

[72] Inventor Louis A. Stevenson, Jr.
Houston, Tex.
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[73] Assignee "Automatic" Sprinkler Corporation of
America

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Primary Examiner—Donald J. Yusko
Assistant Examiner—Perry Palan
Attorney—Dressler, Goldsmith, Clement & Gordon

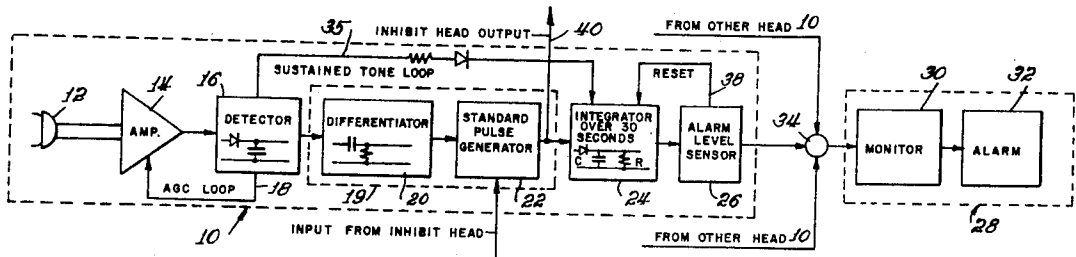
[54] ALARM SYSTEM
16 Claims, 3 Drawing Figs.

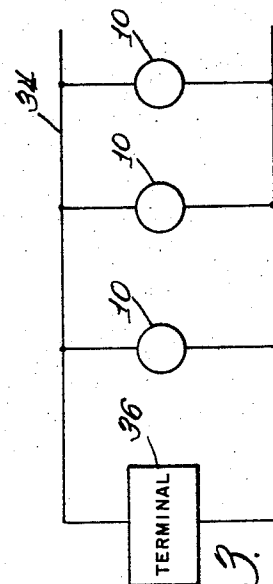
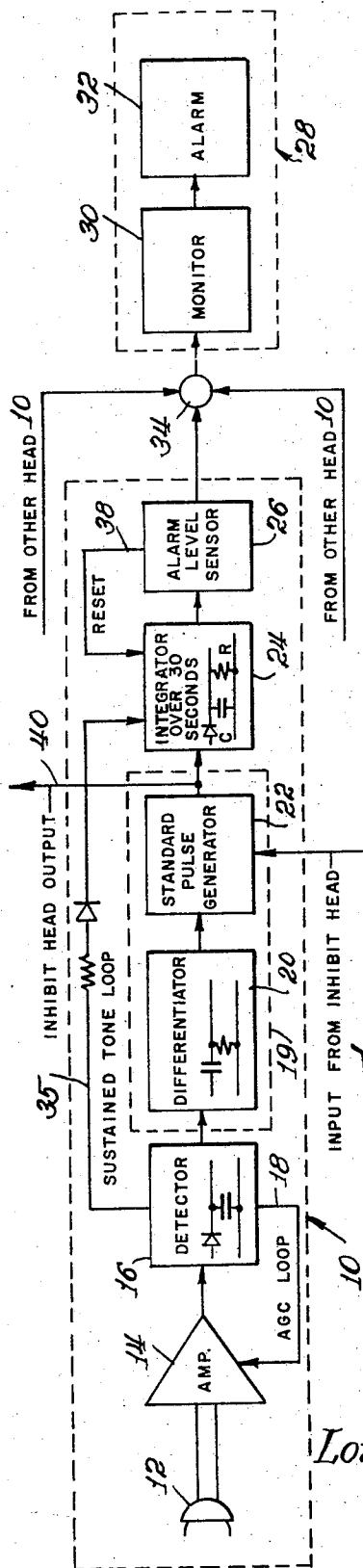
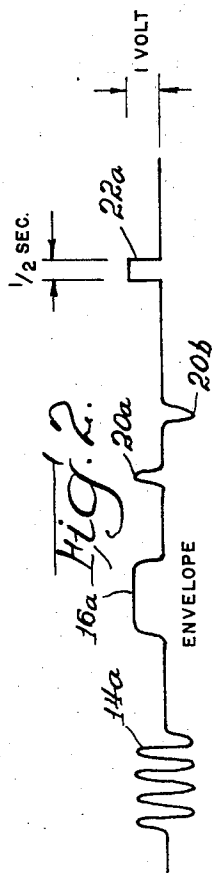
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ABSTRACT: An alarm system having a plurality of disturbance-detecting head means each such head including circuitry for evaluating the disturbance detected and for generating an output when the disturbances detected are alien to the area being monitored. A system circuit capable of assuming different distinct states interconnects the plurality of head means with an alarm. The system circuit changes from one of its states to another of its states in response to the generation of an output from any of the detection heads to thereby trigger the alarm. The alarm may also be triggered as a result of any tampering with the heads or the circuit or as a result of loss of power in the system.





INVENTOR.
 Louis A. Stevenson, Jr.
 BY Dressler, Goldsmith,
 Clement & Gordon
 Att'ys.

ALARM SYSTEM

BACKGROUND

Electronic detection and alarm systems for use in property protection are continually in ever-increasing demand. Such systems are utilized to protect property against theft, vandalism or other illegal intrusion, particularly when the property is unoccupied such as, for example, during the evening and night hours when a business may be closed. Such systems are particularly useful in protecting large normally unoccupied areas such as warehouses which in the normal course of events are entered or inspected at infrequent intervals.

The difficulty with existing "standard" property protection systems, such as watchmen, inspection services and other mechanical or electrical devices is that they have either been relatively easily avoided, i.e., they are not truly effective or are so sensitive as to generate a large number of false alarms.

An effective alarm system is one that is not easily avoided, one which has the required sensitivity to detect the presence of intruders but which also has the capability of distinguishing between events which are representative of the presence of intruders and events which normally occur and can be expected to occur within the area being protected.

GENERAL DESCRIPTION

Since random sounds and noises do occur within large areas even when unoccupied, an effective alarm system must be able to distinguish between such noises and alien noises typical of those made by an intruder.

Since an intruder is likely to make either a plurality of short distinct sounds or a sound of prolonged duration during his attempted illegal entry into a building being protected or during his illegal presence in such an area, a highly effective approach in evaluating sounds is to count sounds and to initiate an alarm if more than a selected number of sounds occur within a selected period of time, independently of their intensity or duration. In addition, a single sound having a duration in excess of a selected period of time would also initiate an alarm. Typically, an alarm would be triggered if three sounds were detected within a period of 30 seconds or, alternatively if a single sound had a duration in excess of 30 seconds.

In accordance with the present invention, there is provided an alarm system which is capable of detecting and evaluating sounds and noises occurring in the area being monitored, which is capable of evaluating such sounds to determine which are alien sounds representative of the presence of an intruder and which are normally occurring sounds and which responds to the occurrence of such alien sounds to initiate an alarm.

While the detection capabilities of the system of the present invention have the desired sensitivity to alien sounds, the system also has desired insensitivity to normally occurring sounds, to sounds occurring externally of the protected area and to interference, typically electrical noise, within the system itself.

To effect the desired performance characteristics, a plurality of detection heads are disposed in the area to be protected each head being responsive to sounds in a portion of the area. The system responds to each detected sound by quantizing the signal generated in response to such sound to generate a single standard pulse for each sound regardless of the length or volume of the sound detected.

The standard pulses are counted and an alarm is initiated if a selected number of pulses are generated within a selected period of time. The system also initiates an alarm in response to a sustained sound which has a duration greater than a selected period of time for also initiating an alarm.

The system automatically adjusts to variant ambient background noise levels in order to prevent initiation of an alarm due to such background noise. False alarms are also prevented by providing auxiliary heads at locations where expected or normal sounds may occur, such as, for example, adjacent to furnaces or clocks, alarms or bells. In order to prevent initiation of a false alarm as a result of sounds occur-

ring external to the protected area, the system is rendered unresponsive to low frequency signals since, typically, only such low frequencies penetrate the walls and windows of a structure being protected.

Systems generally having such capabilities are described in copending application of Jesse L. Patterson, Jr. and Louis A. Stevenson, Jr., Ser. No. 610,069, filed Jan. 18, 1967 now abandoned and assigned to the same assignee as this application.

In the system of that application, a plurality of sound-responsive transducers are disposed in an area to be protected. The outputs of all these transducers are connected to a common control unit which is responsive to the outputs of all of the transducers. The audio low-level output of the transducers is fed to the input of the control unit which then performs the functions as described above of frequency discrimination to eliminate those signals from external sources, quantizing each sound into a uniform pulse, counting the pulses over a selected interval of time and initiating an alarm in response to occurrence of a selected number of pulses within that period of time. The control unit is also responsive to the occurrence of any sound detected by any of the transducers which is sustained over a period greater than a selected interval to initiate the alarm.

In such a system, the sensitivity of the system is adjusted to the overall ambient background noise levels as sensed by all of the transducers. "Cancellation" transducers which are also connected to the input of the control unit are placed at locations within the monitored area at points where normal sounds are expected to occur.

As effective as such a system is, and as superior as it is as compared to other existing systems, difficulties still arise with respect to initiation of false alarms when the system is adjusted to desired sensitivity. For example, since sounds detected by all the transducers are coupled to the control unit, it is possible for random widely dispersed sounds to occur within the selected interval, thereby triggering the alarm even though they do not represent alien sounds. Furthermore, the low-level signal lines between the transducers and the control unit are quite sensitive to electrical noise, and any electrical disturbance, therefore, can cause electrical interference in that line simulating sounds, thereby triggering a false alarm.

In accordance with the present invention, the detection and evaluation circuitry is self-contained within each detection head, the output of which is connected to an alarm through a system circuit that does not require low-level signal lines.

Each detection head is responsive to sounds within only a portion of the area being protected and generates an output only if alien sounds occur within that portion of the area. The possibility of random noises occurring within any single portion of an area being protected in a pattern to trigger a false alarm is so much less than within the entire area that the effectiveness of the system is improved to a point that the system is capable of functioning under conditions which previously rendered the system substantially unusable.

Furthermore, the output of each detection head may be "digital" in nature in that the system circuit can be maintained in a first condition during normal operation and can be switched to a second discrete condition in response to an output from any detection head to initiate the alarm.

Appropriate auxiliary, inhibit heads can be connected where needed directly to one or in one of the detection heads in an area being protected. By connecting inhibit heads directly to only a few detection heads, the entire alarm system is not disabled during an occurrence of expected noise.

Thus, in effect, a system in accordance with the present invention incorporates a plurality of individual alarm systems in the form of detection heads which not only are independently responsive to sounds occurring within the range of each head but which independently evaluate such sounds to generate an output only when alien sounds occur within a portion of the area being protected, with each portion being monitored by an individual detection head.

An additional advantage of such a system is that the sensitivity of each detection head is automatically varied as a function of the ambient background noise level in the vicinity of the head and is unaffected by the noise level in other portions of the area being protected. Thus, the sensitivity of the remainder of the detection heads, and, therefore, the remainder of the system, is not reduced because of high background noise level in only a portion of the area being protected.

Numerous other advantages and features of the present invention will become readily apparent from the following detailed description of the invention and of one embodiment thereof, from the claims and from the accompanying drawings in which each and every detail shown is fully and completely disclosed as a part of this specification, in which like numerals refer to like parts.

FIG. 1 is a block diagram of a system in accordance with the present invention;

FIG. 2 is a diagram of typical waveforms occurring in the system of FIG. 1; and

FIG. 3 is a block diagram showing how the detection heads may be connected in a system circuit.

Referring now to FIGS. 1 and 2 of the drawings there is shown diagrammatically a functional block diagram of a typical head 10 which can be used either as a detection head or as an inhibit head and typical signal waveforms which occur at each point in the head circuit. A plurality of detection heads 10 are disposed in an area to be protected, e.g., inside a building.

Each head 10 includes a self-contained transducer 12, e.g., a microphone, which detects sounds occurring within a portion of the area defined by the detection range of the transducer 12 and converts such sounds to electrical signals. These signals are amplified in amplifier 14 the output of which is an AC signal such as signal 14a having a convenient level for detection.

The signals 14a are detected by a standard detector 16 which produces a DC "envelope," 16a, proportional to the intensity of the sound that is detected by transducer 12. One output of the detector 16 is fed back to the amplifier 14 in an automatic gain control (A.G.C.) loop 18 to reduce the gain of amplifier 14 as the signal level increases, thus preventing overload at any signal level.

The A.G.C. loop 18, by adjusting the gain of the amplifier 14 automatically controls the sensitivity of the detection head 10 as a function of varying ambient background noise levels to reduce the sensitivity of the head 10 as such background noise level increases. In this manner, the sensitivity of each detection head 10 is automatically and independently varied as a function of the ambient noise level immediately adjacent the location of the head.

The second output of detector 16 is connected to a quantizer 19 which generates a standard pulse in response to each detected sound. The quantizer 19 may take the form of a differentiator 20 and pulse generator 22. The differentiator 20 differentiates the envelope 16a providing a pair of pulses 20a and 20b indicative of the leading and trailing edge of the envelope 16a. The output of the differentiator 20 is connected to the standard pulse generator 22 which generates a standard pulse 22a in FIG. 2, of, for example, one-half second duration and 1 volt magnitude.

Such a standard pulse generator is well known and may take the form, for example, of a monostable multivibrator which is responsive to signals of selected amplitude to switch from its stable state to its astable state and remains in such astable state for a fixed period of time.

The output of the standard pulse generator 22 is connected to the input of a pulse counter 24. The pulse counter 24 may take the form of an integrator which accumulates charge proportional to the energy contained within the standard pulse 22a. The pulse counter 24, if an integrator, includes a discharge circuit which discharges the accumulated charge at a selected rate. The output of the pulse counter 24 is con-

nected to an alarm level sensor 26 which generates a standard output pulse when the input thereto reaches a preselected voltage level.

In order for the input to the alarm level sensor 26, i.e., the output of the counter 24 to reach the desired level, a selected number of pulses, three for example, must be received by the pulse counter 24 within a selected period of time, typically 30 seconds. This time interval can be adjusted by varying the value of the counter components, in an integrator by varying the discharge rate thereof. Since the output pulses 22a of the standard pulse generator or quantizer 22 are uniform, the charge accumulated by the integrator in response to each pulse is the same. It is a simple matter, therefore, to adjust the pulse counter to generate the required output in response to receiving a selected number of pulses 22a within a selected time interval.

The output of the alarm level sensor 26 is connected to a control circuit 28, as are the corresponding outputs from other detection heads 10 in the system.

Typically, the control circuit 28 will include a circuit monitor 30 and an alarm circuit 32. The output pulse from alarm level sensor 26 changes the state of the system circuit 34 causing the circuit monitor 30 to energize the alarm to circuit 32 to initiate an alarm signal.

The alarm level sensor 26 also generates an output pulse in response to the detection of a sound having a duration greater than a selected time interval. This is effected by connecting a third output of detector 16 in the form of sustained tone loop 35 directly to the counter 24. In the case of an integrator, the signal in the sustained tone loop 35 charges the integrator at a relatively slow rate, but if the signal persists for the selected time interval, e.g., 30 seconds, the integrator will reach the desired level to cause the alarm level sensor to generate the required output, thereby triggering the alarm 32.

Referring to FIG. 3 there is shown one system circuit 34 suitable for use in the system of the present invention. In the circuit of FIG. 3 each of the detection heads 10 are connected in parallel across the system circuit 34. A circuit terminal, e.g., a fixed impedance, 36 is connected in parallel with the detection heads 10.

In operation, the detection heads normally present an infinite resistance or open circuit. The system circuit terminal 36 completes the circuit so that under normal conditions, the voltage drop across the system circuit will be maintained at a fixed level. When alien sounds are detected by any detection head and the alarm level sensor generates an output pulse, the detection head shorts out the system circuit 34 to trigger the circuit monitor 30 and initiate the alarm 32. If at any time the system circuit 34 is opened, the voltage level will rise to an open circuit voltage which also activates the circuit monitor 30 to initiate the alarm 32.

Alternatively, each of the detection heads 10 may present a fixed resistance so that removing any of the detection heads from the circuit would vary the voltage level and trigger the circuit monitor 30 and the alarm 32.

Thus, the system of the present invention is not only responsive to the detection of alien sounds by any of the detection heads 10, but also permanently monitors the system circuit 34 to initiate an alarm in the event the circuit 34 is tampered with, e.g., shorted or open circuited. The control unit may be provided with auxiliary power source which would trigger the alarm in the event of a general loss of power in the system.

A second output 38 of the alarm level sensor 26 resets the pulse counter 24 so that the detection head 10 is again in condition to detect alien sounds.

The detection head 10 may also be used as an inhibit head by connecting the output 40 of the standard quantizer 19 to an inhibit input 42 of an associated detection head 10. Thus, a head 10 when used as an inhibit head would be located immediately adjacent a source of noise normally present in the area being protected and in the event that such source generates sounds, the output from such inhibit head when connected to input 40 of a detection head 10 would prevent

the standard pulse generator 22 of that detection head from generating the output pulse 22a. It can readily be appreciated that the inhibit input to one detection head would not affect any of the other detection heads in the system so that other alien sounds occurring simultaneously with a normal or expected noise would be detected by the remaining detection heads.

Thus, there has been disclosed an alarm system in which a plurality of self-contained sound detection heads can be utilized to initiate an alarm signal in response to alien sounds occurring within an area, each head being capable of working substantially independently of the others. By utilization of the self-contained detection heads, low-level audio circuits between the area being protected and the control unit are eliminated thereby reducing to a minimum the likelihood of false alarms occurring because of electrical interference in such low-level circuitry.

Furthermore, by effectively protecting a large area by monitoring a plurality of portions of such area, a highly sensitive detection system may be used while reducing the likelihood of false alarms, since the odds of three random sounds occurring within any one portion of the area is considerably less than the likelihood of three random sounds occurring throughout the entire area being protected.

While for convenience the alarm system of the present invention has been described with respect to its operation and capabilities to detect sounds, it is clear that one or more of the independent detection heads can be responsive to other forms of alien disturbances. Each head being a self-contained unit would generate an output which is the identical to the output of any other head in the system for any type of disturbance detected.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concept of the invention. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

I claim:

1. An alarm system comprising a plurality of heads each including transducer means detecting disturbances and generating signals upon detection thereof and evaluating means connected to said transducer means to receive said signals and generate an output pulse in response to such of said signals as are indicative of the occurrence of an alien disturbance; and circuit means connected to said heads to receive output pulses therefrom and initiate an alarm in response to an output pulse from any one of said heads.

2. A system as claimed in claim 1 in which each of said heads generates said output pulse in response to a selected number of signals within a selected period of time.

3. A system as claimed in claim 2 in which each of said heads generates an output pulse in response to a signal having a duration greater than a selected period of time.

4. A system as claimed in claim 1 wherein each of said heads includes means for adjusting the sensitivity thereof as a function of the noise level detected by said head.

5. A system as claimed in claim 1 wherein said circuit means includes a system circuit connected to said plurality of heads and assuming an alarm condition in response to an output pulse from one of said heads and control means connected to said system circuit and initiating an alarm in response to said alarm condition.

6. An alarm system comprising a plurality of detection heads disposed within an area for detecting sounds occurring within said area, each having a limited range for detecting sounds occurring only within a portion of said area and each having means for generating an output pulse only in response to the detection of those sounds occurring within said area as are indicative of the occurrence of an alien disturbance, system circuit means having a normal condition and at least a first alarm condition and responsive to an output pulse from

any one of said heads for assuming said first alarm condition, and control means responsive to said first alarm condition for initiating an alarm.

7. A system as claimed in claim 6 wherein said first alarm condition is a short in said system circuit means.

8. A system as claimed in claim 6 wherein said circuit means has a second alarm condition, said control means being responsive to said second alarm condition for initiating an alarm.

9. A system as claimed in claim 8 wherein said second alarm condition is an open circuit in said system circuit means.

10. A system as claimed in claim 6 in which each detection head includes means for determining whether detected sounds are indicative of an alien disturbance comprising means for counting the number of sounds detected by said head, and means for generating said output pulse in response to a selected number of sounds detected within a selected period of time.

11. A system as claimed in claim 6 in which each detection head includes means for determining whether detected sounds are indicative of an alien disturbance comprising means for generating said output pulse in response to the existence of a detected sound having a duration greater than a selected period of time.

12. A system as claimed in claim 6 in which each detection head includes means for rendering said detection head insensitive to detected sounds occurring outside of said area.

13. A system as claimed in claim 6 including an inhibit head responsive to the occurrence of selected nonalien sounds occurring within said area for generating an inhibit signal, and means for connecting said inhibit head only to those of said detection heads capable of detecting said selected nonalien sounds, whereby said inhibit signal prevents said certain detection heads from generating an output pulse in response to said selected nonalien sounds.

14. An intruder alarm system comprising in combination a plurality of detection heads for detecting sounds occurring within an area, each of said heads including an audio transducer for detecting sounds occurring only within a portion of said area and for generating electrical signals in response thereto, discriminating means for eliminating the low frequency portion of each said signal to prevent detection of sounds from outside the area, quantizing means for generating a single standard pulse in response to each of said signals, circuit means for counting said standard pulses and for generating a voltage in response to the occurrence of a selected number of said standard pulses within a selected interval of time, said counting circuit means also being responsive to said electrical signals for generating said voltage in response to an electrical signal having a duration greater than a selected period of time, and output-sensing means for generating an output pulse in response to said voltage, and control means for initiating an alarm in response to an output pulse from anyone of said heads.

15. A system as claimed in claim 14 including system circuit means having a normal system impedance condition defined by a terminal impedance, means for connecting each of said heads in parallel with said terminal impedance, each of said heads defining an open circuit and including means to short circuit said system circuit in response to said output pulse to define a first system alarm impedance condition, said control means including a circuit monitor for sensing the impedance condition of said system circuit and alarm initiating means connected to said circuit monitor, said circuit monitor energizing said alarm-initiating means in response to said first system alarm impedance condition.

16. A system as claimed in claim 15 wherein effective removal of said terminal means from said system circuit means increases the impedance of said system circuit means to define a second alarm impedance condition, said circuit monitor energizing said alarm-initiating means in response to said second alarm impedance condition.