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(54) Title: A NOTIFICATION SYSTEM FOR AN ELECTRIC VEHICLE, AN ELECTRIC VEHICLE, AND A METHOD

(57) Abstract: A notification system (40) for an electric vehicle (10) is operable when the vehicle is connected to a charging point (26) to monitor the state of charge and produce an audible notification independence on the state of charge to indicate whether or not the vehicle can be disconnected from the charging point. The notification may be a verbal message advising that charging is complete and/or that the vehicle can be disconnected. The system (40) may only produce an audible notification under certain circumstances which may be dependent on the time, the location of the vehicle, and/or whether a person is detected as being in the vicinity. A corresponding method is disclosed.



**A NOTIFICATION SYSTEM FOR AN ELECTRIC VEHICLE, AN ELECTRIC VEHICLE,
AND A METHOD**

TECHNICAL FIELD

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The present invention relates to a notification system for an electric vehicle, an electric vehicle, and a method. In particular, but not exclusively, embodiments of the invention relate to system for a vehicle having an electric propulsion motor powered by charge from an energy storage device for issuing notifications indicating whether the vehicle may be disconnected from a charging point.

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BACKGROUND

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Recent years have seen a great deal of development of Battery Electric Vehicles (BEVs) and Hybrid Electric Vehicles (HEVs), known collectively as Electric Vehicles (EVs), and the popularity of such vehicles in the market is growing steadily.

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A factor in the continued growth of the market for EV's is the ability to charge a vehicle when away from home. Charging stations having one or more charging points where an EV can be re-charged are becoming increasingly common. Nevertheless, availability of charging points remains an issue. In some cases, access to a charging point can be blocked by a vehicle being improperly parked in the charging point's parking space. To help address this issue, it is known to provide two or more parking spaces adjacent a charging point arranged so that either space can be used when charging. However, problems can still arise since only one vehicle can be charged at a time. Accordingly, if a first vehicle parked in one of the spaces is connected to the charging point, a user parking in another of the spaces may still be unable to re-charge their vehicle without disconnecting the first vehicle.

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It is an aim of the present invention to address disadvantages associated with the prior art.

SUMMARY OF THE INVENTION

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Aspects and embodiments of the invention provide a system, a vehicle and a method as claimed in the appended claims.

According to an aspect of the invention, there is provided a notification system for a vehicle having an electric propulsion system including at least one electric motor and an energy

storage device, wherein the notification system is operable to produce a sound in dependence on a determination that the vehicle is connected to a charging point for charging the at least one energy storage device and in dependence on the state of charge of the energy storage device, the sound being audible external to a vehicle in which the notification system is installed and indicative of whether the battery has reached a prescribed level of charge and/or whether the vehicle may be disconnected from the charging point. That is to say that disconnection is authorised or acceptable upon reaching the prescribed level of charge.

The notification system may comprise a means of producing an audible sound. Said means for producing an audible sound may be a loudspeaker or other sound transducer and may be part of a sound generating system. The notification system may comprise an electronic controller or control unit. The system may form part of a motor vehicle control system, or be provided substantially separate therefrom. The system may be arranged to communicate with a motor vehicle control system. For example, the system may be arranged to be connected to a controller area network (CAN) bus or other on-board communications network.

In an embodiment, the notification system is configured to produce said sound periodically.

In an embodiment, the notification system is configured to produce a sound in the form of a verbal message. The notification system may comprise a text to speech module for generating said verbal message.

In an embodiment, the notification system includes means for determining the location of the vehicle, the notification system being configured to produce said sound only if it is also determined that the vehicle is not at a pre-defined location. The notification system may be configured to enable a user to specify one or more of said pre-defined locations. It should be appreciated that the notification system may be configured to produce said sound if it is determined that the vehicle is not at the pre-defined location and one or more other conditions are satisfied, but not if it is determined that the vehicle is at the pre-defined location.

In an embodiment, the notification system includes means for determining the location of the vehicle, the notification system being configured to produce said sound only if it is also determined that the vehicle is at a multi-user charging station. The multi-user charging station having multiple users associated therewith. That is to say a charging station to which

other vehicles may have access. The notification system may comprise a database of charging point locations or have access to a remote database. It should be appreciated that the notification system may be configured to produce said sound if it is determined that the vehicle is at a multi-user charging station and one or more other conditions are satisfied, but not if it is determined that the vehicle is not at a multi-user charging station.

In an embodiment, the notification system includes means for determining the location of the vehicle, the notification system being configured to produce said sound only if it is also determined that the vehicle is at a charging point having multiple parking spaces associated therewith. That is to say, the charging point may be associated with multiple spaces which a charging cable of the charging point can reach. The parking spaces need not be physically marked. The charging point may include any charging point arranged to recharge any one of a plurality of vehicles that occupy positions around the charging point. It should be appreciated that the notification system may be configured to produce said sound if it is determined that the vehicle is at a charging point having multiple parking spaces associated therewith and one or more other conditions are satisfied, but not if it is determined that the vehicle is not at a charging point having multiple parking spaces associated therewith.

The notification system may comprise a database of charging point locations or have access to a remote database.

In an embodiment of the notification system where the sound is in the form of a verbal message, the notification system may be capable of broadcasting said message in a range of different languages, the notification system comprising means for determining the location of the vehicle and being configured to broadcast said message in a language selected from the available range in dependence on the location of vehicle.

In embodiments where the notification system includes means for determining the location of the vehicle, said means may comprise a satellite navigation system such as a global navigation satellite system (GNSS). Alternatively, the notification system may be configured to connect with the internet or to make use of a mobile communications network to establish the location of the vehicle

In an embodiment, the notification system comprises a sensor arrangement capable of detecting the presence of a person in the vicinity of the vehicle, the notification system being configured to produce said sound only if it is also determined that a person is detected in the vicinity of the vehicle. The sensor arrangement may be configured to detect persons in the

proximity of a charging port of the vehicle and the notification system may be configured to produce said sound only if it is also determined that a person is proximal to the charging port of the vehicle. The sensor arrangement may comprise one or more motion sensors and/or proximity sensors. The, or each, sensor may comprise an ultrasonic sensor, an infra-red sensor or a radar sensor, for example. It should be appreciated that the notification system may be configured to produce said sound if it is determined that a person is proximal to the charging port of the vehicle and one or more other conditions are satisfied, but not if it is determined that a person is not proximal to the charging port of the vehicle.

In an embodiment, the notification system includes a sensor arrangement capable of detecting objects in the vicinity of the vehicle and the notification system is configured to produce said sound only if it is also determined that a further vehicle is parked in a further parking space associated with the charging point. The sensor arrangement may comprise one or more motion sensors and/or proximity sensors. The, or each, sensor may comprise an ultrasonic sensor, an infra-red sensor or a radar sensor, for example. It should be appreciated that the notification system may be configured to produce said sound if it is determined that a further vehicle is parked in a further parking space associated with the charging point and one or more other conditions are satisfied, but not if it is determined that no further vehicles are parked in further parking spaces associated with the charging point.

In an embodiment, the notification system comprises means for determining the time, the notification system being configured to produce said sounds only within prescribed time periods. The means for determining time may be a clock or other timing system or the notification system may be connectable to a remote source to determine the time. The remote source may be the internet or a mobile communications system, for example.

In an embodiment, the notification system is configured to produce a sound indicative that the energy storage device has reached a prescribed state of charge and/or that the vehicle may be disconnected from the charging point. In an embodiment in which the sound is in the form of a verbal message, the message may be indicative that the vehicle may be disconnected from the charging point. Alternatively, or in addition, the notification system may be configured to produce a sound indicative that the energy storage device has not reached a prescribed state of charge and/or that the vehicle should not be disconnected from the charging point. In an embodiment in which the sound is in the form of a verbal message, the message may be indicative that the vehicle should not be disconnected from the charging point.

In an embodiment, the prescribed or predetermined state of charge corresponds to a substantially full state of charge or to a user-prescribed amount of charge.

In accordance with a further aspect of the invention, there is provided a notification system for a vehicle having an electric propulsion system including at least one electric motor and an energy storage device, wherein the notification system is installed in the vehicle and operable to produce a notification discernible external to the vehicle in dependence on a determination that the vehicle is connected to a charging point for charging the at least one energy storage device and in dependence on the state of charge of the energy storage device, the notification being indicative of whether the energy storage device has reached a prescribed level of charge and/or whether the vehicle may be disconnected from the charging point. That is to say disconnection is authorised or acceptable upon reaching the prescribed level of charge.

In an embodiment, the notification is a visual notification such as a message displayed on a display or one or more lights.

In accordance with a still further aspect of the invention, there is provided a vehicle having an electric propulsion system including at least one electric motor and an energy storage device, the vehicle comprising a notification system in accordance with either of the previously defined aspects of the invention.

In accordance with a yet further aspect of the invention, there is provided a method of charging a vehicle having an electric propulsion system including at least one electric motor and an energy storage device, the method comprising: determining whether the vehicle is connected to a charging point; monitoring the charging status of the vehicle energy storage device; producing a sound audible external to a vehicle when it is determined that the vehicle is connected to a charging point for charging the at least one energy storage device and in dependence on the state of charge of the energy storage device, the sound being indicative of whether the energy storage device has reached a prescribed level of charge and/or whether the vehicle may be disconnected from the charging point. That is to say disconnection is authorised or acceptable upon reaching the prescribed level of charge.

In an embodiment, the method comprises producing said sound periodically.

The method may comprise using a loudspeaker or other sound transducer to produce the sound. The method may comprise using an electronic controller having a CPU.

In an embodiment, the method comprises producing said sound in the form of a verbal message. The method may comprise using text to speech techniques to generate the message.

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In an embodiment, the method comprises determining the location of the vehicle and producing said sound only if it is also determined that the vehicle is not at a pre-defined location. The method may comprise pre-defining one or more locations at which no notifications are to be broadcast.

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In an embodiment, the method comprises determining the location of the vehicle and producing said sound only if it is also determined that the vehicle is at a multi-user charging station. The method may comprise consulting a database containing details of charging stations, including their locations.

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In an embodiment, the method comprises determining the location of the vehicle and producing said sound only if it is also determined that the vehicle is at a charging point having multiple parking spaces associated therewith. The method may comprise consulting a database containing details of charging stations, including their locations.

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In an embodiment, the method comprises determining the location of the vehicle and producing said message in a language selected in dependence on the location.

Where the method comprises determining the location of the vehicle, the method may comprise using a global navigation satellite system (GNSS) and/or the internet, and/or a mobile communications network to determine the location of the vehicle.

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In an embodiment, the method comprises using a sensor arrangement suitable for detecting the presence of people in the vicinity of the vehicle and producing said only if it is determined that a person is detected. The method may comprise producing said sound only if it is also determined that a person is proximal to a charging port of the vehicle.

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In an embodiment, the method comprises using a sensor arrangement suitable for detecting the presence of vehicles in a further parking space associated with the charging point and producing said sound only if it is also determined that a further vehicle is present in said further parking space.

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In an embodiment, the method comprises producing said sounds only within prescribed time periods.

In an embodiment, the method comprises producing a sound indicative that the vehicle may be disconnected from the charging point following a determination that the energy storage device has reached a prescribed state of charge. Where the sound is in the form of a verbal message, the message may be indicative that the vehicle may be disconnected from the charging point.

In an embodiment, the method comprises producing a sound indicative that the vehicle should not be disconnected from the charging point following a determination that the energy storage device has not reached a prescribed state of charge. Where the sound is in the form of a verbal message, the method may comprise issuing a message which provides an estimate of time before the vehicle can be disconnected from the charging point.

In an embodiment, the prescribed state of charge corresponds to a substantially full state of charge or to a user-prescribed amount of charge.

In accordance with a further aspect of the invention, there is provided a method of charging a vehicle having an electric propulsion system including at least one electric motor and an energy storage device, the method comprising: determining whether the vehicle is connected to a charging point; monitoring the charging status of the vehicle energy storage device; producing a notification discernible external to a vehicle when it is determined that the vehicle is connected to a charging point for charging the at least one energy storage device and in dependence on the state of charge of the energy storage device, the notification being indicative of whether the energy storage device has reached a prescribed level of charge and/or whether the vehicle may be disconnected from the charging point. That is to say disconnection is authorised or acceptable upon reaching the prescribed level of charge.

The notification may be a visual notification such as a message displayed on a display or one or more lights.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or

features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally
5 claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

10 Figure 1 is a schematic representation in plan of an HEV in accordance with an aspect of the invention incorporating an embodiment of a notification system in accordance with a further aspect of the invention;

15 Figure 2 is a schematic representation of the notification system incorporated into the vehicle of HEV of Figure 1; and

Figure 3 is a flow diagram illustrating an embodiment of a method in accordance with an aspect of the invention.

20 DETAILED DESCRIPTION

Figure 1 illustrates a hybrid electric vehicle (HEV) 10 according to an embodiment of the present invention. The vehicle 10 has a propulsion system including an internal combustion
25 engine 12, a clutch 14, a crankshaft-integrated electric motor/generator 16 coupled with the engine 12 through the clutch 14 and a transmission 18. The propulsion system is operable to provide drive torque to the transmission 18 and the road wheels of the vehicle by means of the engine 12 alone, the motor/generator 16 alone, or the engine 12 and the motor/generator 16 in parallel. The transmission 18 may be a manual transmission or an
30 automatic transmission. The vehicle 10 may be a four wheel drive vehicle as illustrated or two wheel drive.

The vehicle 10 has an energy storage device in the form of a battery 20 electrically connected to the motor/generator 16 via an inverter 22. When the motor/generator 16 is
35 operated as a motor it draws electrical energy from the battery through the inverter 22 and when operated as a generator the motor/generator 16 delivers a charge to the battery 20.

The battery 20 is also connected to a charging port 24 accessible from an exterior of the vehicle 10. The charging port 24 allows the battery 20 to be connected to a charging point 26 by means of a charging cable 28 to allow recharging of the battery 20. The vehicle 10 may therefore be described as a HEV of the 'plug-in' type. However, aspects of the invention can be applied to any suitable EV.

The various states of use of the engine 12, motor/generator 16 and the battery 20 are controlled by a controller 30 of the vehicle. The controller 30 may be part of a larger vehicle electronic control unit (ECU), or may be a separate or otherwise integrated ECU, module, or other electronic or computer circuit comprising a central processing unit (CPU) 31 or program.

Such HEVs, and various alternative embodiments of EV, as well as their use and control systems, are well known in the prior art and will not further be dealt with in detail here.

As is known in the art, the vehicle 10 has a sound generating system, indicated generally at 32, for generating an externally audible sound when the vehicle is being operated in an electric mode and the engine 12 is not running. In these conditions, the vehicle propulsion system produces very little sound and there is a risk that pedestrians or other road users may not be aware of the vehicle and so such noise producing systems have been developed as a safety feature. The active noise producing system 32 includes a sound generating module 34 connected with a speaker 36 or other sound transducer. The sound generating module 34 may also be part of a larger vehicle ECU, or may be a separate or otherwise integrated ECU, module, or other electronic or computer circuit or program.

In accordance with an aspect of the invention, the vehicle 10 has an audible notification system, indicated generally at 40. The audible notification system 40 is arranged to produce a notification audible external to the vehicle 10 when the vehicle is connected to a charging point in order to inform anyone wishing to use the charging point 26 whether the vehicle can be disconnected from the charging point 26. In an embodiment, the audible notification system 40 is arranged to broadcast a verbal message informing anyone in the vicinity of the vehicle 10 that charging is completed and/or that the vehicle may be disconnected from the charging point once the battery 20 has reached a predetermined state of charge. The message to be broadcast may be pre-recorded or it may be generated by the controller 30, or by the sound generating module 34 in response to an input from the controller 30. The message could, for example, be generated using text to speech techniques. A message of the type "charging is complete, please disconnect" might be used but it will be appreciated

that any number of different verbal messages could be used to indicate to a potential user of the charging point 26 the information that they may disconnect the vehicle. For example, a message may simply state that “charging is complete” and leave it to the listener to infer that they can disconnect the vehicle from the charging point.

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Whilst the notification system 40 can be a standalone system, in an embodiment the system 40 conveniently incorporates or utilises components of the vehicle 10 which are also used for other purposes. In the present embodiment, the audible notification system 40 incorporates the sound generating system 32 (or at least the speaker 36) and the controller 30. Alternatively, the notification system may comprise a separate ECU or may be provided as a module forming part of the controller 30. The notification system 40 system and its various components may be arranged to communicate with a motor vehicle control system. For example, the system may be arranged to be connected to a controller area network (CAN) bus or other on-board communications network.

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The audible notification system 40 includes a means 42 for detecting whether the vehicle 10 is connected to a charging point 26 and a means 44 for monitoring the state of charge of the battery 20. In the present embodiment where the vehicle has a charging port 24 into which a charging cable 28 from a charging point is inserted, the means 42 for detecting that the vehicle is connected to a charging point could take the form of a sensor to detect the physical presence of a charging cable connector in the charging port 24. For example, this could take the form of a switch in the vehicle’s connector. Alternatively, the attachment of a charging cable 24 to the vehicle charging port 24 can be detected electronically. A low voltage connection or “electronic handshake” is generally established between a charging point and a vehicle when the charging cable is connected to allow the charging point to communicate with the vehicle so that the charging process can be controlled. This low voltage connection is maintained during the charging cycle and can be used as an indication that the vehicle is connected to a charging point. However, those skilled in the art will be able to devise various alternative ways of detecting connection to a charging point. Alternatively, the audible notification system may determine that the vehicle 10 is connected to a charging point 26 when charging is initiated.

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Monitoring of the state of charge of the battery 20 is carried out by the controller 30 for example by a state of charge monitoring module 44 and may be part of the usual state of charge monitoring process for the vehicle 10.

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The predetermined level of charge of the battery 20 may be a fully or substantially fully charged state. However, this need not be the case and the predetermined state of charge could be less than a fully charged state. In an embodiment, the system 40 has inputs 48 which allow a user of the vehicle to set a user-defined predetermined level of charge which could be less than fully charged. For example, the vehicle user may specify that charging can be discontinued when the battery reaches a particular level of charge, say 80% or 90% of fully charged, depending on their requirements and this level is used by the notification system 40 as the predetermined level of charge. Alternatively, rather than the user defining the required level of charge as such, the user may enter data that enables the system 40 to calculate a predetermined level of charge. For example, the user may enter a required range of travel and the system 40 will determine what level of charge is required to ensure the vehicle can achieve the specified range of travel, possibly allowing for a factor of safety, and set this as the predetermined level of charge.

In an embodiment, the vehicle has an electronic navigation system 46, such as a global navigation satellite system (GNSS) or the like. In this case, rather than entering the range of travel, the user may enter the location of the next charging point or the next destination and the system will calculate a required state of charge by using the navigation system to determine the distance between the vehicle's current location and the next charging point or destination. Alternatively, the user may enter a plurality of journeys for the remainder of the day, i.e. until returning to a prime (home) charging location, and the system will similarly calculate the required state of charge to complete those journeys. Each of these later arrangements can also be considered as a user-defined predetermined state of charge. User inputs 48 to the notification system 40 can be provided as part of the overall vehicle control system. In an embodiment, the navigation system may be configured to automatically determine any inferred journeys and the system will similarly calculate the required state of charge independent of a user input. The inferred journeys may include, for example, any remaining journeys necessary to return to the prime (home) charge location or any journeys inferred by a current driving route and/or historic route data.

An audible notification may be issued by the notification system 40 only when the battery 20 has achieved the predetermined level of charge to indicate that the vehicle may be disconnected for a charging point. However, the notification system 40 could additionally issue an audible notification before the predetermined level of charge is reached to indicate that charging is in progress and that the vehicle should not be disconnected from the charging point. Such a notification could be in the form of a verbal message and could include an estimate of the time left before charging will be complete.

A method according to an aspect of the invention is illustrated in Figure 3.

The method begins at step 50 and the audible notification system 40 is initialised at step 52.

5 At step 54, the system 40 determines whether the vehicle is connected to a charging point. If no connection is detected step 54 is repeated. However, if a connection is detected then the system proceeds to step 56 where it determines whether the battery 20 has reached the predetermined level of charge. Step 56 is repeated until the battery 20 is determined to have reached the predetermined level of charge and the notification system then moves on to step
10 58, where a determination is made as to whether an audible notification is required. As discussed below, step 58 is an optional step and could be omitted. Where step 58 is included, the system 40 can use a range of parameters to decide whether an audible notification is required, which may depend on any one or more of: the location of the vehicle, the time and/or whether anyone is detected as being in the vicinity of the vehicle, for
15 example. These various possibilities are discussed in more detail below. If the notification system 40 determines that an audible notification is required, or in the absence of step 58, the system moves on to step 60 and an audible notification is issued and the procedure stops at step 62. The notification system may be arranged to broadcast notifications periodically after a determination has been made that the predetermined level of charge has
20 been reached and may be arranged to stop broadcasting notifications when the vehicle is disconnected from the charging point and/or after a given period of time.

As noted above, step 58 in the method of Figure 2 could be omitted and in a simple form the notification system 40 may be arranged to broadcast a message periodically whenever the
25 vehicle 10 is determined to be connected to a charging point and that the battery has achieved a predetermined level of charge. However, the audible notification system 40 can be enhanced so that messages are only broadcast when they are likely to be of value and/or to reduce unnecessary noise. For example, the vehicle user may have an option to turn the notification system on and off. In this case the user would be expected to turn the system on
30 only when using a charging point 26 which has multiple parking spaces and/or where someone might be expected to have a legitimate reason to disconnect the vehicle from the charge point. However, there is a risk that vehicle users may forget to set the notification system and so negate some of its benefits. To avoid this, the notification system 40 in various embodiments incorporates a degree of automation in selecting when to broadcast
35 messages in step 58.

In an embodiment, the vehicle 10 is equipped with a global navigation satellite system (GNSS) 46 for determining the location of the vehicle 10. As part of the process of determining whether an audible notification is required, the navigation system 46 is used to determine the location of the vehicle 10 and the notification system will produce an audible notification only if certain further conditions are met regarding the location. In one embodiment, the vehicle user is able to pre-define one or more locations at which no audible notification is to be produced via inputs 48. The pre-defined locations could include a home location and/or the location of other regularly used charging points where audible notifications are not required, such as a work based charging point where only one vehicle can access the charging point, for example. If the notification system 40 determines that the vehicle is at one of the pre-defined locations, no audible notification is produced. In a further embodiment, once the notification system 40 has determined the location of the vehicle 10 it consults a database (not shown) to determine if the charging point is part of a multi-user charging station, that is to say a charging station to which other vehicles may have access. This may be a public station or private charging station with multiple users, such as a charging station at a place of work. In this embodiment, an audible notification is only produced if the vehicle is determined to be at a multi-user charging station and all other conditions are met. In a yet further embodiment, the database also identifies charging points that have more than one allocated parking space to which the charging cable can reach and the system only produces an audible notification if it is determined that the vehicle is at such a charging point and all other conditions are met. Such a database may be stored on-board the vehicle or it may be stored remotely and accessed wirelessly, for example via the internet 64.

In an embodiment, the audible notification system 40 is configured to be able to broadcast messages in a range of different languages. In such an embodiment the vehicle user may be able to set which language is to be used or the notification system may select a language automatically based on the location of the vehicle. For example, where the vehicle has a GNSS system 46, the notification system may determine the location of the vehicle and consult a database of languages (not shown) for use in different countries and/or regions and be configured to select the most appropriate language according to a pre-defined protocol. The database may be stored on-board the vehicle or stored remotely and accessed via the internet 62 or the like. The notification system 40 may select a language each time a notification is to be broadcast or the language may be set by the system periodically in response to location data and only changed if the system detects that the vehicle has moved from one language region to another. The notification system 40 could be configured to

broadcast a message in more than one language at any given location where this appropriate.

Where the notification system is a standalone system used in a vehicle not having a satellite navigation system 46, or where connection to the vehicle's satellite navigation system is not possible, the notification system may be provided with its own dedicated satellite navigation system or other means of determining the location of the vehicle. In a further alternative, the notification system may be configured to connect with the internet or use a mobile communications system to determine the location of the vehicle.

In an embodiment, the audible notification system 40 is configured to produce audible notifications only during certain time periods, such as during the day. The notification system 40 may include a clock 66 or other means for measuring or determining the time. Alternatively, the controller 30 may interrogate a remote system to determine the time at the vehicle's location. This could be via the internet 64 or some other wireless communication system. Such an arrangement can be used to prevent audible notifications being produced during the night or at other times when they might cause a disturbance.

In an embodiment, the notification system 40 includes a sensor arrangement 68 capable of detecting the presence of people in the vicinity of the vehicle 10 and the system 40 arranged so that it only produces an audible notification when a person is detected near the vehicle and all other conditions are met. The sensor arrangement 68 may, for example, include one or more sensors capable of detecting motion of an object within the vehicle's environment as a way of determining whether a person is likely to be present. In a refinement, the system 40 is configured so that an audible notification is only triggered if a person is detected as being in close proximity to the vehicle's charging port 24. In this way, a person approaching the charging port 24 who may be investigating the possibility of disconnecting the vehicle will trigger an audible notification. In this embodiment in particular, the system 40 may be arranged to issue a notification indicating that charging is not complete and/or that the vehicle should not be disconnected if a person is detected close to the charging port 24 but where the battery 20 has not reached the predetermined state of charge. Such a message could also be triggered if an attempt to disconnect the vehicle from the charging point is detected and the predetermined level of charge has not been achieved. As an alternative, or in addition, to detecting persons in the vicinity of the vehicle 10, the sensor arrangement 68 is adapted to detect the presence of an object, such as vehicle, in an adjacent parking space associated with a charging point 26 and to issue an audible notification only if it is determined that the adjacent parking space is occupied and all other conditions are met. The

sensor arrangement may have one or more ultrasonic sensors, infra-red sensors or a radar sensors, for example.

It will be appreciated that the method as illustrated in Figure 3 is only one possible embodiment and that various additional steps could be included or that the order of certain steps in the method could be varied. For example, a determination of whether an audible notification is required could be made immediately after it is determined that the vehicle is connected to a charging point. In this case, the subsequent steps of monitoring the state of charge of the battery 20 can be omitted where no audible notification is required. In embodiments where the notification system 40 is configured to issue message prior to the battery 20 reaching the predetermined state of charge indicative that the vehicle should not be disconnected, the method would be modified to allow for different messages being issued prior to the battery 20 reaching the pre-defined state of charge and after.

An audible notification in the form of a verbal message is particularly suitable as it means that no specialist knowledge is required to interpret the notification. Nevertheless, the audible notification system could be configured to issue an audible notification in a non-verbal manner. In this case, it is expected that a standard would be agreed in which certain sounds are assigned specific meanings. For example a first sound can assigned to indicate that charging is complete/that the vehicle may be disconnected and a second sound that charging is not complete/the vehicle should not be disconnected. Furthermore, in accordance with alternative embodiments, the notification system 40 could be configured to produce non-audible notifications such as visual notifications. Such a non-audible notification could take the form of a message displayed on a display screen, or one or more lights which could be of different colours. For example, a green light could be used to indicate that charging is complete and/or that the vehicle can be disconnected and a red light that charging is incomplete and/or that the vehicle should not be disconnected.

The audible notification system 40 provides a means of advising other potential users of a charging point 26 when they can disconnect the vehicle 10 from the charging point without compromising the charge of the vehicle. This improves the effective utilisation of charging points. The system may also reduce the likelihood of a vehicle being disconnected before a charge is complete as the other charging point users will be able to rely on the system to let them know when they can disconnect the vehicle and so they may be less inclined to disconnect the vehicle 10 regardless.

The above embodiments are described by way of example only. Many variations are possible without departing from the scope of the invention as defined in the appended claims.

CLAIMS

- 5 1. A notification system for a vehicle having an electric propulsion system including at least one electric motor and an energy storage device; wherein the notification system has a sound generating system and an electronic controller in communication with the sound generating system, the notification system being configured in use to produce a sound in dependence on a determination that the vehicle is connected to a charging point for charging the at least one energy storage device and in
10 dependence on the state of charge of the energy storage device, the sound being audible external to a vehicle in which the notification system is installed and indicative of whether the vehicle may be disconnected from the charging point.
- 15 2. A notification system as claimed in claim 1, wherein the notification system is configured to produce said sound periodically.
3. A notification system as claimed in claim 1 or claim 2, wherein the notification system is configured to produce a sound in the form of a verbal message.
- 20 4. A notification system as claimed in any preceding claim, wherein the notification system includes a vehicle location detection system for determining the location of the vehicle.
- 25 5. A notification system as claimed in claim 4, wherein the notification system is configured to produce said sound only if it is determined that the vehicle is not at a pre-defined location.
- 30 6. A notification system as claimed in claim 4 or claim 5, wherein the notification system is configured to produce said sound only if it is determined that the vehicle is at a multi-user charging station.
- 35 7. A notification system as claimed in any of claims 4 to 6, wherein the notification system is configured to produce said sound only if it is determined that the vehicle is at a charging point having multiple parking spaces associated therewith.
8. A notification system as claimed in any of claims 4 to 7, wherein the notification system is configured to produce a sound in the form of a verbal message in a range

of different languages, the notification system being configured to broadcast said message in a language selected from the available range in dependence on the location of vehicle.

- 5 9. A notification system as claimed in any of claims 4 to 8, wherein the vehicle location detection system for determining the location of the vehicle comprises at least one of a global navigation satellite system (GNSS) and a system for connecting with the internet.
- 10 10. A notification system as claimed in any preceding claim, the notification system comprising a sensor arrangement capable of detecting the presence of a person in the vicinity of the vehicle, the notification system being configured to produce said sound only if the presence of a person is detected.
- 15 11. A notification system as claimed in any preceding claim, the notification system including a sensor arrangement capable of detecting objects in the vicinity of the vehicle, the notification system being configured to produce said sound only if it is determined that a further vehicle is located in a parking space associated with the charging point.
- 20 12. A notification system as claimed in any preceding claim, wherein the notification system is configured to produce said sounds only within predetermined time periods.
- 25 13. A notification system as claimed in any preceding claim, wherein the notification system is configured in use to produce a sound indicative that the vehicle may be disconnected from the charging point where it is determined that the energy storage device has reached a predetermined state of charge.
- 30 14. A notification system as claimed in any preceding claim, wherein the notification system is configured in use to produce a sound indicative that the vehicle should not be disconnected from the charging point where it is determined the energy storage device has not yet reached a predetermined state of charge.
- 35 15. A notification system as claimed in any preceding claim, wherein the predetermined state of charge corresponds to a substantially full state of charge or to a user-defined state of charge.

16. A vehicle having an electric propulsion system including at least one electric motor and an energy storage device, the vehicle comprising a notification system as claimed in any preceding claim.

5 17. A method of charging a vehicle having an electric propulsion system including at least one electric motor and an energy storage device, the method comprising: determining whether the vehicle is connected to a charging point; monitoring the charging status of the vehicle energy storage device; producing a sound audible external to the vehicle when it is determined that the vehicle is connected to a
10 charging point for charging the at least one energy storage device and in dependence on the state of charge of the energy storage device, the sound being indicative of whether the vehicle may be disconnected from the charging point.

15 18. A method as claimed in claim 17, the method comprising producing said sound periodically.

19. A method as claimed in claim 17 or claim 18, wherein the method comprises producing said sound in the form of a verbal message.

20 20. A method as claimed in claim 19, the method comprising determining the location of the vehicle and producing said message in a language selected in dependence on the location.

25 21. A method as claimed in any of claims 17 to 20, the method comprising determining the location of the vehicle and producing said sound only if it is determined that the vehicle is not at a pre-defined location.

30 22. A method as claimed in any of claims 17 to 21, the method comprising determining the location of the vehicle and producing said sound only if it is determined that the vehicle is at a multi-user charging station.

35 23. A method as claimed in any of claims 17 to 22, the method comprising determining the location of the vehicle and producing said sound only if it is determined that the vehicle is at a charging point having multiple parking spaces associated therewith.

24. A method as claimed in any of claims 17 to 23, the method comprising using at least one of a global navigation satellite system (GNSS) and the internet to determine the location of the vehicle.
- 5 25. A method as claimed in any of claims 17 to 24, the method comprising using a sensor arrangement capable of detecting the presence of people in the vicinity of the vehicle and producing said sound only if it is also determined that a person is detected.
- 10 26. A method as claimed in any of claims 17 to 25, the method comprising producing said sound only within predetermined time periods.
- 15 27. A method as claimed in any of claims 17 to 26, wherein the method comprises producing a sound indicative that the vehicle may be disconnected from the charging point when it is determined that the energy storage device has reached a predetermined state of charge.
- 20 28. A method as claimed in any of claims 17 to 27, wherein the method comprises producing a sound indicative that the vehicle should not be disconnected from the charging point when it is determined that the energy storage device has not reached a predetermined state of charge.
- 25 29. A method as claimed in any of claims 17 to 28, wherein the predetermined state of charge corresponds to a substantially full state of charge or to a user-defined state of charge.

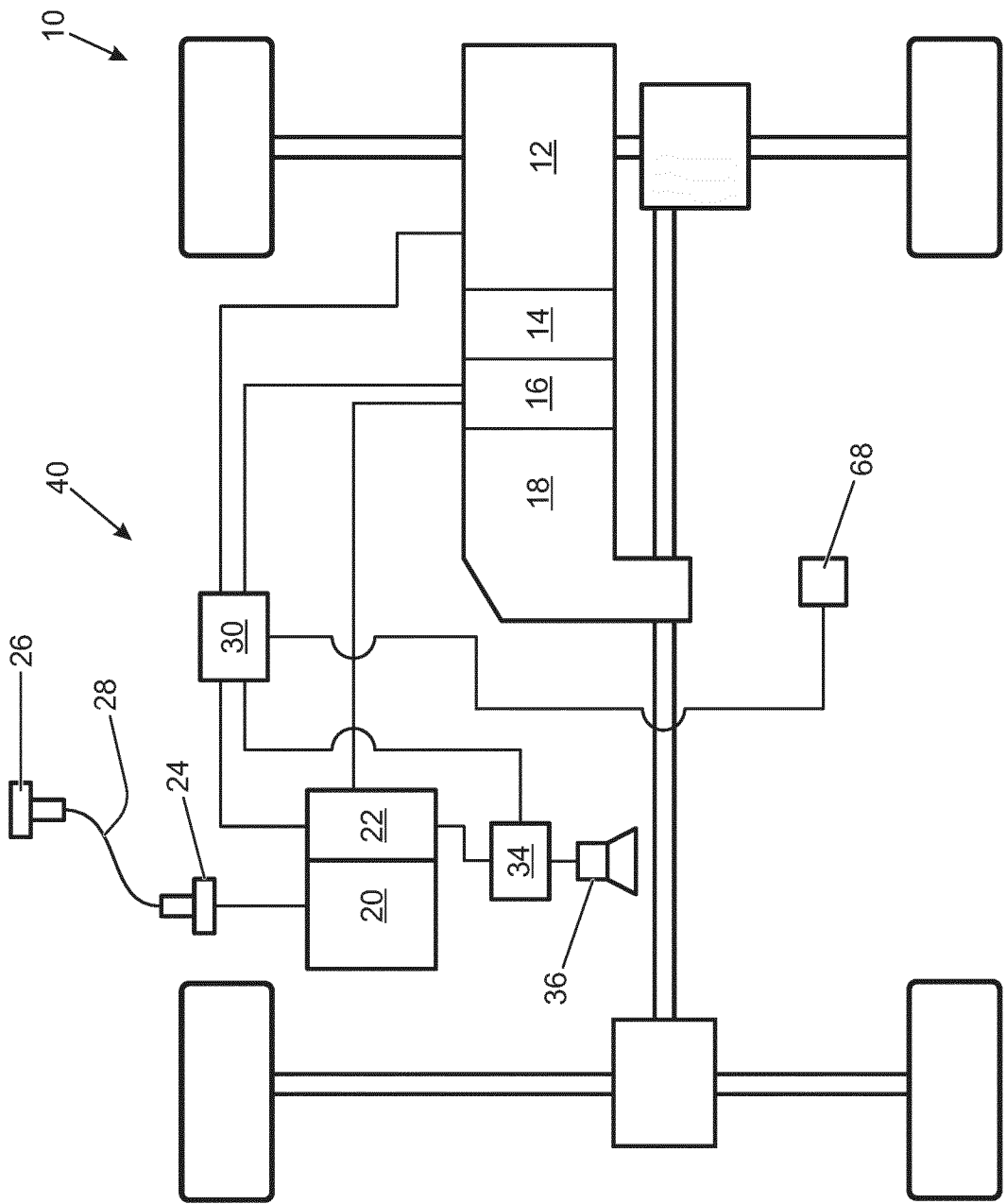


FIG. 1

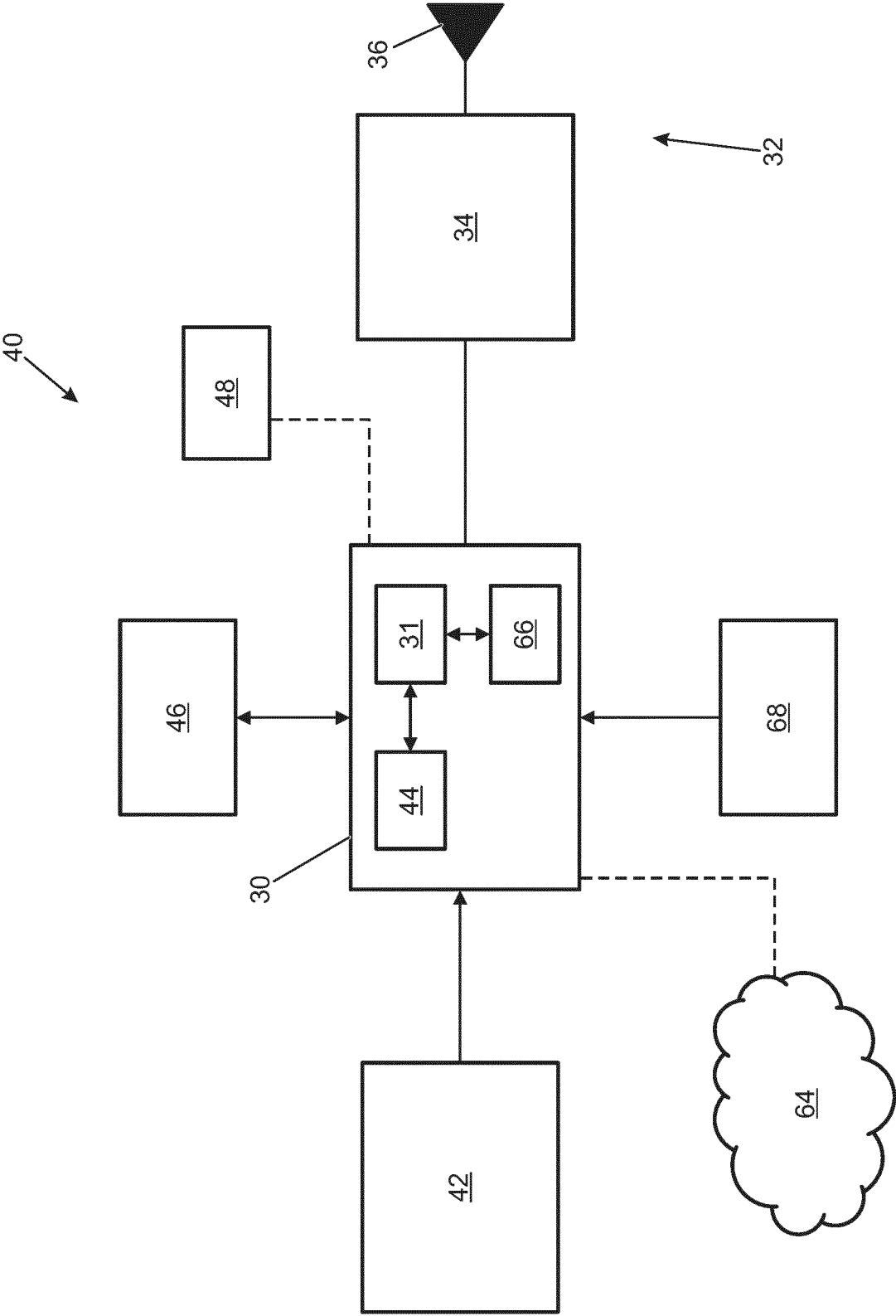


Fig. 2

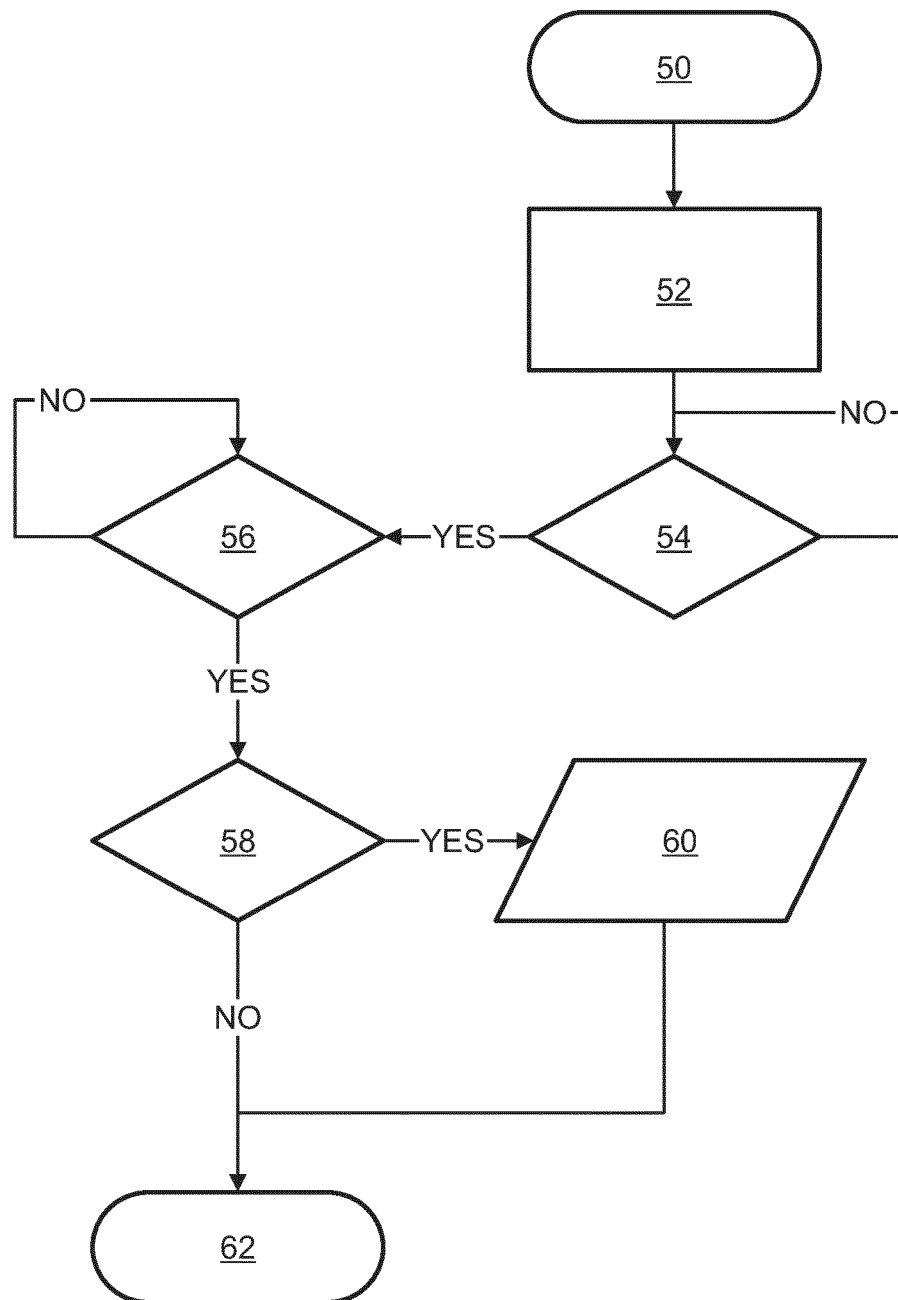


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079184

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60L11/18
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)
B60L

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)

EPO-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	GB 2 513 610 A (JAGUAR LAND ROVER LTD [GB]) 5 November 2014 (2014-11-05) abstract figures 1,2 page 1, lines 25-27 page 2, lines 26-36 page 3, lines 5-9, 24-28, 30-31 page 10, lines 22-29, 30-33 page 12, lines 19-23, 33-35 page 13, lines 1-4, 20-21, 28-32 page 14, lines 4-5, 7-8, 16, 31-34 ----- -/-	1-29



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 February 2018

Date of mailing of the international search report

19/03/2018

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Tzortzopoulos, 0

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079184

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 204 465 065 U (ZHONGNENG SHIHUA BEIJING ENERGY SAVING SCIENCE & TECHNOLOGY) 8 July 2015 (2015-07-08) abstract paragraphs [0015], [0017] - [0018] -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/079184

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			GB 2530848 A	06-04-2016
			GB 2548961 A	04-10-2017

US 5563491	A	08-10-1996	NONE	

CN 204465065	U	08-07-2015	NONE	
