

[54] **METHOD AND APPARATUS FOR INHIBITING ARTICLE THEFT**

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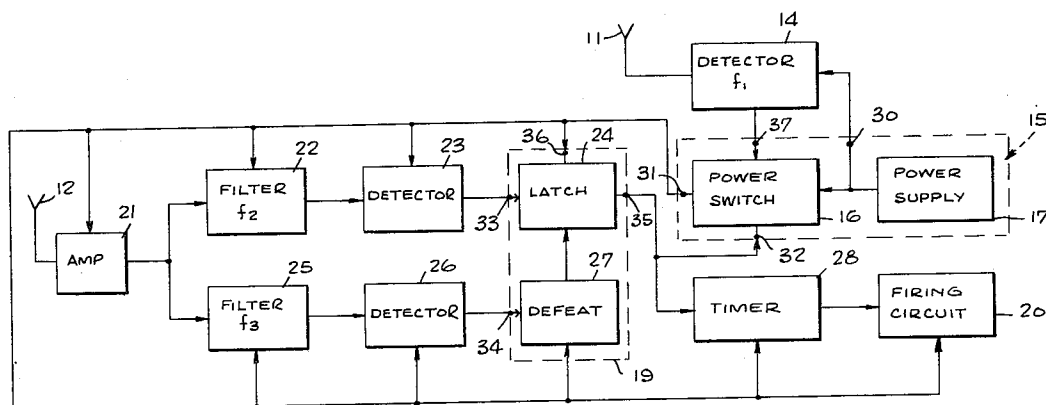
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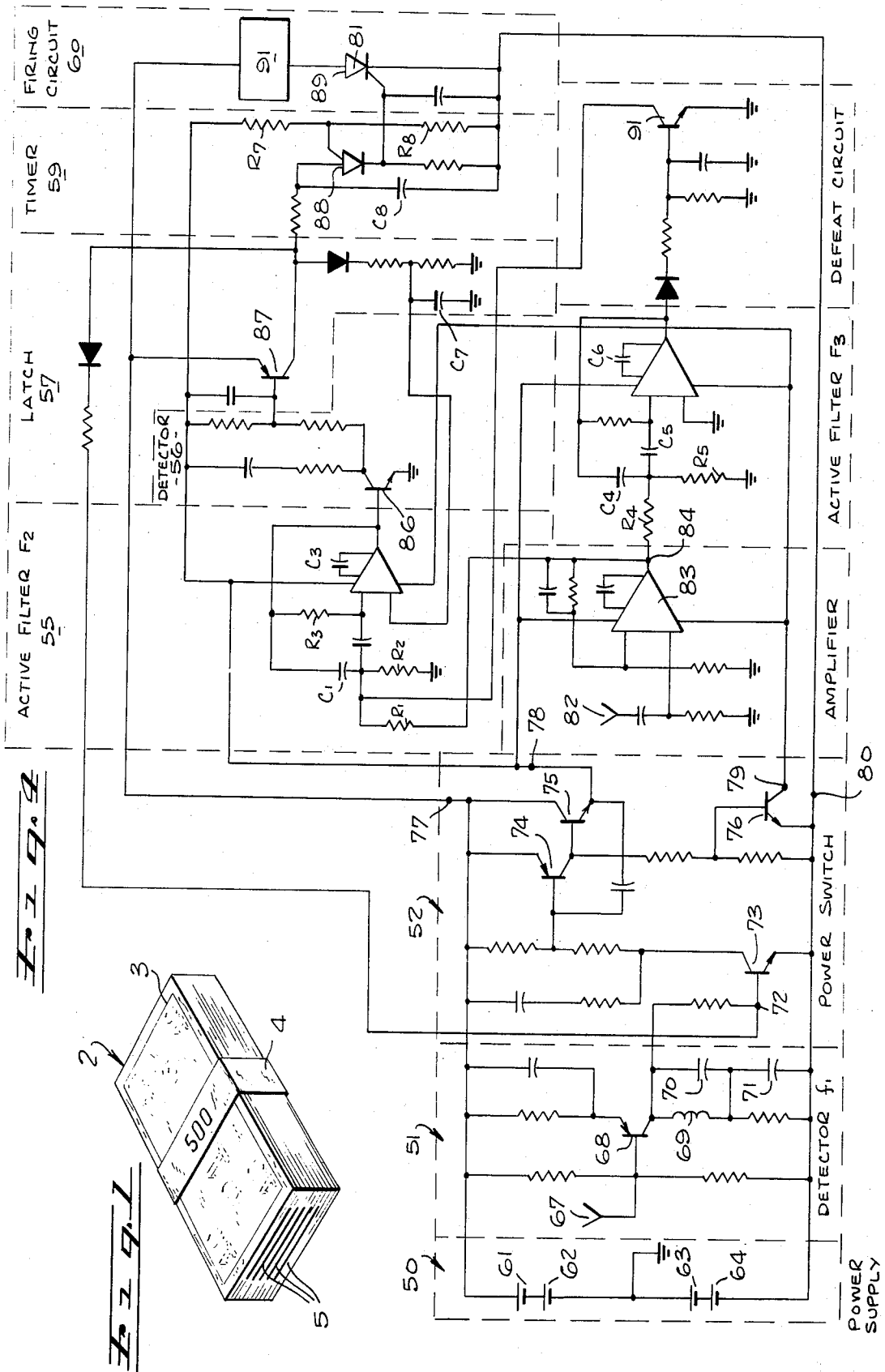
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[57] **ABSTRACT**

A system for detecting article theft wherein different frequency signals are transmitted at the access paths and a receiver associated with the article is responsive to the transmitted signals to actuate a timing device. At the end of an interval, a tear gas cartridge or similar device is fired. The receiver is inhibited from operation by the receipt of a third frequency signal to prevent false triggering.

19 Claims, 4 Drawing Figures





METHOD AND APPARATUS FOR INHIBITING ARTICLE THEFT

BACKGROUND OF THE INVENTION

This invention relates to systems which indicate the unauthorized movement of articles along an identified path or through a given exit.

The unauthorized taking of articles from stores and banks has generated an increasing need for systems which can effectively monitor the movement of these articles through the exits of the building or along given exit paths. Since the unauthorized taking is often accompanied by a threat of violence, it is important that the system detecting article theft not be actuated until the taker has removed the article from the premises. Preferably, the security device is not triggered until after a predetermined interval after the unauthorized taking to insure the safety of the personnel.

Due to the fact that the thefts occur primarily from commercial establishments, it is necessary that the system be effectively prevented from false triggering so that the employees and clientele are not unduly alarmed or embarrassed. Furthermore, the reliability of the system must be high or the system will not accomplish its intended purpose.

The system reliability should be maintained over a relatively long period; in other words, have a long shelf life, or it will not receive commercial success. In the past, mechanical devices have been employed due to their long shelf life. However, the remote or delayed actuation of this type of device normally relies on a hydraulic cylinder as a timer thereby decreasing reliability, increasing size and manufacturing cost, and relying on an actuation of the mechanism at the time of the taking and not at the time of exit from the premises. Thus, the risk assumed by the employees is substantially increased.

Due to the limitations of mechanical systems, different types of magnetically sensitive systems have been employed. Typically, these systems establish a magnetic field at the exit of a predetermined strength and either monitor changes in the field strength due to the transportation of the article and an accompanying field disturbance or rely on the magnetic field to actuate a device accompanying the article. Since the magnetic fields are easily perturbed by transient conditions and/or distorted by the earth's magnetic field, these systems are susceptible to false triggering.

As an alternative, the transmission and reception of an electrical signal at the exit with reliance placed on the monitoring of power levels has been proposed. The article is associated with a power absorbing device which changes the power level at the exit and thus alerts a guard. This type of system requires sensitive power monitoring equipment at the exit and is found to be sensitive to the movement of articles whose removal is authorized. As a result, this system is expensive, sensitive to the transient environment, and subject to false triggering.

Accordingly, the present invention is directed to a system for inhibiting theft which is relatively insensitive to the environment and is protected against false triggering. Furthermore, the system is compact, has a reasonably long shelf life, and is not readily detectable by the unauthorized taker.

SUMMARY OF THE INVENTION

The present invention employs in a security system for inhibiting the theft of articles a receiver contained within a particular article so as to mask its presence. The receiver includes means for receiving first, second, and third signals of different frequencies. A transmitter is located proximate to the exit or along the passageway within which the movement of articles is to be monitored. The transmitter provides first and second frequency signals in a localized area.

The receiver includes first and second means for receiving the first and second signals, respectively. The receiver also includes a power supply system containing a power supply switch which is energized by receipt of the first signal and causes the circuit means of the receiver to be energized. The receipt of the second signal causes a latching means within the receiver to be actuated. The output signal from the latching means continues to energize the power supply switch and at the same time initiate the action of a timing means incorporated in the receiver. After a predetermined interval, the timing means provides an output signal to a firing circuit which results in the triggering of a firing circuit and the actuation of a security device such as a tear gas cartridge.

As mentioned, the receipt of the first signal energizes the power switch means which in turn causes the circuit means of the receiver to then be energized. Thus, when the receiver is not actively utilized, only the first means for receiving is connected to the power supply means and the power utilization or power drain of a stored receiver is minimized.

To insure against false triggering, the receiver is provided with means for receiving a signal having a third frequency. The receipt of a third frequency signal causes the receiving means to provide a signal to a defeat circuit means, the output signal of which is coupled to the latch means. The signal from the defeat circuit means prevents the latch means from energizing the power switch. Thus, the receipt of a third frequency signal prevents the timer from being actuated to energize the firing circuit. Since the transmitter located at the exit provides only the first and second frequency signals, the reception of a third frequency signal is indicative of noise and, thus, the firing circuit is disabled to guard against false triggering.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of a receiver in accordance with the invention.

FIG. 2 is a block schematic of one embodiment of the receiver.

FIG. 3 is a block schematic of an embodiment of the transmitter.

FIG. 4 is an electrical schematic for one embodiment of the receiver.

DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1, a package 2 appearing to consist solely of currency such as bill 3 and bound by the typical currency band 4 contains a receiver including antennae and the protective device, typically a tear gas cartridge. In the protection of packages of currency, the receiver is constructed to have external dimensions identical with the dimensions of U.S. currency. Several bills are placed on the top and bottom of the receiver and then

bound with the currency band so that the complete package appears as a stack of currency. The edges of the package are lined to appear as a currency stack. However, end 5 contains apertures to permit the passage of the tear gas therethrough when the firing device is actuated.

Referring now to FIG. 2, the receiver is shown in block form including antennas 11 and 12, typically an etched printed circuit board in an inter-digitated configuration. Antenna 11 is connected to the first signal receiving means 14 shown as detector f_1 . The detector f_1 receives and detects the first frequency signal. The output signal from the detector f_1 is supplied to power switch 16 of power supply means 15.

Power supply means 15 contains the receiver power supply 17 which is coupled directly at terminal 30 to the first frequency receiver means 14. Power supply 17 is coupled via power switch 16 and terminal 31 to receiver circuit elements 20 through 28. As a result, the receiver circuit element with the exception of detector f_1 are not electrically connected to the power supply 17 during the times that the first frequency signal is not received and, consequently, the power drain during storage is reduced.

The receiver also includes antenna 12 connected to amplifier 21 the output of which is supplied to second and third signal frequency receiving means 22 and 25 shown as filters f_2 and f_3 , respectively. When a second frequency signal is received at antenna 12 concurrently with the reception of the first frequency signal at antenna 11, the second frequency signal is filtered by filter f_2 and amplified therein and an active filter is employed. The second frequency signal f_2 is supplied to detector 23 which provides the detected output signal at terminal 33 of logic circuit means 19.

The logic circuit means 19 is shown including latch circuit 24 and defeat circuit 27. The receipt of the detected f_2 signal at terminal 33 and the presence of the detected f_1 signal at terminal 37 of the power supply means which energizes the f_2 filter 22 and the f_2 detector 23 result in a latching signal appearing at output terminal 35 of logic circuit means 19. If the f_1 signal is not present, the circuit elements are not energized and the f_2 signal cannot appear at terminal 33. The latching signal generated as a result of the reception of the f_1 and f_2 signals is supplied to timer 28 and to terminal 32 of power supply means 15. The latch circuit 24 provides the latching signal when both first and second (f_1 and f_2) signals have been received and continues to provide this signal for a predetermined interval after one or both of these signals are no longer received.

The latching signal is supplied to timer 28 and initiates a timing output signal. The timing output signal occurs a predetermined interval after the receipt of latching signal. As shown, the timing output signal is supplied to firing circuit 20 and causes the tear gas cartridge within circuit 20 to be actuated. As mentioned previously, the latch 24, timer 28 and firing circuit 20 are coupled to terminal 31 of the power supply means. Thus, these circuit elements rely on the actuation of power switch 16 to provide energy. Since the package containing the receiver is intended to complete its operation a period of time after the unauthorized taker has removed the package from the premises, power must continue to be provided when the receiver is out of the broadcast range of a transmitter located at the exit. The continuance of the latching signal after the

termination of the reception of either or both of the first and second signals f_1 and f_2 and the coupling of this latching signal to power switch 16 insures that switch 16 remains closed and the circuit elements continue to be energized.

However, signals f_1 and f_2 may be broadcast by other than the transmitter located at the exit or exits. To prevent the presence of these noise signals from triggering the firing circuit and thus making the system unreliable, the receiver includes means for receiving and detecting a third frequency signal f_3 . Since noise is generated over a portion of the frequency spectrum rather than just at discrete frequencies, such as frequencies f_1 and f_2 , the means for receiving the third signal f_3 are tuned to a frequency which is close to the frequencies of the first and second signals f_1 and f_2 . In practice, reliability is improved by selecting frequency f_3 so that it is substantially midway between signals f_1 and f_2 in the frequency spectrum. However, it is necessary that the three signals be non-harmonically related. Thus, typical noise contains components having frequencies of at least the two closest frequency signals.

When the third frequency signal f_3 is received at antenna 12, it is amplified and passes through filter 25 to detector 26. The detected third signal f_3 is supplied at terminal 34 to the defeat circuit 27 of logic means 19. The receipt of the detected third signal results in defeat circuit 27 providing an output signal which is coupled to the latch circuit 24 and prevents this circuit from obtaining the latched state even when the first and second signals f_1 and f_2 occur simultaneously therewith. As a result, the timer 28 and the firing circuit 20 are not actuated and the system is inhibited from being falsely triggered. While the embodiment shown in FIG. 2 utilizes the output signal of the defeat circuit to directly inhibit the latch circuit, the defeat circuit output signal may be utilized at the filter 22 or detector 23 to prevent the detected second signal from being supplied to terminal 33. Also, as mentioned previously, the receiver of FIG. 2 is incorporated in the package of FIG. 1 for currency protection. However, the package configuration may be readily altered for other applications.

Referring now to FIG. 3, a transmitter 40 for generating the first and second signals f_1 and f_2 is shown. the power supply 41 is coupled to tuned oscillators 42 and 44 each of which is output coupled to corresponding filters 43 and 45, respectively. The output of each filter is supplied to a summing amplifier 46 and to power amplifier 47. The frequencies f_1 and f_2 are typically 22 and 50 Khz and with a third signal frequency f_3 of 35 Khz. The transmitter is located at the place where the monitoring of the articles is to be performed, generally an exit. The signal strength determines the amount of coverage provided by the system and is chosen in accordance with the application and the applicable regulations.

An electrical schematic of one embodiment of the receiver is shown in FIG. 4. The schematic has been shown by dashed lines in block form to correspond with the diagram of FIG. 2. Turning first to power supply 50, four batteries 61 through 64 are connected between terminals 65 and 66. Each battery is typically a 1.5 volt alkaline cell characterized by a low internal impedance and long storage life. As shown, terminal 65 is at an approximate + 3 volts while terminal 66 is at an approximate -3 volts.

The power supply 50 is coupled directly to detector 51 which is adapted to receive the first frequency signal f_1 . The antenna 67 is coupled to the base of transistor 68, the collector of which is coupled to a tuned filter including inductor 69 and capacitors 70 and 71. The filter is tuned so that the reception of the first frequency signal at the antenna provides a signal at terminal 72 of power switch 52. This drives transistor 73 on and thereby causes a higher negative voltage at the base of transistor 74 and drives it into conduction. Transistor 75 is paired with transistor 74 to increase the power gain. When transistor 74 goes into conduction, transistor 76 is driven into conduction. Thus, the receipt of the first frequency signal f_1 results in transistors 74, 75, and 76 being driven into conduction and power flow taking place between terminals 78 and 79 of the power switch. It shall be noted that the supply voltage is continuously present between terminals 77 and 80 which are connected directly to the firing device of firing circuit 60. This connection is different than that shown in the block diagram of FIG. 2 wherein the power supply switch is coupled to the firing circuit. In the embodiment of FIG. 4, a gate-controlled semiconductor device SCR 81 is utilized in the firing circuit so there is essentially no power flow between terminals 77 and 80 in the absence of a signal applied to the gate electrode of SCR 81. However, in embodiments wherein different types of electrical elements are utilized in the firing circuit, the connection as shown in FIG. 2 is preferred.

Antenna 82 is shown coupled to the noninverting input terminal of integrated circuit amplifier 83 which increases the level of the signal appearing at amplifier output terminal 84. In a particular embodiment tested and operated, amplifier 83 is a National Semiconductor LM301 operational amplifier. The amplified signal at terminal 84 is supplied to active filters 54 and 55.

Active filter 55 is tuned to the second signal frequency f_2 while filter 54 is tuned to the third frequency signal f_3 . As previously mentioned, the transmitter of FIG. 3 provides the first and second signals at the exit while the third signal if present is attributed to noise. Both filters are essentially identical and utilize National Semiconductor LM301 operational amplifiers to impart gain to the signal. The particular filters employed utilize the resistors and capacitors coupled to the non-inverting input terminal of the operational amplifier to obtain frequency selectively. In this embodiment, wherein the second and third signal frequencies are 22 KHz and 35 KHz, respectively, the particular component values utilized are as follows:

$R_1 = 4.7 \text{ K ohms}$	$C_1 = 1000 \text{ pF}$
$R_2 = 390 \text{ ohms}$	$C_2 = 1000 \text{ pF}$
$R_3 = 150 \text{ K ohms}$	$C_3 = 3 \text{ pF}$
$R_4 = 3 \text{ K ohms}$	$C_4 = 3 \text{ pF}$
$R_5 = 240 \text{ ohms}$	$C_5 = 1000 \text{ pF}$
$R_6 = 91 \text{ ohms}$	$C_6 = 1000 \text{ pF}$

It is recognized that many different types of filters may be utilized in place of the particular filter shown in FIG. 4 and that for certain applications the filters need not be active.

The second frequency signal f_2 from filter 55 is supplied to detector 56 wherein the base-emitter junction of transistor 86 acts as a detecting diode. When the second signal causes transistor 86 to conduct, transistor 87 of latch 57 is turned on and capacitor C_7 is charged. The voltage on this capacitor is applied to the opera-

tional amplifier of filter 55. This input signal continues the conduction of transistors 86 and 87 in the event that the receiver is moved without the range of the transmitter and thus no longer receives the second frequency signal f_2 . It shall be noted that the collector of transistor 87 is coupled to the base of transistor 73 of the power switch. The base drive provided by the latch insures that the receiver circuit elements continue to receive power in the absence of the second signal.

When transistor 87 of latch 57 is turned on, capacitor C_8 of timer 59 begins to charge. The latch circuit includes programmable unijunction transistor 88 which conducts when the voltage on capacitor C_8 reaches a level that is determined in part by the ratio of resistors R_7 and R_8 . When transistor 88 conducts, current is supplied to the gate electrode of SCR 89 thereby triggering it into conduction. SCR 89 of firing circuit 60 is non-conductive until triggered. When triggered, current flows through the tear gas detonator 91 and causes the tear gas cartridge to explode, thereby causing the unauthorized taker to release the articles he is transporting.

The output signal from filter 54 is the third signal f_3 and is supplied to the base of transistor 91 of defeat circuit 58 and causes it to conduct. When transistor 91 is turned on, the non-inverting input terminal of the operational amplifier of filter 55 is maintained substantially at ground potential. As a result, transistor 87 is not driven into conduction and the latching operation cannot take place. Thus, the reception of the third signal f_3 at the time of the reception of the second signal f_2 prevents the timer from being triggered and thus guards against noise signals causing the tear gas cartridge to be discharged.

Since the unauthorized taker is transporting the article from the exit to a location outside the building where the noise conditions differ, it should be noted that the subsequent detection of the third signal f_3 does not alter the latched condition of the circuit when latching has previously taken place. This is due to the fact that the voltage on capacitor C_7 of latch 57 continues to be supplied to the operational amplifier of filter 55 and transistor 86 is maintained in conduction regardless of whether transistor 91 clamps the other input terminal of the amplifier to ground.

While the above description has been with reference to a particular embodiment, it will be recognized that many modifications and variations may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A system for monitoring the unauthorized movement of articles along a prescribed path, said system comprising:

a. transmitting means located proximate to said prescribed path, said means transmitting first and second signals of different frequencies;

b. receiver means associated with an article the unauthorized movement of which is to be monitored, said receiver including:

i. first means for receiving said first signal and providing a first output signal at the first output terminal thereof;

ii. power supply means for energizing said first means and coupled to the first output terminal of said first means, said power supply means being responsive to the first output signal to provide power at its power supply output terminal upon

receipt of said first output signal, said terminal being coupled to the receiver circuit elements;

iii. second means for receiving said second signal and providing a second output signal at the second output terminal thereof;

iv third means for receiving a third signal and providing a third output signal at the third output terminal thereof;

v logic means coupled to said second and third output terminals, said logic means having a fourth output terminal coupled to said power supply means and providing a fourth output signal in response to said second signal, the receipt of said fourth output signal by said power supply means causing power to be provided at the power supply output terminal, said logic means being inhibited by the receipt of said third output signal to provide no output signal; and

vi firing means including a firing device and coupled to the fourth output terminal of said logic means for receiving the fourth output signal and actuating said firing device to indicate the unauthorized movement of the monitored article.

2. The system in accordance with claim 1 wherein said logic means provides a fourth output signal having a predetermined duration, said power supply thereby continuing to provide power for the duration of said third signal.

3. The system in accordance with claim 1 wherein the frequencies of said first, second, and third signals are nonharmonically related.

4. The system in accordance with claim 3 wherein the frequency of the third signal is located near the middle of the frequency band between the first and second signals.

5. The system in accordance with claim 1 wherein said power supply means includes:

- a. a power supply having an output terminal coupled to the first means for receiving said first signal; and
- b. a power switch coupled to the power supply output terminal and to the fourth output terminal, said power switch receiving the first output signal and causing the receiver circuit elements to be energized in response thereto.

6. The system in accordance with claim 5 wherein the output terminal of said power supply is coupled to the firing device of said firing means, said firing device being a gate-controlled semiconductor device.

7. The system in accordance with claim 6 wherein said firing means includes timing means coupled to the fourth output terminal of said logic means and provides a timing output signal to the firing device a predetermined interval after receipt of said fourth signal.

8. The system in accordance with claim 1 wherein said transmitter comprises:

- a. first and second oscillators for generating said first and second signals respectively;
- b. amplifying means coupled to receive the signals from said oscillators for combining and amplifying the signals therefrom; and
- c. an antenna coupled to said amplifying means.

9. The system in accordance with claim 5 wherein the output terminal of said power supply is coupled to the firing device of said firing means, said firing device being a gate-controlled semiconductor device.

10. In an electronic security system of the type wherein the reception of first frequency and second

frequency signals are utilized to actuate a security device, a receiver which comprises:

receiver means associated with an article the unauthorized movement of which is to be monitored, said receiver including:

i first means for receiving said first signal and providing a first output signal at the first output terminal thereof;

ii power supply means for energizing said first means and coupled to the first output terminal of said first means, said power supply means being responsive to the first output signal to provide power at its power supply output terminal upon receipt of said first output signal, said terminal being coupled to the receiver circuit elements;

iii second means for receiving said second signal and providing a third output signal at the third output terminal thereof;

iv third means for receiving a third signal and providing a third output signal at the third output terminal thereof;

v logic means coupled to said second and third output terminals, said logic means having a fourth output terminal coupled to said power supply means and providing a fourth output signal in response to said second signal, the receipt of said fourth output signal by said power supply means causing power to be provided at the power supply output terminal, said logic means being inhibited by the receipt of said third output signal to provide no output signal; and

vi firing means including a firing device and coupled to the fourth output terminal of said logic means for receiving the fourth output signal and actuating said firing device to indicate the unauthorized movement of the monitored article.

11. The system in accordance with claim 10 wherein said logic means provides a fourth output signal having a predetermined duration, said power supply thereby continuing to provide power for the duration of said third signal.

12. The system in accordance with claim 11 wherein the frequency of the third signal is located near the middle of the frequency band between the first and second signals.

13. The system in accordance with claim 10 wherein said power supply means includes:

- a. a power supply having an output terminal coupled to the first means for receiving said first signal; and
- b a power switch coupled to the power supply output terminal and to the fourth output terminal, said power switch receiving the first output signal and causing the receiver circuit elements to be energized in response thereto.

14. The system in accordance with claim 9 wherein said firing means includes timing means coupled to the fourth output terminal of said logic means and provides a timing output signal to the firing device a predetermined interval after receipt of said fourth signal.

15. A method for inhibiting the unauthorized movement of articles along a defined path which comprises the steps of:

- a. transmitting first frequency and second frequency signals across a portion of said defined path;
- b providing said article with receiver means responsive to the first and second signals when said article is moved within said portion of the defined path;

c filtering said first and second signals;
d detecting the presence of a third frequency signal in said receiver means and inhibiting circuit action in response thereto.

e producing a firing signal in response to the receipt of said first and second signals and the absence of said third signal to thereby indicate the unauthorized movement of articles along said defined path.

16. A system for monitoring the unauthorized movement of articles along a prescribed path, said system comprising:

a transmitting means located proximate to said prescribed path, said means transmitting first and second signals of different frequencies;

b receiver means associated with an article the unauthorized movement of which is to be monitored, said receiver including:

i first means for receiving said first signal and providing a first output signal at the first output terminal thereof;

ii a power supply having an output terminal coupled to the first means for receiving said first signal;

iii power switch means coupled to the power supply output terminal, said power switch means receiving the first output signal and causing receiver circuit elements to be energized in response thereto;

iv second means for receiving said second signal and providing a second output signal at the second output terminal thereof;

v circuit means coupled to said second output terminal and having a third output terminal coupled to said power switch means, said circuit means providing a third output signal in response to said second output signal, and

vi firing means including a firing device and coupled to said circuit means for receiving the third output signal and actuating said firing device to indicate the unauthorized movement of the monitored article.

17. The system in accordance with claim 16 wherein said circuit means provides a third output signal having a predetermined duration, said power supply thereby continuing to provide power for the duration of said third signal.

18. The system in accordance with claim 16 wherein the frequencies of said first and second signals are non-harmonically related.

19. The system in accordance with claim 16 wherein said firing means includes timing means coupled to the third output terminal of said circuit means and providing a timing output signal to the firing device a predetermined interval after receipt of said third output signal.

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