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Vehicle with AC outlet

Technical Field

The present invention relates to electric or plug-in hybrid motor vehicles having
5 a battery that may be charged by means of an external charging station. The
present invention primarily concerns land motor vehicles, but may also be used
for other hybrid or electrically driven vehicles, such as boats, ships or yachts.
The present invention especially concerns providing AC power to accessories
or equipment of the motor vehicle.

Background and Prior Art

Electric and plug-in hybrid motor vehicles usually comprise a charging
connector for receiving power from an external charging station. Charging
stations may include means for supplying electric DC power as well as electric
15 AC power. For receiving AC power, a plug-in hybrid vehicle may be provided
with a charger in the form of an AC/DC converter that converts the AC power
into DC power, which is supplied to, and charges, the battery of the hybrid
vehicle.

20 Land motor vehicles, such as cars, buses or trucks, usually include a low
voltage DC electric system, e.g. a 12 V or 24 V system, to power equipment
and accessories, such as for example lights, a stereo, a cooler, a heater. The
low voltage DC electric system has limited energy storage means. Electric and
hybrid motor vehicles usually include a second electric system at a higher DC
25 voltage, which is used for storing energy to power an electric machine or
electric motor of the vehicle. The second electric system is used for propelling
the vehicle and usually has a higher energy storing capacity than the low
voltage system.

30 Many electrical apparatuses run on AC power, such as 110 V or 220 V of AC
power. In order to use such apparatuses in a vehicle it is beneficial if the vehicle
is provided with AC power outlets. Such AC power outlets could be powered

with energy of the high voltage DC system provided an AC/DC converter is used to convert the DC power into AC power.

US 2007/0012492 (D1) describes a hybrid vehicle that selectively may output AC power to a load. The hybrid vehicle includes a battery or power storage (30 in D1) that can power an electric machine (17 in D1), by means of an AC/DC converter (32 in D1) that converts DC power from the battery into AC power for the electric machine (17), see figure 2 in D1. The hybrid vehicle of D1 also comprises a switch/power conditioning module (50 in figure 2) that may power a load (52 in figure 2). The switch/power conditioning module (50) includes a transformer, see §0044 of D1. D1 does however not describe a plug-in hybrid vehicle.

Moreover, the AC/DC converter used in D1 for powering the loads is the AC/DC converter used for powering the electric motor, and is as such probably specifically adapted for powering the electric motor and may not be ideal for powering other types of AC apparatuses.

Summary of Invention

An aim of the invention is to provide an alternative way for an electric or hybrid vehicle to supply AC power.

An aim of the invention is to provide an electric system for a motor vehicle that is better adapted for providing AC power than known systems.

A further aim of the invention is to provide a more versatile electric system for a motor vehicle that may output AC power in a variety of situations.

In accordance with a first aspect, the present invention provides an electric system for a motor vehicle. The electric system comprises an electric machine for propelling the motor vehicle, a battery for powering the electric machine, at least one charging connector provided with an AC connection for connection to

an external charging station, a first AC/DC converter having a DC side and an AC side, wherein the first AC/DC controller is:

- configured to receive AC power from the at least one charging connector,
- configured to convert the AC power into DC power, and
- 5 - configured to supply DC power, from its DC side, to the battery during charging of the battery from the external charging station.

The electric system further comprises at least one controller, which at least one controller is operatively connected to the first AC/DC converter and the charging
10 connector and which at least one controller is configured to control the electric system in a first mode of operation.

Especially, the electric system comprises at least one AC power outlet arranged between the charging connector and the AC side of the of the first AC/DC
15 converter, wherein the first mode of operation comprises receiving AC power from the charging connector during charging from an external charging station that supplies AC power, and supplying AC power to the at least one AC power outlet.

20 Thus, the electric system may provide AC power to the outlet or outlets directly from the external charging station, i.e. without any intermediate DC power steps, so that an AC power connection is established between the charging connector and the AC power outlet or outlets.

25 The motor vehicle may include an internal combustion engine, wherein the vehicle is a so called plug-in hybrid vehicle, but may also be a fully electrical vehicle.

In an embodiment of the first aspect, the first AC/DC converter is a bi-directional
30 converter and wherein the at least one controller is configured to control the electric system in at least one further mode of operation, which at least one further mode of operation comprises supplying AC power from the first AC/DC

converter to the at least one AC power outlet. Thus, the electric system may for example provide AC power to the power outlet or outlets also when the vehicle is not connected to an external charging station.

- 5 In an embodiment of the first aspect, the at least one charging connector is provided with a DC connection for connecting to an external charging station that supplies DC power.

- 10 In an embodiment of the first aspect, the electric system further comprises a current collector configured to receive DC power from overhead lines.

In an embodiment of the first aspect, the at least one further mode of operation comprises a second mode of operation comprising:

- 15 - receiving DC power, which DC power is received by means of either one of the at least one charging connector and the current collector,
- charging the battery, and
- simultaneously convert DC power into AC power by means of the first AC/DC converter.

- 20 Thus, the electric system may provide AC power to the AC power outlet or outlets also when being charged by DC power.

- 25 In an embodiment of the first aspect, the at least one further mode of operation comprises a third mode of operation comprising converting DC power from the battery to AC power by means of the first AC/DC converter. Thus, the electric system may provide AC power to the AC power outlet, or outlets, by using DC power of the battery.

- 30 In an embodiment of the first aspect, the at least one further mode of operation comprises a fourth mode of operation comprising powering the electric machine by converting DC power from the battery into AC power by means of the second AC/DC converter, and converting DC power from the battery to AC power by

means of the first AC/DC converter. Thus, the electric system may propel the vehicle by means of the electric machine simultaneously as supplying AC power to the AC power outlet, or outlets.

- 5 In an embodiment of the first aspect, the at least one further mode of operation comprises a fifth mode of operation comprising using the electric machine to retrieve power during travelling, convert the retrieved power into DC power by means of the second AC/DC converter, charging the battery with DC power from the second AC/DC converter, and converting DC power into AC power by
10 means of the first AC/DC converter. Thus, the electric system may provide AC power to the AC power outlet, or outlets, simultaneously as providing a re-generative charging of the battery.

- In an embodiment of the first aspect, the electric system is further provided with
15 an induction power receiver configured to receive electric power from an external source by means of induction, and to supply DC power to the battery, wherein the at least one further mode of operation comprises a sixth mode of operation comprising receiving power by means of the induction power receiver, charging the battery and simultaneously converting DC power into AC power by
20 means of the first AC/DC converter.

- In accordance with a second aspect, the present invention provides an electric or hybrid motor vehicle that includes an electric system according to the first aspect of the present invention.

25

In accordance with a third aspect, the present invention provides a method for controlling an electric system of a motor vehicle, which motor vehicle comprises:

- an electric machine for propelling the motor vehicle,
- 30 - a battery for powering the electric machine,
- at least one charging connector provided with an AC connection for connection to an external charging station,

- a first AC/DC converter having a DC side and an AC side.

The first AC/DC controller of the motor vehicle is configured to receive AC power from the at least one charging connector, is configured to convert the AC power into DC power and is configured to supply DC power to the battery during
5 charging of the battery with power from the external charging station. The electric system further comprises at least one AC power outlet arranged between the charging connector and the AC side of the of the first AC/DC converter. The method of the third aspect comprises controlling the electric system in a first mode of operation that comprises:

- 10 - receiving AC power from the charging connector during charging from an external charging station that supplies AC power, and
- supplying AC power to the at least one AC power outlet at the same time as supplying DC power to the battery.

- 15 The received AC power is supplied directly to the at least one AC power outlet without any intermediate conversion into DC power.

An embodiment of the third aspect, further comprises controlling the electric system in at least one further mode of operation, which at least one further
20 mode of operation comprises supplying AC power from the first AC/DC converter to the at least one AC power outlet.

In an embodiment of the third aspect, the at least one further mode of operation comprises a second mode of operation comprising

- 25 - receiving DC power, and
- converting DC power into AC power and supplying AC power to the at least one AC power outlet at the same as supplying DC power to the battery.

In an embodiment of the third aspect, the at least one further mode of operation
30 comprises a third mode of operation comprising

- converting DC power from the battery to AC power, and
- supplying the AC power to the at least one AC power outlet.

In an embodiment of the third aspect, the at least one further mode of operation comprises a fourth mode of operation comprising:

- converting DC power from the battery to AC power,
- 5 - supplying AC power to the at least one AC power outlet and at the same time supplying AC power the electric machine.

In an embodiment of the third aspect, the at least one further mode of operation comprises a fifth mode of operation comprising:

- 10 - retrieving power during travelling by using the electric machine as a generator, -converting the retrieved power into DC power and supplying DC power to the battery, and
- converting DC power into AC power and supplying AC power to the at least one AC power outlet.

15

The electric system is configured for performing the control method of a third aspect of the invention, and the motor vehicle of the second aspect may include an electric system that is configured to perform the method of the third aspect.

20 **Brief Description of Drawings**

Figure 1 illustrates parts of a motor vehicle in accordance with the present invention, especially the electric system of the vehicle;

Figures 2A-E illustrates different ways of controlling the electric system of the vehicle in order to power an AC outlet of the vehicle;

25 Figure 3 illustrate a control method for the electric system.

Description of Embodiments

Figure 1 shows parts of a motor vehicle, especially the electric system 1 of the motor vehicle. The motor vehicle comprises an electric machine 13 for
30 propelling the motor vehicle and may also comprise an internal combustion engine (not illustrated). The electric system 1 of the motor vehicle is provided with a battery 2 and a charging connector 7 for charging the battery 2. The

battery 2 has a voltage level of for example 400 V or 650 V. The charging connector 7 is a combined AC and DC connector configured for receiving AC power as well as DC power from an external charging station 20.

- 5 In an alternative embodiment (not illustrated), i.e. instead of the combined AC and DC charging connector 7, the electric system 1 comprises two separate charging connectors; one for AC power and one for DC power. As an alternative or in addition to the separate DC connector, and in addition to the separate AC connector, or to the combined connector 7, the electric system 1 may be
- 10 provided with other means (7A, 7B) for charging the battery 2. Figure 1 illustrate to such charging means in dashed lines;
- a current collector 7A configured to receive DC power from an overhead line 20A and supply DC power to the battery 2, and
 - an induction receiver 7B configured for receiving power by means of induction
- 15 from an inductive power source 20B, such as an inductive power source 20B provided in a road surface.

The current collector 7A that is configured to receive current from an overhead line system may for example comprise a one- or two-arm pantograph collector, a bow collector or a trolley pole.

20

The induction receiver 7B is configured to receive inductive power and transform the power into DC power that is supplied in the DC side of the electric system 1 to charge the battery 2.

25

The electric system 1 of figure 1 may preferably be adapted for receiving AC power at different voltage levels, three-phase AC as well as single-phase AC by means of the charging connector 7, for example single-phase 230 V AC and three-phase 400 V AC. The charging connector 7 is configured to receive DC

30 power of at least one voltage level, such as two different levels, for example at 400 V DC and 650 V DC. A DC/DC converter 11 is arranged electrically between the charging connector 7 and the battery 2 and configured for

converting DC power received at the charging connector 7 to the voltage level of the battery 2. The DC/DC converter 11 is arranged to selectively be connected between the charging connector 7 and the battery, and selectively bypassed when the DC power is received at the same voltage level as the voltage level of the battery 2.

The electric system 1 is provided with an AC/DC converter, or first AC/DC converter, 4 arranged electrically between the charging connector 7 and the battery 2, and which first AC/DC converter 4 is configured for converting AC power received at the charging connector 7 to DC power at the voltage level of the battery 2. The electric system 1 also includes a DC junction box 8 arranged to selectively connect the first AC/DC converter 4 to the battery 2.

The electric system 1 is further configured to supply power from the battery 2 to the electric machine 13. The battery 2 is connected to the electric machine 13 via the DC junction box 8 and a second AC/DC converter 12. The electric machine 13 may also act as a generator and retrieve AC electric power during driving and/or braking and feed this re-generated electric power to the battery 2 via the second AC/DC converter that converts the AC power to DC power, and via the DC junction box 8. Thus, the second AC/DC converter 12 is bi-directional.

The electric system 1 also includes an AC junction box 9 arranged electrically between the charging connector 7 and the first AC/DC converter 4. The electric system 1 further comprises a first AC outlet 5 and a second AC outlet 6 connectable to the first AC/DC converter 4 and/or the charging connector 7 by means of the AC junction box 9. Also the first AC/DC converter 4 is a bi-directional AC/DC converter 4 configured to receive AC as well as DC and supply DC and AC, respectively.

Both junction boxes 8, 9 are configured with relays and breakers to enable a selective power transfer between the devices. The electric system 1 further

includes a controller 10 that is operatively connected to the AC junction box 9, the DC junction box 8, the DC/DC converter 11, the first AC/DC converter 4 and the second AC/DC converter 12.

- 5 The DC junction box 8 is configured for selective power transfer between the battery 2, the DC side of the first AC/DC converter 4, the DC side of the second AC/DC converter 12, and the charging connector 7. The DC junction box 8 is either connected to the charging connector 7 directly, or via the DC/DC converter 11 (i.e. via the DC/DC converter 11 when the received DC power has
10 a different voltage level than the battery 2).

The AC junction box 9 is configured for selective interconnection of the charging connector 7, the AC side of the first AC/DC converter and the AC outlets 5, 6. Thus, the first AC outlet 5 and the second AC outlet 6 may selectively receive
15 power from either the AC side of the first AC/DC converter 4 or from the charging connector 7.

For ease of illustration, the controller 10 is illustrated as a central control system, but may be arranged as a plurality of electronic control units in a
20 distributed fashion among the different devices.

Figures 2A-2E illustrates different uses of the electric system 1 for providing AC power to the outlets 5, 6. These uses can be seen as different modes of operation; a first mode of operation illustrated in figure 2A, a second, third,
25 fourth and fifth mode of operation illustrated in figures 2B, 2C, 2D and 2E, respectively.

It should be note that the first AC/DC converter 4 is bi-directional and acts as:
- a battery charger in the first mode by converting AC power from the external
30 charging station into DC power, which is fed to the battery 2; and as

- an AC power supplier for the outlets 5, 6 in the second to fifth mode, by converting DC power into AC power, which is fed to the one or more of the outlets 5, 6.

- 5 In the second to fifth mode, the controller 10 controls the AC junction box 9 so that the AC connection of the charging connector 7 is disconnected, and no AC power is supplied to the charging connector 7 from the first AC/DC converter 4.

10 In the first mode of figures 2A, the motor vehicle is charged by receiving AC power from an external charging station 20, which AC power is received by the charging connector 7 and supplied in the AC side of the electric system to the outlets 5, 6 and the AC side of the first AC/DC converter 4 via the AC junction box 9. Thus, the AC power is fed without conversion to the outlets 5, 6, i.e. without AC conversion and without conversion into intermediate DC power.

- 15 Further, in the first mode, the first AC/DC converter 4 acting as a charger of the battery 2, converts AC power into DC power and supplies the DC power to the battery 2, via the DC junction box 8. The second AC/DC converter 12, and thereby the electric machine 13, is disconnected from the DC power by means of the DC junction box 8, as controlled by the controller 10.

20

- In the second mode, illustrated in figure 2B, the motor vehicle is charged by receiving DC power from an external charging station 20, which DC power is supplied to the battery 2. The DC power is supplied either directly to the battery 2, or in case the voltage level differs from the voltage level of the battery, via the
25 DC/DC converter 11 that converts the DC power into the voltage level of the battery 2. The controller 10 is configured to connect the DC power (i.e. the DC power of the voltage level of the battery) to the DC side of the first AC/DC converter 4. The first AC/DC converter converts the DC power into AC power which is fed, via the junction box 9, to one or more of the outlets 5, 6.

30

The motor vehicle may be provided with a PTO, or power take-off, (not illustrated) which may be propelled by the electric machine 13, or the internal

combustion engine. Thus, in addition to charging the battery 2 in the first and second mode, the electric machine 13 may be supplied with electric power and power the PTO, as indicated by broken arrows in figures 2A and 2B. The electric machine should never drive the wheels of the vehicle during charging
5 from an external charging station 20, and the gearbox may preferably be locked in the neutral or in a parking brake position. The PTO may include a PTO shaft connected via a separate additional gearbox (not illustrated).

In the first and the second mode, the motor vehicle is charged by means of an
10 external charging station 20, whereas in the third, fourth and fifth mode, the motor vehicle is not charged by an external charging station 20, i.e. does not receive power from any external charging station, and the charging connector is not connected to any external power source. Moreover, in the third, fourth and fifth mode the controller 10 is configured to disconnect the charging connector
15 7, or keep the charging connector 7 disconnected, from the other parts of the electric system.

In the third mode and fourth modes, illustrated in figures 2C and 2D, one or more of the outlets 5, 6 is supplied with power originating from the battery 2,
20 which power is converted into AC power by means of the first AC/DC converter 4.

In the third mode, the electric machine is not used, whereas in the fourth mode, the electric machine 13 is used as a motor to propel the motor vehicle. For
25 instance, the third mode of operation can be used when the motor vehicle is parked or propelled by an internal combustion engine (if the motor vehicle has such an engine).

In the fifth mode, the electric machine 13 is used as a generator for retrieving
30 power when the motor vehicle is travelling, e.g. being driven or during braking, and thus the fifth mode provides a re-generative mode wherein power is supplied from the electric machine 13, via the second AC/DC converter 12 to

charge the battery 2. The AC/DC converter 4 is operated in the same way as in the second to fourth modes and converts DC power into AC power which is supplied to at least one of the outlets 5, 6.

5 Since, the first AC/DC converter 4 acts as an AC power supplier in the second to fifth mode, and converts the DC power received at its DC side into AC power for the outlets 5, 6, the first AC/DC converter 4 does not need to change its operation when the motor vehicle switches between any of the second to fifth mode. However, when the motor vehicle switches between operation in the first
10 mode and any other mode the controller 10 is configured to temporarily inactivate the first AC/DC converter 4 during the mode switch. For example, when the first AC/DC converter acts in any mode as a AC power supplier, and the charging connector 7 is being connected by the driver to an external charging station 20 that supplies AC power, the controller 10 is configured to
15 temporarily inactivate the AC/DC converter 4 so that no power is fed from the AC/DC converter before establishing a power connection from the charging connector 7 to any of the outlets 5, 6 and the AC side of the first AC/DC converter 4.

20 Figure 3 illustrate a control method for the electric system 1. The control method 200 comprises a first mode of operation 201 that includes
- receiving AC power (201a) from the charging connector (7) during charging from an external charging station (20) that supplies AC power, and
- supplying AC (201b) power to the at least one AC power outlet (5, 6) at the
25 same time as supplying DC power to the battery (2).

The control method 200 comprises further modes of operation 202-206 that includes supplying 210 AC power from the first AC/DC converter (4) to the at least one AC power outlet (5, 6). The further modes of operation include a second 202, third 203, fourth 204, fifth 205 and sixth 206 mode of operation.

30 The second mode of operation 202 comprises

- receiving 202a DC power and charging the battery 2, and

- converting 202b DC power into AC power.

In the second mode, the AC power is supplied to the at least one AC power outlet 5, 6 at the same as DC power is supplied to the battery 2.

5 The third mode of operation 203 comprises:

- converting 203a DC power from the battery 2 to AC power, and
- supplying 203b the AC power to the at least one AC power outlet 5, 6.

Thus, in the third mode of operation 203, the power outlets 5, 6 are powered by the battery 2.

10

The fourth mode of operation 204 comprises:

- converting 204a DC power from the battery 2 into AC power for the electric machine and into AC power for at least one outlet,
 - supplying 204b AC power to the at least one AC power outlet 5, 6 and at the
- 15 same time supplying AC power the electric machine 13.

Thus, in the fourth mode of operation 204, the power outlets 5, 6 and the electric machine 13 are powered by the battery 2.

The fifth mode of operation 205 comprises:

- 20 - retrieving 205a power during travelling by using the electric machine 13 as a generator;
 - converting 205b the retrieved power into DC power and supplying DC power to the battery 2, and
 - converting 205c DC power into AC power and supplying AC power to the at
- 25 least one AC power outlet 5, 6.

Thus, in the fifth mode of operation, the electric machine 13 is used for re-generative charging of the battery with retrieved power. Retrieved power is also used for powering the AC power outlet or outlets 5, 6, wherein the retrieved power is first converted from AC power, of the electric machine 13, to DC power

30 and thereafter converted from DC power to AC power for the outlets.

The sixth mode of operation 206 comprises receiving 206a power by means of the induction power receiver (7B), charging 206b the battery (2) and simultaneously converting DC power into AC power by means of the first AC/DC converter (4).

5

An electric system 1 for a motor vehicle and a method for controlling the electric system has been described in embodiments. The electric system 1 comprises an electric machine 13, a battery 2 for powering the electric machine 13, at least one charging connector 7 provided with an AC connection for connection to an external charging station 20, a first AC/DC converter 4 configured to receive AC power from the at least one charging connector 7, to convert the AC power into DC power and to supply DC power to the battery 2 during charging. The at least one AC power outlet 5, 6 is arranged between the charging connector 7 and the AC side of the of the first AC/DC converter 4, wherein in a first mode of operation the electric system receives AC power by means of the charging connector 7 and supply AC power directly to the at least one AC power outlet. In further modes of operation, the first AC/DC converter is used to power the at least one AC power outlet 5, 6.

The present invention is however not limited to these embodiments. Rather these embodiments are examples for providing the present invention. A person skilled in the art will appreciate that the electric system, the method and the motor vehicle may be provided in further embodiments within the scope of the claims.

25

Claims

1. An electric system (1) for a motor vehicle comprising an electric machine (13) for propelling the motor vehicle, a battery (2) for powering the electric machine (13), at least one charging connector (7) provided with an AC connection for connection to an external charging station (20), a first AC/DC converter (4) having a DC side and an AC side, wherein the first AC/DC converter is configured to receive AC power from the at least one charging connector (7), to convert the AC power into DC power and to supply DC power to the battery (2) during charging, and wherein the electric system comprises at least one controller (10), which at least one controller (10) is operatively connected to the first AC/DC converter (4) and the charging connector (7) and which at least one controller (10) is configured to control the electric system (1) in a first mode of operation,

characterized in comprising at least one AC power outlet (5, 6) arranged between the charging connector (7) and the AC side of the first AC/DC converter (4), wherein the first mode of operation comprises receiving AC power by means of the charging connector (7), and supplying AC power to the at least one AC power outlet (5, 6).

2. An electric system (1) according to claim 1, wherein the first AC/DC converter (4) is a bi-directional converter and wherein the at least one controller (10) is configured to control the electric system in at least one further mode of operation, which at least one further mode of operation comprises supplying AC power from the first AC/DC converter (4) to the at least one AC power outlet (5, 6).

3. An electric system (1) according to claim 2, wherein the at least one charging connector (7) is provided with a DC connection for connecting to an external charging station (20) that supplies DC power.

4. An electric system (1) according to claim 2 or 3, further comprising a current collector (7A) configured to receive DC power from overhead lines (20A).

5 5. An electric system (1) according to claim 3 or 4, wherein the at least one further mode of operation comprises a second mode of operation comprising receiving DC power by means of either one of the at least one charging connector (7) and the current collector (7A), charging the battery (2), and simultaneously convert DC power into AC power by means of the first
10 AC/DC converter (4).

6. An electric system (1) according to any of claims 2 to 5, wherein the at least one further mode of operation comprises a third mode of operation comprising converting DC power from the battery (2) to AC power by means of
15 the first AC/DC converter (4).

7. An electric system (1) vehicle according to any of claims 2 to 6, wherein the at least one further mode of operation comprises a fourth mode of operation comprising powering the electric machine (13) by converting DC
20 power from the battery (2) into AC power by means of the second AC/DC converter, and converting DC power from the battery (2) to AC power by means of the first AC/DC converter (4).

8. An electric system (1) vehicle according to any of claims 2 to 7,
25 wherein the at least one further mode of operation comprises a fifth mode of operation comprising using the electric machine (13) to retrieve power during travelling, convert the retrieved power into DC power by means of the second AC/DC converter (12), charging the battery (2) with DC power from the second AC/DC converter (12), and converting DC power into AC power by means of the
30 first AC/DC converter (4).

9. An electric system (1) vehicle according to any of claims 2 to 8, further provided with an induction power receiver (7B) configured to receive electric power from an external source (20B) by means of induction, and to supply DC power to the battery (2), wherein the at least one further mode of operation comprises a sixth mode of operation comprising receiving power by means of the induction power receiver (7B), charging the battery (2) and simultaneously converting DC power into AC power by means of the first AC/DC converter (4).

10. A motor vehicle comprising an electric system according to any of claims 1 to 9.

11. A method for controlling an electric system (1) of a motor vehicle, which motor vehicle comprises an electric machine (13) for propelling the motor vehicle, a battery (2) for powering the electric machine (13), at least one charging connector (7) provided with an AC connection for connection to an external charging station (20), a first AC/DC converter (4) having a DC side and an AC side, wherein the first AC/DC converter is configured to receive AC power from the at least one charging connector (7), configured to convert the AC power into DC power and to supply DC power to the battery (2) during charging of the battery (2) from the external charging station (20), and which electric system (1) comprises at least one AC power outlet (5, 6) arranged between the charging connector (7) and the AC side of the of the first AC/DC converter (4), wherein said method comprises controlling the electric system (1) in a first mode of operation (201) that comprises:

- receiving AC power (201a) from the charging connector (7) during charging from an external charging station (20) that supplies AC power, and
- supplying AC (201b) power to the at least one AC power outlet at the same time as supplying DC power to the battery (2).

12. The method for controlling an electric system (1) of a motor vehicle according to claim 11, said method further comprising controlling the electric

system in at least one further mode of operation, which at least one further mode of operation comprises supplying AC power from the first AC/DC converter (4) to the at least one AC power outlet (5, 6).

5 13. The method for controlling an electric system (1) of a motor vehicle according to claim 12, wherein the at least one further mode of operation comprises a second mode of operation (202) comprising

- receiving (202a) DC power, and
- converting (202b) DC power into AC power and supplying AC power to the at

10 least one AC power outlet (5, 6) at the same as supplying DC power to the battery (2).

14. The method for controlling an electric system (1) of a motor vehicle according to claim 12 or 13, wherein the at least one further mode of operation

15 comprises a third mode of operation (203) comprising

- converting (203a) DC power from the battery (2) to AC power, and
- supplying (203b) the AC power to the at least one AC power outlet (5, 6).

15. The method for controlling an electric system (1) of a motor vehicle

20 according to any of claims 12 to 14, wherein the at least one further mode of operation comprises a fourth mode of operation (204) comprising:

- converting (204a) DC power from the battery (2) to AC power,
- supplying (203b) AC power to the at least one AC power outlet (5, 6) and supplying AC power the electric machine (13).

25

16. The method for controlling an electric system (1) of a motor vehicle according to any of claims 12 to 15, wherein the at least one further mode of operation comprises a fifth mode of operation (205) comprising-

- retrieving (205a) power during travelling by using the electric machine (13) as

30 a generator,

- converting (205b) the retrieved power into DC power and supplying DC power to the battery (2), and

- converting (205c) DC power into AC power and supplying AC power to the at least one AC power outlet (5, 6).

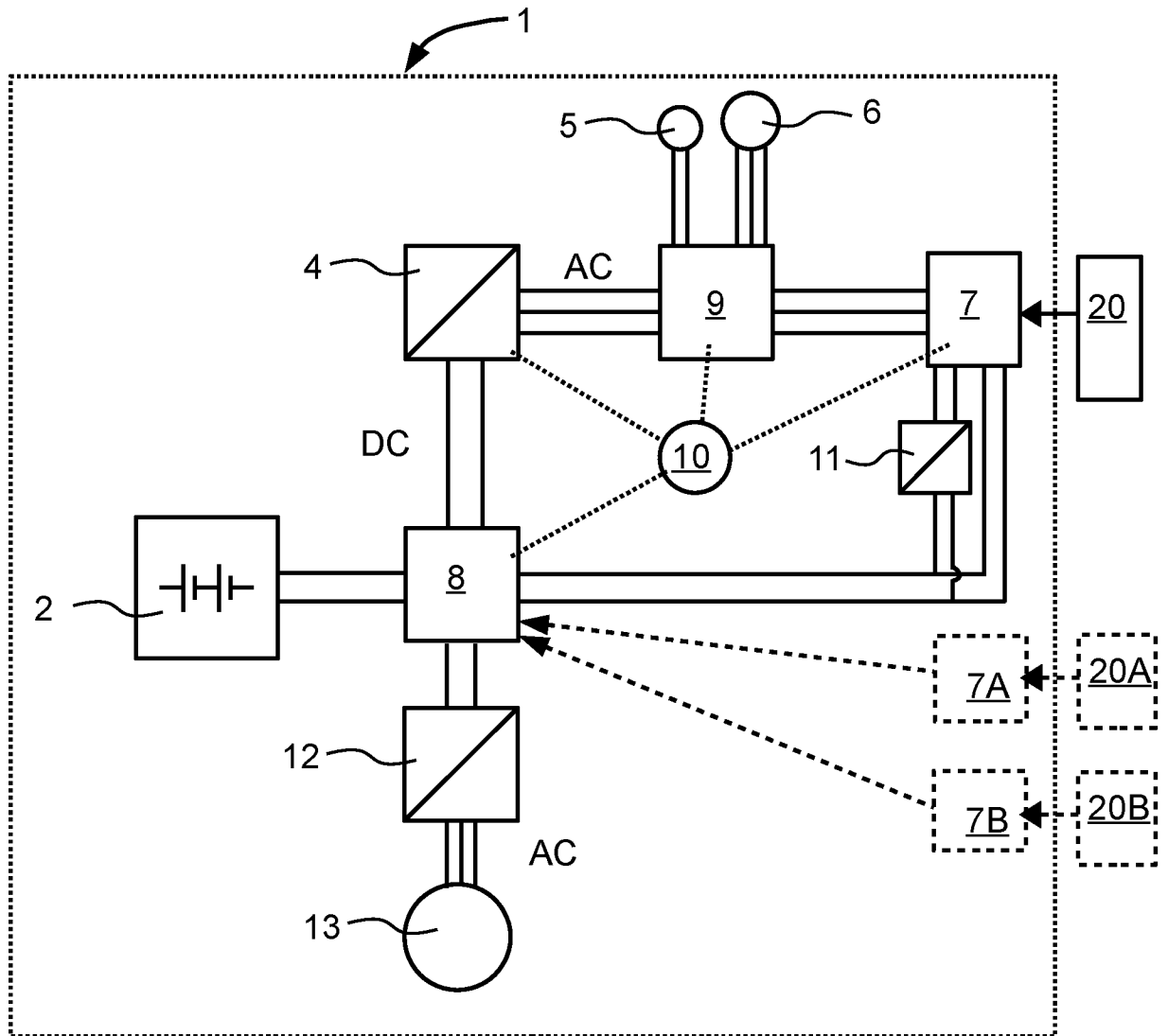


Fig. 1

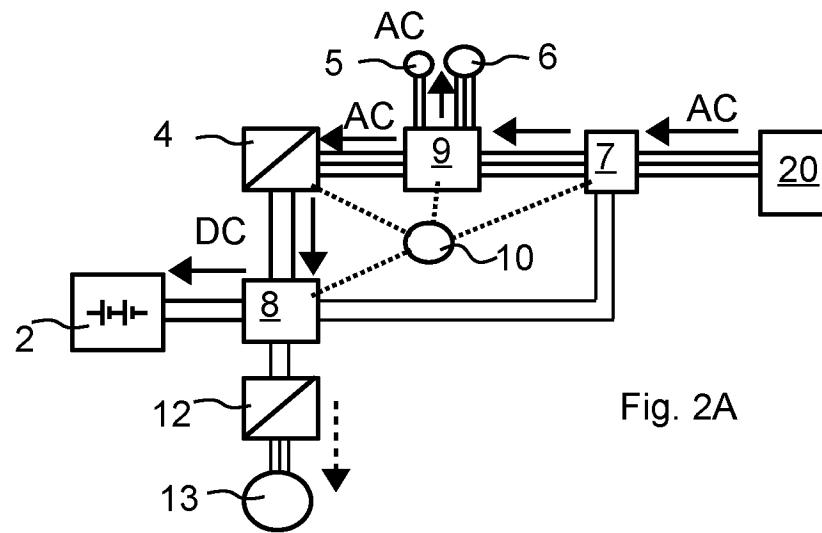


Fig. 2A

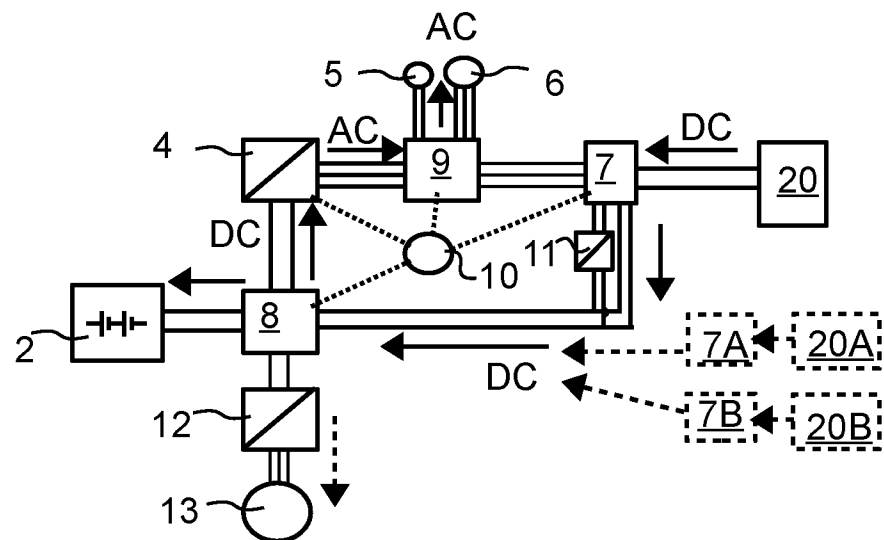
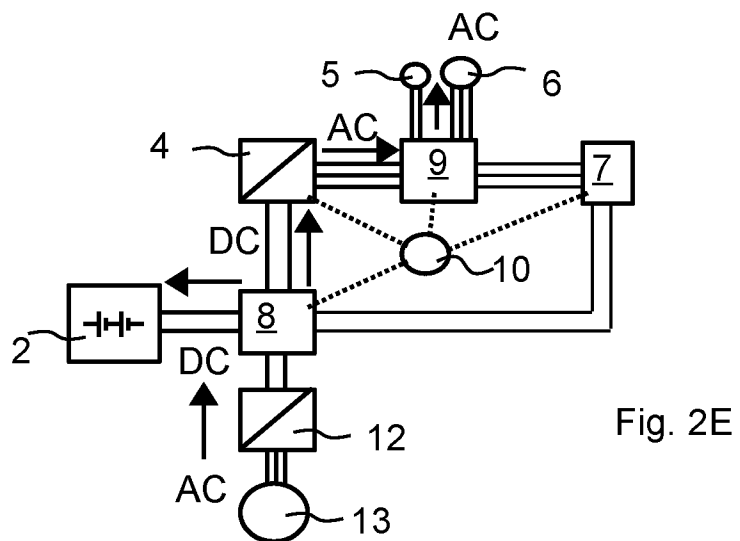
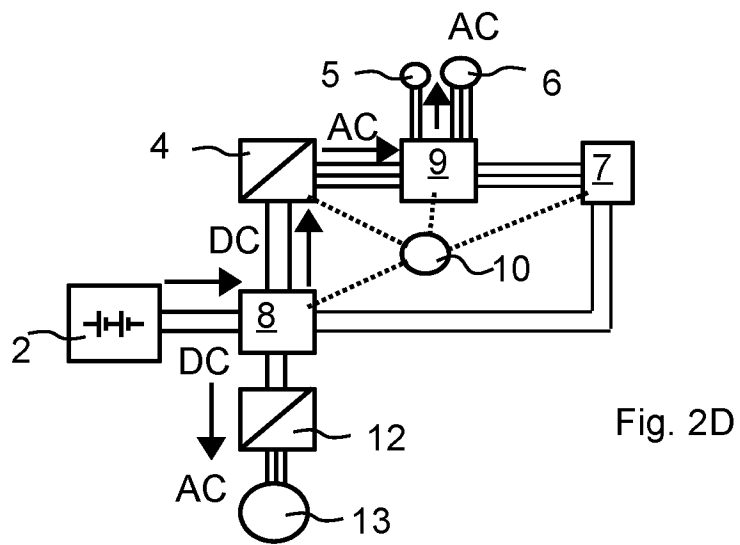
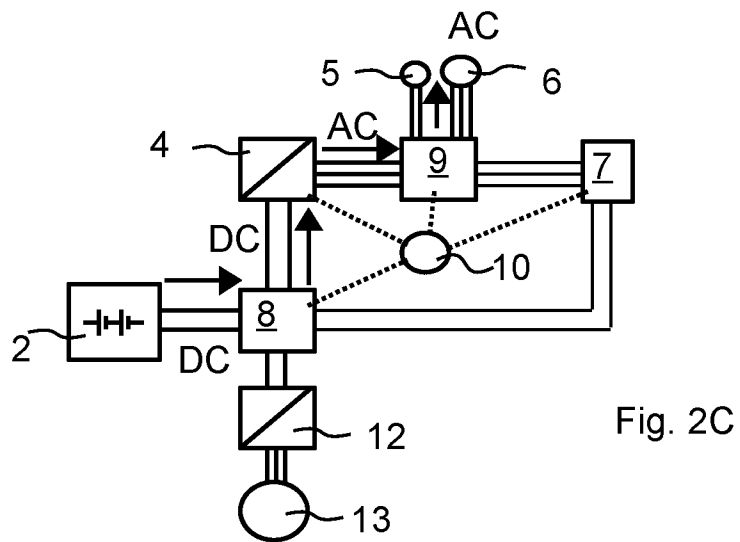


Fig. 2B



200. Control Method

201. First mode of operation
201a receive AC power
201b supply AC power directly to the outlets

210. Further modes including:
Supplying power to the outlets by means of
AC/DC converter

202. Second mode of operation
202a Receive DC and charge battery
202b Convert DC to AC for outlets.

203. Third mode of operation
203a Convert DC from battery into AC
203b Supply AC to outlets

204. Fourth mode of operation
204a Convert DC from battery into AC
204b Supply AC to machine 13 and outlets

205. Fifth mode of operation
205a Retrieve power
205b Convert power to DC (for the battery)
205c Convert DC to AC for outlets

206. Sixth mode of operation
206a Receive inductive power
206b Charge battery and power the outlets

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050683

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B60R, B63H, B63J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, 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	WO 2008113999 A1 (CUMMINS GENERATOR TECHNOLOGIES ET AL), 25 September 2008 (2008-09-25); page 11, line 5 - page 14, line 7; figures 1,2	1-2, 6-8, 10-12, 14-16
A	--	3-5, 9, 13
A	WO 2008063612 A2 (CUMMINS POWER GENERATION IP IN ET AL), 29 May 2008 (2008-05-29); abstract; figure 1	1-16
A	US 8043132 B1 (WYANT JOHN W), 25 October 2011 (2011-10-25); abstract; figure 7	1-16
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 21-08-2017	Date of mailing of the international search report 23-08-2017
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Tomas Erlandsson Telephone No. + 46 8 782 28 00

Continuation of: second sheet

International Patent Classification (IPC)

B60R 16/033 (2006.01)

B63H 21/00 (2006.01)

B63J 3/04 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2017/050683

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			US	20100105259 A1	29/04/2010
WO	2008063612 A2	29/05/2008	NONE		
US	8043132 B1	25/10/2011	NONE		