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(54) Title: SECURITY SYSTEM FOR A VEHICLE

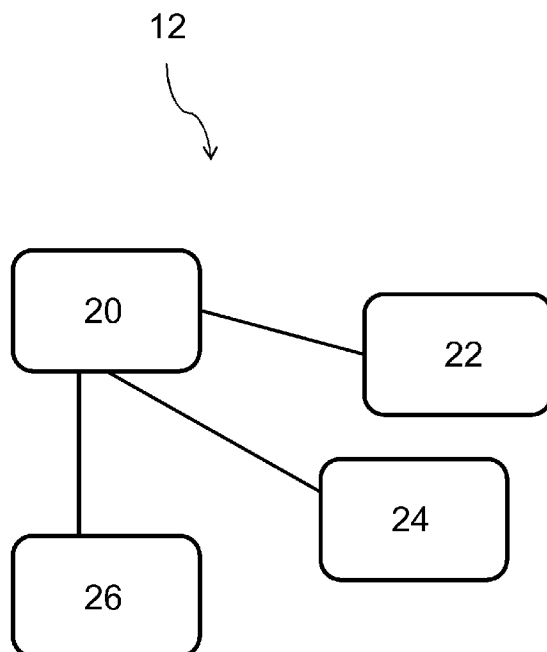


Figure 2

(57) Abstract: A security system (12) and method for automatically immobilising a vehicle (10); the security system (12) comprising: at least one smart key (22), a control unit (20) and an immobiliser (26). Wherein the key (22) enables a user to access the vehicle (10) and or control over the vehicle (10). The control unit (20) is configured to determine the presence of the key (22) within the vehicle (10) when the engine is running. Whereupon interaction by a user with the vehicle (10) and/or compliance with a one or more predetermined criteria, in the absence of the key (22), the control unit (20) activates the immobiliser (26) thereby automatically immobilising the vehicle (10) and preventing the vehicle (10) from being driven.



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SECURITY SYSTEM FOR A VEHICLE

FIELD OF THE INVENTION

The present invention relates to a security system for a vehicle and a method of securing a vehicle. More particularly, but not exclusively, the invention relates to a system and method of securing the vehicle comprising a smart or electronic (keyless start) key with the vehicles engine running.

BACKGROUND OF THE INVENTION

It is known to provide vehicles with security systems to secure the vehicle, thereby restricting access to the vehicle and functionality of the vehicle. These security systems typically comprise locks which may be provided on the doors, tailgate, boot or trunk, bonnet or hood and fuel filter cap and ignition switch. A key is provided to release the lock, the key need not comprise a blade to mechanically engage with the lock but may interact or communicate with the lock via an electronic control unit by providing the electronic control unit with an access code or password to unlock the vehicle thereby authorising a user access to and/or operation or control of the vehicle. Such keys also known as smart keys allow a driver to keep the key fob in their pocket when unlocking, locking and starting the vehicle.

It is also known to provide a system that allows a mechanical key, which mechanical key is placed into a lock barrel to activate an ignition switch, to be removed from the lock barrel or ignition of a vehicle whose engine is running without stopping the engine. The system stops the engine if the foot brake or accelerator is pressed; such systems bypass the ignition switch thereby allowing the engine to keep running.

In vehicles with a smart key system the smart key disengages the immobiliser and activate the ignition, provided the key is within the vehicle, the vehicle may be started typically by pressing a starter button or turning an ignition switch. The smart key only needs to be present within the vehicle to start the vehicle, once started the key does not need to be within the vehicle or in the vicinity of the vehicle for the vehicle to be driven, this poses a security risk for theft.

It is an aim of the present invention to address the problems of the prior art.

SUMMARY OF INVENTION

- 2 -

According to one aspect of the present invention there is provided a security system for a vehicle comprising at least one key, a control unit and an immobiliser, wherein the key enables a user to access the vehicle and/or control functions of the vehicle, the control unit being arranged to determine the presence of the key within the vehicle when the engine is running, wherein upon interaction by a user with the vehicle and/or compliance with one or more predetermined criteria, in the absence of the key, the control unit activates the immobiliser thereby automatically immobilising the vehicle and preventing the vehicle from being fully operated.

- 10 The control unit may be further arranged to determine if the vehicle has been driven, with the key present within the vehicle, either: over a threshold speed; or over a threshold distance, the control unit being further arranged to disable the automatic immobilisation of the vehicle if the vehicle has been driven over the threshold.
- 15 One advantage provided by the present invention is that a vehicle which may be automatically activated, manually activated and/or conditionally activated in which the security system immobilises the vehicle with the engine running, for example in the circumstance where the user has left the vehicle with the engine running because the user wishes to warm up the vehicle or vehicle cabin, cool down the vehicle cabin, defrost or demist the vehicles windows, retrieve an item they have left behind or to perform a time critical task outside the vehicle such as might be performed by a member of one of the emergency services.

Optionally, the vehicle is immobilised with the engine running.

- 25 In some embodiments the control unit activates one or more alerts to indicate that the key has not been detected.

Optionally, the one or more predetermined criteria comprise elapse of a predefined period of time.

30

Optionally, the one or more predetermined criteria comprise completion of a predefined number of tasks such as polling for the key.

Optionally, the control unit activates a lock upon one or more of the vehicle control systems.

Optionally, the control unit transmits a signal to one or more of the vehicle control systems to disable said vehicle control system.

- 5 Optionally, the control unit is programmed to disregard vehicle control signals from one or more control components of the vehicle in the absence of the key.

Optionally, the immobiliser intercepts or otherwise prevents a vehicle control signal from being received by the control unit.

10

In some embodiments the control unit determines if the vehicle has been driven, with the key present within the vehicle, for a predefined time.

- 15 It may be that the control unit is arranged to determine the presence of the key within the vehicle while the vehicle is immobilised with the engine running, the control unit being further arranged to poll for a key upon interaction with the vehicle by the user, wherein upon detecting a valid key the control unit automatically deactivates the immobiliser thereby allowing the vehicle to be driven.

- 20 One advantage of this is that the security system deactivates the immobiliser automatically or upon request by a user upon their return to the vehicle.

According to a further aspect of the invention there is provided a vehicle comprising the
aforedescribed security system.

25

According to another aspect of the invention there is provided a method of immobilising a vehicle whose engine is running, comprising:

- polling for an authorised key within a predefined range of the vehicle;
- rendering one or more vehicle controls inoperable if an authorised key is not found.

The method may further comprise:

- determining if the vehicle has been driven, with the key present within the vehicle, either over a threshold speed or over a threshold distance; and
- 30 only rendering one or more vehicle controls inoperable if the vehicle has not been driven over the threshold.

Optionally, the method is carried out upon interaction by a user with one or more access points to the vehicle.

- 5 Optionally, the method is carried out upon compliance with one or more predetermined criteria, such as elapse of a predefined period of time.

Optionally, the method is carried out upon interaction by a user with one or more vehicle controls.

10

Optionally, the method is carried out at the request of an authorised user, for example pressing the lock button on the vehicle or key fob.

- 15 In some embodiments the vehicle controls may be operated, with the key present within the vehicle, for a predefined time, whereby allowing the vehicle to be driven, prior to the method described herein being carried out.

Rendering one or more vehicle control inoperable may comprise activating an immobiliser.

- 20 The method may further comprise: detecting interaction by a user with one or more access points to the vehicle, in particular the driver's door; determining the presence of a key within the vehicle; deactivating the immobiliser thereby allowing the authorised user to operate the vehicle.

- 25 According to still further aspects of the invention there is provided a control unit programmed to carry out the method and a non volatile memory device comprising instructions for carrying out the method.

- 30 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

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1. is a schematic illustration of a vehicle comprising a security system according to
5 embodiments of the invention;

FIGURE 2. is a schematic illustration of a security system according to an embodiment of the
invention;

10 FIGURE 3. is a flow chart illustrating the algorithms carried out by a security system
according to an embodiment of the invention; and

FIGURE 4. is a table illustrating steps in the method of operation of the security system of
the embodiment of Figure 3.

15

DETAILED DESCRIPTION OF EMBODIMENTS

Detailed descriptions of specific embodiments of the security system are disclosed herein. It will
be understood that the disclosed embodiments are merely examples of the way in which certain
aspects of the invention can be implemented and do not represent an exhaustive list of all of the
20 ways the invention may be embodied. Indeed, it will be understood that the security system
described herein may be embodied in various and alternative forms. The figures are not
necessarily to scale and some features may be exaggerated or minimised to show details of
particular components. Well-known components, materials or methods are not necessarily
described in great detail in order to avoid obscuring the present disclosure. Any specific
25 structural and functional details disclosed herein are not to be interpreted as limiting, but merely
as a basis for the claims and as a representative basis for teaching one skilled in the art to
variously employ the invention.

Referring to Figure 1 and 2 there is shown vehicle 10 comprising a vehicle body 18 having one
30 or more access points, for access to the vehicle such as but not limited to doors 16. Access
points may also include, tailgate, boot or trunk, bonnet or hood, fuel filter cap. The vehicle 10
comprises a security system 12; security system 12 includes a control unit 20. In the illustrated
embodiment the control unit 20 is dedicated to control the security system 12. In alternative

embodiments the control unit 20 may also control other functions of the vehicle 10, such as but not limited to engine management, in car entertainment or communications.

5 It is envisaged that the control unit 20 will comprise one or more microprocessors including a central processing unit and non volatile memory storage devices such as, but not limited to, an EPROM, EEPROM or flash memory.

10 The security system 12 also comprises a smart key 22 which is in communication with the control unit 20. The smart key 22 may comprise a transceiver or separate transmitter and receiver. The smart key 22 may be an active device or a passive device such as Radio Frequency Identification Tag.

15 It is envisaged that the control unit 20 will comprise or be coupled to a transceiver or separate transmitter and receiver for communicating with the smart key 22. In those embodiments where the smart key 22 is a passive device the control unit 20 will comprise or be coupled to a reader device for reading information stored on the smart key 22.

20 The security system 12 further comprises one or more sensors 24 for detecting physical interaction by a user with the vehicle 10. The sensors 24 may be provided on the access points, in particular the doors 16, for detecting opening/closing of the access points. In one embodiment the sensor 24 may be a switch provided on one of the door pillars for interactions with a respective one of the doors 16. In other embodiments the sensors may be positioned on the door handles, in particular the external door handles, and may detect a user interaction with the door handle.

25 In another embodiment the sensor 24 may be a switch, position sensor, pressure sensitive switch or potentiometer provided upon the vehicle controls including but not limited to: foot pedals; brake; clutch; accelerator; gear selector which may take the form of a gear stick or gear lever, gear selector paddles, or a rotary gear selector control; hand brake. The security system 30 12 is coupled or communicates with an immobiliser 26. In some embodiments the immobiliser 26 may be integrated within the control unit 20.

The immobiliser 26 may activate a physical lock on one or more of the components of the vehicle 10 such as the vehicle controls, for example in a vehicle 10 having an automatic

transmission, a physical lock that prevents shifting of the gear lever from park to drive may be deployed by the immobiliser 26 to prevent the gear lever from being moved into drive position when the smart key 22 is absent from the vehicle 10. Additionally or alternatively, with vehicles using electronically controlled transmissions, the immobiliser 26 may be arranged to intercept or otherwise block a signal from the gear selector to the transmission in the absence of a smart key 22, so as to render the transmission inoperable. It is envisaged that the immobiliser 26 may activate an existing lock provided on the vehicle 10 for other functions; however provision of a dedicated lock is also envisaged in some embodiments.

In other embodiments the immobiliser 26 may disable one or more of the vehicle controls by preventing control signals from being transmitted by the respective vehicle control e.g. accelerator pedal or by instructing the relevant control unit to ignore control signals received from the vehicle control for example the engine management control unit will be directed ignore or disregard signals received from the accelerator pedal. In this way the control unit 20 will take no action in response to receipt of such control signals. In yet another embodiment the immobiliser may disable or lock the throttle; in other words rather than locking or disabling the vehicle control the immobiliser locks or disables one or more components which are being controlled. In one embodiment the control unit 20 or immobiliser 26 may intercept or block control signals from being transmitted to the relevant electronic control unit or vehicle component. Additionally or alternatively, the immobiliser 26 may be arranged to hold open an input clutch to the transmission, preventing drive from the engine to the transmission and thus prevent drive to the vehicle wheels.

In some embodiments the immobiliser 26 may prevent a parking pawl from being disengaged; or alternatively may engage a parking pawl with an output shaft of the transmission.

Figure 3 illustrates a flow chart of algorithms executed by the security system 12 for performing a method according to embodiments of the present invention. The control unit 20 is capable of executing the algorithms shown in Figure 3 each time the vehicle 10 is operated from the state shown in stage A1.

A1. Represents the condition of the vehicle 10 prior to use; the vehicle 10 is in a stationary and locked condition.

- A2. A door handle is operated by a user; the security 12 system detects operation of the door handle.
- 5 A3. The security system 12 polls for smart key 22; for example by transmitting a signal to prompt response from an authorised smart key 22 within the predetermined range of the vehicle.
- 10 A4. The security system 12 receives or reads data from smart key 22 and confirms that the smart key 22 is authorised; for example the data may be a rolling or hopping code or a fixed code. Furthermore the code may be encrypted using public key cryptography or private key cryptography such as 128 bit Advanced Encryption Standard. The security system 12 decrypts the code and confirms that the code is an authorised code.
- 15 A5. A user opens a door 16; the security system 12 detects the status of the door 16 as open or closed by means of a sensor or switch in the door 16 or door pillar. The security system 12 may use an existing switch/sensor on the vehicle 10, for example a switch used to activate one or more interior lights within the vehicle 10.
- 20 A6. A user may close the door 16; the security system 12 detects the status of the door 16. In some circumstances the user may omit this step and start the engine with the door 16 open.
- 25 A7. The user starts the vehicle's engine, for example by pushing a start button or turning ignition switch.
- 30 A8. The security system 12 is optionally configured to detect if the vehicle 10 is driven in accordance with one or more predetermined criteria, for example the security system 12 can determine or calculate if the vehicle 10 has been driven over a threshold distance, or driven at a speed in excess of a threshold speed value, or for a period of time greater than a threshold value. If the security system 12 detects that one or more of the predetermined criteria has been complied with then it may disable or cease executing the algorithms controlling automatic immobilisation of the vehicle 10 in stages A9 to A33. The security system 12 subsequently behaves or is operable as a known vehicle, as

shown in stage A34, in other words the vehicle cannot be automatically immobilised with the engine running.

Steps A9, A11, A12, A13, A16, A20, A22, and A26 comprise an algorithm which operates an incremental timer or counter once the security system 12 determines that the engine of the vehicle 10 is running and the smart key 22 is not within the vehicle 10. Optionally, the timer or counter algorithm may be dependent upon the outcome of the test in step A8; for example, the timer algorithm may only be executed if the vehicle 10 has not been driven over threshold distance.

A9. Step A9 may follow any of steps A7, A8, A12 or A15. The security system 12 attempts to communicate with the smart key 22. The security system 12 may poll for the smart key 22 at the same time as the engine starts or within a predefined period of time after the engine is started.

A11. If the smart key 22 is not found then an incremental timer or counter is started. The security system 12 will continue to poll for the smart key 22 a predefined number of times or for a predefined period of time.

A22. The security system 12 determines whether or not the predetermined threshold value of polls or time period is reached, if the threshold value is reached then the security system 12 executes stage A26, if the threshold value is not reached step A20 is executed.

A20. If the limit or threshold value is not reached, the security system 12 polls again for the smart key 22. If the smart key 22 is found A12 then the algorithm resets to A9. If the smart key 22 is not found A16 then the counter or timer increases, the step A22 is executed.

A26. The vehicle 10 is immobilised by the immobiliser 26, the engine may continue to run, however one or more vehicle controls are disabled; for example, the gear shifter is locked or retracted into an inoperable position.

Steps A10, A13, A15, A17, A18, A35, A21, A23, A24 and A26 comprise algorithms executed by the security system 12 which are executed in response to a user interacting with the vehicle 10.

The steps A10, A13, A15 are executed after step A7; optionally the step A10 may be executed after step A8. In the steps A10, A13, A15 the security system 12 determines the status of one or more doors 16 of the vehicle 10.

5

A10. The security system 12 receives a signal indicating that a door 16 of the vehicle 10 has been opened. Step A19 may follow step A10 or steps A13 or A15 may follow step A10.

10

A13. The user closes the door 16 this is detected by a signal received from a sensor on the door 16 or door pillar or by changing the state of a switch coupled to the door 16 or door pillar. The engine of the vehicle 10 is running. Steps A18 or A19 may follow A13.

15

A18. The security system 12 detects operation of the door handle, upon detecting this security system 12 initiates step 21.

20

A19. This step may follow step A10 or A13. Optionally, the user, upon exiting the vehicle 10 with the engine running may attempt to lock the vehicle 10, with the door 10 open or closed, either by pressing the lock button on the smart key fob or by pressing a lock button on the vehicle which may be located on the door 16 or door handle. Step A25 follows step A19.

25

A25. The security system 12 does not lock the access points or doors 16 of the vehicle 10 because the engine is running but does execute step A26.

30

A26. The security system 12 activates the immobiliser thereby preventing the vehicle 10 from being driven but maintaining the engine running. The vehicle 10 is immobilised with the engine running either in response to a request by the authorised user to immobilise the vehicle 10 or a user interaction with the vehicle 10 in the absence of an authorised smart key 21 or in response to the timer algorithm reaching the predefined threshold value.

A15. This step may follow steps A10 or A7. The security system 12 detects that the vehicle 10 has at least one open door or access point; the engine is running. The steps A9, A17, A19, or A21 may follow this step; if step A19 follows the user attempts to lock the vehicle with the door open. Optionally, step A15 may be followed by A21 (not illustrated) in

which embodiments the security system 12 may initiate polling for the smart key 22 because the door 16 is open or because the door 16 has been left open for a predefined period of time. In some embodiments Step A9 may follow step A15 such that the security system 12 initiates the timer algorithm of steps A9, A11, A12, A13, A16, A20, 5 A22, and A26; in these embodiments the initiation of the timer algorithm is conditional upon the state of the vehicle door 16, this is advantageous since when the door 16 is in an open condition the vehicle's security risk is higher and therefore the vehicle 10 will be automatically immobilised irrespective of whether or not an actual threat to the vehicle 10 is made by a user or third party interacting with the vehicle 10.

10 Step A17 or A35 may follow step A15, in this situation the door 16 is in an open condition; the security system 12 detects a user interacting with the vehicle 10.

15 A17. A user closes the door 16, the security system detects door 16 being closed. The user may be an intruder or thief or may be an authorised user with or without the smart key 22.

20 A35. A user operates one or more of the vehicle control systems, the security system detects said one or more of the vehicle control systems being used. The user may be an intruder or thief or may be an authorised user with or without the smart key 22. Since the door 16 is in an open condition a user or third party is able to enter the vehicle without opening the door 16.

25 A21. The security system 12 has detected a user interacting with the vehicle 10, for example by opening the door 16, closing the door 16 or operating one of the vehicle contents. In some embodiments the security system 12 may determine that the door 16 has been in an open condition for a predefined period of time by monitoring the period of time since the control unit received a signal indicating that the door 16 was opened; the control unit may record an actual time of receipt of the signal and compare to the current time or 30 may in the alternative a commence a countdown, or count up, timer. In response to detecting the interaction the security system 12 polls for the smart key 22 within the vehicle 10. Step A23 or A24 may follow depending upon whether or not a smart key is found.

- 12 -

A23. The security system 12 receives no response from a smart key 22 or does not receive a response from an authorised smart key 22. Step A26 follows A23.

5 A24. The security system 12 receives a response or reads data from an authorised smart key 22. In one embodiment the security system 12 receives a response or reads data from the smart key 22, the security system 12 confirms if the smart key 22 found is the same smart key 22 used to start the vehicle's engine. In other embodiments 16 the security system 12, upon receiving a response from a smart key 22, performs a check to determine if the detected smart key 22 is one of a group of one or more of authorised
10 smart keys 22 contained in a predefined list of authorised smart key 22. If the smart key 22 is defined in the authorised list the security system 22 may check the user privileges provided to the user by the detected smart key 22 before enabling some or all of the vehicle controls. Step A34 follows step A24.

15 Steps A27, A28, A29 and A32 describe an algorithm for deactivating the immobiliser. Steps A27, A28, A30, A31, and A33 describe an algorithm for turning off the immobilised vehicles' engine in the absence of the smart key 22.

20 A27. The security system 12 detects a user entering the vehicle 10 or interacting with the vehicle controls whilst in an immobilised state with the engine running. The step A28 follows step A27.

A28. The security system 12 polls for a smart key 22 in response to detecting a user interaction in step A28. Step A29 or A30 may follow depending upon the result of polling
25 for an authorised smart key 22.

A29. The security system 12 receives a response, or reads data, from a smart key 22 and validates the data received confirming that the smart key 22 is authorised. Step 32 follows step A29.

30 A32. The security system 12 instructs the immobiliser 26 to deactivate, for example by disengaging a physical lock on the gear lever. Step A34 follows step A30.

- 13 -

A30. The security system 12 does not receive a valid response from an authorised smart key 22. Step A31 or A26 follows step A30. If step A26 follows the vehicle 10 remains immobilised with the engine running.

5 A31. An unauthorised user, that is to say the user without a valid smart key 22 presses the start/stop button or turns the ignition switch. Step A33 follows A31.

A33. The engine management system control unit stops or shuts down the engine. Step A34 follows step A33.

10

A34. In step A34 the automatic immobilisation feature of the security system 12 is inactive; the vehicle may be drivable or may be locked and/or immobilised or otherwise secured as is known in the art. The engine may or may not be running.

15 Figure 4 illustrates examples of how the security system 12 may be employed in a vehicle 10 by a user.

At stage 1a user unlocks the vehicle 10; the security system detects a valid smart key 22 and unlocks the vehicle 10.

20

In stage 2 the user opens the door 16.

In stage 3 the user presses the start/stop button or turns an ignition switch. The security system 12 detects the presence in the vehicle 10 of the smart key 22 and allows the engine control unit
25 to start the vehicle 10.

Step 4 is optional, the user may drive the vehicle 10, with a smart key 22 present in the vehicle 10, for a given distance or period of time.

30 The security system 12 may execute an optional algorithm to determine how far the vehicle 10 has been driven.

In step 4a1 security system 12 determines that the vehicle 10 has been driven over the threshold distance, speed or time by a user.

As a consequence the automatic immobilisation function is disabled step 4b1, steps 5, 6, 7, 8 and a follow.

- 5 In alternative step 4a2 the user drives the vehicle 10 under the threshold distance/speed or time security system 12 determines that the threshold value has not been met. In this circumstance the automatic immobilisation is active 4b2 the user may then complete steps 5, 6, 7, 8 and 9.

10 In step 5 the user leaves the vehicle 10. The steps 5a1 to 5e1, 5a2 to 5g2 and/or 5a3 to 5e3 may be executed. Optionally, these steps may or may not be executed; the security system 12 may determine whether to execute these steps dependent upon the distance / speed / period of time for which the vehicle 10 is driven.

15 In step 5a1 the user closes the door 16 and in step 5b1 the user takes the smart key 22 out of the detection range of the vehicle 10. The user has left the vehicle 10 with engine running and the vehicle 10 unlocked. A third party, someone who doesn't have an authorised smart key 22, opens the door 16, step 5c1; in some circumstances the third party may be the previous user without the smart key 22. The security system 12 detects the door 16 opening. The security system 12 subsequently polls for the smart key 22 in response to the door 16 opening. The
20 security system 12 does not recognise a valid smart key 21, step 5d1,

The security system 12 immobilises the vehicle 10, step 5e1. Steps 6, 7, 8 and 9 may follow.

25 Alternatively, when the authorised user exits the vehicle 10 they leave the door 16 open, and the engine running step 5a2. The user takes the smart key 22 out of the detection range of the security system 12 step 5b2.

30 In step 5c1 an unauthorised user enters the vehicle 10. The third party operates one or more of the vehicle contents 5d2, such as the foot brake, handbrake, accelerator, gear lever or paddle. The security system 12 polls for an authorised smart key 22 upon detecting that one or more of the vehicle controls have been operated, step 5e2. In step 5f2 the car fails to recognise a valid smart key 22 present within the vehicle 22. As a consequence the security system 12 activates the immobiliser 26 to prevent the vehicle 10 from being driven by the unauthorised user step 5g2. Steps 6, 7, 8 and 9 may then follow.

Additionally or alternatively to the completion of the steps 5a1 to 5e1 or the steps 5a2 to 5g2 the steps in 5a3 to 5e3 may be executed.

5 Once the vehicle 10 has detected the authorised user leave the stationary vehicle 10 with the engine running step 4, the security system 12 automatically begins polling for the smart key 22. In step 5a3 the security system 12 commences a timer and after a predetermined period of time polls for the smart key 22. If the user has taken the smart key 22 out of the detection range of the vehicle 10 then the timer commences again and polls for the smart key 22 once again, this
10 repeats each time the smart key 22 is not found until the security system 12 has polled for the smart key 22, a predefined number of times, or after a predefined period of time has elapsed since a valid smart key 22 was last detected. The security system 12 activates the immobiliser 26. Steps 6, 7, 8 and 9 may follow.

15 In step 6 a user returns to the vehicle 10 if the security system 12 has activated the immobiliser 26 then the immobiliser 26 may be deactivated by the steps of 6a1 to 6d1, 6a2 to 6c2 or 6a3 to 6d3. If the immobiliser 26 has not been activated, the security system 12 will poll for the smart key 22 in response to the users' interaction with the vehicle 10.

20 When the security system 12 received a valid code or reads valid data from the smart key 22 the security system 12 will allow the user to operate the vehicle 10. Steps 7, 8 and 9 may follow.

If the security system 12 has detected interaction with the vehicle 10, for example by a third
25 party attempting to steal the vehicle 10 or by a unsupervised child, then the steps in 6a1 to 6d1, 6a2 to 6c3 or 6a3 to 6d3 may follow.

In step 6a1 the user opens the door 16. Upon detecting the door 10 being opened, the security system 12 polls for the smart key 22. If the security system 12 detects the valid smart key 22 it
30 will deactivate the immobiliser 26. Steps 7, 8 and 9 may follow.

Alternatively the steps in 6a3 may be executed, for example the door 16 was left open by the third party or the user, the user enters the vehicle 10. The third party or the user operates one or more of the vehicle controls, for example the brake, as in step 6a3. The security system 12

polls for the smart key 22, upon detecting interaction by the user with the vehicle control, step 6b3. The security system 12 recognises the smart key 22, step 6c3; that is to say the security system 12 receives or reads a valid code from the smart key 22. The security system 12 may perform a decryption algorithm upon the data read or received to determine the authorisation code.

The security system 12 then compares the authorisation code against an authorised code, or a list of authorised codes stored in a memory device to confirm if the smart key 22 is authorised to allow operation of the vehicle 10 by the user. If the code received or read from the smart key 22 is the same as the expected code or one of the expected codes stored by the control unit 20 then the control unit 20 deactivates the immobiliser 26, step 6d3. Steps 7, 8 and 9 may follow to steps 6a1 to 6d1 and 6a3 to 6d3.

Additionally or alternatively the security system 12 may poll for the smart key 22 at predefined time intervals, whilst the immobiliser 26 is activated, step 6a2. If the security system 12 detects, or receives a response from a valid smart key 22, step 6b2, then the security system 12 will deactivate the immobiliser 26 step 6c2. Steps 7, 8 and 9 may follow.

In step 7 the user drives the vehicle 10, stops the vehicle 10 in step 8 and locks the vehicle 10 in step 9.

It can be appreciated that various changes may be made within the scope of the present invention. It will be appreciated that aspects of the security system 12 could be configured to meet an individual user's preferences, such configurable user settings could be made either by the user or by a technician In a workshop, for example the user could specify the period of time to elapse on the timer functions, or the distance/speed threshold, whether or not the authorised smart key used to start the vehicle must be the same smart key used to deactivate the immobiliser when activated.

It is also envisaged that the security system 12 may in addition to being configured to immobilise the vehicle 10 with the engine running to include the optional feature of automatically locking one or more storage compartments within or on the vehicle 12, such as the glove box, centre console, boot or trunk.

It will be recognised that as used herein, directional references such as "top", "bottom", "front", "back", "end", "side", "inner", "outer", "upper" and "lower" do not limit the respective features to such orientation, but merely serve to distinguish these features from one another.

CLAIMS

1. A security system for a vehicle comprising at least one key, a control unit and an immobiliser, wherein the key enables a user to access the vehicle and/or control functions of the vehicle, the control unit being arranged to determine the presence of the key within the vehicle when the engine is running, wherein upon interaction by a user with the vehicle and/or compliance with a one or more predetermined criteria, in the absence of the key, the control unit activates the immobiliser thereby automatically immobilising the vehicle and preventing the vehicle from being driven.
2. A security system according to claim 1, wherein the control unit is further arranged to determine if the vehicle has been driven, with the key present within the vehicle, either:
 - over a threshold speed; or
 - over a threshold distance,the control unit being further arranged to disable the automatic immobilisation of the vehicle if the vehicle has been driven over the threshold.
3. A security system according to claim 1 or claim 2 wherein the vehicle is immobilised with the engine running.
4. A security system according to any preceding claim wherein the control unit activates one or more alerts to indicate that the key has not been detected.
5. A security system according to any preceding claim wherein said one or more predetermined criteria is elapse of a predefined period of time.
6. A security system according to claim 1 to 4 wherein said one or more predetermined criteria is completion of a predefined number of tasks such as polling for the key.
7. A security system according to claim 1 to 6 wherein the control unit activates a lock upon one or more of the vehicle control systems.
8. A security system according to claim 1 to 6 wherein the control unit transmits a signal to one or more of the vehicle control systems to disable said vehicle control system.

9. A security system according to any of claims 1 to 6 wherein the control unit is programmed to disregard vehicle control signals from one or more control components of the vehicle in the absence of the smart key.
10. A security system according to any of claims 1 to 6 wherein the immobiliser intercepts or otherwise prevents a vehicle control signal from being received by the control unit.
11. A security system according to any preceding claim wherein the control unit is arranged to determine the presence of the key within the vehicle while the vehicle is immobilised with the engine running, the control unit being further arranged to poll for a key upon interaction with the vehicle by the user, wherein upon detecting a valid key the control unit automatically deactivates the immobiliser thereby allowing the vehicle to be driven.
12. A vehicle comprising the security system according to any preceding claim.
13. A method of immobilising a vehicle whose engine is running, comprising:
 - polling for an authorised key within a predefined range of the vehicle;
 - rendering one or more vehicle controls inoperable if an authorised key is not found.
14. A method according to claim 13, the method further comprising:
 - determining if the vehicle has been driven, with the key present within the vehicle, either over a threshold speed or over a threshold distance; and
 - only rendering one or more vehicle controls inoperable if the vehicle has not been driven over the threshold.
- 5
15. A method according to claim 13 or 14 wherein the method is carried out upon interaction by a user with one or more access points to the vehicle.
16. A method according to claim 13 or 14 wherein the method is carried out upon compliance with one or more predetermined criteria.
17. A method according to claim 13 or 14 wherein the method is carried out upon interaction by a user with one or more vehicle controls.

18. A method according to claim 13 or 14 wherein the method is carried out at the request of an authorised user.
19. A method according to claims 13 to 18 wherein the vehicle controls may be operated with the key present within the vehicle for a predefined time whereby allowing the vehicle to be driven prior to the method being carried out.
20. A method according to any of claims 13 to 19, wherein rendering one or more vehicle control inoperable comprises activating an immobiliser.
21. A method according to claim 20, the method further comprising detecting interaction by a user with one or more access points to the vehicle, in particular the driver's door, determining the presence of a key within the vehicle, deactivating the immobiliser thereby allowing the authorised user to operate the vehicle.
22. A control unit programmed to carry out the method of any of claims 13 to 21.
23. A non volatile memory device comprising instructions for carrying out the method of claims 13 to 21.
- 5 24. A security system for a vehicle substantially as described herein with reference to and/or as illustrated by the accompanying Figures.
25. A vehicle as described herein with reference to and/or as illustrated by the accompanying Figures.
26. A method of securing a vehicle as described herein with reference to and/or as illustrated by the accompanying Figures.

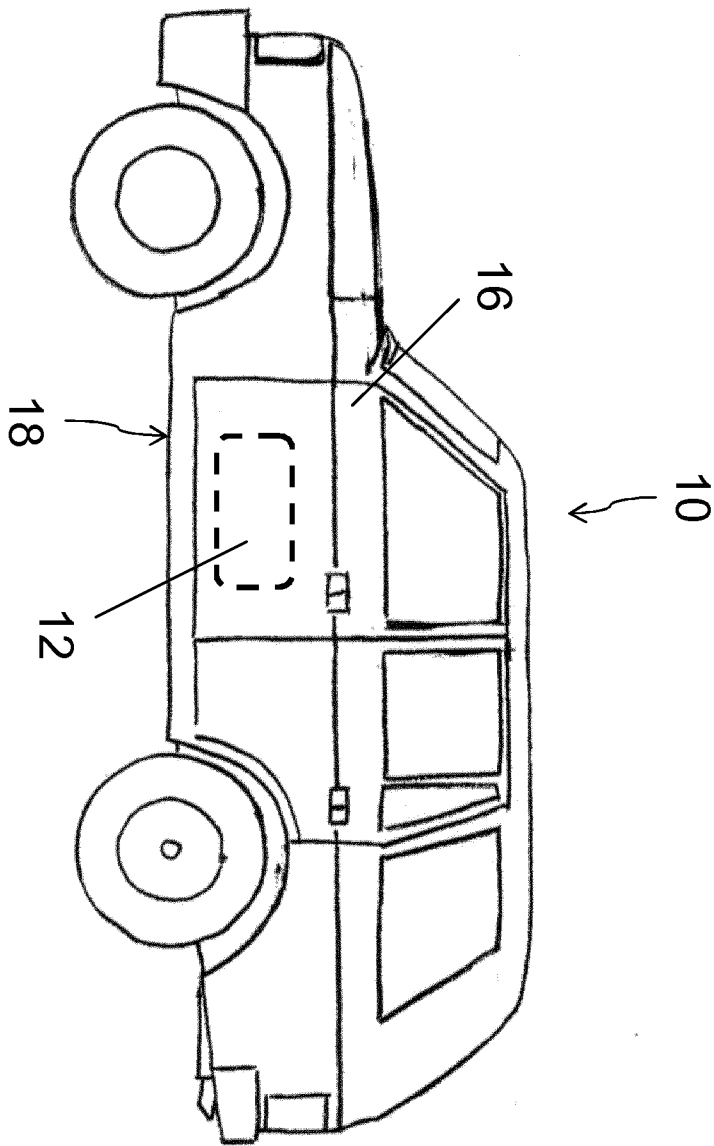


Figure 1

2/5

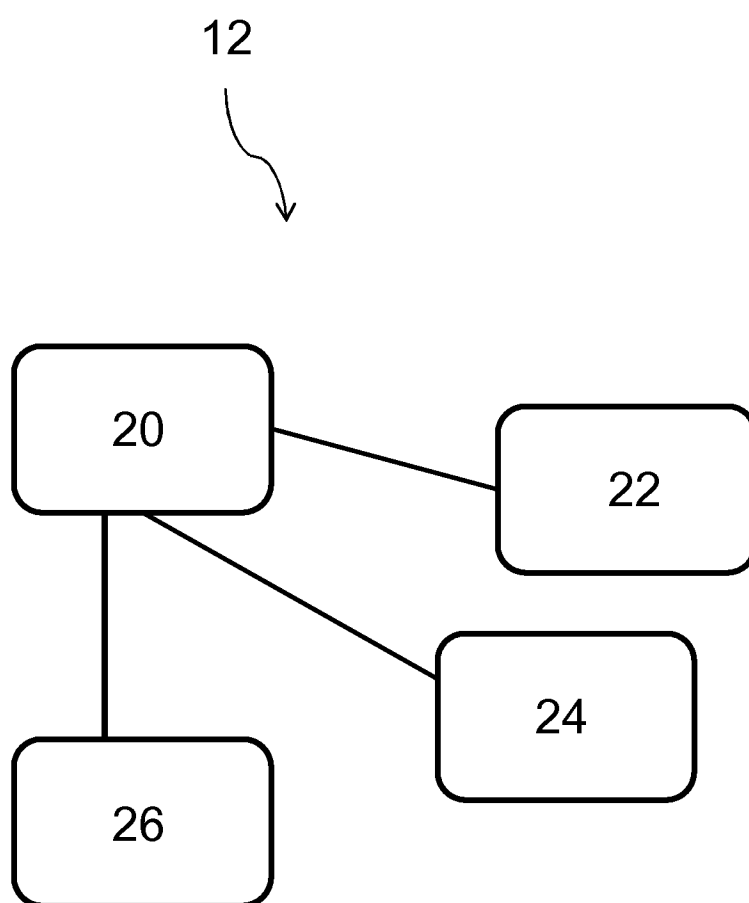


Figure 2

3/5

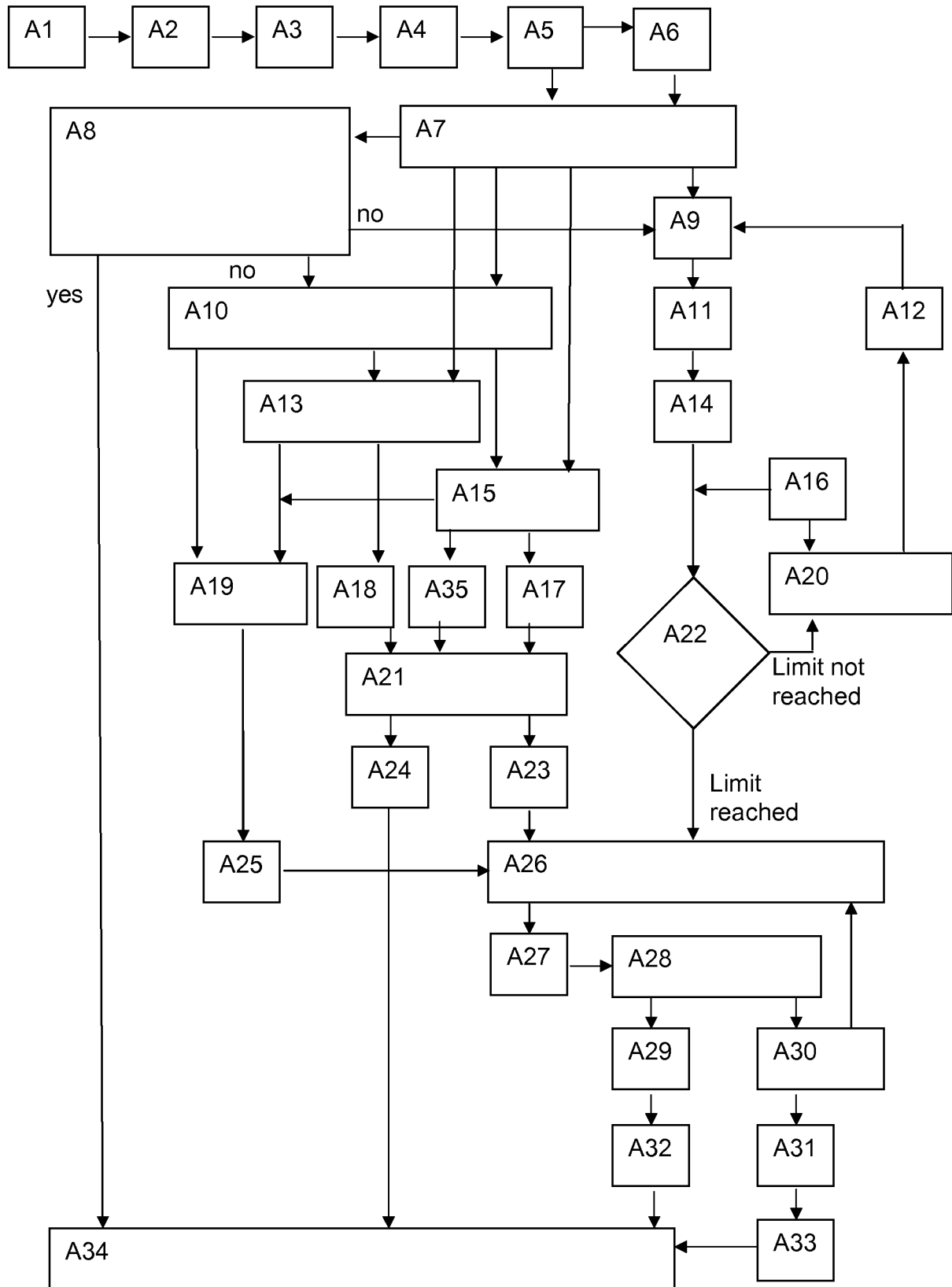


Figure 3

Main Use Case

- 1 User unlocks vehicle
- 2 User opens door
- 3 User starts vehicle
- 4 User drives vehicle
- 5 User leaves vehicle
- 6 User returns to vehicle
- 7 User drives vehicle
- 8 User stops vehicle
- 9 User locks vehicle

Main use case:

Typical workflow of a user going to their vehicle, starting the engine, leaving the vehicle and then returning to it.

Initial drive use case

- 4a1 User drives over threshold distance/speed
- 4b1 Automatic immobilisation deactivated
Return to main use case
- 4a2 User drives under threshold distance/speed
- 4b2 Automatic immobilisation active
Return to main use case

Initial drive (Optional):

The user may need to move the vehicle. The system may allow the user to drive the vehicle a set distance and still allow automatic immobilisation (depending on local legislation), for example driving out of a garage.

Automatic Immobilise Use cases (dependant on drive distance)

- 5a1 User closes door
- 5b1 User takes smart key out of detection range
- 5c1 Third party opens door
- 5d1 Car does not recognise key on door open
- 5e1 Vehicle immobilises
Return to main use case
- 5a2 User leaves door open
- 5b2 User takes smart key out of detection range
- 5c2 Third party enters car
Third parts operates controls to start car (i.e. brake)
- 5d2
- 5e2 Car requests key approval on control detection
- 5f2 Car does not recognise key on door open
- 5g2 Vehicle immobilises
Return to main use case
- 5a3 Timer starts counting
- 5b3 System polls for key
- 5c3 User takes smart key out of detection range
- 5d3 Counter reaches set period for key not found
- 5e3 Vehicle immobilises
Return to main use case

Automatic immobilisation:-

When the system automatically immobilises the vehicle in response to the smart key not being found.

Manual Immobilise Use cases (not dependant on drive distance)

- 5a User presses lock button
- 5b Vehicle immobilises
Return to main use case

Manual immobilisation:-

When the system immobilises the vehicle on a user input, for example pressing the lock button on the car or on the key fob.

Figure 4a

5/5

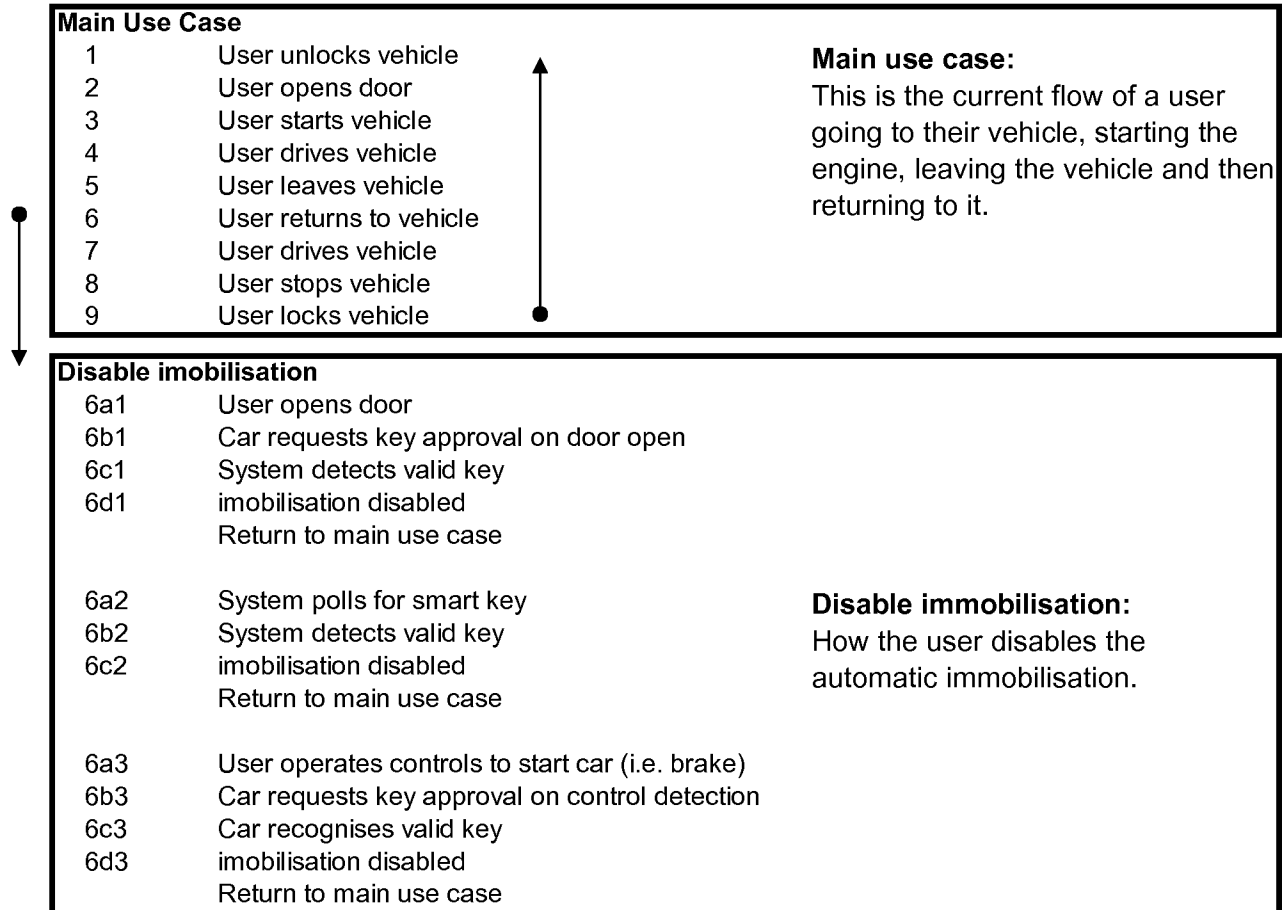


Figure 4b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/072859

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60R25/24
ADD.

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)
B60R G07C

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)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 156 998 A1 (BOSCH GMBH ROBERT [DE]) 24 February 2010 (2010-02-24)	1,3,5, 9-13, 16-20, 22,23
Y	paragraph [0001] - paragraph [0003] paragraph [0005] - paragraph [0022] -----	2,4-8, 14,15,21
Y	EP 2 072 354 A1 (DEFOND COMPONENTS LTD [CN]) 24 June 2009 (2009-06-24) paragraph [0002] - paragraph [0022] paragraph [0024] - paragraph [0051] -----	4,6
Y	EP 1 410 961 A1 (HELLA KG HUECK & CO [DE]) HELLA KGAA HUECK & CO [DE]) 21 April 2004 (2004-04-21) the whole document -----	2,5,7,8, 14,15,21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

"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

"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

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"&" document member of the same patent family

Date of the actual completion of the international search

22 February 2013

Date of mailing of the international search report

28/02/2013

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/072859

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