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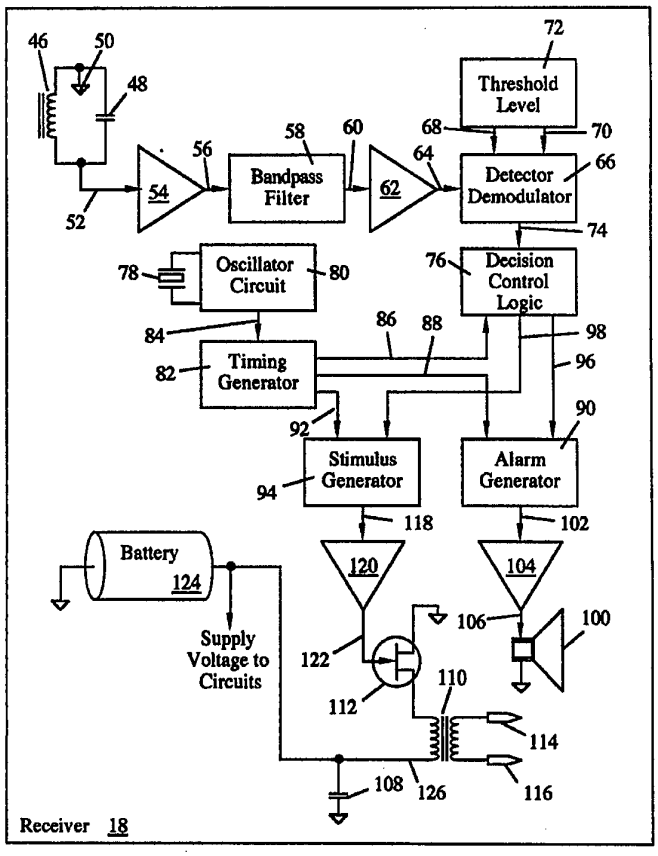
(54) Title: ANIMAL CONTROL SYSTEM

(57) Abstract

A modulated electromagnetic field is established in a designated area to exclude animals from that area. A receiver (18) carried by the animals compares the received modulated electromagnetic field signal level with a pair of predetermined levels (68, 70). A warning (100) is provided if the signal level surpasses the first predetermined level (68) and a control indication (114, 116) is given if it surpasses the second predetermined level (70) to discourage entry into the designated area.



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ANIMAL CONTROL SYSTEM

Field of the Invention:

The present invention relates to systems for restraining the access of animals to particular areas. More particularly, the present invention relates to those systems which are wireless.

Background of the Invention:

Owners of pets often wish to restrict the range of the animal to particular areas of a yard or house. Often, a pet owner wishes to restrict a pet to a particular yard which he may do by, for example, fencing in the yard.

Often, it is more desirable to use a radio controlled pet containment system which relies upon a wire at the perimeter of the animal's range which sends a signal to a collar worn by the animal. As the animal approaches the wire, it receives a stimulus signal which trains the animal to avoid that perimeter. Such a system uses a relatively high power transmitter to provide the current necessary for sending the signal from the wire to the receiver worn by the animal. Further, these systems are designed to contain the pet in a relatively large area such as a yard. In addition, such systems are generally designed to contain the animal rather than restrict an animal from a particular area.

Often, pet owners wish to restrict the access of their pets to particular areas of a house or yard. For example, a cat owner may wish to restrict the access of the cat into a particular room of a house occupied by a person

having an allergy to cats. Further, a pet owner may wish to exclude a dog from a garden area in a yard. These are relatively small scale areas since it is usually only necessary inside the house, for example, to prevent an animal from entering a door of a room.

Thus, there exists a need for a relatively small scale system for excluding pets from particular areas.

It is an object of the present invention to deter an animal's passage into a particular area without inconvenience to people.

It is a further object of the invention to supply a system which will train an animal to avoid a particular area.

It is another object of the invention to provide a low power, wireless system which will prevent an animal from entering a particular area.

Summary of the Invention:

Having regard to the above and other objects and advantages, the present invention generally provides for a system for excluding animals from an area. The system comprises means for setting up a modulated electromagnetic field in at least a portion of the area. The system also comprises means for detecting the modulated electromagnetic field as an animal approaches the area. This means is releasably attached to the animal.

The system also provides means for determining the signal level and timing characteristic of the detected modulated electromagnetic field and means for comparing the signal level of the detected modulated electromagnetic

field with a first predetermined signal level. There is also means for giving a warning indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the first predetermined signal level.

Further, the present invention provides means for comparing the signal level of the detected modulated electromagnetic field with a second predetermined signal level and means for giving a control indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the second predetermined signal level.

In a preferred embodiment of the invention, the means for giving a warning indication to the animal is a speaker and the warning indication is a sound. Another preferred embodiment provides that the means for giving a control indication is a set of electrodes substantially next to the skin of the animal and the control indication is an electric shock to the animal.

It is also preferred that the means for detecting the modulated electromagnetic field as an animal approaches the certain area, the means for determining the signal level of the detected modulated electromagnetic field, the means for comparing the signal level of the detected modulated electromagnetic field with a first predetermined signal level, the means for giving a warning indication to the animal, the means for comparing the signal level of the detected modulated electromagnetic field with a second predetermined signal level, and the means for giving a

control indication to the animal are contained on a collar worn by the animal.

In the preferred embodiment of the invention, the means for setting up a modulated electromagnetic field further comprises means for generating a modulated electromagnetic signal having a particular frequency, means for generating a modulating reference signal having a particular modulation characteristic, means for amplifying the modulated reference signal to drive an LC circuit tuned to the particular reference frequency, and inductive loop antenna means for generating the electromagnetic field. It is more particularly preferred that the loop antenna includes at least one coil of wire having a plurality of windings.

The present invention also provides a method for excluding animals from an area. The method comprises setting up a modulated electromagnetic field in at least a portion of the area. The modulated electromagnetic field is detected as the animal approaches the area and the signal level of the detected modulated electromagnetic field is determined. The signal level of the detected modulated electromagnetic field is then compared with a first predetermined signal level which leads to giving a warning indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the first predetermined signal level. The signal level of the detected modulated electromagnetic field is also compared with a second predetermined signal level which leads to giving a control indication to the animal if the

signal level of the detected modulated electromagnetic field is greater than the second predetermined signal level.

Brief Description of the Drawings:

The above and other features and advantages of the invention will become further known from the following detailed description of preferred embodiments of the invention in conjunction with the drawings in which:

FIGURE 1 is a simplified diagrammatic view of a system according to the present invention for excluding an animal from a particular area;

FIGURE 2 is a simplified functional schematic diagram of a transmitter to be used in a system according to the present invention; and

FIGURE 3 is a simplified functional schematic diagram of a receiver to be used in the present system according to the present invention.

Detailed Description of the Invention:

Referring now to the drawings in which like reference characters designate like or corresponding parts throughout the several views, FIGURE 1 shows a system embodying the present invention. A pet 10 is to be excluded from a room 12. A transmitter 14 is placed in the room 12 close by a doorway 16.

As the pet 10 attempts to enter the doorway 16 of room 12, a receiver 18 on a collar worn by the pet 10 receives a signal from the transmitter 14. As the receiver 18 enters a warning area 20, the pet 10 receives a warning indication, such as a sound, which tells the pet 10 that it

is entering a warning area 20. If the pet 10 continues to move toward the doorway 16, the pet 10 will enter the control area 22. In the control area 22, the pet 10 will receive a control indication such as a slight electrical stimulation to deter the pet 10 from entering the room 12. If the pet 10 remains in a safe area 24, the pet 10 receives neither a warning or control indication.

The system disclosed in FIGURE 1 is a relatively low power system which relies upon the use of a electromagnetic field generated by the coil inductor or antenna and detected by the receiver 18. The strength, B, of the magnetic intensity, H, at any point in the same plane of a coil inductor is given by the formula $B = [(\mu AI)/(4\pi r3)]N$, where μ is a constant, A is the area of the coil inductor, I is the current used to generate the field, r is the distance at the point from the center of the transmitting inductor or antenna generating the field, and N is the number of turns of a coil inductor. Since the strength of the electromagnetic field is dependent on the inverse cube of the distance from the antenna, B drops off rapidly as one moves away from the antenna. Thus, it is possible to generate a relatively well defined electromagnetic field over a relatively small area.

As the pet 10 moves through the electromagnetic field, the signal generated in the receiver 18 will approach a certain level at which time the pet will have entered the warning area 20. A further increase in signal

received by the receiver 18 will indicate that the pet has entered the control area 22.

Referring now to FIGURE 2, there is shown a simplified schematic diagram of the transmitter 14 in which there is a reference oscillator 26 which generates an unmodulated frequency signal 28. The unmodulated signal 28 is sent to a modulator 30 where it is periodically amplitude modulated to produce a particular modulated signal and frequency 32. The output from the modulator 30 is sent to an amplifier stage 34 which drives a tuned LC circuit 36 to increase the transmitted signal power.

The tuned LC circuit 36 contains a capacitor 38 and inductor 40 and a ground 42. The capacitor 38 and inductor 40 are chosen to resonate with the frequency generated by the modulator 30. The resonance frequency, f, of the tuned LC circuit 36 is given by the formula $f = (2\pi[LC]1/2)-1$, where C is the value of the capacitor 38 in farads and L is the value of the inductor 40 in henrys. The inductor 40 sets up the electromagnetic field with a signal 44 which is detected by the receiver 18 attached to the pet 10. Thus, the inductor 40 acts as a transmitting antenna.

Referring now to FIGURE 3, there is shown a simplified functional schematic diagram of the receiver 18 which is worn by the animal 10. The receiver 18 comprises several functional elements necessary to accomplish reception and detection of the modulated electromagnetic signal. The electromagnetic signal is first detected by an antenna pickup circuit consisting of a coil inductor 46 and a tuning capacitor 48. The antenna inductor 46 is

typically fabricated from several turns of wire on a ferrite bobbin core form. The use of a ferrite bobbin core form provides higher inductance than an air core, and therefore stronger signal pickup than non-ferrite core inductors, more stable temperature characteristic, and better fabrication tolerance. The tuning capacitor 48 is used with the inductor 46 to provide resonance at the particular frequency of the transmitted electromagnetic signal 44. Resonant tuning of the input circuit provides maximum signal amplification at the particular electromagnetic field frequency. The input antenna circuit can be connected either to ground 50 for single ended amplification or differentially amplified.

In the preferred embodiment of the present invention, the receiver circuit detects the magnitude of the magnetic field as generated by the transmitter 14. As the receiver coil antenna 46 moves through the magnetic field, the received signal 52 varies in direct proportion to the rate of change of the magnetic field flux density. The received signal 52 is given by the equation $v = (dB/dt)(\mu QN2)(CORE)$, where dB/dt is the rate of change of the magnetic flux density of the generated magnetic field, μ is the effective permittivity of the inductor 46 bobbin material, Q is the resonant Q of the receiver circuit, N is the number of turns of wire for the inductor 46, and CORE is a constant given by (Ae/Le), where Ae is the effective area of the bobbin core and Le is its effective magnetic path length.

The signal 52 from the tuned receiver circuit is then passed to a high gain amplifier stage 54 with a gain of around 1000. The output 56 from the amplifier 54 is then passed to a bandpass filter stage 58 to remove unwanted signal components. The bandpass filter 58 center frequency is set to the particular frequency of the generated electromagnetic signal 44. The output 60 of the bandpass filter 58 is then amplified and conditioned by the buffer amplifier 62. The output 64 of the buffer amplifier 62 is then passed to the detector and demodulator circuit 66. The modulated envelope of the electromagnetic signal is reconstructed at the output 64 of amplifier 62 and contains both amplitude and periodic timing information. The demodulator circuit 66 detects the envelope of the received modulated signal and compares the detected level to two predetermined threshold levels. The first predetermined threshold level 68 and the second predetermined threshold level 70 are generated by the threshold level circuit 72. The output 74 of the demodulator circuit 66 is then passed to the decision logic circuit 76.

The timing circuit for the receiver consists of the crystal 78, the oscillator circuit 80 and the timing generator 82. The crystal 78 provides the reference oscillator resonator for generating the primary clock signal. A standard series resonant crystal can be used or a ceramic resonator. The oscillator circuit 80 provides the interface and feedback to the crystal 78. The oscillator circuit 80 further buffers the clock and

generates a timing clock signal 84. The timing clock signal 84 is passed to a timing generator circuit 82 that then provides a timing signal 86 for the decision circuit 76, a timing signal 88 for the alarm warning circuit 90, and a timing signal 92 for the stimulus generator circuit 94.

The decision logic circuit 76 uses the signal transition and timing information present in the output 74 of the demodulator 66 to determine which of the zones the receiver 18 is within. The decision circuit 76 receives a timing signal 86 from the timing generator 82 and uses this to compare the time information present in the demodulated signal 74. The decision circuit 76 provides a signal 96 to the alarm generator 90 and a signal 98 to the stimulus generator circuit 94. If the level of the signal 64 is greater than the signal from the first predetermined threshold level 68 and the length of the demodulated signal 74 is within a certain predetermined bounds, then the decision circuit 76 generates a signal 96 to the alarm generator circuit 90 to indicate that the animal is within the alarm or warning area 20. This would occur when receiver 18 is within the warning area 20 as shown in FIGURE 1. If the level of the signal 64 is greater than the signal from the second predetermined threshold level 70 and the length of the demodulated signal 74 is within a second certain predetermined bound, then the decision circuit 76 generates a signal 98 to the stimulus generator circuit 94 to indicate that the animal is within the

control area 22. This would occur when receiver 18 is within the control area 22 as shown in FIGURE 1.

A warning device is generally included in the collar that is worn by the pet 10. A suitable warning device would be a speaker or piezotransducer 100 which would give an audible warning indication sound, perhaps a buzz or chirp. The alarm generator circuit 90 uses timing information 88 from the timing generator 82 and a control signal 96 from the decision logic circuit 76 to determine when to generate an alarm indication. The indication is provided using a signal 102 that contains a series of beeps or chirps at a predetermined frequency. The signal 102 is further amplified with amplifier 104 to provide additional drive capability and interfacing to give a signal 106 to drive the audible speaker or piezotransducer 100.

A control device is also generally included within the collar receiver unit 18 worn by the pet 10. A useful control device is a system for generating a shock to the skin of the animal. This system generally comprises a capacitive discharge circuit consisting of capacitor 108, transformer 110, switch transistor 112, and electrodes 114 and 116. Thus the control signal generated is an electrical stimulus or shock generated to indicate to the animal that it is within the control zone 22.

The stimulus generator circuit 94 uses timing information 92 from the timing generator 82 and a control signal 98 from the decision logic circuit 76 to determine when to generate a control indication. The control

indication is provided using a signal 118 that contains a series of predetermined pulses at a predetermined periodic rate. The signal 118 is further amplified with amplifier 120 to provide additional drive capability and interfacing to give a signal 122 to drive the switch transistor 112. The control circuit works by charging and discharging the capacitor 108 energy into the primary of the transformer 110. The capacitor 108 is allowed to charge to the battery 124 supply voltage 126 during most of the time. When the stimulus circuit 94 is triggered by signal 98 from the decision logic circuit 76, the stimulus circuit 94 provides a drive signal 118 through amplifier 120 to turn on the switch transistor 112 for a predetermined amount of time, typically 200 μsec to 300 μsec. The current in the primary circuit of the transformer 110 increases approximately linearly during this period. The switch transistor 112 is then turned off by the stimulus circuit 94. The sudden switching off of the charging current in the primary circuit of the transformer 110 causes the flux in the transformer core to achieve a sudden increase in rate of change. This condition causes the secondary of the transformer 110 to switch polarity and rise to a very high voltage in a short period of time, typically 5000 volts to 6000 volts in approximately 15 to 20 μsec. The high voltage condition at the secondary of transformer 110 is then sensed by the animal through electrodes 114 and 116. The stimulus shock is of such magnitude and time length to be of no physical harm to the animal yet quite effective in deterring the animal from entering the control area 22.

The system of the present invention is not limited to use indoors. A suitable transmitter 14, powered either by batteries or household current, may be used outdoors to exclude pets 10 from, for example, a garden or playground area. In addition, the receiver 18 is usable for both indoor and outdoor operation with the transmitter 14.

Having thus described various preferred embodiments of the invention and several of it benefits and advantages, it will be understood by those of ordinary skill that the foregoing description is merely for the purpose of illustration and that numerous substitutions, rearrangements, and modifications may be made in the invention without departing from the scope and spirit of the appended claims.

WHAT IS CLAIMED IS:

Claim 1. A system for excluding animals from an area, the system comprising:

means for setting up a modulated electromagnetic field in at least a portion of the area;

means for detecting the modulated electromagnetic field as an animal approaches the area, said means for detecting the modulated electromagnetic field being releasably attached to the animal;

means for determining the signal level of the detected modulated electromagnetic field;

means for comparing the signal level of the detected modulated electromagnetic field with a first predetermined signal level;

means for giving a warning indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the first predetermined signal level;

means for comparing the signal level of the detected modulated electromagnetic field with a second predetermined signal level; and

means for giving a control indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the second predetermined signal level.

Claim 2. The system of Claim 1 wherein the means for giving a warning indication to the animal is a speaker and the warning indication is a sound.

Claim 3. The system of Claim 1 wherein the means for giving a control indication is a set of electrodes substantially next to the skin of the animal and the control indication is an electric stimulus to the animal.

Claim 4. The system of Claim 1 wherein the means for detecting the modulated electromagnetic field as an animal approaches the certain area, the means for determining the signal level of the detected modulated electromagnetic field, the means for comparing the signal level of the detected modulated electromagnetic field with a first predetermined signal level, the means for giving a warning indication to the animal, the means for comparing the signal level of the detected modulated electromagnetic field with a second predetermined signal level, and the means for giving a control indication to the animal are contained on a collar worn by the animal.

Claim 5. The system of Claim 1 wherein the means for setting up a modulated electromagnetic field further comprises:

means for generating an electromagnetic signal having a particular frequency;

means for modulating the electromagnetic signal thereby producing a modulated electromagnetic signal;

an LC circuit tuned to the particular frequency of the modulated electromagnetic signal for generating the modulated electromagnetic field.

Claim 6. The system of Claim 5 wherein the loop transmitting antenna includes at least one coil of wire having a plurality of windings.

Claim 7. A method for excluding animals from an area, the method comprising:

setting up a modulated electromagnetic field in at least a portion of the area;

detecting the modulated electromagnetic field as an animal approaches the area;

determining the signal level of the detected modulated electromagnetic field;

comparing the signal level of the detected modulated electromagnetic field with a first predetermined signal level;

giving a warning indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the first predetermined signal level;

comparing the signal level of the detected modulated electromagnetic field with a second predetermined signal level; and

giving a control indication to the animal if the signal level of the detected modulated electromagnetic field is greater than the second predetermined signal level.

Claim 8. The method of Claim 7 wherein giving a warning indication to the animal includes generating a sound.

Claim 9. The method of Claim 7 wherein giving a control indication includes producing an electric stimulus to the animal.

Claim 10. The method of Claim 7 wherein setting up a modulated electromagnetic field further comprises:

generating a modulated electromagnetic signal having a particular frequency;

modulating the electromagnetic signal thereby producing a modulated electromagnetic field;

preparing a LC circuit tuned to the particular frequency of the electromagnetic signal for generating the modulated electromagnetic field; and

preparing at least one loop antenna which includes at least one coil of wire having a plurality of windings.

Claim 11. The method of Claim 10 wherein at least one loop antenna includes at least one coil of wire having a plurality of windings.

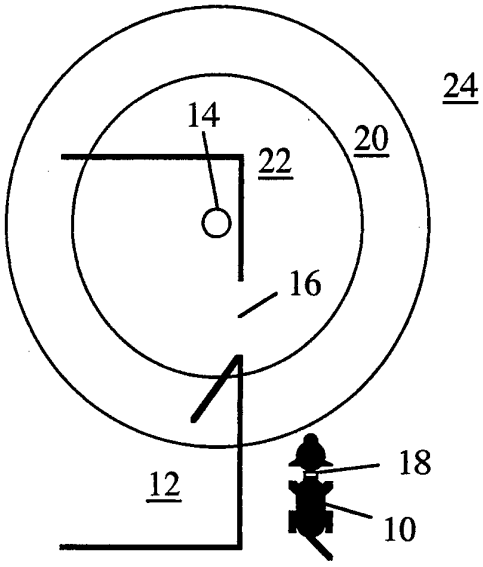
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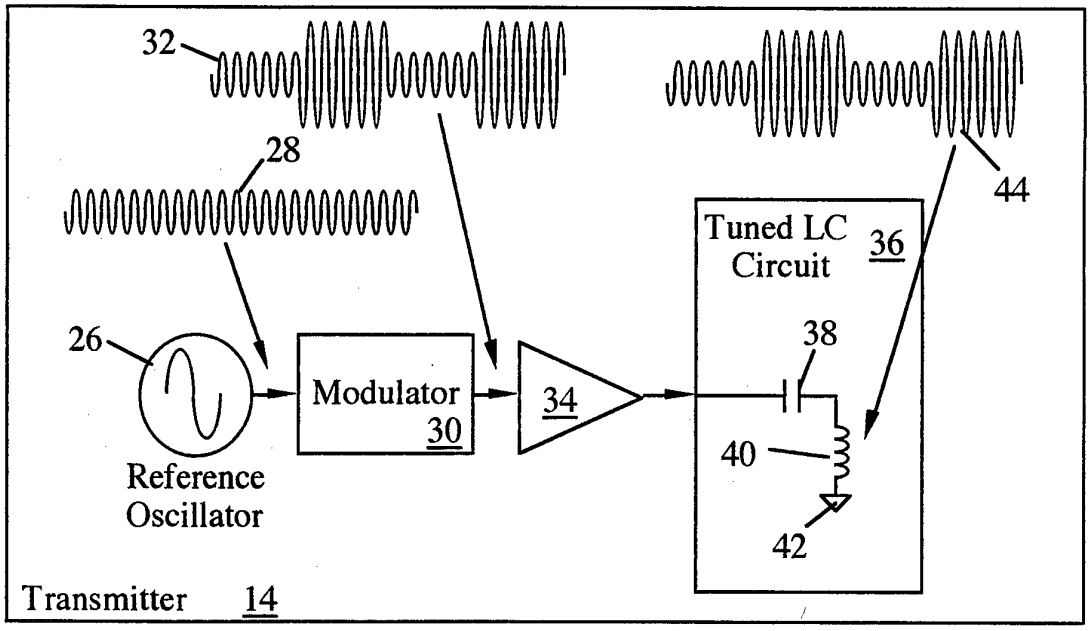
Fig.1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Tuned LC Circuit
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Modulator
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Reference Oscillator
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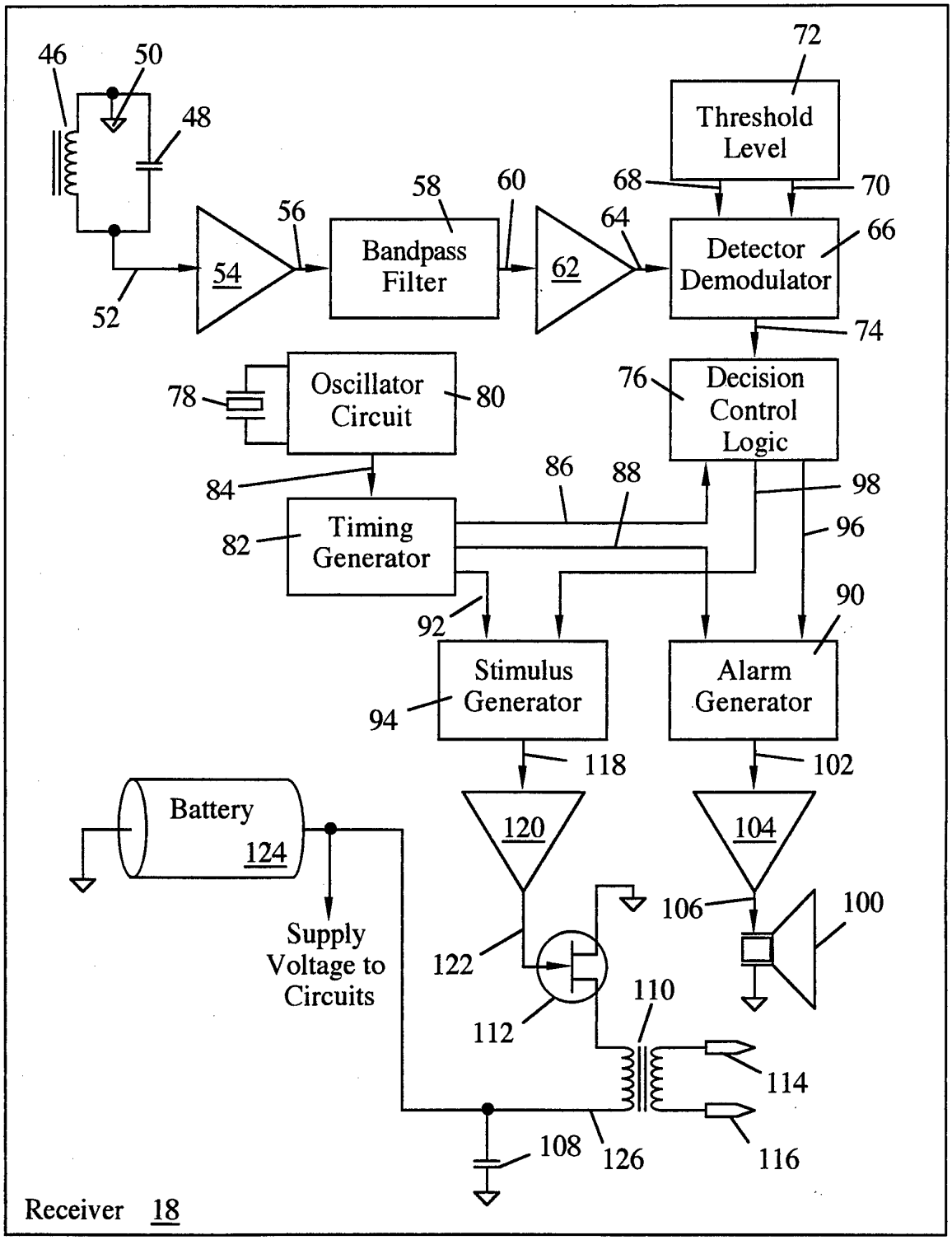
Transmitter 14

Fig. 2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Bandpass Filter
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Threshold Level
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Detector Demodulator
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74
76
Decision Control Logic
78
Oscillator Circuit
80
84
86
88
98
96
82
Timing Generator
92
90
94
Stimulus Generator
Alarm Generator
118
102
120
104
Battery
124
Supply Voltage to Circuits
106
100
122
110
112
114
108
126
116
Receiver 18

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/03600

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G08B 21/00; A01K 15/02
US CL :340/573; 119/721
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/573; 119/721, 720, 908

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US, A, 5,381,129 (BOARDMAN) 10 January 1995, Figure 3 and column 5, lines 14-61.	1-4 & 7-9
Y		5-6 & 10-11
Y	US, A, 5,055,835 (SUTTON) 08 October 1991, Figure 1 and column 3, lines 52-58.	5-6 & 10-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
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Date of mailing of the international search report
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