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(71) Applicant(s):
Jaguar Cars Limited
(Incorporated in the United Kingdom)
Abbey Road, Whitley, COVENTRY, Warwickshire, CV3 4LF, United Kingdom

(72) Inventor(s):
Mohammed Khan
Howard Siswick

(74) Agent and/or Address for Service:
Jaguar Land Rover
Patent Department W/1/073, Abbey Road, Whitley, COVENTRY, CV3 4LF, United Kingdom

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(56) Documents Cited:
DE 004404501 A1 **US 6056076 A**
US 20090205384 A1 **US 20030155779 A1**

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INT CL **B60R, G07C**
Other: **WPI, EPODOC, TXTE**

(54) Title of the Invention: **Electronic access system and key**
Abstract Title: **Electronic vehicle access system and key**

(57) The present invention relates to a vehicle (3) comprising a main battery, an auxiliary electrical energy storage means (9), an electronic control unit (7), a first data port (33) accessible from the exterior of the vehicle, and at least one vehicle door having an electrically operated locking mechanism arranged so as to be powered by either one of the main battery or the auxiliary electrical energy storage means (9) under the control of the electronic control unit (7). The electronic control unit (7) is configured to transmit a challenge signal to an electronic key connected to the first data port (33); receive a response signal from the electronic key and, in the event that the response signal is authenticated, to initiate unlocking of said at least one door by selectively controlling the supply of power to the locking mechanism from one of the main battery and the auxiliary electrical energy storage means (9). The control unit can monitor the charge level of the main battery and depending on whether the charge level is below a threshold, the auxiliary or back-up battery can be used. Access to a vehicle can still be granted even when the main battery is flat.

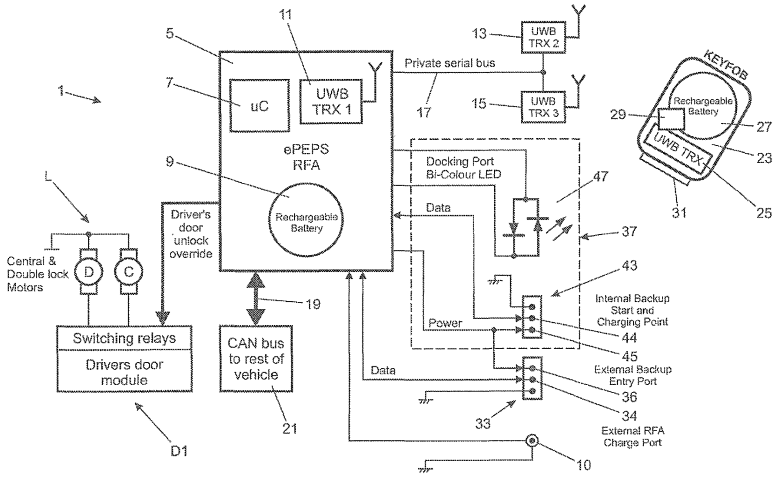

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

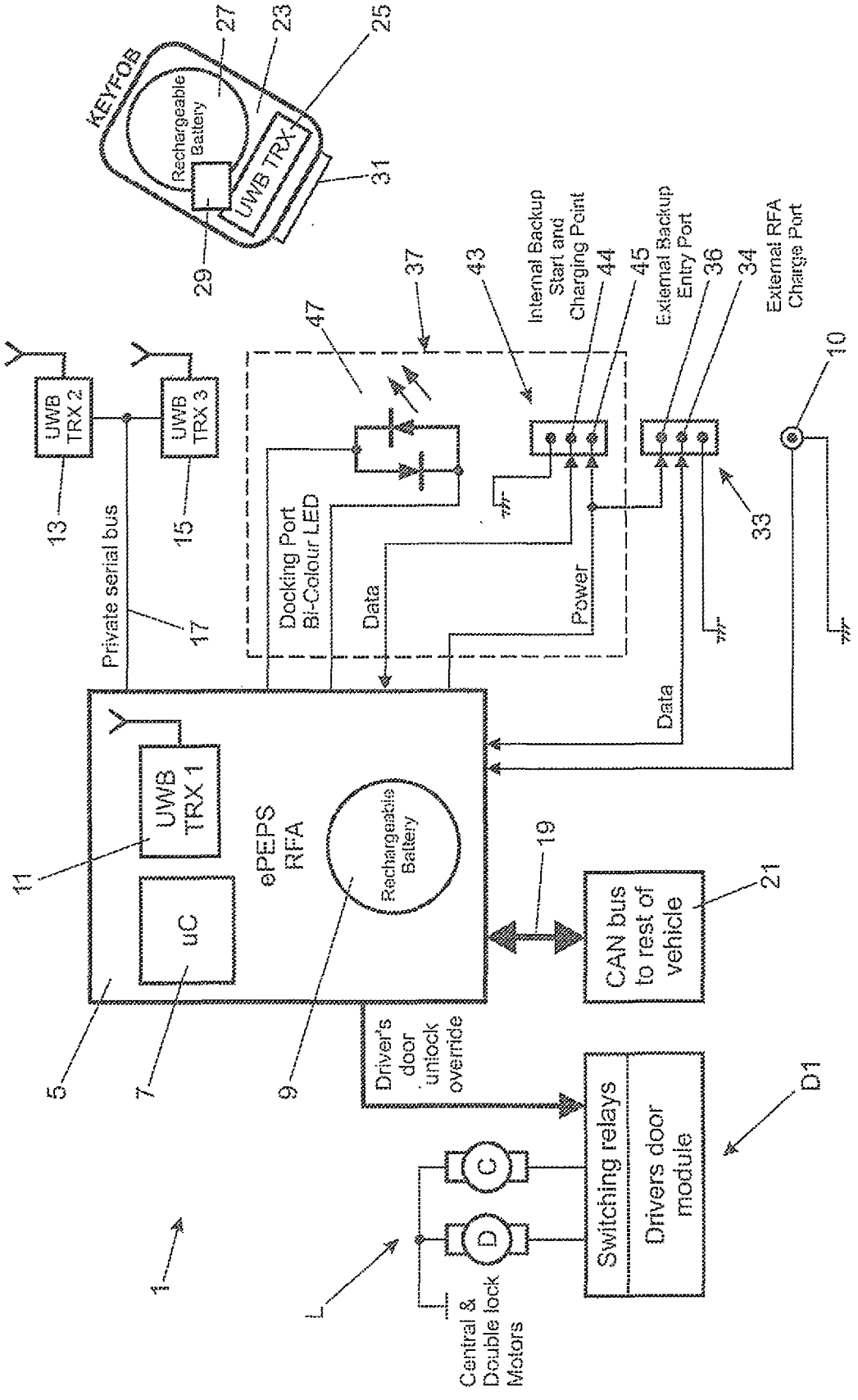
KEYFOB
Rechargeable Battery
UWB TRX
27
23
25
31
29
37
43
47
Internal Backup Start and Charging Point
44
45
External Backup Entry Port
36
34
External RFA Charge Port
10
UWB TRX 2
UWB TRX 3
13
15
Private serial bus
17
Docking Port Bi-Colour LED
Data
Power
33
Data
UWB TRX 1
11
ePEPS RFA
uC
Rechargeable Battery
19
CAN bus to rest of vehicle
21
5
7
9
Driver's door unlock override
Switching relays
Drivers door module
D1
1
C
D
Central & Double lock Motors

FIG. 1

11 02 13

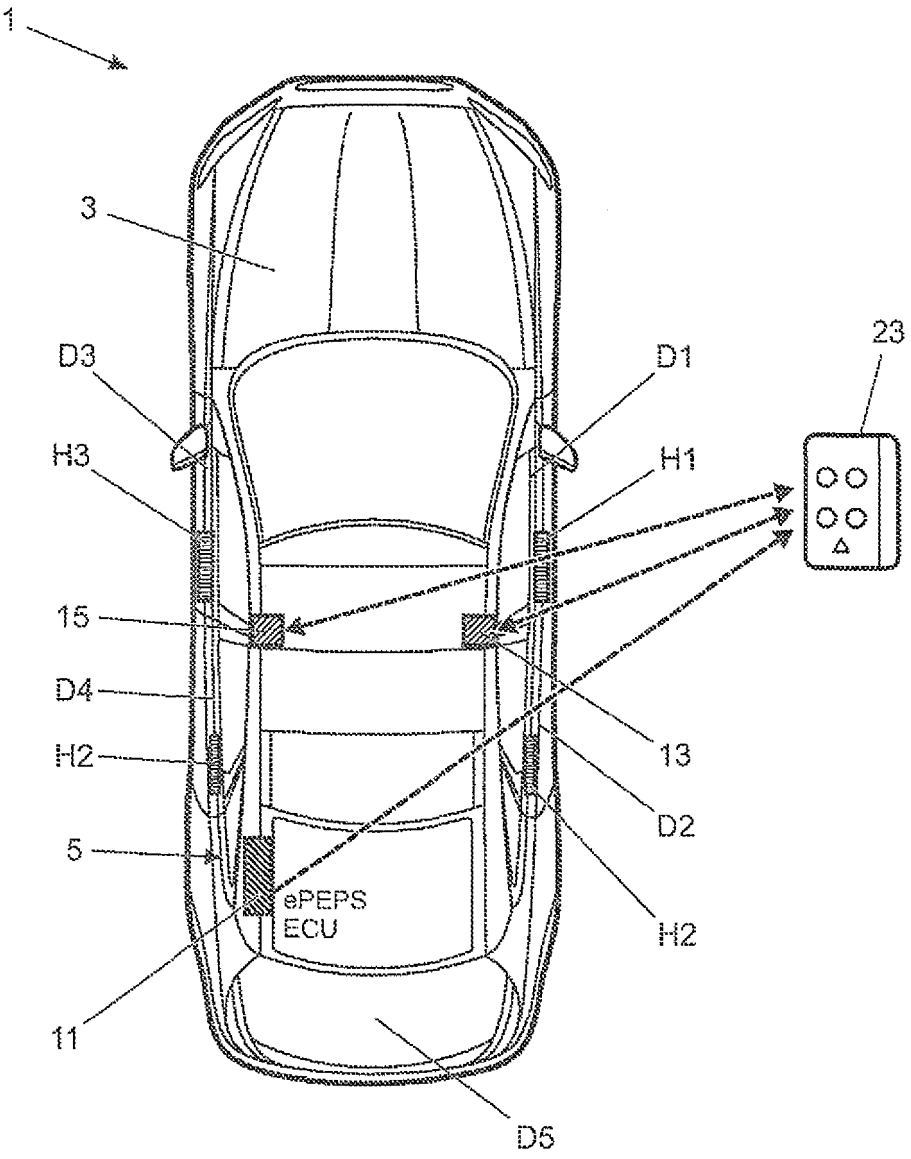

FIG. 2

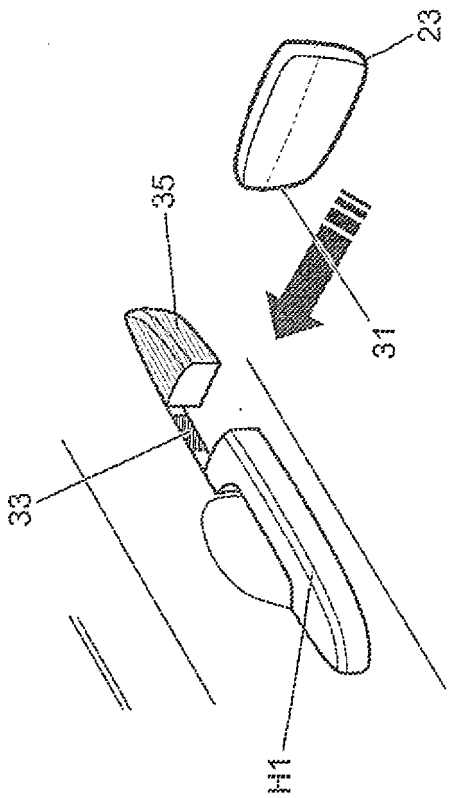

FIG. 3B

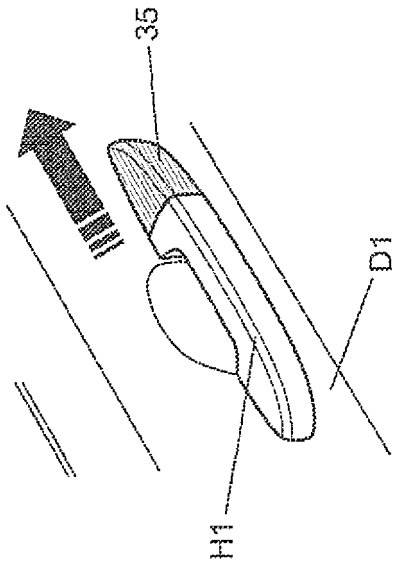

FIG. 3A

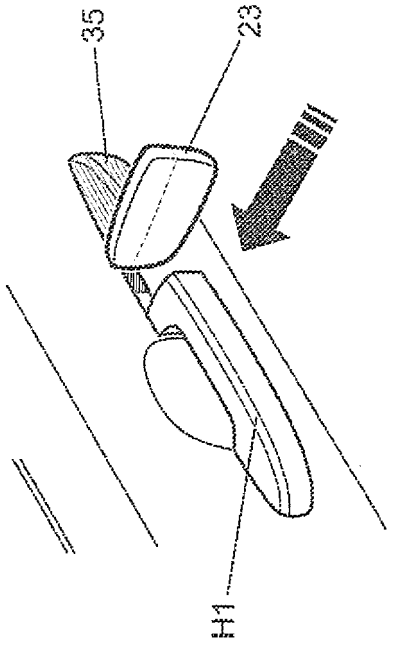

FIG. 3C

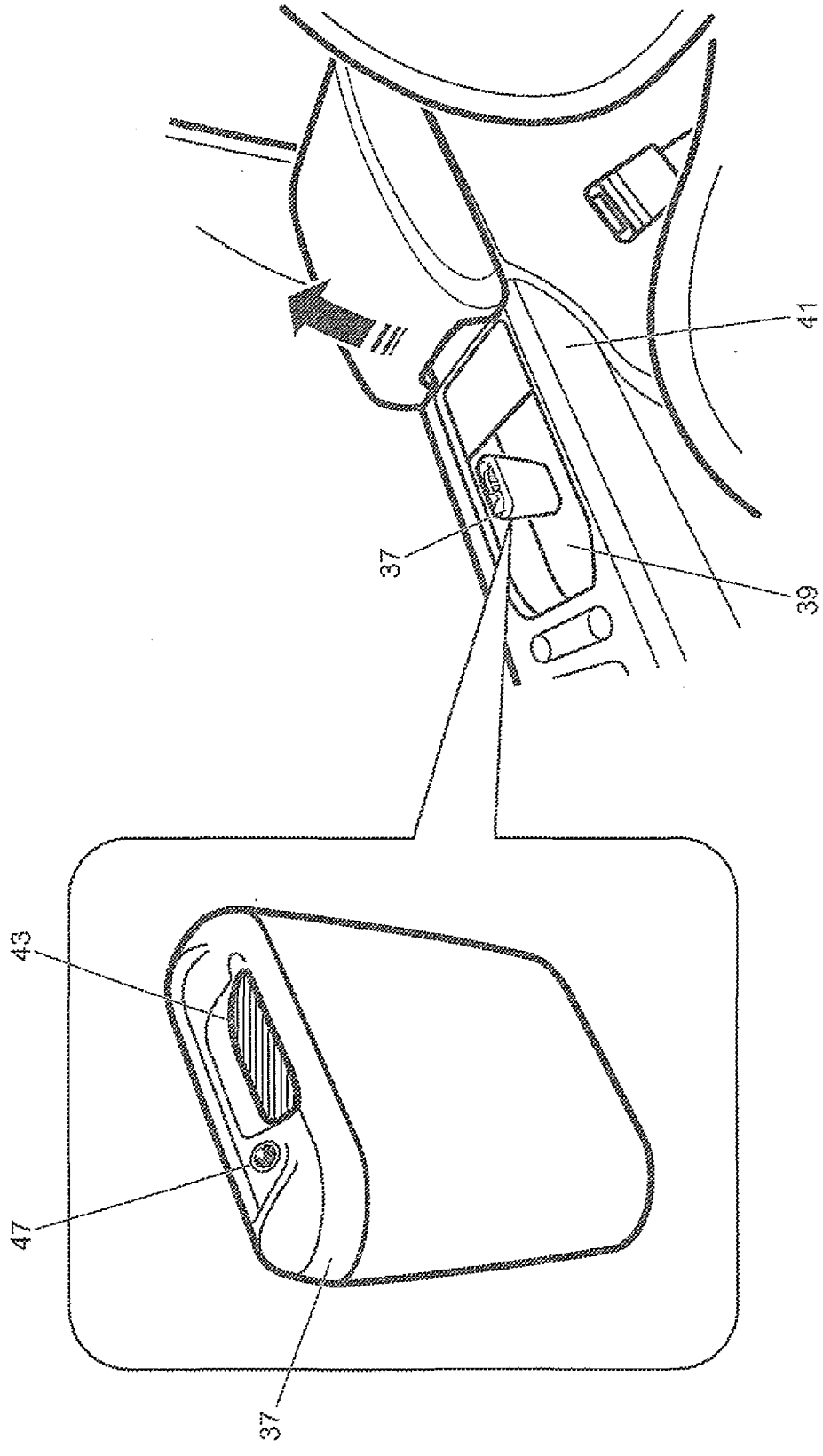

FIG. 4A

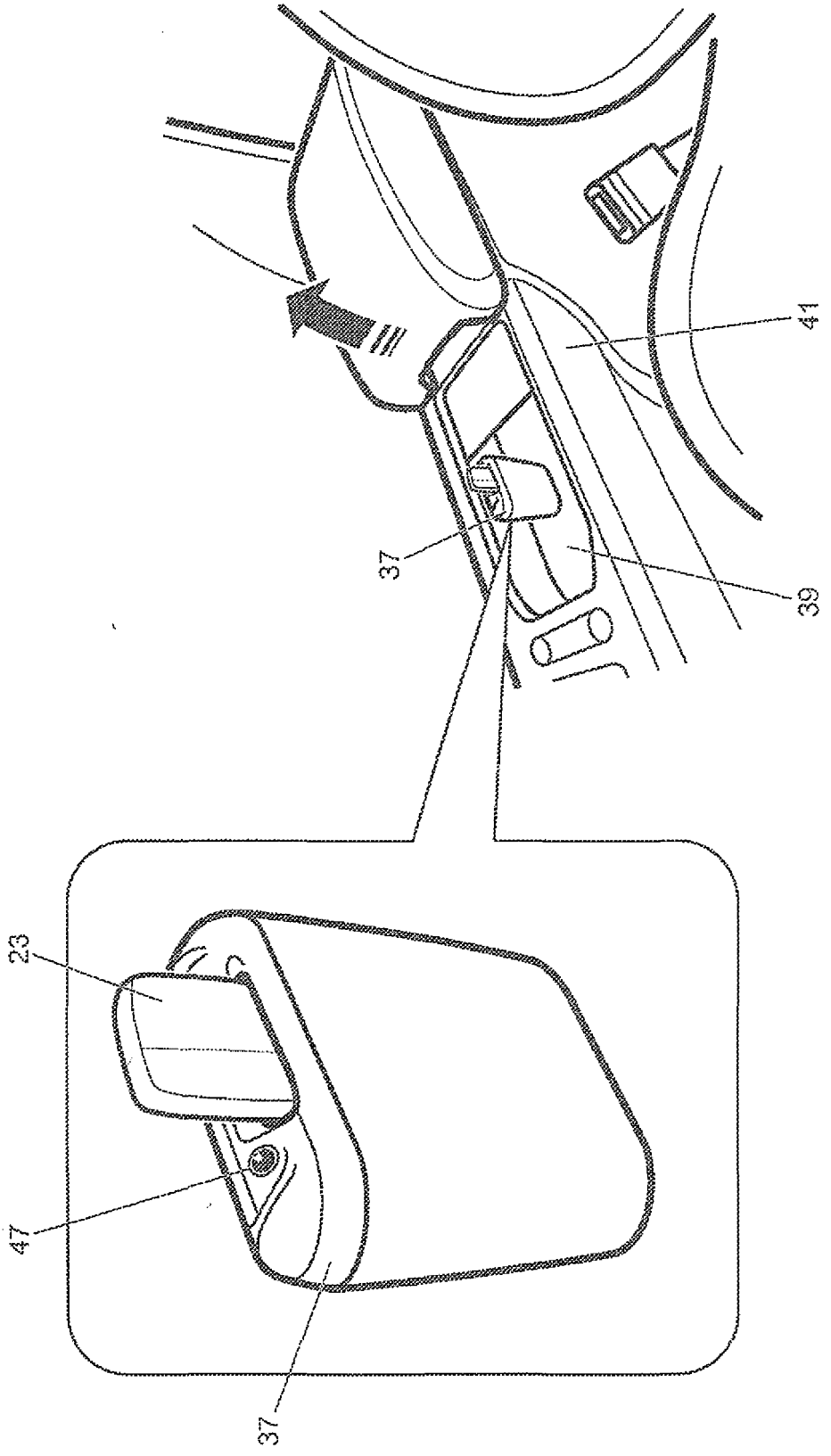

FIG. 4B

ELECTRONIC ACCESS SYSTEM AND KEY

TECHNICAL FIELD

The present invention relates to a vehicle and an electronic key for controlling access to the vehicle. More particularly, but not exclusively, the invention relates to an electronic key which provides a back-up means accessing the vehicle.

BACKGROUND OF THE INVENTION

It is well known to utilise a portable electronic key to control access to a vehicle. The electronic key typically comprises a transceiver for wireless communication with a base station in the vehicle. Once activated, the base station transmits a challenge signal to the electronic key. A response signal is transmitted by the electronic key and this is validated by the base unit. Only when the key has been authenticated is the vehicle unlocked. The electronic key can also be used to control operation of the vehicle.

A problem with electronic keys is that the internal battery may become depleted over time. If there is insufficient charge in the battery, the electronic key will become inoperable. To provide a back-up means to access the vehicle, the electronic key is typically provided with a mechanical key-blade for operating a door lock mechanism. The key-blade is typically accommodated inside the electronic key requiring a separate compartment. Also, appropriate lock barrels and the related operating links must be provided in the vehicle's door. It will be appreciated that providing a mechanical key-blade increases the complexity and cost of both the electronic key and the vehicle door. Furthermore, the mechanical key blade represents a security risk because it can be copied.

It is an aim of the present invention to address or ameliorate some of the shortcomings associated with known electronic keys.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides a vehicle comprising a main battery, an auxiliary electrical energy storage means, an electronic control unit, a first data port accessible from the exterior of the vehicle, and at least one vehicle door having an electrically operated locking mechanism arranged so as to be powered by either one of the

main battery or the auxiliary electrical energy storage means under the control of the electronic control unit;

wherein the electronic control unit is configured to transmit a challenge signal to an electronic key connected to the first data port; receive a response signal from the electronic key and, in the event that the response signal is authenticated, to initiate unlocking of said at least one door by selectively controlling the supply of power to the locking mechanism from one of the main battery and the auxiliary electrical energy storage means.

Thus, an electronic key can be connected to at least the first data port when the vehicle is locked. The electronic key therefore functions as a back-up means for accessing the vehicle. Conveniently, the vehicle does not require a key cylinder operable by a mechanical key-blade to open a door. Thus, a security risk associated with the mechanical key-blade for the key cylinder being copied is eliminated. Furthermore, the electronic key can be used to access the vehicle even if the main vehicle battery is flat.

The electronic control unit may be configured to control the supply of power to the locking mechanism of said at least one door from one of the main battery and the auxiliary electrical energy storage means in dependence on the charge stored on the main battery.

The electronic control unit may be configured to control the supply of power to the locking mechanism of said at least one door from the auxiliary electrical energy storage means, when the charge stored on the main battery is determined to be below a predetermined threshold value.

The electronic control unit may configured to control the supply of power to the locking mechanism of said at least one door from the main battery, when the charge stored on the main battery is determined to be above a predetermined threshold value.

The electronic control unit may be configured to control the supply of power to the locking mechanism of said at least one door from the auxiliary electrical energy storage means.

The auxiliary electrical energy storage means may be a battery, optionally a rechargeable battery. The vehicle may comprise a charging port for charging the auxiliary battery, wherein the charging port is accessible from the exterior of the vehicle.

A cover can provided over at least the first data port to provide protection. The cover can be waterproof.

At least a second data port can be provided in an interior of the vehicle for establishing a wired connection with the electronic key. The vehicle can further comprise a dock on an interior of the vehicle for connecting the electronic key. The second data port can be provided in the dock.

A challenge/response sequence can be performed via the second data port. The electronic control unit can output an engine start request upon authentication of the electronic key.

In another aspect, the present invention provides an electronic key for use with a vehicle as described above.

The electronic key can be provided without a mechanical key-blade. In other words, the electronic key can be key-bladeless.

The electronic key may comprise a data connector and control circuitry configured to receive a challenge signal via the data connector; and/or to output a signal via the data connector.

The electronic key may comprise storage means storing vehicle access information.

The control means may be configured to output a response signal comprising vehicle access information stored in the storage means in response to receiving a challenge signal via the data connector.

In a further aspect, the present invention provides a combination of a vehicle and an electronic key as described above.

Within the scope of this application it is envisaged that the various aspects, embodiments, examples, features and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings may be taken independently or in any combination thereof. For example, features described in connection with one embodiment are applicable to all embodiments unless there is incompatibility of features.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

Figure 1 shows a schematic representation of a vehicle access system according to an embodiment of the present invention;

Figure 2 shows the installation of the base station and transceivers of the vehicle access system in a motor vehicle;

Figures 3A, 3B and 3C illustrate the procedure for connecting the key fob to a first data port provided on the vehicle; and

Figures 4A and 4B illustrate the docking of the key fob inside the vehicle.

DETAILED DESCRIPTION OF AN EMBODIMENT

An access system 1 in accordance with an embodiment of the present invention is shown in Figure 1. The vehicle access system 1 is configured to provide enhanced Passive Entry and Passive Start (ePEPS) of a vehicle 3. In particular, the vehicle access system 1 supports keyless access and, optionally, remote engine start.

The vehicle access system 1 will be described with reference to the vehicle 3 which has a front right door D1, a rear right door D2, a front left door D3 and a rear left door D4. The vehicle 3 also has a boot lid D5 (also known as a deck lid) which can be locked/unlocked by the vehicle access system 1 but this is not described herein for the sake of brevity. The doors D1-D4 each have a lock mechanism L and an external handle H1-H4; and the front doors D1, D3 each have a folding door mirror. The lock mechanisms L each comprise a central lock motor, a double lock motor and a door lock switch to provide a locking signal to indicate the status of the respective lock mechanism.

The vehicle access system 1 comprises a base station 5 to be installed in the vehicle 3 to provide a Remote Function Actuator (RFA) for the vehicle 3. The base station 5 comprises an electronic control unit 7 and a first rechargeable battery 9. The first rechargeable battery 9 provides a dedicated power supply for the base station 5 to enable independent operation. A main vehicle battery (not shown) typically provides power to actuate the door lock mechanisms. In the event that the main vehicle battery is depleted, the first rechargeable battery 9 can provide power to operate at least one of the door lock mechanisms.

The main vehicle battery and the first rechargeable battery 9 are charged during normal vehicle operation. An external charge port 10 is provided for charging the first battery 9 if it is depleted. In the exceptional circumstance that both the main vehicle battery and the first rechargeable battery 9 are depleted, the first rechargeable battery 9 can be re-charged via the external charge port 10 to enable at least one door lock mechanism to be operated.

The base station 5 further comprises first, second and third ultra-wideband transceivers 11, 13, 15. The first transceiver 11 is provided proximal the electronic control unit 7. The second and third transceivers 13, 15 are positioned in the vehicle 3 remote from the electronic control unit 7 and connected via a dedicated local interconnect network (LIN) 17. Other types of private serial communication bus can be employed in place of the LIN 17. The transceivers 11, 13, 15 each have an integrated antenna.

The base station 5 is connected to the vehicle systems (denoted generally by the reference numeral 19) via a CAN bus 21. The base station 5 can thereby receive the locking signals from the door lock switches; and control operation of the door lock mechanisms. The CAN bus 21 can also be employed to convey instructions from the electronic control unit 7 to the engine control unit to enable/disable passive engine starts.

The vehicle access system 1 further comprises a key fob 23 having a remote ultra-wideband transceiver 25 and a second rechargeable battery 27. The key fob 23 is portable and is typically carried by the user. As described herein, in normal use, the key fob 23 communicates with the base station 5 to enable passive entry to the vehicle. The key fob 23 does not have a mechanical key-blade to mechanically operate a door look mechanism.

The installation of the vehicle access system 1 is illustrated in Figure 2. The base station 5 and the first transceiver 11 are located at the rear of the vehicle 3 and the second and third transceivers 13, 15 are located in the upper part of the vehicle (typically in the roof) on the right and left sides respectively of the vehicle 3.

The key fob 23 further comprises an electronic controller 29 for controlling the remote transceiver 25 and a hardware data connector 31 for connecting the key fob 23 to a first data port 33 on the vehicle 3. A first data line 34 provides a wired connection between the first data port 33 and the electronic control unit 7. A wired data connection is established between the controller 29 and the electronic control unit 7 when the data connector 31 is connected to the first data port 33. The first data port 33 also has a power connector 36 for supplying power to the controller 29 via the data connector 31. The wired connection allows

the key fob 23 to be used to access the vehicle 3 when wireless communication is not available, for example when the second battery 27 is depleted. The data connector 31 thereby serves as a replacement to a mechanical key-blade typically provided as back-up for an electronic key.

As shown in Figures 3A-3C, the first data port 33 is positioned adjacent to a first door handle H1 on the front right door D1. The first data port 33 has a protective cover 35 profiled to match the first door handle H1. The cover 35 is slidably mounted and can be displaced along a longitudinal axis to expose the first data port 33, as shown in Figure 3B. The key fob 23 can then be physically connected to the data port 33 via the data connector 31, as shown in Figure 3C. One or more additional data ports can be provided on the vehicle 3. For example, a second data port (not shown) can be provided adjacent a third door handle H3 on the front left door D3.

As shown in Figures 4A and 4B, the base station 5 further comprises an internal connector dock 37 for receiving the key fob 23. The connector dock 37 is mounted on the interior of a compartment 39 provided in a central console 41 of the vehicle 3. The connector dock 37 has a second data port 43 to enable wired communication between the base station 5 and the key fob 23. A second data line 44 provides a wired connection between the second data port 43 and the electronic control unit 7.

A charging connection 45 is also provided in the connector dock 37 to charge the second rechargeable battery 27 when the key fob 23 is docked. A bi-colour light emitting diode 47 is provided in the connector dock 37 to indicate the status of the key fob 23 (for example to indicate that the second rechargeable battery 27 is charging or is fully charged). When the key fob 23 is not docked, the light emitting diode 47 may flash periodically to indicate the position of the connector dock 37. The charging connection 45 is connected to a power supply unit (PSU) provided in the base station 5.

As illustrated by dashed lines in Figure 2, in use, the transceivers 11, 13, 15 communicate with the key fob 23. The remote transceiver 25 transmits a polling signal which, when received by the first transceiver 11, initiates communication between the base station 5 and the key fob 23. Upon receipt of the polling signal, the first transceiver 11 responds by transmitting a challenge signal. The challenge signal is received by the key fob 23 and prompts the transmission of a response signal. The electronic control unit 7 validates the response signal.

If the response signal is authenticated, the electronic control unit 7 continues to communicate with the key fob 23 and tracks its position in relation to the vehicle 3. Moreover, provided the challenge/response sequence is completed successfully, the electronic control unit 7 will provide access to the vehicle 3 subject to operating criteria being satisfied. If the response signal is not authenticated, the electronic control unit 7 will not unlock the vehicle 3.

The base station 5 and the key fob 23 can communicate with each other over a range of at least 20 metres and an authorization zone having a radius of 2 metres is defined around the vehicle 3. When the electronic control unit 7 determines that the key fob 23 is inside the authorization zone it automatically unlocks one or more of the vehicle's doors D1-D4. Conversely, when the electronic control unit 7 determines that the key fob 23 is outside the authorization zone, it automatically locks the vehicle's doors D1-D4.

When the second battery 27 is discharged, it is not be possible to establish wireless communication between the base station 5 and the key fob 23. Rather, a wired connection must be established and this will now be described with reference to the accompanying figures.

The user slides the cover 35 forward to expose the first data port 33, as illustrated in Figures 3A and 3B. The data connector 31 is then connected to the first data port 33, as shown in Figure 3C, to establish a wired connection between the controller 29 and the electronic control unit 7. The first data port 33 also provides power to the key fob 23 to enable the controller 29 to operate.

Once the wired connection has been established, a challenge/response sequence is initiated via the wired connection. The electronic control unit 7 transmits a challenge signal which prompts the controller 29 to issue a response signal. The electronic control unit 7 validates the response signal and, if authenticated, outputs a door unlock signal to initiate unlocking the front right door D1. The user may then operate the first door handle H1 to open the door D1. If the response signal is not authenticated, the electronic control unit 7 does not output a door unlock signal and the door D1 remains locked.

In the event that the main vehicle battery is depleted, the base station 5 and the first rechargeable battery 9 can operate at least one of the door lock mechanisms substantially independently of the vehicle's conventional locking system. The first rechargeable battery 9 providing sufficient power to operate at least one door lock L.

In order to start the vehicle 3, the key fob 23 is inserted into the connector dock 37 to re-establish the wired connection between the electronic control unit 7 and the controller 29. The challenge/response sequence is repeated via the wired connection to validate the key fob 23. Once the key fob 23 has been authenticated, the electronic control unit 7 will output an engine start authorisation signal to allow the engine to be started when a starter button is pressed. If the key fob 23 is not authenticated, the electronic control unit 7 will not output the required authorisation signal.

The user can leave the key fob 23 in the connector dock 37 to be recharged automatically. The second battery 27 will be fully recharged in approximately 30 minutes.

It will be appreciated that various changes and modifications can be made to the device described herein without departing from the spirit and scope of the present invention. For example, the external charge port 10 could be integrated with the first data port 31 to enable charging of the first battery 9.

In place of, or in addition to, the charging connection 45, inductive charging coils can be provided inside the vehicle and the key fob 23 respectively to enable inductive charging of the second rechargeable battery 27. An inductive coil can be positioned in the vehicle for powering the key fob 23 when it is outside the vehicle. By positioning the key fob 23 in proximity to the energised coil on the vehicle, a contact-less dialogue could be performed between the discharged key fob 23 and the base station 5. Thus, the key fob 23 could be operated when the second rechargeable battery 27 is depleted to communicate with the base station 5 to unlock the vehicle.

In a further embodiment, the vehicle access system 1 may be operated by an electronic key which comprises the hardware data connector 31 and authenticating means, but which does not comprise any of the electronic controller 29, the ultra-wideband transceiver 25 or the second rechargeable battery 27. The authenticating means may comprise control circuitry and/or a storage device, such as an EEPROM, non-volatile memory or the like. In this case, the electronic key functions as a back-up key for accessing the vehicle 3. With this configuration, the electronic key may be smaller in size than the remote key fob 23 since it does not include a battery or transceiver. Furthermore, as the electronic key does not have a battery, it can be stored indefinitely without the user having to worry that the battery will be depleted.

Use of the electronic key is similar to the previously described embodiment. First, the user must connect the hardware data connector 31 of the key to the first data port 33 on the vehicle. Once the wired connection has been established, a challenge/response sequence is initiated via the wired connection. The first data port 33 may also provide power to the electronic key. In one embodiment, the authenticating means comprises a storage means for storing an access code and control circuitry. The electronic control unit 7 of the vehicle transmits a challenge signal to the electronic. In response to the challenge signal, the control circuitry is operable to retrieve the access code from the storage means and transmit it to the electronic control unit 7 over the wired connection. Upon authentication of the access code, the electronic control unit outputs a door unlock signal to initiate unlocking of at least one of the vehicle doors. In the presently described embodiment, the first rechargeable battery 9 acts as an auxiliary battery which supplies power to each of the electronic control unit 7, the first data port 33, from where power is transferred to the electronic key via the wired connection, and at least one of the door lock mechanisms for unlocking an associated vehicle door in the case that the response signal from the electronic key is authenticated.

The electronic control unit 7 may be configured such that the power for the locking mechanism of the door is always supplied by the first rechargeable battery 9 when the electronic key is used to access the vehicle. Alternatively, the electronic control unit 7 may be operable to determine the remaining charge on the main battery and to control the supply of power for the locking mechanism from the main battery in the case that there is sufficient charge remaining to activate the mechanism. In this case, the first rechargeable battery 9 may only be used to supply power to the locking mechanism of the door in the event that the charge remaining on the main battery is below a predetermined threshold value.

With this above-described configuration, the user can always gain access to the vehicle 3, regardless of the charge of the main vehicle battery. Furthermore, the need for a mechanical key blade is obviated, which provides the advantages of enhanced security and cost/weight savings associated with the fact that there is no longer a need to provide a key cylinder lock arrangement in the vehicle doors. In a variation of the above-described embodiment, instead of the first rechargeable battery 9, the auxiliary power may be supplied by another find of electrical energy storage means, such as a capacitor.

CLAIMS:

1. A vehicle comprising a main battery, an auxiliary electrical energy storage means, an electronic control unit, a first data port accessible from the exterior of the vehicle, and at least one vehicle door having an electrically operated locking mechanism arranged so as to be powered by either one of the main battery or the auxiliary electrical energy storage means under the control of the electronic control unit;

wherein the electronic control unit is configured to transmit a challenge signal to an electronic key connected to the first data port; receive a response signal from the electronic key and, in the event that the response signal is authenticated, to initiate unlocking of said at least one door by selectively controlling the supply of power to the locking mechanism from one of the main battery and the auxiliary electrical energy storage means.

2. A vehicle according to claim 1, wherein the electronic control unit is configured to control the supply of power to the locking mechanism of said at least one door from one of the main battery and the auxiliary electrical energy storage means in dependence on the charge stored on the main battery.

3. A vehicle according to claim 2, wherein the electronic control unit is configured to control the supply of power to the locking mechanism of said at least one door from the auxiliary electrical energy storage means, when the charge stored on the main battery is determined to be below a predetermined threshold value.

4. A vehicle according to claim 2 or claim 3, wherein the electronic control unit is configured to control the supply of power to the locking mechanism of said at least one door from the main battery, when the charge stored on the main battery is determined to be above a predetermined threshold value.

5. A vehicle according to claim 1 wherein the electronic control unit is configured to control the supply of power to the locking mechanism of said at least one door from the auxiliary electrical energy storage means.

6. A vehicle according to any preceding claim, wherein the auxiliary electrical energy storage means is a rechargeable battery.

7. A vehicle according to claim 6, comprising a charging port for charging the rechargeable battery, wherein the charging port is accessible from the exterior of the vehicle.

8. A vehicle according to any preceding claim, wherein said at least one door does not have a key cylinder for receiving a mechanical key-blade.

9. An electronic key for use with a vehicle according to any one of claims 1 to 8.

10. An electronic key according to claim 9, comprising a data connector and control circuitry configured to receive a challenge signal via the data connector; and/or to output a signal via the data connector.

11. An electronic key according to claim 10, comprising storage means storing vehicle access information.

12. An electronic key according to claim 11, wherein the control means is configured to output a response signal comprising vehicle access information stored in the storage means in response to receiving a challenge signal via the data connector.

13. A combination of a vehicle according to any one of claims 1 to 8 and an electronic key according to any one of claims 9 to 12.

Application No: GB1220631.4 **Examiner:** Andrew Hole

Claims searched: 1-13 **Date of search:** 28 February 2013

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X: 1-6 & 8-13. Y: 7.	US 2003/0155779 A1 (BELMOND et al.) Please see abstract, drawings and paragraphs 37-52 in particular.
X,Y	X: 9-12. Y: 1-8 & 13.	US 2009/0205384 A1 (POMERANTZ) Please see abstract, drawings and paragraphs 39-53 in particular.
Y	1-8 & 13.	US 6056076 A (BARTEL et al.) Please see abstract, drawings and the specific description starting column 4, line 46 onwards.
Y	7	DE 4404501 A1 (MARQUARDT) Please see drawings, EPODOC abstract and WPI/Thomson abstract, accession number 1995-284208 [38].

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B60R; G07C

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTE

International Classification:

Subclass	Subgroup	Valid From
G07C	0009/00	01/01/2006
B60R	0025/01	01/01/2013
G07C	0009/00	01/01/2006