connected between the grid of the tube 100 and ground is the potentiometer 88. The output obtained on the variable tap of the potentiometer 88 provides for positive feedback to the grid of the tube 76 over line 90 and through resistor 94. Negative feedback is also supplied from this tap to the cathode of tube 76 over line 92 and through resistor 96. The positive feedback is applied to the tank circuit 80 in the grid circuit of the tube 76 and the negative feedback is applied across the unbypassed resistor 82 in the cathode circuit of this tube. The variable resistors 94 and 96 provide for fine control of the relative amounts of feedback.

When the tank circuit 80 is tuned to the frequency of the energy emitted by the transmitter unit 12 (17,000 cycles per second) the circuit 80 will offer maximum impedance to signals of that frequency. At any other frequency the impedance will be somewhat lower depending upon the frequency variation. At a deviation of more than 400 cycles per second from the 17,000 cycles per second center frequency the impedance of the circuit 80 will be so low that the signal will be almost completely dissipated.

Since the positive feedback is applied across the tank circuit 80, the maximum amount of positive feedback signal will occur at the frequency of normal operation, that is 17,000 cycles per second. On the other hand, the negative feedback is applied across the unbypassed resistor 82 and, therefore, the relative amount of negative feedback will remain essentially constant regardless of the frequency of the signal. If the two feedback circuits were adjusted so that the feedback voltages were equal at 17,000 cycles per second the tube will operate at maximum gain. However, such operation is too critical since a slight increase in the positive feedback or a slight de-

crease in the negative feedback would cause the tube to act as a dual feedback oscillator. Therefore, the relative amounts of feedback are adjusted so that the negative feedback predominates to a small extent. It can be seen from the above that if the incoming signal deviates from the normal operating frequency, the voltage developed across the tank circuit 80 will decrease thereby decreasing the positive feedback. The negative feedback will predominate and the gain of the tube will be reduced.

The amount of selectivity required for the proper operation of any particular receiver can be obtained by varying the position of the tap on the potentiometer 88. Variation of this tap will determine the magnitude of the feedback voltages and therefore maximum selectivity is obtained when the tap is at the high end of the potentiometer.

The variable selectivity circuit just described is isolated from the changing load imposed by the detector 98 by means of the vacuum tube 100. A low plate resistance is used in this stage to provide for good impedance matching with the detector 98 thereby providing for the maximum transfer of energy to this device. The input of the tube 100 is capacitively coupled through the condenser 102 to the plate circuit of the tube 78.

Tests of this system indicate that the intensity of the carrier at the microphone 18 varies slowly with time. This fluctuation is believed to be due to ambient conditions disrupting the standing wave pattern in the protected enclosure. Such instability would prevent the maintenance of a constant general system sensitivity with any particular setting of the gain control to be subsequently described. Therefore, it has been found necessary to include a form of automatic gain control 110 which is associated with the tube 100 and which automatically adjusts the circuit's overall gain to compensate for variations in the level of the input carrier at the microphone 18. Sufficient control of this kind is obtained by tapping off the output of the tube 100 through a loose capacitive coupling 112. This signal is rectified and applied to the grid of the tube 100 to vary the grid bias of this tube.

By accomplishing this compensation in one stage, the problem of incidental positive feedback and consequent oscillation is avoided to a great extent. The automatic gain control circuit has proven very effective. It relinquishes control only when the standing wave pattern produces a complete null at the microphone. The appearance of such absolute nulls is so rare that the general sensitivity of the system is well stabilized.

The output of the tube 100 delivers energy to the detector 98 through capacitor 103 and transformer 104. The detector 98 is a conventional detector circuit using a diode as the rectifying element. The low frequency signals from the detector are amplified by two stages of amplification provided by the dual triode 114. The first section of the tube is operated as a class A-1 amplifier and the second section is operated as class A-2. The grid of the first section of the tube is capacitively coupled through capacitor 116 to the output of the detector unit. The potentiometer 118 serves as a manual gain control for the entire receiver unit. Inductive coupling through transformer 120 is used between the first and second stages of amplification. A capacitor 122 is shunted across the primary of the coupling transformer to prevent any high frequency energy from entering the following stages. The plate of the tube in the second stage of amplification is inductively coupled by means of another transformer 124 to the diode rectifier 126. An isolating resistor and decoupling capacitor, for instance, resistors 132 and capacitors 134 in the plate feeds to the dual triode 114, are included in the plate circuit of all of the tubes to prevent feed-back through the power supply line 24.

The output from the transformer 124 is rectified by the diode 126 and the resulting pulsating direct current is then filtered by the electrolytic capacitor 130 so that the alarm relay 128 can be actuated without chattering. The

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electrolytic condenser is made somewhat larger than that which would normally be required for filtering the D.-C. in order to provide a small time delay in the operation of the relay. This is done so that short lived random disturbances will not actuate the relay. The armature 136 of the relay 128 is connected in the central office control circuit and when this armature is caused to contact the contact 138 as a result of actuation of the relay, a signal is produced in the central office circuit thereby indicating the presence of an intruder.

Consider now the steps in the operation of the receiver unit. Before an intruder enters the protected enclosure the 17,000 cycle mechanical wave energy propagated from the microphone 10 associated with the transmitter unit 12 undergoes a complex process of reflection and absorption within the enclosure. The pick-up microphone 18 associated with the receiver unit 20 located elsewhere in the enclosure is acted upon by a portion of this mechanical energy which arrives at this microphone 18 along an infinite number of paths. However, since all the reflecting surfaces in the enclosure are stationary, the frequency of all the energy acting on the receiver microphone is 17,000 cycles. In addition a substantially stationary standing wave pattern is set up in the enclosure so that each direct and reflected wave arriving at microphone 18 terminates there at some fixed point between a loop and node, and consequently the amount of energy actuating the microphone remains substantially constant. The microphone 18 converts this mechanical energy of constant frequency and constant amplitude into electrical energy of constant frequency and constant amplitude. This electrical energy is then amplified by tube 60 and further amplified by tubes 76 and 78. The feedback to tuned circuit 80 has no appreciable effect on the amplitude of the output of tube 78 because all the energy is at the transmitted frequency for which circuit 80 is tuned, and the positive feedback under these conditions very nearly cancels the negative feedback at all times. The output of tube 78 is then further amplified by tube 100 which is provided with an automatic gain control 110 as described. If for any reason the standing wave pattern in the enclosure should begin to shift slowly, for instance because of a change in air temperature, the result would be a change in the total mechanical energy acting on the microphone 18 and a consequent change in amplitude of the input of tube 100. The automatic gain control 110 substantially compensates for such slow changes in amplitude, and the amplitude of the output of tube 100 is more or less constant. This latter output passes through transformer 104 and is rectified and filtered in detector 98. The direct current output of detector 98 with a ripple thereon is fed to the grid 114b in the first section of amplifier tube 114. In the plate circuit of this first section the high frequency ripple which was not by-passed by the condenser in rectifier circuit 98 is by-passed to ground through condenser 122. Since there is no low frequency energy to pass through transformer 120 the receiver unit circuit beyond this transformer is inactive.

Assume now that an intruder enters the protected enclosure and moves about therein. His movement has two effects on the mechanical wave energy actuating the microphone 18. First of all, those waves arriving at the microphone after being reflected from the intruder's moving body have a different frequency than the frequency of propagation in accordance with the Doppler Effect. Secondly, the intruder's movement causes the standing wave pattern to shift thus bringing about a change in the total amount of energy arriving at the microphone.

The frequency modulated signal produced as a result of the Doppler Effect is converted into electrical energy by the speaker 18 and amplified by the tube 60. The signal is further amplified by the tubes 76 and 78, a portion of the output from the tube 78 being fed back to the tube 76 over the positive and negative feedback paths. The relative proportion of the signal on the negative feed-

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back path remains the same as when an intruder was not in the enclosure. However, since the frequency of the signal has been varied to some extent as a result of the intruder's movements the impedance of the tank circuit 80 is not as high with respect to this signal as it was to the 17,000 cycle normal input. Therefore, the positive feedback voltage is reduced thereby reducing the gain of the tube 76 by an amount dependent upon the frequency deviation. This circuit therefore converts the FM signal to an AM signal. The AM signal which is produced by the movement of the intruder is combined in the tube 76 with the AM signal produced by the variable selectivity circuit. Therefore the output of the tube 76 is an AM signal having a magnitude which is indicative of the two effects produced by the movement of the intruder. The combined signals are further amplified in the tube 100 and applied to the standard detector 98 through the transformer 104. The output of this detector is fed to the first section of the tube 114 through the manual volume control 118. The signal is further amplified by the second section of the tube 114 and applied to the rectifier 126 through the transformer 124. The rectified and filtered signal is then applied to the coil of the relay 128.

It is apparent from the above that the present system utilizes all effects produced in the standing wave pattern by the movements of the intruder to obtain an unusually large initial signal. Also, since the system is responsive to the rate of movement of the intruder, automatic gain control can be employed in this system.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by these claims.

We claim:

1. A receiver unit for a space type burglar alarm system in which the waves in an ultrasonic standing wave pattern are both frequency modulated and amplitude modulated by the movement of an intruder in the protected enclosure, which receiver unit comprises a first means for converting the ultrasonic wave energy into electrical energy, a second means for converting said frequency modulated signal to an amplitude modulated signal and for combining the last mentioned amplitude modulated signal with the first mentioned amplitude modulated signal, third means for detecting the combined amplitude modulated signals, fourth means for rectifying the detected signal and an alarm relay connected to be actuated by said rectified signal thereby indicating the presence of an intruder.

2. A receiver unit for a space type burglar alarm system in which the waves in an ultrasonic standing wave pattern are both frequency modulated and amplitude modulated by the movement of an intruder in the protected enclosure which receiver unit comprises a first means for converting the ultrasonic wave energy into electrical energy, a second means for converting said frequency modulated signal to an amplitude modulated signal and for combining the last mentioned amplitude modulated signal with the first mentioned amplitude modulated signal, amplifying means for amplifying the combined signal, an automatic gain control circuit coupled between the input and output of said amplifying means, third means for detecting the combined amplitude modulated signals, fourth means for rectifying the detected signal and an alarm relay connected to be actuated by said rectified signal thereby indicating the presence of an intruder.

3. A receiver unit for a space type burglar alarm system in which the waves in an ultrasonic standing wave

pattern are both frequency modulated and amplitude modulated by the movement of an intruder in the protected enclosure, which receiver unit comprises a first means for converting the ultrasonic wave energy into electrical energy, a second means for converting said frequency modulated signal to an amplitude modulated signal and for combining the last mentioned amplitude modulated signal with the first mentioned amplitude modulated signal, amplifying means for amplifying the combined amplitude modulated signals, automatic gain control means for maintaining the output of said amplifying means constant when the input of said amplifying means varies with respect to time below a predetermined rate, third means for detecting the combined amplitude modulated signals, fourth means for rectifying the detected signal and an alarm relay connected to be actuated by said rectified signal thereby indicating the presence of an intruder.

4. A receiver unit for a space type burglar alarm system in which the waves in an ultrasonic standing wave pattern are both frequency modulated and amplitude modulated by the movement of an intruder in the protected enclosure, which receiver unit comprises a first means for converting the ultrasonic wave energy into electrical energy, a second means for converting said frequency modulated signal to an amplitude modulated signal and for combining the last mentioned amplitude modulated signal with the first mentioned amplitude modulated signal, amplifying means for amplifying the combined amplitude modulated signals, automatic gain control means for maintaining the output of said amplifying means constant when the input of said amplifying means varies with respect to time below a predetermined rate, third means for detecting the combined amplitude signals, fourth means for rectifying the detected signal, fifth means for filtering the rectified signal and an alarm relay connected to be actuated by said rectified signal, said fifth means providing a short time delay in the actuation of said alarm relay.

5. A receiver unit for a space type burglar alarm system in which the waves in an ultrasonic standing wave pattern are both frequency modulated and amplitude modulated by the movement of an intruder in the protected enclosure, which receiver unit comprises a first means for converting the ultrasonic wave energy into electrical energy, second means for amplifying the electrical energy, a positive feedback circuit connected between the input and output circuits of said second means, frequency responsive means included in said positive feedback circuit for producing maximum feedback at the normal frequency of the waves in the standing wave pattern, a negative feedback circuit connected between the input and output circuits of said second means, the relative output of said negative feedback circuit remaining constant over the operating frequency range of the receiver unit, third means for detecting the output signal of said second means, fourth means for rectifying the detected signal, fifth means for filtering the rectified signal and an alarm relay connected to be actuated by said rectified signal, said fifth means providing a short time delay in the actuation of said alarm relay.

6. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means and also responsive to a change in the frequency of the standing waves from a normal frequency to actuate the switch means, said apparatus comprising an electric circuit having means for converting the wave energy into electrical energy fluctuations, amplifier means for amplifying the fluctuations, first rectifier means for rectifying the output of said amplifier means, second rectifier means for rectifying a non-constant output of said first rectifier means, switch means adapted to be actuated by an output from said second rectifier means, and a positive feedback circuit associated with said amplifier means and adapted to provide maximum reinforcement

ment of the output of said amplifier means when the fluctuations occur at the normal frequency, said positive feedback circuit providing substantially less reinforcement when the fluctuations occur at any other frequencies, whereby the output of the first rectifier means is made non-constant by a change in the wave energy converted by the converter means upon a shift in the standing wave pattern, and whereby the output of the first rectifier means is also made non-constant by a change in the frequency of the fluctuations from the normal frequency upon a change in the frequency of the waves from the normal frequency.

7. The apparatus as defined in claim 6 having a negative feedback circuit associated with the amplifier means to provide an attenuation of the amplifier means output which is unaffected by the frequency of the fluctuations.

8. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means and also responsive to a change in the frequency of the standing waves from a normal frequency to actuate the switch means, said apparatus comprising an electric circuit having converter means for receiving the standing waves, said converter means converting the wave energy so received into electrical energy fluctuations, amplifier means for amplifying the fluctuations, first rectifier means for rectifying the output of said amplifier means, second rectifier means for rectifying a non-constant output of said first rectifier means, switch means adapted to be actuated by an output from said second rectifier means, and a positive feedback circuit connected between the output and input circuits of the amplifier means and adapted to provide a maximum reinforcement of the output of said amplifier means when the fluctuations occur at the normal frequency, said positive feedback circuit providing substantially less reinforcement when the fluctuations occur at any other frequencies, whereby the output of the first rectifier means is made non-constant by a change in the wave energy received by the converter means upon a shift in the standing wave pattern, and whereby the output of the first rectifier means is also made non-constant by a change in the frequency of the fluctuations from the normal frequency upon a change in the frequency of the waves from the normal frequency.

9. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means and also responsive to a change in the frequency of the standing waves from a normal frequency to actuate the switch means, said apparatus comprising an electric circuit having converter means adapted to receive the waves, said converter means converting the waves so received into electrical energy fluctuations, amplifier means for amplifying the fluctuations, first rectifier means for rectifying the output of said amplifier means, second rectifier means for rectifying a non-constant output of said first rectifier means, the switch means adapted to be actuated by an output from said second rectifier means, positive feedback means connecting the output and input circuits of said amplifier means to provide reinforcement of the output of said amplifier means, and tuned circuit means associated with the feedback means for making said reinforcement maximum when the fluctuations occur at the normal frequency and substantially less than said maximum when the fluctuations occur at any other frequencies, whereby the output of the first rectifier means is made non-constant by a change in the wave energy received by the converter means upon a shift in the standing wave pattern, and whereby the output of the first rectifier means is also made non-constant by a change in the frequency of the fluctuations from the normal frequency upon a change in the frequency of the waves from the normal frequency.

10. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means and also responsive to a change in the frequency of the standing waves from a normal frequency to actuate

the switch means, said apparatus comprising an electric circuit having converter means for receiving the waves, said converter means converting the wave energy so received into electrical energy fluctuations, amplifier means for amplifying the fluctuations, said amplifier means having input and output terminals, first rectifier means for rectifying the output of said amplifier means, second rectifier means for rectifying a non-constant output of said first rectifier means, the switch means adapted to be actuated by an output from said second rectifier means, resistor means connected between the amplifier means output terminal and a point in the circuit, positive feedback means connecting the amplifier means input terminal to a point on the resistor means to provide reinforcement of the output of said amplifier means, and tuned circuit means connected between the amplifier means input terminal and the said point in the circuit for making said reinforcement maximum when the fluctuations occur at the normal frequency and substantially less than said maximum when the fluctuations occur at any other frequencies, whereby the output of the first rectifier means is made non-constant by a change in the wave energy received by the converter means upon a shift in the standing wave pattern, and whereby the output of the first rectifier means is also made nonconstant by a change in the frequency of the fluctuations from the normal frequency upon a change in the frequency of the waves from the normal frequency.

11. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means and also responsive to a departure of the frequency of the standing waves from a normal frequency to actuate the switch means, said apparatus comprising an electric circuit having converter means for receiving the waves, said converter means converting the wave energy so received into electrical energy fluctuations, amplifier tube means for amplifying the fluctuations, said amplifier tube means having control and output electrodes, first rectifier means for rectifying the output of said amplifier tube means, second rectifier means for rectifying a non-constant output from said first rectifier means, the switch means adapted to be actuated by an output from said second rectifier means, resistor means connected between the output electrode of the amplifying means and a point in the circuit, positive feedback means connecting the control electrode of the amplifying means to a point on the resistor means to provide reinforcement of the output of said amplifier tube means, and tuned circuit means connected between the control electrode and the said point in the circuit, said tuned circuit means having an inductor and a capacitor in parallel and presenting maximum impedance to current flow from the output electrode through the feedback means and tuned circuit means when said current is fluctuating at the normal frequency and presenting substantially less impedance to said current when the latter is fluctuating at any other frequency, whereby the output of the first rectifier means is made non-constant by a change in the wave energy received by the converter means upon a shift in the standing wave pattern, and whereby the voltage on the control electrode de-

creases and causes a decrease in the reinforcement of the amplifier tube means input when the frequency of the fluctuations departs from the normal frequency upon a departure of the frequency of the waves from the normal frequency to make the output of the first rectifier means non-constant.

12. The apparatus as defined in claim 11 in which the amplifier tube means has an emitter electrode and in which negative feedback means are connected between the emitting electrode and the said point on the resistor means to provide an attenuation of the amplifier tube means output which is unaffected by the frequency of the fluctuations.

13. Electrical apparatus responsive to a shift in a pattern of standing waves in an enclosure to actuate a switch means when the rate of shift exceeds a particular rate and also responsive to a departure of the frequency of the waves from a normal frequency to actuate the switch means when the rate of said departure exceeds a predetermined rate, said apparatus comprising a principal electric circuit, microphone means for receiving the waves and converting them into electrical fluctuations, electron tube amplifier means for amplifying the fluctuations, said amplifier means having emitter, control and output electrodes, first rectifier means for rectifying the output of said amplifier means, second rectifier means for rectifying the output of said first rectifier means if the amplitude thereof is non-constant, the switch means capable of being actuated by the output of said second rectifier means when the amplitude of the latter exceeds a predetermined amplitude, resistor means connected between the output electrode and a point in the principal circuit, positive feedback means connecting the control electrode to a point on the resistor means to provide reinforcement of the input of said amplifier means, tuned circuit means connected between the control electrode and the said point in the principal circuit, said tuned circuit means having an inductor and a capacitor in parallel and adapted to present maximum impedance to current flow from the output electrode through the positive feedback means, said tuned circuit means making said reinforcement maximum when said current is fluctuating at the normal frequency, and said tuned circuit means presenting progressively less impedance to said current for progressively decreasing the amount of reinforcement of the amplifier means input as the frequency of the fluctuations departs further from the normal frequency, additional resistor means connecting the emitter electrode to the said point in the principal circuit, and negative feedback means connecting the emitter electrode to said point on the resistor means for providing an attenuation of the amplifier means output which is unaffected by the frequency of the fluctuations, whereby a shift of the standing wave pattern at a rate which exceeds the particular rate causes the amplitude of the second rectifier means output to exceed the predetermined amplitude, and whereby a departure of the frequency of the waves from the normal frequency at a rate which exceeds the predetermined rate also causes the amplitude of the second rectifier means output to exceed the predetermined amplitude.

No references cited.