INVENTORY & LOCATION SYSTEM

Methods and apparatus for locating items using transponders called radio frequency identification devices or "RFIDs" (15) are disclosed. In a first embodiment of the invention, a small business like a law firm or doctor’s office can use self-adhesive RFID labels (44) to keep track of files (46) and other objects.
Inventory & Location System

TECHNICAL FIELD

The present invention pertains to methods and apparatus for object location, inventory management, asset tracking and building marketing databases. More particularly, one preferred embodiment of the invention employs wireless radio frequency identification "RFID" devices and software to provide a novel business or household object tracking system.

BACKGROUND ART

The business of managing and tracking assets and goods using wireless radio frequency identification device (RFID) equipment is just beginning to find application in commercial markets. In general, an RFID is a device which emits a response when it is in the presence of an electromagnetic field. Over the past few decades, RFIDs have been used in combination with labels pasted to the inside covers of books to control the flow of library books. Many items sold by retailers, including articles of clothing and digital recordings like CDs and DVDs are protected with RFIDs that are stuck onto packaging that enclose the recordings.

While RFIDs have been proposed for use in some warehouse or institutional settings to track various items, they generally have not been employed as part of a widely deployed business or household inventory management system. The development of such a system would constitute a major technological advance, and would satisfy long felt needs and aspirations in the inventory control and asset location industries.

DISCLOSURE OF THE INVENTION

The present invention comprises methods and apparatus for locating items using passive transponders called radio frequency identification devices or "RFIDs." In a first embodiment of the invention, a small business like a law firm or doctor's office can use self-adhesive RFID labels to keep track of files and important papers. In a second embodiment, items purchased from a retailer which are already attached to an RFID label are automatically detected and tracked by a wireless sniffer when the purchases are brought home. In a third embodiment, a retailer uses the RFID labels to conduct an automatic wireless inventory. In a fourth embodiment, the retailer uses the same system to reduce losses due to theft of merchandise. In a fifth embodiment, the retailer uses the RFID labels to provide automatic wireless checkout. In a sixth embodiment, the retailer analyzes the inventory of goods within a customer's home to enhance sales and marketing strategies. In a seventh embodiment, the retailer uses the home inventory data to furnish automatic order fulfillment. In an eighth embodiment, the customer uses the portable sniffer to retrieve information about a product stored in an RFID. In another embodiment, labels are stored in a shielded container so that only one label at a time is exposed to the field of radio signals emitted by the sniffer. Yet another embodiment comprises a specialized printer which incorporates an "RFID Splurter." In yet another embodiment of the invention, small dedicated sniffers may be placed in metal file cabinets.
An appreciation of the other aims and objectives of the present invention and a more complete and comprehensive understanding of this invention may be obtained by studying the following description of a preferred embodiment, and by referring to the accompanying drawings.

**A BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 supplies views of a conventional RFID.

Figure 2 exhibits how an RFID functions like a transponder, emitting a response when stimulated or illuminated by an interrogation signal.

Figure 3 reveals internal circuit details of a sniffer.

Figure 4 shows a customer purchasing a roll of RFID labels. Each label has an RFID chip with a memory embedded in the label.

Figure 5 shows the customer applying an RFID label to a file. Each RFID label is has its own unique “serial number,” and is configured to emit a distinctive, identifiable response when stimulated by an interrogation signal.

Figure 6 depicts the file being brought within the active range of an RFID label “sniffer,” which is connected to a personal computer.

Figure 7 is an excerpt from an RFID/Object Database.

Figure 8 illustrates the screen of the personal computer conveying a prompt for the customer to supply a file identification number that will be assigned to the RFID label that has been applied to the file that was just detected.

Figure 9 reveals the same computer screen, which now displays a confirmation of the assignment of a file identification number to the detected RFID file label.

Figure 10 depicts the customer using the software database which contains the RFID serial numbers and their associated file identification numbers. The customer has entered the identification for the file he now wants to find.

Figure 11 portrays the customer as he picks up the portable “sniffer” from its desktop cradle. The database software has instructed the sniffer to search for a particular file.

Figure 12 shows the customer hunting for the lost file with the portable sniffer, which begins to beep louder and louder as it approaches the lost file.

Figure 13 shows the customer as he finds the missing file.

Figures 14 & 15 exhibit a flow chart which characterizes one embodiment of the Invention.

Figure 16 shows a customer purchasing a Skil® Saw at a big hardware store. An RFID label is already attached to the box.

Figure 17 depicts the customer as he enters the front door of this home, carrying the new Skil® Saw. A wireless sniffer positioned on the floor near the front door detects the RFID label attached to the outside of the Skil® Saw, and reports the new purchase to the customer’s personal computer.

Figure 18 reveals the display at the personal computer which has just updated the software
database wirelessly and automatically as a result of the customer bringing the new purchase into the home.

Figure 19 depicts the method of automatic wireless inventory management. Every item on the shelf in the Big Hardware Store is attached to an RFID label. Each RFID is configured to respond to a single inventory signal emitted by a sniffer mounted on the ceiling of the store. Particular items may be located by causing the sniffer to emit an interrogation signal which causes each RFID to emit a unique response.

Figure 20 depicts the method of loss mitigation. A thief who has shoplifted merchandise bearing an RFID label has been stopped by a wireless sniffer mounted above the exit of a retailer.

Figure 21 depicts the method of wireless automatic check-out. Neither the customer nor the sales clerk need remove the items from the shopping cart. All the RFID labels in the cart are detected by a sniffer mounted overhead, and the sales total is reported to the cash register wirelessly and automatically.

Figure 22 provides a view of tallying inbound shipments at a loading dock.

Figure 23 depicts the method of automatic home inventory data mining. All the items in the customer’s house are attached to RFID labels, which are automatically detected by a sniffer or sniffs placed inside the house. A personal computer inside the house keeps track of the inventory of items in the house, and periodically reports the inventory automatically to the retailer via a modem using a conventional telephone line. The retailer and/or his suppliers use this information to analyze their sales and marketing strategies.

Figure 24 depicts the method of automatic order fulfillment. Once the retailer has received home inventory data, he can supply the customer with periodic or specific shipments of items whose stock has run low at the customer’s house. The retailer may arrange to have a supplier ship these goods directly to the consumer.

Figure 25 depicts the method of customer support information. A customer uses a portable sniffer to retrieve a model number, purchase and manufacturing information and phone numbers for technical support, warranty claims and repair information that are stored in the RFID label attached to the television set.

Figure 26 offers a perspective view of a shielded label dispenser.

Figure 27 supplies a view of a sheet of labels protected by two layers of foil.

Figure 28 is an illustration of a printer with an “RFID Splurter.”

Figure 29 provides details of the RFID Splurter within the printer shown in Figure 28.

Figure 30 portrays a file cabinet configured with dedicated sniffers.

Figure 31 furnishes a detailed view of one drawer within the file cabinet shown in Figure 30.
BEST MODE FOR CARRYING OUT THE INVENTION

1. Overview of the Invention

The present invention comprises methods and apparatus for locating items using transponders called radio frequency identification devices or "RFIDs." In a first embodiment of the invention, a small business like a law firm or doctor's office can use self-adhesive or other kinds of RFID labels to keep track of files and important papers. In a second embodiment, items purchased from a retailer which are already attached to an RFID label are automatically detected and tracked by a wireless sniffer when the purchases are brought home. In a third embodiment, a retailer uses the RFID labels to conduct an automatic wireless inventory. In a fourth embodiment, the retailer uses the same system to reduce losses due to theft of merchandise. In a fifth embodiment, the retailer uses the RFID labels to provide automatic wireless checkout. In a sixth embodiment, the retailer analyzes the inventory of goods within a customer's home to enhance sales and marketing strategies. In a seventh embodiment, the retailer uses the home inventory data to furnish automatic order fulfillment. An eighth embodiment, sniffers are employed in a secure vault to assure the integrity of chain of custody of items of evidence in legal proceedings. In a ninth embodiment, the customer uses the portable sniffer to retrieve information about a product stored in an RFID. In a tenth embodiment, RFID labels are stored in a shielded enclosure to keep the labels from being exposed to the sniffer's radio signals before they are deployed. In an eleventh embodiment, office machines are configured with an RFID "splurter" which is capable of deploying RFID chips on sheets of paper as they emerge from printers, copiers, fax machines and other paper appliances. A twelfth embodiment provides a solution for automatically finding files in a file cabinet.

2. Preferred & Alternative Embodiments of the Invention

In general, a conventional RFID 10 is a relatively small, thin, planar device comprising a substrate 12 and a conductor 14 as depicted schematically in Figure 1. The conductor 14 may be configured as a spiral, some other different continuous pattern, or a set of separate conductors.

A newer version of the RFID is a passive integrated circuit or chip 15 which is capable of storing a unique serial number or some other identifying information. This serial number may be associated with other information using a software database. In general, all the older forms of the RFID 10 are not incorporated in a chip, emit an identical response when stimulated by an external radio signal, and do not include a memory. In general, the newer forms of RFIDs 15 which are incorporated in an integrated circuit or chip are specifically designed to store a unique serial number in an onboard memory, and, therefore, enable the emission of a unique response when illuminated by a stimulating radio signal. In some embodiments of the invention, an RFID 15 may also be incorporated directly into the surface or body of a product during the manufacturing process.

Passive RFIDs do not require a power source like a battery. One embodiment of the invention generally utilizes passive RFIDs 15 having no onboard power supply like a battery or solar cell, although
some situations may call for the use of an active, powered RFID. Generally planar, limited-life batteries may be combined with the RFID during the manufacturing process. In general, RFIDs are transponders which emit a response signal when they are interrogated, stimulated or illuminated by an external signal. Although the preferred embodiment of the invention employs transponder devices which operate in the radio frequency bands, other transponders that may employ acoustic, ultrasonic, infrared or other optical signals or any other kind of sensible response may be utilized to practice the invention. In the simplest terms, an RFID takes some of the energy of an external signal, and converts it to a particular emanation or reflection that can be sensed by a transceiver or detector. In general, the present invention may employ any type of transponder means like an RFID which responds to an external signal that is intended to find an item which may not be found, enumerated or tracked easily using the sense of sight because it is lost, misplaced or otherwise difficult to locate or account. In this Specification and in the Claims that follow, this detector is usually called a “sniffer or reader” 16. This sniffer is usually automatic, and may be wired or wireless. In this Specification and in the Claims that follow, the term “sniffer” refers to any device or means which is able to emit a radio signal that stimulates a response in an RFID. In some embodiments of the invention, the sniffer is also able to receive this RFID response or return signal. This response may only be a weak reflection or regeneration of the original interrogating signal from the sniffer. The sniffer 16 may be powered by batteries, or may require a standard cable and plug for a 110VAC (in the U.S.) electrical outlet. In one embodiment of the invention, the sniffer communicates wirelessly with a personal computer.

In an alternative embodiment of the invention, the sniffer and the personal computer which runs the database may be combined into a single specialized unit or appliance for finding objects. This device may comprise any portable means which would conveniently serve as both the sniffer and the repository of the RFID database. In this embodiment, a single enclosure houses both the sniffer and the computer which maintains the database.

In this Specification and in the Claims that follow, the terms “RFID” or “transponder” generally comprise any device, apparatus, method or means, whether passive or active, which enables a first signal, wave or field to be varied, reflected, returned, emitted, emanated or propagated in a way that enables the remote detection, sensing or identification of a particular item. Each RFID 15 may be manufactured with a different serial number burned in its memory, so that each uniquely configured RFID in a set of many RFIDs will return a unique signal when they each encounter the external signal. The invention may also utilize RFIDs that are configured so that they all simultaneously respond to a single “all-hands” or “inventory” signal.

An RFID chip currently manufactured by Hitachi, called the “mu-chip,” and its improvements and variations, may be utilized to implement the various embodiments of the invention.

In a preferred embodiment of the invention, a sniffer is a wireless device which emits a generally continuous “interrogation” radio frequency signal. The effective range of the sniffer may be a few feet, or
may encompass a large range to incorporate a single room, an entire house, or a very large retail store. The area of operation of the sniffer comprises an interrogation zone. As shown in Figure 2, a sniffer 16 generally includes a transmitter 18 that is capable of emitting this interrogation signal 20. When each RFID 15 within the operating range of the sniffer 16 emits its unique response 22, a receiver 24 within the sniffer 16 detects all of these responses. In the preferred embodiment of the invention, the sniffer is also capable of communicating wirelessly with a personal computer using a personal computer transmitter/receiver 28. The personal computer is loaded with database software which associates the unique RFID serial number with identifying information about the object or item which is attached to a particular RFID label. While a preferred embodiment of the invention uses database software which runs in the background and which is invoked with a few simple keystrokes, any means storing associations among RFID serial numbers and object descriptions may be employed to practice the invention. Based on instructions from the computer user, the database software can instruct the sniffer to listen only for one particular response signal, which enables the user to find a particular item using the sniffer.

Figure 3 is a schematic diagram showing the generalized circuit details of one embodiment of a sniffer 16. An external antenna 26 is coupled to circuit stages which generate an interrogation signal, receive RFID response signals, and communicate with a personal computer. In alternative embodiments, the sniffer 16 may communicate with other devices, such as personal digital assistants, televisions, telephones or kitchen appliances such as refrigerators. Other sections of the sniffer’s internal circuitry may include a control chip, a memory 30, a contact chip 32, an audio beeper 34, a file found button 36, and a rechargeable battery. In one embodiment, the sniffer is powered by a battery which receives power through contacts 38 that mate with similar contacts on the sniffer’s desktop cradle.

3. First Embodiment: Finding Files in an Office

In a first embodiment of the invention, a small business like a law firm or doctor’s office can use self-adhesive RFID labels to keep track of files, papers, equipment or other objects, items or things.

As shown in Figure 4, a customer 40 purchases a roll of self-adhesive RFID labels 44 at an office supply or retail store 42. Each of these labels has an RFID integrated circuit or chip 15 embedded in it, or otherwise attached to it. Each chip 15 has a memory, and a unique serial number or other identifying information is permanently stored in this memory. The size of the RFID chip 15 shown in Figure 4 is greatly exaggerated. While a preferred embodiment of the invention utilizes labels with a pre-applied sticky backing which is ready to apply to an object, any label, paper, card, Velcro® strips, or other material which can serve as a carrier for the relatively small RFID chip may be employed to practice the invention. As an alternative, a bare RFID chip may be glued, bonded or otherwise affixed to an object without a label, but this alternative is generally less convenient than using a label. The RFID may also be embedded in an object. In an alternative embodiment of the invention, the customer can use RFID label software to print his own labels using a printer that employs conductive ink.
Figure 5 shows the customer 40 applying an RFID label 45 to a file 46 or other object that he wishes to track. In this Specification and in the Claims that follow, an RFID label is generally described as being attached to an object which a customer wishes to track. The term “object” encompasses any device, article or physical entity which the user may at some time seek to find. The term “attached” generally refers to any affixing, installation, adhesion, or other physical coupling that occurs between an RFID label and its object.

In one embodiment of the invention, the RFID labels are kept out of the effective range of the sniffer until they are ready to be attached to objects. In one embodiment, labels may be shielded from the radio field emanated by the sniffer by a conductive cover or enclosure. This method prevents the sniffer from detecting new labels which are not yet recorded in the database until the user is ready to deploy them on objects.

Figure 6 depicts a table 47 in the customer’s home or office 48. In general, the customer will try to find a file or object within a generally limited or bounded zone or space, such as in an opened file cabinet drawer, in a storage area, or in a cubicule or room within a building. Since the sniffer emits radio waves of limited strength, the sought object bearing an RFID must generally be located with an expected “detection zone.” In general, a detection zone is any space or region bounded or limited by the effective range of the sniffer. A personal computer 50 on the table 47 is attached by a USB cable 52 to a sniffer cradle 53 that holds and powers a sniffer 16. While a specific embodiment of the invention is described which utilizes a personal computer to maintain a database, any suitable device or appliance which can hold the database and communicate with the customer, the sniffer and the RFIDs may be utilized to implement the present invention. In one embodiment, the connection between the personal computer and the sniffer may be a wireless connection that uses WiFi (802.11b), Bluetooth, or a 900 MHz band transceiver, or some other wireless communication means. In a preferred embodiment, the customer has installed database software on the personal computer 50 which associates a set of RFID serial numbers to information supplied and input by the customer. An illustrative excerpt from the database is depicted in Figure 7. The left column of the database lists unique serial numbers, which are permanently configured in each RFID at the factory. The right column is a description of an item to which an RFID has been affixed. This description is provided by the user.

When the file bearing the RFID label 54 is brought within the operating range of the desktop sniffer 16 for the first time, the sniffer detects the new label, and reports its presence to the database software. Figure 8 shows the screen of the personal computer 50, which now displays a message or prompt 56A on the computer screen 51 for the user to enter some identifying information about the object to which he has just attached an RFID label. Since the object in this case is a file containing important papers, the software requests the user to enter a “file identification number.” As shown in Figure 9, the user responds 56B to the prompt by entering file ID number “XYZ123.” The software then automatically associates this RFID with the serial number on the RFID to which it is attached. Once this association is stored in the
database, the software determines that this particular RFID label is no longer new. After this event occurs, a response signal from the RFID that is detected by the sniffer will generally be ignored, so that the software no longer identifies this RFID as a “new” RFID which requires user intervention and identification.

At some time in the future, the customer has lost or misplaced file XYZ123. He then turns to the database software for assistance. In one embodiment, the software is running in the background, but is activated with a few simple keystrokes that cause a new window or box to be generated on the computer display. Figure 10 shows a query 56C entered by a customer, which requests the database software to find the RFID serial number that is uniquely associated with file XYZ123. The software quickly retrieves the serial number, which has been stored in a file on the personal computer’s hard drive, and issues instructions 58 to the sniffer. These “location instructions” tell the sniffer to emit an “interrogation signal” that will stimulate a response from all the RFIDs within the operating range of the sniffer. The sniffer is adapted to emit a radio signal on a suitable frequency band. Most importantly, the sniffer is instructed to “listen for” only the response of the RFID that is attached to file XYZ123. All other responses are then ignored until the missing file is found.

As shown in Figure 11, the software displays a message 56D which prompts the user to pick the portable sniffer 16 up out of its desk top cradle 53. The sniffer then begins to emit its interrogation signal. The user then walks around the office holding the sniffer. When the response 64 from the missing file with the correct identifying information or serial number is detected, the sniffer begins to emit an audible alarm or beep 66. While the sniffer uses an audible signal in this particular embodiment, the invention may utilize any form of reporting the successful finding of an object which is sought, including any suitable form of audible, visual or other remote signal or alarm.

Figure 12 depicts the user as he “homes in” on the missing file. The missing file is somewhere on the file folder table 60 among the piles of files 62. As the user approaches the missing file, the beeping becomes louder, leading him toward the wayward file. Figure 12 shows the user as he finds the lost file in a stack on another table in the office. The file is found in the illustration shown in Figure 13. Once the file is found, the user can press a button on the sniffer or enter a command at the computer to indicate that the locating process has been successfully completed. This method is not limited to files, but may also be utilized to find objects like staplers, scissors, discs, diaries, glasses, car keys, separate pieces of paper or virtually any other object that may be attached to an RFID label.

Figures 14 & 15 present a multi-page flow chart which illustrates the steps involved in marking an object with a label, and then subsequently finding it.

4. Second Embodiment: Finding Items at Home

In a second embodiment, items purchased from a retailer which are already attached to an RFID label are automatically detected and tracked by a wireless sniffer when the purchases are brought home.
Figure 16 portrays a customer 40 as he leaves a Big Hardware Store 68, carrying his new purchase, a Skil® Saw 70. Figure 17 shows the customer entering the front door 72 to his home. The manufacturer or the retailer has already placed or printed an RFID on the box 70 which encloses the saw. As the customer enters the door 72 to his residence, a sniffer 16 placed on the floor near the doorway detects the new purchase. In a preferred embodiment, this wireless sniffer automatically and continuously emits an interrogation signal 73 that searches for an RFID label which it has never seen before. The user’s house may contain many sniffers, which all communicate wirelessly with a personal computer. A sniffer could even be installed in the user’s car. This mobile sniffer would be able to report new purchases as the car enters the driveway or garage. In each case, the first job of these “front-door” sniffers is to detect new RFID labels once and once only whenever a previously undetected response 22 is received. As described above in Section 3, the database software running on the customer’s personal computer makes an entry in a database as soon as a new RFID, which has a new unique serial number that has never been sensed previously, has been detected for the first time.

Figure 18 exhibits a message 56E displayed on the computer screen 51, which indicates that the new purchase has been automatically logged without any user intervention. This automatic recordation is made possible by the fact that the RFID on the Skil® Saw box 70 contains information about the new saw. This information is reported automatically to the computer. Just as printed barcodes each convey particular information about items or packaging, the present invention allows RFIDs to be used to automatically identify new additions to a household inventory. The invention also enables the composition of a master library of RFID “words” and data, which are uniquely defined and universally utilized to represent fields of information in the database.

In an alternative embodiment of the invention, the “front door” sniffer can be configured to sense RFIDs as they pass out of the house. The location method may be enhanced if each room or closet in the house has its own sniffer.

As RFIDs become more prevalent in the marketplace, some may be directly embedded into the products themselves during manufacturing. As an example, when the plastic handle of the Skil Saw is formed, an RFID may be deployed in the plastic, obviating the need for the subsequent placement of an RFID label on the package.

5. Third Embodiment: Automatic Wireless Inventory

In a third embodiment, a retailer uses the RFID labels to conduct an automatic wireless inventory. Figure 19 provides a general view of the Big Hardware Store 68. Specialized inventory sniffers 76 are mounted on the ceiling. Every item of stock 80 on the store shelves 82 has an RFID label attached. When the sniffers are activated and emit interrogations signal, every RFID responds by issuing a return signal 84. The continuous inventory sniffers 76 are coupled to a local computer, or perhaps to a central, remote computer at corporate headquarters. This method enables automatic, continuous inventory without the
enormous labor cost of a manual inventory. This embodiment of the invention is applicable to any retailer, warehouse, storeroom, factory, court, or legal evidence facility, library or any other site or environment where many items need to be tracked or located.

6. Fourth Embodiment: Loss Mitigation

In a fourth embodiment, the retailer uses the same system to reduce losses due to theft of merchandise. Figure 20 shows an anti-shoplifting sniffer 87 which emits a continuous theft detection signal 88 mounted over a door 90 at the same retailer. Any time a thief 89 steals an article of merchandise 92 attached to an RFID label approaches an exit without having first been purchased, an alarm 95 is activated, and retail staffers 86 respond. A computer running database software is able to keep track of which items leaving the store have been paid for, and of those which have been pilfered. This method provides loss mitigation by reducing shoplifting or theft by employees or vendors. This method may be improved by using RFIDs which have been embedded in the body or surface of the merchandise, rather than simply placing RFIDs on boxes or packaging. As an example, the Skil® Saw described in Section 3 may be manufactured with its RFID embedded in its body or handle.

7. Fifth Embodiment: Automatic Wireless Check-Out

In a fifth embodiment, the retailer uses the RFID labels to provide automatic wireless check-out. Figure 21 depicts a shopper 102 who is ready to ring up the items 106 in her shopping cart 104 at the check-out counter 100 in the Big Hardware Store 68. Every item 106 in the cart 104 has an RFID attached to it. An automatic check-out sniffer 96 mounted overhead is capable of detecting only the items in the shopping cart below it. The sniffer wirelessly totals the purchases by issuing an interrogation signal 98. Each RFID has price information stored in its memory. The sniffer collects the responses 108, and reports the sales data to the cash register 110.

This method may also be employed in the Receiving Department 112. As shown in Figure 22, Delivery detection sniffers 114 issue delivery sensing signals 116 to detect items 120 brought to the store by trucks 118. Unloaded items 122 emanate response signals 124 and greatly simplify the job of store staff 126 charged with the task of accounting for incoming shipments. Sniffers mounted over loading bay doors tally the arrival of goods from suppliers wirelessly and automatically.

8. Sixth Embodiment: Automatic Home Inventory

In a sixth embodiment, the retailer analyzes the inventory of goods within a customer’s home to enhance sales and marketing strategies. Figure 23 depicts a consumer’s house 128. The consumer 129 has purchased items at Big Retailer, a store whose merchandise bears RFIDs. When the consumer brings these items home, home inventory sniffers 130 inside or near the house 128 automatically report the purchases 132 to the personal computer inside the house via a host of RFID return signals 134. In this embodiment...
of the invention, automatic reporting software has been installed on the personal computer. This software automatically compiles a household inventory of all the purchased items 132 in the consumer’s home 128, and submits the inventory to a central computer at Computer Data Mining Co. 140 in electronic reports 138 using a modem and a conventional telephone line. Large computers at Computer Data Mining Co.’s computer center analyze the inventories reported from the homes of many consumers. All this data is analyzed to improve Big Retailer’s sales and marketing methods. The data reported to Big Retailer enables the retailer to better understand brand affinities, purchasing habits and sales demographics. This data may be shared with or sold to Big Retailer’s suppliers. Big Retailer may offer a discount on purchases at its stores for consumers who agree to participate in this home inventory reporting.

9. Seventh Embodiment: Automatic Order Fulfillment

In a seventh embodiment, the retailer uses the home inventory data described in Section 8 to furnish automatic order fulfillment. Once Big Retailer has received home inventory data for specific houses, it is able to automatically fill orders to restock household items that are in short supply. The customer can create a standing order that is filled periodically, or deliveries may be dispatched when supplies run low. The orders may be filled directly by Big Retailer’s suppliers as shown in Figure 24. This figure shows the inventory reports 138 being conveyed to Computer Data Mining Co. 140, which determines that a particular household item is required. An order 142 is then conveyed electronically directly to the manufacturer 144, bypassing Big Retailer completely. The manufacturer 144 ships the ordered goods 150 to the consumer’s home periodically 146 or as needed using couriers 148 like UPS® or Federal Express®, or their own delivery trucks. This method of the invention enables the retailer to generate additional sales without incurring the overhead costs normally associated with stocking the store shelf with merchandise.

10. Eighth Embodiment: Evidence Tracking

The invention also enables inventory or evidence tracking within a room or other specified space or zone. As an example, evidence sealed in bags with attached RFID labels which must be maintained within the confines of a secured room or vault can be continuously tracked by sniffers installed in the vault. Trial judges or other judicial officials may be sure that items stored in this room were never moved before the beginning of a trial, and that the chain of custody is intact.

11. Ninth Embodiment: Retrieving Product Information

In an eighth embodiment, a customer 152 uses the portable sniffer 16 to retrieve information about a product stored in an RFID 15. Figure 25 shows a customer using a sniffer to retrieve information from an RFID attached to a television 154 that needs repair. The RFID may be programmed to store information about the television set, including the model number, manufacturing date, serial number and purchase
information. The RFID can also store phone numbers that the customer can use to obtain warranty or repair service or to obtain technical support.

12. Tenth Embodiment: An RFID Label Dispenser

It is important to regulate the exposure of labels to the radio field emanated by the sniffer 16. As soon as the sniffer detects a label which has never been identified before, it alerts the database software running on the personal computer, and prompts the user to enter identifying information with a pop-up window. The user then enters some information about the object which is affixed to the new label, and this information is matched to the serial number stored in the memory of the RFID. The database software may also be customized to work with the customer’s own particular software, such as the docket software of a law firm, or the file inventory software of some other type of office or business.

In one embodiment, only one label is exposed to the radio waves of the sniffer at a time by storing the labels in a shielded container 156. As an example, the container or canister which envelopes a roll of labels 158 shown in Figure 26 may be shielded with foil, coated with a metallic substance, or may be manufactured from metal. One label 160 can be exposed individually through a slot 161 in the canister.

In an alternative embodiment shown in Figure 27, the labels are stored on a paper or planar substrate which is covered on both sides by a layer of foil. A foil and label assembly 162 is shown in Figure 27, comprising an upper peel-away layer 164 placed over an array of labels 166 which are temporarily adhered to a bottom layer of foil 168.

13. Eleventh Embodiment: RFID Deployment in the Office

An additional feature of the invention is depicted in Figure 28, which depicts a specialized printer 170 which incorporates an “RFID Splurter.” This printer 170 may be a laser, ink jet or any other type of printer which transfers toner, ink or some other image-forming agent to a sheet of paper, plastic, label, envelope, package or some other substrate or material. In this Specification and in the Claims that follow, the term “substrate” includes any generally planar surface or generally flat object which may be imprinted with an image. In this Specification and in the Claims that follow, the term “image” includes any text, pattern, photograph, or any other sensible arrangement of one material affixed or applied to a substrate below it.

One embodiment of the invention comprises a printer 170 which includes a specially configured RFID applicator or splurter that deploys or applies RFID chips and associated objects to the same sheet of paper or substrate. As shown in Figure 28, a printer 170 first creates printed text, a photograph or other image on a sheet of paper 174 using by a primary printer drum or head 172. In an alternative embodiment of the invention, an RFID antenna 176 may be printed on the paper after or while the text or image is printed. The antenna 176 may be printed using a special conductive toner material. After the conventional printing is completed, an RFID chip applicator 178 conveys a single RFID chip 180 from a storage canister 182, and ejects it onto or embeds it into the sheet of paper 174. The final product is a sheet of paper 184.
with an RFID affixed to it 192.

Figure 29 provides some additional detail of one embodiment of the RFID applicator 178. The RFID chips 180 may be deposited or sprayed from a dispenser 182 into a mixer 185 which first mixes it with some other medium, such as a liquid glue, ink or other binding agent 186. The supply of RFIDs may be contained in an enclosure, may be serially deployed on a tape, or otherwise moved, conveyed, fed, injected, extruded, or provided to an applicator using any mechanical means that enables RFID chips to be adhered to a substrate. One RFID is conveyed in a droplet of glue 190 which is emitted from a nozzle or jet 188 toward the paper below.

In an alternative embodiment of the invention, it may be necessary or beneficial to also create an antenna that is mechanically connected or electro-magnetically coupled to the RFID chip. This antenna may be printed or sprayed using conductive ink. The antenna may be formed simultaneously with the application of the RFID, or may be formed in a separate step that occurs before or after the RFID application. In another alternative, the antenna may be pre-formed into the paper that is loaded into the printer.

In another embodiment, an RFID may be applied to an existing, printed document by feeding the existing document into the printer, and then directing the printer to only apply an RFID chip without printing a new image. The RFID applicator may be a stand-alone device whose only function is to apply an RFID chip to a surface or object.

The inventions described in this Specification will enable customers to apply RFIDs directly to printed documents, copies or pages received by facsimile. The novel RFID applying print head may be incorporated into printers, copiers, fax machines, scanners or any other machine that processes paper or other substrates. In another embodiment, RFID chips may be applied directly to a surface using a handheld device that resembles a gun, stapler or tape dispenser.

14. Twelfth Embodiment: A Filing Cabinet Embodiment

In an alternative embodiment of the invention, small dedicated sniffers may be placed in metal file cabinets. This embodiment is intended to overcome the problem encountered when a missing or lost file is sought, but is located in a closed filing cabinet. In general, radio signals are unable to penetrate metal or generally electrically conductive enclosures. Figure 30 portrays a filing cabinet 194 with a dedicated sniffer 196 installed in each drawer 198. Each sniffer 196 is configured to detect RFIDs within its assigned drawer 198. In one embodiment of the invention, this may be accomplished by using directional antennas on each sniffer. As shown in Figure 31, the internal antenna 200 is configured to receive signals from RFIDs inside each drawer. The external antenna 202 is designed to emit collected signals to a computer outside the cabinet 194. In one embodiment, this external antenna 202 emits signals through the slot 204 former by the cabinet 194 and a drawer 198. In another embodiment, the external antenna 202 may extend outside the cabinet through a hole or other orifice or slot.
III. A Small-Scale Embodiment of the Invention

In one embodiment of the invention, RFID's are created, applied, prepared, assembled or configured at the customer's residential, office or business environment; as opposed to being manufactured in a large industrial facility. The RFID's are activated or made functional or usable employing small-scale, non-industrial, desktop-sized equipment that resemble the modest printers and copiers that are already used in conventional home and office environments. These products are generally produced in relatively small, non-industrial scale quantities by this personal, household, customer-based, or small-business equipment. They are used or consumed at that site, and not intended for resale. In general, this specific, home-made or self-made embodiment requires the end-user's intervention or activity, as opposed to a product that is completely assembled and ready-to-use that is fabricated elsewhere.

CONCLUSION

Although the present invention has been described in detail with reference to one or more preferred embodiments, persons possessing ordinary skill in the art to which this invention pertains will appreciate that various modifications and enhancements may be made without departing from the spirit and scope of the Claims that follow. The various alternatives for providing an Inventory & Location System that have been disclosed above are intended to educate the reader about preferred embodiments of the invention, and are not intended to constrain the limits of the invention or the scope of Claims. The List of Reference Characters which follows is intended to provide the reader with a convenient means of identifying elements of the invention in the Specification and Drawings. This list is not intended to delineate or narrow the scope of the Claims.

INDUSTRIAL APPLICABILITY

The present invention is designed to provide a system for assisting a person find an item that they can not see or locate. The invention will find beneficial uses in the a wide variety of home and office environments.
**LIST OF REFERENCE CHARACTERS**

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<td>Thin film substrate</td>
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<tr>
<td>14</td>
<td>Metal coil</td>
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<tr>
<td>15</td>
<td>RFID chip with unique serial number stored in memory</td>
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<td>16</td>
<td>Sniffer</td>
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<td>18</td>
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<td>Response receiver</td>
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<td>Antenna</td>
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<td>32</td>
<td>Contact chip</td>
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<td>34</td>
<td>Audio beeper</td>
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<tr>
<td>36</td>
<td>File found button</td>
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<tr>
<td>38</td>
<td>Power contacts for cradle</td>
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<tr>
<td>40</td>
<td>Customer</td>
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<td>42</td>
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<td>47</td>
<td>Computer table</td>
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<td>48</td>
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<td>50</td>
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<td>Computer screen</td>
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<td>USB cable</td>
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<td>56</td>
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<td>58</td>
<td>Instructions from computer to reader</td>
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<td>File folder table</td>
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<td>Piles of files</td>
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<td>63</td>
<td>Misplaced file</td>
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<tr>
<td>64</td>
<td>Response from label on misplaced file</td>
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</table>
Audible alarm
Hardware store
New purchase
Doorway
Continuous interrogation signal
Hardware store shoppers
Multiple inventory sniffsers mounted on ceiling
Interrogation “all-hands” signal for continuous inventory
Products in store
Store shelves
RFID response signals
Store clerk
Anti-shoplifting sniffer
Anti-shoplifting interrogation signal
Shoplifter
Store exit
Pilfered item
Response signal from pilfered item
Alarm for theft detection
Check-out sniffer
Check-out interrogation signal
Check-out counter
Customer at check-out counter
Shopping cart
Item in cart with RFID
Response signal from item in cart
Check-out register
Store Receiving Department
Receiving dock sniffer
Interrogation signal for off-loaded items
Delivery truck
Box on truck
Box on dock offloaded from truck
Response signal from box on dock
Worker on dock
Consumer’s house adapted for product data-mining
Consumer consenting to automatic home inventory
Automatic home product inventory sniffer
Products in house
Home product inventory return signal
Automatic inventory signals conveyed to data-mining computer
Data-mining facility
Automatic product order based on automatic inventory
Product manufacturer
Automatic order fulfillment delivery
Courier
Order arrives at consumer’s premises
Customer using sniffer to obtain warranty information
Broken appliance
Shielded container
Roll of labels with RFIDs inside shielded container
Labels exposed to sniffer radio signals one at a time
Slot in shielded container
Sheet of foil-protected labels
Top layer of foil
Labels in center layer
Bottom layer of foil
Printer with splurter
Printer drum
Paper
Printed RFID antenna
RFID chip applicator
RFID chip
RFID canister
Applied RFID on paper
Mixer & dispenser
Glue
Nozzle
Emitted droplet of adhesive with RFID
RFID affixed to paper
File cabinet
Drawer dedicated sniffer
198  Drawer
200  Directional RFID antenna
202  External antenna for communication with computer
204  Slot in file cabinet
CLAIMS

What is claimed is:

1. A method comprising the steps of:

   using a wireless sniffer means (16) for producing an interrogation signal (20) in a detection zone;
   said wireless sniffer means (16) also for communicating with a personal computer means (50) for
   running a database software means (55) on said personal computer means (50) to track an object
   in said detection zone;

   introducing a wireless transponder means (15) for responding to said interrogation signal (20) into
   said detection zone; said wireless transponder means (15) being physically associated with an
   object;

   using said wireless sniffer means (16) to receive a return signal (22) generated by said wireless
   transponder means (15) in response to said interrogation signal (20); and

   reporting the presence of said wireless transponder means (15) in said detection zone.

2. A method as recited in Claim 1, in which said wireless transponder means (15) is a radio frequency
   identification device (RFID).

3. A method as recited in Claim 2, in which said radio frequency identification device (15) stores unique
   identifying information.

4. A method comprising the steps of:

   manually applying a wireless transponder means (15) to an object; and

   finding said object using a audible signal generated by a portable wireless sniffer (16) which has
   received location instructions from a personal computer (50) running a database software program
   (55) that tracks said object.
5. A method as recited in Claim 4, in which said object is a file (46) in an office.

6. A method as recited in Claim 4, in which said object is a household item.

7. A method as recited in Claim 1, in which said interrogation signal (20) generated by said wireless sniffer means (16) which communicates with said database software means (55) running on said personal computer means (50) which communicates with a remote computer (140), which enables home automated inventory.

8. A method as claimed in Claim 1, in which a plurality of said return signals (134) is compiled to produce an automatic wireless inventory.

9. A method as claimed in Claim 1 comprising the additional steps of:

   using said wireless sniffer means (16) to detect the departure of an object from said detection zone; and

   communicating said departure of said object to said personal computer means (50).

10. A method as recited in Claim 9, which is used to enable automatic order fulfillment.

11. A method as claimed in Claim 9, in which a retailer detects said departure of said object from a detection zone to generate an alert to reduce losses due to theft of merchandise.

12. A method as claimed in Claim 1 comprising the additional steps of:

   using said wireless sniffer means (16) to detect the continuous presence of an object in said detection zone; and

   communicating a record of continuous presence of said object to said database software means (55) running on said personal computer means (50) to enable automatic object tracking.

13. A method as recited in Claim 12, in which said object is an item of evidence in a legal proceeding whose chain of custody must be preserved.

14. A method as claimed in Claim 9, in which a retailer detects said object to generate a sales total to enable automatic check-out.
15. A method as claimed in Claim 9, in which a retailer detects an arrival of an object to enable automatic receiving tallies of shipped goods.

16. A method as claimed in Claim 9, in which said portable sniffer means (16) is used to retrieve information about a product stored in said wireless transponder means (15).

17. A propagated signal; said propagated signal being characterized by a response from a radio frequency identification chip (15); said radio frequency identification chip having a memory; said memory storing a unique identification; said unique identification being used to locate an object attached to said radio frequency identification chip (15) when said chip is illuminated by an external radio signal; said external radio signal being emitted by a portable sniffer (16); said portable sniffer (16) receiving a set of instructions from a computer program stored on a computer (50).

18. A method for sensing an object comprising the steps of:

   maintaining a database (55) on a computer (50);

   attaching an RFID chip (15) to an object; said RFID chip (15) having a memory; said RFID chip (15) having a unique identification number stored in said memory; said RFID chip (15) being generally exposed to radio signals just before it is applied to said object;

   associating an object with a particular RFID chip identification number in said computer database (55) using a sniffer (16); said sniffer (16) for emanating a radio signal which generates a response from said RFID chip (15); said sniffer (15) also for receiving an RFID response (22); and

   detecting said object by looking up said RFID chip identification number in said computer database (55); by instructing said sniffer (16) to listen for a response signal (22) from said RFID chip (15) with a specific identification number; and by moving said sniffer (16) in an area to locate said object by following audible tones emitted by said sniffer (16) when said object is approached.

19. A method as recited in Claim 18, in which said object is a file (46).
20. An apparatus for shielding a label from radio signals prior to attachment to an object comprising:

an enclosure (156);

said enclosure (156) having an inner chamber suitable for storing a supply of labels (158);

said enclosure (156) being formed from a material which shields said supply of labels (158) stored within said enclosure (156) from being detected by a radio signal.

21. An apparatus for shielding a label from radio signals prior to attachment to an object comprising:

a first conductive layer (164);

a second conductive layer (168);

a label (166); said label (166) being generally situated between said first and said second conductive layers (164, 168) prior to being attached to said object.

22. An apparatus for detecting an object in a generally conductive container comprising:

a sniffer (16); said sniffer (16) being located within said generally conductive container; said sniffer (16) for emitting a radio signal; said sniffer (16) also for receiving a response from an RFID chip (15) inside said generally conductive container; and

an external receiver; said external receiver being located outside said generally conductive container; said external receiver for receiving a wireless signal from said sniffer (16) to report the location of said object.

23. A method as recited in Claim 22, in which generally shielded container is a file cabinet (194).

24. A method as recited in Claim 22, in which said external receiver is a computer (50).
25. A method comprising the steps of:

providing a generally planar substrate means (174);

conveying a transponder means (15) to said generally planar substrate means (174) after an image is formed on said planar substrate means (174);

said transponder means (15) then adhering to said generally planar substrate means (174).

26. A method as recited in Claim 25, in which said generally planar substrate means (174) is capable of receiving a printed image.

27. A method as recited in Claim 25, in which an image is printed on said generally planar substrate means (174) prior to said transponder means (15) being adhered to said generally planar substrate means (174).

28. A method as recited in Claim 25, in which an image is printed on said generally planar substrate means (174) after said transponder means (15) is adhered to said generally planar substrate means (174).

29. A method as recited in Claim 25, comprising the additional step of:

forming an RFID antenna (176) on said generally planar substrate means (174).

30. A method as recited in Claim 29, in which said antenna (176) is mechanically connected to said transponder means (15).

31. A method as recited in Claim 29, in which said antenna (176) is electrically coupled to said transponder means (15).

32. A method as recited in Claim 25, comprising the additional step of:

conveying said transponder means (15) to said generally planar substrate means (174) in a printer (170).
33. A method as recited in Claim 25, comprising the additional step of:

conveying said transponder means (15) to said generally planar substrate means (174) in a copier.

34. A method as recited in Claim 25, comprising the additional step of:

conveying said transponder means (15) to said generally planar substrate means (174) in a facsimile machine.

35. A method as recited in Claim 25, comprising the additional step of:

conveying said transponder means (15) to said generally planar substrate means (174) in a scanner.

36. A method as recited in Claim 25, comprising the additional step of:

conveying said transponder means (15) to said generally planar substrate means (174) in a stand-alone device whose only function is to apply said transponder means (15) to said generally planar substrate means (174).

37. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174) for use by the customer.

38. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174), and said transponder means (15) is generally made usable by the customer.

39. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174) for use in a residential environment.

40. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174) for use in an office environment.

41. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174) and is intended for use at the same site.
42. A method as recited in Claim 25, in which said transponder means (15) is adhered to said generally planar substrate means (174) and is not intended for resale.

43. A method as recited in Claim 25, in which a plurality of said transponder means (15) are adhered to a plurality of generally planar substrate means (174) in relatively small, non-industrial quantities.

44. A method as recited in Claim 25, in which a plurality of said transponder means (15) are adhered to a plurality of generally planar substrate means (174) by the same person who will use said transponder means (15) to locate objects owned by that person.

45. A method comprising the steps of:

   providing a generally planar substrate means (174);

   conveying an RFID chip (15) to said generally planar substrate means (174);

   said RFID chip (15) then adhering to said generally planar substrate means (174).

46. An apparatus for finding an object comprising:

   a generally handheld and portable enclosure;

   a sniffer (16); said sniffer (16) being housed within said enclosure; said sniffer (16) for emitting a radio signal for stimulating a return signal (22) from an RFID (15); and

   a computer (50); said computer (50) being housed within said enclosure and being connected to said sniffer (16); said computer (50) including an alarm;

   said computer (50) including a memory; said memory including database software (55) for storing an association between an object and an RFID identification number;

   said alarm being activated when an object which is sought is located.

47. A method as recited in Claim 1, in which said wireless transponder means (15) is embedded in an object.
48. A method as recited in Claim 1, in which said wireless transponder means (15) is passive.

49. A method as recited in Claim 1, in which said wireless transponder means (15) includes a power supply.
Fig. 14

User needs to find object; alerts database software by entering "CONTROL + F" → Database software responds with prompt window requesting identifying information → User enters text describing sought object, then "ENTER" → Database software searches for this text in database entries, finds all matching entries

Install database software → Connect sniffer to computer or place near computer (if wireless connection) → Expose single label to single object and affix exposed label to object → Sniffer detects exposed label and prompts user for information → User enters identifying information identifying object
Sniffer receives response signals from all RFID's, but "listens" for only the response signal which contains selected RFID serial number → When response signal with selected serial number is acquired, sniffer emits audible alarm which grows in volume as sniffer approaches source → When user finds lost object, user depresses "File Found" button and the alarm stops

Matching entries are displayed on screen; user selects one → Database software retrieves RFID serial number of selected object and sends it to sniffer → Sniffer emanates "all-hands" signal that causes all RFID's in sniffer range to respond
Hey!

You bought a new Skil® saw! Cool! I'll keep track of that for you.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : G08B 13/14  
US CL : 340/568

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. : 235/472.01; 156/265; 364/403; 280/47.34; 340/572

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)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>US 6,318,636 B1 (REYNOLDS et al.) 20 November 2001, col. 3, line 43 to col. 6, line 52.</td>
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<td>Y</td>
<td>WO 99-05658 (BOWERS) 04 February 1999 (04.0299), line 19, page 15 to page 28, page 16; lines 9-16, page 23.</td>
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<td>US 4,636,950 A (CASWELL et al.) 13 January 1987 (13.01.1987), col. 4, line 19 to col. 8, line 37.</td>
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<td>US 4,694,283 A (REEB) 15 September 1987 (15.09.1987), col. 4, lines 45-66.</td>
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<td>US 4,720,048 A (MARONEY et al) 19 January 1988, col. 2, lines 13-41; col. 6, lines 42-58.</td>
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**Further documents are listed in the continuation of Box C.**  

**See patent family annex.**

- **A** document defining the general state of the art which is not considered to be of particular relevance.
- **B** earlier application or patent published on or after the international filing date.
- **L** document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified).
- **O** document referring to an oral disclosure, use, exhibition or other means.
- **P** document published prior to the international filing date but later than the priority date claimed.
- **P** document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention.
- **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.
- **Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- **Z** document member of the same patent family.

**Date of the actual completion of the international search**

18 June 2003 (18.06.2003)

**Date of mailing of the international search report**

11 JUL 2003

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703)305-3230

Authorized officer
Michael Horabik
Telephone No. 703-305-3937

Form PCT/ISA/210 (second sheet) (July 1998)
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