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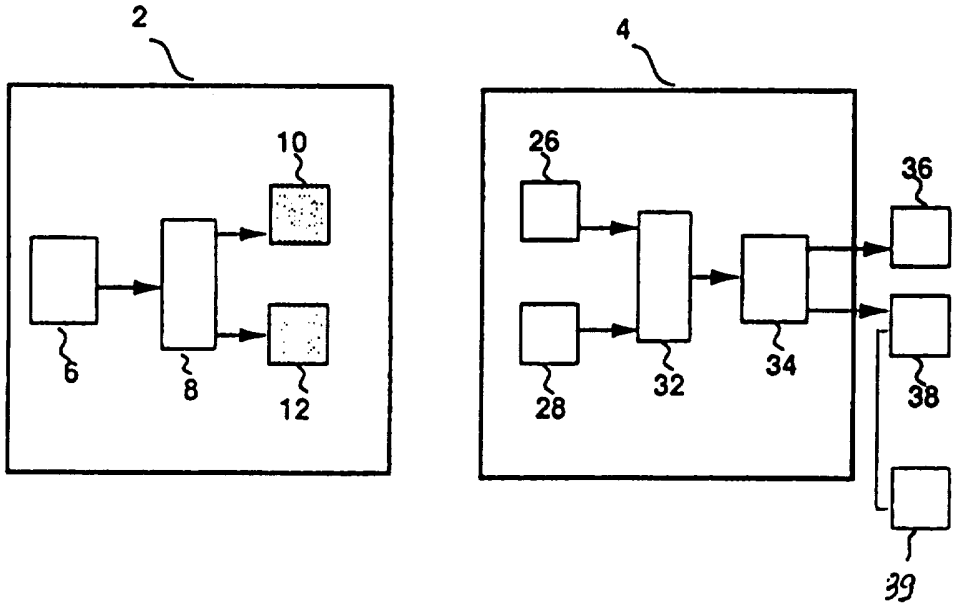

(57) Abstract

An electronic lock and key system including a lock unit (4) and a key unit (2), wherein at least a first one of the lock unit and the key unit includes at least first and second transmitters (10, 12) capable of respectively transmitting in first and second transmission media, and wherein at least a second one of the lock unit and the key unit includes a first receiver (26) capable of receiving signals transmitted by the first transmitter (10) and a second receiver (28) capable of receiving signals transmitted by the second transmitter (12), and wherein the key unit (2) comprises a microprocessor (6) and at least one transmitter (10, 12) and the lock unit comprises a microprocessor and at least one receiver (26, 28).

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AN ELECTRONIC LOCK AND KEY SYSTEM

FIELD OF INVENTION

The present invention relates to a novel security method and a remote controlled locking system for high level security protection of various objects, for instance vehicles, against unauthorized entry and/or use.

BACKGROUND OF INVENTION

Remote controlled electronic locking systems are well known and widely used for various applications. They utilize the principle of wireless communication between a remote hand-held transmitter acting as a key, and a receiver installed in and operating a lock. A standard unit includes a transmitter for generating an encoded signal and a receiver which is connected to the lock and/or any other anti-theft system. Such a locking system is described in US Patent No. 5,049,867 entitled "Vehicle security apparatus". Several alternative ways of transmitting energy are used, namely: radio frequency (including microwaves), infrared and ultrasonic waves.

Opportunities do however exist for unauthorized persons to open a lock (for instance in a vehicle) fitted with a remote locking system by listening for the key code, storing the code and retransmitting it. A device which provides this operation is known in the art as a "key-grabber". A detailed example of such a device is described is an article by Deas A.R. entitled "Algorithms to Evade Key-Grabbers (vehicle security). IEE Colloquium on "Vehicle Security (Digest No.138, p.8/1-3) 1990.

Existing systems do not provide an absolute solution to the problem of car theft but only slow unauthorized entry and usage or, at best, may discourage unauthorized persons from selecting a particular secured target.

An increase of the level of security provided by electronic locking systems has been the subject of many papers published in recent technical literature. An indication of the

state of the art is provided by German Patent No. 4,308,899. This publication describes a sophisticated algorithm for an alternate code processing microprocessor unit and a dialogue mode of operation for a security system. A key unit and a lock unit exchange encoded signals wherein the code is varied inside the microprocessor unit according to a predetermined algorithm. In the patent there is suggested a usage of the system with one of the following transmission media: radio, light and ultra-sound. Main disadvantages of this solution are, first, very complex signal processing that is required and which increases the probability of errors, and second, vulnerability to key-grabbing.

Another approach, described in South-African Patent No. 91007736 entitled "Distress Alarm Transmitting System for Person or Property Protection...", utilizes several radio frequencies for communication, for increases the level of security to a certain extent but still does not solve the problem of key-grabbing.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a novel remote controlled lock and key system which is reliable, easy to install and use, and which provides a higher level of security to property against unauthorized entry and/or use. In addition, the invention permits detection of unauthorized attempt of intrusion using key-grabber or similar apparatus.

There is thus provided in accordance with a preferred embodiment of the present invention an electronic lock and key system as well as a communications method for operating the system. The system includes:

a lock unit and

a key unit,

wherein at least a first one of the lock unit and the key unit includes at least first and second transmitters capable of respectively transmitting in first and second transmission media, and

wherein at least a second one of the lock unit and the key unit includes a first receiver capable of receiving signals transmitted by the first transmitter and a second receiver capable of receiving signals transmitted by the second transmitter, and

wherein the key unit comprises a microprocessor and at least one transmitter and the lock unit comprises a microprocessor and at least one receiver.

The system is characterized by the following features:

the number of receivers in the lock unit corresponds to the number of transmitters in the key unit;

the number of receivers in the key unit corresponds to the number of transmitters in the lock unit; and

the key unit includes at least one transmitter.

A further characteristic of a system constructed in accordance with the invention is that it has the capability of operating in accordance with the method of the invention in which at least two different transmission media signals are transmitted from at least a first one of the lock unit and the key unit, and detecting these signals in the second one of the lock unit and the key unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further understood and appreciated from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is a block diagram of a lock and key system constructed in accordance with a first embodiment of the present invention which utilizes two different media for signal transmitting.

Fig. 2 is a block diagram of a lock and key system constructed in accordance with a second embodiment of the present invention which uses three different media for communication between the key unit and the lock unit.

Fig. 3 is a block diagram of a lock and key system constructed in accordance with a third embodiment of the invention with alternate time delay between two signals of different transmission media.

Fig. 4 is a block diagram of a lock and key system constructed in accordance with a fourth embodiment of the invention which represents a system working in a dialogue mode with one transmitter inside the lock unit which works permanently.

Fig. 5 is a block diagram of a lock and key system constructed in accordance with a fifth embodiment of the invention which represents a system working in a dialogue mode with two transmitters of different transmission media, inside the lock unit which work permanently.

Fig. 6 is a block diagram of a lock and key system constructed in accordance with a sixth embodiment of the invention which shows a system working in a dialogue mode with two transmitters of different transmission media and two receivers of different transmission media, inside both the key unit and the lock unit.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a novel remote controlled lock and key system . As will be appreciated from the following description, the system of the invention is characterized by a high level of security, improved reliability and performance. The present system utilizes two or more different media of transmission, namely radio, sound and light and thus can not be fully read by key-grabbers which are known to be adapted to only one medium of transmission.

It will further be appreciated that the whole spectral range of each of these media can be utilized:

- light - from Infra-red (hereinafter IR) to ultra violet.
- sound - from bass frequencies to ultrasound.
- radio - full spectral range.

The present invention overcomes the disadvantages of the prior art by combining two or more different kinds of transmission media during communication between a remote hand-held transmitter acting as a key and a receiver installed in a lock. This is accomplished by using in at least one direction of communication, two or more transmitters of different transmission media, for instance, a radio frequency transmitter and an ultrasonic transmitter both operated synchronously and simultaneously (or with predetermined delay) after their actuation. Accordingly it is an object of the present invention to provide a novel remote control locking system which provides a magnitude of security higher than systems which are known in the art.

Referring now to Fig. 1 there is seen a schematic block diagram of a system, constructed in accordance with an embodiment of the invention. A key unit 2 includes a microprocessor 6, connected to a synchronizer 8 which is further connected to two transmitters 10 and 12. Transmitters 10 & 12 transmit signals in two different kinds of

transmission media, for instance, transmitter 10 may be a radio frequency (hereinafter RF) transmitter and transmitter 12 may be an IR transmitter. A lock unit 4 has receivers 26 & 28, connected to a comparator 32 which is further connected to a microprocessor 34. Receiver 26 is adapted to receive the transmission of transmitter 10 and thus, in the present example is an RF receiver while receiver 28 is adapted to receive the transmission of transmitter 12 and thus in the present example is an IR receiver. Microprocessor 34 typically has two output ports 36 & 38. Port 36 is for connecting lock unit 4 to a conventionally known lock opening device and port 38 is for connecting lock unit 4 to a known alarm and/or other security device. It will be appreciated by those skilled in the art that transmitters 10 and 12 use any two of radio, sound or light, as long as transmitter 10 uses a different transmission medium than that used by transmitter 12.

The system operates as follows: after actuation of the key unit 2, transmitters 10 and 12 emit pulsed signals which are preliminarily encoded by microprocessor 6 in a conventional manner using a predetermined code. These signals are also known in the art as "lock opening signals". Synchronizer 8 controls both transmitters 10 & 12 and permits synchronization of these two signals. If no synchronization is required, synchronizer 8 may be a simple electric conductor. Receivers 26 and 28 detect the two signals and produce output signals to the comparator 32. The comparator 32 works as a logic circuit which checks synchronization of the received signals. Comparator 32 provides the signals to the microprocessor 34, which decodes and compares them to a predetermined code. If both signals fit the code, microprocessor 34 outputs a lock opening command via port 36 to a conventionally known lock opening device. If at least one of the received signals has a wrong code or/and if comparator 32 detects only one signal, microprocessors 34 can send a command via port 38 to an external alarm system, which may be able to provide as audio signals, visual alarm signals, long distance radio signals, or to take physical actions such as immobilization of the engine of a protected vehicle

and the like. Since erroneous transmissions are possible, it will be appreciated that microprocessor 34 makes the decision whether or not to send a signal via port 38 or to wait for reception of an additional set of received signals. Such a decision is performed utilizing algorithms known in the art.

It will be appreciated that a lock opening device connected to port 36 may be any of electromechanical locking device, an electronic switch, a computerized controller which may control several other locking devices, and the like. Thus, the lock and key system of the present invention is adapted to control entry into and/or enable use of a secured object.

In accordance with one embodiment of the invention, the lock opening device of the invention may be incorporated into a vehicle ignition control system , thereby to prevent access to the vehicle and/or use thereof except to an authorized user. In the present example, therefore, port 38 is connected to an electric switching device 39 which may be a main switch of a vehicle ignition system. Accordingly, switching device 39 remains open as long as a lock opening command is not provided by microprocessors 34 and thus the vehicle is secured since the engine of the vehicle can not be operated.

Fig. 2 shows a schematic block diagram of a system constructed in accordance with another embodiment of the invention. Key unit 42 is generally similar to key unit 2 and includes microprocessor 6 which is connected to the synchronizer 8 which is further connected to three transmitters 10, 12 and 14. Lock unit 44 is generally similar to lock unit 4 and includes three receivers 26, 28 and 30, being connected to comparator 32 which is further connected to microprocessor 34. Microprocessor 34 has two output ports 36 & 38 as described in Fig 1. This construction is used to further increase of security level. In this case transmitter 10 and receiver 26 operate on radio communication, transmitter 12 and receiver 28 use ultrasonic waves and transmitter 14 and receiver 30 utilize infrared transmission and reception media.

The system operates in a manner, similar to that of the system of Fig. 1. The main difference is that microprocessor 34 outputs a lock opening command via port 36 only if all three signals are detected synchronously. If one of the signals is not detected or it has an incorrect code the alarm device connected to port 38 can be actuated by the microprocessor 34, as described above in conjunction with the system of Fig. 1.

Fig. 3 shows a schematic block diagram of a system constructed in accordance with yet another embodiment of invention. This system is able provide a time delay between emitted signals. This is done in order to provide a further increase of security by implementation of alternate time delay between the emitted signals.

Key 52 is generally similar to key unit 2 and includes a microprocessor 6 which is connected to a synchronizer 8 and to a delay generator 15. Delay generator 15 is also connected to synchronizer 8 and to one of the transmitters, which in the present example is transmitter 10. Lock unit 54 is generally similar to lock unit 4 and includes receivers 26 and 28 which are able to receive the transmissions of transmitter 10 and 12 correspondingly. Lock 54 further includes a delay detector 31 for detecting the delayed signal transmitted by transmitter 10. Delay detector 31 is connected to receiver 28, comparator 32 and microprocessor 34.

The system operates as follows. After actuation of the key, two signals, encoded by microprocessor 6 are transmitted. A first signal is transmitters by transmitter 12 immediately, and a second signal is delayed by delay generator 15 in respect to a delay value which can either be predetermined or be produced by microprocessor 6 utilizing algorithms known in the art, which may be incorporated in the memory of microprocessor 6. Receiver 28 detects the signal transmitted by transmitter 12 and directs it to comparator 32 via the delay detector 31. Receiver 26 detects the signal transmitted by transmitter 10 and directs it to comparator 32 , where delay time is subtracted. Accordingly, a delay value which can either be predetermined or be produced by the microprocessor 34 in a way similar to that which is described above in conjunction

with microprocessor 6. The comparator 32 checks synchronization of the two signals. Comparator 32 then provides a signal to microprocessor 34 for decoding, which in turn controls ports 36 and 38 as described above. The microprocessor 34 forms a command via port 36 to open a lock only in a case where both signals are detected and decoded with proper delay. The delay value of the system can be changed by microprocessors 6 and 34 as a function of many parameters, for example, time, number of times of actuation of the system.

After each actuation of the system, the delay value can be changed by microprocessors 6 and 34, thus preventing any possibility for key-grabber to use parameters which were received during previous lock actuation acts. An alarm system, in this case, can be actuated by port 38 when the comparator 32 and the delay detector 31 detect a wrong delay between two signals and/or when the signal code is wrong.

All three embodiments described above in conjunction with Figs 1-3, principally are able to operate in two different modes: a first, manual actuation mode where the key unit is actuated manually by the user, a second, automatic actuation mode where interaction between the key unit and the lock unit takes place when the key unit is situated within a certain distance from the lock unit, thus providing a more convenient way of operation. Both modes are generally known in the art. In the automatic mode the key is actuated by microprocessor 6 either at fixed predetermined time intervals, or at time intervals which are chosen randomly or by any known algorithm for this purpose. In this mode as soon as the receivers of a lock unit are within the transmission range of all of their corresponding transmitters of the key unit, actuation of port 36 is possible. However, taking into account that the hand-held key unit is usually equipped with a small size energy source, and that the second mode of operation would result in a higher power consumption compared with the first manual mode, and consequently result in a shorter term for energy source exchange. To overcome this disadvantage so as to minimize the energy consumption of a key unit, the invention offers a so called "dialogue

mode" of operation. This is described below in accordance with the embodiments of Figs 4-6

Referring now to Fig. 4 where there in shown a block diagram of a system constructed in accordance with a further embodiment of the present invention where a dialogue mode of operation is used. A key unit 62 is generally similar to key unit 2 and includes a receiver 13 and two transmitters 10 and 12, where each of these transmitters utilizes a different transmission medium as described above. Transmitters 10 and 12 are connected to microprocessor 6 via synchronizer 8. Receiver 13 is connected to microprocessor 6. A lock unit 64 is similar to lock unit 4 and further includes receivers 26 and 28 which are connected to the microprocessor 34 via a comparator 32. Lock unit 64 includes a transmitter 33 which is connected to a microprocessor 34. Receivers 26 and 28 are able to receive the transmissions of transmitter 10 and 12 correspondingly. Transmitter 33 and the receiver 13 are adapted to use one of the above transmission media.

The system, in addition to the operation modes described above, provides an additional mode which is an additional kind of automatic mode, which like the previous one, does not require manual actuation of the key unit. The transmitter 33 sends signals encoded by the microprocessor 34, continuously, at fixed predetermined time intervals, or at timed intervals which are chosen either randomly or by any known algorithm for this purpose. These signals are known in the art as probe signals. If the key unit 62 is situated within the transmission range of transmitter 33, a signal transmitted by transmitter 33 can be detected by receiver 13. Microprocessor 6 receives this probe signal from the receiver 13 and decodes it. After decoding, microprocessor 6 forms encoded signals and transfers them to transmitters 10 and 12, synchronized by the synchronizer 8, for transmission. Receivers 26 and 28 detect these signals and produce output signals to the comparator 32. Comparator 32 generates an output signal to the microprocessor 34 and so the procedure is carried in a similar way as described in

conjunction with the system of Fig. 1. It will be appreciated that such a dialog may include more that one exchange of signals between the two units.

In Fig. 5 there is shown a block diagram of an electronic lock and key system constructed in accordance with yet a further embodiment of the present invention where another type of a dialogue mode of operation is used. In this case a key unit 72 is generally similar to key unit 62 and includes receivers 11 and 13 which are connected to a microprocessor 6 via a comparator 7. Key unit 72 further includes a transmitter 10 connected to microprocessor 6. Transmitters 11 and 13 are each of a different transmission medium.

Because the power consumption of a transmitter is generally higher than that of a receiver, a system constructed in accordance with this embodiment has the advantage of lower power consumption in the key unit which is generally equipped with a small power source in order to maintain a relatively small physical size.

A lock unit 74 is generally similar to lock unit 64 and includes transmitters 33 and 35, connected to a synchronizer 37 which is further connected to a microprocessor 34. Microprocessor 34 has output ports 36 and 38 for connection to a lock opening device and to an alarm system as described above in conjunction with previous embodiments. It will be appreciated that transmitter 33 and receiver 11 use one of the three transmission media described above and that transmitter 35 and receiver 13 use a medium of the remains. Transmitter 10 and receiver 26 utilize one of the above transmission media.

The system operate as follows. Transmitters 33 and 35 emit probe signals and are synchronized by the synchronizer 37. When key unit 72 is situated within the transmission range of both transmitters 33 and 35, receivers 11 and 13 detect the probe signals and provide them to the comparator 7 which checks synchronization and sends these signals to the microprocessor 6 for decoding. If synchronization and code of the signals are approved, the microprocessor 6 generates an encoded signal sequence which is then transferred to and transmitted by transmitter 10. This signal is detected by the

receiver 26 and is transferred to the microprocessor 34 which forms a lock opening command if the signal is approved.

Referring now to Fig. 6 where there in shown a block diagram of a system constructed in accordance with a further embodiment of the present invention where an improved dialogue mode of operation is used. This embodiment provides yet a the higher level of security utilizing two different media for each of the probe signal and the lock opening signal. A key unit 82 which is generally similar to key unit 72 and includes two transmitters 10 and 12 connected to a synchronizer 8 and two receivers 11 and 13 connected to a comparator 7. Synchronizer 8 and comparator 7 are controlled by a microprocessor 6. A lock unit 84 is generally similar to lock unit 72 and includes two transmitters 33 and 35 connected to a synchronizer 37 and two receivers 26 and 28 connected to a comparator 32. A microprocessor 34 controls both synchronizer 37 and comparator 32, and has output ports 36 and 38. Transmitter 33 and receiver 11 use one of the above transmission media. Transmitter 35 and receiver 13 use one medium of the remains. Transmitter 10 and receiver 26 use one of the above transmission media. Transmitter 12 and receiver 28 use one medium of the remains which is not used by transmitter 35 and receiver 13.

The system operates as follows. Transmitters 33 and 35 generate probe signals, which are synchronized by the synchronizer 37 and encoded by the microprocessor 34. When key unit 82 is situated within the transmission range of both transmitters 33 and 35, receivers 11 and 13 detect these probe signals and provide them to the comparator 7. The comparator 7 checks the synchronization and generates a signal to the microprocessor 6, which performs signal decoding. If the signals matches a predetermined code, microprocessor 6 generates encoded signals and sends them via synchronizer 8 to transmitters 10 and 12. Transmitters 10 and 12 emit these encoded signals which are then detected by receivers 26 and 28, checked in the comparator 32 and are then directed to the microprocessor 34. If synchronization and code of these

signals are approved the microprocessor sends a command to the lock opening unit 36, otherwise the alarm unit 38 may be actuated as described above in conjunction with previous embodiments.

It will be appreciated that the systems described above can be extended so as to include elements which will enable them to utilize all three transmission media either for the probe signals or for the lock opening signal, or for both. In such systems microprocessors 6 and 34 can be adapted to control the transmitters which are connected to them so as to send sequences of signals characterized by more than three transmissions, for example a sequence commencing by a simultaneous radio and sound transmission, followed by a light transmission, followed by a radio transmission and ending with a simultaneous light and sound transmission. It will be further appreciated that signals of the same transmission sequence and of different transmission media can incorporate a certain degree of overlap, for example: a radio transmission which commences at a time t1 and ends at a time t2 and a light transmission which commences at a time t3 and ends at a time t4 wherein $t1<t3<t2<t4$ or $t1<t3<t4<t2$ or $t3<t1<t2=t4$ and the like.

It will be appreciated that if microprocessors 6 and 32 comprise high performance microprocessors, they can function in addition as synchronizers and delay components. Systems which include such components, may be adapted so as to transmit several different commands from one unit to another, so as to perform several different external operations via port 36, as do remote controlled systems known in the art. Such systems may use a different combination or set of transmission media for each different external operation for example a first command may be transmitted in a first transmission medium, a second command may be transmitted in a second transmission medium and a third command may be transmitted in the second and a third transmission media.

It will be appreciated by those skilled in the art that a system constructed in accordance with any of the embodiments of the invention can be installed with great ease

wherever authorization of either usage or entrance is limited for example in doors and entrance limitation devices either indoors, outdoors, in doors of vehicles, safes and the like. Such a system can also be installed either to protect or to provide an additional level of security to devices, systems or appliances such as computer systems, full pumps, alarm systems, communications systems, automatic teller machines and the like.

Such a system is especially suitable for use in vehicles because the lock unit physical dimensions are relatively very small, and therefor such a lock unit can be installed in a hid or concealed location in the vehicle (for example in the frame, the engine, the ignition system, the dash board and the like.), thus making it difficult for an unauthorized person, such as a burglar, to allocate and dismantle it.

It will be appreciated by those skilled in the art that the invention is not limited to what has been shown and described hereinabove by way of example. Rather, the scope of the invention is limited solely by the claims which follow.

CLAIMS

1. An electronic lock and key system comprising:

a lock unit and

a key unit,

wherein at least a first one of said lock unit and said key unit comprises at least first and second transmitters capable of respectively transmitting in first and second transmission media, and

wherein at least a second one of said lock unit and said key unit comprises a first receiver capable of receiving signals transmitted by said first transmitter and a second receiver capable of receiving signals transmitted by said second transmitter, and

wherein said key unit comprises a microprocessor and at least one transmitter and said lock unit comprises a microprocessor and at least one receiver.

2. An electronic lock and key system as claimed in claim 1 wherein each said first media is one of the group which consists of radio, sound, and light and each said second media is one of the group which consists of radio, sound, and light.

3. An electronic lock and key system as claimed in claim 1 wherein said first one of said lock unit and said key unit comprises at least a third transmitter capable of transmitting in a third transmission medium and said second one of said lock unit and said key unit further comprises a third receiver capable of receiving signals transmitted by said third transmitter;

4. An electronic lock and key system as claimed in claim 1 wherein said first one of said lock unit and said key unit comprises delay means for delaying a signal which is transmitted by said first transmitter with respect to a signal which is transmitted by said second transmitter and said second one of said lock unit and said key unit further

comprises delay detecting means for detecting the delay of a signal detected by said first receiver in respect of a signal detected in said second receiver;

5. An electronic lock and key system as claimed in claim 1 further adapted for use in a vehicles ignition system wherein said lock unit further comprises means for controlling the said ignition system, said controlling means being connected to said microprocessor of said lock unit;

6. An ignition system comprising :

ignition means for igniting a vehicle engine,

a lock unit and

a key unit,

wherein at least a first one of said lock unit and said key unit comprises at least first and second transmitters capable of respectively transmitting in first and second transmission media, and

wherein at least a second one of said lock unit and said key unit comprises a first receiver capable of receiving signals transmitted by said first transmitter and a second receiver capable of receiving signals transmitted by said second transmitter, and

wherein said key unit comprises a microprocessor and at least one transmitter and said lock unit comprises a microprocessor and at least one receiver.

7. An ignition system as claimed in claim 6 wherein said lock unit is connected to said ignition means.

8. A method of operating an electronic system which includes a lock unit and a key unit, said method comprising the following steps:

a. generating at least two encoded signals at the key unit;

b. transmitting said signals from the key unit, in at least two different kinds of transmission media;

c. detecting said transmitted signals at the lock unit;

d. decoding said signals;

e. comparing said decoded signals with predetermined codes; and

f. generating a lock opening command if said decoded signals match said predetermined codes.

9. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 8, wherein at least a first one of said signals is transmitted in a predetermined time period after a second one of said signals.

10. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 8, said method further comprising the following step:

h. generating an alarm operating command if said encoded signals that were detected by said lock unit, do not match said predetermined codes and the number of received unmatched signals exceeds a predetermined number.

11. A method of operating an electronic system which includes a lock unit and a key unit, said method comprising the following steps:

a. generating at least two encoded probe signals at the lock unit

b. transmitting said probe signals from the lock unit, in at least two different kinds of transmission media;

c. detecting said transmitted probe signals at the key unit

d. decoding said detected probe signals

e. comparing said encoded probe signals with predetermined codes

f. generating at least one encoded signal at the key unit if said probe signal matches a predetermined probe code

g. transmitting said signals from the key unit, in at least one kind of transmission media;

h. detecting said transmitted signals at the lock unit

i. decoding said signals

j. comparing said decoded signals with predetermined codes

k. generating a lock opening command if said decoded signals match said predetermined codes.

12. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 11, wherein at least a first one of said signals is transmitted in a predetermined time period after a second one of said signals.

13. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 11, wherein at least a first one of said probe signals is transmitted in a predetermined time period after a second one of said probe signals.

14. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 11, said method further comprising the following step:

h. generating an alarm operating command if said encoded signals that were detected by said lock unit, do not match said predetermined codes and the number of received unmatched signals exceeds a predetermined number.

15. A method of operating an electronic system which includes a lock unit and a key unit, said method comprising the following steps:

a. generating at least one encoded probe signals at the lock unit

b. transmitting said probe signals from the lock unit, in at least one kind of transmission media;

c. detecting said transmitted probe signals at the key unit

d. decoding said detected probe signals

e. comparing said decoded probe signals with predetermined codes

f. generating at least two encoded signals at the key unit

g. transmitting said signals from the key unit, in at least two kinds of transmission media;

h. detecting said transmitted signals at the lock unit

i. decoding said signals

j. comparing said decoded signals with predetermined codes

k. generating a lock opening command if said decoded signals match said predetermined codes.

16. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 15, wherein at least a first one of said signals is transmitted in a predetermined time period after a second one of said signals.

17. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 15, wherein at least a first one of said probe signals is transmitted in a predetermined time period after a second one of said probe signals.

18. A method of operating an electronic system which includes a lock unit and a key unit, as claimed in claim 15, said method further comprising the following step:

h. generating an alarm operating command if said encoded signals that were detected by said lock unit, do not match said predetermined codes and the number of received unmatched signals exceeds a predetermined number.

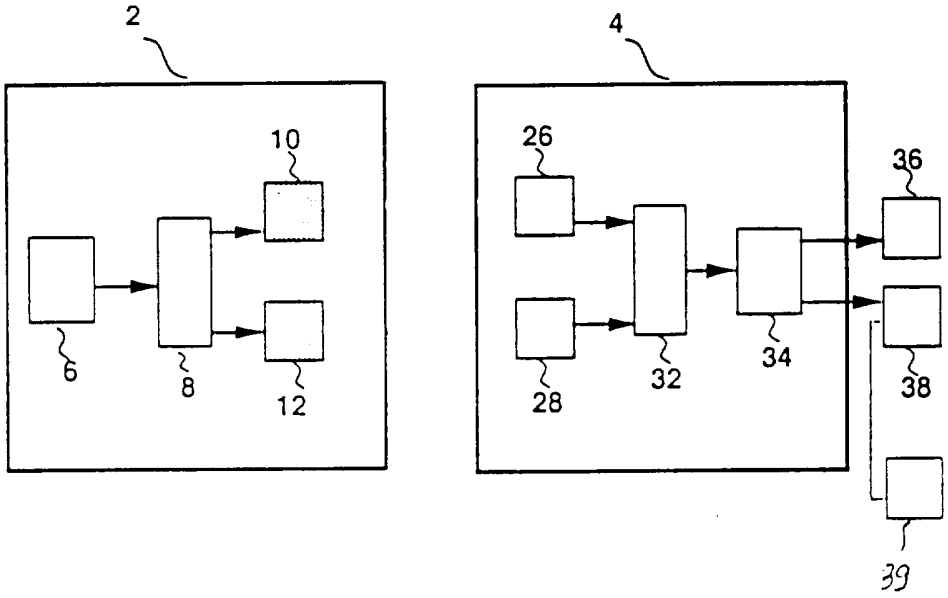


FIG. 1

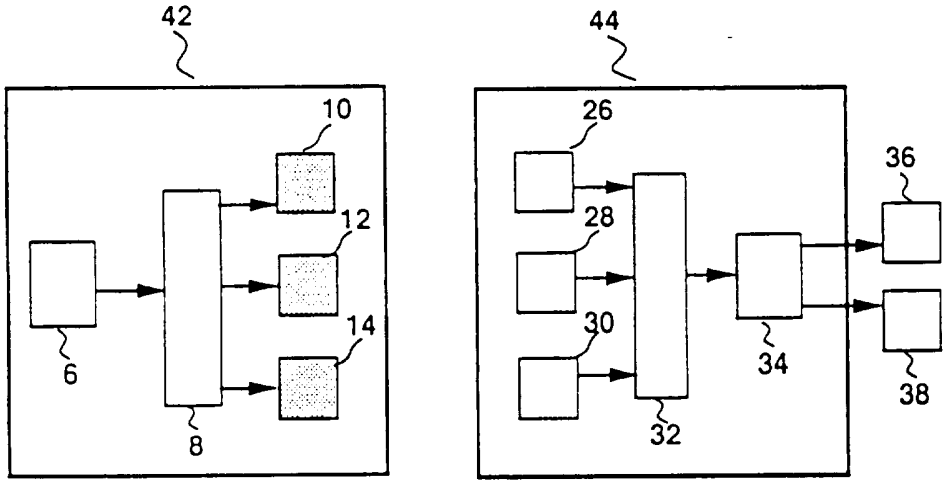


FIG. 2

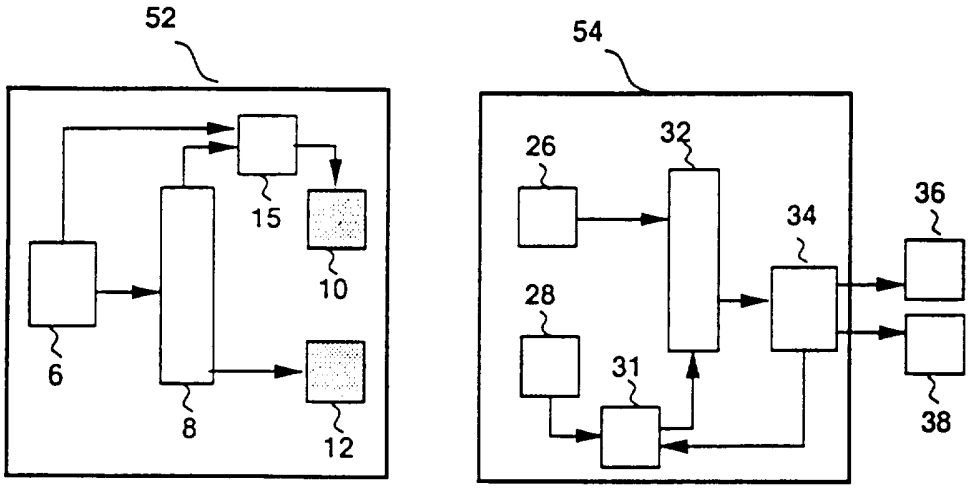
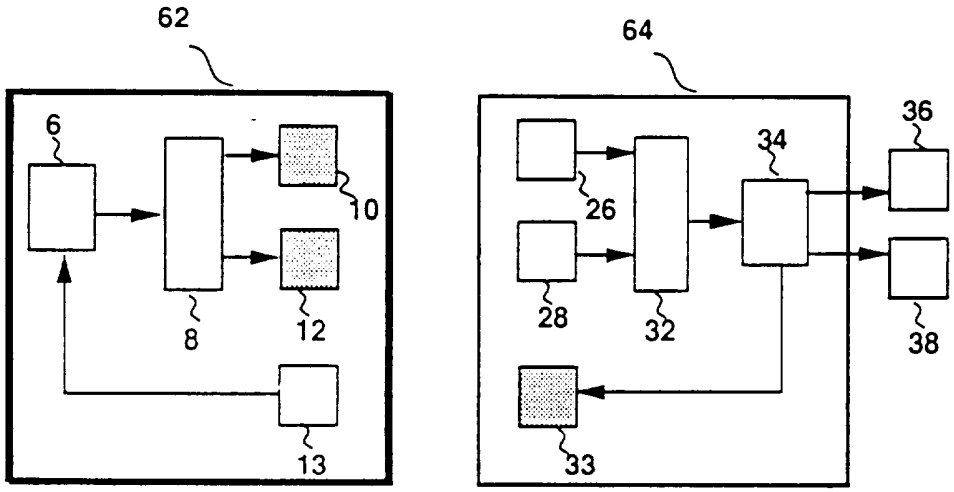

52
54
15
10
6
8
12
26
32
34
36
28
31
38

FIG. 3


62
64
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12
13
36
34
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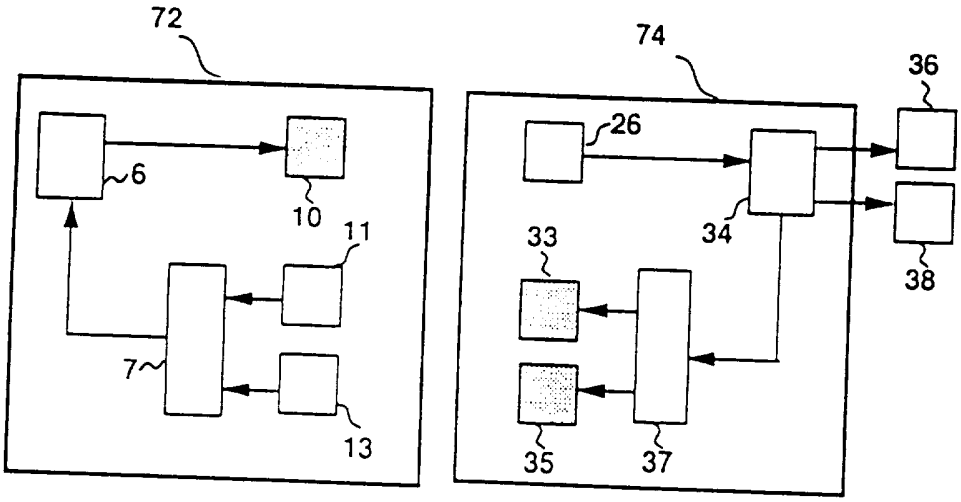
38
33

FIG. 4


72
74
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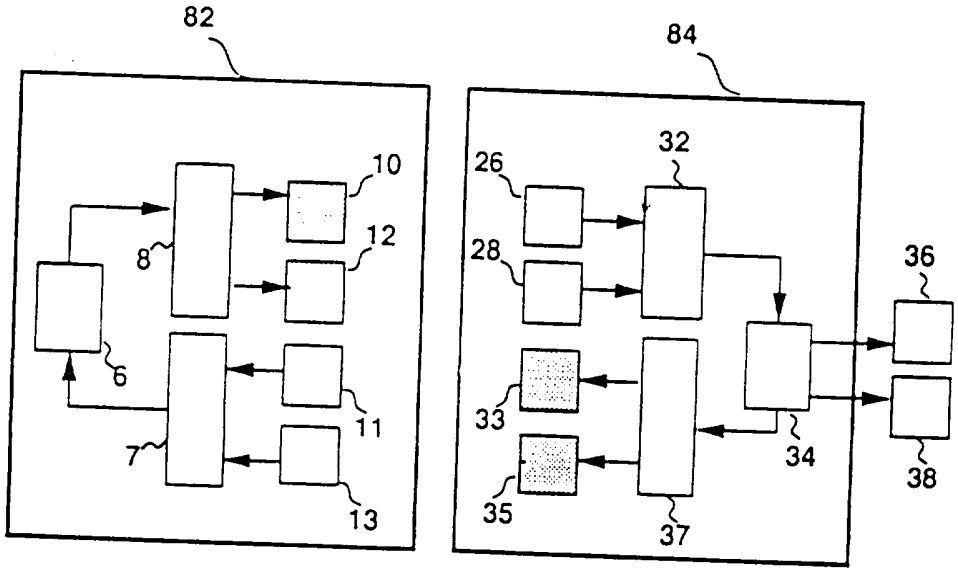
35
37

FIG. 5


82
84
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32
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28
36
8
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33
11
34
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38
13
35
37

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/15004

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 7/04; G08C 19/00; B60R 25/10, 25/00
US CL :340/825.31, 825.72, 426; 307/10.2
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/825.31, 825.32, 825.69, 825.72, 426, 531, 534; 307/10.2, 10.3, 10.4

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 4,354,189 (LEMELSON) 12 OCTOBER 1982, COL. 1, LINES 15-27, COL3. LINE 43-COL. 4, LINE 29, COL. 4,LINES 58-66, COL. 11, LINES 24-60, COL.12, LINES 39-47, COL. 12, LINE 64- COL. 13, LINE 8.	1-2, 6-8 3-5,9-18
Y	US, A, 5,319,364 (WARAKSA ET AL.) 07 JUNE 1994, ABSTRACT	15
A,P	US, A, 5,379,033 (FUJII ET AL.) 03 JANUARY 1995, ABSTRACT	15
A,P	US, A, 5,382,948 (RICHMOND) 17 JANUARY 1995, ABSTRACT	14, 18
A	US, A, 4,897,644 (HIRANO) 30 JANUARY 1990, ABSTRACT	1

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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

Date of the actual completion of the international search 09 FEBRUARY 1996	Date of mailing of the international search report 20 MAR 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3603	Authorized officer EDWARD MERZ Telephone No. (703) 305-4869

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/15004

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5,034,997 (IWASAKI) 23 JULY 1991, ABSTRACT	1
A	US, A, 5,355,525, (LINDMAYER ET AL.) 11 OCTOBER 1994 ABSTRACT	1
A	GB, A, 2,265,238 (BENTLEY-BEARD) 22 SEPTEMBER 1993, ABSTRACT	1