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**Roatis et al.**

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(54) **ELECTRONIC SECURITY APPARATUS AND METHOD FOR MONITORING MECHANICAL KEYS AND OTHER ITEMS**

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(75) Inventors: **Calin V. Roatis**, Des Plaines, IL (US);  
**William D. Denison**, Lake Zurich, IL (US); **Gary L. Myers**, Monee, IL (US)

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Correspondence Address:  
**LEYDIG VOIT & MAYER, LTD**  
**TWO PRUDENTIAL PLAZA, SUITE 4900**  
**180 NORTH STETSON AVENUE**  
**CHICAGO, IL 60601-6780 (US)**

(57) **ABSTRACT**

A security container with an electronic lock circuit is used to securely store mechanical keys or other valuable items. Items to be protected are placed in a secured location in the security container. A detector of the security container detects whether the items are indeed in the secured location, such as by means of receiving signals from a transponder attached to the items. The security container is locked only if the items are detected to be in the secured location. Audit trail records for the locking and unlocking events of the security container may be downloaded for analysis. A monitoring device with a location identification device, such as a GPS sensor, may be attached to items to be monitored for tracking locations and activities of the items.

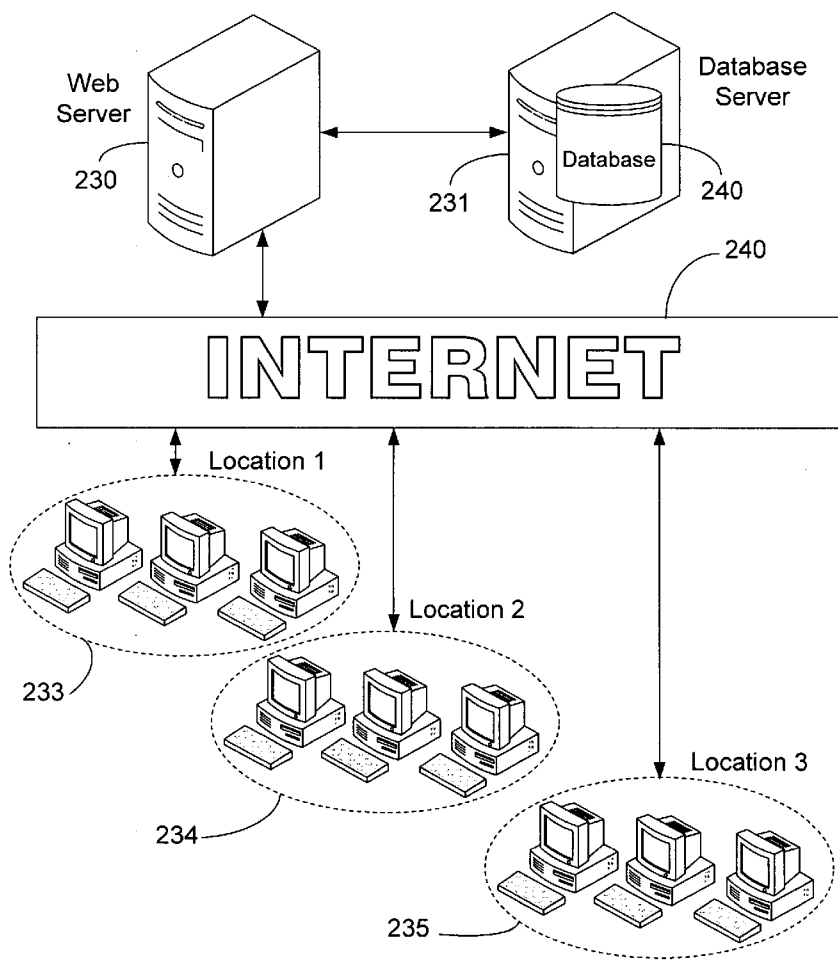
(73) Assignee: **TriTeq Lock and Security, LLC**, Elk Grove, IL (US)

(21) Appl. No.: **11/111,559**

(22) Filed: **Apr. 21, 2005**

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 11/010,661, filed on Dec. 13, 2004.



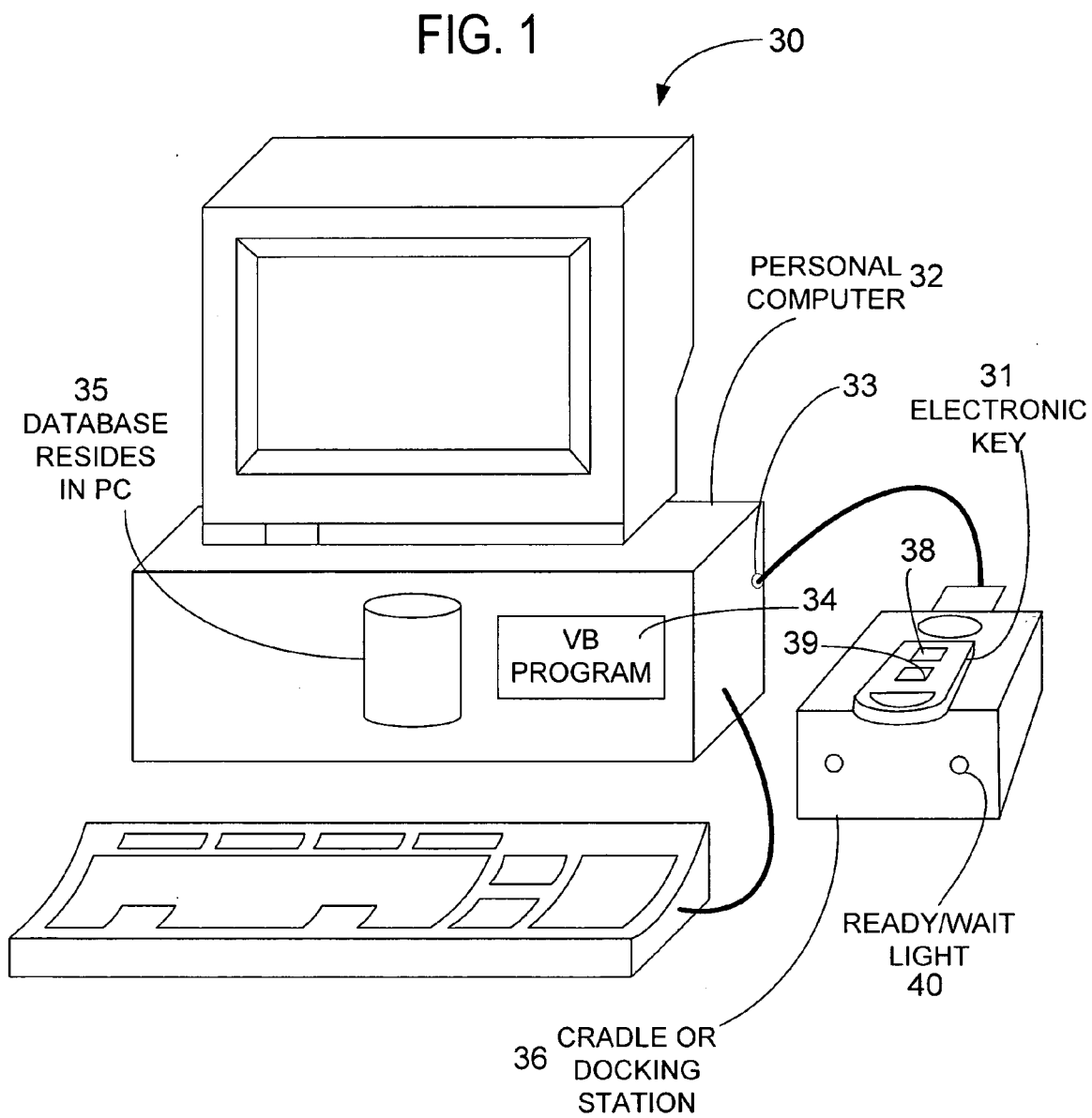


FIG. 2A

43

42

44

45

**Software Registration Menu**

Enter Cradle Label#  CD Software Label:   Check this box  
If you are an independent

Bottler Name:  Business Unit (If applicable):

Market Unit (If applicable):

Contract Name: First and Last:  Address:

City, State  ZIP

Phone: xxx-xxx-xxxx  Fax: xxx-xxx-xxxx

Email:

Step 1. Click here After Entering Above

**Generate System ID#** **Back**

Step 2. If this station is connected to a printer, click on \*Get Registration button to print out your registration, if not, write down all info Shown here and fax it to: 847-640-7008

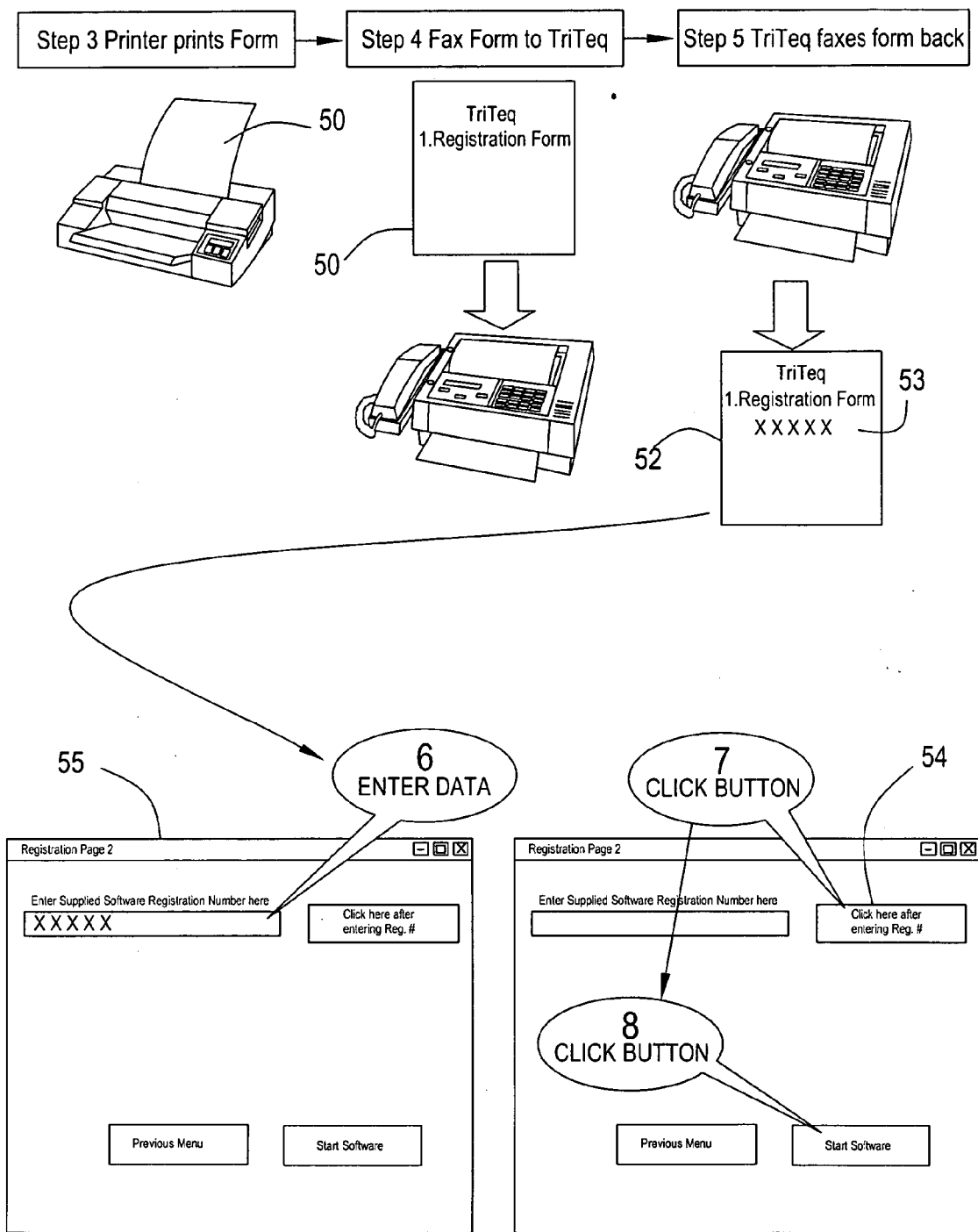
**Get Registration #**

Step 3 Click Here After Receiving Registration #

**Go Next**

REGISTRATION  
Number appears

FIG. 2B



# FIG. 3A

58

The dialog box titled "Enter Password" contains a label "Password" followed by a text input field containing "&&&&&". Below the input field are two buttons: "OK" and "Cancel". A callout line labeled "58" points to the dialog box.

60

The main window titled "AutoTraq PC Interface V-6.5" has a menu bar with "File", "Audit Trails", "Edit Key Limits", "Lock Utilities", "Routes", "Tools", and "Mode". The interface includes several input fields: "Name", "Key ID", "Accesses Allowed", "Accesses Per Day", "Refresh Days", "Expires on", and "Days Valid". It also has "Key Type", "Start Time", and "Stop Time" fields. A checkbox labeled "Cradle Ready for Key FOB" is present. At the bottom are three buttons: "EXIT", "Audit Trails", and "Clear Form". A callout line labeled "60" points to the main window.

FIG. 3B

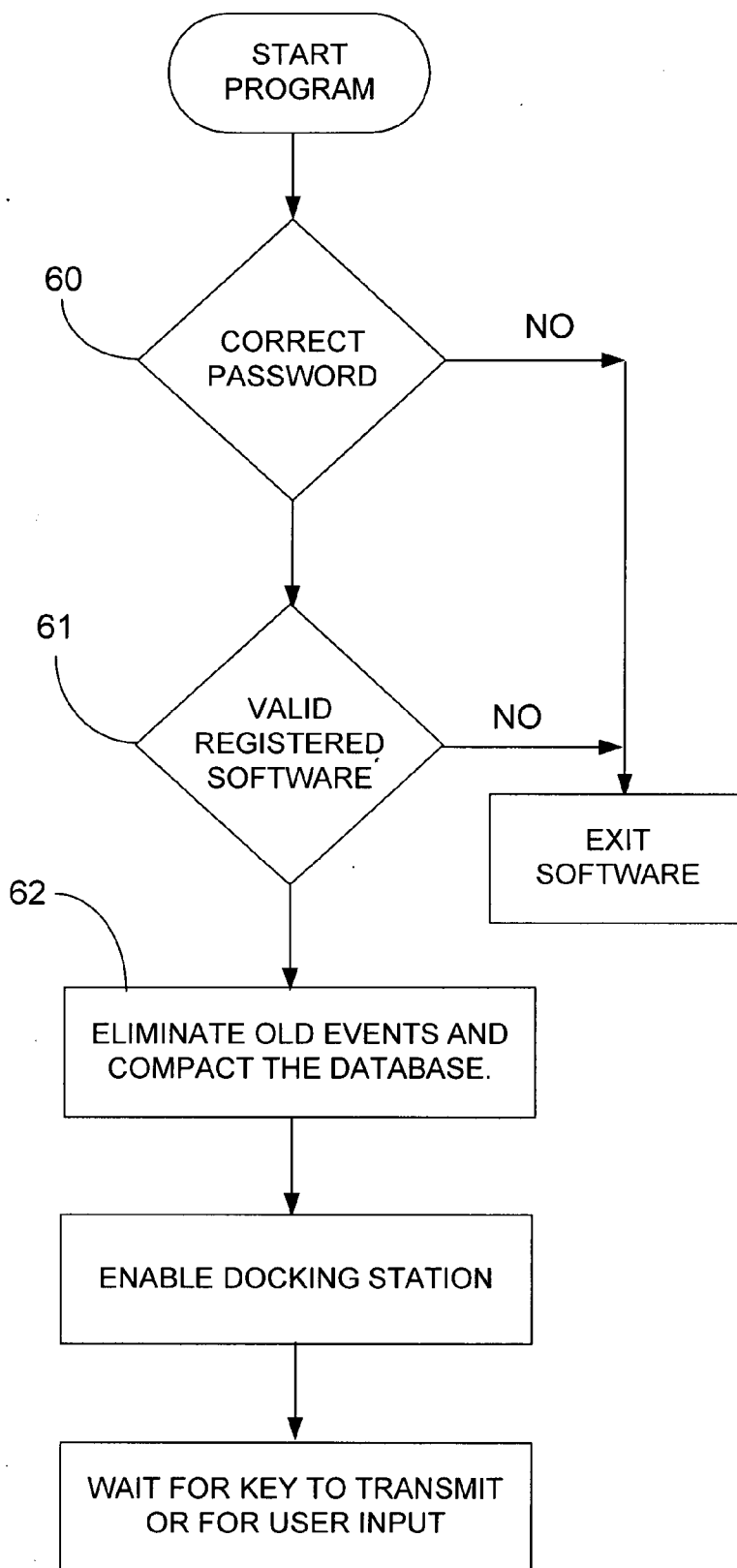


FIG. 3C

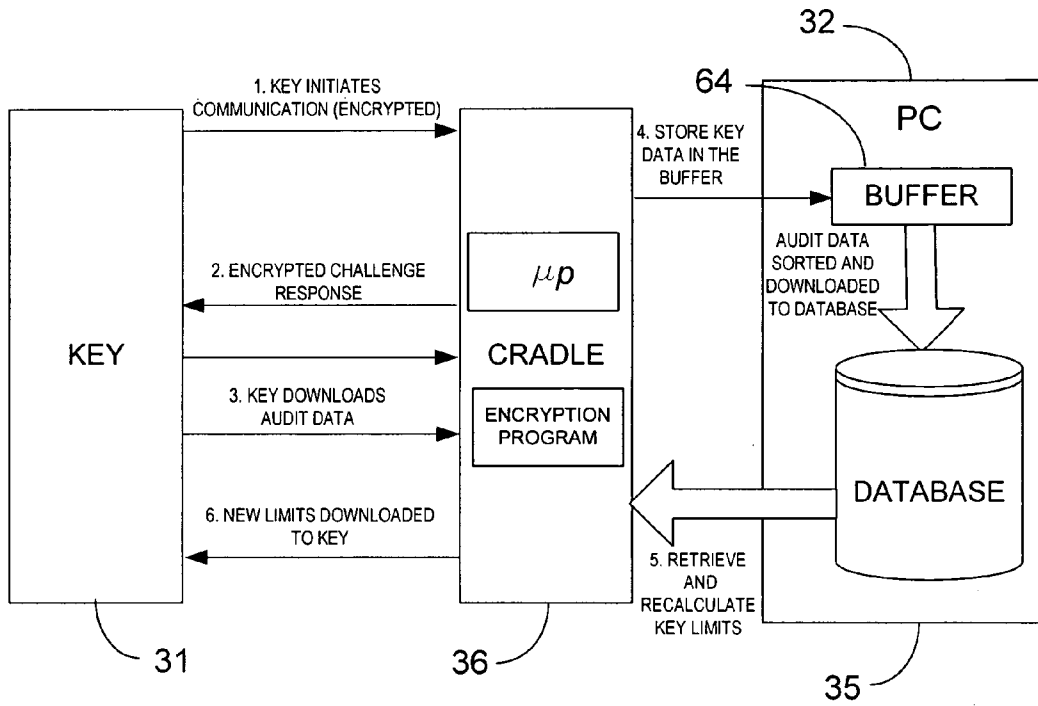


FIG. 4A

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File Audit Trails Edit Key Limits Lock Utilities Routes Tools **Mode**

Name  Key **Administrator**  
**Supervisor**  
 **User**

Key ID

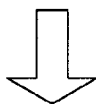
Accesses Allowed  Start Time

Accesses Per Day  Stop Time

Refresh Days

Cradle Ready for Key FOB

**EXIT** **Audit Trails** **Clear Form**



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**AutoTraq PC Interface V-6.5**

**Administrator Password**

ENTER  
ADMINISTRATOR  
PASSWORD

\*\*\*\*\*

**Cancel** **Accept**

Accesses Per Day  Stop Time

Refresh Days

Expires on

Days Valid

Cradle Ready for Key FOB

**EXIT** **Audit Trails** **Clear Form**



FIG. 4B

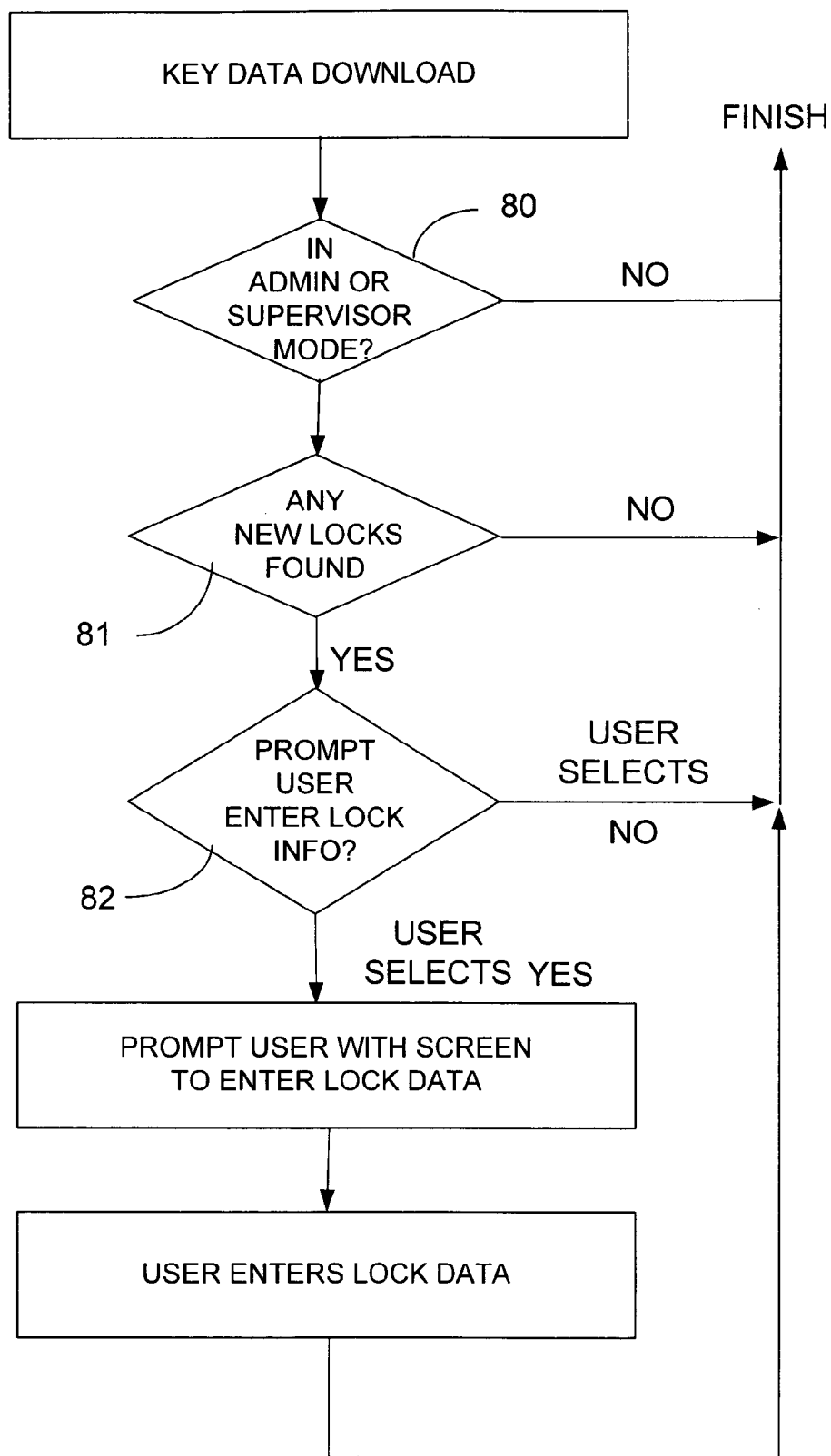


FIG. 5A

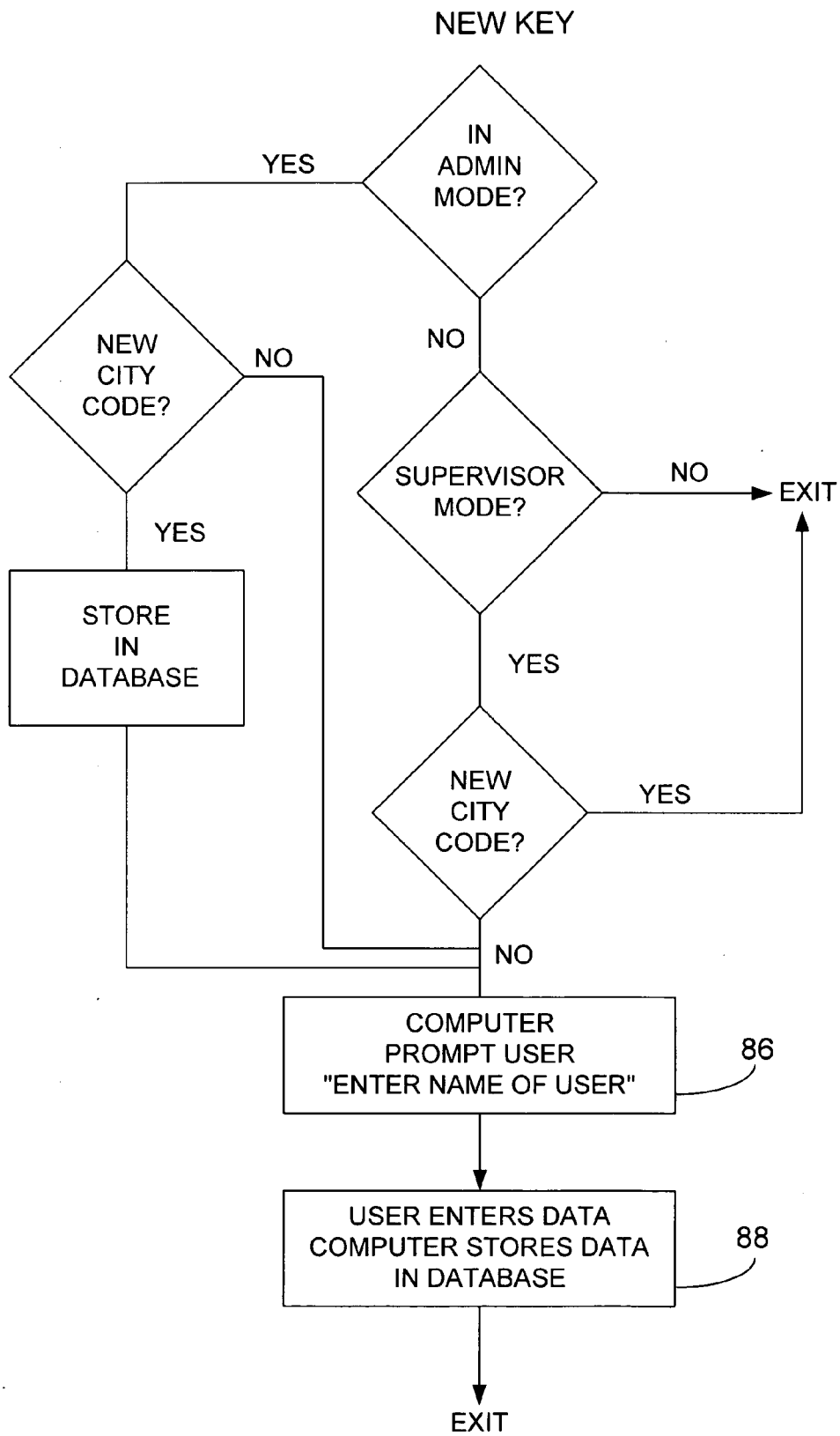


FIG. 5B

90

**NEW ZONE KEY**

Accesses Per Day  Stop Time

Refresh Days

Expires on

Days Valid

Reading number of ATs

93

94



96

**Key Registration Form**

**Name**

**Address**

**City**

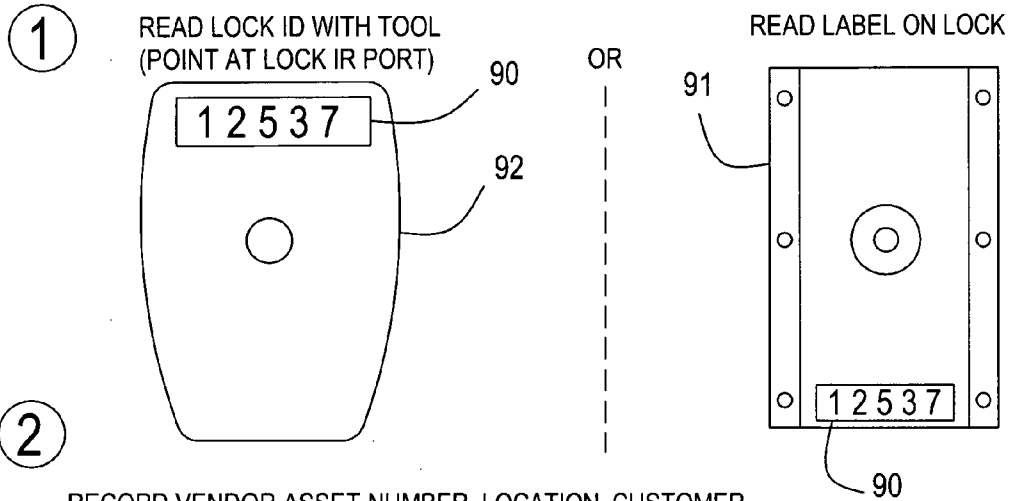
**Zip Code**

**Phone**

**Key ID**

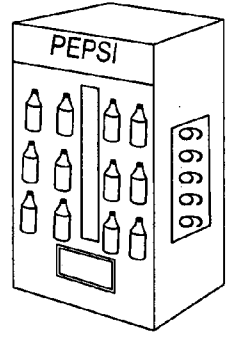
**FIG. 6A**

**RECORDING LOCK ID# & VENDOR DATA  
MANUAL PROCEDURE**



② RECORD VENDOR ASSET NUMBER, LOCATION, CUSTOMER, TIME AND DATE ON PAPER

LOCK ID	ASSET	LOCATION	TIME/ DATE
12537	99999	35TH ST WALMART	6/10/03 9:55 AM



③ ENTER ASSET #, LOCATION/CUSTOMER DATA ON COMPUTER WHEN PROMPTED

ON 6-10-03 AT 9:55 AM,  
LOCK ID # 12357 WAS PUT INTO  
SERVICE. PLEASE ENTER THE  
FOLLOWING DATA:

ASSET NUMBER \_\_\_\_\_

LOCATION \_\_\_\_\_

CUSTOMER \_\_\_\_\_

# FIG. 6B

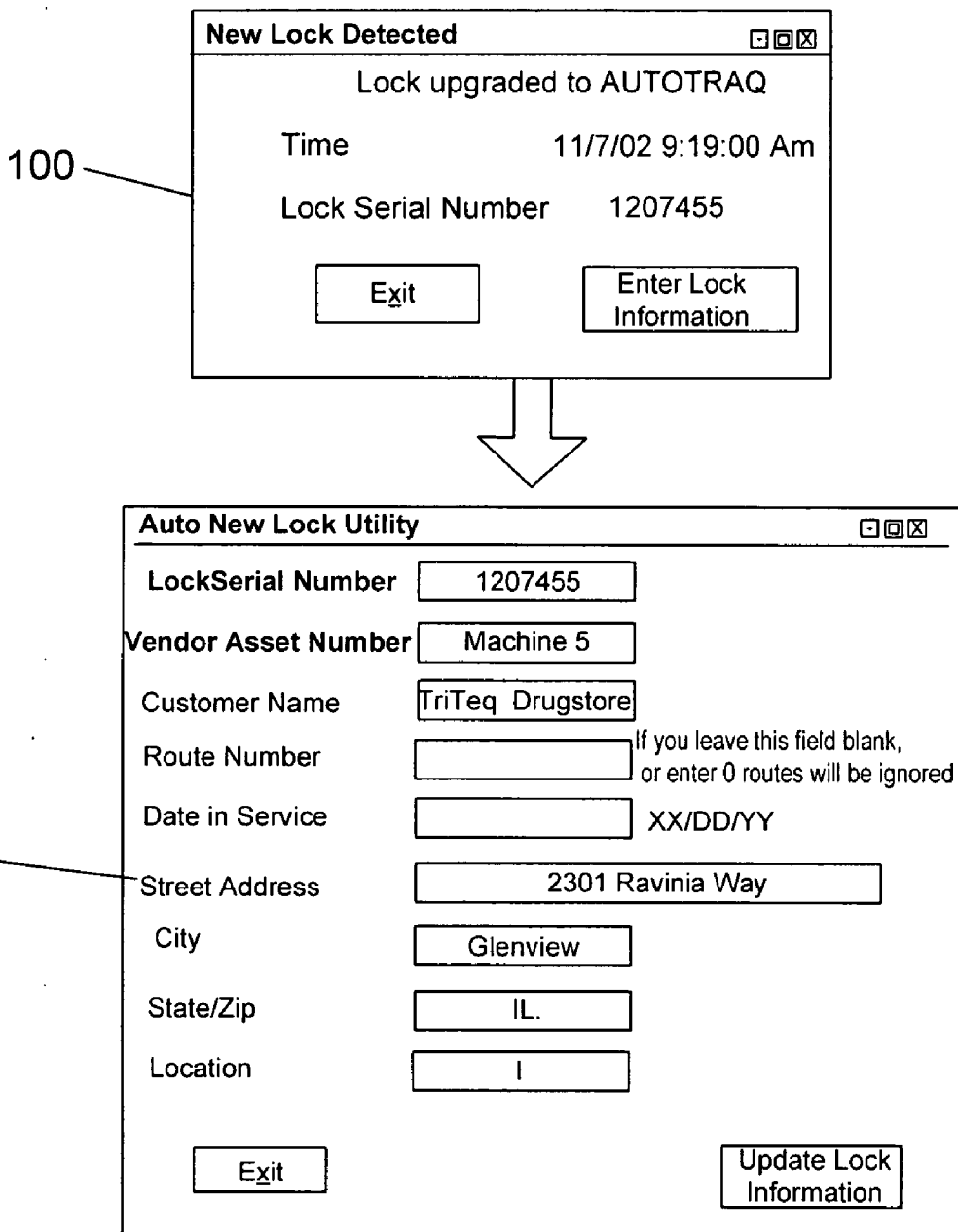


FIG. 6C

RECORDING LOCK ID# & VENDOR DATA  
ELECTRONIC PROCESS

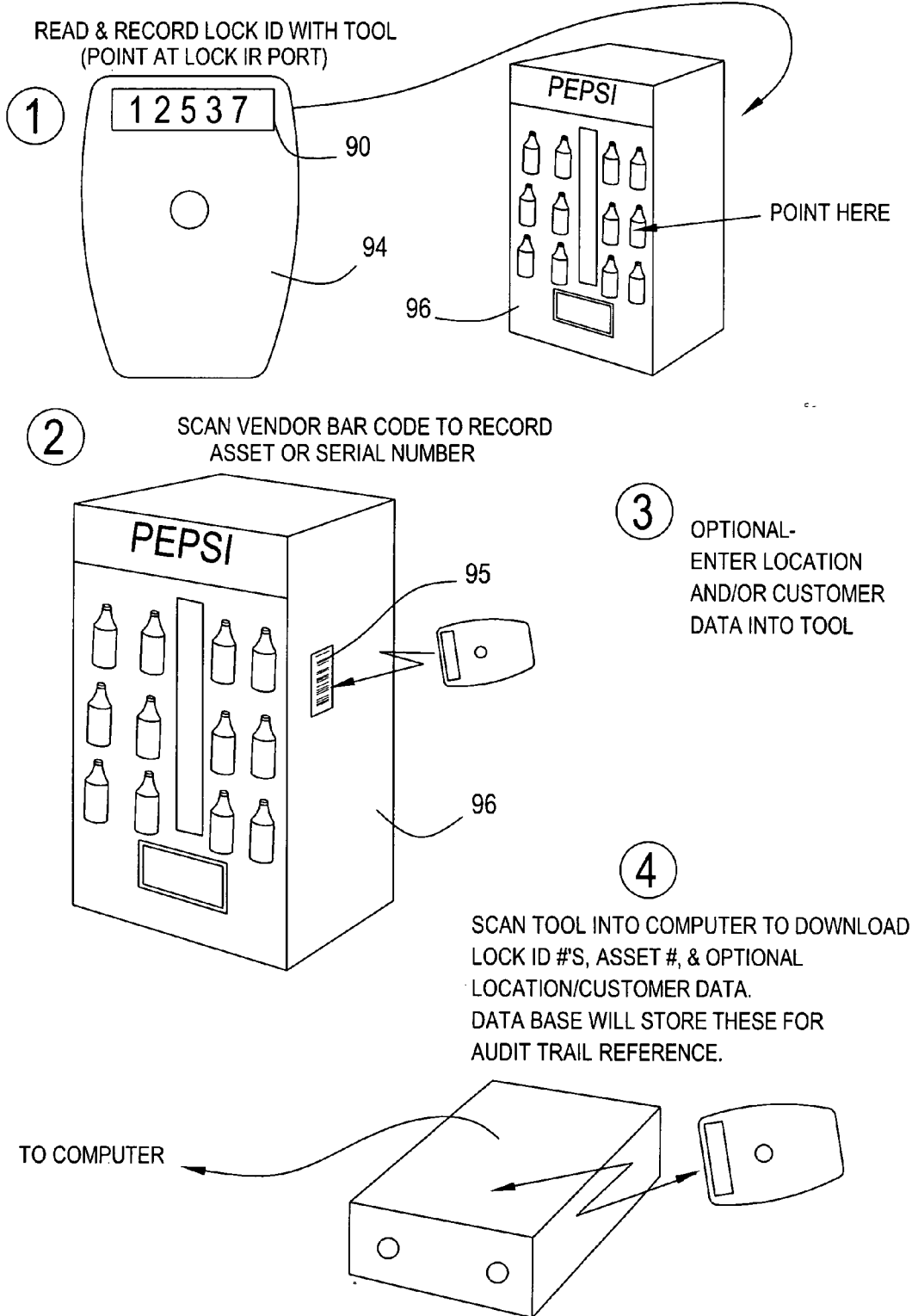


FIG. 7

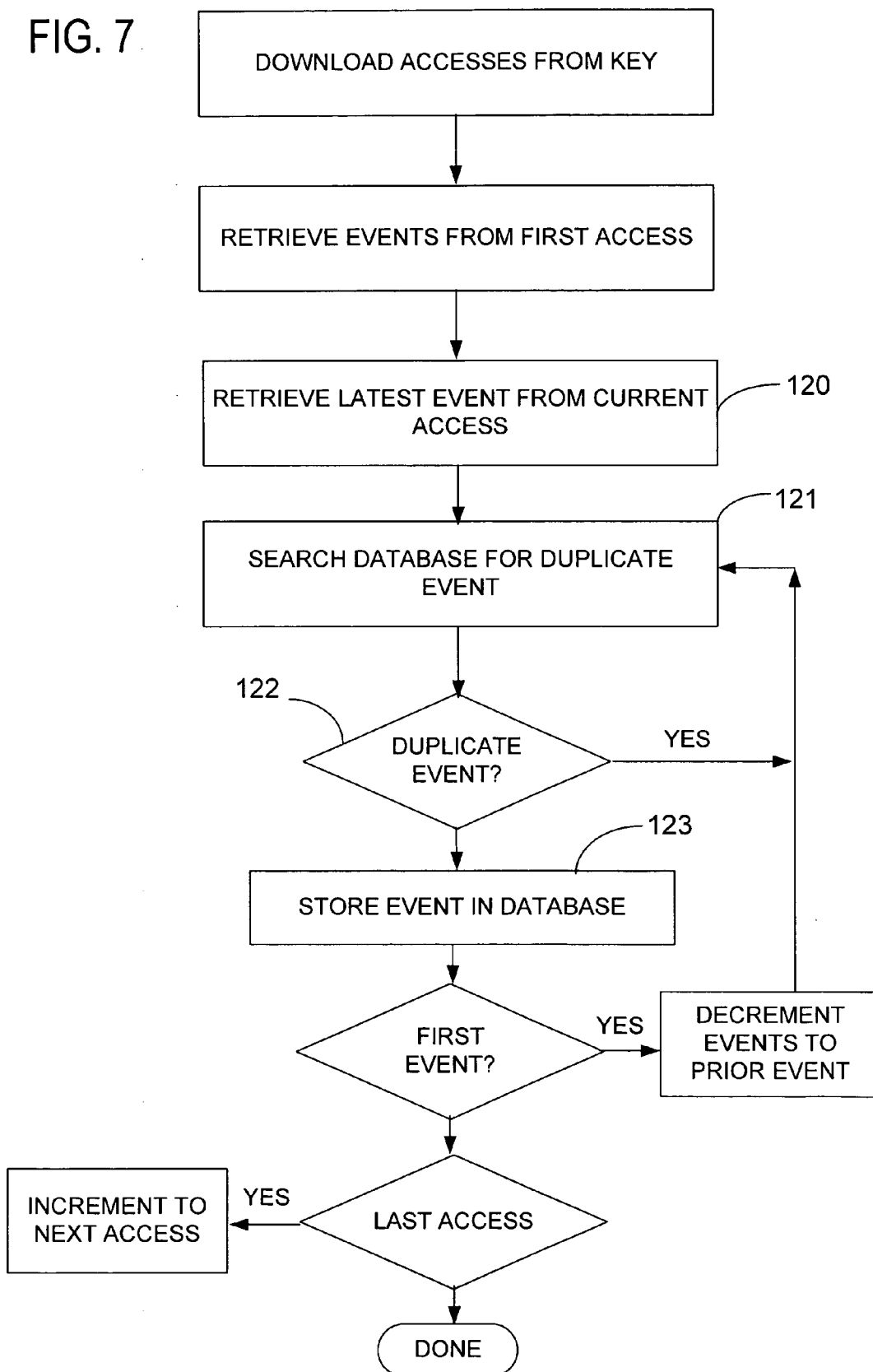


FIG. 8

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Administrator Logged in: □ □ ×

File Audit Trails Edit Key Limits Customer/Lock Info Routes Tools Mode Registration Help

Display AT

Only for KEY FOBS starting with: AB Key Type Full Serve - FS

Name Art Tefissial

Key ID ABA5011

Total Accesses 300 Start Time 8:00 am

Accesses Per Day 60 Stop Time 5:00 pm

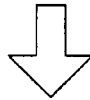
Refresh days 7

Expires on 11/14/02 12:00:00 AM

Days Valid \_MTWTF\_

At      Cradle Ready for Key FOB  
REFRESHED FOB ABA5011  
Art Tefissial

EXIT Audit Trails Clear Form



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NAME	KEY CODE	ASSET #	CUSTOMER NAME	DATE/TIME	ACTIVITY
Art Tefissial	ABA5011	Machine 4	Triteq Day Spa	11/7/02 9:14:00 AM	
Art Tefissial	ABA5011	Machine 7	Triteq Towing	11/7/02 9:14:00 AM	
Art Tefissial	ABA5011	Machine 5	Triteq Drugstor	11/7/02 9:14:00 AM	
Art Tefissial	ABA5011	Machine 3	Triteq Motel	11/7/02 9:14:00 AM	
Art Tefissial	ABA5011	Machine 5	Triteq Drugstor	11/7/02 9:15:00 AM	
Art Tefissial	ABA5011	Machine 1	Triteq Gym	11/7/02 9:15:00 AM	
Art Tefissial	ABA5011	Machine 2	Triteq Dairy	11/7/02 9:15:00 AM	
Art Tefissial	ABA5011	Machine 3	Triteq Motel	11/7/02 9:15:00 AM	
Art Tefissial	ABA5011	Machine 4	Triteq Day Spa	11/7/02 9:16:00 AM	
Art Tefissial	ABA5011	Machine 7	Triteq Towing	11/7/02 9:16:00 AM	
Art Tefissial	ABA5011	Machin3 2	Triteq Dairy	11/7/02 9:17:00 AM	
Art Tefissial	ABA5011	Machine 3	Triteq Motel	11/7/02 9:17:00 AM	
Art Tefissial	ABA5011	Machine 1	Triteq Gym	11/7/02 9:17:00 AM	
Art Tefissial	ABA5011	Machine 4	Triteq Day Spa	11/7/02 9:18:00 AM	
Art Tefissial	ABA5011	Machine 7	Triteq Towing	11/7/02 9:18:00 AM	
Art Tefissial	ABA5011	Machine 5	Triteq Drugstor	11/7/02 9:18:00 AM	

All Time Records     Click to enable Automatic Audit Printing    Sort by Access: All    Activity Abbreviations:  
 Last Week Records    Print Current Screen    Sort by Driver: Art Tefissial    BA = Battery Removed  
 Last Month Records       Sort by Asset #: All    BR = Bad Route  
 Time Range Records    From: 11/7/02 9:52:56 AM    To: 11/7/02 9:52:56 AM    L = Limited  
Execute Close    U = Unauthorized

SORT/PRINT/FUNCTIONS



FIG. 9A

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**Administrator Logged in:** □ □ ✕

File Audit Trails Edit Key Limits Customer/Lock Info Routes Tools Mode Registration Help

Name  Key Type

Key ID

Total Accesses  Start Time

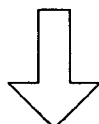
Accesses Per Day  Stop Time

Refresh days

Expires on

Days valid

AT:  Cradle Ready for Key FOB



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**Users and Keys** □ □ ✕

User Name	Key Code	Key Types
<b>Art Tefissial</b>	<b>ABA5011</b>	<b>Full Serve - FS</b>
Lee Ning	ABA0008	Full Serve - FS
Dan Druff	ABA0003	Full Serve - FS

Expires on

        Change Limits for ALL Key Types assigned to selected user

FIG. 9B 136

**Edit Key Limits**

Name

Authorized By

---

Start

Stop

Total Accesses

Accesses Per Day

Refresh days

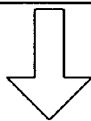
Days valid  
 Sunday  
 Monday  
 Tuesday  
 Wednesday  
 Thursday  
 Friday  
 Saturday

Disable FOB

FOB ID

Key Type  Route

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**Administrator Logged in:**

File Audit Trails Edit Key Limits Customer/Lock Info Routes Tools Mode Registration Help

Only for KEY FOBS starting with: AB

Name  Key Type

Key ID

Total Accesses  Start Time

Accesses Per Day  Stop Time

Refresh days

Cradle Ready for Key FOB

REFRESHED FOB ABA5011

Art Tefissial

FIG. 9C

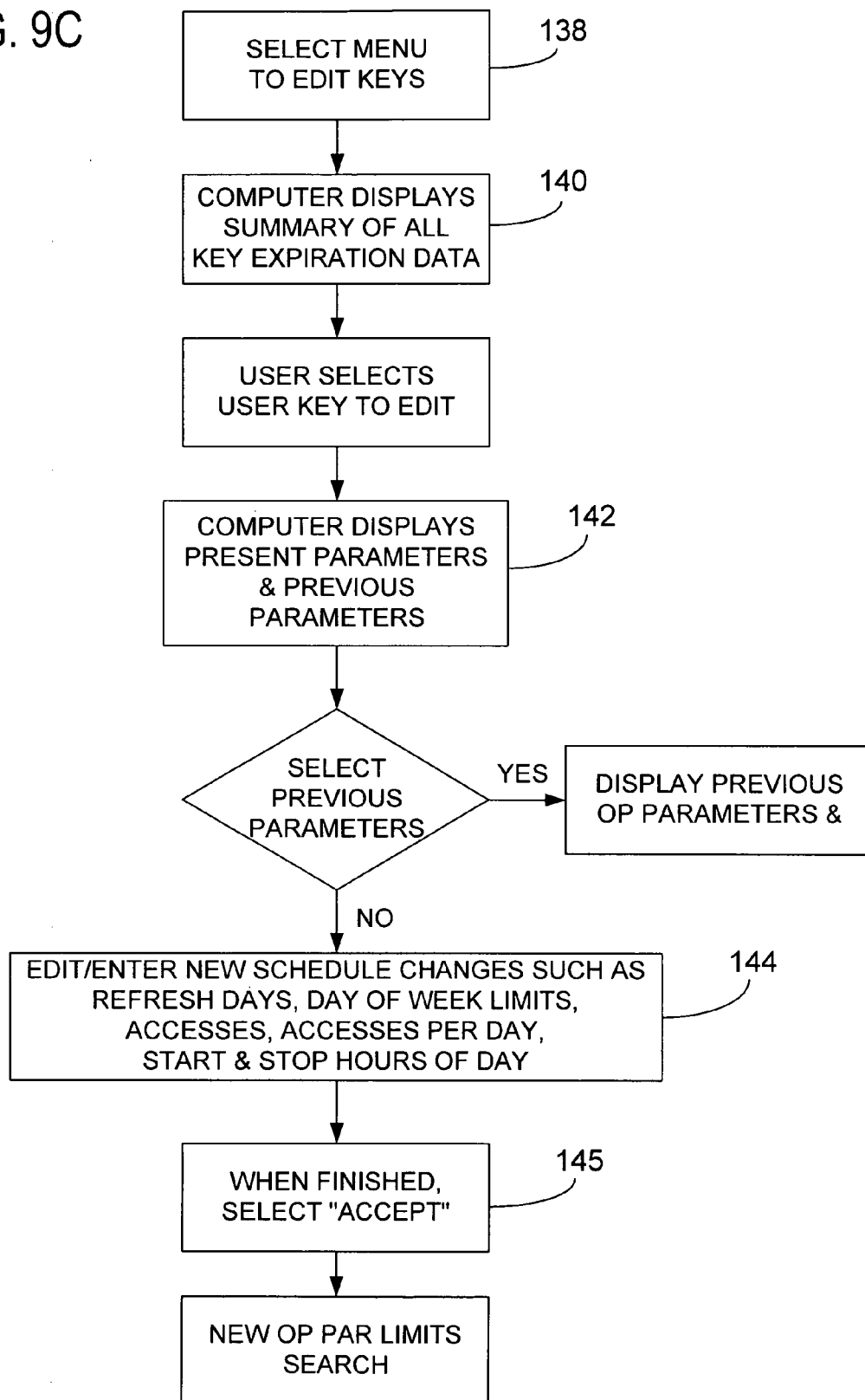


FIG. 10

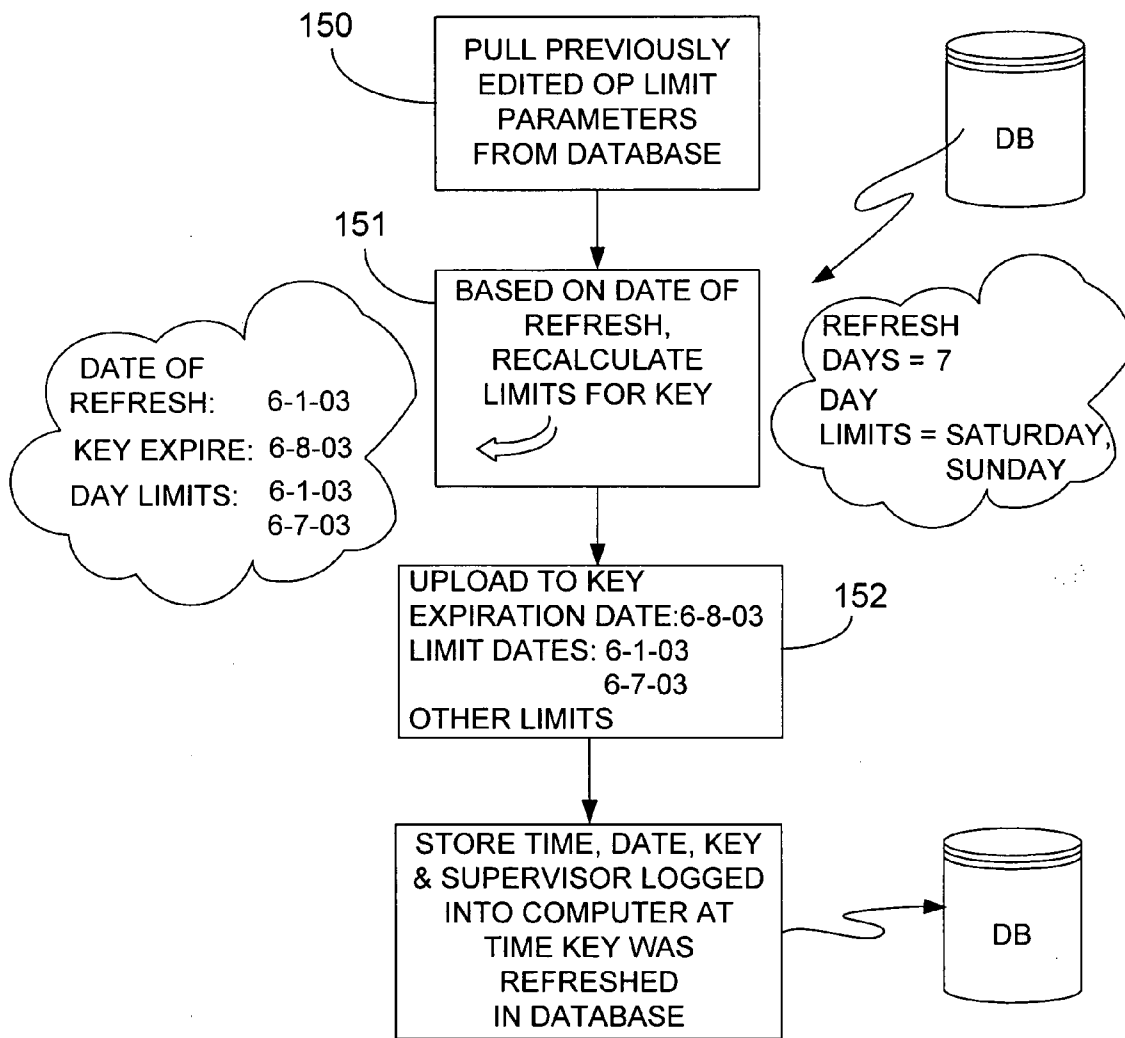


FIG. 11

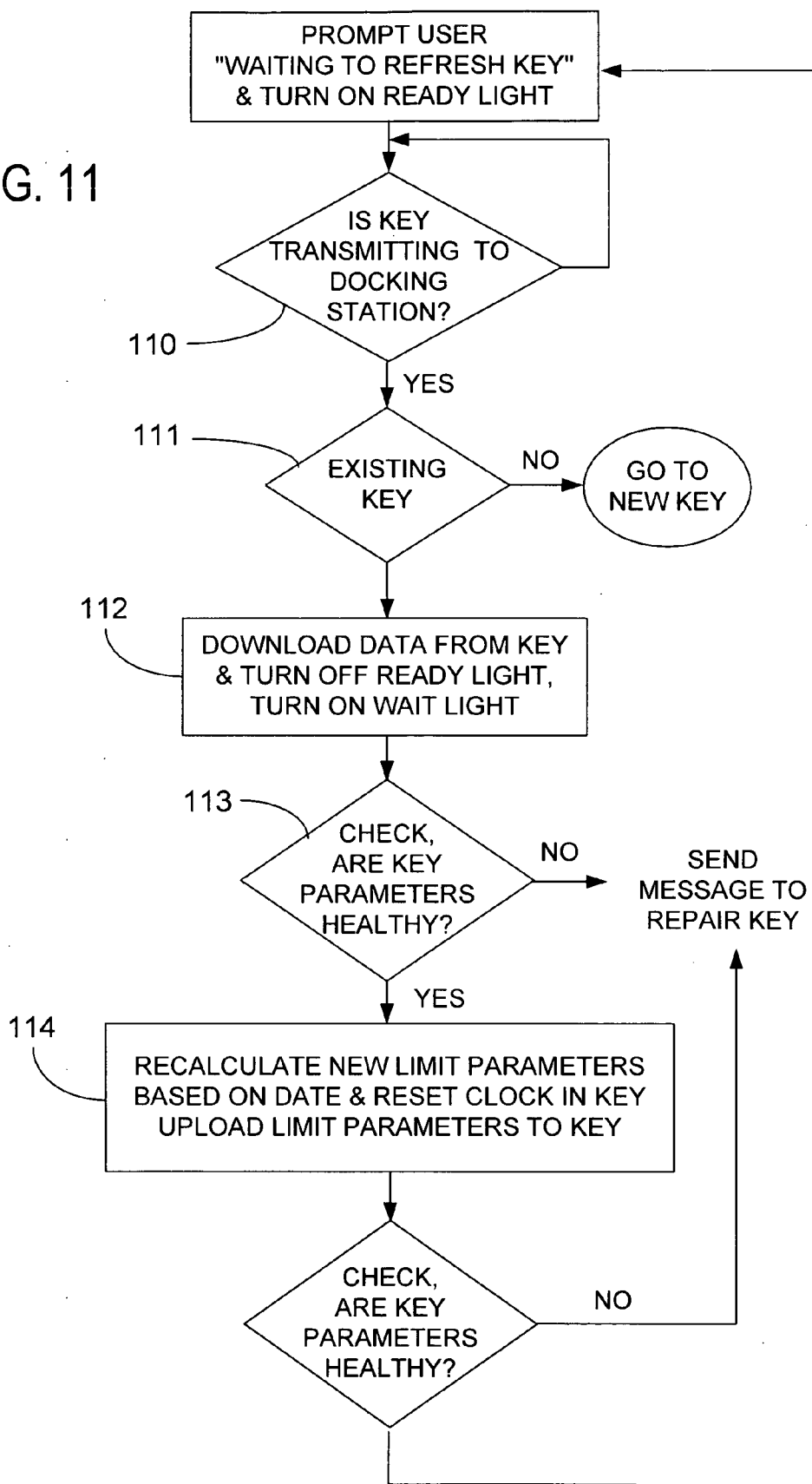
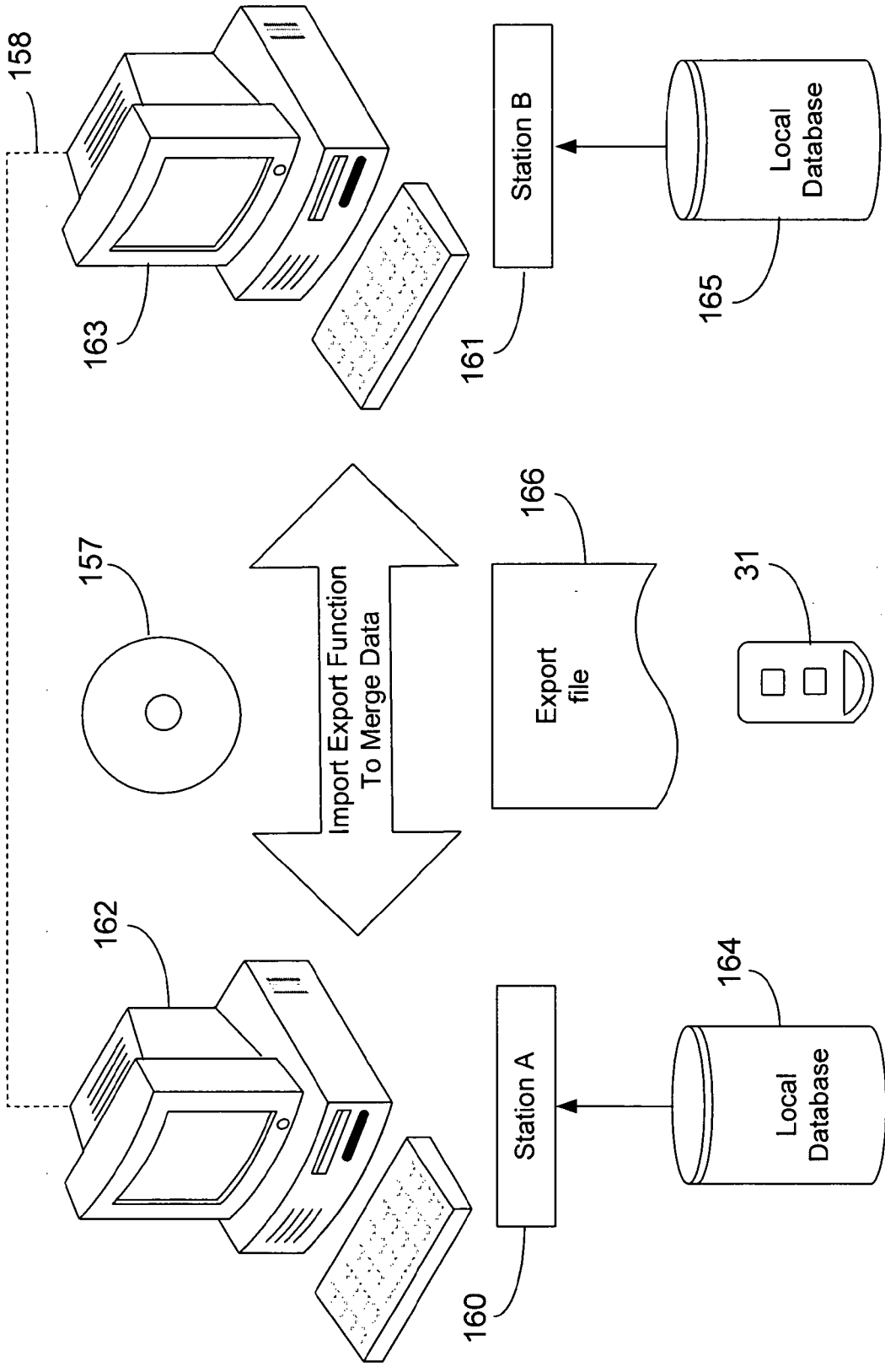


FIG. 12



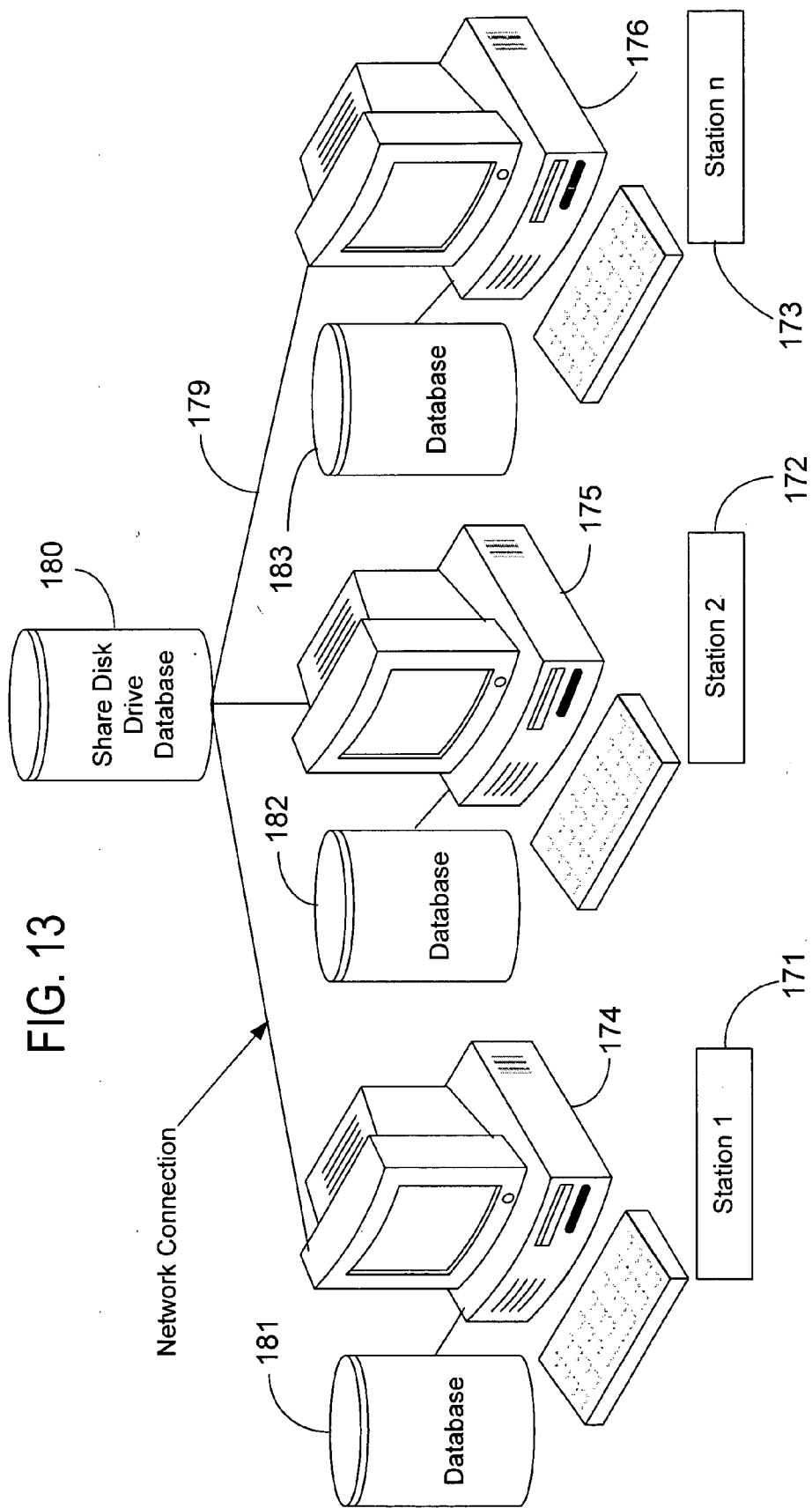


FIG. 13

FIG. 14A

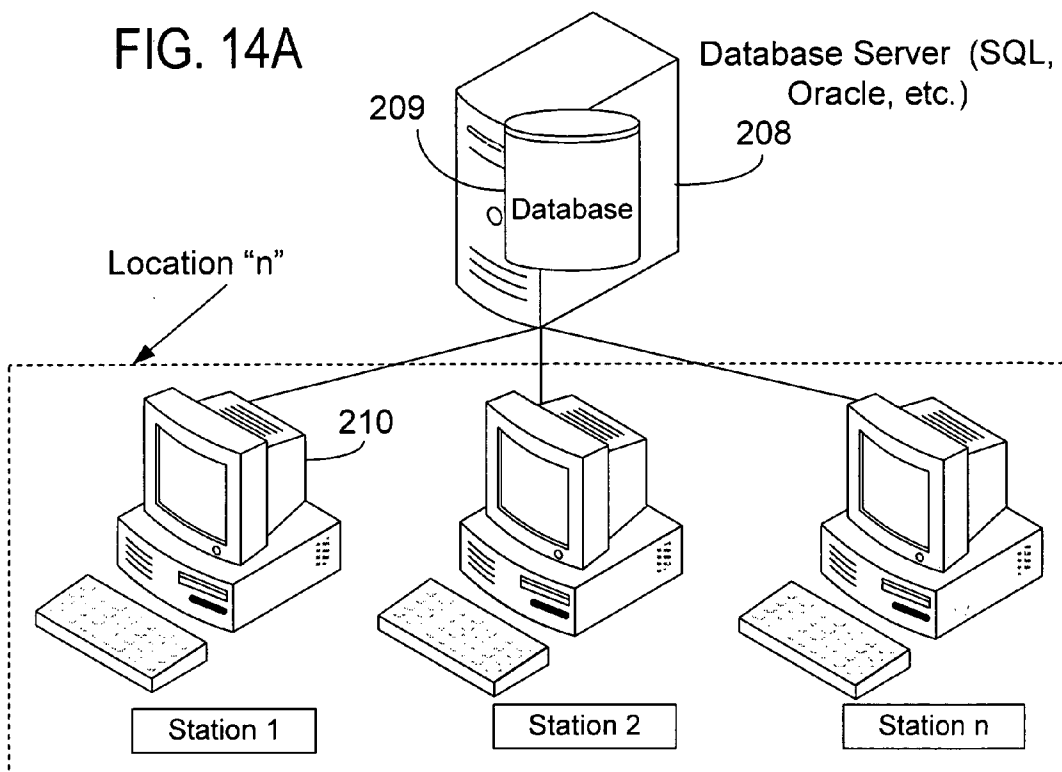


FIG. 14B

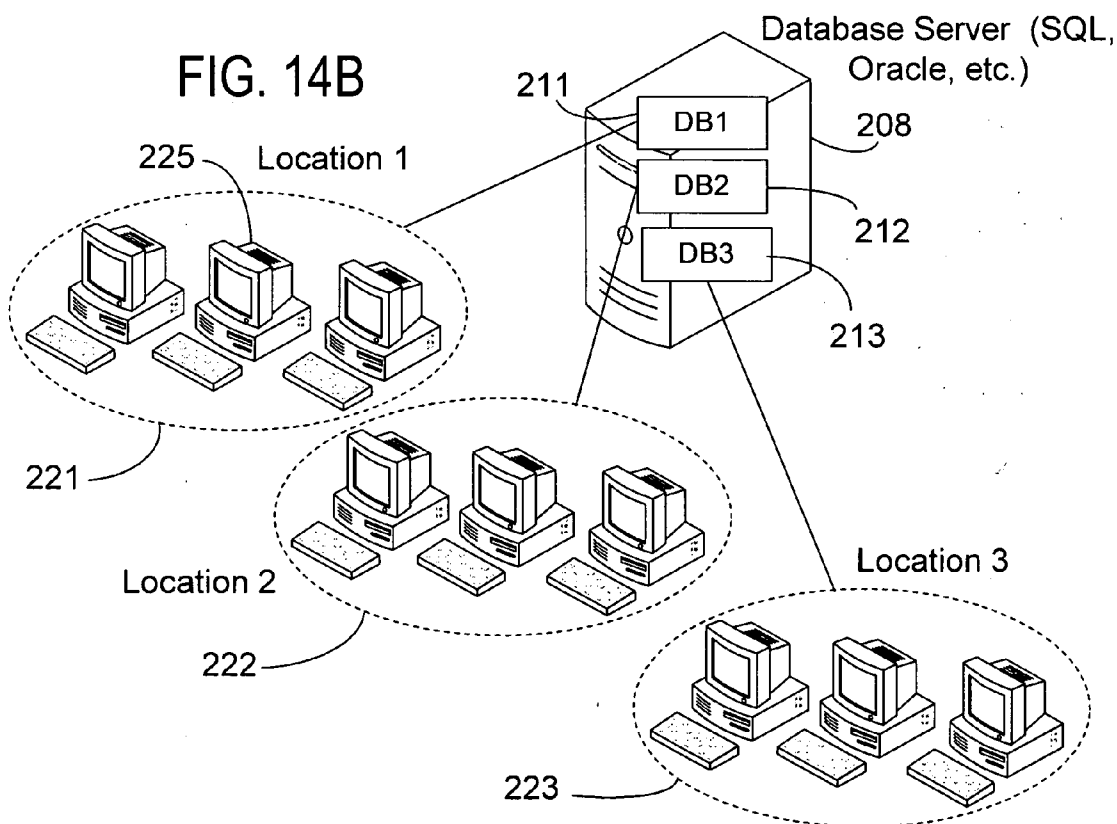




FIG. 15

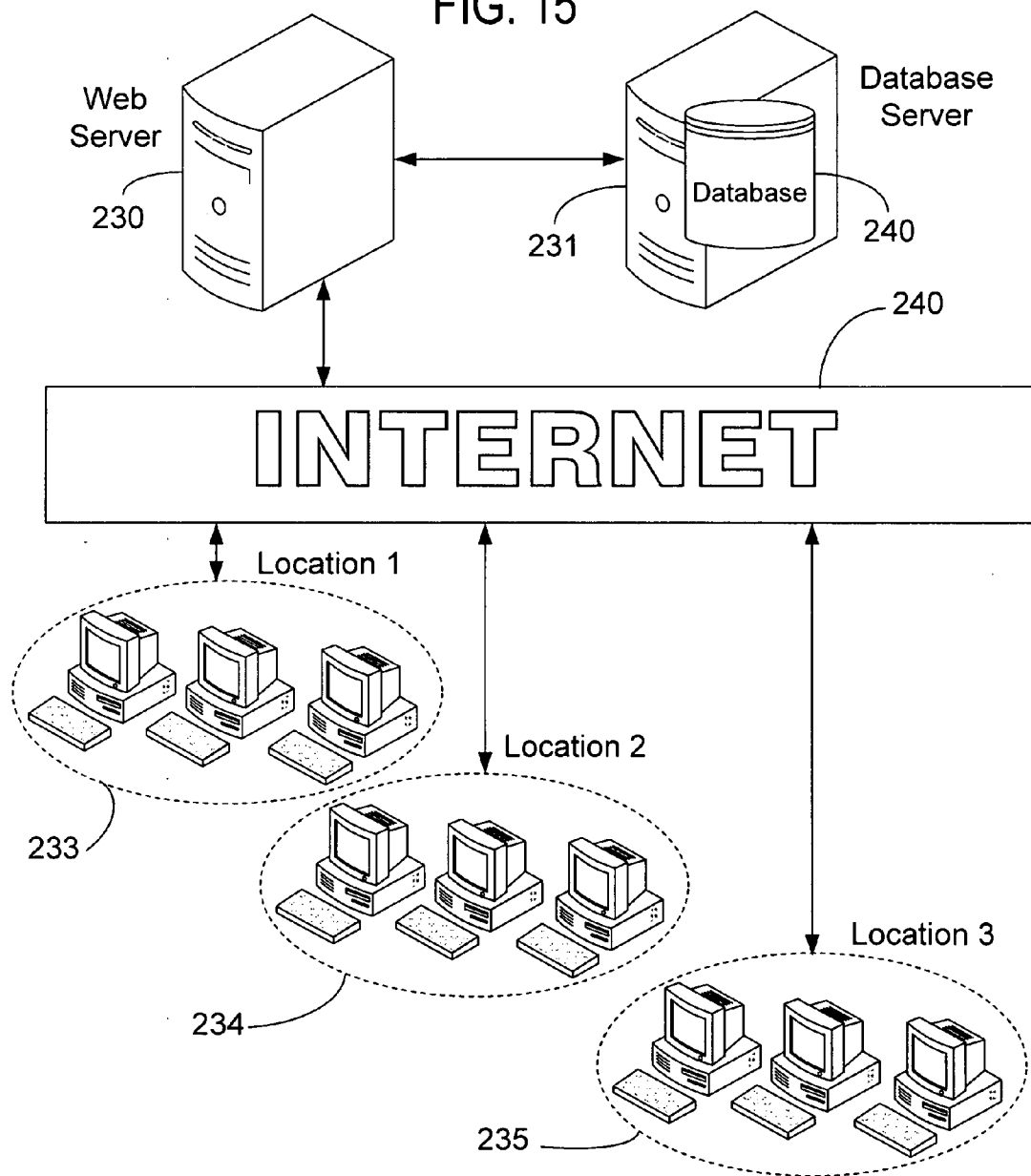


FIG. 16 167

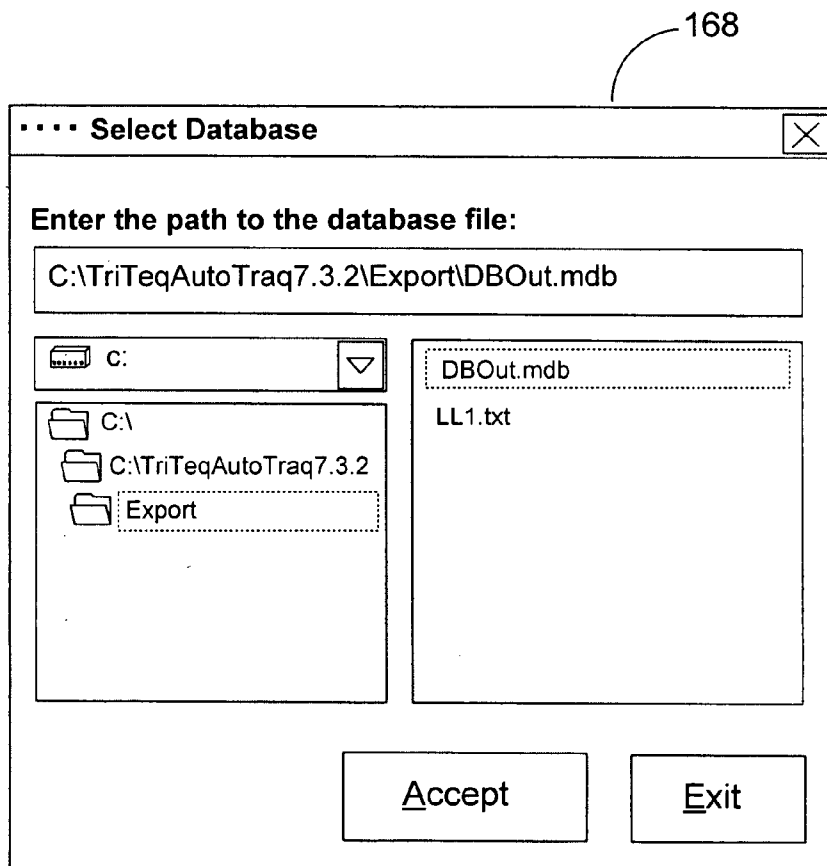
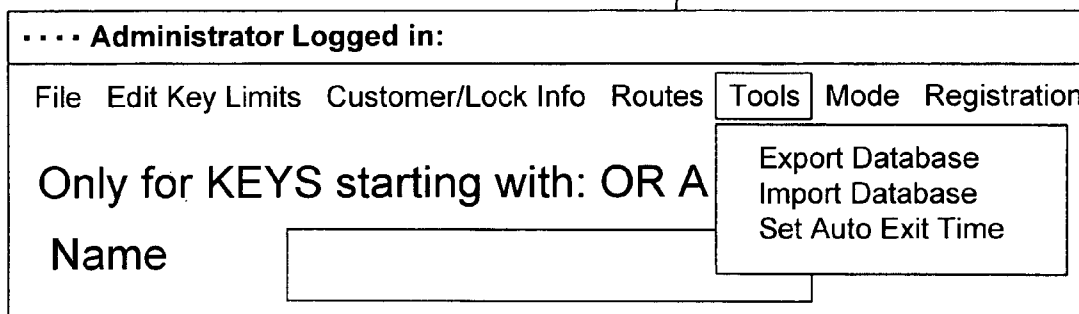


FIG. 17

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.... Software Auto-Exit & Archive Settings

**Auto Exit software at:**    
Select hour from the list or type in (24 hour format).  
00:00 – 23:59

**No login required when software starts**

**Compact database**

**Auto Archive Audit events older than:**  
  **days**

Click on the text above to change the path

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FIG. 18

**Scheduled Task Wizard** [Close]

Select the time and day you want this task to start.

Start Time:  [Up] [Down]

Perform this task:

Every Day

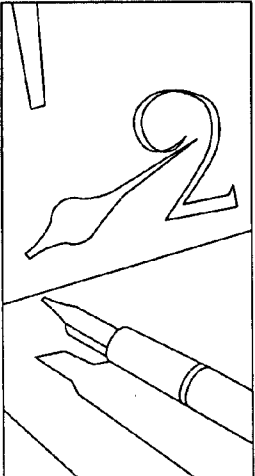
Weekdays

Every  [Up] [Down]

Start date:  [Down]

[<Back] [Next>] [Cancel]

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**Scheduled Task Wizard** [Close]

Enter the name and address of a user. The task will Run as if it were started by that user.

Enter the user name:

Enter the password:

Confirm password:

[<Back] [Next>] [Cancel]

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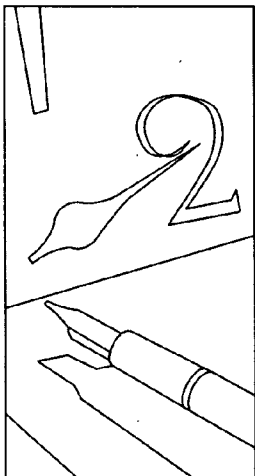


FIG. 19

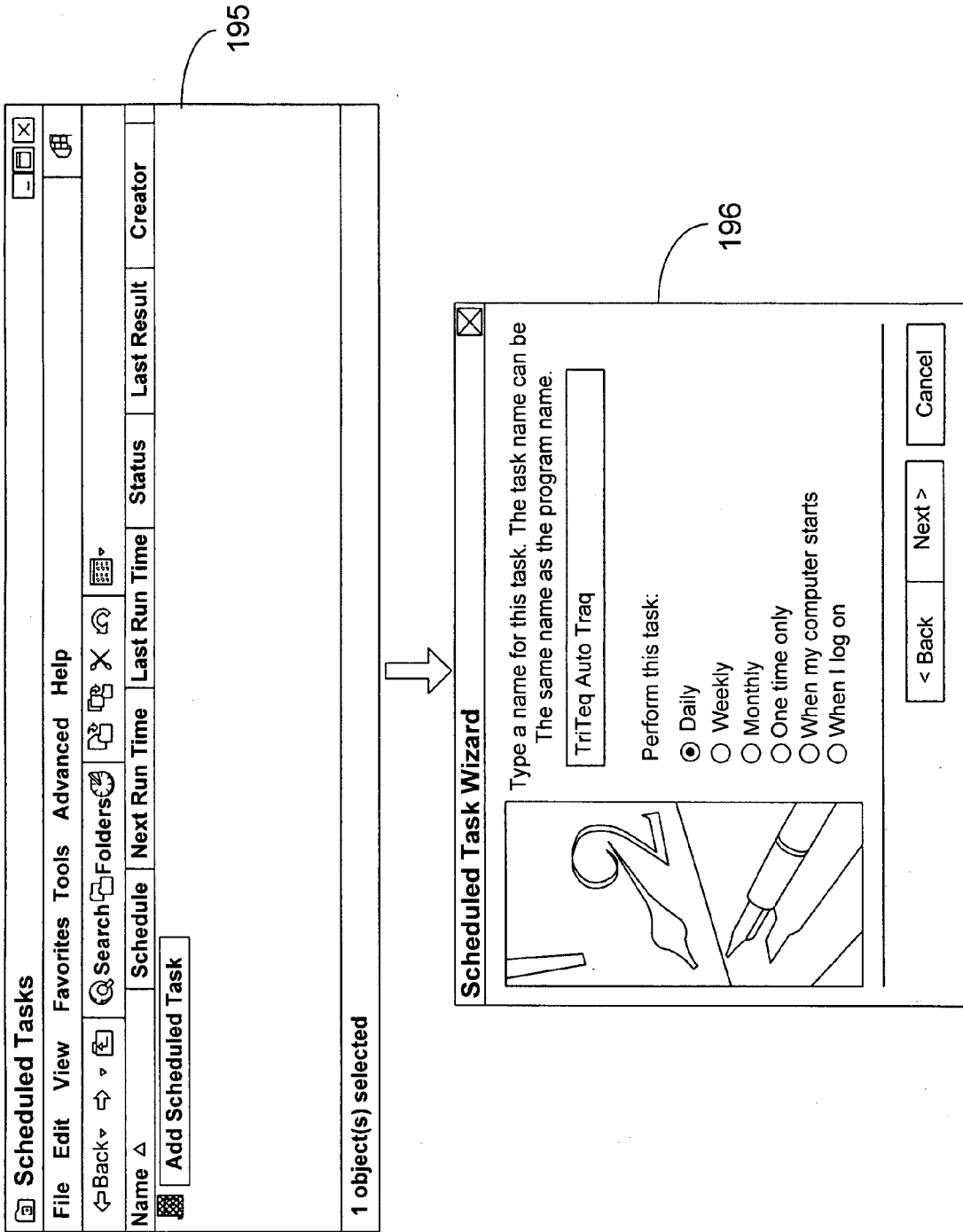


FIG. 20

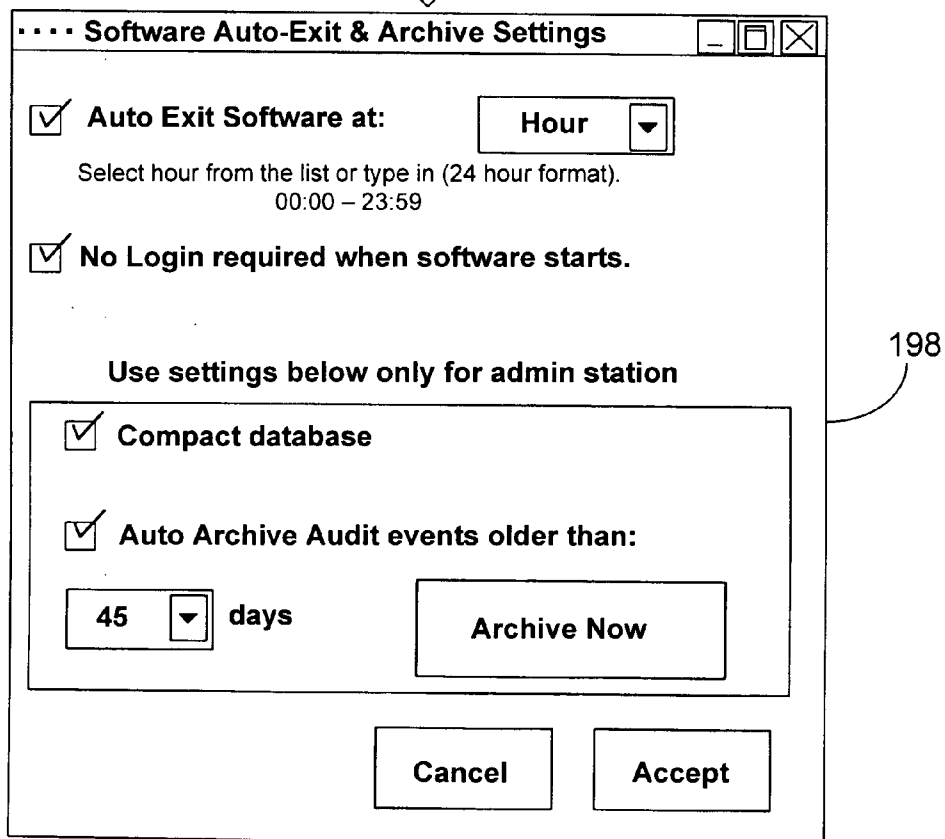
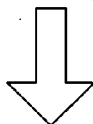
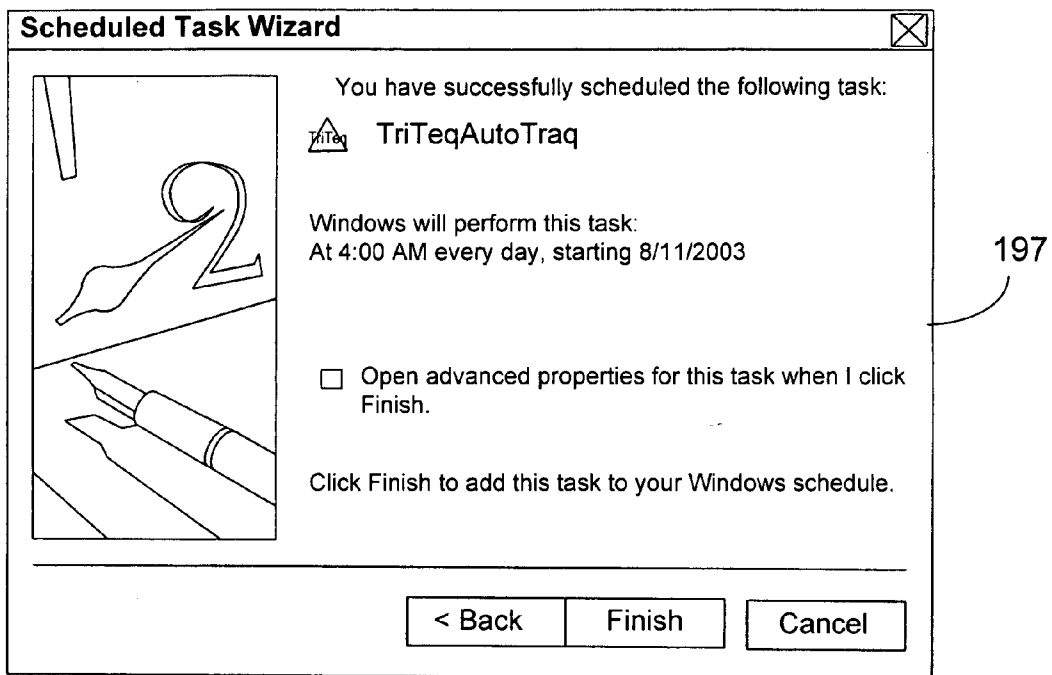


FIG. 21

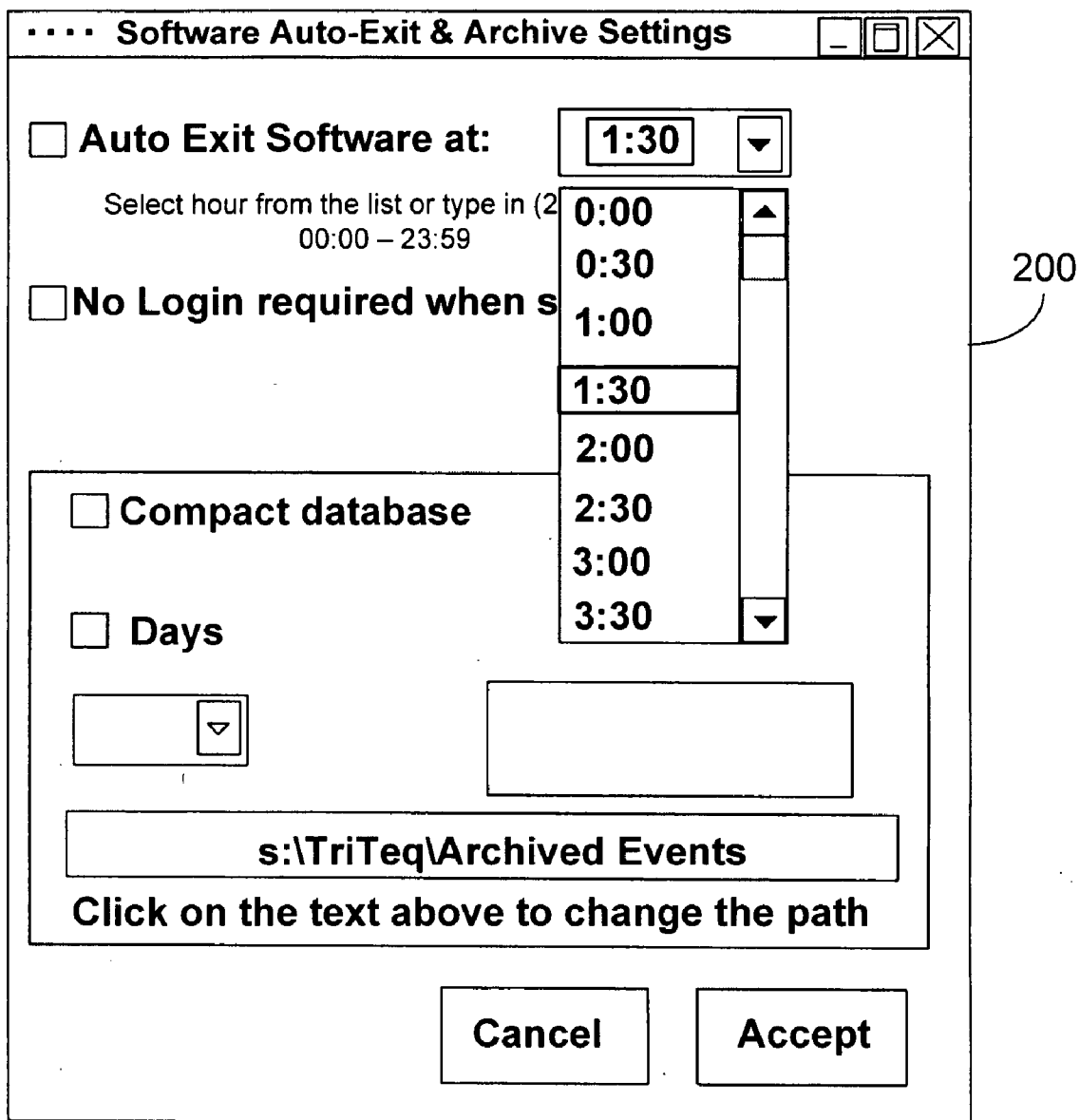


FIG. 22

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.... Software Auto-Exit & Archive Settings

**Auto Exit software at:**    
Select hour from the list or type in (24 hour format).  
00:00 – 23:59

**No login required when software starts**

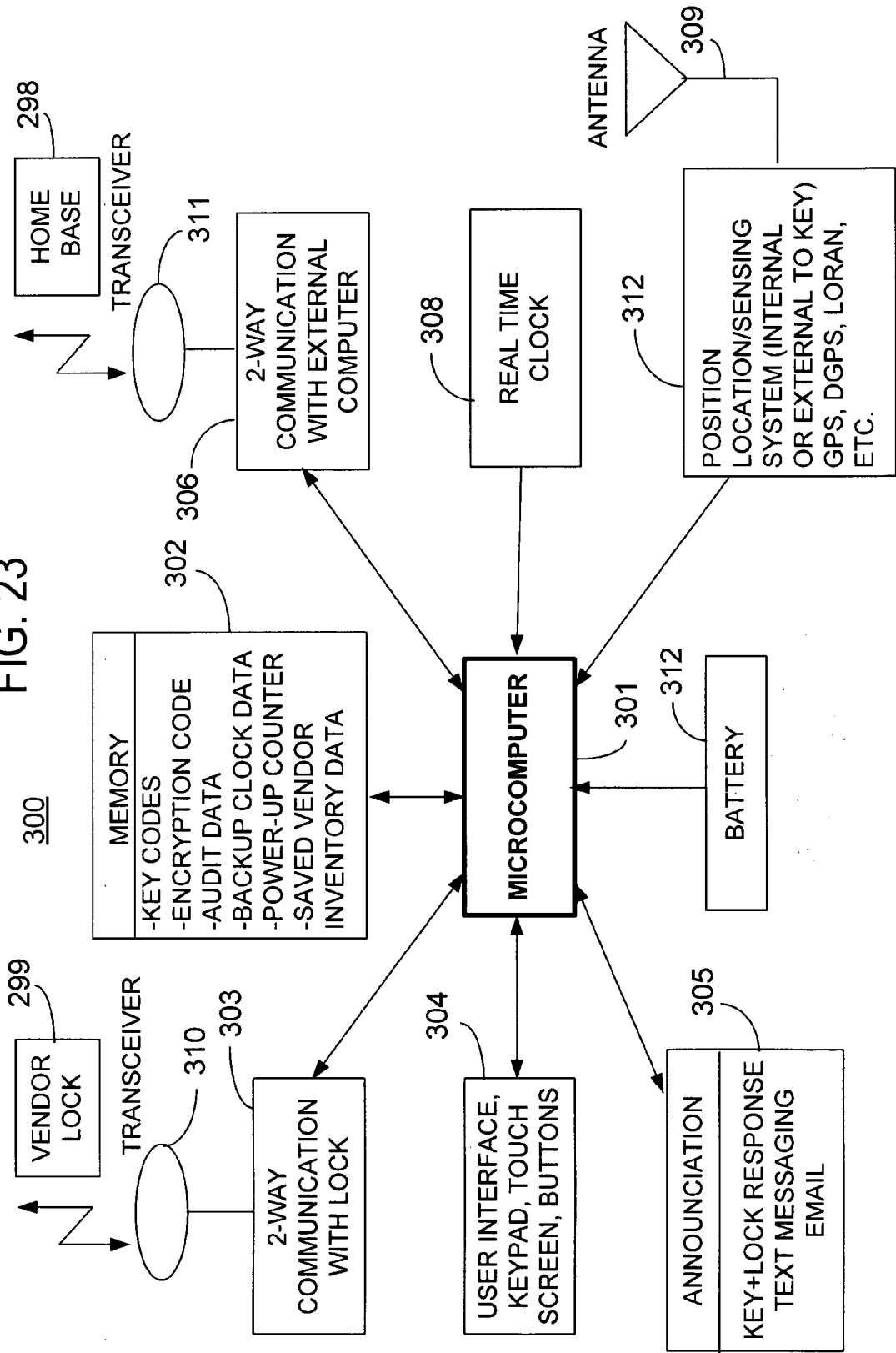
**Compact database**

**Auto Archive Audit events older than:**  
  **days**

Click on the text above to change the path



FIG. 23



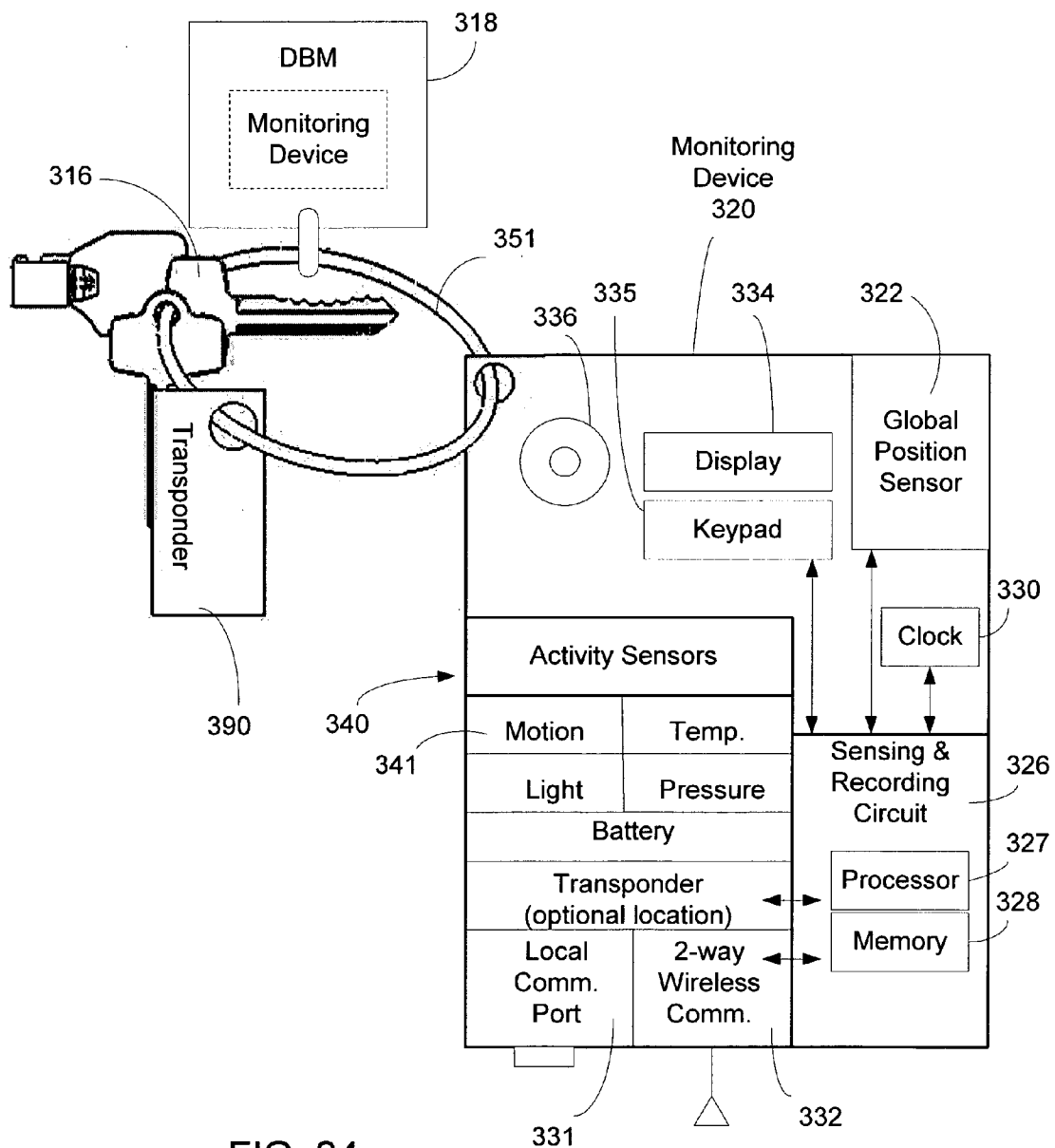


FIG. 24

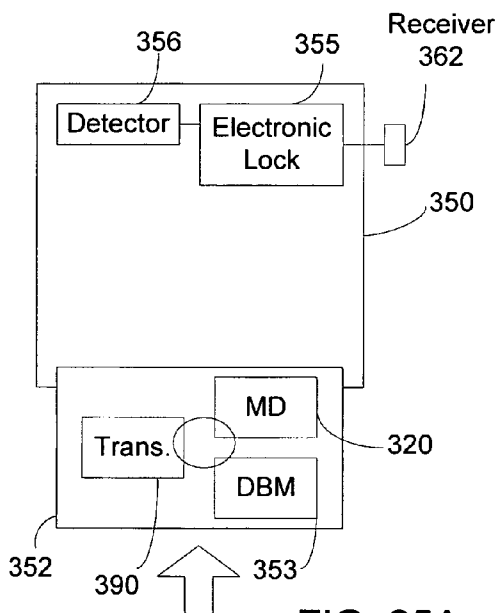


FIG. 25A

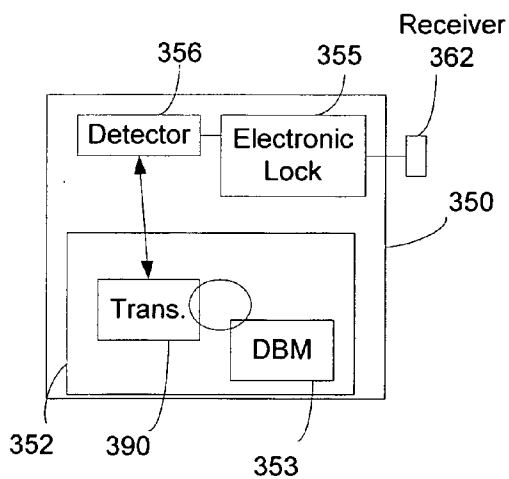


FIG. 25B

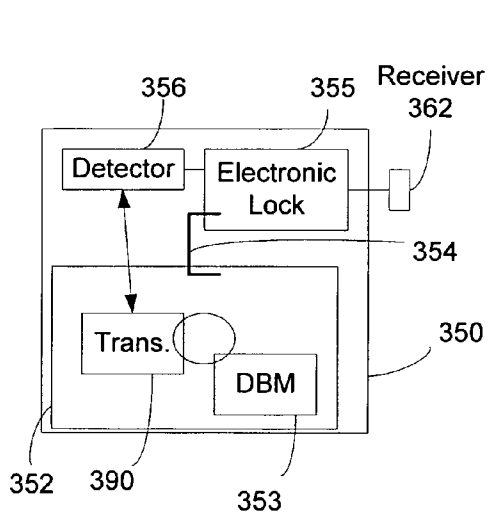


FIG. 25C

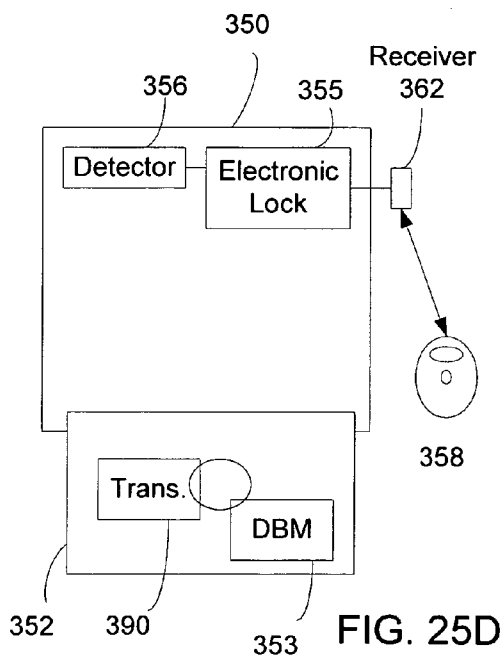


FIG. 25D

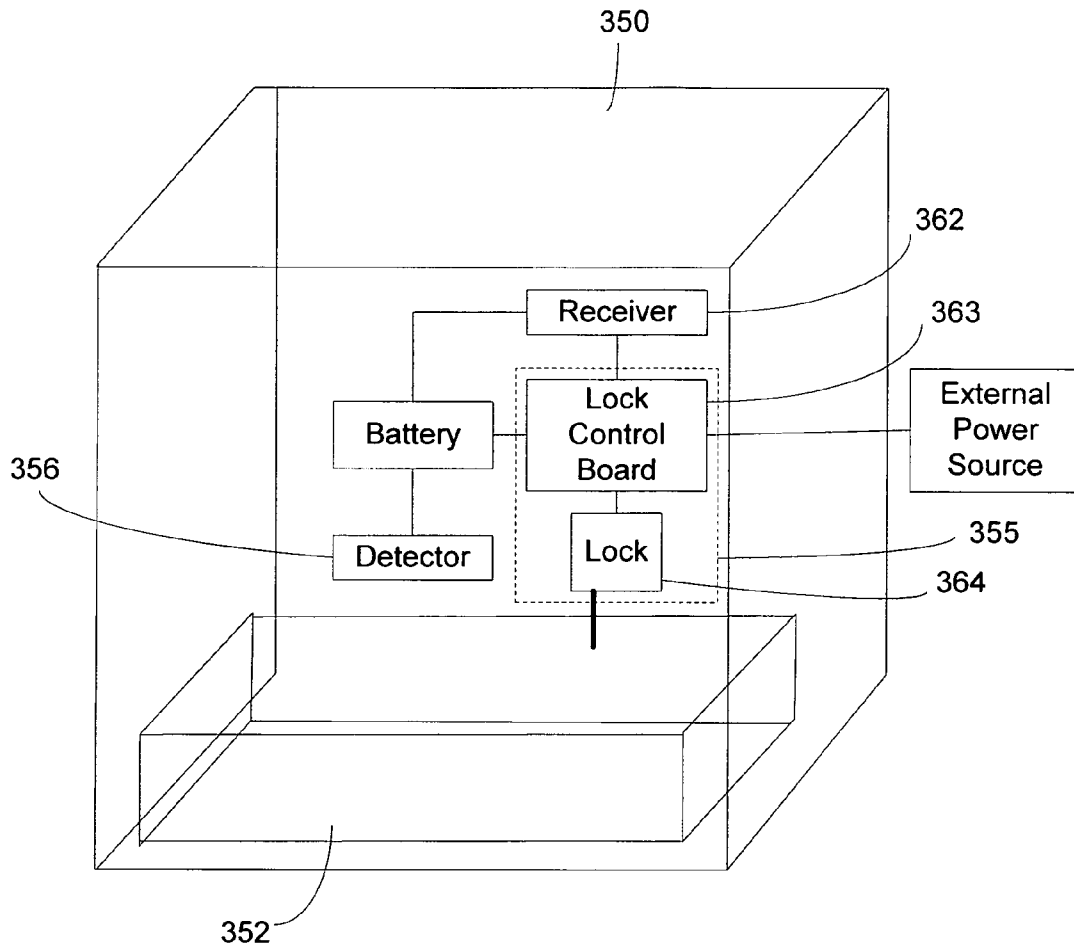


FIG. 26

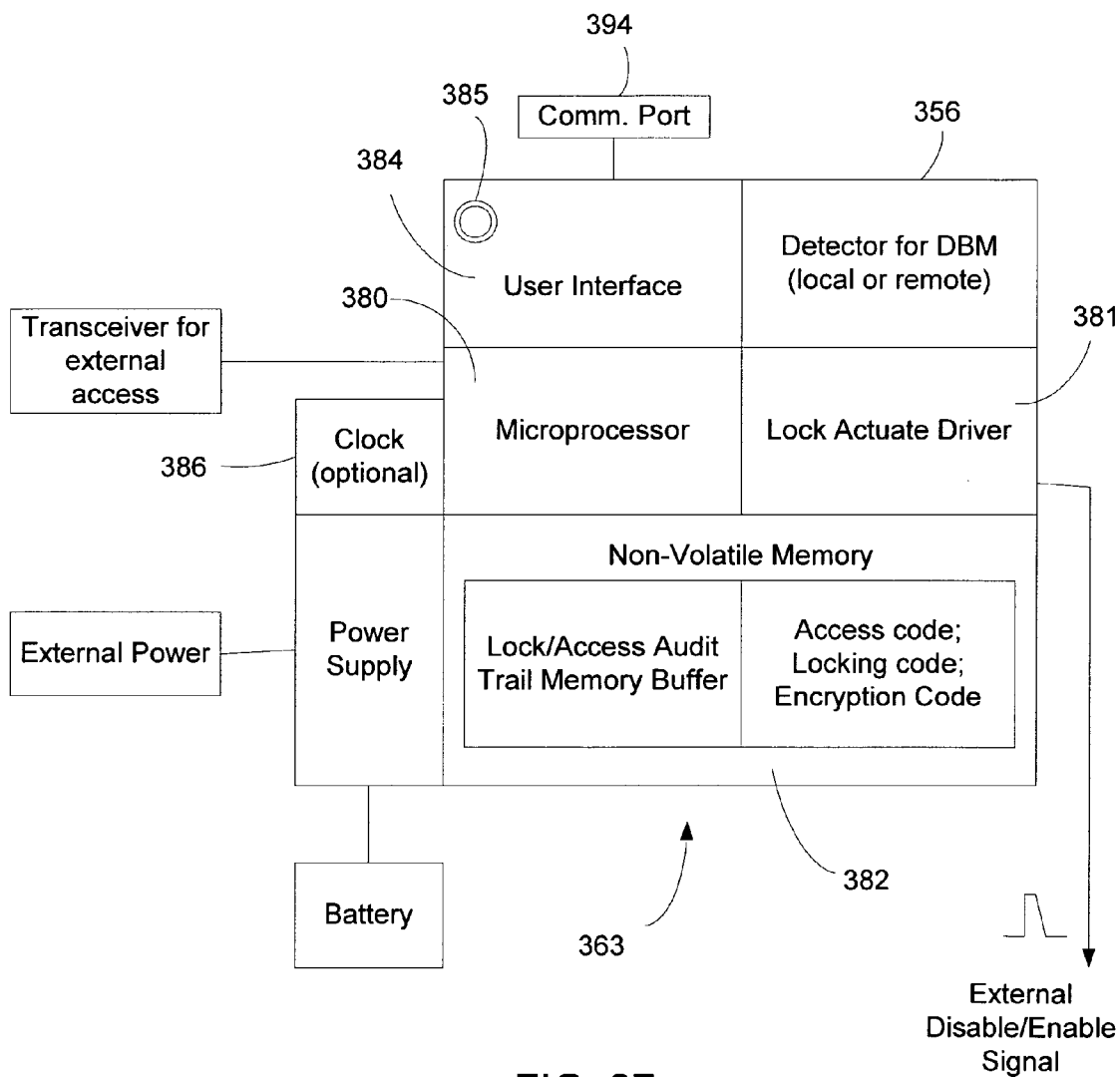


FIG. 27

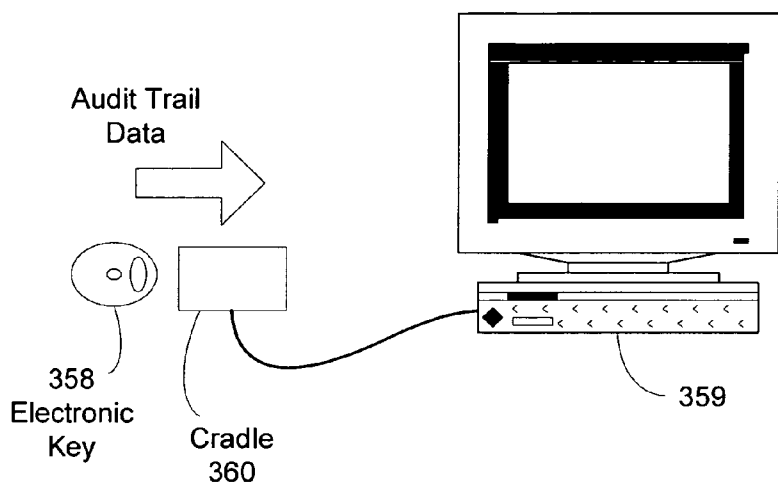


FIG. 28

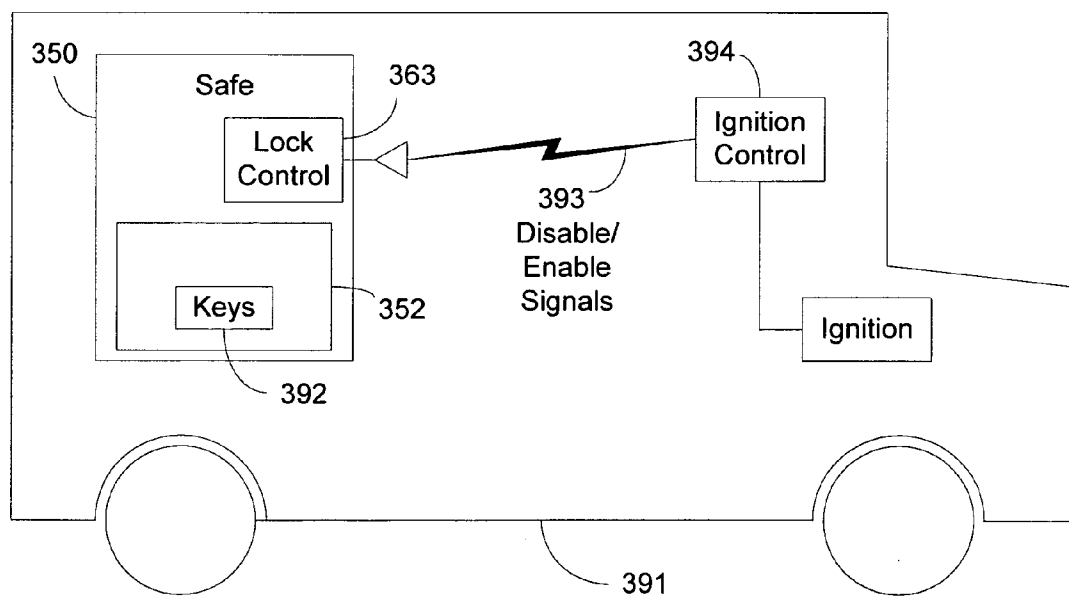


FIG. 29

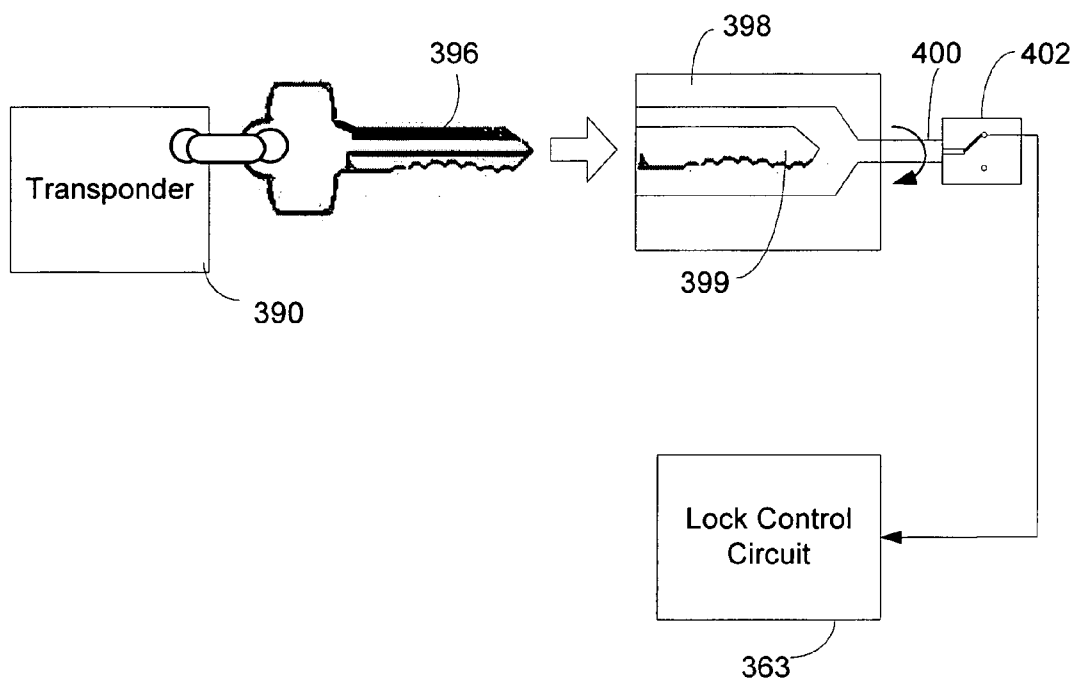


FIG. 30

**ELECTRONIC SECURITY APPARATUS AND METHOD FOR MONITORING MECHANICAL KEYS AND OTHER ITEMS**

**RELATED APPLICATION**

[0001] This application is a continuation-in-part of U.S. application Ser. No. 11/010,661 filed Dec.13, 2004, which claims the priority of U.S. Provisional Application 60/528, 831, filed Dec. 11, 2003.

**FIELD OF THE INVENTION**

[0002] This invention relates to an electronic security system and method for monitoring the location of and controlling access to mechanical keys or other types of valuable items.

**BACKGROUND OF THE INVENTION**

[0003] Mechanical locks and keys have been used on vending machines for over the past 50 years. One particular problem with mechanical keys is the difficulty in keeping track of the whereabouts and usage to ensure that the mechanical keys are not used by unauthorized persons or by authorized persons but at unauthorized times or places. For instance, mechanical keys for vending machines are typically given to employees responsible for assigned vending machine routes. The employee for a given route has a schedule for visiting the vending machines on the route at particular times to collect money and restocking goods in the machines. It has been a common concern that the mechanical keys for the vending machines may be stolen and used by thieves to steal money and goods from the machines. Also, it is a concern that the keys may be used either by authorized or unauthorized persons at unauthorized times to access the vending machines. What is required is an electronic security system to overcome some of the management and security problems associated with the use of mechanical keys.

**BRIEF SUMMARY OF THE OBJECTS OF THE INVENTION**

[0004] In view of the foregoing, it is an object of the invention to monitor the location, position, and operation capability of access control devices, especially mechanical keys.

[0005] It is an object of the invention to provide an apparatus to secure, enable/disable, and track the location and disposition of access control devices such mechanical keys, and other valuable items such as money, fire arms, tools, etc.

[0006] It is a related object of the invention to provide a record regarding the location and accessibility of an access control device or valuable item being monitored for auditing purposes.

[0007] These objects and other advantages of the invention will be apparent from the detailed description provided herein.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0008] FIG. 1 is a schematic representation of an embodiment of a key management system including a personal computer having a local database and software program, and

cradle that functions as an interface for communications between an electronic key and the computer;

[0009] FIGS. 2A and 2B are schematic diagrams showing the user interface screen and process for registering the software and the cradle of the key management system;

[0010] FIGS. 3A, 3B and 3C are schematic diagrams describing a start-up and refresh sequence of the keys;

[0011] FIGS. 4A is a schematic diagram showing user interface screens for a user to entering supervisor and administrator modes;

[0012] FIG. 4B is a flow chart showing a process for a user to enter electronic lock information;

[0013] FIG. 5A is a flow chart for a process of starting up or logging in new keys;

[0014] FIG. 5B is a schematic diagram showing user interface screens for the operation of entering key user information;

[0015] FIG. 6A is a schematic diagram showing a process of collecting electronic lock ID information;

[0016] FIG. 6B is a schematic diagram showing user interface screens for prompting a user of the key management system to enter information regarding a new electronic lock;

[0017] FIG. 6C is a schematic diagram showing an alternative process for collecting electronic lock ID information;

[0018] FIG. 7 is a flow chart describing a process of receiving and storing audit data;

[0019] FIG. 8 is a schematic diagram showing user interface screens for displaying audit trails data collected by electronic keys from vending machines;

[0020] FIGS. 9A and 9B are schematic diagrams showing user interface screens for a process of editing key limit operational parameters;

[0021] FIG. 9C is a flow chart showing a process of editing key limit parameters;

[0022] FIG. 10 is a flow chart showing a process of re-calculating key limit parameters during a key refresh operation;

[0023] FIG. 11 is a flow chart showing a process of refreshing the memory of an electronic key;

[0024] FIG. 12 is a schematic diagram showing a configuration of multiple key management databases that are synchronized using export files;

[0025] FIG. 13 is a schematic diagram showing a configuration with multiple key management stations connected via a network to a central key management database;

[0026] FIG. 14A is a schematic diagram showing a configuration of multiple key management stations connected to a central database with a database server;

[0027] FIG. 14B is a schematic diagram showing a configuration of key management stations at multiple remote separate locations connected to a central database server with multiple databases for the separate locations;



[0028] FIG. 15 is a schematic diagram showing a configuration with key management stations at different locations connected to a central database server through the Internet;

[0029] FIG. 16 shows user interface screens for generating an export file for synchronizing distributed databases;

[0030] FIG. 17 shows a user interface screen for setting software auto-exit and archive settings.

[0031] FIGS. 18-20 show user interface screens involved in scheduling the operation of the key management system for auto start up;

[0032] FIGS. 21 and 22 show user interface screens involved in setting the auto-exit time for the key management system;

[0033] FIG. 23 is a schematic diagram showing in functional blocks an electronic key that has a position sensing component for detecting the locating of the electronic key during field operation;

[0034] FIG. 24 is a schematic diagram of a monitoring device with location detection capability that is attached to items being monitored;

[0035] FIGS. 25 A-D are schematic diagrams of a security container in the form of a safe that is configured for securely storing valuable items such as mechanical keys;

[0036] FIG. 26 is a schematic view of the safe in the embodiment of FIGS. 25A-D with electronic components for monitoring the presence of valuable items in the safe;

[0037] FIG. 27 is a functional block diagram showing features of an electronic lock control board of the safe in FIG. 26.

[0038] FIG. 28 is a schematic view showing an electronic key downloading audit trail records collected from the safe in the embodiment of FIGS. 25A-C to a computer;

[0039] FIG. 29 is a schematic view showing an embodiment in which a safe transmits signals to disable or enable the ignition of vehicle; and

[0040] FIG. 30 is a schematic diagram showing an alternative embodiment of a security container for securely storing mechanical keys.

#### DETAILED DESCRIPTION OF THE INVENTION

[0041] The present invention provides a system and method for monitoring the location of mechanical keys and/or other access control devices or valuable items, to prevent unauthorized access to the keys or valuable items. Prior to describing embodiments of the invention, a system for managing electronic keys used for accessing vending machines or the like and for managing audit data collected by the electronic keys from the vending machines is first described with reference to FIGS. 1-23. The technologies involved in the electronic keys and key management system may be advantageously used in implementing the system and method of the invention, which are described in detail with reference to FIGS. 24-30.

[0042] In an embodiment shown in FIG. 1, the electronic key management system (or station) 30 includes a computer

32 which may be a desktop personal computer (PC), with appropriate computer software and hardware for carrying out the functionality of key management and database operations. The software program 34 for key management and database operations may be a Visual Basic program executing on the PC. The computer 32 also includes a database for storing data for key management and audit data collected from vending machines. As used herein, "database" may include data files as well as a database program. In one implementation, the database 35 may be a Microsoft ACCESS database residing on the PC 32.

[0043] As illustrated in FIG. 1, the electronic key 31 includes a status indicating device which may be an LED light 38, and a push button 39 that when pressed causes the key to start wireless transmission. To communicate with the electronic key, the key management system 30 includes an interface device for forwarding and receiving communications to and from an electronic key. In the embodiment illustrated in FIG. 1, the interface device is in the form of a cradle 36 (or docking station) that interfaces the key to a communication port 33 on the PC 32. The cradle 36 has a receiving place for receiving the electronic key, and indicators such as a ready/wait light 40.

[0044] The database 35, software 34 and cradle 36 transceiver interface systems are limited for secure operation on only one particular computer 32 by means of registration. The software programs and the cradle can properly function only after they are registered with an authorized control center. Thus, a thief cannot install stolen components on a computer at an unauthorized location. The steps of an exemplary registration process are described with reference to FIGS. 2A and 2B. FIG. 2A shows an interface screen that presents a registration form 42 and a Software Registration Menu. After the software programs are installed on the computer 32, a user may click on a "registration" tab in the menu bar to bring up this registration form. To fill in the required data, the user looks at the bottom of the cradle 36 for the cradle serial number, and enters this number into the form 42. The user looks at the compact disc (CD) containing the key management software for the CD serial number, and enters it into the form. The user also fills in other required information, such as contact information including the bottler name, contract name, address, phone number, etc., into the registration form. Once the registration form 42 is properly filled, the user clicks on the "Generate System ID#" button 44. After this button is pushed, the software program generates a system ID number for this system based on the serial numbers and/or other information entered by the user. The system ID number appears at the bottom of the form 42 under the "Get Registration #" button 45. The user then clicks on the "Get Registration #" button. In response, the software program generates a registration form containing the user-entered information and the system ID number, and sends the form to the printer for printing, as illustrated in FIG. 2B. This registration form 50 is then sent, for example via facsimile, to the control center (e.g., TriTeq Corporation) so that the control center can register the key management system using the system ID number. The control center then issues a special code 53 as a registration number for the user's system. The special code is generated based on the system ID number and possibly other information provided by the registration form 50. This registration number 53 may be sent to the user in a registration response form 52 that may be transmitted via facsimile to the user. The registration

number may also be sent via other means of communication, such as email, mail, or voice communication (e.g., a phone call). The user then goes to the next screen **55** of the user interface for software registration, and enters the received code **53** into a provided field. After the user clicks an Enter button **54**, the software stores the entered registration number in a special memory location.

[**0045**] The registration process described above links together the serial numbers assigned to and/or embedded in the software **34**, the interface cradle station **36**, and the computer **32** to create an authorization number stored in the database **35**. Each time the software **34** is restarted, it reads the serial numbers of each of the components to calculate the authorization number, and then compares this number to the authorization number in the database to make sure they match before operating. If the calculated authorization number does not match the stored authorization number, the software does not allow the user to access the system management functions, and the system is inoperative.

[**0046**] **FIGS. 3A & 3B** describe how the database interaction with the docking station or cradle is initiated by starting the software system which allows database accesses and data transfer to/from the database. One password is optionally required to initiate the "User" operation mode. As shown in **FIG. 3A**, after the software is started, the software presents a window **58** on the computer screen for the entering of a password. The software then presents a key control window **60** that contains various control parameters or limits for controlling the operations of the electronic key. For instance, the key control screen in **FIG. 3A** includes fields for the name of the user of the key, the ID number for the electronic key, the key type, the total number of accesses allowed, the allowed number of accesses per day, the start and end times of the operative period of the day, the expiration day and time, and the number of days in which the key is valid, etc.

[**0047**] Referring to **FIG. 3B**, when the software program **34** is started, the software presents the password window as shown in **FIG. 3A** and waits to receive a user mode password. When a password is received, the program determines whether the password is correct (step **60**). If the user password is incorrect, the software program exits from operation. If the user password is correct, the program determines whether the system is properly registered in the way described above. If the system is registered, the program works on the database **34** by eliminating old events and compacting the database (step **62**). The program then turns on the cradle **36**, and waits for transmissions from an electronic key docked in the cradle.

[**0048**] Turning now to **FIG. 3C**, to initiate a docking or refresh operation of the key **31**, the key is placed within communication distance of the cradle **36**. As shown in **FIG. 1**, the cradle **36** may have a receiving location on its top into which the key may be placed. The user then presses the transmit button **39** of the key **31** to cause the key to start transmission. The transmission from the key is received by the cradle **36** and forwarded to the computer **32**. Likewise, communications from the computer **32** are sent to the cradle **36**, which then transmits the communications to the key **31**. **FIG. 3C** illustrates that first the key **31** and cradle **36** exchange encryption messages to ensure that an authorized key is communicating with the station. To that end, the

cradle **36** includes a microprocessor for providing the processing power and has software programs including an encryption program for handling the encryption/decryption involved in the challenge-response communications and any subsequent communications. Next, if the key contains access audit data collected from vending machines in the field, the data is downloaded from the key and stored in a buffer **64**. The data in the buffer **64** may then be sorted and loaded into the database **35**. The new operation limits (see **FIG. 3A**) pre-set by a supervisor for that electronic key are then downloaded into the key **31**.

[**0049**] In accordance with a feature of the embodiment, the operation of refreshing the key and downloading data from the key is automatic, without requiring a user to oversee or activate each of the steps involved in the process. All the user has to do to initiate the key refreshing operation is to place the key **31** in the cradle **36** and press the transmit button **39** of the key, and the software program **34** will finish the operation without requiring further attention from the user or system administrator. During this process the database **35** proceeds to service the key without prompting the user to enter any information or data at the computer either before or after the key is initiated. As a result, the key refreshing operation may run in the background, without the need to have an open window on the computer screen, thereby allowing the computer **32** to be used for other operations such as word processing or communications over the Internet. To service the next key, the previous key is removed, the new key is inserted and its transmit button is pressed. Again, the database proceeds to service the key without prompting the user to enter any information or data at the computer either before or after the key is initiated. The docking or refresh operation can be performed without the supervisors present, which allows the system to perform without daily maintenance.

[**0050**] **FIGS. 4A & 4B** illustrates an advanced set-up feature of an embodiment of the key management system that is only accessible by entering a secure operating mode, which may be either the "Supervisor" or "Administrator" modes. As shown in **FIG. 4A**, the software first presents a key control window **70** similar to that in **FIG. 3A**. By clicking on the Mode option in the Menu bar, a user can select to run the software in a Supervisor mode or a User mode. Selecting the Supervisor mode causes the software to open a password entry window for either the administrator or supervisor. The user then enters the password as an administrator or supervisor into the field provided. In one implementation, an administrator oversees multiple supervisors, while each supervisor supervises multiple users to which electronic keys are assigned. When a user signs in as the administrator, he can use the software to add or remove supervisors from the key management system as well as administrating the functions of the key management system. A supervisor can use the software to add or remove electronic keys and/or key users, and set or change key limit parameters.

[**0051**] As shown in **FIG. 4B**, when audit data is downloaded from an electronic key, the software program determines whether it is in the administrator mode or supervisor mode (step **80**). If neither, the program finishes the key refreshing operation by loading new key parameters into the key. If the program is in the administrator or supervisor mode, the program checks the audit data received from the

key to see whether the data contains identifications of any vending machine electronic lock that is not found in the database (step **81**). In this regard, the audit data stored in an electronic key are collected from electronic locks in vending machines accessed using the electronic key. The audit data collected from an electronic lock contains, among other things, a serial number of the electronic lock. It is possible for the electronic lock of a vending machine to be programmed in the field to work with a given key before the ID number of the lock is registered in the database of the key management system. If the key management program finds a new lock serial number in the audit data downloaded from an electronic key, it prompts the user to enter the lock information into the database (step **82**). If the user selects not to do so at that time, the program continues the key refreshing operation. If the user selects to enter the lock information, the program present a user interface window (step **83**) to allow the user to enter information about the electronic lock (step **84**). The program then continues to finish the key refreshing operation.

[**0052**] The electronic keys contain certain key codes for access authorization purposes. It is desirable to limit which keys can be serviced by which computers such that stolen or lost keys cannot be serviced at computers they are not authorized to be serviced at. Thus, the database preferably contains a feature to limit which serial number sequence keys it will service and which it will not service. If a key is not in this serial number range, the database, computer, and software will refuse to service it. The limit parameters are usually entered into the database by a supervisor just after installing the software.

[**0053**] Key Set-Up

[**0054**] Certain set-up procedures are implemented in the system in order to make the security features of the system useful and easy to use. **FIGS. 5A & 5B** illustrate these features. First, the electronic keys need to be assigned to the employees. This is accomplished by a simple operation, as shown in **FIGS. 5A and 5B**. First, a new key never previously initialized (or not contained in the database) is placed within communication distance of the cradle station interface and the transmit button of the key is pressed. Next, the supervisor is prompted to enter the name or identifier of the user to which the key is to be assigned (step **86**). The supervisor enters the required data, and the data is stored in the database (step **88**). If it is for a new key user, the process is described in **FIG. 5B**. The software recognizes automatically that a new key is introduced into the system. In one implementation, the key indicator light stays "ON" and the cradle light stays "RED" when it is communicating with the key. Afterward, the program provides the user interface screen **90** shown in **FIG. 5B** to prompt the supervisor or administrator to assign the key to either a new user or an existing user. If the supervisor presses the "Assign New User" button **93**, the screen **96** appears for the supervisor to enter information regarding the new user who is going to use the key. After entering the information, the supervisor clicks on the "Accept" button, and the new user information is stored in the database **35**. Next, the transmit button **39** of the key is pressed again, and the program presents the key control window to allow the supervisor to set the limits for the key operation. When the user enters this name, the database links the serial number embedded in the non-volatile memory of key with the name for reference pur-

poses. Also, a set of default limits are assigned to the key in the database, such as 200 total accesses, 20 access per day, 6 AM to 6 PM operation, 7 days of operation, Monday through Friday operation. **FIG. 5A** also illustrates how only the supervisory or administrator sets the database up to allow the territory code to communicate to the database.

[**0055**] In managing the keys in an on-going basis, the supervisor may use the system to check the limit parameter status of the keys to quickly see which keys are either expired or approaching the end of their operation limit parameters. This is accomplished for example by selecting the "Edit Key Limit" menu on the main screen of **FIG. 4A**. In response, the program displays a list of the registered electronic keys and for each key the expected time and date the key will exceed its limits in a row and column format for viewing by the user.

[**0056**] Next, the electronic locks to be accessed with the keys need to be assigned to Customers, locations, and/or asset identifier numbers (identification data). **FIGS. 6A-6C** illustrate two methods. This procedure is necessary because the lock is initially identified by the database using a lock serial number embedded inside the lock non-volatile memory that is not easy or obvious for the user of the system to reference or identify to. Once each lock is referenced to a number or name that the user can more easily identify with, understanding and using the audit trail data will be more likely. There are several possible procedures for entering the lock information. Each procedure is possible even if the lock is remotely located from the computer and either cannot or does not directly transfer its serial number to the computer and database.

[**0057**] In one procedure shown in **FIG. 6A**, the lock serial number **90** is printed on a label **91** attached to the lock as an alphanumeric number or as a barcode or other identifier. This number can be visually read and recorded in a form **93** along with the customer, location, and/or asset identifier number for the lock, and then manually entered into the database **35**. The disadvantage of this system is if the serial number label is lost or not legible, it would be difficult to identify the electronic lock.

[**0058**] In another procedure also shown in **6A**, the lock serial number **90** is not printed on a label, but is read from the lock by a diagnostic tool **92** to make certain the correct serial number is recorded. This number can be visually read from the tool display, recorded along with the customer, location, and/or asset identifier number, and manually entered into the database. In this procedure, a lost label on the lock will not impede the process.

[**0059**] **FIG. 6B** describes the manual entry process of entering the collected lock, vending machine, and location information and entering it into the database. In the shown example, a key assigned to a user "Gary Myers" has visited a new vending machine that are not registered in the database **35**. The electronic lock information is time-stamped into the key when the key is used to access the lock. When the key user returns to the key management system **30** and places the electronic key into the cradle **36** for key refreshing operation, the lock information is downloaded from the key to the computer. The program notices that the downloaded key data contains new lock information not already entered into the database. For each new electronic lock identified in the key data, the program presents a "New

Lock Detected" window **100** on the computer screen showing the lock serial number and the time at which the lock was accessed. When the user clicks the "Enter Lock Information" button, the program presents a "New Lock Data" screen window **102** to allow the user to enter detailed information about the vending machine containing that electronic lock, such as the vending machine asset number, customer number, route number, date in service, and location address, etc. After entering the information, the user clicks the "Update Lock Information" button, and the information is stored into the database. The program then presents another "New Lock Data" screen for the next new lock identified in the downloaded key data.

[0060] In another procedure shown in **FIG. 6C**, the user has an electronic tool **94** that electronically reads or scans the serial number **90** from the electronic lock (either by communicating with the lock or reading the printed label) and electronically reads or scans an identifier label **95** on the vending machine **96**. This electronic reader or scanning device links the two identifier numbers together in memory. This procedure can be repeated for many vending machines for as long as the reader does not run out of memory. After the scan/read process is completed, the reader **94** can download its data into a computer that can ultimately transfer this data to the database. In this procedure, the lock and vending machine data is electronically linked, so the manual data entry procedure can be avoided.

#### [0061] Lock-Database Data Exchange

[0062] Data may be exchanged to/from electronic locks of vending machines and the key management database **35**. One method involves using an electronic key to collect the audit information in the lock and ultimately transfer this data to the database **35**. In alternative embodiments, wireless communications may be used for the data transfer. For example, the lock can communicate directly (or indirectly) through a wireless medium to a computer transceiver interface to transfer the data to/from the database. The preferred embodiment described below uses the electronic keys to transfer the access limits and the audit trail information, but this invention is not limited to this method.

[0063] During service of the key **31**, data is exchanged from the key to the computer **32** and from the computer to the key as described in **FIG. 11**. Before this exchange takes place, the cradle **36** is in the receive mode, wherein any transmission signal from the key will initiate the data exchange process. The timing and sequence of the data exchange is automatic, and it is only necessary to initiate one start operation at the key to exchange the data in both directions. The communication between the key and the cradle is preferably protected by bi-directional encryption methods. During the process, the program determines whether the key is transmitting to the cradle (step **110**). If the key transmission is received, the program determines whether the key is an existing key or new key (step **111**). If the key is an existing key, the data stored in the key is downloaded from the key (step **112**). The program then checks whether the key parameters are healthy (step **113**). If so, the program retrieves or recalculates new limit parameters for the key, resets the clock in the key, and uploads the limit parameters into the key (step **114**). The computer will proceed to service the key provided it is authorized to do so. Such authorization may be provided in the database locally

stored on the computer hard drive. One can have such authorization at multiple computers if the authority is granted.

[0064] In the event of multiple computers authorized to service the same keys, rather than having multiple computers with multiple databases local to the respective computers, it may be more convenient to have one database residing on a central server or shared drive so more than one computer and cradle can be used to service the keys. Thus, the authority to service the key resides in one database and all of the data exchanged is managed in one database rather than multiple databases. In that case, the data exchanged from the key to the computer may be immediately transported to the database or stored locally at the computer and later processed by the computer and loaded in the remotely located database. This may be a more desirable process since the data transfer may be very time consuming during heavy traffic hours on the network and may better and more reliably be transferred during low traffic times.

[0065] During this data exchange process, the health of the electronic key can be diagnosed. For example, the clock in the electronic key is read by the computer and compared to the clock in the computer. If there is a mismatch in time, the computer can alert the supervisor that the key can a faulty clock or battery. Likewise with the memory in the key. If the data exchange process is not successful, the battery or the memory may be suspect to be faulty, and the computer will display this fault for the user or the supervisor so the battery can be replaced or the key taken out of service.

#### [0066] Audit Data

[0067] During service of the key, the vending machine audit data collected by the key is downloaded from the key to the cradle **36**, next to the computer memory buffer **64**, and last to the database **35** of the computer. The data is managed by the supervisor by allowing each lock serial number to be identified in the database by the customer, location, and/or asset identifier number as previously described is set-up. The software may allow several options for managing this data in the database. This process is executed only one time for identifying the asset number, and one time for each time the vending machine is assigned to a customer or a location. The processes for identifying this data are as follows:

#### [0068] Pop-Up Request Process

[0069] **FIG. 6B** illustrates this process. In this process, the software will run a test while in the supervisor mode that will search the lock serial number in the data base. If no such number is identified, the software will prompt the supervisor to enter the data. The software will provide as much information about the vending machine as possible to help for the identification, such as the time and data the lock was first put into service or accessed.

#### [0070] Manual Process

[0071] The software will provide a menu to select the identification process. Next, a drop down list will list in numerical order all lock serial numbers that are not identified. Next, the user will select the lock that he/she wishes to identify. After selected, a screen is provided to enter the data. Also provided is a field for entering the effective data in case the identification data is entered several days or weeks after the data the data is valid.

[0072] This process can also be executed when viewing audit events from the database. In this situation, the lock serial number is displayed to identify the vending machine (in lieu of the vending machine asset number, customer, and location data). By selecting this number from this display position and clicking, the screen to enter the vending machine data will pop-up for ease of data entry.

[0073] FIG. 6B also illustrates that this process is also used after a lock is identified but the user wishes to change or modify some of the data, such as changing the customer information or location if a vending machine is moved or relocated. In this situation, the effective date field is used to properly record the exact date the change took place in case the data entry follows the change by a delay period.

[0074] Automatic process. It is possible for the identification data to be transferred automatically into the lock database. This identification data will be entered separately from another computer and/or database which separately contains the vending machine identification data.

[0075] Referring now to FIG. 7, as audit data is received from the key it is compared to previous data in the database. Since one or more key may bring duplicate access audit data back to the same database, it is necessary to compare the new data received from the keys with the data presently in the database and discard the like data so duplicate access data is not stored. To that end, when the program receives data downloaded from the key regarding an access attempt event (step 120), it searches the database for any event that is duplicate to the downloaded event (step 121). If a duplicate event is found in the database (step 122), the downloaded event is discarded. Otherwise, the event is stored into the database (step 123), and the program moves to the next event described in the downloaded data.

[0076] If access data is determined to be new, it is stored in the database 35. Suitable data sorting techniques are preferably used in order to efficiently store this data, and to efficiently retrieve this data in the future, and in the future compare this data to new data collected. The software shall be configured such that the audit information in the database cannot be modified or deleted, either accidentally or on purpose, in order to preserve the integrity of the security monitoring system. After audit data is stored in the database, certain data sorting techniques are required to make the viewing of the data useful.

[0077] For example, FIG. 8 illustrates it is possible to sort and view the data by Access, by Driver or Employee, by Asset number, or between certain time and date periods. Each of these sort parameters can be combined to sort multiple combinations of parameters. Also, as the audit information is displayed, unusual activity that occurred before or during the access event can be displayed, such as Battery Removed (from key), Bad Route, Limited, and Unauthorized. To view the audit trails data, the user either clicks the "Audio Trails" button at the bottom of the Key Control Data screen 126 or use the task bar menu. This function is only available to supervisors and administrators. The program then displays the audit trails screen 128. The bottom portion of the screen 128 presents sorting options that allow the data to be sorted in various ways, such as by time, access, key user, or asset number, etc. Different combinations of these options may be used to refine a search.

[0078] The audit trails data may also be printed. In one implementation, the printing options available are "Auto-

matic Audit Printing" and "Print Current Screen." Automatic printing allows for printing when a key refresh is executed and prints all the new events the key has encountered. The audit screen does not have to be displayed on the computer screen to enable printing.

[0079] Limiting Operational Parameters for Keys

[0080] Limiting operational parameters are available for keys. To ensure the security of the system, in a preferred embodiment such new limits can be assigned only when the computer is in the Supervisor or Administrator modes. FIGS. 9A-9C and FIG. 10 illustrate the process.

[0081] In FIG. 9A, if the supervisor wishes to assign a custom (non-default) set of parameters to this key, he selects the "Edit Key Limits" option in the menu bar of the screen 130 and then selects the "Set User/Key Limit" option from the drop-down menu (step 138 of FIG. 9C). In response, the system program presents a drop-down list 132 of keys (by names assigned to the keys) which also displays the expiration dates of the keys (step 140 of FIG. 9C). Next, as shown in 9B, the parameter customization screen 136 is displayed by selecting the user or key. This screen shows the key parameters since the last key refresh operation. For security reasons, the software tracks which supervisor last authorized limit changes. By clicking on the two buttons "View Present Limits" and "View Previous Limits," the user can see when the last changes were made on the key and by which supervisor (step 142 of FIG. 9C). On this screen, the pointer will move the cursor to the parameter the user wishes to change. The user then enters the desired value (step 144 of FIG. 9C). After typing in the change, another parameter may be selected and changed. When all parameters have been changed, the "Accept" button is selected to record the new parameters in the database (step 146 of FIG. 9C). At the time these are stored, the name of the supervisor operating the computer is also stored to archive the authorization in case a key is given limits beyond their approved level and an audit of who assigned these unauthorized limits is required.

[0082] A "Disable FOB" button 137 is provided in the screen 136 to disable the key at its next refresh. In this regard, if the key reaches any of the limits, it will become disabled. The key will indicate that it is disabled by flashing brightly three times when the key is in the cradle and the transmit button of the key is pressed.

[0083] After the new parameters have been stored, prior parameters for this key are also kept in the database for easy viewing. In addition, the time and date of the prior docking event and the parameters can be stored and easily viewed.

[0084] Later, in a key refreshing operation, the button of the key is pressed on the key and the limit parameters are loaded into the memory of the key. FIG. 10 illustrates by way of example the process of re-calculating the limit parameters during the key refreshing operation. The program 34 takes the limits defined for the key from the database (step 150) and, at the time of refresh, using the existing date and time to calculate certain date specific limit parameters such as the date the key should expire and the days the key should operate (step 151). Last, these parameters are loaded into the key (step 152). This process allows the supervisor to maintain work schedules in the database for each employee and as long as the schedule does not change the expiration limits will be properly re-calculated at

the time of each refresh. Thus, the supervisor does not need to maintain key parameters on a routine basis, as they are automatically calculated at each refresh based on the database information for each key.

[0085] It is advantageous to provide the capability of more than one docking station or cradle to service the same keys and vending machine locks. This is accomplished by providing a mechanism for either (1) multiple cradles communicating with multiple databases, wherein these databases would be synchronized and merged from time to time (FIG. 12); or (2) multiple cradles communicating with a single central database (FIGS. 13-15). The advantages and disadvantages of each configuration are described below.

[0086] Multiple Cradles Communicating with Multiple Databases:

[0087] In one configuration illustrated in FIG. 12, multiple cradles are located at multiple separate locations, with each cradle interfaced to a PC containing separate databases. For simplicity of illustration, FIG. 12 shows only two cradles 160 and 161 attached to computers 162 and 163, respectively, but more cradles and computers at other locations may be included. In the illustrated embodiment, the database 164 is accessible to the computer 162, and the database 165 is accessible to the computer 163. The databases 164, 165 may be local to the computers 162, 163, respectively, or may be at remote locations and connected to the computers via network connections. It is possible to allow electronic keys to visit and be refreshed by more than one cradle/database. One way to accomplish this is to initialize each key into one cradle 160 or PC database 164. Once each key 31 is initialized, the databases 164 and 165 may be synchronized. Synchronization is accomplished by exchanging the key and vending machine lock data from one database 164 to another 165 and vice versa until all databases share the same key and vending machine lock data. This may be accomplished, for example, by creating an "export" file by the export utility from each database that contains the key and vending machine data of the database. The user interface screens 167 and 168 for this operation are shown in FIG. 16. In the screen 167, the user selects to export the database, and in the screen the user identifies the path to the database file. In the illustrate example, the export directory contains the file DBOut.mdb as the container of the export file. The export file may be stored on a transportable medium, such as a floppy disk, a CD ROM 157, a USB key, a memory card, etc. Alternatively, the export file may be transmitted to another computer via a network 158, preferably in an encrypted format to ensure the security of the transmission. This export file 166 is next presented to another computer database by using the import utility. This import utility will search for data in the export file that is not in the local database, and load this new data into the local database. If the data presented by the export file is a duplicate of data already existing in the database running the import utility, the data is not imported as a duplicate and is discarded. For example, if a vending machine lock serial number and location is in the export file 166 and presented to the database 164 by the import utility, but already exists in the database, it is not entered into the database. This import and export procedure should be executed on a regular basis and the key and vending machine data will stay consistent in each database.

[0088] Multiple cradles communicating with a single database: In an embodiment of this configuration shown in FIG. 13, multiple cradles 171, 172, 173 are located at multiple remote locations, each interfaced to a separate PC 174, 175, or 176 that has access to a shared database 180 via a network connection such as a local-area network (LAN) 179. Since there is only one database, there is no need for synchronization. In this embodiment, each cradle and PC has access to send/receive data to/from the network-centralized database 180. There are several issues about giving access to the central database 180 to more than one computer. One such issue is if two computers attempt to access the database at the same time, data could be lost or over-written. Another concern is the time it takes to access and communicate with the database. For example, if a significant amount of data must be downloaded from a key at one station, this download process could take several minutes to finish. If another key is also trying to download data and receive new access limits from another computer and cradle, the waiting time could be significant.

[0089] Thus, it is a feature of the embodiment to provide multiple cradles with access to the same database and provide a fast refresh time so employees are not delayed waiting for their keys to be refreshed. One mechanism to accomplish this is for each computer 174, 175, 176 to hold a refresh buffer 181, 182, or 183 locally in its PC in order to allow for fast refreshes during busy working hours, and during non-work hours when network traffic is minimized the PC will upload it's data in the database 180 on the network. Also in this example the local PC may use the refresh buffer as a local database, or use a separate database, for holding the key limit data. This allows fast refresh of key limits, and would store the audit trail data in the buffer. A copy of the shared database is downloaded from the shared drive by each station and stored locally. In the case the connection to the shared database 180 is interrupted, each individual station can continue servicing keys without interruption using the local database. In this mode, typically no changes or additions are allowed to the database such as key limits and vending machine information.

[0090] Database Compacting and Archive:

[0091] Compacting and Archiving of the database are tasks that need to be executed at a frequency dependent on the amount of data that is being added to the database. The more data that is added, the more frequent these task should be executed. In one embodiment, the system allows the user to select an automatic compacting and archiving of the audit trail data. Also allowed is selecting automatic exiting of the software and automatic login of the software at selected intervals. FIG. 17 shows a user interface screen 190 for a user to select the parameters. In this example, the user selects the system will automatically compact and archive each 45 days. Also selected is the path & location of the archive 192. In addition, the system is capable of monitoring the amount of data entering the database and executing an automatic compaction and archive if a certain volume of data is moved into the database.

[0092] System Start/Exit

[0093] The system is capable of automatically starting up and exiting from operation on a daily basis. The start and stop times can be pre-determined and entered into the system as a scheduled task. FIGS. 18-20 show a sequence

of user interface screens **193, 194, 195, 196, 197, 198** to illustrate an example of how the system is scheduled to start-up at 4:00 AM every day. **FIGS. 21-22** contains user interface screens **200, 201** that illustrate an example of how the user selects the system to automatically exit from operation at 1:30 AM each day.

[0094] In an alternative embodiment illustrated in **FIG. 14A** referred to as the pre-enterprise configuration, the single database configuration uses a dedicated database server **208**. This configuration contains all of the above-described features from the LAN network single database embodiment, while each station is allowed to access a dedicated database server **208** (SQL, Oracle, etc). A local station **210** connecting to the database **209** will be accomplished using the standard "Data Source (ODBC)" included in all Windows operating systems. After connection to database is accomplished, the user uses the key control operation features the same as in the previous configuration. Potential advantages of this configuration are increase database reliability, faster response time on accessing, changing, or adding records to the database, and significantly less data traffic.

[0095] Referring to **FIG. 14B**, the added capacity of a dedicated database server **208** can be used by mounting multiple databases **211, 212, 213** for serving multiple locations **221, 222, 223**, respectively. In such instances the databases **211, 212, 213** can be identified by the specific city code, or group of city codes each database represents. A location can be, for instance, a cluster of bottling stations and/or a bottling station and several satellite locations. Stations from each location are assigned rights to access only the database they are associated with. For instance, computers at the location **221** may access only the database **211**, and computers at the location **222** may access only the database **212**. This configuration adds the benefit of creating global access reports that will include reports from all locations. Another benefit of this configuration is the option of remote control and administration of database from a remote location. For example, if appropriate rights are assigned to Station **225** at Location **221**, this station can manage keys, users and vending machines at location **221** as well as the other locations. By using a LAN type network, the security of this configuration should adequately prevent hackers from gaining access to the database and the security of the system.

[0096] In another alternative embodiment of the single database configuration illustrated in **FIG. 15**, a web server **230** connected to a database server **231** is used. This configuration is referred to as the Enterprise configuration. Each of the individual stations uses a simple web browser (e.g., Internet Explorer, Netscape, Opera, etc.) to communicate with the web server **230** to access the database or databases **240** maintained by the database server **231**. In this way, the individual stations can accomplish functions related to key refresh, adding keys and users, adding vending machines and asset numbers, and modify key settings as in the previously described configurations. In the event of lost Internet connection, the stations in this configuration operate a simplified version of the software as described in **FIGS. 13 & 14** for refreshing keys while the connection with the web server **230** is severed. One benefit of this configuration is the ability to use the Internet infrastructure to create a wide-area network for remotely operating the stations and thus elimi-

nate the need to support a separate or dedicated structure to accomplish the same. Another benefit of this configuration is that software updates for the functionality of the stations as well as adding and deleting stations will be done in the web server and may not require user intervention at the station when these tasks are performed. One potential disadvantage is that hackers may attempt to get access to the database since the network is accessible to almost anyone with a browser and access to the web.

[0097] An enhanced electronic key may be provided with additional hardware and software features to enhance the security, tracking, audit data control, and assisting of the employee to fill and service the vending machine. **FIG. 23** is a functional block diagram of the enhanced electronic key **300**. The key **300** has a microprocessor or microcomputer **301**, a non-volatile memory **302**, a real-time clock **307**, and a battery **312** for powering the components of the key. The memory **302** may contain software and data required for the operation of the key, such as key codes, an encryption code for use in encrypting and decrypting communications with an electronic lock, encryption/decryption algorithms, backup clock data, power-up counter. The key memory may also contain data collected from vending machines, such as access audit data and vending machine inventory data.

[0098] The key **300** includes a two-way communication module **303** with a transceiver **310** for two-way communications with the electronic lock **299** of a vending machine. The key may also include user interface features **304** such as a keypad, touch screen, or buttons with specific functions. An annunciation component **305**, such as LCD screen, may be included for displaying key-lock responses, text messaging, email, etc. The key may include another two-way communication component **306** that has a transceiver **311** for communicating wirelessly with a home-base **298**.

[0099] As a feature of the embodiment, the electronic key **300** may further include a position sensing component **308** for identifying the current location of the key. This component, which may include an antenna **309** and may be internal or external to the key, may be based on one of the positioning systems such as GPS, DGPS, LORAN, etc.

[0100] The advantage of including the position sensing system component **308** in the key is that ability to track the location of each key used to access the vending machines. For example, electronic keys that include location tracking would pinpoint the geographical location of each vending machine the user of the key was attempting to access. Thus, and audit event for an access attempt would consist of the user of the key, the key code, the date and time of the attempt, the limits (if any) of the key, the serial or ID number of the vending machine, and the physical location (preferably at least 2-dimensional latitude and longitudinal coordinates, and possibly the third dimensional or altitude coordinate) of the vending machine being accessed. These coordinates could be translated by computer to common street address and location (for example, 100 W. Plainfield Rd, Countryside, Ill., second floor, suite 202).

[0101] When an electronic key has the capability of obtaining the location coordinates of a vending machine (either by receiving these coordinates itself by a position sensing system or by communication with a position sensing system at the vending machine location), the previously described step of reading the serial number of the vending

machine (with a reader tool, or a bar code reading device, or by the electronic key) and entering the vending machine location data into the computer **32** manually may be eliminated. Since the electronic key will produce or receive the location coordinates at the time it attempts to access the vending machine, this data can be provided to the database as the vending machine location in lieu of a manual entry, which is subject to human error.

[0102] An additional benefit of the position sensing feature in the electronic key **300** is the ability to keep track of and/or locate keys if they are lost or stolen. Since this key has the data exchange feature described above, it can transmit its location coordinates to the central or home-base location or to a person possessing a computing device that would receive the location information.

[0103] An additional feature of this key **300** is the data transfer capability. In addition to its capability of transferring data in short range to the docking cradle (as described for other keys in this system) this key may be equipped with the capability to transmit and receive data over longer distances. Thus, as a key is being operated the audit data and the vending machine sales and inventory data would be transferred back to a central or home-base location. The enhanced communication capabilities would include text messaging and email in order for the person using the key to send and receive information concerning the route they are working on, changes and additions, reports, etc.

[0104] Monitoring and/or Tracking Keys and Other Items

[0105] The present invention is directed to a security system and method for monitoring the locations of mechanical keys or other access control devices, and to provide secured storage for the keys. Although the security system and method of the invention are especially advantageous for managing access and use of mechanical keys, they can also be used to monitor and control access to other types of valuable items.

[0106] In another implementation based on the embodiment described in FIG. 23, the electronic key **300** utilizes the GPS position data to decide if it is enabled for operation. To that end, the electronic key **300** includes additional registers or memory space for storing limiting parameters concerning the relative position of the key for deciding whether the key should be enabled or disabled. The position limiting parameters may, for example, specify the coordinates of areas in which the key **300** is allowed to be used to access locks of vending machines. The position limiting data may be downloaded to the key **300** during a refresh operation when the key is placed in the cradle of the key management system (e.g., at the bottling facility) as described earlier. Alternatively, the position limiting data may be received by the key **300** wirelessly via the transceiver **311** when the key is in the field. In operation, the GPS receiver **308** receives position data indicating the current position coordinates of the key **300**, and forwards the data to the processor of the key. The key **300** compares the received position data with the position limiting data stored in it to determine whether the key is in a valid territory for operation as specified by the position limiting data. If the key is in a valid territory for operation, when key is actuated by the user, it will proceed with the unlocking operation, if the other operation limiting parameters are not exceeded. If,

however, the key is not located in a valid territory, it will enter a disabled mode and cannot be used for accessing locks. If the key is later moved into a valid territory, it receives updated position coordinate data from the GPS receiver and determines that it is now in a valid territory, and returns to the enabled mode so that it can be used to access locks.

[0107] Turning to FIG. 24, in accordance with a feature of one embodiment of the invention, a monitoring device **320** is provided to allow the tracking of the whereabouts of access control devices, such as mechanical keys **316**, so that the locations of the access control devices at different times can be monitored either in real time or audited at a later time. It will be appreciated, however, that the monitoring device **320** can also be used to track the locations of other valuable items such as remote control devices, fire arms, tools, appliances, etc. The monitoring device **320** is equipped with the capability of identifying its location, which may be implemented in different ways. In the embodiment shown in FIG. 24, the monitoring device **320** is equipped with a Global Position System (GPS) device **322** for identifying the current location of the monitoring device. Other types of positioning devices/systems can also be used. The monitoring device **320** also has a digital sensing and recording circuit **326** that includes a microprocessor **327** and a memory **328**. The sending and recording circuit **326** allows the monitoring device to detect the current location through the GPS sensor **322**, and record the location data in the memory **328** for auditing purposes. A clock **330** provides time information, which may be stored in the memory as part of the location and event records.

[0108] As shown in FIG. 24, the monitoring device **320** is attached to or associated with the mechanical keys **316** or any other device being monitored (hereinafter sometimes referred to as "DBM"), such as the device **318**. Due to the association between the monitoring device **320** and the items to be monitored, the location of the monitoring device is also that of the items being monitored. To that end, the monitoring device **320** is preferably attached to the mechanical keys **316** and other DBM's in a way such that they cannot be easily separated. The means **338** for attaching the monitoring device **320** and the items being monitored may be, for example, a steel cable or closed ring. Alternatively, the monitoring device **320** may be built into a device being monitored **318**, instead of being a physically separate device.

[0109] The monitoring device **320** is used to monitor, record, and annunciate the location and activity of the devices being monitored, such as the mechanical keys **316**. The recording circuit **326** tracks the location of the monitoring device (and thus the location of the keys **316**) and records in the memory **328** the locations at different times. Thus, the recorded data provides a history of where the monitoring device **320** and the items attached thereto have been. The recorded data preferably includes the date and time of the sensed locations. In addition, the recording circuit **326** may also record the date and time of any detected activity of the devices being monitored.

[0110] To enable the monitoring device **320** to communicate with other devices, the monitoring device further includes a communication port **331** and a transceiver **332**, which preferably transmits and receives signals via a wire-



less band, such as infrared or radio frequency. The communication port **331** allows a computer to download the position and time data from the monitoring device **320** at a convenient time. For example, after a driver for a vending machine route returns to the company at the end of the day, the data from the monitoring device **320** attached to the keys **316** assigned to that driver can be downloaded to a system management station like the one in the embodiment shown in **FIG. 1**. In this way, it can be determined whether the driver has stayed on the vending machine route as scheduled or has deviated from that route. If real-time location monitoring is desired, the wireless transceiver **332** can be used to transmit the location data in real time to a remote receiver, such as one located at the company.

[**0111**] The monitoring device **320** can also be used to monitor and record other information that may indicate the activities occurring to the items being monitored and whether there have been attempts to tamper with the items. For example, events or conditions that are electronically measurable, such as the motion, temperature, barometer pressure, and ambient light, etc., can be sensed by respective sensors **340** in the monitoring device **320** and recorded for later analysis. Also, if the GPS sensor **322** is not in operation or has been disabled or cannot receive a signal, the monitoring device **320** can rely upon the activity sensors **340** to detect activities or changes of conditions. Thus, in this sense, the activity sensors **340** can be used to supplement the location identification by the GPS sensor **322** to provide more information that can be used to determine what may have happened to the items attached to the monitoring device. The parameters detected by the activity sensors **340** can be recorded locally (i.e., into the memory **328**) and downloaded at a later time for analysis. Alternatively, the parameters can be transmitted by the wireless communication component **332** to a remote receiver to provide real-time information about activities concerning or surrounding the devices being monitored.

[**0112**] For purposes of interfacing with a user, the monitoring device **320** has a display **334** for displaying information and a keypad **335** that can be used to enter data and commands. An audio annunciator **336**, such as an audio transducer or a buzzer, provides auditory information which may be used to indicate the various states of operations.

[**0113**] In accordance with another aspect of the invention, a security container with an electronic lock system and a closure that may be used to store the mechanical keys or other items in a secured manner to protect them unauthenticated access. The security container is configured to ensure that the mechanical keys or other items to be protected are actually present in a secured location within it. The secured container is especially useful for storing items that are frequently taken out from and returned to it. For example, a driver for a given route of vending machines may receive the mechanical keys **316** for accessing the vending machines at the beginning of a workday, and return the keys to the company at the end of the work day by placing the keys into the secured container. The security container of the invention can be advantageously used to store the returned keys and to record the time the keys are returned and the time the keys are taken out again. A detection mechanism of the security container ensures that the keys are actually placed in the container and stay in the container until the next time the keys are taken out.

[**0114**] In one embodiment shown in **FIGS. 25A-D**, the security container is in the form of a safe **350**, and the closure is a drawer **352**. The safe **350** is illustrated in **FIGS. 25A-D** in a top view as a cabinet. The drawer **352** is movable between an open position as shown in **FIG. 25A** and a closed position as shown in **FIG. 25B**. In this embodiment, the safe **350** does not have a door, although a door may be added to provide further protection from attempts to physically break into the safe. Items **353** to be protected, such as mechanical keys, are placed into the drawer **352** when the drawer is in the open position. The drawer **352** is then closed with the items to be protected in it. In this way, the items to be protected are placed in a secured position before the safe can be locked. The term "secured position" as used herein means that the items in that position are not accessible from outside the security container. Placing the items in the secured position, however, does not mean that they are locked in that position. For example, as shown in **FIG. 25B**, the space in the closed drawer **352** represents the secured location, but the drawer may not be locked at that point and thus may still be pulled to expose the items to be protected. It will be appreciated that a closed drawer in a safe is only one example of providing a secured position, and there are many other ways to provide a secured position depending on the detailed implementation of the security container.

[**0115**] In accordance with a feature of the invention, the security container is configured such that it does not lock up unless the items to be protected are detected in the secured position. This feature ensures that the items to be protected are actually placed in the security container. It prevents, for example, a dishonest employee from pretending that he has returned the mechanical keys assigned to him to the safe **350** by opening and closing the drawers **352** without actually leaving the keys in the drawer.

[**0116**] To detect the presence of the items to be protected, the safe **350** is provided with a detector **356**. By way of example, in **FIG. 25B**, the drawer **352** is closed with the items **353** to be protected in it. The detector **356** of the safe then tries to detect the presence of the items **353** to ensure that the items are really in the drawer **352**. If the items **353** are detected in the drawer in the closed position (i.e., the items are in a secured position), the safe **350** locks the drawer in the closed position, as illustrated in **FIG. 25C**. In this embodiment, the locking is by means of a latch **354** of the electronic lock **355** of the safe. An audit trail record is created for the locking event to indicate that the items **353** have been locked in the safe. Later, the safe may be unlocked using an authorized electronic key **358**, and the drawer **352** may be opened to allow retrieval of the items **353**, as illustrated in **FIG. 25D**. Another audit trail record for the unlocking event may be created to indicate that the safe has been unlocked to allow removal of the items **353**. The audit trail records for the locking and unlocking events may be stored in the memory of the electronic lock of the safe and later transferred to a computer system for auditing.

[**0117**] On the other hand, if the drawer **352** is closed, but the detector **356** cannot detect the presence of the items **353** inside the drawer, the safe **350** will not lock the drawer, and will not record a locking event. As a result, the items can still be accessed by opening the drawer, and the person attempting the locking event is still responsible for the security of the items as he has no proof that the items has been locked in the safe.

[0118] The electronic lock 353 of the safe 350 includes a locking mechanism 364 controlled by a lock control circuit 363 as shown in FIG. 26. A receiver or transceiver 362 allows the lock control circuit to receive an access code from an external access control device such as the electronic key 358 shown in FIG. 25. Referring to FIG. 27, the lock control circuit 363 includes a microprocessor 380, a lock actuator drive 381 controlled by the microprocessor for actuating the lock, and a non-volatile memory 382 for storing data. The data stored in the memory 382 may include an access code for unlocking the safe, a locking code that when received from an external device will trigger the actuation of the lock, and encryption codes for encrypted communications. The memory 382 further stores audit trail data for the lock/access events of the safe. The lock control circuit may also have components for user interface, such as push buttons for various functions.

[0119] To detect the presence of the items to be protected, the safe lock control circuit 363 further includes a detector 356, which may be placed together with the rest of the circuit or at a separate location in the safe, depending on the detection mechanism used and the physical layout of the safe. Returning to FIG. 25, the detector 356 detects the presence of the items to be protected when the items are placed in the secured position. In the embodiment shown in FIG. 25, this means that the detector 356 will detect the items 353 when they have been placed in the drawer 352 and the drawer is closed.

[0120] Various ways may be used by the detector to detect the items to be protected. For instance, the detector may use optical sensors to detect the presence of the items.

[0121] Alternatively, in a preferred embodiment, the detector may cooperate with an identification device attached to the items 353 to facilitate the item detection. The identification device may transmit signals, interact with the detector via two-way communications, or otherwise enable the detector to determine its presence. Since the identification device is attached to the items to be protected, the detection of the identification device by the detector is an indication that the items to be protected are also present in the secured location. The identification device may be attached to the items to be protected by different ways, such as by means of gluing, strapping, mechanical fastening, chaining, etc., to provide a reliable association between the items 353 and the identification device.

[0122] In the embodiment shown in FIGS. 25A-D, the identification device is a transponder 390 attached to the items 353 by means of an attachment device 351, such as a ring. The transponder 390 may be an item different than the items 353 to be protected, or may be built into the items to be protected. The transponder 390 may transmit and receive signals to and from the detector 356 to allow the detector to sense its presence. The communications between the detector and transponder may be implemented in different ways, such as via a cable or through wireless transmissions in infrared or radio frequency. To enhance the security of the system, the communications may be encrypted, using encryption codes stored in the lock memory 382 and the transponder 390. The use of encrypted transmission would prevent a dishonest person from creating a fake locking event by placing an unauthorized transponder in the safe to deceive the detector.

[0123] In this regard, the transponder may be a part of an electronic key similar to the electronic keys for vending machines as in the embodiments described earlier. The electric key may be, for example, put on the same key ring with the mechanical keys. When the keys are moved to the secured position, the detector 356 communicates with the electronic key to determine that a valid transponder has been put in the secured position, and then locks the drawer 352 so that the electronic key with the mechanical keys attached to it are locked in the secured position.

[0124] Optionally, a location identification device, such as a GPS device, may be attached to the items to be protected to allow detection of the location of the items in the safe. This location identification device may be integrated with the transponder 390, or may be a separated device. For example, FIG. 25A shows a monitoring device 320 optionally attached to the items 353 to be protected. As mentioned above, the monitoring device 320 may include a GPS sensor for location identification. The GPS sensor in the monitoring device allows the detection and recording of the location of the items attached to the monitoring device 320. The location of the safe can also be monitored this way, if the safe is being moved around, for example in the case where the safe is mounted in the vehicle of a driver for a vending machine route, or in the case where the safe has been stolen and removed from its normal location.

[0125] In accordance with a feature of the invention, to prevent falsification (or "spoofing") of item detection, it is advantageous to make the communications between the detector and the transponder short-ranged or directional, so that the detector can detect the presence of the transponder only when the transponder is placed in the secured location in the security container. For example, in the embodiment in FIG. 25B, the detector 356 can detect the transponder 390 only when the transponder is placed in the drawer 352 and drawer is pushed in to the closed position. This feature is intended to eliminate the possibility of a dishonest user attempting to defeat the security by keeping the items outside the safe while simultaneously triggering the link between the detector and the transducer to cause the locking operation of the safe. Thus, the detection link is preferably designed to prevent the possibility of devices such as waveguides, light pipes, extension wires, mirrors, repeaters, etc. being used to cause the detector to decide that the items to be protected are in the secured location when they are not.

[0126] One example of preventing such deceptive tricks is to develop the communications between the detector and the transponder to be optical in nature so as to be highly directional. For instance, the transmission of the signals may be in the infrared band, and the detector may be located such that it can only receive or transmit signals over a very narrow angle. Another example is to set the power of communications between the detector 356 and the transponder 390 such that the communications are short in range, thus preventing the reception of deceptive signals sent over a long distance. This can be accomplished by either reducing the transmission powers of the detector 356 and transponder 390, or reducing their reception sensitivity. In this regard, the effective detection range for the detector 356 to sense the presence of the transponder 390 should be set according to the distance from the detector to the expected storage location of the items in the safe. For instance, for a small safe less than 1 cubic-foot in volume, a short detection range of

several inches may be used, while in a large safe the detection range should be increased accordingly while still kept sufficiently short to prevent the detector from being able to sense the transponder when the latter is outside the safe. The high directionality of the transmission can be combined with the short communication range to enhance the effectiveness of the spoof prevention.

[0127] Once the presence of the items 353 to be protected in the secured location is detected, the electronic lock control circuit 363 actuates the lock 355 of the safe 350, thereby locking the items inside the safe. As part of the locking operation, an audit trail record is created for the storing and locking event. The audit trail data can be produced and stored either at the beginning or at the end of the lock event, and typically may include the time and date of the event. If a location device, such as a monitoring device 320 with a GPS sensor, is attached to the items, the location data can also be stored as part of the audit trail record. The audit trail record may be stored into the memory 382 of the lock control circuit of the safe. Alternatively, the audit trail record may be stored into a memory of the monitoring device 320, if the transponder is part of the monitoring device.

[0128] The detector 356 can monitor the item being locked in the safe before, during, and after the locking event to confirm that the items 353 are indeed in the safe when the safe is locked. After the items 353 are successfully locked in the safe, it may be advantageous to constantly or intermittently confirm that the items remain in safe while the safe is locked. For example, this may be accomplished by (a) the detector 356 maintaining constant or intermittent detection of the transponder 390, (b) the transponder maintaining constant or intermittent signaling to the detector, or (c) the transponder maintaining constant or intermittent detection of the detector. This feature will further discourage a dishonest person from rigging up an apparatus to trick the safe into locking without the items in it, because even if the safe can be somehow tricked into locking, the subsequent reconfirmation operation will show that the items are actually missing from the safe, and as a result audit trail records will be logged to alert an auditor of the records the breach of security.

[0129] Optionally, a monitoring device 320, like the one used in embodiment of FIG. 24, can be attached to the items being protected to detect any unusual event while the items are in the safe. The monitoring device 320 is placed in a monitoring mode in which it monitors the states of its activity sensors in addition to the GPS sensor. For example, if the motion detection sensor of the monitoring device senses movement, the monitoring device 320 can communicate with the detector 356 to ensure that it is still locked in the safe (i.e., the detector can still detect its presence).

[0130] If at any time the communication between the detector and the transponder is lost or missing after the safe is locked, the electronics of the safe lock may log an audit trail record to indicate that event. Alternatively, if the transponder is part of the monitoring device 320 or has a communication link with the monitoring device, the monitoring device may log an audit trail record in its memory if the communication link between the detector and the transponder is broken. In addition, the safe lock electronics 363 or the monitoring device 320 can transmit an alarm signal,

such as an audio alert signal for alerting a local user or a wireless signal transmitted to a remote monitoring station, to indicate a possible breach of security.

[0131] To determine the timing of the access/locking events for generating the audit trail data, the lock control circuit 363 may include a clock 386. The clock is optional because the time information may be provided by the transponder 390, and/or by an external access control device such as the electronic key 358 used to access the safe, and the time data may be transferred to the electronic lock circuit 363 of the safe during a communication event. Thus, the safe is not required to keep and maintain a clock in its electronic lock control circuit.

[0132] The transponder 390 and the electronic key 358 used to access the safe need to be synchronized or linked to the safe lock, so that duplicate devices (i.e. other transponders or keys) cannot be substituted in their place to overcome the security of the system. To that end, in one implementation, each transponder contains a unique identification (ID) code, such as a serial number. This unique ID code is "learned" by the electronic lock circuit of the safe during a setup operation, in which the ID code is transferred to the lock circuit and stored in the lock memory. Similarly, another unique ID code is assigned to the electronic key 358, and that code is also transferred to the lock memory during the setup operation. The code transfer process may be initiated by the user pressing a learn button 385 to put the lock control circuit 363 in a learn mode, and the electronic key and transponder are then actuated to wirelessly transmit their access codes, including the respective ID codes, to the lock circuit. Alternatively, the access codes of the electronic key and transponder may be transferred to the lock control circuit of the safe via the communication port 394. Alternatively or additionally, it is also possible to synchronize or link the transponder and the electronic key to the safe lock by transferring the codes from the safe lock to the transponder and the electronic key.

[0133] Thereafter, the ID codes learned into the lock memory will allow the safe lock control circuit to work only with those particular devices identified by those codes. When the detector 356 receives transmissions from a transponder 390, the lock control circuit compares the ID number in the received transmissions with the ID numbers stored in the lock memory. If no match is found, it is an indication that an unauthorized transponder is being used, and the safe will not trigger a locking event. In addition, the safe stores an audit trail record in the memory to indicate the detection of an unauthorized transponder. In this regard, the safe may store in the lock memory an audit trail record each time it detects a transponder when it is in the unlocked state, regardless of whether the transponder has been properly registered with the lock circuit.

[0134] In accordance with a feature of one embodiment of the invention, the safe is provided with the capability to display or read out from the lock electronics information regarding the items locked inside the safe. The information to be read out may be, for example, a code, ID number, or name associated with the transponder that is attached to the items being protected. The information display may use the display component 334 of the lock control circuit, while the information readout may be through the communication port 331 or the wireless communication component 332. This

feature is useful in a situation where a plurality of these safes are at a location and a person wants to retrieve a particular item but cannot tell which safe contains that item. Displaying or otherwise providing the information identifying the contents of the safes eliminates the need for the user to resort to the trial-and-error process of unlocking the safes until the item is found.

[0135] When a user wants to retrieve the items 353 stored in the safe, he needs to use an appropriate access control device to unlock the safe. For example, the safe lock may interface with an electronic key 358 similar to the way an electronic key is used to access vending machines as described in earlier embodiments. The electronic key 358 can be used to receive from the safe lock the audit trail records stored in the lock memory 328, and store the retrieved records in its own memory. Later, as shown in FIG. 28, the audit trail records can be downloaded from the electronic key 358 to a computer 359 for sorting, viewing, and auditing purposes when the electronic key is returned to a key refresh station and placed in a cradle 360 connected to the computer. Like the electronic keys for vending machines, the electronic key 358 for the safe 350 can also be given operation limit parameters to restrict the use of the key to access the safe and the items to be protected by the safe.

[0136] In an alternative embodiment, the operation of the external electronic key 358 can also be used to trigger the locking operation of the safe once the items are placed in the secured location. The user first places the items to be protected at the secured location where the detector can detect the presence of the transponder attached to the items. In the embodiment shown in FIG. 25B, this means placing the items with the transponder in the drawer and then closing the drawer. Next, the external key 358 communicates with the receiver of the electronic lock of the safe to trigger the locking operation. In response to the trigger signal from the key, the safe 350 locks the drawer 352 only if the detector 356 senses the presence of the transponder 390 in the secured location. In other words, instead of automatically locking itself upon detection of the items 353, the safe will wait for the trigger signal sent by the electronic key. This additional step would ensure that the electronic key 358 is outside the safe when the locking event takes place, thus preventing the user from accidentally putting the electronic key 358 with the items 353 to be protected in the drawer and locking them together in the safe. The trigger signal may also cause the safe lock circuit 363 to transfer the audit trail records for locking and unlocking events to the electronic key 358.

[0137] In another embodiment of the invention, the lock control circuit is configured to provide enable and disable signals for an external device depending on the status of the safe. For example, in a vending route drive application, mechanical or electronic keys are given to the driver of an assigned route. The safe 350 may be placed inside the vehicle 391 driven by the driver for temporary storage of the keys 392 when the driver moves from one vending machine site to the next. In that case, the safe lock circuit 363 may be configured to transmit signals 393 to the ignition control circuit 394 of the vehicle to enable or disable the ignition of the vehicle. When the driver arrives at a vending machine site, he unlocks the safe 350 to take the vending machine keys 392 out of the safe so that they can be used to access the vending machines. In response to the unlocking event,

the safe lock circuit 363 transmits a disable signal to the vehicle ignition control circuit 394 to disable the ignition. Later, when the driver returns the keys 392 to the safe, the safe lock circuit determines that the keys are indeed put back in the safe, locks the safe, and then transmits an enable signal to the vehicle ignition control circuit 394 to enable the ignition. The route driver can then start the vehicle 391 and drive it to the next vending machine site. Since the ignition is disabled if the keys are not in the safe, the route driver will not be able to operate the vehicle unless the keys are returned to the safe. In this way, if the driver forgets to take the keys after accessing the vending machines, he will be reminded of it since the vehicle will be inoperable.

[0138] In an alternative embodiment designed for securing mechanical keys, in addition to using a transponder 390 to facilitate detection of the keys in a security container, mechanical means is used to further ensure that the mechanical keys are properly placed inside the security container. As shown in FIG. 30, for a mechanical key 396 to be stored in the safe, a mechanical lock plug 398 is provided in the safe for interfacing with that key. The lock plug is secured in the drawer 352 (see FIG. 25) of the safe 350. The lock plug 398 has a slot 399 configured for receiving the blade of the corresponding mechanical key 396. To secure the mechanical key, the key 396 is inserted into the slot 399 of the lock plug 398 and rotated by a pre-determined angle, such as 180 degrees, into a storage position. The lock plug 398 is configured such that the key 396 in the rotated position cannot be removed from the lock plug. The lock plug 398 has a shaft 400 that is rotated when the key is turned. The shaft 400 is coupled to an electrical switch 402 such that the switch is closed when the key is rotated to the storage position. The electrical switch 402 is linked to the electronic lock control circuit 363 of the safe so that the lock control circuit can detect whether the switch is closed or open. A closed switch is an indication that the mechanical key 396 correspond to the lock plug 398 has been inserted into the lock plug and rotated to the storage position in which the key cannot be removed. The safe may have multiple lock plugs for different mechanical keys, and the lock control electronics of the safe may be configured to require that each of the switches associated with the lock plugs has been put in the closed position, i.e., all the corresponding mechanical keys have been inserted into the respective lock plugs and rotated to the stored position, before the lock can be actuated. The lock control circuit may further require the detection of the transponder 390 in the drawer in the closed position as an additional condition for locking. Once these conditions are detected, the electronic lock circuit of the safe actuates the lock, either automatically or in response to a trigger from an external device such as the electronic key used to unlock the safe.

[0139] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements

in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

1. A security container comprising:
  - a lock;
  - an electronic lock control circuit for controlling operations of the lock;
  - a closure for containing an item to be protected, the closure being movable to an open position for receiving the item and a closed position in which the item contained in the closure is not accessible; and
  - a detector for detecting presence of the item in the closure, the detector and the closure being disposed such that the item in the closure is detectable by the detector when the closure is in the closed position, the electronic lock control circuit being configured to actuate the lock to lock the closure in the closed position only if the detector has detected the presence of the item in the closure at the closed position.
2. A security container as in claim 1, wherein the item to be protected has a transponder attached thereto, and wherein the detector receives a detection signal from the transponder to detect the presence of the transponder in the closure in the closed position.
3. A security container as in claim 2, wherein the detection signal is a directional optical signal.
4. A security container as in claim 2, wherein the detection signal is a wireless communication signal.
5. A security container as in claim 4, wherein the wireless communication signal is encrypted.
6. A security container as in claim 2, wherein the detector interacts with the transponder via bi-directional communications.
7. A security container as in claim 2, wherein the detector is configured to have an effective range of detection for the detection signal shorter than a dimension of the security container.
8. A security container as in claim 1, wherein the electronic lock control circuit includes a microprocessor and a memory, the microprocessor being programmed to generate a locking event record when the lock is actuated and to store the locking event record in the memory.
9. A security container as in claim 8, wherein the electronic lock control circuit includes means for transferring the locking event record from the memory to an external device.
10. A security container as in claim 9, wherein the means for transferring is a communication port.
11. A security container as in claim 1, wherein the electronic lock control signal transmits a control signal to an external device to control an operation of the external device when the lock is actuated.
12. A security container as in claim 1, wherein the detector and the closure are disposed such that the item in the closure is detectable by the detector only when the closure is in the closed position.
13. A security storage system comprising:
  - a security container having a lock, an electronic lock control circuit for controlling operation of the lock, and a closure for containing an item to be protected, the closure being movable to an open position for receiving the item and a closed position in which the item

contained in the closure is not accessible, and a detector for detecting presence of the item in the closure, the detector and the closure being disposed such that the item in the closure is detectable by the detector when the closure is in the closed position;

a transponder attached to the item to be protected, the transponder generating a detection signal detectable by the detector when the transponder is contained in the closure in the closed position,

the electronic lock control circuit being configured to actuate the lock to lock the closure in the closed position only if the detector has detected the presence of the transponder in the closure at the closed position.

14. A security storage system as in claim 13, wherein the detection signal is a wireless communication signal.

15. A security storage system as in claim 14, wherein the wireless communication signal is encrypted.

16. A security storage system as in claim 15, wherein the detector is configured to have an effective range of detection for the detection signal shorter than a dimension of the closure.

17. A security storage system as in claim 13, wherein the electronic lock control circuit includes a microprocessor and a memory, the microprocessor being programmed to generate a locking event record when the lock is actuated and to store the locking event record in the memory.

18. A security storage system as in claim 17, wherein the electronic lock control circuit includes means for transferring the locking event record from the memory to an external device.

19. A security storage system as in claim 13, further including a position monitoring device attached to the item to be protected, the position monitoring device providing data indicating a location of the item to be protected.

20. A security storage system as in claim 13, wherein the item to be protected is a mechanical key, and wherein the security container further includes a lock plug disposed in the closure for receiving the mechanical key, the lock plug being interfaced with the electronic lock control circuit for determining whether the lock plug has received the mechanical key.

21. A security storage system as in claim 13, wherein the detector and the closure are disposed such that the item in the closure is detectable by the detector only when the closure is in the closed position.

22. A monitoring apparatus for tracking a location of an item being monitored, comprising:

a location sensor for sensing a location of the apparatus;

an event sensor for sensing a parameter indicative of an event occurring to the monitoring apparatus;

a memory;

a microprocessor for processing readings of the location and motion sensors and storing audit records in the memory, the audit records having data indicative of the readings of the location and motion sensors and data providing timing information for the readings;

a communication component for transferring the audit data to an external device; and

means for attaching the monitoring apparatus to the item to be monitored.

23. A monitoring apparatus as in claim 22, wherein the event sensor is a motion sensor for sensing movement of the apparatus.

24. A monitoring apparatus as in claim 22, wherein the communication component includes a wireless communica-

tion device for transfers the audit records via wireless transmissions.

25. A monitoring apparatus as in claim 22, wherein the item being monitored is an access control device.

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