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(71) **Applicant**: **JAGUAR LAND ROVER LIMITED** [GB/GB]; Abbey Road, Whitley, Whitley, Coventry Warwickshire CV3 4LF (GB).

(72) **Inventors**: **WHITE, David**; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB). **GREENWOOD, Jeremy**; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB). **CLARKE, Chris**; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB). **PARKINS, Richard**; c/o Jaguar Land Rover, Patents Department W/1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

(74) **Agent**: **HOLMES, Matthew**; Jaguar Land Rover, Patents Department W /1/073, Abbey Road, Whitley, Coventry Warwickshire CV3 4LF (GB).

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(54) **Title**: VEHICLE WITH WIRELESSLY POWERED DEVICE

(57) **Abstract**: A vehicle having a wirelessly powered electrical device, a secondary inductive receiver is provided for drawing electrical power from a base station; whilst a primary inductive receiver is aligned with an inductive transmitter of the base station.

VEHICLE WITH WIRELESSLY POWERED DEVICE

TECHNICAL FIELD

The present invention relates to a system for powering a device on a vehicle and method of powering a device on a vehicle and particularly, but not exclusively, to a method of, and system for inductively coupling a heater to an external power supply. Aspects of the invention relate to a system, to a vehicle and to a method.

BACKGROUND

It is known to provide vehicles with a traction battery for propulsion of the vehicle when coupled to an electric drive motor; such traction batteries require charging. It is desirable to wirelessly couple the vehicle to a charging station; such systems may employ inductive coupling between a pair of coils or arranging elements to charge the traction battery.

It is against this background that the present invention has been conceived. Embodiments of the invention may provide a system, a vehicle or a method which provides an improvement in the field of inductively coupled power supply systems that has particular application for vehicles. Other aims and advantages of the invention will become apparent from the following description, claims and drawings. The invention may be utilised in applications other than for vehicles.

SUMMARY

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

According to one aspect of the invention for which protection is sought, there is provided a system for electrically powering a vehicle component of a vehicle when docked at a base station, the vehicle comprising a traction battery and a vehicle component, and the system comprising a first inductive receiver for inductively coupling with a inductive transmitter of the base station, the first inductive receiver being electrically coupled to a vehicle component such that electric power is transferred directly to the vehicle component from the base station when the base station is operational.

This has the advantage that a vehicle component such as a heater may be powered directly from a base station rather than via one of the vehicle's power systems.

Advantageously, in embodiments where the vehicle comprises a battery which is being charged from the base station, the vehicle component being powered directly by the base station does not drain power from the vehicle's power systems during a charging cycle such that the charging rate or charging time in not increased.

Optionally, the vehicle comprises a second inductive receiver coupled to the traction battery of the vehicle, the second inductive receiver being substantially aligned with the inductive transmitter for charging the traction battery.

Optionally, when the second inductive receiver is substantially aligned with the inductive transmitter, the first inductive receiver is misaligned with the inductive transmitter of the base station.

Optionally, the first inductive receiver additionally provides electric power to a vehicle battery whereby charging the vehicle battery.

Optionally, the first inductive receiver or second inductive receiver is in vertical alignment with the inductive transmitter. Alternatively, the second inductive receiver is in vertical alignment with the inductive transmitter.

Optionally, one of the first or second inductive receivers is aligned with respect to the inductive transmitter to maximise coupling efficiency between said one of the first or second inductive receivers and inductive transmitter.

In some embodiments the vehicle component is an electrical device and is powered independently of the vehicle battery and/or battery charging system.

Optionally, the vehicle component is an electric heater thermally coupled to a further vehicle component.

Optionally, the inductive receiver is thermally coupled to the vehicle component and has an electrical resistance which generates heat when current flow is induced in the receiver so as to heat the vehicle component. Optionally, the inductive receiver comprises the vehicle component. The inductive receiver may be powered independently of the vehicle battery and/or battery charging system.

According to another aspect of the invention for which protection is sought, there is provided a method of powering a vehicle component comprising;

providing a vehicle which comprises an inductive receiver, a traction battery and a vehicle component;

placing the inductive receiver within range of an inductive transmitter of a base station;

transferring electrical power from the inductive transmitter to the inductive receiver by inducing current flow in the inductive receiver, and

powering a vehicle component directly from the inductive receiver with at least a portion of the electrical power transferred to the inductive receiver.

Optionally, the method comprises;

aligning the inductive receiver with the inductive transmitter of the base station;

wherein optimising power transfer from the inductive transmitter to the inductive receiver.

Optionally, the method comprises;

providing the vehicle with a second inductive receiver;

placing the second inductive receiver within range of an inductive transmitter of a charging station;

transferring electrical power from the inductive transmitter to the second inductive receiver by inducing current flow in the second inductive receiver, and

charging the vehicle battery with the electrical power transferred to the second inductive receiver.

Optionally, the method comprises;

aligning the second inductive receiver with the inductive transmitter of a charging station;

wherein optimising power transfer from the inductive transmitter to the second inductive receiver for maximising the charging efficiency of the vehicle battery.

According to a further aspect of the invention for which protection is sought, there is provided a method of powering a vehicle component comprising:

providing an electric vehicle having a first inductive receiver and a second inductive receiver;

placing the first inductive receiver within range of an inductive transmitter of a charging station;

inducing a first electric current in the first inductive receiver for charging a traction battery of the vehicle;

inducing a second electric current in a second inductive receiver disposed on a vehicle component so as to provide electrical power directly to the vehicle component from the charging station whilst charging the traction battery.

Optionally, placing the first inductive receiver within range of the inductive transmitter of the charging station comprises substantially aligning the first inductive receiver with the inductive transmitter and placing the second inductive receiver within range of the inductive transmitter.

According to a still further aspect of the invention for which protection is sought, there is provided a kit of parts for a vehicle, the vehicle comprising a traction battery, the kit of parts comprising:

a first inductive receiver; and

a vehicle component,

the first inductive receiver being attachable to the vehicle such that when the vehicle is docked at a base station the first inductive receiver is suitable for inductively coupling with an inductive transmitter of the base station, and the vehicle component being attachable to the vehicle such that the first inductive receiver is electrically coupled to the vehicle component such that electric power from the first inductive receiver is transferred directly to the vehicle component.

Optionally, the vehicle component may be a heater.

According to a still further aspect of the invention, there is provided a method of heating a vehicle component comprising;

providing a vehicle having a inductive receiver thermally mounted on a vehicle component;

placing the inductive receiver within range of an inductive transmitter of a base station;

inducing an electric current in the inductive receiver by inductive coupling the inductive receiver with the inductive transmitter;

passing the electric current through an electrical resistance to generate heat, and

transferring the heat to the vehicle component.

According to yet a further aspect of the invention for which protection is sought, there is provided a heater for a vehicle wherein the heater comprises an inductive receiver for coupling with an inductive transmitter of a base station, wherein the inductive receiver draws electrical power from the base station for heating a vehicle component.

Optionally, the inductive receiver is thermally coupled to the vehicle component, the inductive receiver having an electrical resistance which generates heat when current flow is induced in the inductive receiver which heat is transferred to said vehicle component.

Alternatively, the inductive receiver is electrically coupled to an electric heater provided for heating the vehicle component, the inductive receiver powering the electric heater directly from the base station.

According to yet another aspect of the invention for which protection is sought, there is provided a vehicle comprising a vehicle system for electrically powering a vehicle component comprising; a first inductive receiver for coupling with an inductive transmitter of a base station wherein an electrical device or system is coupled to the first inductive receiver for being electrically directly powered by the base station.

Optionally, the vehicle is an electric vehicle comprising a traction battery for propulsion of the vehicle.

Optionally, the first inductive receiver is also coupled to the traction battery for charging thereof.

The vehicle may comprise a second inductive receiver coupled to the traction battery for charging thereof.

Optionally, the electrical device or system is coupled to the first inductive receiver such that an electrical current induced in the first inductive receiver powers the electrical device or system.

Optionally, the second inductive receiver is coupleable to the inductive transmitter of the base station simultaneously with the first inductive receiver.

The first inductive receiver may be coupled to any electrical device or system of the vehicle which would otherwise be powered by the battery or battery charging system when the vehicle is uncoupled from the base station.

The vehicle component may be an electrical device and may be powered independently of the vehicle battery and/or battery charging system.

Advantageously, the base station, preferably simultaneously, provides electrical power to one or more components of the vehicle, whilst charging the battery, which electrical power is converted into heat by the inductive receiver; this removes the need for a separate heater component thereby reducing the number of components and vehicle weight improving fuel efficiency.

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. For example, features described in connection with one embodiment are applicable to all embodiments, unless such features are incompatible.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIGURE 1 is a schematic side view of a vehicle according to an embodiment of the invention;

FIGURE 2 is a schematic side view according to another embodiment of the invention; and

FIGURE 3 is a schematic side view according to a further embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Detailed descriptions of specific embodiments of the inductively coupled power supply system, methods and vehicles of the present invention are disclosed herein. It will be understood that the disclosed embodiments are merely examples of the way in which certain aspects of the invention can be implemented and do not represent an exhaustive list of all of the ways the invention may be embodied. Indeed, it will be understood that the inductively coupled power supply system, methods and vehicles described herein may be embodied in various and alternative forms. The figures are not necessarily to scale and some features may be exaggerated or minimised to show details of particular components. Well-known

components, materials or methods are not necessarily described in great detail in order to avoid obscuring the present disclosure. Any specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the invention.

General aspects of the invention provide a mechanism for providing electrical power or heat energy to parts of a vehicle that preferably though nevertheless optionally comprises an electric traction battery.

Aspects of the invention are not limited in their application to fully electric or hybrid vehicles, (though it is expected that most advantage will be gained in such applications). For example, in colder climates where vehicle cabin heating, vehicle component heating and vehicle lubricant heating are required, an electrically powered heater and or a heat-generating inductive element may be installed on a non-electric (or electric or hybrid) vehicle.

In such an arrangement a vehicle can be positioned relative to a base or charging station for wirelessly and inductively transferring electrical power to a charging coil of an electric traction battery and rather than (or in addition to) the electric traction battery being charged (also referred to as supplied with electric energy), a power source for an electrically powered heater and/or a heat generating inductive element may be charged (or supplied with electrical energy). It is further envisaged that in a wider application one or more inductively operated electrical power receiving elements may be provided on a vehicle (in addition to or alternative to a traction battery charging coil) for powering a variety of vehicle components.

Figure 1 illustrates a vehicle 10 comprising a traction battery 12 coupled to an electric drive motor (not shown) for providing propulsion to the vehicle 10. Optionally, vehicle 10 additionally comprises an internal combustion engine 20 for providing propulsion to the vehicle 10. Traction battery 12 is charged using a charging system 9. Vehicle 10 comprises a first coil 14 which is coupled to the traction battery 12.

First coil 14 is mounted to or proximate to the underside of the body 11 of the vehicle 10. In alternative embodiments alternative locations are envisaged for example in the front or rear bumpers, behind the front grille, on or within a body panel of the vehicle 10.

The charging system 9 comprises the first coil 14 and a second coil 16. The second coil 16 is located externally and remotely from the vehicle 10. In the illustrated embodiment the second coil 16 is disposed at ground level beneath the vehicle 10 for co-operation with the first coil 14 that is optionally mounted on or to the underside of the vehicle body 11. In other envisaged embodiments, the second coil 16 may be located in, and/or on a wall or post. The second coil 16 is coupled to a control unit 18, which is coupled to a power supply (not shown) such as mains electricity supply. Together the control unit 18, power supply and the second coil 16 form a charging station 8. The first coil 14 is inductively coupled to the second coil 16 of the charging station 8, when the first and second coils 14, 16 are sufficiently aligned with one another and electrical current is passed through the second coil 16.

Electrical current is passed through the second coil 16, creating a magnetic field F. The presence of first coil 14 in the magnetic field F inductively couples the first coil 14 to the second coil 16, thus causing electrical current to flow in the first coil 14. This induced current flow can be utilised to charge or recharge the traction battery 12. In order to optimise charging efficiency the first and second coils 14, 16 are optionally, vertically aligned. The physical alignment is dependent upon the shape or configuration of the magnetic field F created by passing electrical current through the second coil 16.

The vehicle 10 comprises a control unit 15 coupled to the first coil 14, the control unit 15 being capable of communicating with the charging station 8 via the first coil 14, for example by modulating a signal on an electric current in the first coil 14 so as to influence or change the magnetic field F which change is detected by the controller unit 18 at the charging station 8. In this way, the charging station 8 can determine that the vehicle 10 is a legitimate receiver of energy from the charging station 8. The control unit 15 may also instruct the charging system 9 to shut down or reduce the current flow in the first coil 14 when the traction battery 12 has attained a predefined state of charge. Alternative to terminating current flow to the second coil 16, the control unit 15 may be configured to electrically disconnect the first coil 14 from the traction battery 12 to prevent overcharging or overheating.

It is envisaged that communications between the charging station 8 and the vehicle 10 will be two-way, that is to say the vehicle 10 may send information to the charging station 8 and the charging station 8 may send information to the vehicle 10, which information may be displayed to the driver. For example the charging station 8 may convey billing information to

the driver, the vehicle 10 may convey information necessary for invoicing the driver or vehicle owner to the charging station 8.

In the presently described optional embodiment, the vehicle 10 comprises a third coil 22 disposed on the engine 20, optionally on the engine block or oil sump. The third coil 22 is configured to be inductively coupleable to the second coil 16 of the charging station 8.

Third coil 22 is misaligned, which is to say, it is not physically or electrically aligned or positioned necessarily to optimise the coupling efficiency, with respect to the second coil 16 of the charging station 8.

Current flow is induced in the third coil 22, by the second coil 16 of the charging station 8 optionally but preferably at the same time as the second coil is used to charge first coil 14. Due to the electrical resistance of the third coil 22, heat is generated in the third coil 22 by the induced current flow. This heat is transferred to the engine 20, in particular the engine block (not shown). The heat transferred, in turn heats lubricants contained within the engine 20.

The material from which the third coil 22 is made and the shape and configuration of the third coil 22 may be varied so as to charge the thermal and/or electrical characteristics of the third coil 22.

In alternative embodiments it is envisaged that more than one third coil 22 may be provided and such heating coils may be provided on other vehicle components, for example, but not limited to: screen wash reservoir bottle, radiator pack, coolant reservoir, power steering or brake fluid reservoirs, or cabin heater components.

In other embodiments of the invention the traction battery 12 may be omitted and the vehicle 10 may be propelled by an internal combustion engine or other suitable means; in such embodiments the first coil 14 may be omitted or may be used to provide power to an alternative device for example cabin heater in such embodiments the first coil 14 may be coupled to, or mounted on the cabin heater instead of being coupled to the traction battery 12. In embodiments in which the first coil 14 is omitted the third coil 22 may be aligned with the second coil 16 of the base or charging station 8.

Referring now to Figures 2 and 3 there are shown alternative embodiments of the charging system 9 of the present invention. In the alternative illustrated embodiments, like numerals

have, where possible, been used to denote like parts, albeit with the addition of the prefix "100" and "200" to indicate that these features belong to the alternative embodiments respectively.

Figure 2 illustrates another embodiment of the present invention, a vehicle 110 comprises a traction battery 112 coupled to a first coil 114. First coil 114 is inductively coupled to a second coil 116; second coil 116 forms part of a charging station 108. Alignment (physical and/or electrical) of the first and second coils 14, 16 with respect to one another has been optimised to maximise electrical coupling efficiency.

Vehicle 110 comprises an internal combustion engine 20 having an engine block to which an electric heater 124 is mounted. Electric heater 124 is electrically coupled to first coil 114; such that electric heater 124 draws electrical power from the charging station 108 via the first coil 114. A control unit 115 controls communications between the vehicle 110 and the charging station 108, such that the charging station 108 may control the current flow in the second coil 116 so as to control the magnitude of the current flow induced in the first coil 114. Thus the control unit 115 is configured to also control the electrical energy transferred to the traction battery 112 and to the electric heater 124 via its electrical coupling to the first coil 114. For example, the control unit 115 may be configured to prevent overcharging of the battery 112 or overheating of the engine components and/or to variably control the rate of charging and heating.

Figure 3 illustrates a further embodiment of the present invention in which a vehicle 210 comprises a traction battery 212 coupled to a first inductive coil 214. Charging station 208 comprises a second coil 216 and a control unit 218 is coupled to a power supply (not shown). Vehicle 210 comprises an internal combustion engine 220 having an electrical heater 224 mounted thereto. Electrical heater 224 is electrically coupled to a third inductive coil 222.

Third coil 222 is optionally located underneath the vehicle body 211 substantially adjacent or proximate to the first coil 214. Third coil 222 is inductively coupled to the second coil 216 by the magnetic field F created by passing electrical current through second coil 216. The inductive coupling between third coil 222 and second coil 216 induces current flow in the third coil 222, which electrical current flow is used to power the electric heater 224 to which it is coupled.

It can be appreciated that various changes may be made within the scope of the present invention, for example, in other embodiments of the invention it is envisaged that the coils may be replaced with other structures suitable for inductive electrical power transfer, for example plates, wires or pipes.

In yet other embodiments the vehicle component may be configured in shape, size composition material and/or position within the vehicle such that it inherently inductively couples with the charging station. For example a container for lubricant such as oil may be formed within an embedded wire or coil therein and/or the container maybe formed of a metallic material.

In further embodiments of the invention the vehicle 10, 110, 210 may be fully electric and it will be understood that the combustion engine may be omitted.

In further embodiments, the invention comprises an apparatus, for example in the form of a self-adhesive pad, arranged to be affixed to a vehicle component. The pad includes one or more inductive coils, for example of the type described in connection with the illustrated embodiments, configured to inductively couple with a cooperating inductive charging apparatus, such as a base station, when disposed in close proximity thereto. The apparatus is configured such that a current induced in the or each inductive coils is converted into heat energy through resistive heating, which heat energy is transmitted into the component to which the apparatus is attached, for example through conduction,

By way of example, an inductive heating pad may be affixed to an engine sump, engine block, transmission case, oil cooler, radiator, HVAC module, battery or any temperature sensitive component of a vehicle by means of an adhesive. When the vehicle is suitably positioned over an inductive charging base station, for example as described above, a current is induced in the inductive coils of the pad generating heat which is transmitted into the component by conduction. This increases the temperature of the component, improving performance.

It will be appreciated that the system of the present invention can be utilised in a vehicle to power any of a vehicle's electrical systems, such as but not limited to a heater or fan for conditioning the vehicle or vehicle cabin, from an external power supply; such as mains electricity supply. This avoids the need to draw the electrical power from a battery or other electrical power source provided on the vehicle, such as an alternator, dynamo or solar panel. A wireless power receiver is mounted on the vehicle for coupling with a wireless

power transmitter. The electrical device or system being powered by the invention is powered independently or separately from the usual vehicle electrical power sources, the battery and charging system (alternator). Thus the electrical system being powered by the invention draws electrical power directly from the base or charging station omitting the battery and battery charge system. The electrical systems coupled to the inductive receiver may additionally be powered by the on board vehicle electrical power supply systems for those periods when the vehicle is out or range of a base or charging station.

In electric or hybrid electric vehicles the system can be utilised to electrically power any of the vehicles systems other than the battery charging system by the provision of a further wireless power receiver in addition to that provided for charging the battery.

CLAIMS

1. A system for electrically powering a vehicle component of a vehicle when docked at a base station, the vehicle comprising:

a traction battery; and

a vehicle component,

the system comprising a first inductive receiver for inductively coupling with a inductive transmitter of the base station, the first inductive receiver being electrically coupled to a vehicle component such that electric power is transferred directly to the vehicle component from the base station when the base station is operational.

2. The system according to claim 1 wherein the vehicle comprises a second inductive receiver coupled to the traction battery of the vehicle, the second inductive receiver being substantially aligned with the inductive transmitter for charging the traction battery.

3. The system according to claim 2 wherein the first inductive receiver is misaligned with the inductive transmitter of the base station.

4. The system according to claim 1 wherein the first inductive receiver additionally provides electric power to a vehicle battery whereby charging the vehicle battery.

5. The system according to any of claims 1, 2 or 4 wherein the first inductive receiver is in vertical alignment with the inductive transmitter.

6. The system according to claim 2 wherein the second inductive receiver is in vertical alignment with the inductive transmitter.

7. The system according to any of claims 2, 4 or 5 wherein one of the first or second inductive receivers is aligned with respect to the inductive transmitter to maximise coupling efficiency between said one of the first or second inductive receivers and the inductive transmitter.

8. The system according the claim 1 wherein the vehicle component is an electrical device and is powered independently of the vehicle battery and/or battery charging system.

9. The system according to any preceding claim wherein the vehicle component is an electric heater thermally coupled to a further vehicle component.

10. The system according to claim 1 wherein the inductive receiver is thermally coupled to the vehicle component and has an electrical resistance which generates heat when current flow is induced in the receiver so as to heat the vehicle component.

11. The system according the claim 9 wherein the inductive receiver is powered independently of the vehicle battery and/or battery charging system.

12. A method of powering a vehicle component comprising;

providing a vehicle which comprises an inductive receiver, a traction battery and a vehicle component;

placing the inductive receiver within range of an inductive transmitter of a base station;

transferring electrical power from the inductive transmitter to the inductive receiver by inducing current flow in the inductive receiver, and

powering a vehicle component directly from the inductive receiver with at least a portion of the electrical power transferred to the inductive receiver.

13. The method according to claim 12 comprising charging the traction battery with a portion of the electrical power transferred to the inductive receiver.

14. The method according to claim 12 comprising;

aligning the inductive receiver with the inductive transmitter of the base station;

wherein optimising power transfer from the inductive transmitter to the inductive receiver.

15. The method according to claim 12 comprising;

providing the vehicle with a second inductive receiver;

placing the second inductive receiver within range of an inductive transmitter of a charging station;

transferring electrical power from the inductive transmitter to the second inductive receiver by inducing current flow in the second inductive receiver, and

charging a vehicle battery with the electrical power transferred to the second inductive receiver.

16. The method according to claim 15 comprising;

aligning the second inductive receiver with the inductive transmitter of a charging station;

wherein optimising power transfer from the inductive transmitter to the second inductive receiver for maximising the charging efficiency of the vehicle battery.

17. A method of powering a vehicle component comprising;

providing an electric vehicle having a first inductive receiver and second inductive receiver;

placing the first inductive receiver within range of an inductive transmitter of a charging station;

inducing a first electric current in the first inductive receiver for charging a traction battery of the vehicle;

inducing a second electric current in a second inductive receiver disposed on a vehicle component so as to provide electrical power directly to the vehicle component from the charging station whilst charging the traction battery.

18. The method according to claim 17 wherein placing the first inductive receiver within range of the inductive transmitter of the charging station comprises substantially aligning the first inductive receiver with the inductive transmitter and placing the second inductive receiver within range of the inductive transmitter.

19. An apparatus comprising an inductive receiver for inductively coupling with an inductive transmitter, the apparatus being configured to be affixed to a component of a vehicle, the apparatus being configured to at least partially convert a current induced in one or more coils of the inductive receiver into heat and to transmit said heat to the vehicle component.

20. An apparatus as claimed in claim 19, comprising a pad including one or more coils, the pad being configured to be attached to a vehicle component.

21. An apparatus as claimed in claim 19 or claim 20, wherein the apparatus includes an adhesive for affixing the apparatus to a vehicle component.

22. An apparatus as claimed in any of claims 19 - 21, wherein the vehicle component is a heater.

23. A system, vehicle, kit of parts or method substantially as described herein with reference to and/or as illustrated by the accompanying Figures.

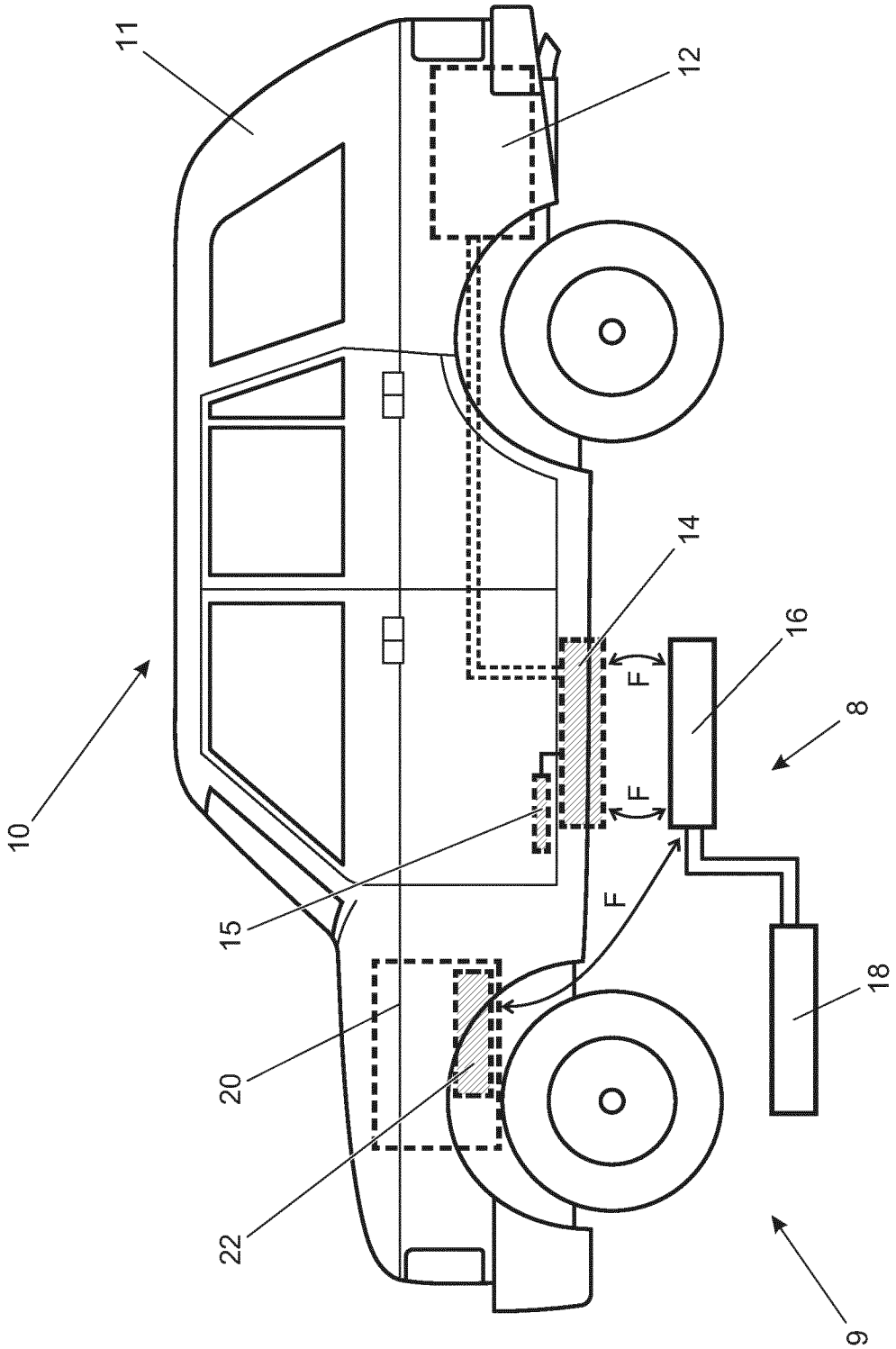

Figure 1

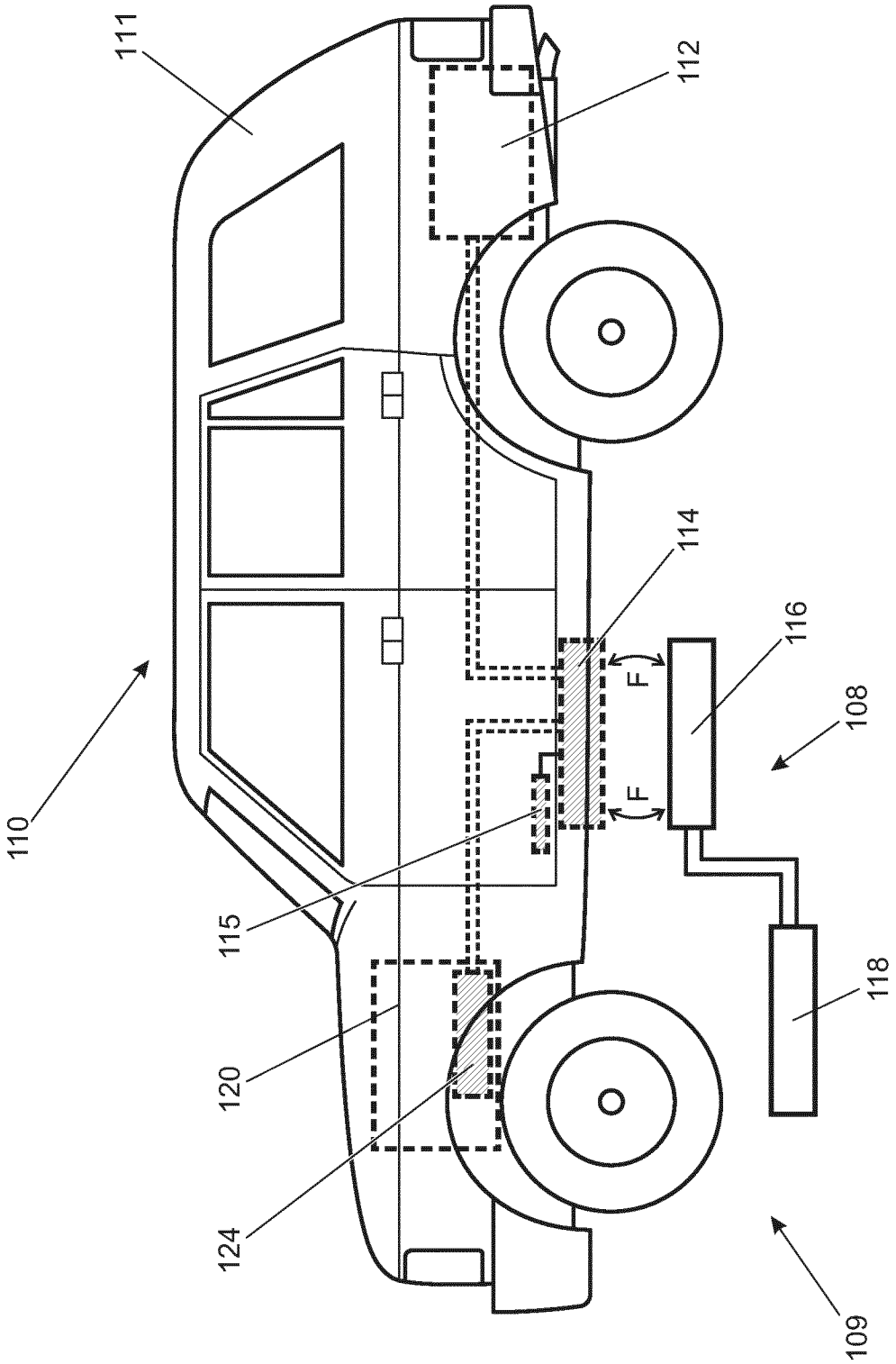

Figure 2

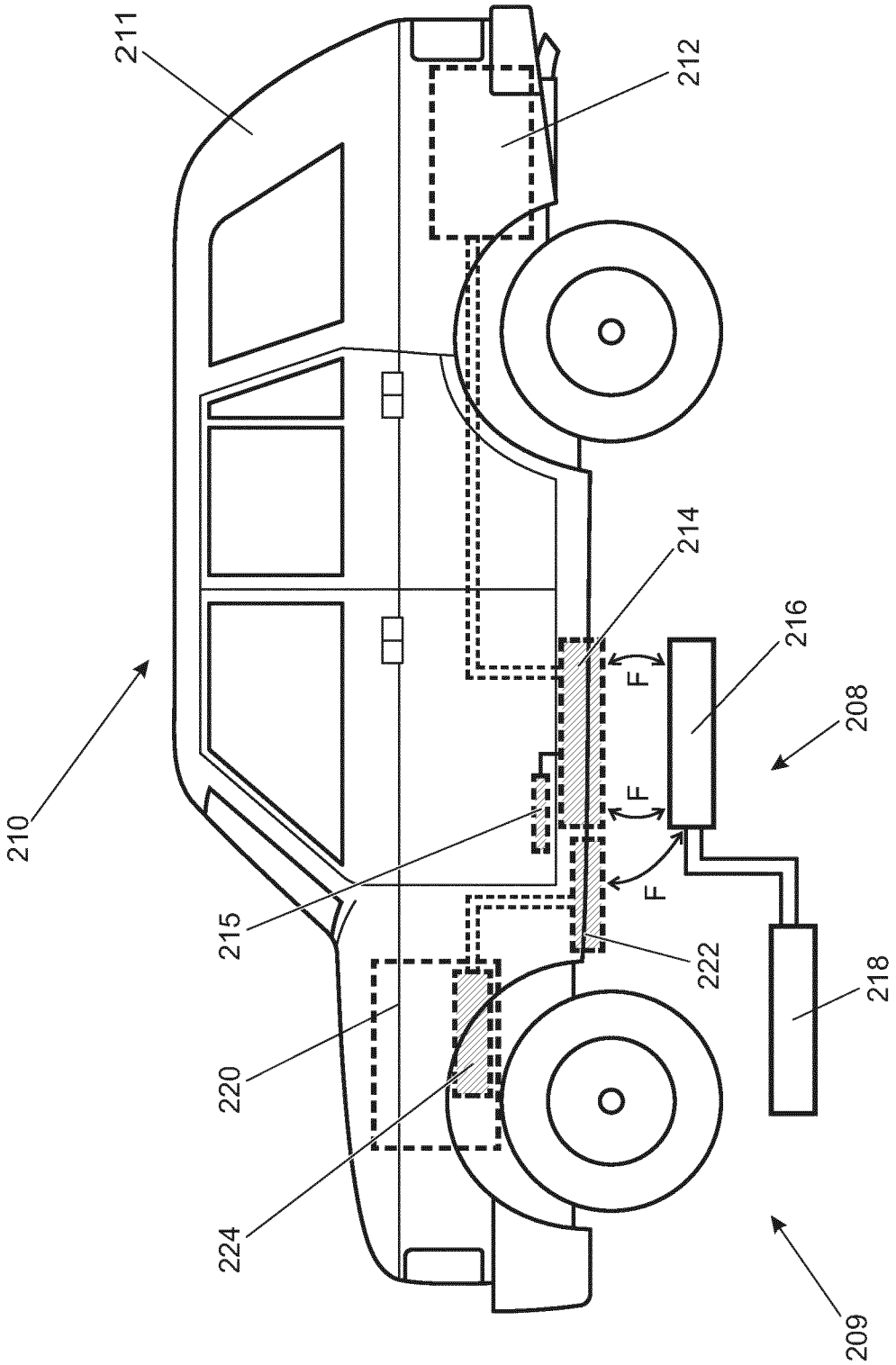

Figure 3