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[54] **SECURITY ALARM SYSTEM WITH FREQUENCY SWEEPING**

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[52] **U.S. Cl.** **340/224,** 325/420

[51] **Int. Cl.** **H04b 1/16,** H04q 1/42

[58] **Field of Search** 325/47, 64, 346, 419, 420; 340/224, 182, 207, 209, 412, 414, 415, 416

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[57] **ABSTRACT**

A system for providing an alarm upon detection of an alarm condition such as intrusion, fire, etc., having a number of sensors which each produce and transmit an rf signal modulated by an identification frequency audio signal unique to the protected facility and a combination of audio frequency signals defining the sensor function and a central alarm control which receives the rf signal and communicates via telephone lines with a central station. In order to eliminate the need for precisely tuning the rf frequency at each sensor and maintaining the rf frequency constant, the alarm control includes a unijunction oscillator circuit which varies a local oscillator connected to a mixer circuit, which forms part of a superhetrodyne receiver, between preset limits to sweep continuously. When an identification frequency signal of sufficient amplitude is detected, an electronic switch is operated to disable the unijunction oscillator and lock the system at the rf frequency onto which the detected identification frequency is modulated.

12 Claims, 3 Drawing Figures

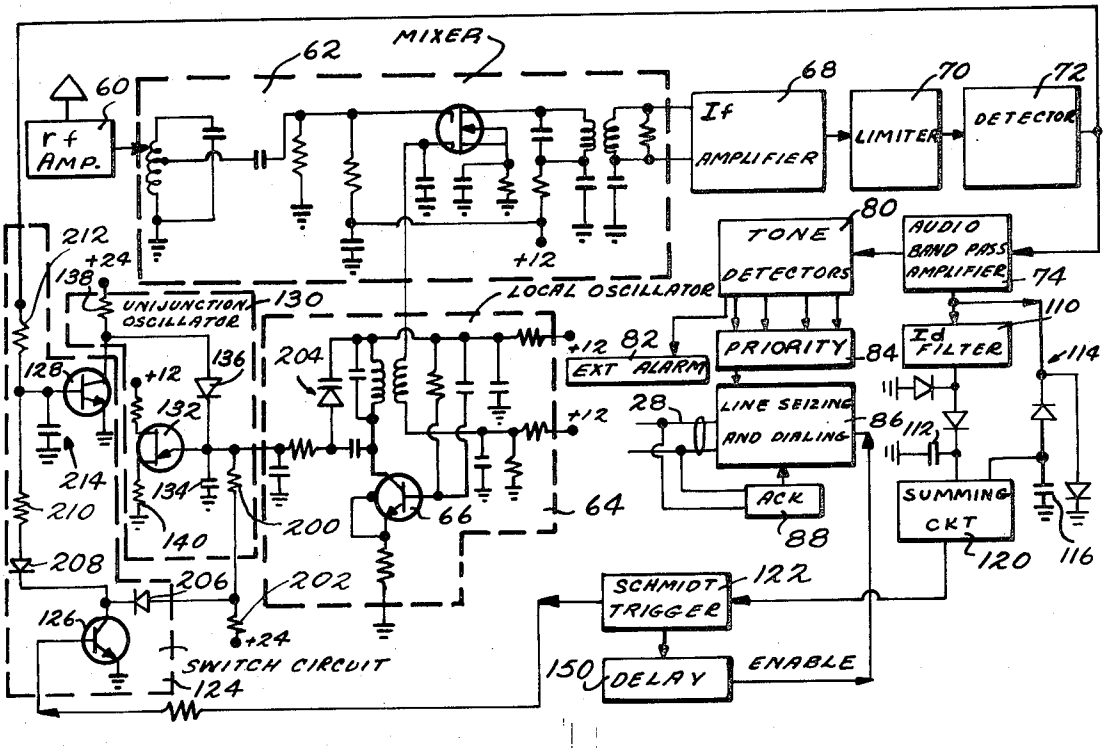


Fig. 1.

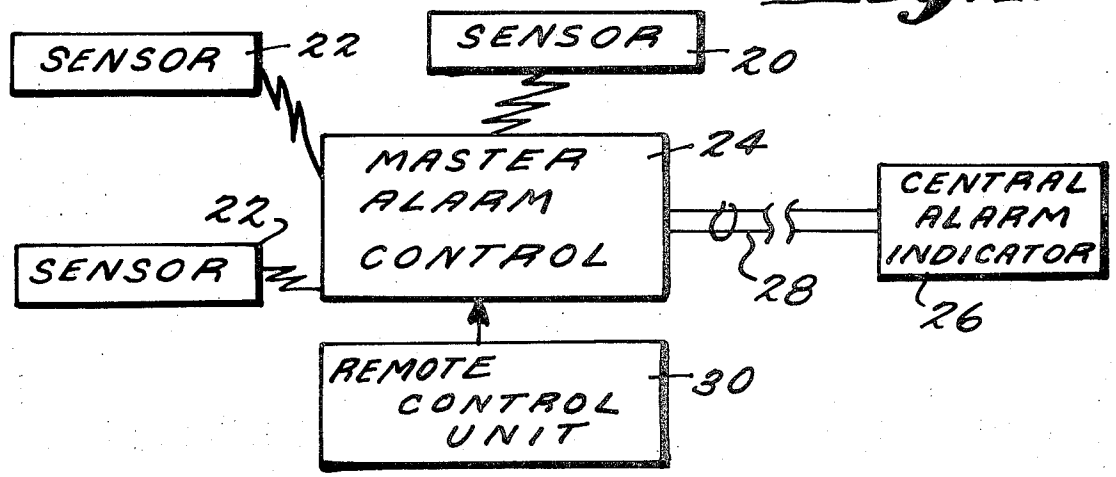

SENSOR
22
SENSOR
20
MASTER ALARM CONTROL
24
22
SENSOR
28
CENTRAL ALARM INDICATOR
26
REMOTE CONTROL UNIT
30

Fig. 2.

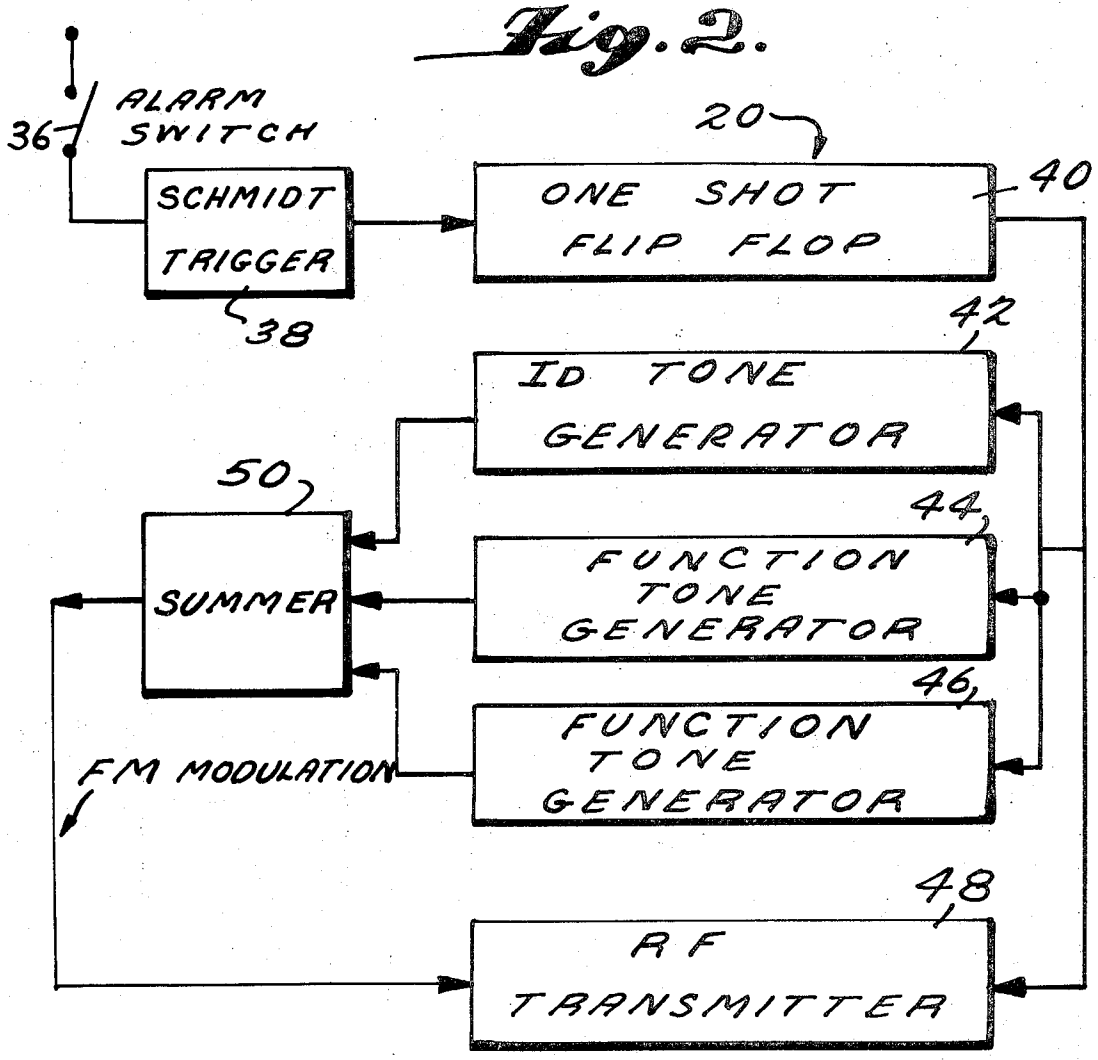
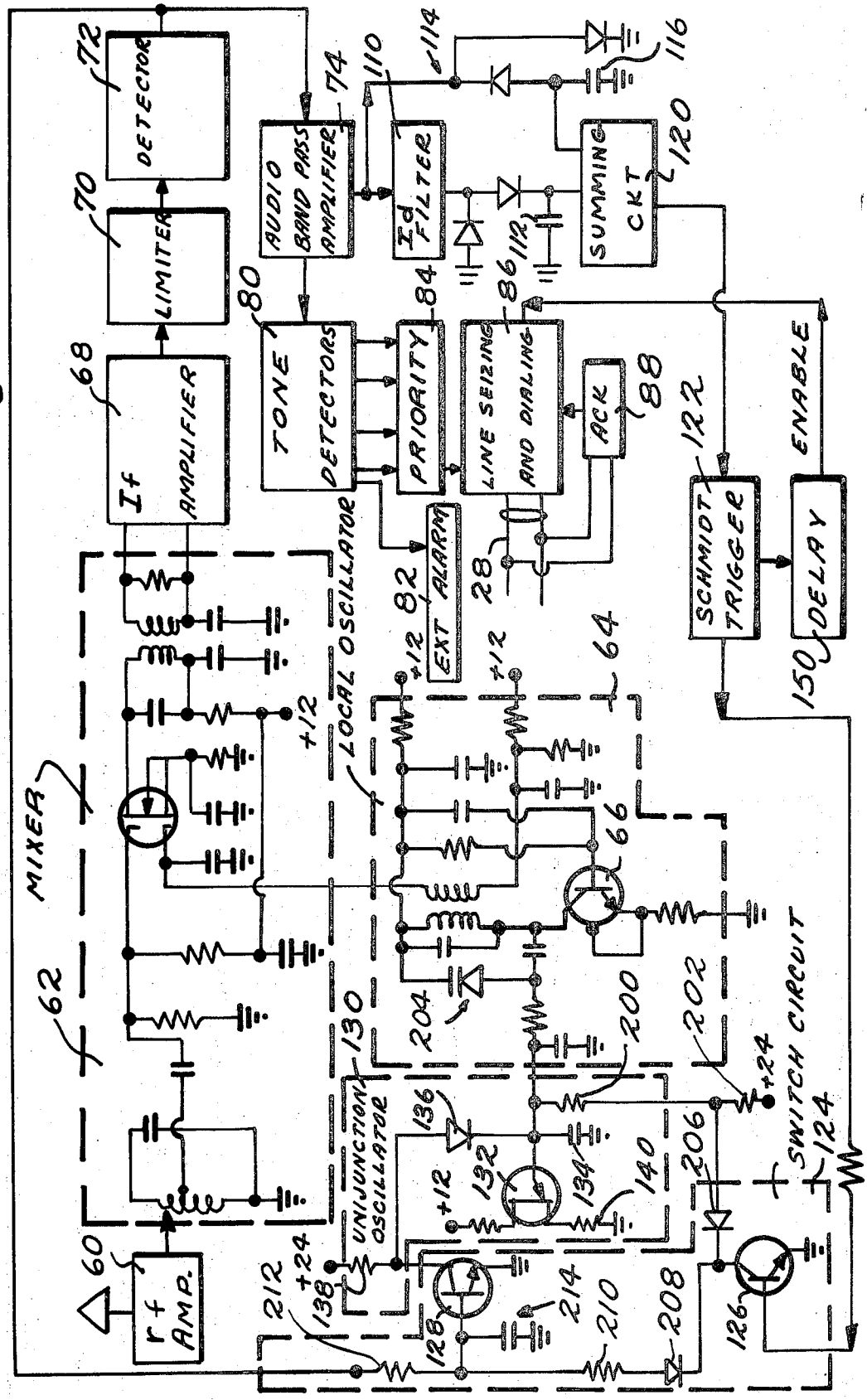

36
ALARM SWITCH
20
SCHMIDT TRIGGER
38
ONE SHOT FLIP FLOP
40
42
ID TONE GENERATOR
50
44
SUMMER
FUNCTION TONE GENERATOR
46
FM MODULATION
FUNCTION TONE GENERATOR
48
RF TRANSMITTER

Fig. 3.


DETECTOR
LIMITER
If AMPLIFIER
AUDIO BAND PASS AMPLIFIER
Id FILTER
SUMMING CKT
TONE DETECTORS
PRIORITY
LINE SEIZING AND DIALING
ACK
EXT ALARM
SCHMIDT TRIGGER
DELAY
ENABLE
MIXER
LOCAL OSCILLATOR
UNIJUNCTION OSCILLATOR
SWITCH CIRCUIT
rf AMP.
+12
+24
60
62
64
66
68
70
72
74
80
82
84
86
88
110
112
114
116
120
122
124
126
128
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134
136
138
140
150
200
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206
208
210
212
214

SECURITY ALARM SYSTEM WITH FREQUENCY SWEEPING

BRIEF DESCRIPTION OF THE PRIOR ART AND SUMMARY OF THE INVENTION

The invention relates to an improvement in a security alarm system of the type having a plurality of sensors which transmit signals to a master alarm control upon detection of an alarm condition such as intrusion, fire, etc. with the master alarm control then communicating by telephone with a central facility which takes appropriate action.

Many different types of security alarm systems which protect home offices and other facilities against intrusion, fire and other emergencies are in use today. One type of system which has been found to be particularly advantageous is comprised of a plurality of remote independent sensors which guard different parts of the building or other facility, and which are in radio contact with a master control unit within the facility. Some of the sensors may be disposed so as to transmit an alarm signal to the control unit if an associated door or window is opened. Other sensors are constructed so as to provide a signal upon detection of a condition which indicates fire. Some sensors may be manually operated transmitter units with which a guard or an individual can carry about with him to signal an emergency condition to the master alarm control.

The master alarm control, upon receipt of the signal from one of its associated sensors indicating an emergency condition, establishes contact with a central alarm indicator, for example, by dialing a number on a telephone, and transmitting a signal indicating the master control which is communicating with the central facility and a signal indicating the emergency condition which exists. An individual at the central facility can then take appropriate action, calling police, fire, hospital, or taking whatever action that needs to be accomplished. The master control alarm can also operate external alarms such as bells, lights, etc.

In order to minimize false alarms and at the same time maximize reliability of the system, the sensors can be constructed so as to transmit a radio frequency signal which is modulated by a predetermined identification frequency signal which is unique to that particular set of sensors associated with a single master alarm control. If several security systems are located within the same geographical area, the identification frequencies, can then be differennt for each of the different systems so that a transmitted signal from one sensor in one facility does not activate a master alarm control in another neighboring facility, causing confusion and anxiety. The identification frequency signal does not identify the individual sensor transmitting to the master alarm control, but indicates to the master alarm control that one of its own sensors and not one of the sensors of some neighboring facility is transmitting an alarm signal. In addition to modulation by the identification frequency signal the transmitted rf signal can also be modulated by a combination of audio tones, the combination defining the function of the sensor, be it fire, intrusion, or other emergency, so that the master alarm control can communicate that information to the central alarm indicating facility.

One of the difficulties which has been noted with the type of system described above is that it is hard to set

the transmitters in each of the individual sensors to exactly the same rf transmitting frequency as the frequence for which the master alarm control is prepared. One of the chief advantages of the system described above wherein the sensors are in radio contact rather than attached by a wire to the master alarm control is that the system can be quickly and easily installed by relatively unskilled persons. Properly adjusting the sensors to produce exactly the same rf frequency is, however, a time-consuming job requiring considerable skill. Further, with time the frequencies produced by different sensors tend to drift slightly as the elements age and other parameters, such as environmental conditions within the protected facility, change.

One solution to this problem as described in detail below and according to one aspect of the novel invention of this application is to provide a sweep circuit within the master alarm control which continually sweeps over a given rf frequency range looking for an rf signal having the proper modulated identification frequency. The sensors thus need only be adjusted within relatively broad limits and need not be readjusted unless their operation changes radically.

According to the specific embodiment described in detail below, this is accomplished by mixing the output of a conventional local oscillator circuit in a mixer circuit of a superhetrodyne receiver with the amplified receiver rf signal which has been modulated as described. The frequency of the local oscillator output is varied by a unijunction oscillator circuit providing a ramp output signal so that the frequency of the oscillator circuit output varies back and forth about a nominal mixing frequency. Thus, when a signal is received, which has an rf carrier frequency within the range for which the local oscillator is prepared, the mixer will produce an intermediate frequency output signal. As in conventional superhetrodyne receivers, the output of the mixer stage is amplified in an intermediate frequency amplifier and thereafter limited before being applied to a detector stage, for example, including a pulse width detector and an audio amplifier. The output of the audio amplifier is in turn passed to an audio bandpass amplifier to provide an audio output signal which can then be coupled to tone detectors which detect the audio frequency function tone signals modulated onto the radio frequency signal.

The output of the audio bandpass amplifier is also passed through a filter which detects the identification frequency. Both the output and the input of the identification frequency filter circuit are converted to D.C. signals with an amplitude proportional to the average audio signal with these two signals then combined to minimize noise. The summed signal is then applied to a Schmidt trigger so that if the D.C. amplitude of the Schmidt trigger input exceeds a predetermined level, the Schmidt trigger produces an output pulse which is applied to a switching circuit comprised of a pair of transistors. These transistors are connected to the unijunction oscillator which provides the ramp for varying the output frequency of the local oscillator so that the shifting of the Schmidt trigger as described above switches the two transistors to disable the unijunction oscillator and maintain the voltage at that time applied to the local oscillator so as to lock in the received signal after the presence of an identification frequency has been determined. Following termination of the received signal, the transistor switches are returned to

their normal states and the unijunction oscillator resumes producing its ramp output to again cause the local oscillator to sweep, looking for the appropriate identification frequency signal in the desired rf carrier range.

Many other objects and purposes of the invention will be clear from the following detailed description of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a block diagram of the system of this invention comprising a plurality of sensors in radio contact with a master alarm control which communicates with a central alarm indicator via telephone line upon detection of an alarm signal from one of the sensors.

FIG. **2** shows a block diagram of a sensor for providing an alarm signal to the master alarm control.

FIG. **3** shows a detailed schematic of a portion of the master alarm control shown in FIG. **1.**

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIG. **1** which shows a block diagram of the novel system of this application. As described above, the system comprises a plurality of sensors, including sensors **20, 22** and **24** which may be mounted in a protected facility so as to provide one or more of a variety of different functions such as detection of intrusion, detection of fire, detection of a manually produced signal indicating the need for emergency hospitalization, etc. Upon detection of the condition for which it is intended, the sensor, as described below produces a radio frequency signal which is transmitted to the master alarm control **24** which receives the signal and dials the telephone number of a central alarm indicator **26** via conventional telephone lines **28.** After establishing contact with central alarm indicator **26,** master alarm control **24** transmits signals indicating its identity and thereafter indicating the detected emergency condition, be it fire, intrusion, etc. Master alarm control **24** may also be activated by remote control unit **30** which can also be used to arm and disarm the system and provide a variety of other functions.

Referring to FIG. **2,** a typical sensor **20** is illustrated therein in block diagram. The occurrence of the alarm condition for which sensor **20** is assigned to respond operates to close or open a diagrammatically illustrated switch **36** which may be any of a variety of types of devices including electronic switches, etc. which causes a Schmidt trigger **38** to produce a pulse which in turn activates a one shot flip-flop **40** producing a pulse which is applied to each of the tone generators **42, 44** and **46** as well as to rf transmitter **48.** The application of a pulse to the I.D. tone generator **42** causes that generator to produce an audio frequency signal at the desired identification frequency. Similarly, the function tone generators **44** and **46** produce audio frequency signals following production of a pulse of flip-flop **40.** The combination of audio tones produced by generators **44** and **46** defines the function of the sensor. One combination might define "burglary," another might define "fire," etc. The three audio signals are combined in a conventional summing circuit **50,** and the output of summing circuit **50** applied to a conventional rf transmitter **48** together with the output of flip-flop **40.** The output of summing circuit **50** frequency modulates rf transmitter **38,** which transmits a signal, for example, at 250 Mhz plus or minus 5 Mhz. As discussed below according to one aspect of this invention, the receiver in the main alarm control **24** of FIG. **1** sweeps over a range, for example, between 245–**255** Mhz looking for receipt of a signal within that range and locks on the rf frequency received when a signal having the appropriate I.D. frequency is detected.

Reference is now made to FIG. **3** which shows in greater detail the master alarm control **24,** shown as a block in FIG. **1.** Radio frequency signals from the various sensors are received and amplified by a conventional rf Amplifier **60** with the output applied to a conventional Mixer **62.** The other input to Mixer **62** is from a Local Oscillator **64** which includes transistor **66** and frequency of which is varied over a predetermined range as described below. As in conventional superhetrodyne receivers, the mixing frequency reduces the received rf frequency to an intermediate frequency before demodulation, for example, from 250 Mhz plus or minus 5 Mhz to 10.7 Mhz. Accordingly, when the frequency or rf local oscillator **64** is equal to a frequency which reduces the received rf signal almost exactly to the desired intermediate frequency, the demodulated audio signals will have sufficient strength to trigger an alarm. The output of Mixer **62** is amplified by Intermediate Frequency Amplifier **68** and passes through a conventional Limiter Circuit **70.** The output of Limiter Circuit **70** is applied to a Detector stage **72** preferably including a Pulse Width Detector and an Audio Amplifier. The output of circuit **72** is applied to a conventional Audio-Bandpass Amplifier **74.** Thus, the output of Audio Bandpass Amplifier **74** is comprised of the I.D. tone signal which was produced in the sensor illustrated in FIG. **2** as described above as well as the signals produced by function tone generators **44** and **46.**

The output of Audio Bandpass Amplifier **74,** as shown, is applied to a convention Tone Detector Circuit **80** shown in block diagram which detects the two function tones and provides output signals which are appropriate in view of the function defined by the combination of tones. For certain combinations, external alarm **82** such as lights, bells, etc. may be activated, for example, to deter burglary, give a warning to neighbors that certain conditions have arisen, etc. The output of Tone Detector Circuit **80** is also applied to a priority circuit **84** which, if two alarm conditions are received simultaneously, makes a decision which is the more important. Thus, burglary may be deemed more important than fire, etc. The output of the priority circuit is connected to a Line Seizing and Dialing circuit **86** which operates to dial the telephone number, for example, of the central alarm indicator as shown in FIG. **1,** and thereafter to provide signals on telephone lines **28** to the central station which indicate both the identity of the facility which is reporting and the alarm condition which has been detected. Preferably, the line seizing and dialing the circuit **86** continues dialing until an acknowledge signal is transmitted from the central alarm indicator **26** and detected by acknowledge circuit **88** which thereafter deactivates circuit **86.** In the event that the line seizing and dialing circuit **86** is unable to reach the central alarm indicator **26** or the number is busy, preferably the circuitry will continue to redial the number for a preset number of times and may even be constructed so as to choose and dial a second number alternately.

The output of Audio Bandpass Amplifier **74** is applied to a conventional Filter Circuit **110** which is tuned to detect the identification frequency described above. When that identification frequency signal is detected, the output provided by filter **110** charges capcitor **112** to a voltage which represents the average audio signal output of filter **110.** Likewise the input to filter **110** is applied to a second detection circuit **114** including capacitor **116** which likewise provides a bucking D. C. voltage which is proportional to the average audio signal. The two D. C. levels provided by capacitor **112** and circuit **114** are summed in a conventional summing circuit **120** which subtracts the two signals to in part cancel out noise including improper modulating frequencies and still provide an output signal level sufficient to trigger Schmidt trigger circuit **122.**

The output of Schmidt trigger circuit **122** as mentioned above, is applied to switching circuit **124.** Switching Circuit **124** includes normally non-conductive transistors **126** and normally conductive transistor **128.** Transistors **126** and **128** are connected as shown to a conventional unijunction oscillator **130** which includes a unijunction transistor **132** and a capacitor **134.** Unijunction oscillator circuit **130** provides an output ramp function which increases as capacitor **134** is charged via reistor **200** and resistor **202** while unijunction transistor **132** remains non-conductive. When the charge on capacitor **134** reaches a level sufficient to shift the condition of transistor **132** from non-conductive to conductive, capacitor **134** thereafter discharges through resistor **140** until transistor **132** is turned off and the above process is repeated. Thus unijunction oscillator **130** produces a ramp output signal.

This ramp output signal is applied to conventional local oscillator **64** and provides an input level which varies between preset levels which in turn varies the frequency produced by oscillator **64,** so that varicap **204** sweeps the frequency of the signal applied to Mixer **62** between predetermined limits.

The pulse produced by Schmidt Trigger Circuit **122** shifts transistor **126** from its non-conductive to its conductive state, causing diode **206** to conduct, thereby preventing further charge current from reaching capacitor **134** via resistor **202,** and also establishing a discharge path for capacitor **134** through resistor **200,** diode **206,** and transistor **126.** Transistor **128** is shifted from its conductive (saturated) state to a partially conductive (linear) state by resistor **210,** diode **208,** and transistor **126.** The audio output of Detector **72** is applied to transistor **128** via resistor **212** and capacitor **214,** which are used to roll off the modulation frequencies, leaving the D.C. component, which is proportional to the I.F. frequency. Transistor **128** controls the charge current that may pass through resistor **138** and diode **136** to capacitor **134,** thus controlling the frequency of local oscillator **64,** and effecting an automatic frequency control, or lock condition.

The output of Schmidt Trigger Circuit **122** comprised of inverters is also applied to a delay circuit **150,** and the output thereafter used, for example, to control Tone Detectors **80** or in any other way for operating circuits providing any desired types of function in the novel security system of this invention.

Many changes and modifications in the above described embodiment of the invention can, of course, be made without departing from the scope of the invention. Accordingly, that scope is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. Apparatus for receiving and decoding a modulated radio frequency signal comprising:

a superhetrodyne receiver with a mixing stage for receiving said radio frequency signal, a local oscillator connected to said mixing stage for causing said mixing stage to produce an intermediate frequency signal from said radio frequency signal and the output from said local oscillator, and means connected to said mixing stage for demodulating said intermediate frequency signal,

filter means connected to the output of said demodulating means for providing a given output upon detection of a signal at an identification frequency,

sweep means including an oscillator connected to said local oscillator for normally varying the frequency of said output of said local oscillator over a preset range, and

electronic switch means connected to said filter means and to said sweep means for disabling said oscillator of said sweep means when said filter means provides said given output so as to lock in on the radio frequency of the ratio frequency signal being received.

2. Apparatus as in claim **1** wherein said filter means includes an identification frequency filter, first means connected to the input to said filter for producing a first bucking D.C. voltage having an amplitude proportional to the average of the input signal, a second means connected to the output of said filter for producing a second D.C. signal having an amplitude proportional to the average of the output of said filter means connected to said first and second means for summing said first and second signals, and means connected to said summing means and to said switch means for producing a trigger signal to cause said switch means to disable said switch means when the amplitude of the output of said summing means reaches a predetermined level.

3. Apparatus as in claim **2** wherein said switching means includes first and second transistors and said sweep means includes a unijunction oscillator connected to said first and second transistors.

4. A system for providing an alarm indication upon detection of an alarm condition comprising:

a plurality of sensors for each detecting an alarm condition and each producing and transmitting upon detection thereof at least a first electrical signal at an rf frequency which varies from a nominal rf frequency within predetermined limits, said rf frequency modulated by an identification frequency, and

central control means for receiving said first signals from said sensors, detecting said identification frequency and providing said alarm indication upon detection of said identification frequency including means for sweeping to locate an rf frequency signal within said predetermined limits including a variable output oscillator, means for demodulating a received rf signal, means for detecting an identification frequency and means for disabling said sweeping means upon detection of said identification frequency to lock on a received rf signal including an electronic switch connected to said oscillator of said switch means.

5. A system as in claim 4 wherein said sweeping means includes a mixing stage for receiving said modulated rf frequency signal, a local oscillator connected to said mixing stage for causing said mixing stage to produce an intermediate frequency signal from said ratio frequency signal and the output from said local oscillator and wherein said demodulating means demodulates said intermediate frequency signal.

6. A system as in claim 4 wherein said oscillator of said sweeping means includes a unijunction oscillator connected to said electronic switch.

7. A system as in claim 4 wherein said detecting means includes filter means connected to the output of said demodulating means for providing a given output signal upon detection of a signal at an identification frequency.

8. A system as in claim 7 wherein said filter means includes an identification frequency filter, first means connected to the input to said filter for producing a first bucking D.C. voltage having an amplitude proportional to the average of the input signal, a second means connected to the output of said filter for producing a second D.C. signal having an amplitude proportional to the average of the output of said filter, means connected to said first and second means for summing said first and second signals, and means connected to said summing means and to said switch means for producing a trigger signal to cause said switch means to disable said switch means when the amplitude of the output of said summing means reaches a predetermined level.

9. A system as in claim 4 wherein each of said sensors further includes means for producing a combination of audio frequency signals denoting the function of that sensor, and means for modulating a rf frequency signal by said audio frequency signals and said first signal at said identification frequency and transmitting said rf signal, wherein said central control means further includes means for receiving and amplifying the transmitted rf signal, wherein said sweeping means includes oscillator means for producing an output at a variable frequency, means for varying the output frequency of said oscillator means and means connected to said receiving and amplifying means and to said oscillator means for mixing the amplified rf signal with said variable frequency signal, and wherein said disabling means includes switch means operable to disable said varying means.

10. A system as in claim 9 wherein said central control means further includes an intermediate frequency amplifier connected to said mixing means for amplifying the mixed signal, a limiter circuit connected to said intermediate frequency amplifier a detector circuit connected to said limiter circuit and an audio bandpass amplifier circuit connected to said pulse width detector.

11. A system as in claim 10 further including a filter tuned to said identification frequency connected to said audio bandpass amplifier circuit, means connected to the output of said tuned filter for producing a D.C. signal with an amplitude proportional to the average amplitude of the output of said tuned filter, bucking means connected to the input of said tuned filter for producing a further D.C. bucking signal with an amplitude proportional to the amplitude of the input to said tuned circuit, means for summing said D.C. signal and said further D.C. signal to cancel some noise, and a Schmidt trigger circuit connected between said switch means and said summing means for causing said switching means to disable said sweep means when the output of said summing means exceeds a predetermined level.

12. A system as in claim 9 wherein said varying means includes a unijunction oscillator with a capacitor which is alternately charged and discharged to provide a ramp output and said switch means includes first and second transistors connected to said comparing means so as to shift output conditions when said given signal is produced to maintain the output of said unijunction oscillator at its level when shifting occurs and wherein said oscillator means includes an oscillator circuit connected to said output of said unijunction oscillator for receiving said ramp output and producing a signal at a frequency which varies as a function of the level of the output of said unijunction oscillator.

* * * * *