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(54) **VEHICLE ANTI-THEFT APPARATUS AND METHOD**

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(57) **ABSTRACT**

A vehicle anti-theft apparatus and method can prevent the theft of a vehicle without increasing costs, and hence the illegal use of the theft vehicle. The apparatus includes a smart key carried by a user, and a smart keyless control device installed on the vehicle. The smart key includes a storage section for storing identification information and use time limit information of the vehicle. The smart keyless control device reads the identification information and the use time limit information stored in a memory, and authenticates the vehicle user based on the identification information and the use time limit information upon use of the vehicle. The use of the vehicle is permitted when the identification information and the authentication identification information set beforehand in the smart keyless control device coincide with each other, and when a current time is within a use time limit of the use time limit information.

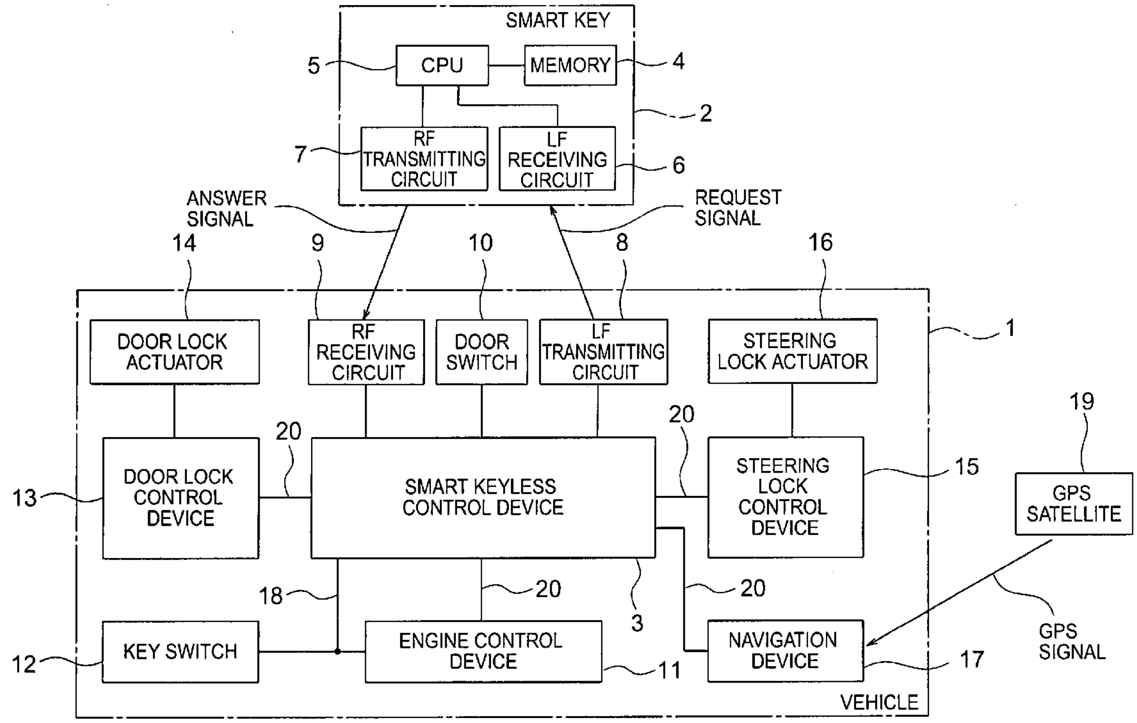


FIG. 1

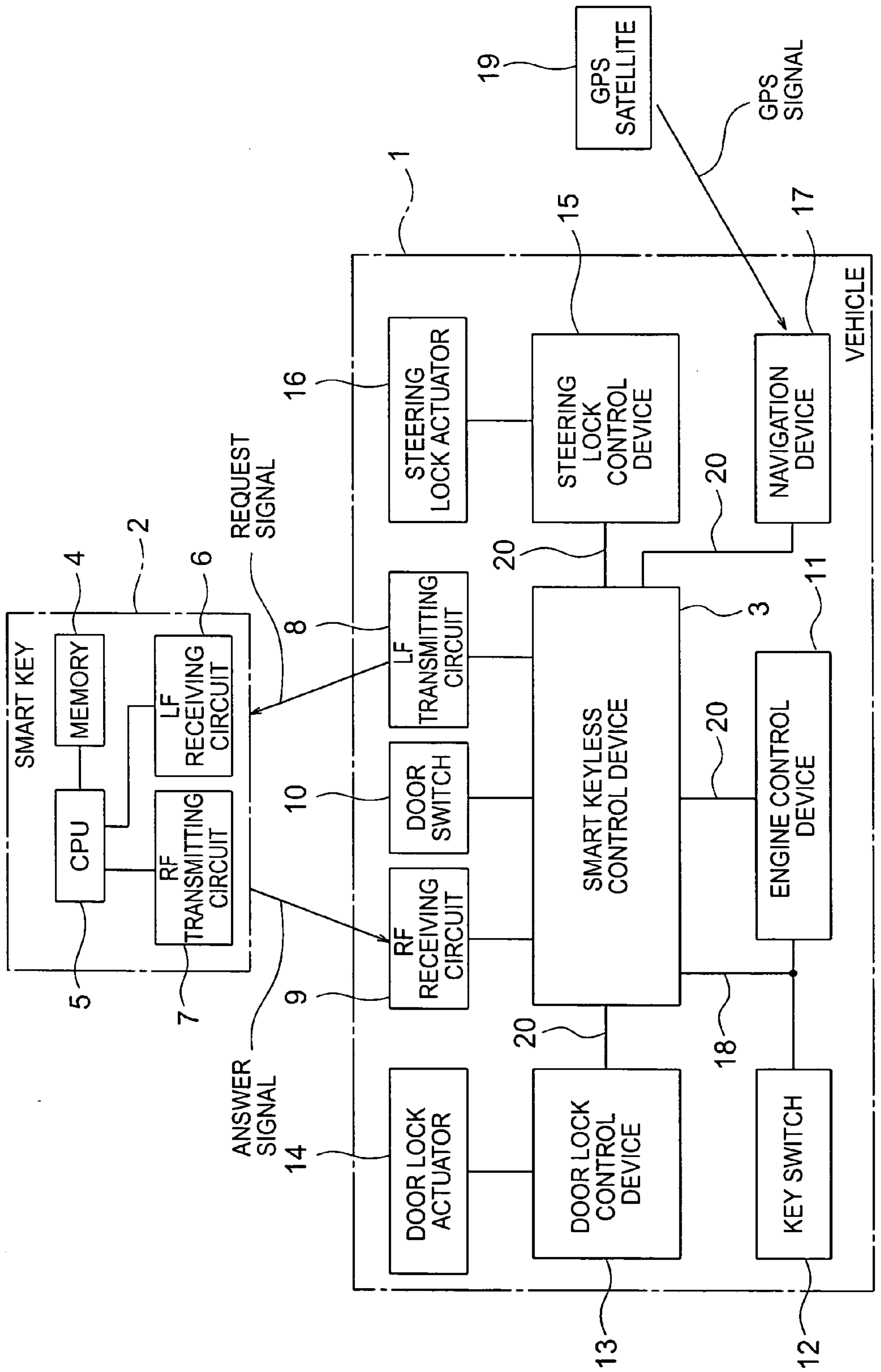

SMART KEY
2
MEMORY
4
CPU
5
LF RECEIVING CIRCUIT
6
RF TRANSMITTING CIRCUIT
7
REQUEST SIGNAL
ANSWER SIGNAL
LF TRANSMITTING CIRCUIT
8
RF RECEIVING CIRCUIT
9
DOOR SWITCH
10
SMART KEYLESS CONTROL DEVICE
3
ENGINE CONTROL DEVICE
11
KEY SWITCH
12
DOOR LOCK CONTROL DEVICE
13
DOOR LOCK ACTUATOR
14
STEERING LOCK CONTROL DEVICE
15
STEERING LOCK ACTUATOR
16
NAVIGATION DEVICE
17
18
GPS SATELLITE
19
GPS SIGNAL
20
20
20
20
VEHICLE
1

FIG. 2

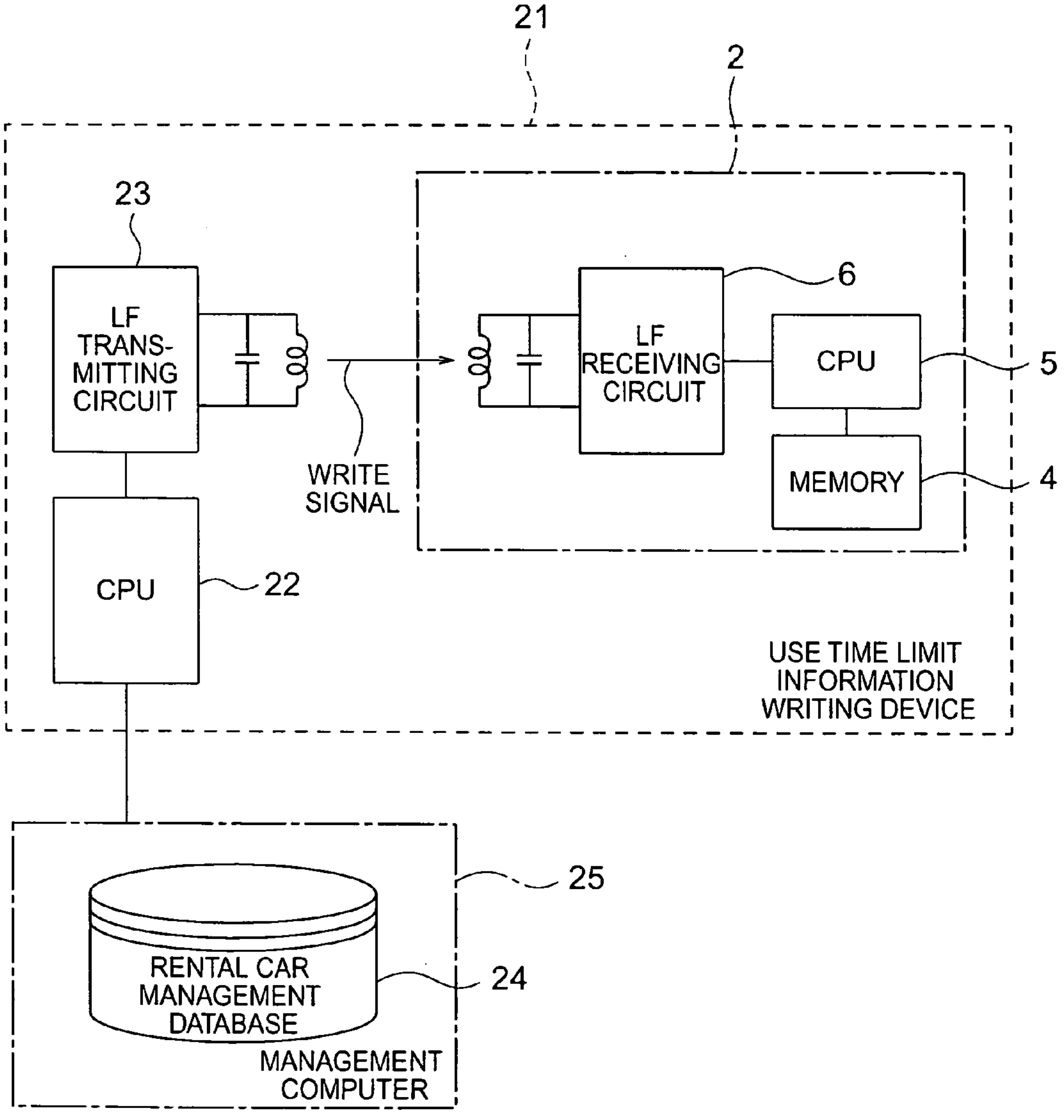

21
2
23
LF TRANS-MITTING CIRCUIT
6
LF RECEIVING CIRCUIT
CPU
5
MEMORY
4
WRITE SIGNAL
CPU
22
USE TIME LIMIT INFORMATION WRITING DEVICE
25
RENTAL CAR MANAGEMENT DATABASE
24
MANAGEMENT COMPUTER

FIG. 3

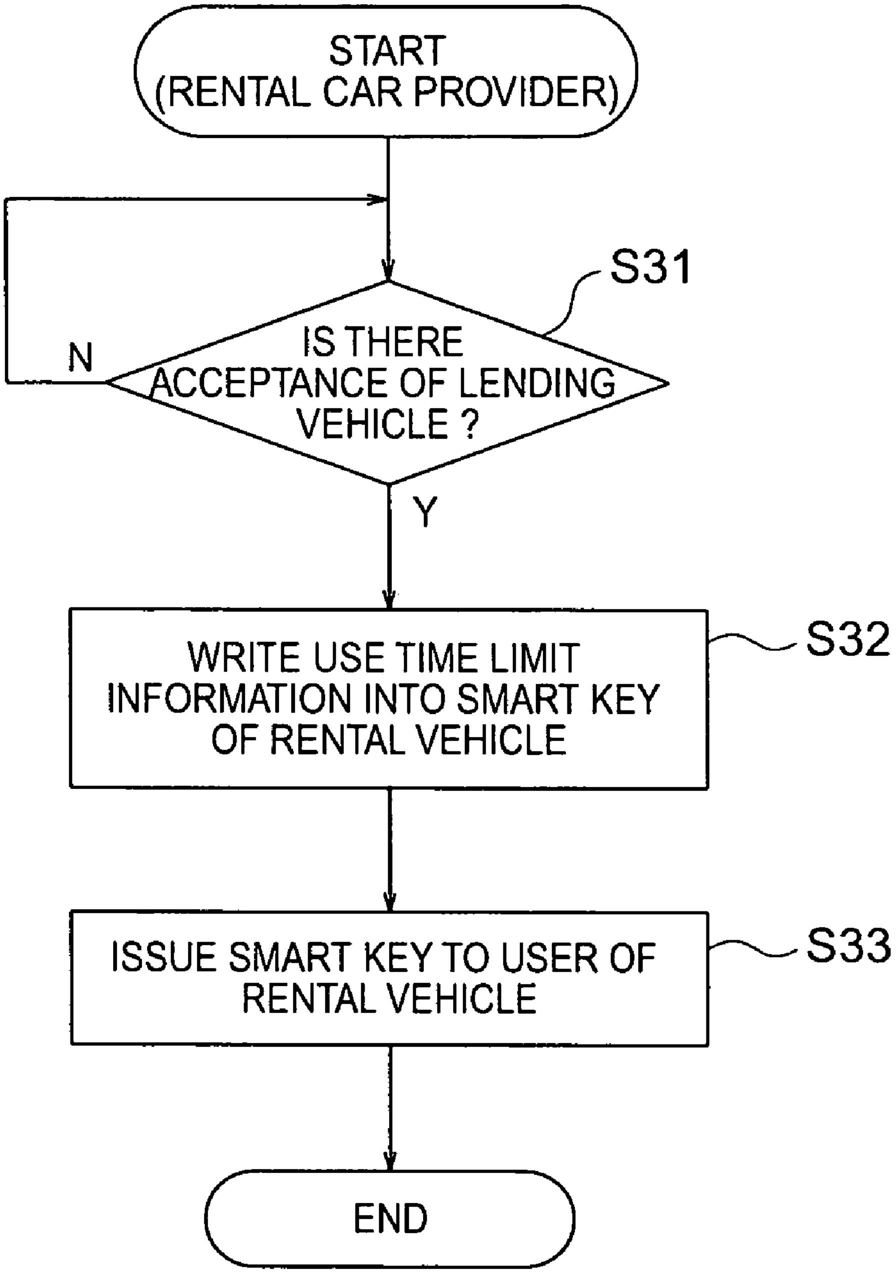

START
(RENTAL CAR PROVIDER)
S31
IS THERE ACCEPTANCE OF LENDING VEHICLE ?
N
Y
WRITE USE TIME LIMIT INFORMATION INTO SMART KEY OF RENTAL VEHICLE
S32
ISSUE SMART KEY TO USER OF RENTAL VEHICLE
S33
END

FIG. 4

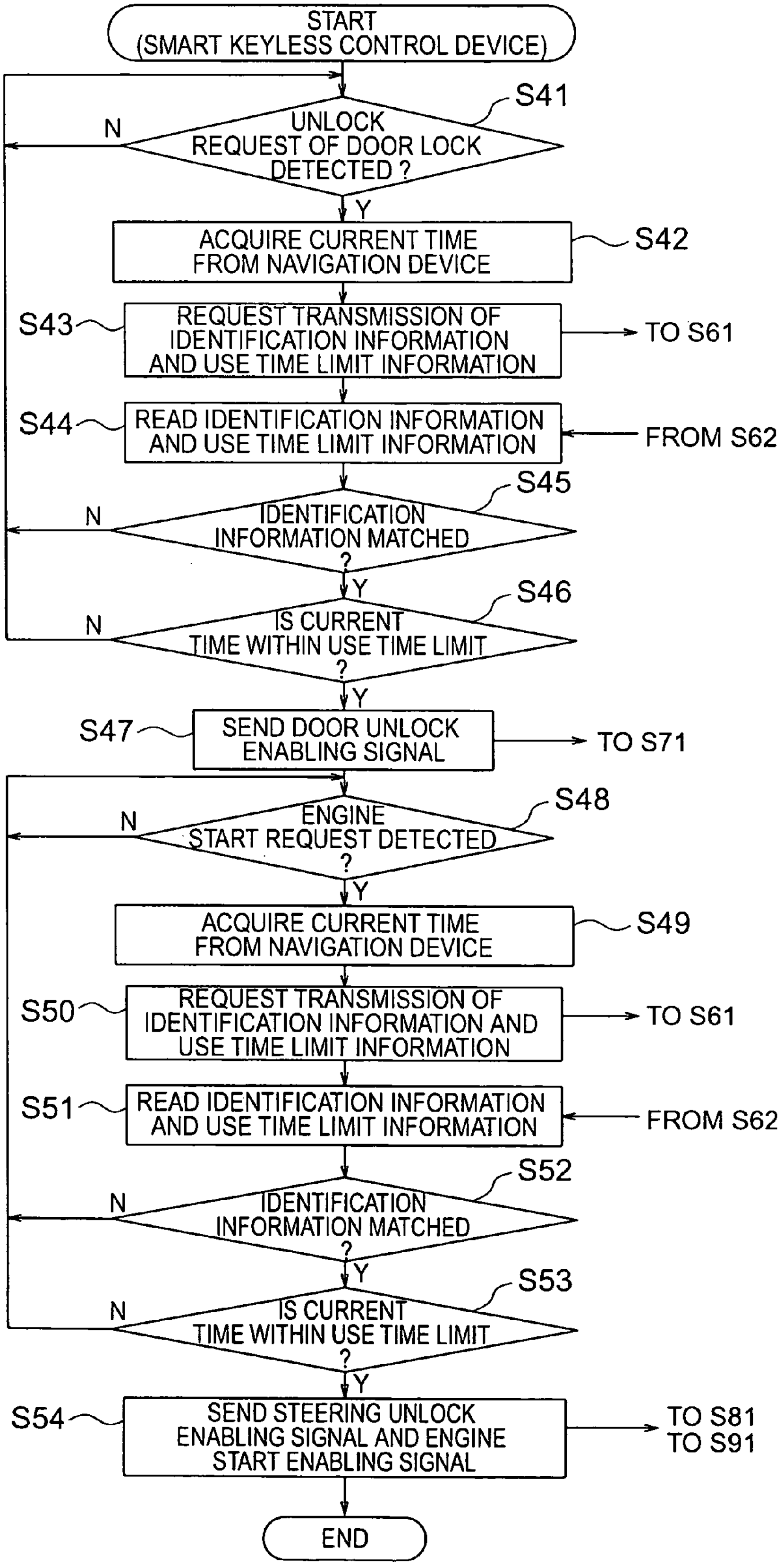

START
(SMART KEYLESS CONTROL DEVICE)
S41
UNLOCK REQUEST OF DOOR LOCK DETECTED ?
N
Y
ACQUIRE CURRENT TIME FROM NAVIGATION DEVICE
S42
S43
REQUEST TRANSMISSION OF IDENTIFICATION INFORMATION AND USE TIME LIMIT INFORMATION
TO S61
S44
READ IDENTIFICATION INFORMATION AND USE TIME LIMIT INFORMATION
FROM S62
S45
IDENTIFICATION INFORMATION MATCHED ?
N
Y
S46
IS CURRENT TIME WITHIN USE TIME LIMIT ?
N
Y
S47
SEND DOOR UNLOCK ENABLING SIGNAL
TO S71
S48
ENGINE START REQUEST DETECTED ?
N
Y
ACQUIRE CURRENT TIME FROM NAVIGATION DEVICE
S49
S50
REQUEST TRANSMISSION OF IDENTIFICATION INFORMATION AND USE TIME LIMIT INFORMATION
TO S61
S51
READ IDENTIFICATION INFORMATION AND USE TIME LIMIT INFORMATION
FROM S62
S52
IDENTIFICATION INFORMATION MATCHED ?
N
Y
S53
IS CURRENT TIME WITHIN USE TIME LIMIT ?
N
Y
S54
SEND STEERING UNLOCK ENABLING SIGNAL AND ENGINE START ENABLING SIGNAL
TO S81
TO S91
END

FIG. 5

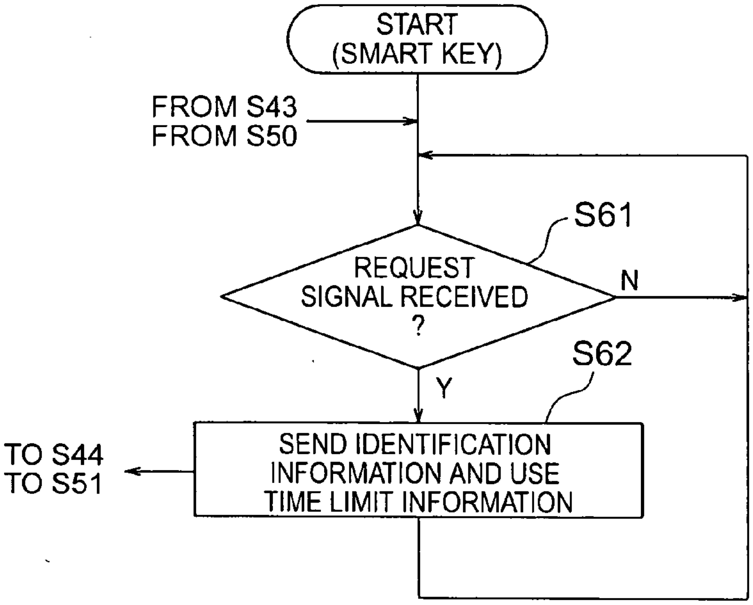

START
(SMART KEY)
FROM S43
FROM S50
S61
REQUEST
SIGNAL RECEIVED
?
N
Y
S62
SEND IDENTIFICATION
INFORMATION AND USE
TIME LIMIT INFORMATION
TO S44
TO S51

FIG. 6

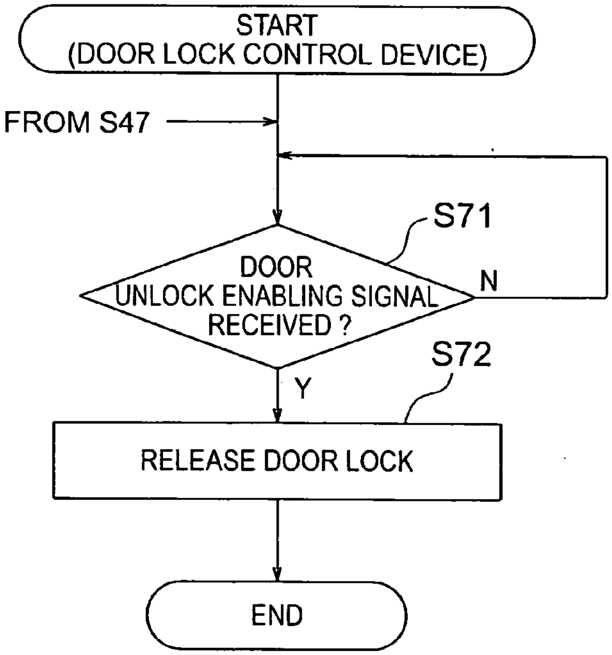

START
(DOOR LOCK CONTROL DEVICE)
FROM S47
S71
DOOR
UNLOCK ENABLING SIGNAL
RECEIVED ?
N
Y
S72
RELEASE DOOR LOCK
END

FIG. 7

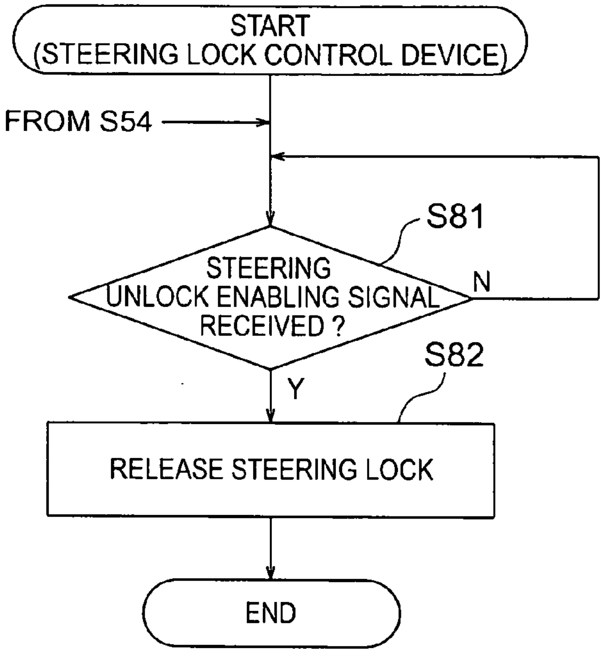
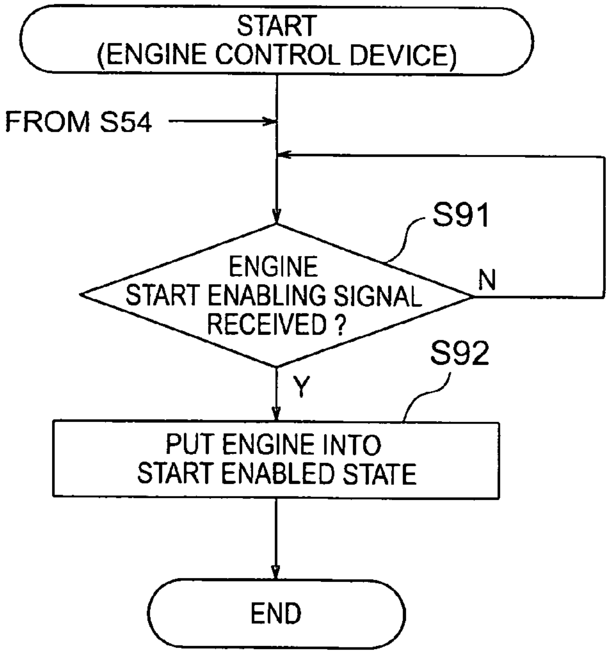

START
(STEERING LOCK CONTROL DEVICE)
FROM S54
S81
STEERING UNLOCK ENABLING SIGNAL RECEIVED ?
N
Y
S82
RELEASE STEERING LOCK
END

FIG. 8


START
(ENGINE CONTROL DEVICE)
FROM S54
S91
ENGINE START ENABLING SIGNAL RECEIVED ?
N
Y
S92
PUT ENGINE INTO START ENABLED STATE
END

VEHICLE ANTI-THEFT APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a vehicle anti-theft apparatus and method in which a smart key and a smart keyless control device are provided for preventing the theft of a vehicle.

[0003] 2. Description of the Related Art

[0004] There has hitherto been known a vehicle anti-theft apparatus which includes a portable transmitter comprising a memory for storing individual identification IDs, a CPU for converting the individual identification IDs in the memory into corresponding data signals for radio transmission, and a transmitter part for transmitting the data signals from the CPU through radio communications, a receiver comprising a receiver part that receives the data signals from the portable transmitter and a CPU that compares the individual identification IDs of the thus received signals with the individual collation identification IDs stored in the memory and outputs only coincident or matched signals to an engine control section, and an engine control section comprising a CPU that manages the operating environment of the engine and performs the management of a vehicle security mechanism.

[0005] When the data signals are sent from the portable transmitter to the receiver, the receiver makes comparison between the individual identification IDs and the individual collation identification IDs, and outputs only the coincident signal to the engine control section thereby to put it into an engine start stand-by state (for example, first patent document: Japanese utility model application laid-open No. H06-74537).

[0006] In addition, there has hitherto been known a rental car system which includes at least one keyless remote controller transmitter to which individual ID information is given and which sends a predetermined unlock signal containing at least ID information in accordance with an unlock operation, at least one vehicle having a keyless remote controller receiver which collates, upon reception of the predetermined unlock signal containing ID information, the ID information contained in the unlock signal to the use permission ID information that has been beforehand registered and set by a vehicle management center through a radio communication section, and unlocks door lock if the result of the collation is a match or coincidence, and a vehicle management center that sends the ID information of a keyless remote controller transmitter held by a reserved or booked user to the keyless remote controller receiver of the vehicle to be lent through the radio communication section (for instance, see a second patent document: Japanese patent application laid-open No. 2000-13326).

[0007] In the conventional vehicle anti-theft apparatus as described in the first patent document, there is a problem that it is necessary to provide the special portable transmitter capable of communicating with the receiver, thus resulting in an increased cost.

[0008] In addition, in the conventional rental car system as described in the second patent document, there is another problem that when the ID information of the keyless remote controller transmitter is registered in the keyless remote controller receiver, it is necessary to provide the vehicle management center, thereby increasing the cost of the system. Moreover, there is a further problem that should the ID information of the keyless remote controller transmitter be deciphered and the vehicle be stolen, the theft vehicle might be illegally used.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention is intended to obviate the problems as referred to above, and has for its object to provide a vehicle anti-theft apparatus and method which are capable of preventing the theft of the vehicle without increasing the cost as well as the illegal use of the theft vehicle.

[0010] Bearing the above object in mind, according to the present invention, there is provided a vehicle anti-theft apparatus including a smart key that is carried by a user of a vehicle, and a smart keyless control device installed on the vehicle. The smart key includes a storage section that stores identification information of the vehicle and use time limit information of the vehicle. The smart keyless control device includes: a reading section that reads the identification information and the use time limit information stored in the storage section; and a determination section that authenticates the user based on the identification information and the use time limit information when the user uses the vehicle. When the identification information and identification information for authentication that is stored beforehand in the smart keyless control device coincide with each other, and when a current time is within a use time limit of the use time limit information, the determination section permits the use of the vehicle.

[0011] According to the vehicle anti-theft apparatus of the present invention, when the identification information of a vehicle and the identification information for authentication stored beforehand in the smart keyless control device coincide with each other, and when the current time is within the use time limit of the use time limit information of the vehicle, the determination section of the smart keyless control device permits the use of the vehicle. Accordingly, it is possible to prevent the theft of the vehicle without increasing the cost, and hence the illegal use of the theft vehicle as well.

[0012] The above and other objects, features and advantages of the present invention will become more readily apparent to those skilled in the art from the following detailed description of a preferred embodiment of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a block diagram showing an anti-theft system of a vehicle anti-theft apparatus according to a first embodiment of the present invention.

[0014] FIG. 2 is a block diagram showing a use time limit information writing device for writing a use time limit information of a smart key according to the first embodiment of the present invention.

[0015] FIG. 3 is a flow chart illustrating a vehicle smart key generation operation of a rental car provider according to the first embodiment of the present invention.

[0016] FIG. **4** is a flow chart illustrating the operation of a smart keyless control device of the vehicle anti-theft apparatus according to the first embodiment of the present invention.

[0017] FIG. **5** is a flow chart illustrating the operation of a smart key of the vehicle anti-theft apparatus according to the first embodiment of the present invention.

[0018] FIG. **6** is a flow chart illustrating the operation of a door lock control device according to the first embodiment of the present invention.

[0019] FIG. **7** is a flow chart illustrating the operation of a steering lock control device according to the first embodiment of the present invention.

[0020] FIG. **8** is a flow chart illustrating the operation of an engine control device according to the first embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Now, a preferred embodiment of the present invention will be described in detail while referring to the accompanying drawings. Throughout respective figures, the same or corresponding members or parts are identified by the same reference numerals and characters.

Embodiment 1

[0022] FIG. **1** is a block diagram that shows an anti-theft system of a vehicle anti-theft apparatus according to a first embodiment of the present invention.

[0023] In FIG. **1**, the anti-theft system includes a smart key **2** that is carried by a user of a vehicle **1**, and the vehicle **1** that has a smart keyless control device **3**. Here, it is assumed that the vehicle **1** is a rental car, for example.

[0024] The smart key **2** has a memory **4** (storage section) and a CPU **5**, an LF (Low Frequency) receiving circuit **6**, and an RF (Radio Frequency) transmitting circuit **7**.

[0025] In addition, the vehicle **1** includes the smart keyless control device **3**, an LF transmitting circuit **8**, an RF receiving circuit **9**, a door switch **10**, an engine control device **11**, a key switch **12**, a door lock control device **13**, a door lock actuator **14**, a steering lock control device **15**, a steering lock actuator **16**, and a navigation device **17** (GPS (Global Positioning System) device).

[0026] The memory **4** stores identification information for identifying the individual vehicle **1**, and use time limit information that indicates the use time limit or expiration date and time of the vehicle **1**. The identification information and the use time limit information are encrypted and rewritable.

[0027] The CPU **5** reads out identification information and use time limit information from the memory **4** in accordance with a request signal (to be described later) of an LF band radio wave received by the LF receiving circuit **6**, and outputs them to the RF transmitting circuit **7**. Also, in accordance with a write signal (to be described later) of an LF band radio wave received by the LF receiving circuit **6**, the CPU **5** stores the use time limit information contained in a write signal into the memory **4**.

[0028] The LF receiving circuit **6** receives the request signal from the LF transmitting circuit **8** of the vehicle **1** or the write signal from the use time limit information writing device **21** (to be described later), and outputs it to the CPU **5**.

[0029] The RF transmitting circuit **7** sends the identification information and the use time limit information output from the CPU **5** to the RF receiving circuit **9** of the vehicle **1** as an answer signal of an RF band radio wave.

[0030] The smart keyless control device **3** requests the smart key **2** to send the identification information and the use time limit information stored in the memory **4**, reads the identification information and the use time limit information from the smart key **2**, and authenticates, upon the use of the vehicle **1**, the user thereof based on the identification information and the use time limit information thus read.

[0031] The LF transmitting circuit **8** sends, as a request signal, a request for transmission of the identification information and the use time limit information of the smart key **2** of the smart keyless control device **3** to the LF receiving circuit **6** through a transmitting antenna (not shown).

[0032] The RF receiving circuit **9** receives the answer signal from the RF transmitting circuit **7** through a receiving antenna (not shown), and outputs it to the smart keyless control device **3**.

[0033] The door switch **10** is mounted on a handle portion of each door of the vehicle **1** for detecting an unlock request for the door lock.

[0034] The engine control device **11** controls to start and stop the engine of the vehicle **1**, and the key switch **12** detects an engine start request for the engine, and the key switch **12** transmits the engine start request to the smart keyless control device **3** and the engine control device **11** through a key switch signal line **18**.

[0035] The door lock control device **13** controls the locking and unlocking of each door lock, and the door lock actuator **14** operates to lock and unlock each door lock.

[0036] The steering lock control device **15** controls the locking and unlocking of a steering lock, and the steering lock actuator **16** operates to lock and unlock the steering lock.

[0037] The navigation device **17** receives a GPS signal sent from a GPS satellite **19**, and acquires the position information of the vehicle **1** and the current time (including the year, month, date, hour, minute and second of the present time) contained in the GPS signal. Also, the navigation device **17** outputs the current time to the smart keyless control device **3**.

[0038] In addition, the engine control device **11**, the door lock control device **13**, the steering lock control device **15** and the navigation device **17** are connected to the smart keyless control device **3** through communication lines **20**, respectively. Arbitrary communication lines such as CAN (Controller Area Network) communication lines used for in-vehicle LAN communication, ISO 14230 communication lines, dedicated serial communication line, etc., are used as the communication lines **20**.

[0039] Moreover, the smart keyless control device **3** includes a reading section (not shown) that reads the identification information and the use time limit information stored in the memory **4**, and a determination section (not shown) that authenticates a user of the vehicle **1** based on the identification information and the use time limit information when the vehicle **1** is used.

[0040] Here, note that the smart keyless control device **3** is composed of a microprocessor (not shown) including a CPU and a memory with programs stored therein. Also, the identification information for authentication (hereinafter referred to as authentication identification information) corresponding to the identification information of the smart key **2** is stored beforehand in the memory.

[0041] When the identification information and the authentication identification information stored in the memory coincide with each other, and when the current time input from the navigation device **17** is within the use time limit of the use time limit information, the determination section permits the use of the vehicle **1**.

[0042] Here, note that the determination section performs the authentication of the user of the vehicle **1** when the user tries to release the door lock, or when the user tries to release the steering lock and start the engine.

[0043] First of all, when the determination section authenticates, upon detection of an unlock request for the door lock by the door switch **10**, the user and permits the use of the vehicle **1**, it outputs a door unlock enabling signal in the form of a serial communication signal to the door lock control device **13**.

[0044] Also, when the determination section authenticates, upon detection of an engine start request by the key switch **12**, the user and permits the use of the vehicle **1**, it outputs a steering unlock enabling signal in the form of a serial communication signal to the steering lock control device **15**, and at the same time outputs an engine start enabling signal in the form of a serial communication signal to the engine control device **11**.

[0045] Here, note that the use time limit information of the vehicle **1** is stored beforehand in the memory **4** of the smart key **2** by the rental car provider before the user carries the smart key **2**.

[0046] Hereinafter, reference will be made to the operation of writing the use time limit information of the smart key **2** by the rental car provider while referring to FIG. **2** together with FIG. **1**.

[0047] FIG. **2** is a block diagram that shows the use time limit information writing device **21** for writing the use time limit of the smart key **2** according to the first embodiment of the present invention.

[0048] In FIG. **2**, the use time limit information writing device **21** includes a CPU **22** and an LF transmitting circuit **23**.

[0049] In addition, the smart key **2** is set into the use time limit information writing device **21**. Here, it is assumed that the identification information of the vehicle **1** is stored beforehand in the memory **4** of the smart key **2**.

[0050] The CPU **22** is connected to a management computer **25** that has a rental car management database **24**. The rental car management database **24** includes the identification information and the use time limit information of the vehicle **1** that the rental car provider owns. The CPU **22** reads in use time limit information from the rental car management database **24** and outputs it to the LF transmitting circuit **23**.

[0051] The LF transmitting circuit **23** outputs the use time limit information output from the CPU **22** to the LF receiving circuit **6** of the smart key **2** as a write signal.

[0052] Next, reference will be made to the operation of the rental car provider issuing or generating the smart key **2** of the vehicle **1** while referring to a flow chart of FIG. **3**.

[0053] First of all, the rental car provider determines whether there is the acceptance of lending the vehicle **1** (step S**31**).

[0054] When it is determined in step S**31** that there is the acceptance of lending (that is, Yes), use time limit information is written into the smart key **2** of the vehicle **1** for rental by using the use time limit information writing device **21**, as previously stated (step S**32**).

[0055] Subsequently, the smart key **2** is issued to the user of the rental vehicle **1** (step S**33**), and the flow chart of FIG. **3** is terminated.

[0056] On the other hand, when it is determined in step S**31** that there is no acceptance of lending (that is, No), a return is performed to step **31** where it is determined again whether there is the acceptance of lending the vehicle **1**.

[0057] Now, reference will be made to the operation of the smart keyless control device **3** of the vehicle anti-theft apparatus according to the first embodiment of the present invention while referring to flow charts of FIG. **4** through FIG. **8**.

[0058] First of all, it is determined whether an unlock request for the door lock has been detected by the door switch **10** (step S**41**).

[0059] When it is determined in step S**41** that an unlock request for the door lock is detected (that is, Yes), the current time is acquired from the navigation device **17** (step S**42**).

[0060] Subsequently, a request for the transmission of the identification information and the use time limit information stored in the memory **4** is made to the smart key **2** (step S**43**), and the identification information and the use time limit information from the smart key **2** are read (step S**44**).

[0061] When the smart keyless control device **3** makes a request for the transmission of the identification information and the use time limit information to the smart key **2** in step S**43**, the LF transmitting circuit **8** sends a transmission request to the LF receiving circuit **6** of the smart key **2** as a request signal, and the RF receiving circuit **9** receives an answer signal and outputs it to the smart keyless control device **3**.

[0062] At this time, the smart key **2** executes an operation that is illustrated in a flow chart of FIG. **5**.

[0063] First, the smart key **2** determines whether a request signal has been received (step S**61**).

[0064] When it is determined in step S**61** that a request signal has been received (that is, Yes), the identification information and the use time limit information are sent to the

RF receiving circuit **9** of the vehicle **1** as an answer signal (step S**62**), and the control flow shifts to step S**61**.

[**0065**] On the other hand, when it is determined in step S**61** that no request signal has been received (that is, No), a return is performed to step **61** where it is determined again whether a request signal has been received.

[**0066**] Then, the determination section determines whether the identification information and the authentication identification information beforehand stored in the memory of the smart keyless control device **3** coincide with each other (step S**45**).

[**0067**] When it is determined in step S**45** that the identification information and the authentication identification information coincide with each other (that is, Yes), it is further determined whether the current time is within the use time limit of the use time limit information (step S**46**).

[**0068**] When it is determined in step S**46** that the current time is within the use time limit (that is, Yes), a door unlock enabling signal is output to the door lock control device **13** (step S**47**).

[**0069**] On the other hand, when it is determined in step S**41** that an unlock request for the door lock has not been detected (that is, No), or when it is determined in step S**45** that the identification information and the authentication identification information do not coincide with each other (that is, No), or when it is determined in step S**46** that the current time is not within the use time limit (that is, No), a return is performed to step S**41** where it is determined again whether an unlock request for the door lock has been detected.

[**0070**] At this time, the door lock control device **13** executes an operation that is illustrated in a flow chart of FIG. **6**.

[**0071**] First, the door lock control device **13** determines whether a door unlock enabling signal has been received (step S**71**).

[**0072**] When it is determined in step S**71** that a door unlock enabling signal has been received (that is, Yes), the door lock is released through the door lock actuator **14** (step S**72**), and the processing of FIG. **6** is terminated.

[**0073**] On the other hand, when it is determined in step S**71** that a door unlock enabling signal has not been received (that is, No), a return is performed to step **71** where it is determined again whether a door unlock enabling signal has been received.

[**0074**] Then, it is determined whether an engine start request has been detected by the key switch **12** (step S**48**).

[**0075**] When it is determined in step S**48** that an engine start request has been detected (that is, Yes), the current time is acquired from the navigation device **17** (step S**49**).

[**0076**] Subsequently, a request for the transmission of the identification information and the use time limit information stored in the memory **4** is made to the smart key **2** (step S**50**), and the identification information and the use time limit information from the smart key **2** are read (step S**51**).

[**0077**] When the smart keyless control device **3** makes a request for the transmission of the identification information and the use time limit information to the smart key **2** in step S**50**, the LF transmitting circuit **8** sends a request signal to the LF receiving circuit **6** of the smart key **2**, and the RF receiving circuit **9** receives an answer signal and outputs it to the smart keyless control device **3**, as previously stated.

[**0078**] At this time, the smart key **2** executes the same operation as illustrated in the flow chart of FIG. **5**.

[**0079**] Then, the determination section determines whether the identification information and the authentication identification information beforehand stored in the memory of the smart keyless control device **3** coincide with each other (step S**52**).

[**0080**] When it is determined in step S**52** that the identification information and the authentication identification information coincide with each other (that is, Yes), it is further determined whether the current time is within the use time limit of the use time limit information (step S**53**).

[**0081**] When it is determined in step S**53** that the current time is within the use time limit (that is, Yes), a steering unlock enabling signal is output to the steering lock control device **15**. Then, an engine start enabling signal is output to the engine control device **11** (step S**54**), and the processing of FIG. **4** is terminated.

[**0082**] On the other hand, when it is determined in step S**48** that an engine start request has not been detected (that is, No), or when it is determined in step S**52** that the identification information and the authentication identification information do not coincide with each other (that is, No), or when it is determined in step S**53** that the current time is not within the use time limit (that is, No), a return is performed to step S**48** where it is determined again whether an engine start request has been detected.

[**0083**] At this time, the steering lock control device **15** executes an operation that is illustrated in a flow chart of FIG. **7**.

[**0084**] First, the steering lock control device **15** determines whether a steering unlock enabling signal has been received (step S**81**).

[**0085**] When it is determined in step S**81** that a steering unlock enabling signal has been received (that is, Yes), the steering lock is released through the steering lock actuator **16** (step S**82**), and the processing of FIG. **7** is terminated.

[**0086**] On the other hand, when it is determined in step S**81** that a steering unlock enabling signal has not been received (that is, No), a return is performed to step **81** where it is determined again whether a steering unlock enabling signal has been received.

[**0087**] At this time, the engine control device **11** executes an operation that is illustrated in a flow chart of FIG. **8**.

[**0088**] First, the engine control device **11** determines whether an engine start enabling signal has been received (step S**91**).

[**0089**] When it is determined in step S**91** that an engine start enabling signal has been received (that is, Yes), the engine is put into a startable state (step S**92**), and the processing of FIG. **8** is terminated.

[**0090**] On the other hand, when it is determined in step S**91** that an engine start enabling signal has not been received (that is, No), a return is performed to step **91** where it is determined again whether an engine start enabling signal has been received.

[0091] Here, note that once the engine becomes a startable state, it holds the startable state until the power supply of the engine control device **11** is turned off, so the engine never stops during the time when the vehicle **1** is traveling.

[0092] According to the vehicle anti-theft apparatus of the first embodiment of the present invention, when the identification information and the authentication identification information stored in the memory coincide with each other, and when the current time is within the use time limit of the use time limit or rental period information, the determination section of the smart keyless control device **3** permits the use of the vehicle **1**. Accordingly, it is possible to prevent the theft of the vehicle **1** without increasing the cost, and hence the illegal use of the theft vehicle.

[0093] In addition, the determination section is arranged in the interior of the smart keyless control device **3** which is difficult to illegally remodel or modify, so the theft of the vehicle **1** can be prevented.

[0094] Also, the determination section authenticates the user of the vehicle **1** at the time when the user tries to release the door lock where the release of the door lock is requested, or at the time when the user tries to release the steering lock and start the engine where the start of the engine is requested.

[0095] Thus, even when the use time limit for use or rental period expires during the vehicle **1** is traveling, the engine is not stopped suddenly, thereby making it possible to ensure proper steering.

[0096] Moreover, the current time is input from the navigation device **17** to the smart keyless control device **3**, so the current time is never modified or falsified by a third party, and hence security can be improved.

[0097] Further, the use time limit or rental period information of the vehicle **1** is stored beforehand by the rental car provider by using the special or dedicated use time limit information writing device **21** before the user carries the smart key **2**. In addition, the identification information and the use time limit information stored in the memory **4** are encrypted. As a result, there is no fear that the identification information and the use time limit information might be falsified by a third party, so security can be improved.

[0098] Although in the above-mentioned first embodiment, the current time is input from the navigation device **17** to the smart keyless control device **3**, the present invention is not limited to this, but the current time may instead be calculated by using a timer device (not shown) built in the smart keyless control device **3** and compared with the use time limit information. Also, the standard wave having time information (current time) may be received and used as the current time. In these cases, too, the operational or advantageous effects similar to those of the above-mentioned first embodiment can be achieved.

[0099] In addition, although in the above-mentioned first embodiment, the description has been made while using the smart key **2**, there may be used, in place of the smart key **2**, an immobilizer key that has an immobilizer function to collate ID codes at the key side and at the vehicle side thereby to control the starting of the engine in accordance with the result of the collation. In this case, too, the operational or advantageous effects similar to those of the above-mentioned first embodiment can be achieved.

[0100] While the invention has been described in terms of a preferred embodiment, those skilled in the art will recognize that the invention can be practiced with modifications within the spirit and scope of the appended claims.

What is claimed is:

1. A vehicle anti-theft apparatus comprising a smart key that is carried by a user of a vehicle, and a smart keyless control device installed on the vehicle,

wherein the smart key includes a storage section that stores identification information of the vehicle and use time limit information of the vehicle; and

the smart keyless control device includes:

a reading section that reads the identification information and the use time limit information stored in the storage section; and

a determination section that authenticates the user based on the identification information and the use time limit information when the user uses the vehicle;

wherein when the identification information and identification information for authentication that is stored beforehand in the smart keyless control device coincide with each other, and when a current time is within a use time limit of the use time limit information, the determination section permits the use of the vehicle.

2. The vehicle anti-theft apparatus as set forth in claim 1, wherein the determination section permits the release of a door lock of the vehicle.

3. The vehicle anti-theft apparatus as set forth in claim 2, wherein the determination section authenticates the user when the user tries to release the door lock.

4. The vehicle anti-theft apparatus as set forth in claim 1, wherein the determination section permits the release of a steering lock of the vehicle and the starting of an engine of the vehicle.

5. The vehicle anti-theft apparatus as set forth in claim 4, wherein the determination section authenticates the user when the user tries to release the steering lock and start the engine.

6. The vehicle anti-theft apparatus as set forth in claim 1, wherein the current time is input from a GPS device, which is installed on the vehicle for detecting the position of the vehicle, to the smart keyless control device.

7. The vehicle anti-theft apparatus as set forth in claim 1, wherein the use time limit information is stored in advance before the user carries the smart key.

8. A vehicle anti-theft method comprising:

a step of storing, into a smart key that is carried by a user of a vehicle, identification information of the vehicle and use time limit information of the vehicle;

a step of reading the identification information and the use time limit information stored in the storage section by means of a smart keyless control device installed on the vehicle; and

a step in which the smart keyless control device permits release of a door lock of the vehicle based on the identification information and the use time limit information, when the identification information and authentication identification information stored beforehand in the smart keyless control device coincide with each other, and when a current time input from a GPS device, which is installed to the vehicle for detecting the position of the vehicle, is within a use time limit of the use time limit information.

9. A vehicle anti-theft method comprising:

a step of storing, into a smart key that is carried by a user of a vehicle, identification information of the vehicle and use time limit information of the vehicle;

a step of reading the identification information and the use time limit information stored in the storage section by means of a smart keyless control device installed on the vehicle; and

a step in which the smart keyless control device permits release of a steering lock of the vehicle and starting of an engine of the vehicle based on the identification information and the use time limit information, when the identification information and authentication identification information stored beforehand in the smart keyless control device coincide with each other, and when a current time input from a GPS device, which is installed on the vehicle for detecting the position of the vehicle, is within a use time limit of the use time limit information.

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