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(54) **Title:** PULSED ELECTRONIC ARTICLE SURVEILLANCE DETECTION SYSTEM ABSENT OF A PHASING REQUIREMENT

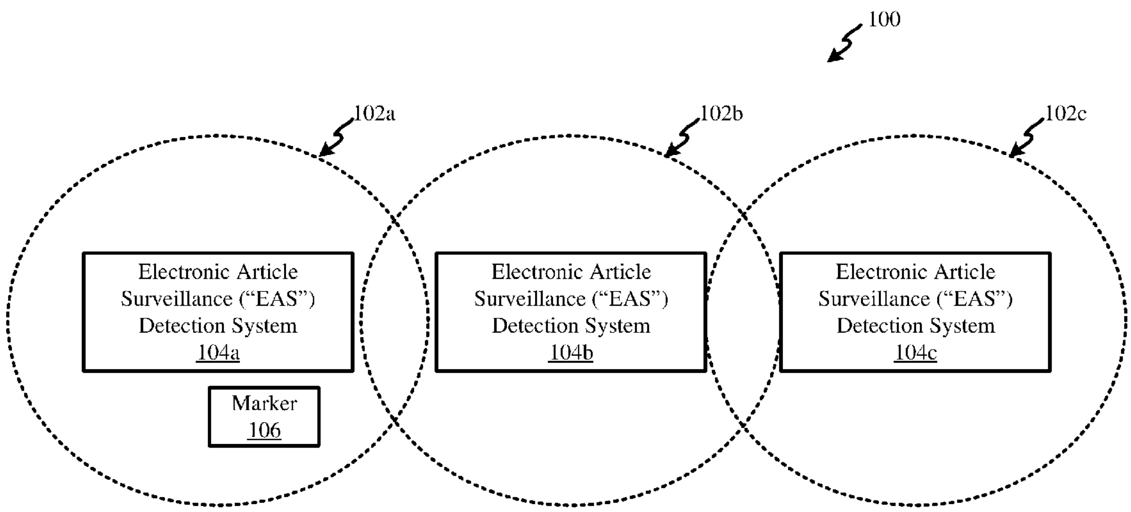

FIG. 1

(57) **Abstract:** Systems and methods for detecting a marker in a pulsed Electronic Article Surveillance ("EAS") system. The methods comprise transmitting, from an EAS detection system, an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system. The excitation signal causes the marker to transmit a response signal having a second frequency different from the first frequency. The response signal is received at the EAS detection system during a receive phase of the E AS detection system.

[Continued on next page]

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PULSED ELECTRONIC ARTICLE SURVEILLANCE DETECTION SYSTEM ABSENT OF A PHASING REQUIREMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of U.S. Provisional Serial Number 62/371,073 filed August 4, 2016, which is incorporated in its entirety by reference herein.

BACKGROUND

Statement of the Technical Field

[0002] The present disclosure concerns generally to Electronic Article Surveillance ("EAS") detection systems. More particularly, the present invention relates to EAS detection systems absent of a phasing requirement.

Description of the Related Art

[0003] A typical EAS system in a retail setting may comprise a monitoring system and at least one marker (e.g., a security tag or label) attached to an article to be protected from unauthorized removal. The monitoring system establishes a surveillance zone in which the presence of markers can be detected. The surveillance zone is usually established at an access point for the controlled area (e.g., adjacent to a retail store entrance and/or exit). If an article is authorized for removal from the controlled area, then the marker thereof can be deactivated and/or detached therefrom. Consequently, the article can be carried through the surveillance zone without being detected by the monitoring system and/or without triggering the alarm. In contrast, if an article enters the surveillance zone with an active marker, then an alarm may be triggered to indicate possible unauthorized removal thereof from the controlled area.

[0004] In acoustomagnetic or magnetomechanical based EAS systems, the monitoring system excites the marker by transmitting an electromagnetic burst at a resonance frequency of the marker. When the marker is present within the electromagnetic field created by the transmission burst, the marker begins to resonate with an acoustomagnetic or magnetomechanical response frequency that is detectable by a receiver in the monitoring system. The monitoring system may then trigger the alarm.

[0005] Notably, the resonance frequency and response frequency are the same. The waveform of the monitoring system's transmitter and the intended receiver signal are the same as well. As a result, if a distant transmitter of a remote EAS system is not phased properly relative to the local EAS system, the remote EAS system could transmit a transmission burst during a receiver timeslot of the local EAS system. Accordingly, pulsed EAS systems are required to be phased together because the transmit and receive signals can be misinterpreted by the EAS systems if not timed properly. Phasing is a complex issue. If not done properly, EAS systems will be desensitized or possibly false alarm. Conventional solutions have been focused on auto phasing schemes, which have either tried to align transmitters or find "quiet" locations in time versus the environment.

SUMMARY

[0006] The present invention concerns implementing systems and methods for detecting a marker in a pulsed EAS system (e.g., a magnetic based EAS detection system). The methods comprise transmitting, from an EAS detection system, an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system. The excitation signal causes the marker to transmit a response signal having a second frequency different from the first frequency. The response signal is received at the EAS detection system during a receive phase of the EAS detection system.

[0007] In some scenarios, the first frequency has a value that cannot be or is unable to be detected by a receiver of the second frequency. The second frequency can be less than or greater than the first frequency. The security tag may comprise a first coil, a second coil, a core on which the first and second coils are disposed, and a timing circuit electrically coupled to the first and second coils.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Embodiments will be described with reference to the following drawing figures, in which like numerals represent like items throughout the figures.

[0009] FIG. 1 is an illustration of an illustrative system.

[0010] FIGS. 2 and 3 provide illustrations of an illustrative EAS detection system.

[0011] FIG. 4 is an illustration of an illustrative system controller for an EAS detection system.

[0012] FIG. 5 is an illustration of an illustrative marker architecture.

[0013] FIG. 6 is an illustration of another illustrative marker architecture.

[0014] FIG. 7 is a flow diagram of an illustrative method for detecting a marker in an EAS system.

DETAILED DESCRIPTION

[0015] It will be readily understood that the components of the embodiments as generally described herein and illustrated in the appended figures could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of various embodiments, as represented in the figures, is not intended to limit the scope of the present disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments are presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

[0016] The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by this detailed description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

[0017] Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present invention should be or are in any single embodiment of the invention. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present invention. Thus, discussions of the features and advantages, and similar language, throughout the specification may, but do not necessarily, refer to the same embodiment.

[0018] Furthermore, the described features, advantages and characteristics of the invention may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize, in light of the description herein, that the invention can be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the invention.

[0019] Reference throughout this specification to "one embodiment", "an embodiment", or similar language means that a particular feature, structure, or characteristic described in connection with the indicated embodiment is included in at least one embodiment of the present invention. Thus, the phrases "in one embodiment", "in an embodiment", and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0020] As used in this document, the singular form "a", "an", and "the" include plural references unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art. As used in this document, the term "comprising" means "including, but not limited to".

[0021] The present solution relates to EAS systems absent of a phasing requirement. Since there is no longer a phasing requirement, the EAS systems are able to be setup without assistance. The EAS systems are designed so that at least one signal characteristic of the transmit and receive signals is the same. The signal characteristic includes, but is not limited to, a frequency. For example, in some scenarios, the resonance frequency $\mathbf{F_1}$ and response frequency $\mathbf{F_2}$ are different (i.e., $\mathbf{F_1} \neq \mathbf{F_2}$). In effect, the marker (e.g., security tag or label) cannot be excited by a far field transmitter of another EAS system. As such, the remote transmitter in any position (time - relative to the zero crossing of an AC line) will not corrupt the marker's interrogation of the local EAS system. Therefore, false alarms are at least significantly reduced by the present solution.

[0022] Referring now to FIG. 1, there is provided an illustration of an illustrative system **100**. System **100** comprises a plurality of EAS detection systems **104a**, **104b**, **104c**. Each of the EAS detection systems **104a**, **104b**, **104c** is configured to monitor an area **102a**, **102b**,

102c (e.g., within a certain range of the EAS detection systems) as is known to detect EAS markers **106** having a predetermined characteristic (e.g., frequency). The coverage for each area **102a**, **102b**, **102c** may overlap with adjacent areas. Further, the EAS detection systems **104a**, **104b**, **104c** may be configured to communicate information therebetween using any suitable communications links (e.g., a wireless communications link).

[0023] Referring now to FIGS. 2 and 3, there are provided illustrations of an illustrative EAS detection system **200**. EAS detection system **104a**, **104b**, **104c** of FIG. 1 is the same as or similar to EAS detection system **200** of FIG. 2. As such, the following discussion of EAS detection system **200** is sufficient for understanding EAS detection systems **104a**, **104b**, **104c** of FIG. 1. EAS detection system **200** is described herein in terms of an AM EAS type detection system. However, the present solution can also be used in other types of EAS detection systems, including other types of magnetic based EAS detection systems.

[0024] The EAS detection system **200** will be positioned at a location adjacent to an entry/exit **204** of a secured facility (e.g., a retail store). The EAS detection system **200** uses specially designed EAS markers **302** which are applied to store merchandise or other items which are stored within a secured facility. The EAS markers **302** can be deactivated or removed by authorized personnel at the secure facility. For example, in a retail environment, the EAS markers **302** could be removed by a store employee (not shown). When an active EAS marker **302** is detected by the EAS detection system **200** in an idealized representation of an EAS detection zone **300** near the entry/exit, the EAS detection system **200** will detect the presence of such marker **302** and will sound an alarm or generate some other suitable EAS response, as described above. Accordingly, the EAS detection system **200** is arranged for detecting and preventing the unauthorized removal of articles or products from controlled areas.

[0025] The EAS detection system **200** includes a pair of pedestals **202a**, **202b**, which are located a known distance apart (e.g., at opposing sides of an entry/exit **204**). The pedestals **202a**, **202b** are typically stabilized and supported by a base **206a**, **206b**. The pedestals **202a**, **202b** will each generally include one or more antennas **108** that are suitable for aiding in the detection of the special markers, as described herein. For example, pedestal **202a** can include at least one antenna suitable for transmitting or producing an electromagnetic exciter signal field and receiving response signals generated by markers in the EAS detection zone **300**. In some scenarios, the same antenna **208** can be used for both receive and transmit functions. Similarly, pedestal **202b** can include at least one antenna **208** suitable for transmitting or producing an electromagnetic exciter signal field and receiving response signals generated by markers in the EAS detection zone **300**. The antennas provided in pedestals **202a**, **202b** can be conventional conductive wire coil or loop designs as are commonly used in AM type EAS pedestals. These antennas will sometimes be referred to herein as exciter coils. In some scenarios, a single antenna can be used in each pedestal. The single antenna is selectively coupled to the EAS receiver. The EAS transmitter is operated in a time multiplexed manner. However, it can be advantageous to include two antennas (or exciter coils) in each pedestal as shown in FIG. 1, with an upper antenna positioned above a lower antenna.

[0026] The antennas **208** located in the pedestals **202a**, **202b** are electrically coupled to a system controller **210**. The system controller **210** controls the operation of the EAS detection system **202** to perform EAS functions as described herein. The system controller **210** can be located within a base **206a**, **206b** of one of the pedestals **202a**, **202b** or can be located within a separate chassis at a location nearby to the pedestals. For example, the system controller **210** can be located in a ceiling just above or adjacent to the pedestals **202a**, **202b**.

[0027] As noted above, the EAS detection system comprises an AM type EAS detection system. As such, each antenna is used to generate an Electro-Magnetic ("EM") field which serves as a marker exciter signal (or interrogation signal). The marker exciter signal causes a response signal to be generated by the marker within an EAS detection zone **300**. In some scenarios, the marker comprises a plurality of resonators having different lengths which facilitate the reception of the marker exciter signal having a first frequency and the generation of a response signal having a second different frequency. In other scenarios, the marker comprises two coils with a common core (e.g., a ferrite core). The present solution is not limited to the marker architectures of these two scenarios. Other marker architectures can be used herein.

[0028] An illustration of an illustrative marker **500** is provided in FIG. 5. As shown in FIG. 5, the marker **500** comprises a plurality of resonators **502** with different lengths. The marker also comprises an optional spacer **504** and a bias element **506**. Components **502-506** are well known in the art, and therefore will not be described herein.

[0029] An illustration of an illustrative marker **600** with a common core **602** architecture is shown in FIG. 6. During operation, the marker exciter signal causes a first voltage **V1** to be generated by a first coil **604** contained in the marker's housing **610**. The first voltage **V1** is supplied to a timing circuit **608** also contained in the marker's housing **610**. Some or all components of the timing circuit **608** can be implemented as hardware, software and/or a combination of hardware and software. The hardware includes, but is not limited to, one or more electronic circuits. The electronic circuits can include, but are not limited to, passive components (e.g., resistors and capacitors) and/or active components (e.g., amplifiers and/or microprocessors). The passive and/or active components can be adapted to, arranged to and/or programmed to perform one or more of the methodologies, procedures, or functions described herein. Upon the expiration of a pre-defined amount of time, the timing circuit **608** supplies a second voltage **V2** to a second coil **606**. The second voltage **V2** can be the same as or different than the first voltage **V1**. In turn, the second coil **606** emits a response signal therefrom. The response signal has a frequency that is different than the frequency of the marker exciter signal.

[0030] The response signal transmission will continue for a brief time after the stimulus signal is terminated. The response signal is received at the receiver antenna. The received response signal is used to indicate a presence of the marker within the EAS detection zone. As noted above, the same antenna contained in a pedestal **202a**, **202b** can serve as both the transmit antenna and the receive antenna. Accordingly, the antennas in each of the pedestals **202a**, **202b** can be used in several different modes to detect a marker exciter signal.

[0031] Referring now to FIG. 4, there is provided an illustration of illustrative architecture for the system controller **210** of FIG. 2. The system controller **210** comprises a power amplifier **406**, a transmitter circuit **408**, a receiver circuit **412**, and a processor **410**. Each of the listed components are well known in the art, and therefore will not be described in detail herein.

[0032] As shown in FIG. 4, the transmitter circuit **408** is coupled to a first antenna **208a**, and the receiver circuit **412** is coupled to a second antenna **208b**. The first antenna **208a** may be disposed in a first pedestal **202a** of a pair of pedestals, and the second antenna **208b** for the receiver circuit **412** may be disposed in a second pedestal **202b** of the pair of pedestals.

The present solution is not limited in this regard. For example, both antennas **208a** and **208b** can be contained in the same pedestal, and/or collectively comprise a single antenna.

[0033] The listed components **406-412** together define a marker monitoring control portion that controls the transmission from and reception of signals at an antenna **208a**, **208b**. The marker monitoring control portion can be provided in any known manner to control the transmissions and receptions at the interrogation antenna **402** to monitor for EAS markers **302** within an interrogation zone **300**. The system controller **210** also includes an optional communication antenna **414** and an optional transceiver **416** to provide communications between different controllers in one or more EAS detection systems.

[0034] The operations of the marker monitoring control portion will now be described in more detail. The transmitter circuit **408** is coupled to the first antenna **208a** via the power amplifier **406**. The first antenna **208a** emits transmit (e.g., "Radio Frequency ("RF")) bursts at a predetermined frequency (e.g., 58 KHz) and a repetition rate (e.g., 50 Hz, 60 Hz, 75 Hz or 90 Hz), with a pause between successive bursts. In some scenarios, each transmit burst has a duration of about 1.6 ms. The transmitter circuit **408** is controlled to emit the aforementioned transmit bursts by the processor **410**, which also controls the receiver circuit **412**. The receiver circuit **412** is coupled to the second antenna **208b**. The second antenna **208b** comprises close-coupled pick up coils of N turns (e.g., 100 turns), where N is any number.

[0035] When the EAS marker **302** resides between the antennas **208a**, **208b** as shown in FIG. 3, the transmit bursts transmitted from the transmitter circuit **408** cause a response signal to be generated by the EAS marker **302**. Notably, the frequency $\mathbf{F_2}$ of the response signal is different than the frequency $\mathbf{F_1}$ of the transmit bursts, i.e., $\mathbf{F_1} \neq \mathbf{F_2}$. The frequencies $\mathbf{F_1}$ and $\mathbf{F_2}$ have values selected so that cross-talk will not occur and/or so that interference does not occur between the two signals. In this regard, the frequency $\mathbf{F_1}$ has to be such that it cannot be or is unable to be seen by the receiver of frequency $\mathbf{F_2}$. This will be dictated by the typical bandwidth of the receiver. For example, in some scenarios, a difference between the values of the frequencies $\mathbf{F_1}$ and $\mathbf{F_2}$ is at least 3-5 KHz. The second frequency $\mathbf{F_2}$ can be greater than or less than the first frequency $\mathbf{F_1}$. Thus, if the first frequency $\mathbf{F_1}$ is 58 KHz, then the second frequency $\mathbf{F_2}$ is 53 KHz or 63 KHz. The present solution is not limited to the particulars of this example.

[0036] The processor **410** controls activation and deactivation of the receiver circuit **412**. When the receiver circuit **412** is activated, it detects signals at the predetermined frequency (e.g., 53 KHz or 63 KHz) within first and second detection windows. In the case that a transmit burst has a duration of about 1.6 ms, the first detection window will have a duration of about 1.7 ms which begins at approximately 0.4 ms after the end of the transmit burst. During the first detection window, the receiver circuit **412** integrates any signal at the predetermined frequency which is present. In order to produce an integration result in the first detection window which can be readily compared with the integrated signal from the second detection window, the signal emitted by the EAS marker **302** should have a relatively high amplitude (e.g., greater than or equal to about 1.5 nanowebers (nWb)).

[0037] After signal detection in the first detection window, the processor **410** deactivates the receiver circuit **412**, and then re-activates the receiver circuit **412** during the second detection window which begins at approximately 6 ms after the end of the aforementioned transmit burst. During the second detection window, the receiver circuit **412** again looks for a signal having a suitable amplitude at the predetermined frequency (e.g., 53 kHz or 63 KHz). Since it is known that a signal emanating from the EAS marker **302** will have a decaying amplitude, the receiver circuit **412** compares the amplitude of any signal detected at the predetermined frequency during the second detection window with the amplitude of the signal detected during the first detection window. If the amplitude differential is consistent with that of an exponentially decaying signal, it is assumed that the signal did, in fact, emanate from an EAS marker **302** between antennas **208a**, **208b**. In this case, the receiver circuit **412** issues an alarm.

[0038] Referring now to FIG. 7, there is provided a flow diagram of an illustrative method **700** for detecting a marker (e.g., marker **500** of FIG. 5 or marker **600** of FIG. 6) in an EAS system (e.g., system **100** of FIG. 1). Method **700** begins with **702** and continues with **704** where an excitation signal is transmitted from an EAS detection system (e.g., EAS detection system **104a-104c** of FIG. 1 or EAS detection system **200** of FIG. 2) into an interrogation zone (e.g., interrogation zone **300** of FIG. 3) during a transmit phase of the EAS detection system. The excitation signal has a first frequency **F1**. The excitation signal is then received by the marker located in the interrogation zone, as shown by **706**. In response to the excitation signal, the marker generates a response signal in **708**. The response signal has a second frequency **F2** different from the first frequency **F1**. The second frequency can be less than or greater than the first frequency. Next in **710**, the response signal is transmitted from the marker. The response signal is received at the EAS detection system during a receive phase of the EAS detection system, as shown by **712**. Subsequently, **714** is performed where method **700** ends or other processing is performed (e.g., return to **704**).

[0039] Although the invention has been illustrated and described with respect to one or more implementations, equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In addition, while a particular feature of the invention may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Thus, the breadth and scope of the present invention should not be limited by any of the above described embodiments. Rather, the scope of the invention should be defined in accordance with the following claims and their equivalents.

CLAIMS

What is claimed is:

1. A method for detecting a marker in a pulsed Electronic Article Surveillance ("EAS") system, comprising:

transmitting, from an EAS detection system, an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system, the excitation signal causing the marker to transmit a response signal having a second frequency different from the first frequency; and

receiving the response signal at the EAS detection system during a receive phase of the EAS detection system.

2. The method according to claim 1, wherein the first frequency has a value that is unable to be detected by a receiver of the EA second frequency.

3. The method according to claim 1, wherein the second frequency is less than the first frequency.

4. The method according to claim 1, wherein the second frequency is greater than the first frequency.

5. The method according to claim 1, wherein the EAS detection system comprises a magnetic based EAS detection system.

6. The method according to claim 1, wherein the marker comprises a first coil, a second coil, a core on which the first and second coils are disposed, and a timing circuit electrically coupled to the first and second coils.

7. A method for operating an Electronic Article Surveillance ("EAS") system, comprising:

transmitting, from an EAS detection system, an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system;

receiving the excitation signal at a marker located within the interrogation zone;

generating, by the marker, a response signal in response to the excitation signal, the response signal having a second frequency different from the first frequency;

transmitting the response signal from the marker; and

receiving the response signal at the EAS detection system during a receive phase of the EAS detection system.

8. The method according to claim 7, wherein the first frequency has a value that is unable to be detected by a receiver of the second frequency.

9. The method according to claim 7, wherein the second frequency is less than the first frequency.

10. The method according to claim 7, wherein the second frequency is greater than the first frequency.

11. The method according to claim 7, wherein the EAS detection system comprises a magnetic based EAS detection system.

12. The method according to claim 7, wherein the marker comprises a first coil, a second coil, a core on which the first and second coils are disposed, and a timing circuit electrically coupled to the first and second coils.

13. A pulsed Electronic Article Surveillance ("EAS") system, comprising:

a marker; and

an EAS detection system comprising a circuit configured to

transmit an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system, the excitation signal causing the marker to transmit a response signal having a second frequency different from the first frequency, and

receive the response signal during a receive phase of the EAS detection system.

14. The pulsed EAS system according to claim 1, wherein the first frequency has a value that is unable to be detected by the second frequency.

15. The pulsed EAS system according to claim 1, wherein the second frequency is less than the first frequency.

16. The pulsed EAS system according to claim 1, wherein the second frequency is greater than the first frequency.

17. The pulsed EAS system according to claim 1, wherein the EAS detection system comprises a magnetic based EAS detection system.

18. The pulsed EAS system according to claim 1, wherein the marker comprises a first coil, a second coil, a core on which the first and second coils are disposed, and a timing circuit electrically coupled to the first and second coils.

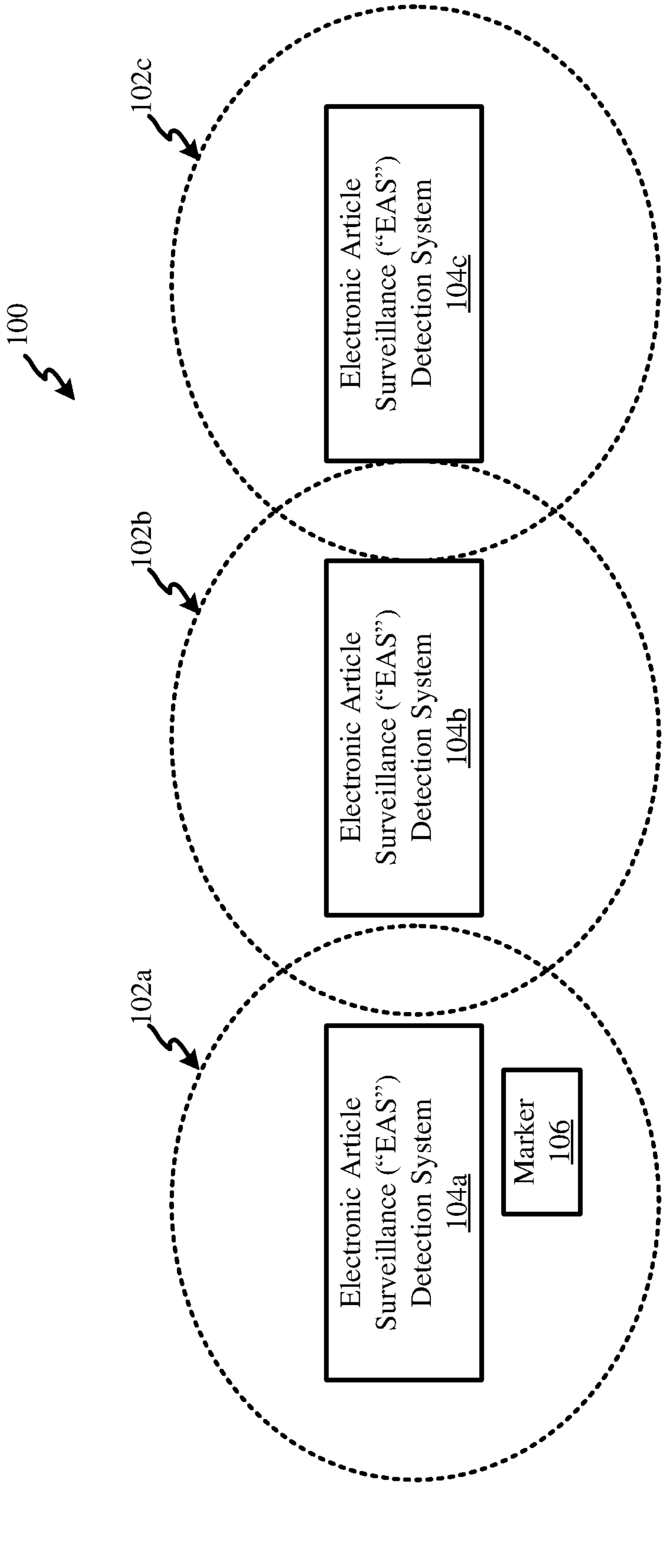
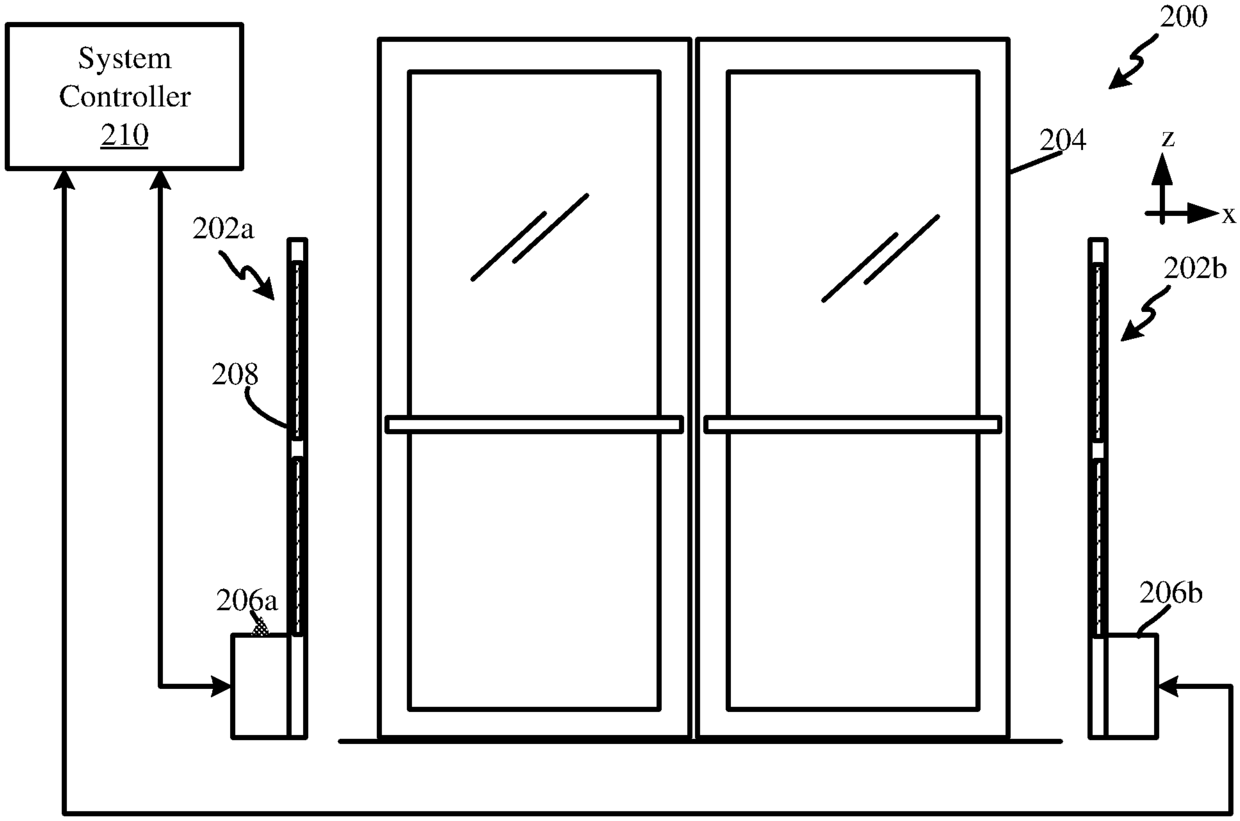
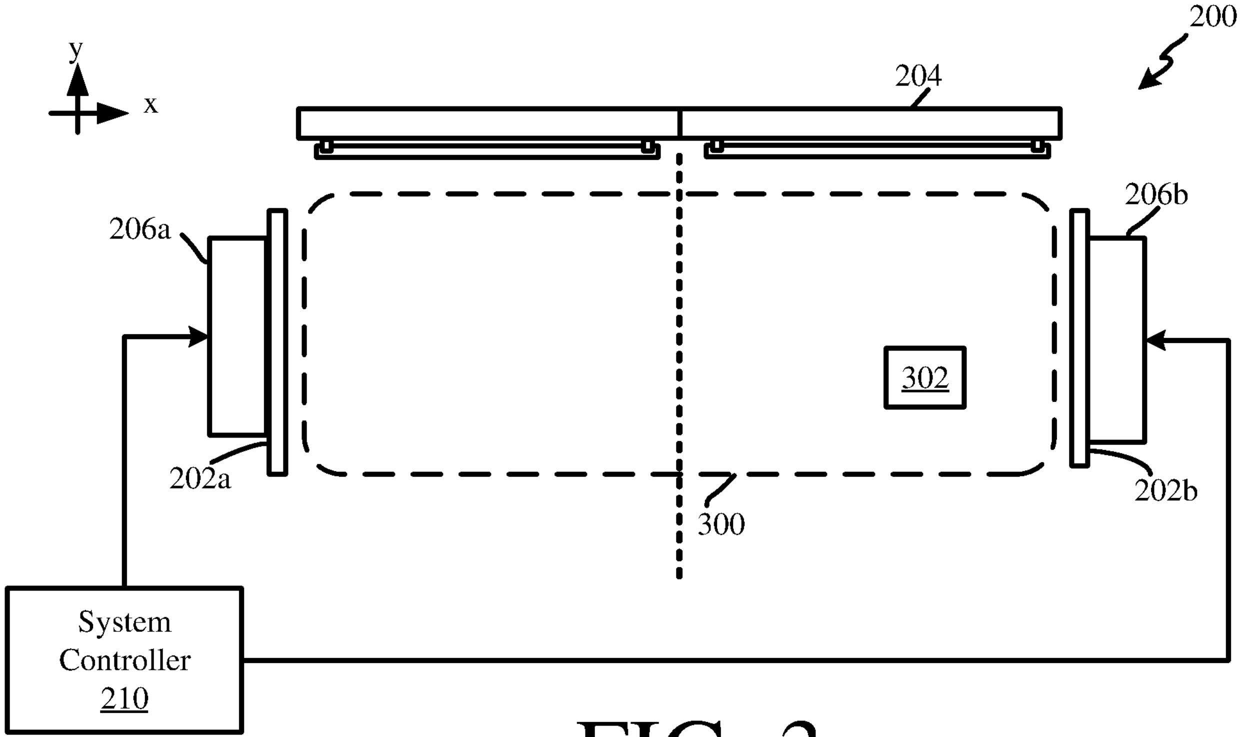

100
102c
Electronic Article Surveillance ("EAS") Detection System 104c
102b
Electronic Article Surveillance ("EAS") Detection System 104b
102a
Electronic Article Surveillance ("EAS") Detection System 104a
Marker 106

FIG. 1



System Controller 210
200
204
z
x
202a
202b
208
206a
206b

FIG. 2



200
y
x
204
206a
206b
302
202a
202b
300
System Controller 210

FIG. 3

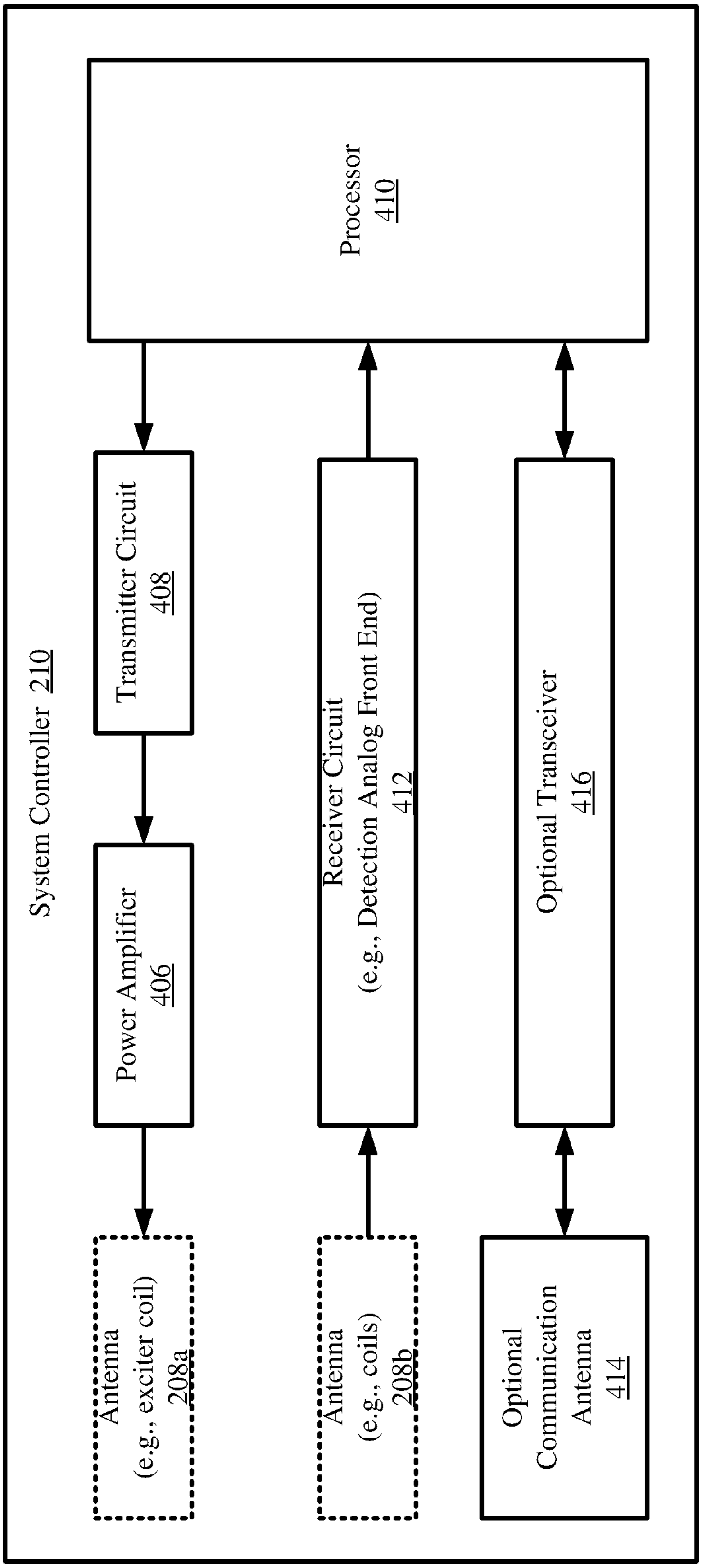

System Controller 210
Processor
410
Transmitter Circuit
408
Power Amplifier
406
Antenna
(e.g., exciter coil)
208a
Receiver Circuit
(e.g., Detection Analog Front End)
412
Antenna
(e.g., coils)
208b
Optional Transceiver
416
Optional
Communication
Antenna
414

FIG. 4

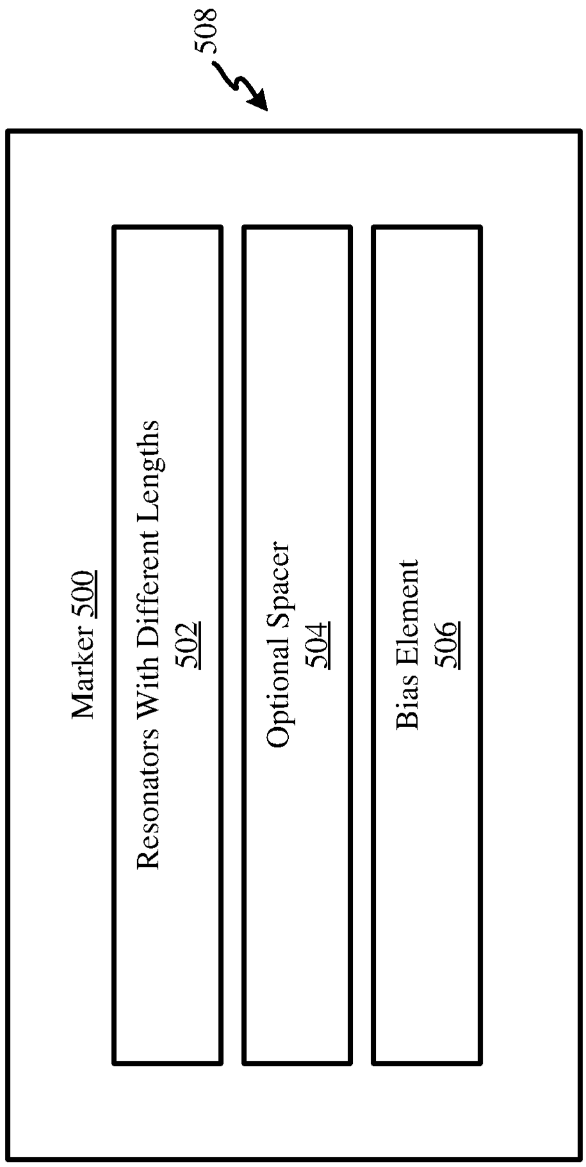

508
Marker 500
Resonators With Different Lengths
502
Optional Spacer
504
Bias Element
506

FIG. 5

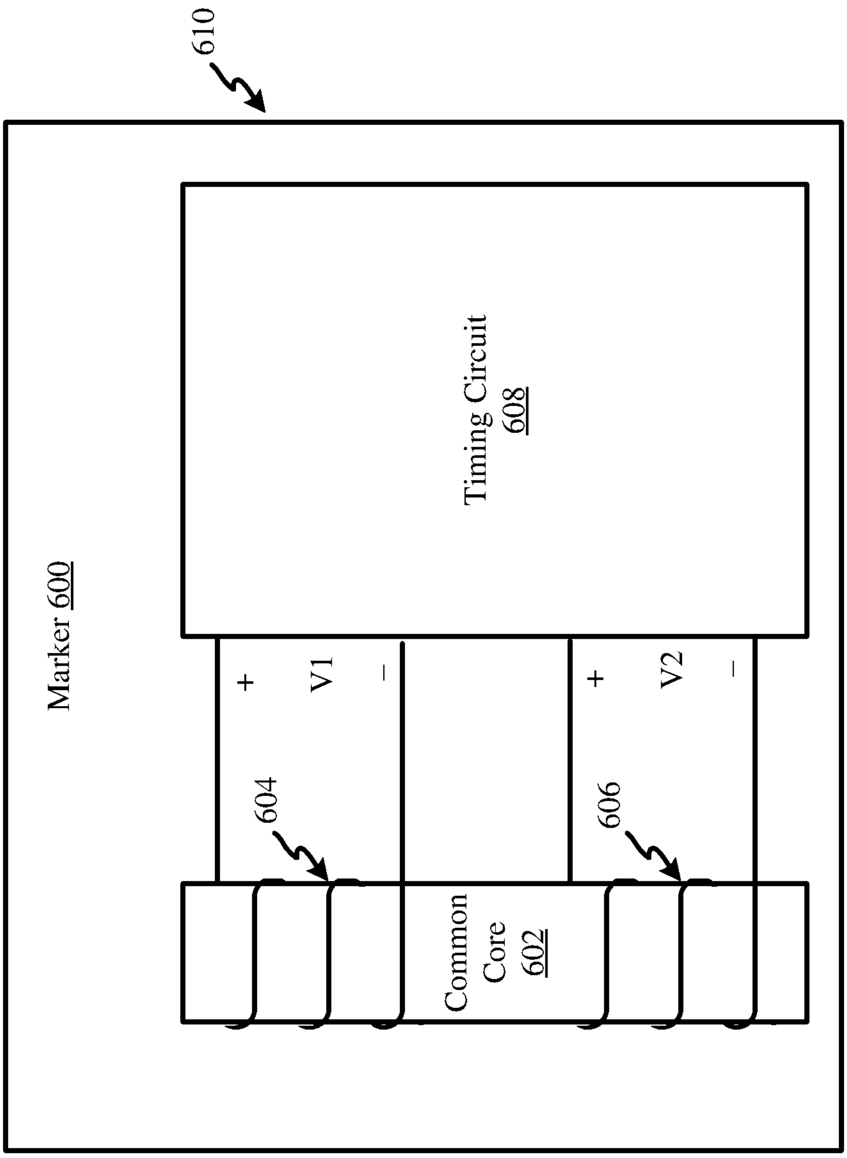

610
Marker 600
Timing Circuit
608
+
V1
–
+
V2
–
604
606
Common
Core
602

FIG. 6

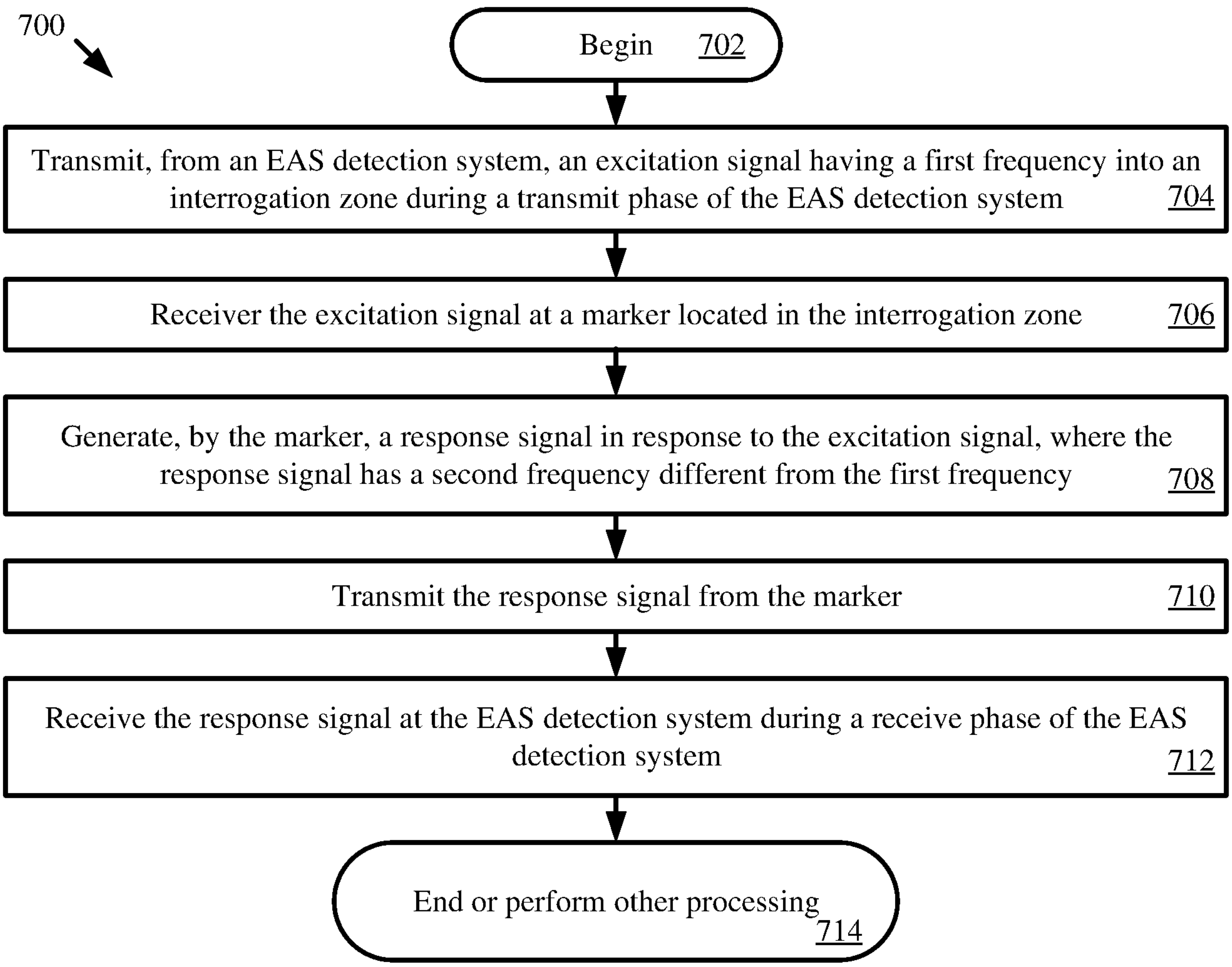

700
Begin 702
Transmit, from an EAS detection system, an excitation signal having a first frequency into an interrogation zone during a transmit phase of the EAS detection system 704
Receiver the excitation signal at a marker located in the interrogation zone 706
Generate, by the marker, a response signal in response to the excitation signal, where the response signal has a second frequency different from the first frequency 708
Transmit the response signal from the marker 710
Receive the response signal at the EAS detection system during a receive phase of the EAS detection system 712
End or perform other processing 714

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/045614

A. CLASSIFICATION OF SUBJECT MATTER
INV. G08B13/24
ADD.

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)
G08B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 798 681 A1 (SENSORMATIC ELECTRONICS CORP [US]) 1 October 1997 (1997-10-01) column 1, lines 31-34; figures 2-4 column 2, lines 17-20 column 4, lines 25-28 column 5, line 16 column 6, lines 25-52,55-58 column 7, line 3 column 8, lines 1-4 -----	1-18
A	US 5 406 262 A (HERMAN FRED W [US] ET AL) 11 April 1995 (1995-04-11) figure 1 column 1, lines 12-22 column 2, lines 1-10,27-30 column 4, lines 37-45 column 6, lines 10-30 ----- -/--	1-18

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 2017	19/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Plathner, B

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 493 955 A (MINASY ARTHUR J) 3 February 1970 (1970-02-03) column 2, lines 21-44 column 3, lines 53-57 column 4, lines 15-18,34-38 column 5, lines 35-56 figure 1 -----	1-18

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/045614

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US 3493955 A	03-02-1970	NONE	