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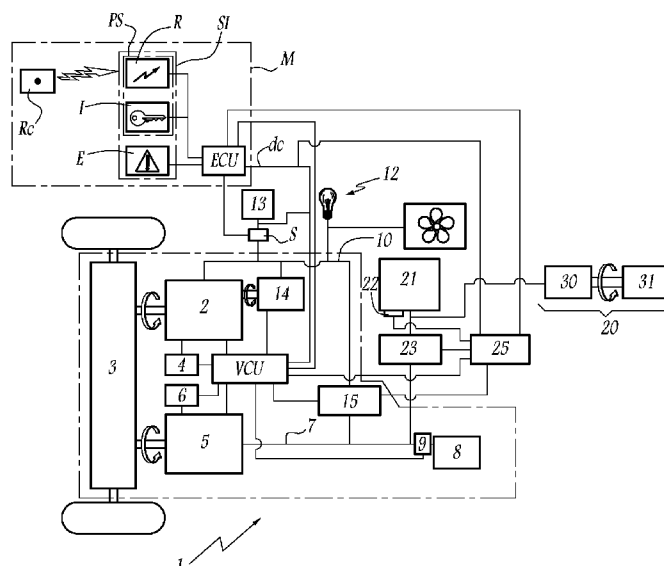


Fig.2

(57) Abstract: A hybrid vehicle including: an electric motor drive system (5) which is connected to a driving battery set (8); a service circuit (10) providing electricity at least to an engine unit (2) and comprising a service battery set (13) and an electronically controlled service switch (S) between the service battery set and the service circuit (10); a master switching unit (M) comprising: - a switching interface (SI); - an electronic control unit (ECU) adapted to, after a triggering of the switching interface (SI): - initiate a driving loads shutdown sequence during which the electrical loads (5) of the driving circuit (7) are stopped if not already stopped, and - implement a shutdown delay at the end of which the service switch (S) is opened.

HYBRID VEHICLE INCLUDING A MASTER SWITCHING UNIT

TECHNICAL FIELD

The invention is directed to a hybrid vehicle comprising an internal combustion engine as well as electric drive motor. The electric drive motor and the engine combustion use alternatively or in conjunction for driving the vehicle, whereas electricity is provided either by a service generator driven by the engine or by a drive generator driven by the driveline during slowing phases of the vehicle. This kind of vehicles is used for many applications such as personal cars, commercial vehicles or trucks, even construction vehicles.

BACKGROUND ART

Hybrid vehicles implement a high voltage circuit providing energy to heavy loads such as the driving motor and a low voltage circuit providing energy to light loads such as the driver's comfort accessories and cooling units of both the engine unit and the electric motor unit. Because of the high voltage and high current circulating in the various electrical circuits of the vehicle, the opening of the circuit breakers or shut-down of the vehicle at an inappropriate moment might induce hazardous over-voltage or over-current which might damage some of the connected devices. Therefore, there is a need for a new kind hybrid vehicle which provides good security conditions for the shut-down of the various energy providing systems.

SUMMARY OF THE INVENTION

Therefore an object of the invention is to propose such a new kind of hybrid vehicle offering very safe shutdown conditions avoiding any over voltage or current risk and enabling in normal condition a good cooling of the drive system components. Accordingly the invention concerns a hybrid vehicle including:

- an electric motor drive system which is connected to a driving circuit comprising a driving battery set;
- a service circuit providing electricity at least to an engine unit and comprising a service battery set and an electronically controlled service switch between the service battery set and the service circuit;

- a service electric generator which is driven by the engine unit and connected to the service circuit;
- a master switching unit comprising:
 - a switching interface;
- 5 – an electronic control unit adapted to, after a triggering of the switching interface:
 - initiate a driving loads shutdown sequence during which the electrical loads of the driving circuit are stopped if not already stopped;
 - implement a shutdown delay at the end of which the service switch is
- 10 opened.

The implementation of the master switching unit guarantees a good level of security as opening of the service switch occurs after the shutdown of all the heavy electrical loads of the vehicles so that the over voltage or current risks during the opening are low.

- 15 According to an embodiment of the invention, the electrical sources of the driving circuit and the service generator are stopped or disconnected during the driving loads shutdown sequence.

According to another embodiment of the invention:

- the switching interface comprises a normal pilot switch and a fast pilot switch;
- 20 and
- the electronic control unit is adapted to :
 - when the normal pilot switch is triggered a first time, initiate the driving load shutdown sequence;
 - when the cab pilot switch is triggered a second time, implement a normal
- 25 shutdown delay as the shutdown delay and initiate the count down of the shutdown;
- when the fast pilot switch is triggered, initiate the driving load shutdown sequence, implement a fast delay shutdown delay as the shutdown delay and initiate the count down of the shutdown delay, the fast shutdown delay
- 30 being shorter than the normal shutdown delay.

Such embodiment of the invention provides two different ways or manner to shutdown the vehicle, one for the normal operating conditions, the other allowing a fast shutdown of the vehicle for emergency situation or, when the

vehicle is under maintenance, for guarantying safe electrical conditions in a short delay for the mechanics to work on the vehicle.

The normal pilot switch may for example comprise a switch manually actuated by an ignition key. In normal circumstances, the driver will firstly switch
5 off the vehicle by turning the key which will trigger the normal pilot switch for the first time and therefore initiate the driving loads shut down sequence. Then the driver will remove the key which will trigger the normal pilot switch for the second time and the normal delay used as shutdown delay for the count down will allow electricity to be provided to accessories of the vehicles, such as electrical
10 ventilators, cooling for example the engine as well as the driving battery sets, even if the vehicle is parked. In emergency situation or when maintenance work must be rapidly done on the vehicle, the user will use the fast pilot switch. The fast shutdown delay being shorter than the normal shutdown delay will thus induce a quicker shutdown of all the energy providing sources and therefore the
15 vehicle will be available for maintenance in a short time. It should be noted that, after triggering of the switching interface, the opening of the service switch at the end of the shutdown delay either normal or fast occurs even if all the load and sources of the driving circuit are not completely stopped or shutdown.

According to the invention the switching interface may implement various
20 types of human machine interfaces allowing the driver or the user of the vehicle to enter his switching order. As previously mentioned, the normal pilot switch may comprise a switch manually actuated through an ignition key. The normal pilot switch may also implement a key comprising a transponder associated with a dedicated detector. The detection of the transponder will correspond to an "on"
25 state of the normal pilot switch and the remoteness of the transponder will trigger the normal pilot switch. The normal pilot switch can also comprise a manual switch with two positions "on" and "off". The normal pilot switch may also comprise a remote control allowing the driver to provide his switching orders even if he is not in the driving cab. Accordingly, if the normal pilot switch has
30 been triggered a first time, an action on the remote control induces the second triggering of the pilot switch.

According to an aspect of the invention, the normal pilot switch may comprise a manually actuated switch and a switch remotely actuated by a

remote control, and the normal shutdown delay is implemented when either the manually actuated switch or the remotely actuated switch is triggered. In this context an action on the manual switch induces the first triggering of the normal pilot switch and, if the normal pilot switch has been triggered a first time, an action on the remote control induces the second triggering of the pilot switch. All in all, the normal pilot switch is a logical switch through which the master switching unit will be able to detect a first triggering action and a second triggering action, either through the same physical switch or through several physical switches.

10 According to the invention, any normal and fast shutdown delays may be implemented, provided naturally the normal shutdown delay is shorter, preferably quite shorter, than the normal shutdown delay. For example, the normal shutdown delay is superior or equal to one minute and the fast shutdown delay is inferior or equal to five seconds. According to an aspect of the invention, the normal shutdown delay is superior or equal to ten minutes and the fast shutdown delay is inferior or equal to two seconds.

20 According to the invention, the hybrid vehicle may comprise other electrical equipment and sources than those of the drive system and the driver's comfort or assisting accessories. For example, the hybrid vehicle may further comprise:

- an electric equipment circuit powering electrical equipment loads and comprising an equipment battery set;
- and an equipment converter between the driving circuit and the equipment circuit;.

25 Accordingly the electronic control unit is adapted, when the switching interface is triggered, to initiate an equipment loads shutdown sequence during which the equipment loads are stopped, if not already stopped, and the equipment converter is stopped. The electrical equipment loads may be of various types and correspond to functionalities adapted on the vehicle by a body builder.

30 In such an embodiment, the various circuits may implement various voltages for example:

- the service battery set (13) may be of a low nominal voltage, preferably being in the range of 12V to 72V;

- the equipment battery set may be of a medium nominal voltage, preferably being in the range of 84 V to 810 V;
- the driving battery set may be of a high nominal voltage or of a medium nominal voltage, preferably being in the range of 120 V to 1000 V.

5 The equipment battery set and the driving battery set will be generally of different voltage.

Naturally, the various above aspects, embodiments or objects of the invention may be combined in various ways with each others provided the combined aspects, embodiments or objects are not incompatible or mutually
10 exclusive.

DESCRIPTION OF THE FIGURES

Furthermore, other aspects and advantages of the present invention will be apparent from the following detailed description made in conjunction with the
15 accompanying drawing illustrating schematically some non-limitative embodiments of the invention.

- Fig.1 is schematic view of a hybrid vehicle according to the invention.
- Fig.2 is another embodiment of a hybrid vehicle according to the invention which differs from the embodiment shown on figure 1 by the implementation of
20 an equipment circuit for body builder equipments.

Corresponding reference numbers indicate corresponding components in the various embodiments illustrated in the drawings.

DESCRIPTION OF THE INVENTION

25 As illustrated on figure 1, a hybrid vehicle, designated as a whole by reference number 1, comprises a drive system D which includes an internal combustion engine unit 2 powering a mechanical driveline 3. The internal combustion engine unit 2 is associated with an engine electronic control unit 4 providing at least a state of the engine unit 2 to a vehicle control unit 17. The
30 drive system D comprises also an electric drive motor system 5 which is as well operatively connected to the driveline 3. The electric drive motor system is associated with a motor electronic control unit 6 connected to the drive system control unit 17. The drive system D can be of different types such as a parallel or

series type or implement a drive line including a power split device such as a planetary gear. In the same manner the electric drive motor system 5 may comprise a single electric motor or a plurality of electric motors combined with a single electric generator or a plurality of electric generator in order to recover
5 during slowing down phases of the hybrid vehicle. As the electric motor and the electric generator may be mutually separate, they also can be combined as an integrated motor/generator which selectively functions as an electric motor or an electric generator.

The hybrid vehicle 1 comprises a driving circuit 7 which provides electricity
10 at least to the electric drive motor system 5 and which comprises a driving battery set 8 comprising at least one driving battery not shown. The driving battery set 8 may of course comprise a plurality of driving batteries either connected in series or in parallel depending on capacity or the nominal voltage of the driving battery set. The driving battery set is preferably of a medium or a high
15 nominal voltage, for example being in the range of 120 V to 1000 V. Furthermore, each driving battery is preferably a battery with a low internal resistance optimized for efficient low duration high current output. In order to monitor the functioning of the driving battery set 8, the hybrid vehicle 1 comprises driving battery set sensing means 9 adapted to provide at least the
20 state of charge of the driving battery set 8 to the drive system control unit 17. The driving battery set 8 may also be associated with a driving battery switch 9.

The hybrid vehicle 1 comprises also a service circuit 10. The service circuit 10 provides electricity at least to the engine unit 2 but also to other electrical consumers 12 schematically depicted as a light bulb and a ventilator on
25 the figures. Such ventilator can be part of a cooling system used to cool the engine 2 and/or the driving battery set 8 and/or motor 5. The service circuit 10 comprises a service battery set 13 which comprises at least one service battery not individually shown on the figures. The service battery set 13 is of a low nominal voltage, for example being in the range of 12 V to 72 V. Each service
30 battery is preferably a battery optimized for deep cyclic uses and for total energy capacity but can also be of a dual type being a compromise between an energy battery and a power battery. The service circuit 10 further comprises an electric service generator 14 operatively connected to the engine unit 2 and therefore

driven by internal combustion engine unit 2. The service circuit 10 is also connected to the driving circuit 7 through a driving converter 15. The driving converter 15 mainly works as a step-down converter lowering voltage of the driving circuit 10 in order to provide electricity to the service circuit 7 and more particularly in order to charge the service battery set 8. The driving converter 15 can also be of a step-up/step-down type in order to reciprocally derive power from the service circuit 10 for providing electricity to the driving circuit 7.

In order to control the availability of electric power, the vehicle further implements a master switching unit M which comprises a switch interface SI allowing the driver to give power on or power off orders. The switching interface SI may implement any kind of suitable human machine interface. In the shown example, the switching interface SI comprises a normal pilot switch PS situated in the driving cab and which is normally used by the driver for shutting down the power on the vehicle or on the contrary turn on the vehicle so that electric power is available for all the accessories and electrical functions of the vehicle.

On the shown embodiment the pilot switch PS comprises a switch I actuated by an ignition key. The pilot switch PS comprises also a switch R remotely activated by a remote control RC. These switches constituting the pilot switch PS are connected to a master switching electronic control unit ECU. On the shown embodiment, the switching interface SI further comprises a fast pilot switch E also connected to the electronic control unit ECU. The ignition switch I is situated on a driving console or dashboard of the vehicle and the fast pilot switch E is situated on the vehicle preferably outside of the driving cab.

In normal operating conditions, when the driver or user of the vehicle wants to shutdown the vehicle he triggers for a first time the pilot switch by turning the key in the ignition switch I. This action corresponds for the Electronic Control Unit to the first triggering of the normal pilot switch in a normal shutdown sequence. The ECU will therefore initiate a driving loads shutdown sequence. During the driving loads sequence, the driving converter and motors are stopped if they are not already stopped. Then, the electrical sources of the driving circuit such as battery set 8 are disconnected and service generator is stopped or its excitation is shutdown. The disconnection of the driving battery set 8 is achieved by the opening of the driving switch 9. During the driving loads shutdown

sequence, the engine may also be stopped if not already stopped. After the first triggering of the normal pilot switch PS, electricity still available on the service circuit 10.

When the drivers leaves the vehicle or wants a complete shut down of the power, he may either remove the ignition key or push the button of the remote control, this action will trigger for a second time the normal pilot switch and initiate the count down of the normal shutdown delay. At the end of the normal shutdown delay a service switch S interposed between the service battery set 13 and the service circuit 10 is opened, so that the service battery set 13 is isolated from the service circuit. In order to enable a good cooling of the driving battery set 8, of the driving converter and/or of the engine even if the vehicle is stopped, the normal shutdown delay lasts preferably more than ten minutes and for example of 20 minutes during which the cooling ventilators may work.

If the user of the vehicle triggers the fast pilot switch E, the ECU will initiate the driving shutdown sequence as previously explained but will implement a fast shutdown delay counted down from the triggering of the switching interface through the fast pilot switch. The fast shutdown delay is quite shorter than the normal shutdown delay and for example, shorter than 5 seconds or preferably inferior or equal to 2 seconds.

It should be noted that either for the normal shutdown or the fast shutdown, the opening of the service switch occurs at the end of the shutdown delay whether or not the driving loads shutdowns sequence is finished.

It should be further remarked that the driving loads shutdown sequence is either directly conducted by the electronic control unit ECU of the master switching unit M or initiated by only sending a shutdown order to the vehicle control unit 17. In the later case, the ECU is connected to the vehicle control unit 17 which will conduct the driving loads shutdown sequence directly or by giving appropriate orders to slave control units.

In order to maintain the control functionality in any circumstance, the vehicle 1 further comprises a direct circuit dc connected to the service battery upstream of the service switch S and connected to the various electronic control units of the vehicle, such as the electronic control unit ECU of the main switching unit M and the vehicle control unit 17.

In the embodiment described in relation with the figure 1, the hybrid vehicle comprises no other electric loads than the driving system and driving or travel accessories dedicated to the moving and security of the vehicle and the security and comfort of the drivers such as for example, electric power steering, road lights, air conditioning of the driving cab this list being neither comprehensive nor limitative. But according to the invention, the hybrid vehicle may also include heavy duty equipment and thus comprises an equipment circuit.

On the embodiment shown in figure 2, the equipment circuit 11 is adapted to provide electricity to at least a bodybuilder electrical equipment 20 in an autonomous manner and therefore comprises an equipment battery set 21 being constituted by at least one service battery and generally more than one equipment battery depending on the nominal voltage of the equipment battery set 21. Preferably, the equipment battery set is of a medium nominal voltage being for example in the range of 84 V to 810 V. Each equipment battery is either a battery with a low or medium internal resistance optimized for efficient low or medium duration high current output or a battery optimized for deep cyclic uses. The equipment battery set has a total energy capacity depending on the type of equipment implemented by the bodybuilder. All the batteries of the equipment battery set are preferably of a same type. The hybrid vehicle 1 may comprise equipment battery set sensing means 22 adapted for providing a step of charge of the equipment battery set 21. The equipment circuit 11 is connected to the driving circuit 7 through an equipment converter 23 which is adapted to step-down the voltage of the driving circuit 7 in order to provide electricity to the equipment circuit 11. The equipment converter 23 may also be of step-up/step-down type in order to reciprocally derive energy from the equipment circuit 11 for charging the driving battery set 8 or powering the electric motor unit 5. In order to optimize the repartition of the energy during slowing phases of the hybrid vehicle as well as the repartition of the electric power provided by the electric generator 14 when the internal combustion engine 2 is running, the hybrid vehicle 1 further comprises a body builder controller 25 which comprises electronic communication and control means and may also comprise a physical interface for the body builder to connect for example a equipment system control unit. The

body builder controller 25 controls the equipment converter 23 so as to provide energy to the equipment circuit 11. In order to achieve this, the body builder controller 25 is connected to the two converters 15, 23 as well as to the equipment battery set sensing means 22. The body builder controller 25 is also
5 connected to the drive system control unit 17. The connection between the body builder controller 5 and these various elements can be direct wire connection as shown, or implement a Controller Area Network (CAN) well-known by the man skilled in the art. The equipment circuit 11 provides for example electricity to an electric motor 30 which drives a hydraulic pump 31.

10 In such hybrid vehicle implementing an equipment circuit, when the switching interface SI is triggered for the first time, the electronic control unit ECU initiates at first an equipment loads shutdown sequence during which the equipment loads, such the motor 30 and the converter 23, are stopped if not already stopped, and, after this sequence, initiates the driving loads shutdown
15 sequence.

Naturally, the other aspects of the operation of the ECU of the master switch unit M are the same as described above in relation with figure 1, particularly the ECU implements the same normal shutdown delay or fast delay according to which of the pilot switch or the fast pilot switch is triggered.

20 While the invention has been shown and described with reference to certain embodiments thereof, it would be understood by those skilled in the art that changes in form and details may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

CLAIMS

1. Hybrid vehicle including :
 - an electric motor drive system (5) which is connected to a driving circuit (7) comprising a driving battery set (8);
 - 5 – a service circuit (10) providing electricity at least to an engine unit (2) and comprising a service battery set (13) and an electronically controlled service switch (S) between the service battery set and the service circuit (10);
 - a service electric generator (14) which is driven by the engine unit (2) and connected to the service circuit (10);
 - 10 – a master switching unit (M) comprising:
 - a switching interface (SI);
 - an electronic control unit (ECU) adapted to, after a triggering of the switching interface (SI):
 - initiate a driving loads shutdown sequence during which the electrical
 - 15 loads (5) of the driving circuit (7) are stopped if not already stopped, and
 - implement a shutdown delay at the end of which the service switch (S) is opened.
2. Hybrid vehicle according to claim 1, wherein, during the driving loads shutdown sequence, the electrical sources (8, 15) of the driving circuit and the
- 20 service generator (14) are stopped or disconnected;
3. Hybrid vehicle according to claim 1 or 2, wherein :
 - the switching interface (SI) comprises a normal pilot switch (PS) and a fast pilot switch (E); and
 - the electronic control unit (ECU) is adapted to :
 - 25 – when the normal pilot switch (PS) is triggered a first time, initiate the driving loads shutdown sequence;
 - when the normal pilot switch (PS) is triggered a second time, implement a normal shutdown delay as the shutdown delay and initiate the count down of the shutdown delay at the end of which the service switch (S) is opened;
 - 30 – when the fast pilot switch (E) is triggered, initiate the driving loads shutdown sequence, implement a fast shutdown delay as the shutdown

delay and initiate the count down of the shutdown delay, the fast shutdown delay being shorter than the normal shutdown delay at the end of which the service switch (S) is opened.

4. Hybrid vehicle according to claim 3, wherein :

- 5 – the normal pilot switch comprises a switch (I) manually actuated through an ignition key;
- the first triggering of the normal pilot switch (PS) is induced by a rotation of the ignition key;
- the second triggering of the normal pilot switch (PS) is induced by the removal
10 of the ignition key.

5. Hybrid vehicle according to claim 3 or 4, wherein:

- the normal pilot switch comprises a switch (R) remotely actuated by a remote control (RC);
- if the normal pilot switch has been triggered a first time, an action on the
15 remote control (RC) induces the second triggering of the pilot switch.

6. Hybrid vehicle according to claim 3, wherein :

- the normal pilot switch comprises a switch (I) manually actuated and a switch (R) remotely actuated by a remote control (RC);
- the normal shutdown delay is implemented when either the manually actuated
20 switch or the remotely actuated switch is triggered;
- an action on the manual switch (I) induces the first triggering of the normal pilot switch;
- if the normal pilot switch has been triggered a first time, an action on the remote control induces the second triggering of the pilot switch.

25 7. Hybrid vehicle according to any of claims 3 to 6, wherein the normal shutdown delay is superior or equal to one minute and the fast shutdown delay is inferior or equal to five seconds.

 8. Hybrid vehicle according to any of claims 3 to 6, wherein the normal shutdown delay is superior or equal to ten minutes and the fast shutdown delay
30 is inferior or equal to two seconds.

9. Hybrid vehicle according to any of preceding claims, further comprising :
- an equipment circuit (11) powering equipment loads (30) and comprising an equipment battery set (21) ;
 - and an equipment converter (23) between the driving circuit and the equipment circuit;
 - and wherein the electronic control unit (ECU) is adapted to, when the switching means are triggered initiate an equipment loads shutdown sequence during witch the equipment loads (30) are stopped, if not already stopped, and the equipment converter (23) is stopped.
10. Hybrid vehicle according to claim 9, wherein
- the service battery set (13) is of a low nominal voltage, preferably being in the range of 12V to 72V;
 - the equipment battery set is of a medium nominal voltage, preferably being in the range of 84 V to 810 V;
 - the driving battery set is of a high nominal voltage or of a medium nominal voltage, preferably being in the range of 120 V to 1000 V.

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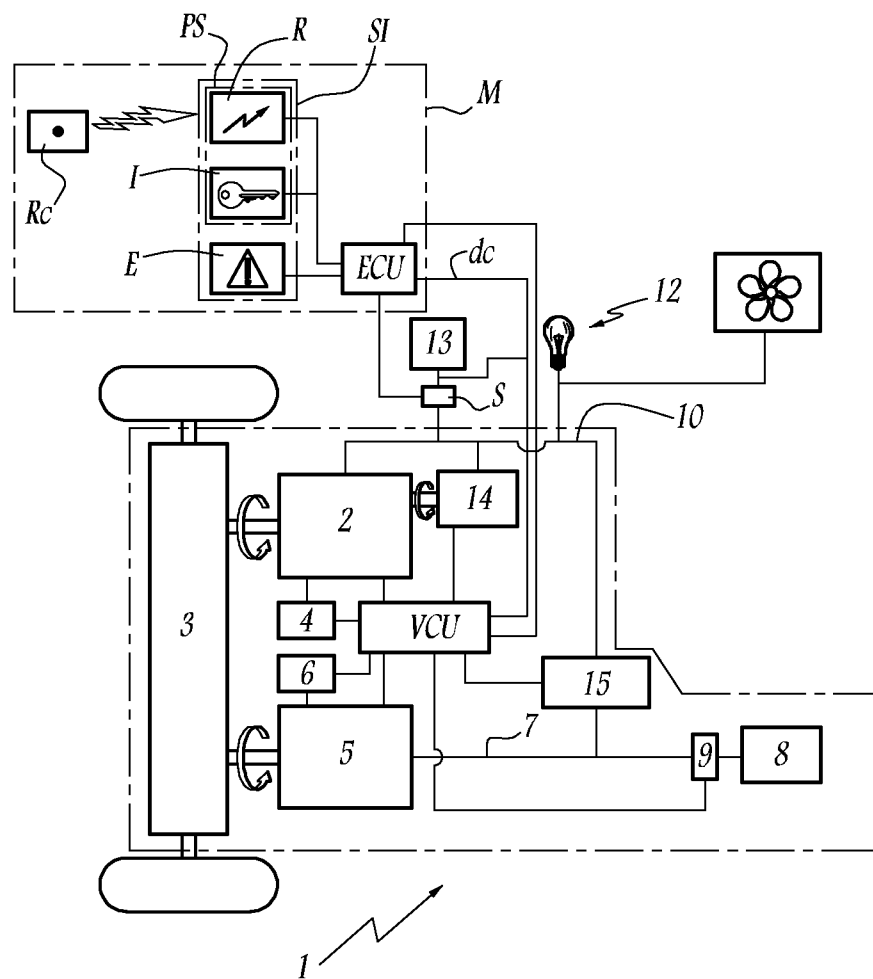


Fig. 1

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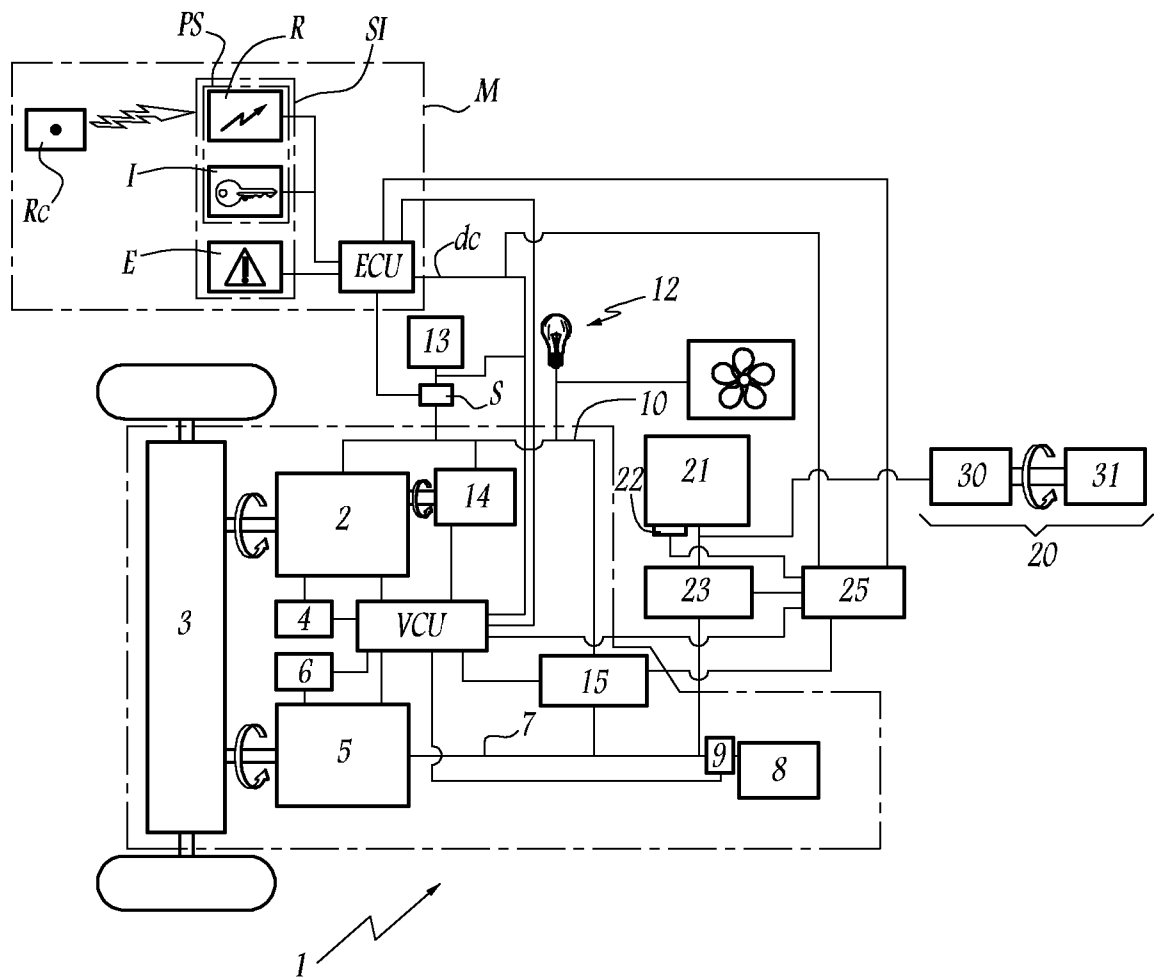


Fig.2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2008/055696

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60K6/28 B60L11/18
ADD. B60W10/26

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)
B60K B60W B60L H02J

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

25 September 2009

Date of mailing of the international search report

09/10/2009

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2008/055696

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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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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