



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.05.2008 Bulletin 2008/22

(51) Int Cl.:
H04K 3/00 (2006.01)

(21) Application number: **07380325.6**

(22) Date of filing: **22.11.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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(30) Priority: **23.11.2006 ES 200602995 P**

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(54) **Method for detecting the use of radio frequency signal inhibitors in wireless communications systems**

(57) The invention relates to a method for detecting the use of radiofrequency signal inhibitors (3) in wireless communications systems, which inhibitors (3) act to prevent the communication between at least one mobile device (2) and a base station (1) of the wireless communications system. The data capture necessary for detecting the inhibitors (3) is carried out in the base station (1), which station obtains the baseline background noise level

el R, the mean power level P received in a time period Δt , generates a function relating the expected mean power P_{EXP} in a certain time period Δt with the average N of the powers assigned to the connections set up in said Δt , and compares P with P_{EXP} to determine if said P exceeds P_{EXP} by a predetermined percentage and/or value; in which case a detection of a use of signal inhibitors (3) will occur.

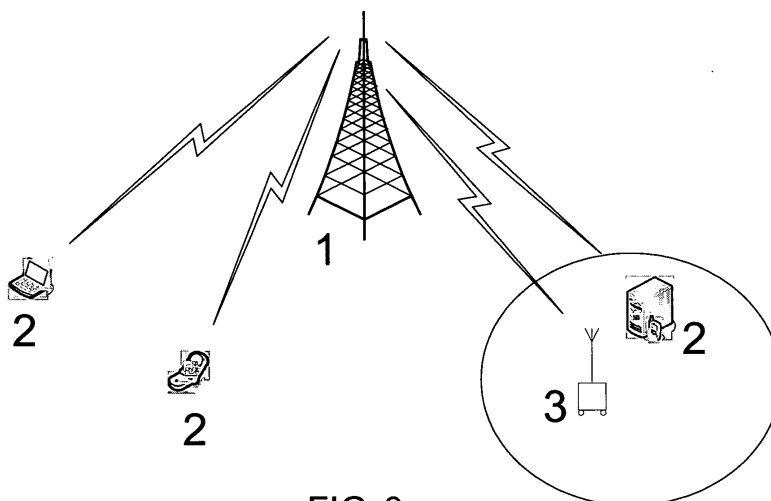


FIG. 3

Description

Field of the Invention

[0001] The present invention relates to a method detecting the blocking of alarm systems with inhibitors emitting in the frequencies used for the communication between the alarm and the base station of a wireless communications system. Said invention is therefore applicable to alert service and security systems used by security companies.

Background of the Invention

[0002] There are currently a number of automated systems for detecting intrusion and emergency situations in buildings and private areas, hereinafter referred to as alarms. Some of these systems include the functionality of initiating a communication towards the party or parties interested in knowing the emergency situation or intrusion, either the owners or users of the building or an alarm center.

[0003] Knowing this alarm functionality, when someone wants to enter without authorization an area in which there supposedly is an operating alarm, he or she can attempt to prevent the communications from the device towards the rest of the communication networks. To that end, he or she can physically cut the fixed transmission lines and/or use devices interfering or disabling the connection by means of radiofrequency waves.

[0004] The current solution consists of maintaining a constant communication or a communication every short time period with the alarm and considering that if the communication is interrupted, it is assumed that there is an emergency situation or intrusion. This type of solution is described in document W02004028184, disclosing a method whereby the mobile devices transmit signals regularly in order to detect a break in the communication. This practice involves a high cost because it requires constant communication between both ends, occupying a transmission resource constantly or at short time intervals in addition to negatively affecting the duration of the battery of the wireless device, and requires a modification in the device in order to carry out these regular communications. Document US 5,687,217 discloses a method whereby wireless communications-receiving stations, also referred to as base stations, detect if there is any other base station that has stopped emitting or if the quality with which it does so has degraded, which differs from the object of the present patent, which consists of detecting elements that do not belong to the wireless communications system.

[0005] The present invention solves the problem of detecting, in wireless communications systems, the break caused in the communication due to the use of radiofrequency signal inhibitors in the bands in which the system operates. This invention solves said problem in an innovative manner that has never been considered before,

improving the current methods in terms of used resources and response time because it does not regularly consume transmission over time and does not need modifications in the user devices. The method object of the invention detects the blocking of alarm systems with inhibitors emitting in the frequencies used for the wireless communication between the alarm and the base stations.

Description of the Invention

[0006] The present invention relates to a method for detecting the use of radiofrequency signal inhibitors in wireless communications systems according to claim 1. Preferred embodiments of said method are defined in the dependent claims.

[0007] The inhibitors act to prevent the communication between at least one mobile device and a base station of the wireless communications system by means of emitting noise in at least one of the frequency bands used by the mobile device and the base station to communicate. In the proposed method, the data capture necessary for detecting inhibitors is carried out in said base station, whereas the detection itself is carried out in said base station or in other equipment, such as a server outside the base station, for example. For each frequency band Δf in which the use of inhibitors is to be detected (the frequency band Δf will depend on each wireless communications system), the method comprises the following steps:

[0008] The power level received in the base station in configurable time periods T is first measured in said frequency band Δf , in order to thus obtain a track of the power level for said frequency band Δf in time domains and which will be used as historical reference data. The baseline background noise level R in said base station for said frequency band Δf and optionally for different times of the day and of the year will subsequently be obtained from the previous measurements, because this background noise can depend on the time and on the season. In other words, the noise in time domains for said frequency Δf is obtained to thus generate a record. Once this historical reference data has been obtained for different times of the day and year, it will initially be unnecessary to carry out more noise measurements in said time periods T , although it would be recommendable to carry out the measurements again from time to time to keep the historical reference data updated, because the external conditions of the noise can vary due to the action of new radiating external elements.

[0009] The mean power level P received in the base station in the frequency band Δf is then measured in time periods Δt , obtaining a value P_i for each measurement carried out in each period Δt_i .

[0010] Each P_i thus obtained is then related to a parameter N_i , where N_i is the average of the powers assigned to the connections set up in the frequency bands Δf and within each time period Δt_i , obtaining pairs of data (P_i, N_i) for the frequency bands Δf . It must be taken into

account that when a connection is set up between the mobile device and the base station, the latter assigns to the mobile device the power that it must use to communicate and it is therefore not fixed for all the mobile devices.

[0011] A function $P_{EXP}=f(N)$ is then generated, which function relates the expected mean power P_{EXP} , in the frequency bands Δf and in a certain time period Δt , with the average N of the powers assigned to the connections set up within said certain time period Δt . The steps of measuring values and generating functions $P_{EXP}=f(N)$ described up until now can be periodically repeated, because the propagation conditions and the noise level R vary over time and the obtained results can be incorporated to the historical data.

[0012] Finally, once the function $P_{EXP}=f(N)$ has been obtained for each measurement of the mean power level P_i received in the base station in each time period Δt_i , it is determined if said power level P_i exceeds the expected mean power P_{EXP_i} in the time period Δt_i , obtained according to the function $P_{EXP}=f(N)$, by a configurable percentage and/or by an also configurable predetermined value; in which case a detection of a possible use of signal inhibitors will occur.

[0013] A series of rules can be applied to this detection to determine the probability of certainty on such detection, which rules can be rules relating to the number of detections in a time period greater than Δt , rules relating to detections in several frequencies or rules relating to the detection from several base stations, for example. In the event that the probability of the use of signal inhibitors is considered sufficiently certain, an alarm of the presence of interference or inhibitor can be generated. Said alarm can be communicated to other entities, such as security companies for example, using suitable communication systems which cannot be affected by the detected signal inhibitors.

[0014] This method can be carried out for both the wireless link from the base station towards the user devices (downlink direction) and for those used in the reverse direction (uplink). The base stations have suitable radiofrequency receivers for the uplink (communication of the mobile device towards the base station) frequency band, therefore the method object of the invention can be directly applied to detect the use of signal inhibitors in said uplink frequency band. In the event that this method is to be applied to detect the use of inhibitors in the downlink (communication from the base station towards the mobile devices) frequency range, means for receiving radiofrequency in the downlink frequency band could be incorporated in the base station.

Brief Description of the Drawings

[0015] To better understand the invention, an embodiment of the invention is briefly described below as an illustrative and non-limiting example thereof. To that end, reference is made to the attached drawings, in which:

Figure 1 shows a generic wireless communications system.

Figure 2 shows a graph in which the concept of background noise R and transmission power of the mobile terminals of Figure 1 can be observed.

Figure 3 shows a wireless communications system in which a signal inhibitor is acting.

Figure 4 shows a graph in which the power balance variation occurring in the case of Figure 3 when there is an inhibitor in the area can be observed.

Figure 5 shows a graph showing an example of the power measured during different times of the day.

Detailed Description of the Invention

[0016] Figure 1 shows a generic wireless communications system, formed by a base station 1 and mobile devices 2, such as mobile telephones, personal digital assistants (PDAs) and wireless alarm systems. The communication can be carried out in a GSM, UMTS, Wi-Fi system or any other wireless communications system. In any communications system there is a noise level R , as shown in Figure 2 (the x-axis represents the frequency whereas the y-axis represents the power), showing a graph in which the concept of background noise R and the transmission power of the mobile terminals of Figure 1, in the frequency bands Δf whereby they communicate with the base station 1, can be observed. Although said communications system operates in the frequency band Δf , a power outside said band Δf , which is precisely the frequency-dependent background noise level R , is measured.

[0017] Figure 3 shows a wireless communications system in which a signal inhibitor 3 is acting, which inhibitor introduces a high noise level, an interference, normally in the frequency band Δf used by the wireless communications system. This is observed in Figure 4, showing a graph in which the power balance variation occurring when there is an inhibitor 3 in the area is observed.

[0018] The radiofrequency signal inhibitors 3 work by emitting an interfering signal in the same frequencies used by the wireless alarm systems 2 to communicate with the base station 1. In the case of the wireless communications systems, the base station 1 is designed to receive signals in the uplink direction (in the direction from the mobile devices 2 towards the base station 1) frequencies, it can therefore detect the use of said inhibitor 3 thanks to the method described below and act accordingly thereafter. It may be necessary to install additional measurement equipment in the base station 1 for the frequency band used in the downlink direction (in the direction from the base station 1 towards the mobile devices 2).

[0019] The method object of the invention consists of several steps. The received power level in a frequency band Δf of interest (normally the uplink direction frequency band) is first measured by the base station 1 in configurable time periods T , which can be of several minutes

or even hours, for example, in order to obtain a signal and noise track in the time domains for said frequency band Δf which can be stored for the purpose of having historical data, obtaining the baseline signal and background noise or R level data.

[0020] The received power level in the frequency band Δf is measured in a similar manner in the base station 1 in time periods Δt , as shown in Figure 5 (the x-axis represents the time variable whereas the y-axis represents the power), and it is related to the number of connections set up and to the power used by each connection, as in many wireless communications systems each connection has different power levels assigned at each time to minimize the emissions by both ends according to several parameters such as quality, transfer rate, etc. The time periods Δt can be as small as they are to be configured, minutes or even seconds, for example. Pairs of values are thus obtained which are related to the power P measured in the frequency band Δf with the occupation, considered in terms of power, of the wireless link N: The weighted number of connections according to the transfer rate as well as the transmission power required for each connection can be used as source data to obtain N. A function $P_{EXP}=f(N)$ is then generated, which function relates the expected mean power P_{EXP} in the frequency bands Δf and in a certain time period Δt with the average N of the powers assigned to the connections set up within said certain time period Δt . The process described in the previous paragraphs for measuring values and generating functions must be carried out regularly given that the propagation conditions and the noise level R vary over time, the obtained functions being able to be stored for the purpose of having historical data. A possible function would be $P_{EXPi}=N_i+R_i$, where P_{EXPi} is the expected mean power for the time period Δt_i , N_i is the average of the powers assigned to the connections set up within said certain time period Δt_i and R_i is the noise considered to exist (normally stored in database record) for that time of the day in which the measurement is carried out.

[0021] Each measurement of the mean power level P_i received in the base station 1 in each time period Δt_i is compared with the expected mean power P_{EXP} . The comparison allows knowing if the measured power level varies by a certain percentage or value with respect to the expected one according to the generated function, giving rise to a detection of the possible presence of interference or inhibitor 3. The chosen value or percentage will determine the percentages of false alarm (an inhibitor 3 or interference is not present) and those of probability of detection (it is not detected even if it is present) with which the system will operate.

[0022] A series of rules can be applied to determine the probability of certainty on such detection, which rules can be rules relating to the number of detections in a time period greater than Δt , rules relating to detections in several frequencies or rules relating to the detection from several base stations 1, for example. In the event that the probability of the use of signal inhibitors 3 is consid-

ered sufficiently certain according to the mentioned rules, an alarm of the presence of inhibitor 3 or interference can be generated.

[0023] Once the alarm has been detected, the system can communicate it to other interested entities using the necessary communication systems.

[0024] Figure 5 shows a graph showing an example of the power measured during different times of the day, in which it is observed that the average background noise and powers can vary during different times of the day, the time of the day is therefore a parameter to be taken into account.

15 Claims

1. A method for detecting the use of radiofrequency signal inhibitors in wireless communications systems, which inhibitors (3) act to prevent the communication between at least one mobile device (2) and a base station (1) of the wireless communications system by means of emitting noise in at least one of the frequency bands used by the mobile device (2) and the base station (1) to communicate, **characterized in that** the data capture necessary for detecting the inhibitors (3) is carried out in said base station (1) and **in that** for each frequency band Δf in which the use of inhibitors (3) is to be detected, the method comprises the following steps:

- a- measuring in said frequency band Δf the power level received in the base station (1) in configurable time periods T;
- b- obtaining from the previous measurements the baseline background noise level R in said base station (1) for said frequency band Δf and optionally for different times of the day and of the year;
- c- measuring in time periods Δt the mean power level P received in the base station (1) in the frequency band Δf , obtaining a value P_i for each measurement carried out in each period Δt_i ;
- d- relating each P_i obtained with a parameter N_i , where N_i is the average of the powers assigned to the connections set up in the frequency band Δf and within each time period Δt_i , obtaining pairs of data (P_i, N_i);
- e- generating a function $P_{EXP}=f(N)$ relating the expected mean power P_{EXP} in a certain time period Δt with the average N of the powers assigned to the connections set up within said certain time period Δt ;
- f- determining for each measurement of the mean power level P_i received in the base station (1) in each time period Δt_i if said power level P_i exceeds the expected mean power P_{EXPi} in the time period Δt_i by a configurable percentage and/or by an also configurable predetermined

value; in which case a detection of a use of signal inhibitors (3) will occur.

2. A method according to the previous claim, **characterized in that** steps a) and e) of measuring values and generating functions $P_{EXP}=f(N)$ are periodically repeated. 5
3. A method according to any of the previous claims, **characterized in that** once the use of signal inhibitors (3) has been detected, an alarm of the presence of inhibitor (3) is generated. 10
4. A method according to any of the previous claims, **characterized in that** means for receiving radiofrequency in the downlink frequency band used by the base station (1) to communicate with the mobile devices (2) are incorporated to the base station (1) to be able to detect the use of inhibitors (3) in said downlink frequency band. 15
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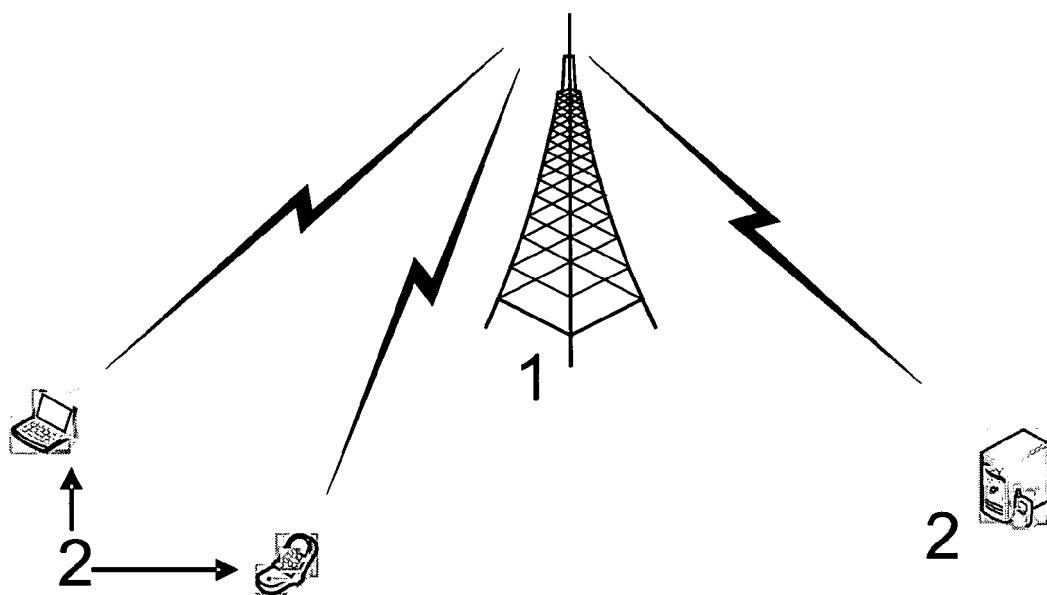


FIG. 1

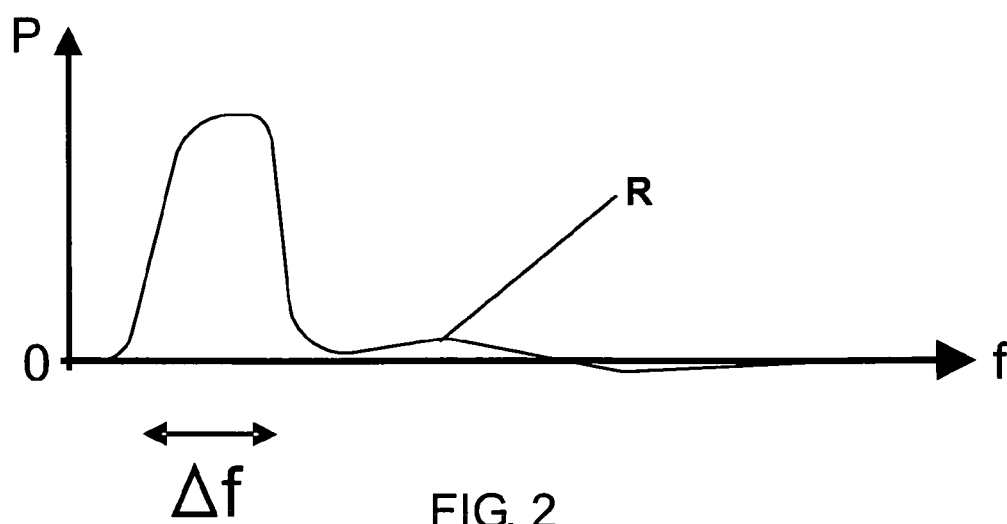


FIG. 2

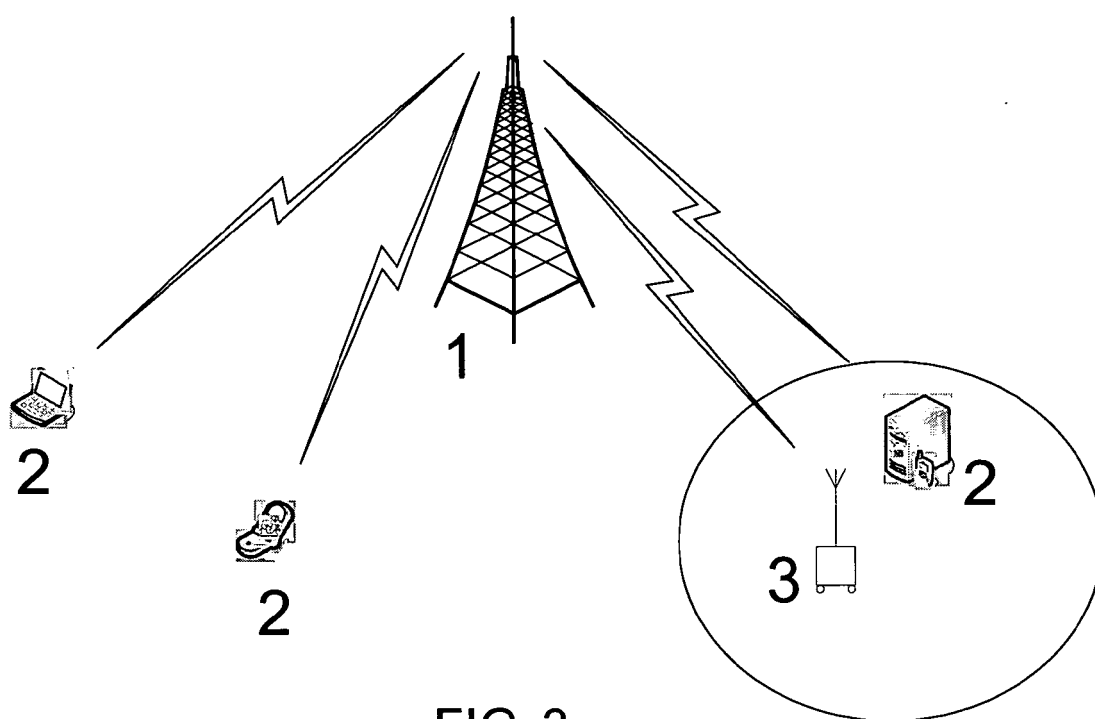


FIG. 3

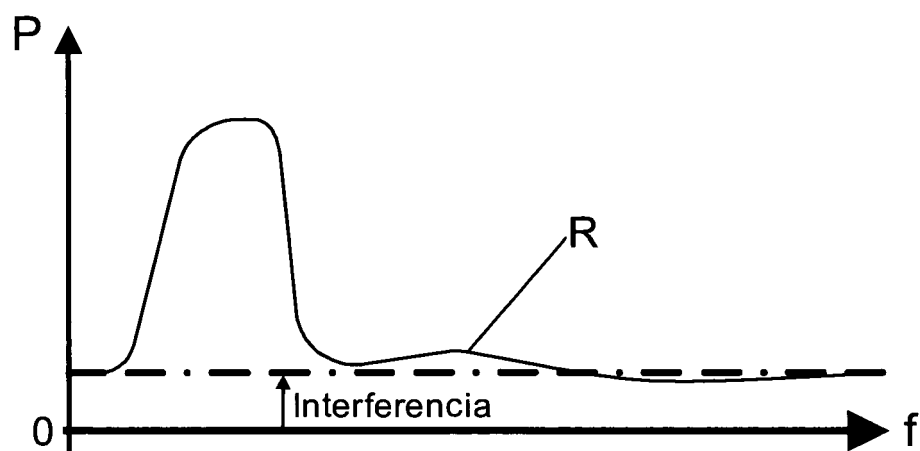


FIG. 4

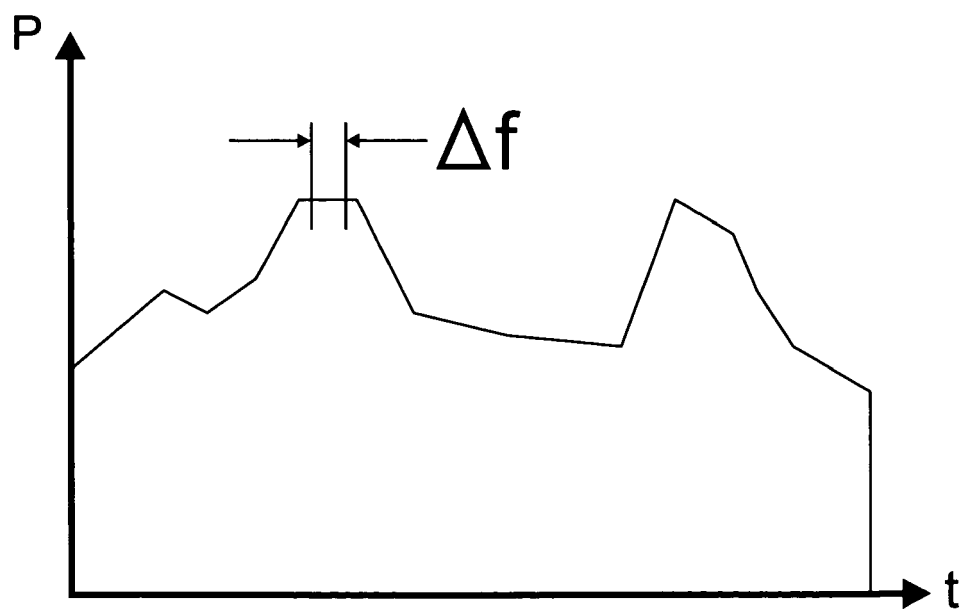


FIG. 5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 38 0325

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 363 421 A (BOOMERANG TRACKING INC [CA]) 19 November 2003 (2003-11-19) * abstract * * paragraph [0001] - paragraph [0004] * * paragraph [0009] - paragraph [0013] * -----	1-4	INV. H04K3/00
A	CA 2 433 242 A1 (NEWTRAX TECHNOLOGIES INC [CA]) 3 January 2004 (2004-01-03) * abstract * * page 1, line 1 - last line * * page 5, line 7 - page 8, line 9 * -----	1-4	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04K G08B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 March 2008	Examiner Liebhardt, Ingo
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03-82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 38 0325

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13-03-2008

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REFERENCES CITED IN THE DESCRIPTION

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