US 20180012197A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2018/0012197 A1
(43) Pub. Date: Jan. 11, 2018
Ricci et al.

(54) **BATTERY EXCHANGE LICENSING PROGRAM BASED ON STATE OF CHARGE OF BATTERY PACK**

(71) Applicant: **NextEV USA, Inc.**, San Jose, CA (US)

(72) Inventors: **Christopher P. Ricci**, Saratoga, CA (US); **Austin L. Newman**, San Jose, CA (US)

(21) Appl. No.: **15/282,337**

(22) Filed: **Sep. 30, 2016**

Related U.S. Application Data

(60) Provisional application No. 62/359,563, filed on Jul. 7, 2016, provisional application No. 62/378,348, filed on Aug. 23, 2016.

Publication Classification

(51) **Int. Cl.**
G06Q 10/00 (2012.01)
G06Q 30/02 (2012.01)

(52) **U.S. Cl.**
CPC ***G06Q 10/20*** (2013.01); ***G06Q 30/0208*** (2013.01)

(57) **ABSTRACT**

A method and system are provided that manage an exchange of a vehicle power source. The system maintains a set of user or vehicle records for each of one or more users or vehicles and a set of equipment records for each of a plurality of pieces of equipment. The system receives a request to exchange a power source of the vehicle, identifies a service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records and selects an available power source for the exchange based on the identified at least one service level and the set of equipment records.

Charging Type	Compatible Vehicle Charging Panel Types	Compatible Vehicle Storage Units	Available Automation Level	Charging Service Status	Charge Rate	Cost	Other	Shielding
Station: manual	Roof, Side	x, z	Low	Up	Low	$100	A, B, C	On
Station: manual	Roof, Side	x, z	Low	Up	Medium	$150	A, C	On
Station: manual	Roof, Side	x, z	Low	Up	High	$400	A, B, C	On
Station: robotic	Roof, Side	x, z	Medium	Down	Medium	$150	A, B, D	On
Station: robotic	Roof, Side	x, z	High	Down	High	$500	B, D	On
Station: robotic	Roof, Side	x, z	High	Down	High	$500	B, C	On
Roadway	Side, Lower	x, z	Low	Up	Low	$50	A, C, E	Off
Roadway	Side, Lower	x, z	Medium	Up	Low	$100	A, C, E	Off
Roadway	Side, Lower	x, z	Medium	Up	Low	$100	A, C, E	Off
Emergency: truck	Roof, Side, Lower	x, y	Low	Up	Low	$150	A, B	Off
Emergency: truck	Roof, Side, Lower	x, y	Medium	Up	Medium	$200	A, B	Off
Emergency: truck	Roof, Side, Lower	x, y	Medium	Up	High	$500	A, D	Off
Emergency: UAV	Roof	x	Medium	Down	Medium	$500	A, B, C	Off
Emergency: UAV	Roof	x	High	Down	High	$800	B	Off
Emergency: UAV	Roof	x	High	Down	High	$800	B	Off
Overhead	Roof	x, y	Low	Up	Low	$150	B, D	Off
Overhead	Roof	x, y	Medium	Up	Low	$200	B, C	Off
Overhead	Roof	x, y	Medium	Up	Low	$200	B, C	Off

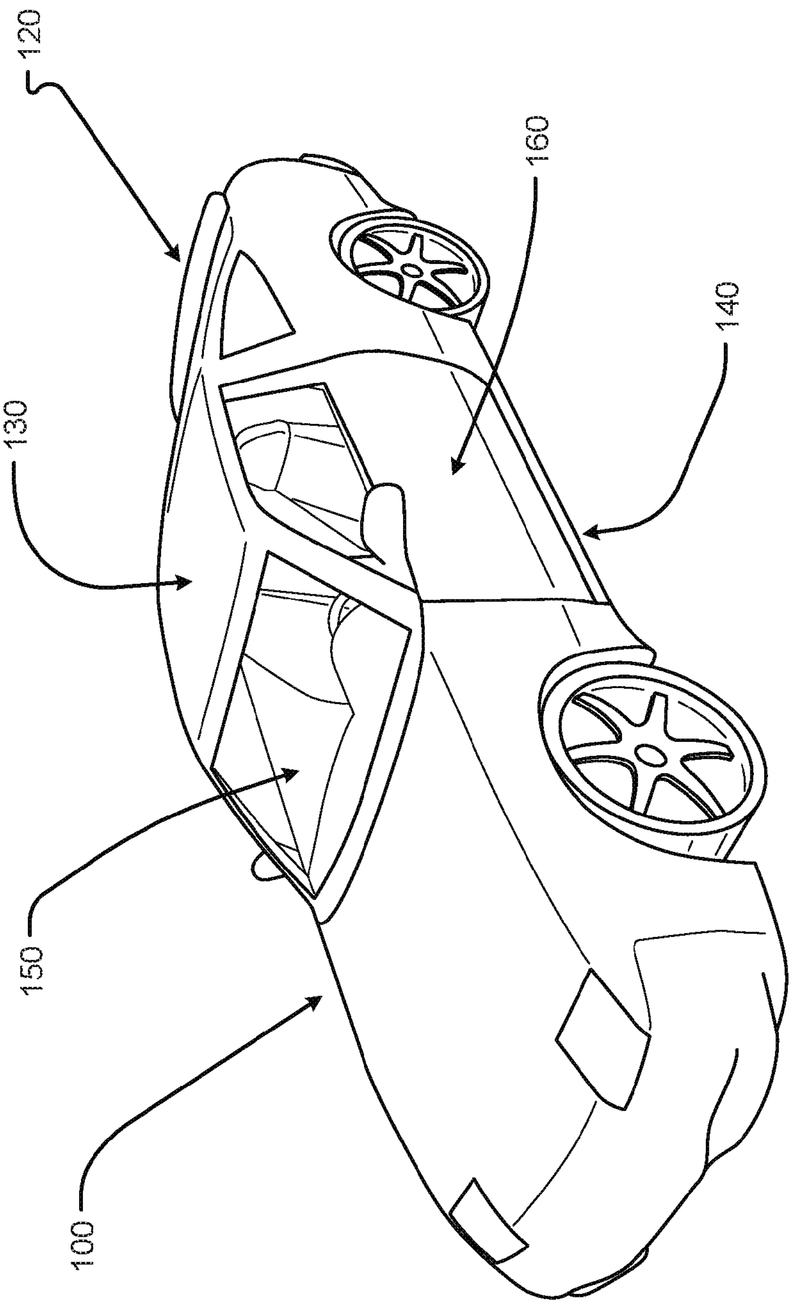

Fig. 1

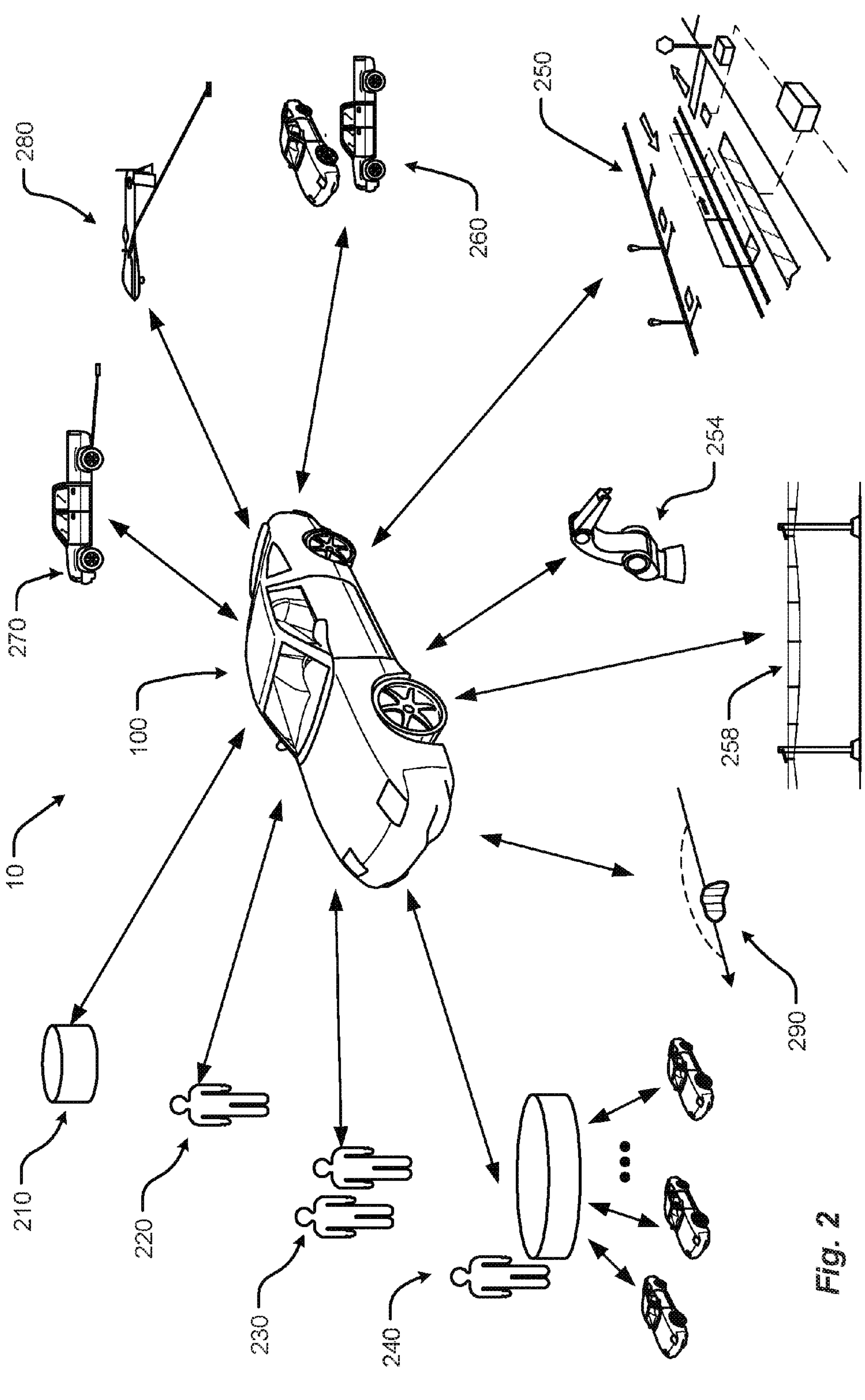

Fig. 2

300

310A 310B 310C 310D 310E 310F 310G 310H 310I

Charging Type	Compatible Vehicle Charging Panel Types	Compatible Vehicle Storage Units	Available Automation Level	Charging Service Status	Charge Rate	Cost	Other	Shielding
Station: manual	Roof, Side	x, z	Low	Up	Low	$100	A, B, C	On
Station: manual	Roof, Side	x, z	Low	Up	Medium	$150	A, C	On
Station: manual	Roof, Side	x, z	Low	Up	High	$400	A, B, C	On
Station: robotic	Roof, Side	x, z	Medium	Down	Medium	$150	A, B, D	On
Station: robotic	Roof, Side	x, z	High	Down	High	$500	B, D	On
Station: robotic	Roof, Side	x, z	High	Down	High	$500	B, C	On
Roadway	Side, Lower	x, z	Low	Up	Low	$50	A, C, E	Off
Roadway	Side, Lower	x, z	Medium	Up	Low	$100	A, C, E	Off
Roadway	Side, Lower	x, z	Medium	Up	Low	$100	A, C, E	Off
Emergency: truck	Roof, Side, Lower	x, y	Low	Up	Low	$150	A, B	Off
Emergency: truck	Roof, Side, Lower	x, y	Medium	Up	Medium	$200	A, B	Off
Emergency: truck	Roof, Side, Lower	x, y	Medium	Up	High	$500	A, D	Off
Emergency: UAV	Roof	x	Medium	Down	Medium	$500	A, B, C	Off
Emergency: UAV	Roof	x	High	Down	High	$800	B	Off
Emergency: UAV	Roof	x	High	Down	High	$800	B	Off
Overhead	Roof	x, y	Low	Up	Low	$150	B, D	Off
Overhead	Roof	x, y	Medium	Up	Low	$200	B, C	Off
Overhead	Roof	x, y	Medium	Up	Low	$200	B, C	Off

310J 310K 310L 310M 310N 310O 310P 310Q

Fig. 3

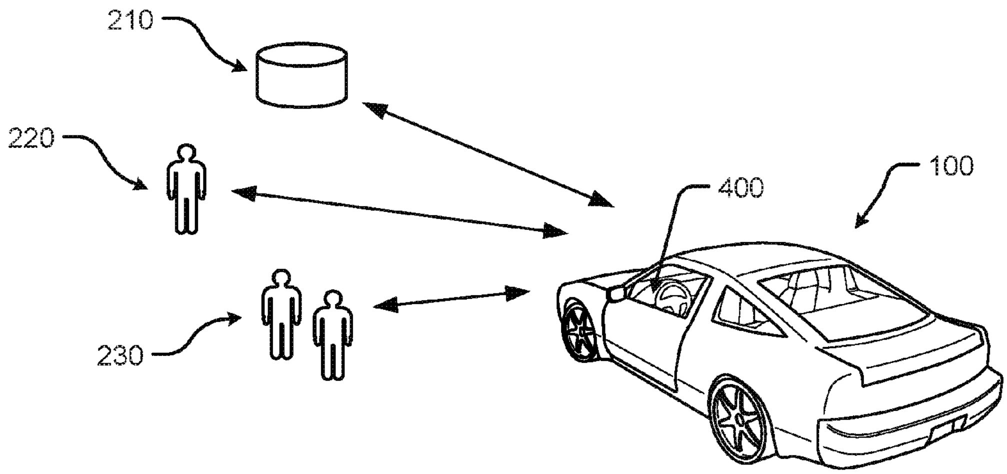

Fig. 4A

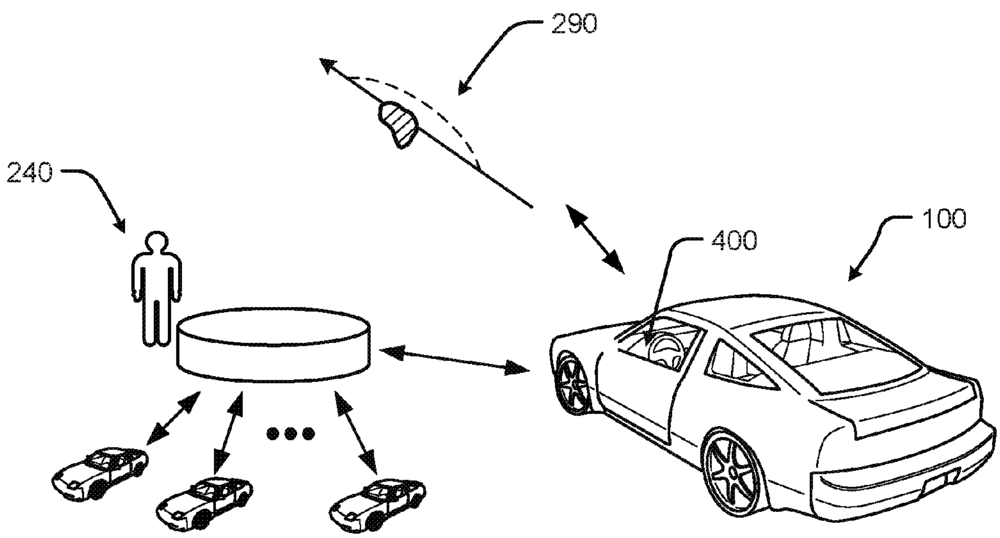

Fig. 4B

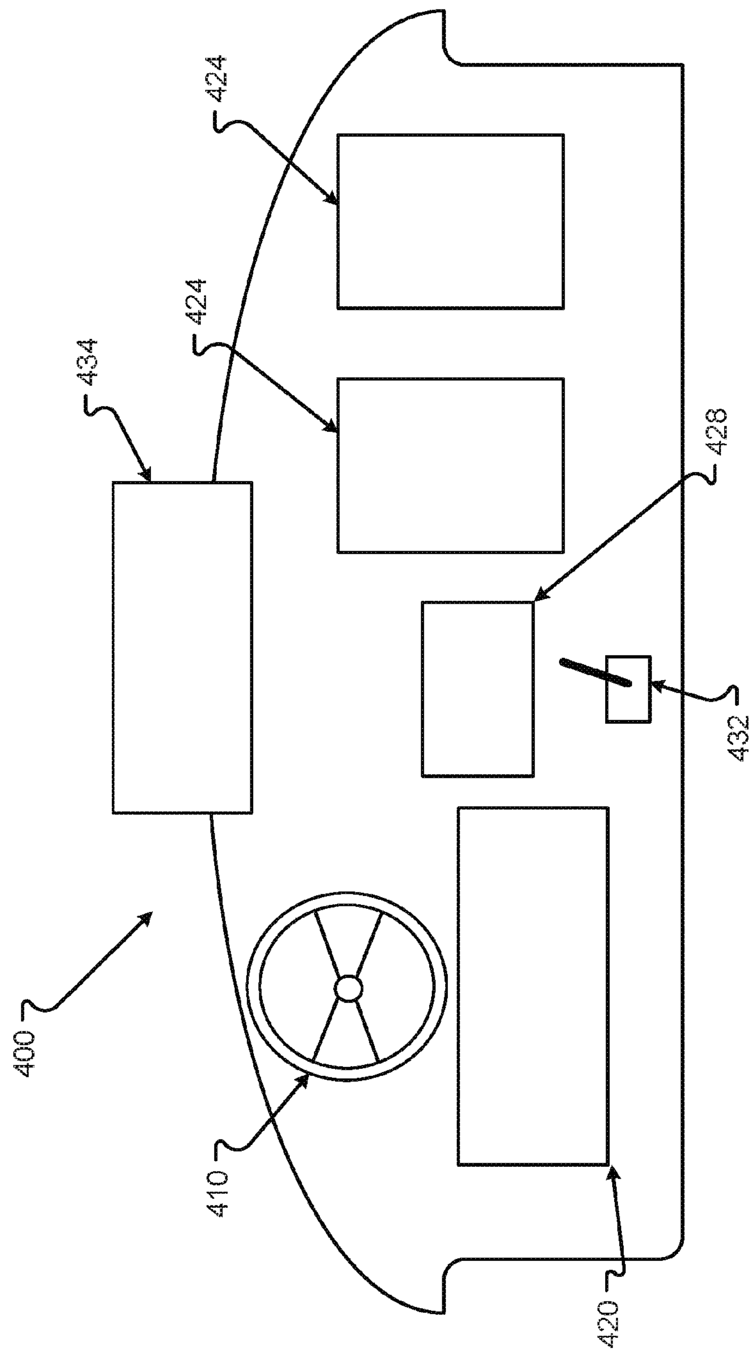

Fig. 4C

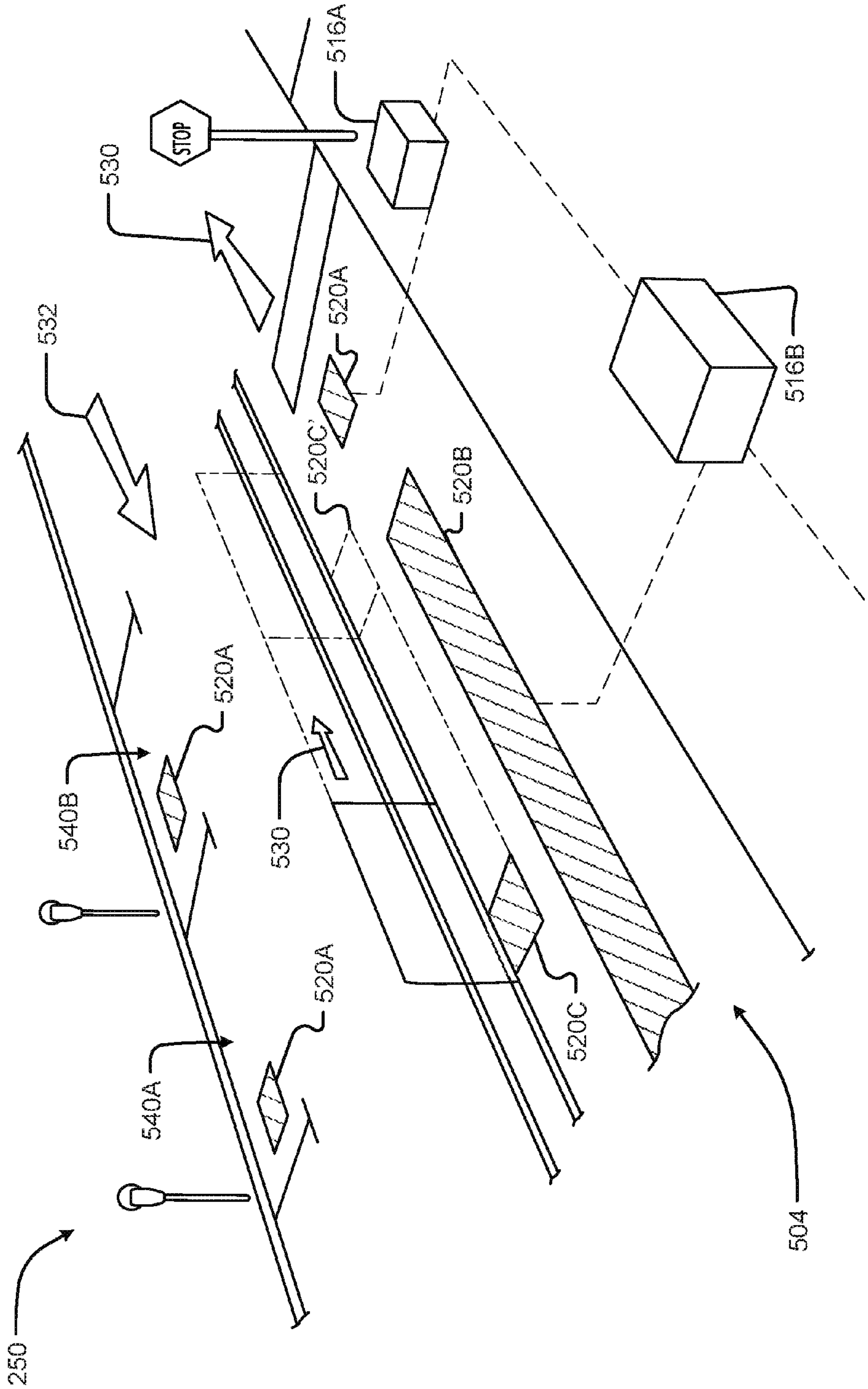
516A
STOP
530
532
520A
520C'
520B
516B
540B
520A
530
540A
520A
520C
504
250

Fig. 5

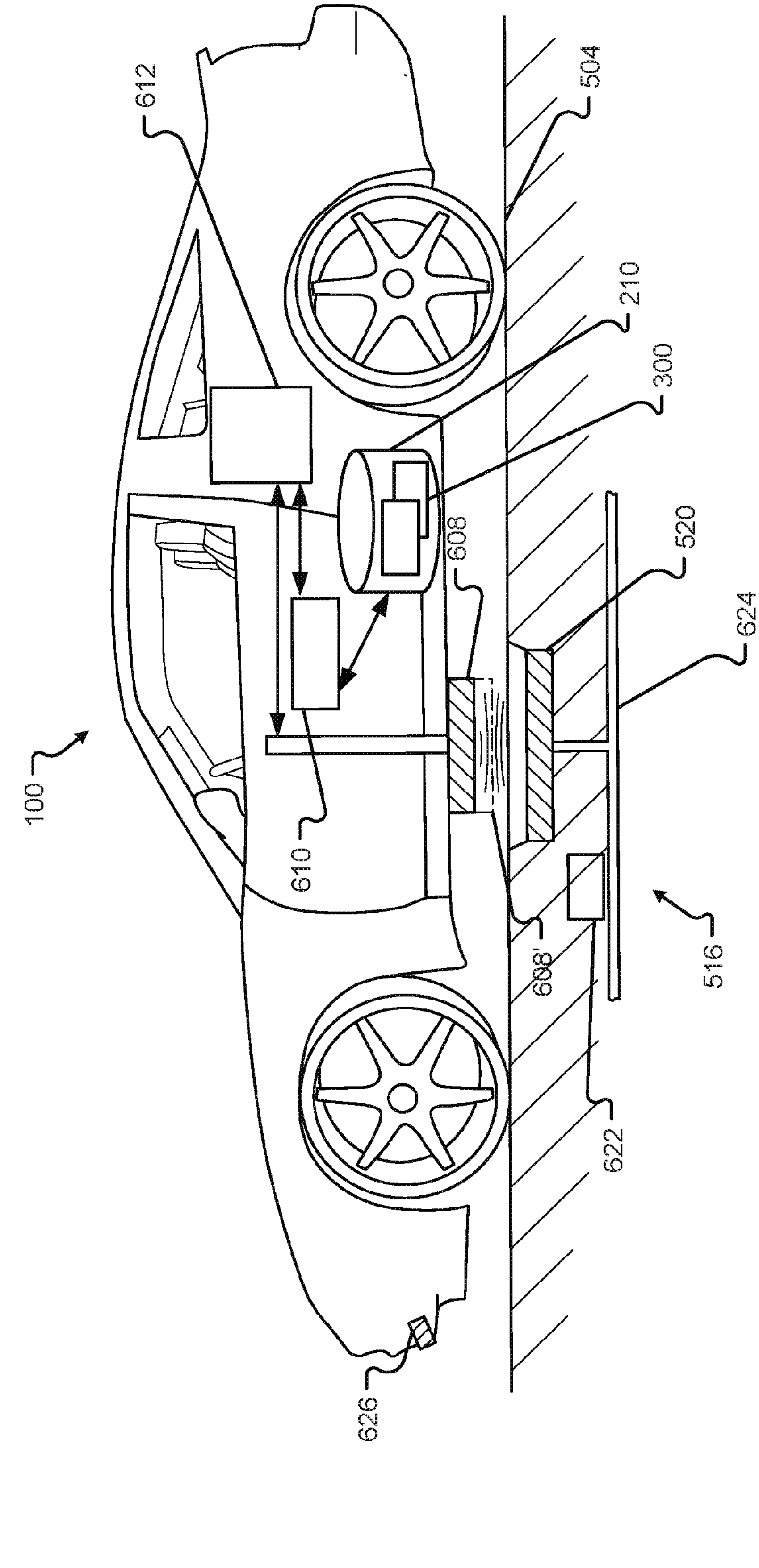

Fig. 6

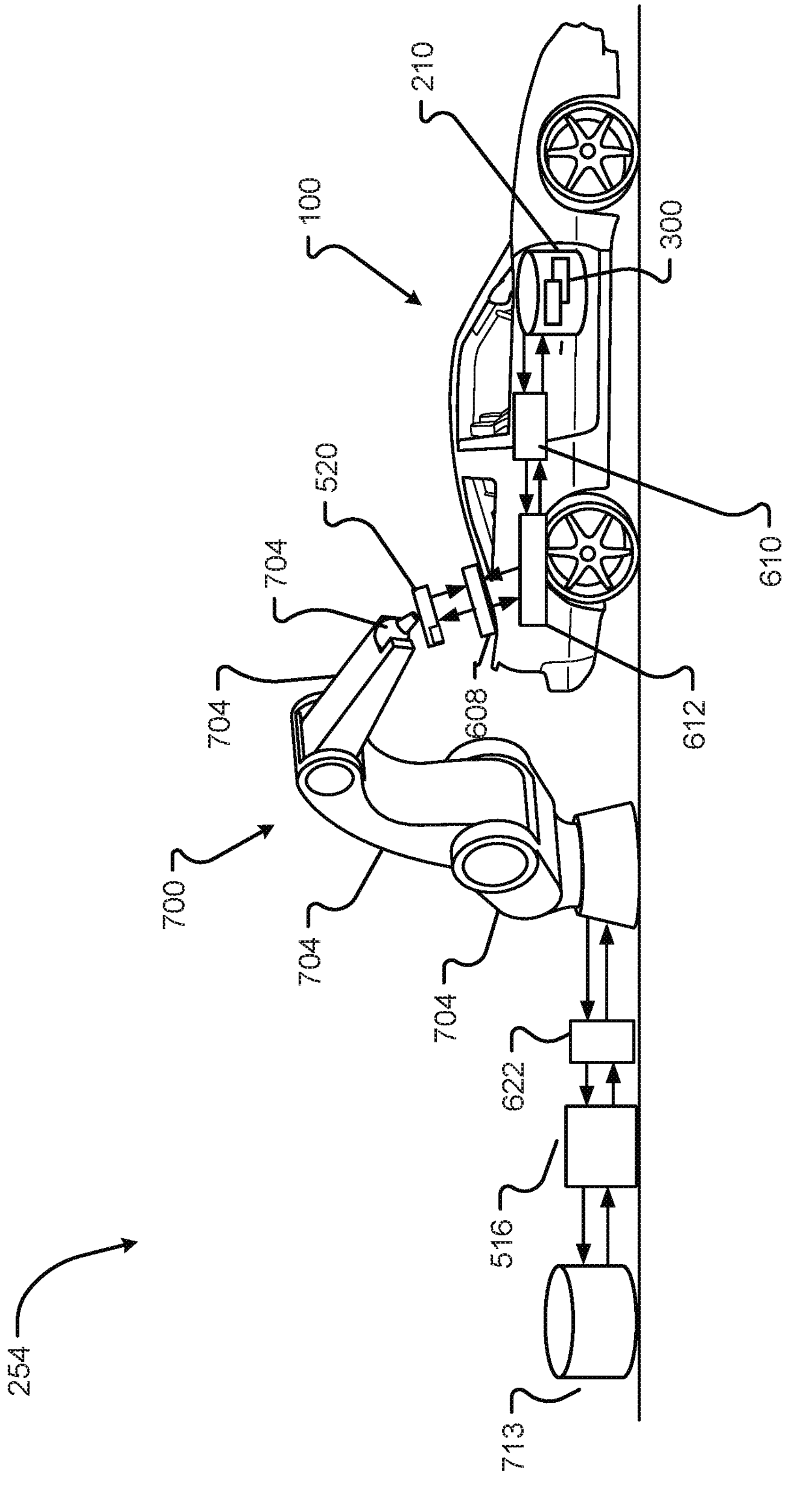
210
100
300
520
704
610
704
608
612
704
700
704
704
622
516
254
713

Fig. 7

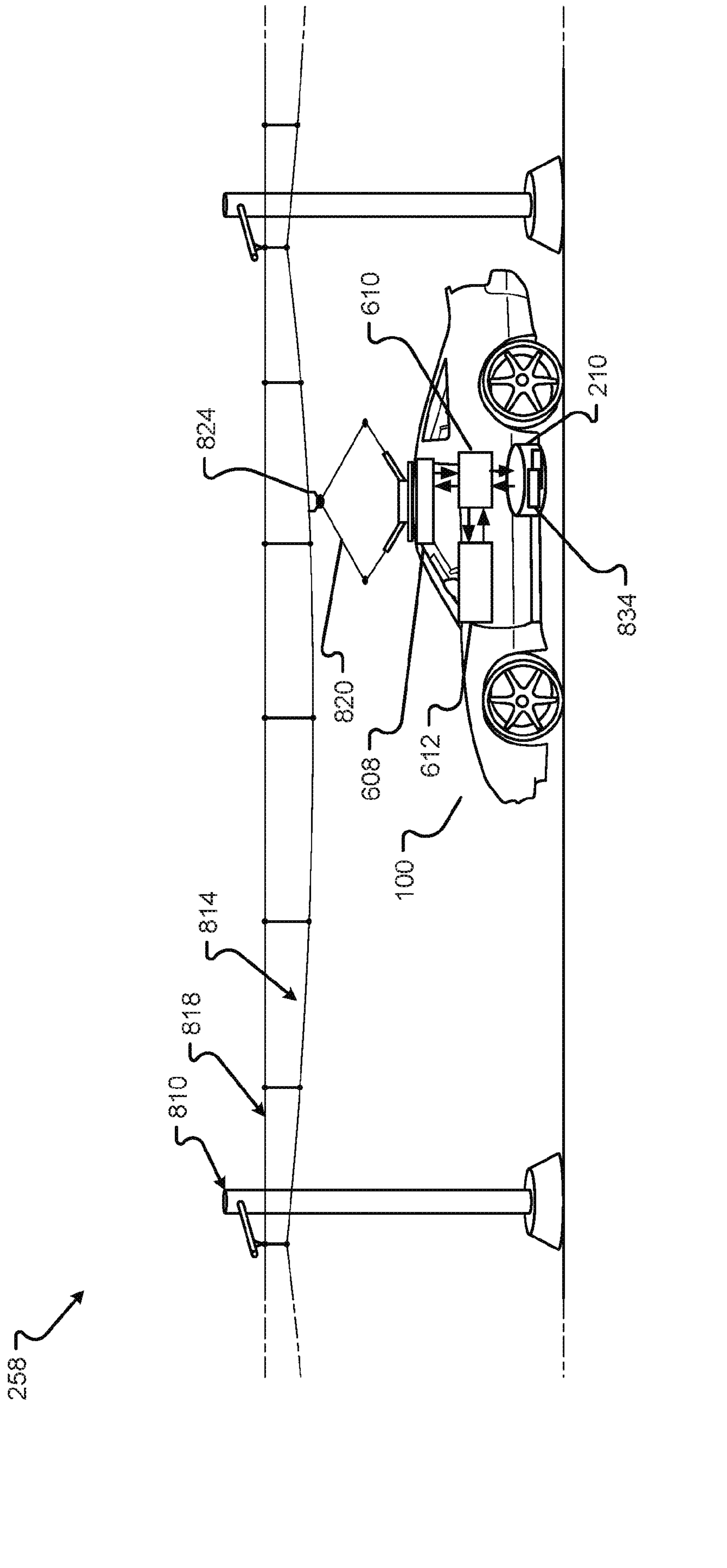

Fig. 8

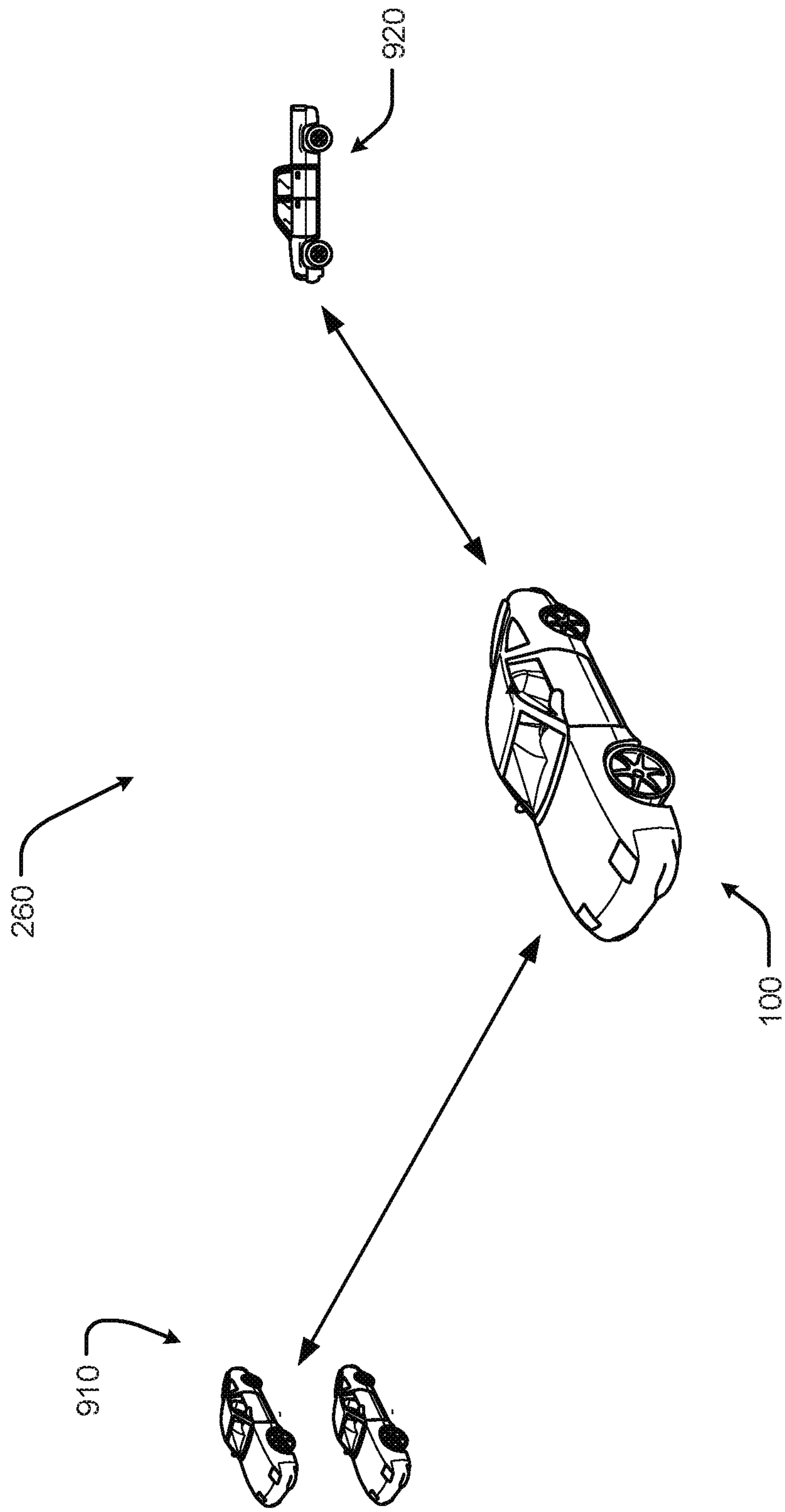

Fig. 9

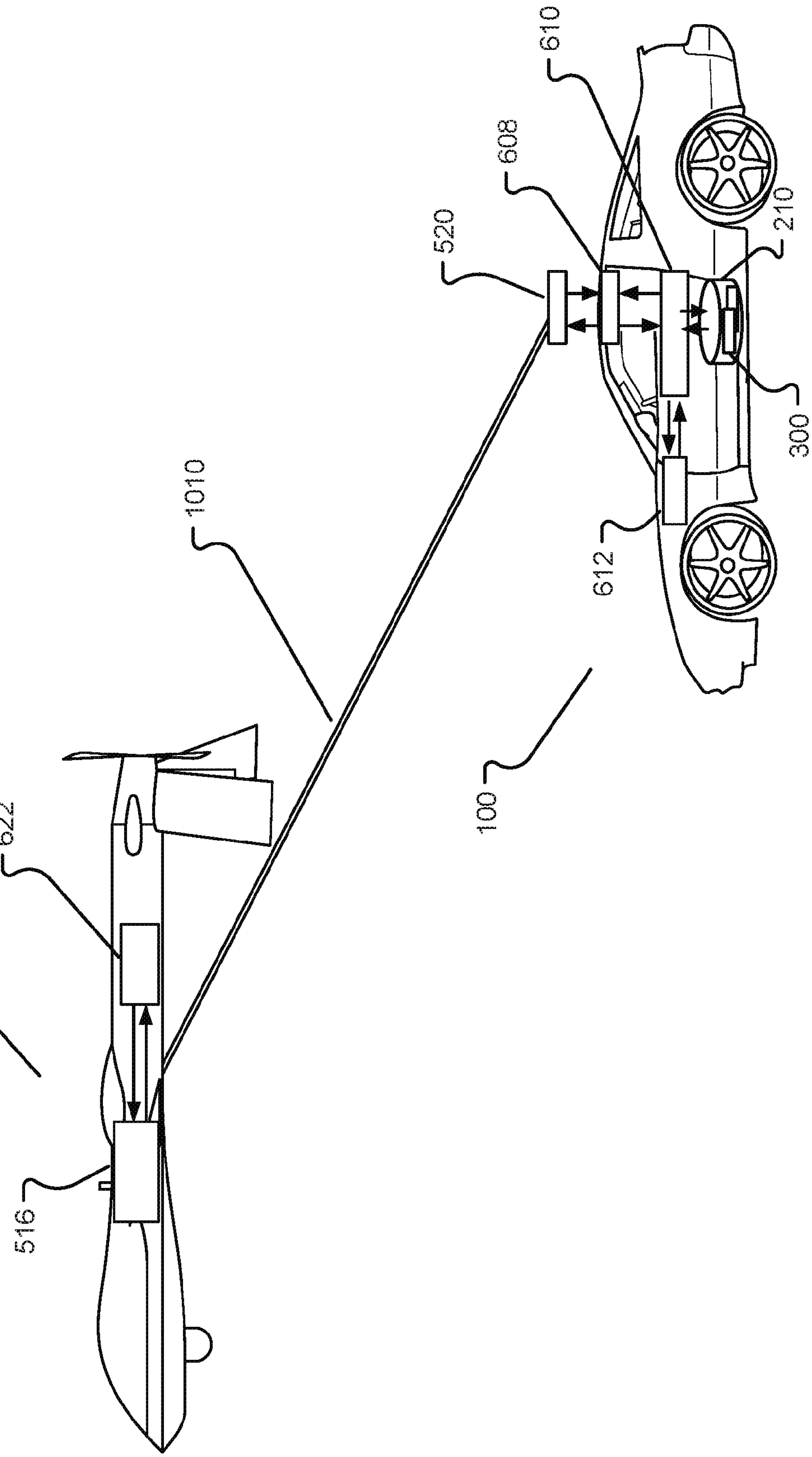

Fig. 10

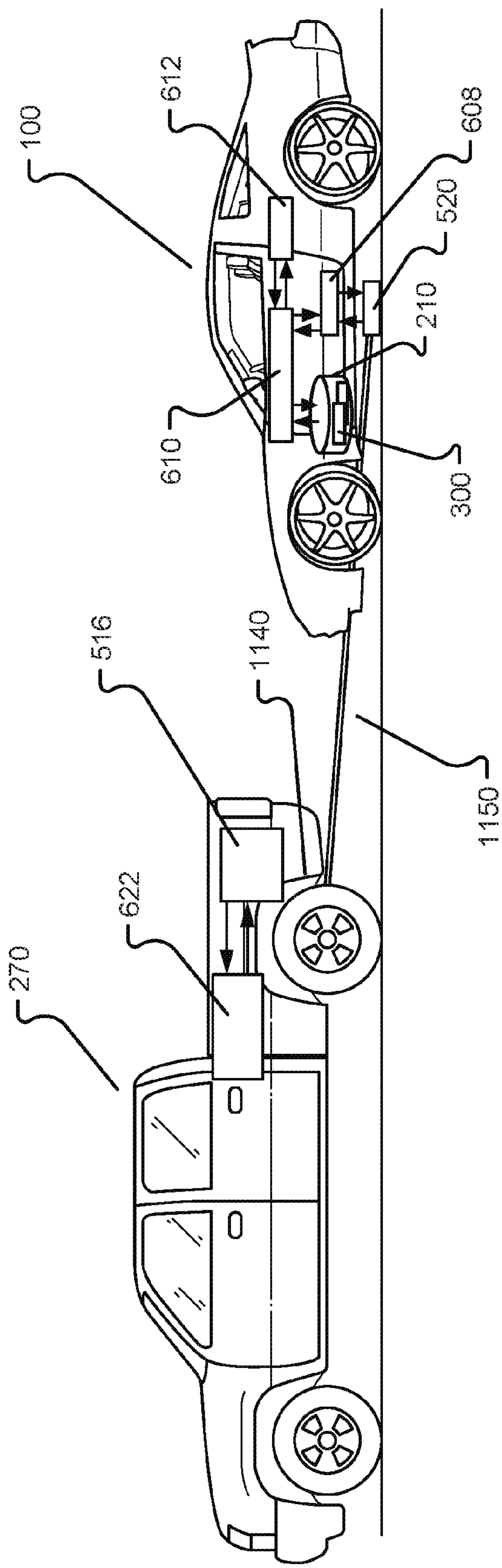

Fig. 11

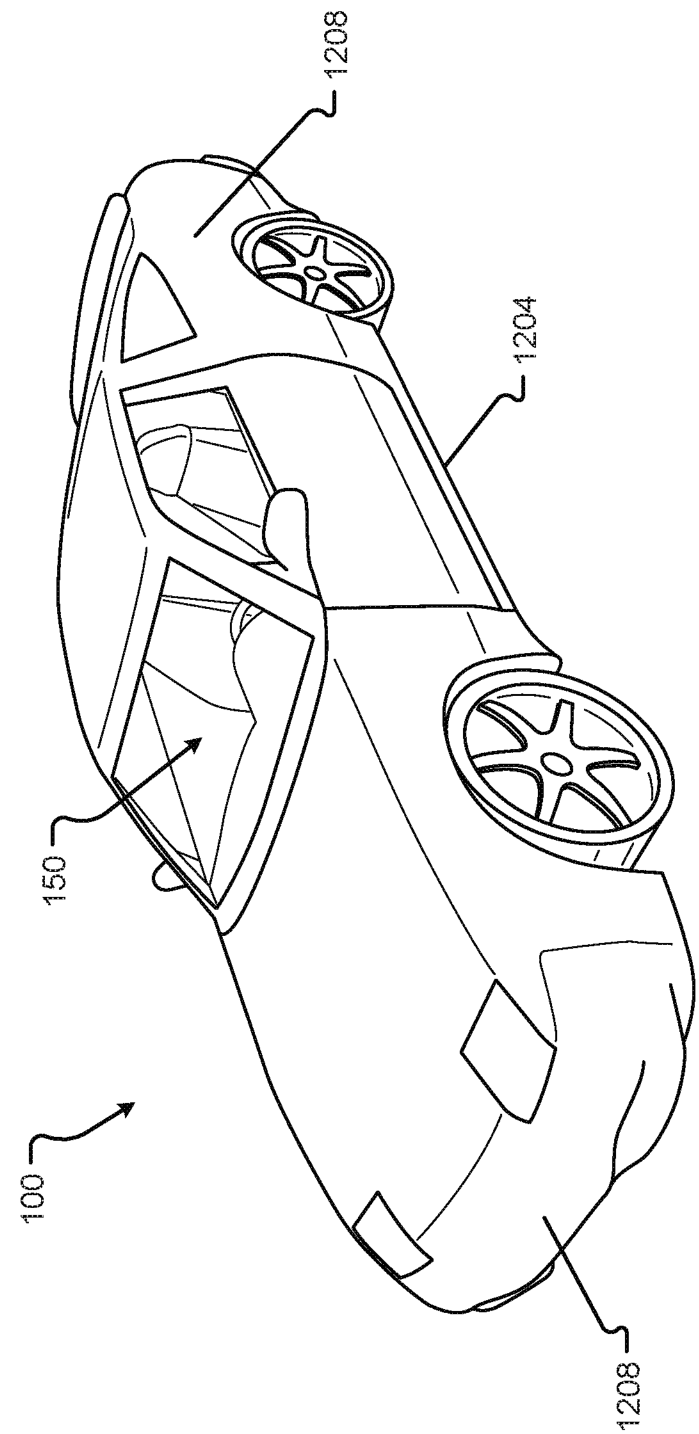

Fig. 12

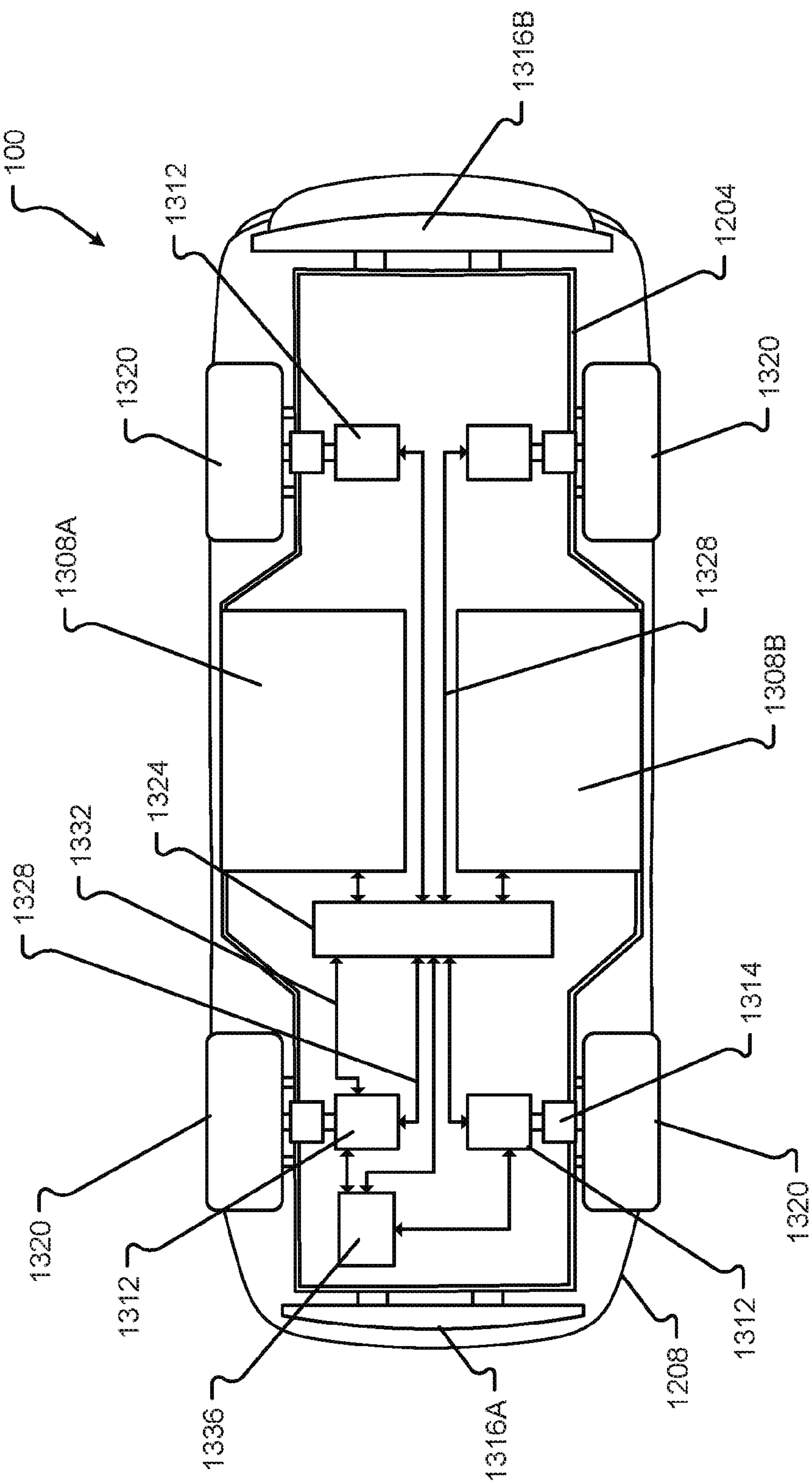
100
1316B
1312
1204
1320
1320
1308A
1328
1308B
1324
1332
1328
1314
1320
1320
1312
1312
1336
1316A
1208

Fig. 13

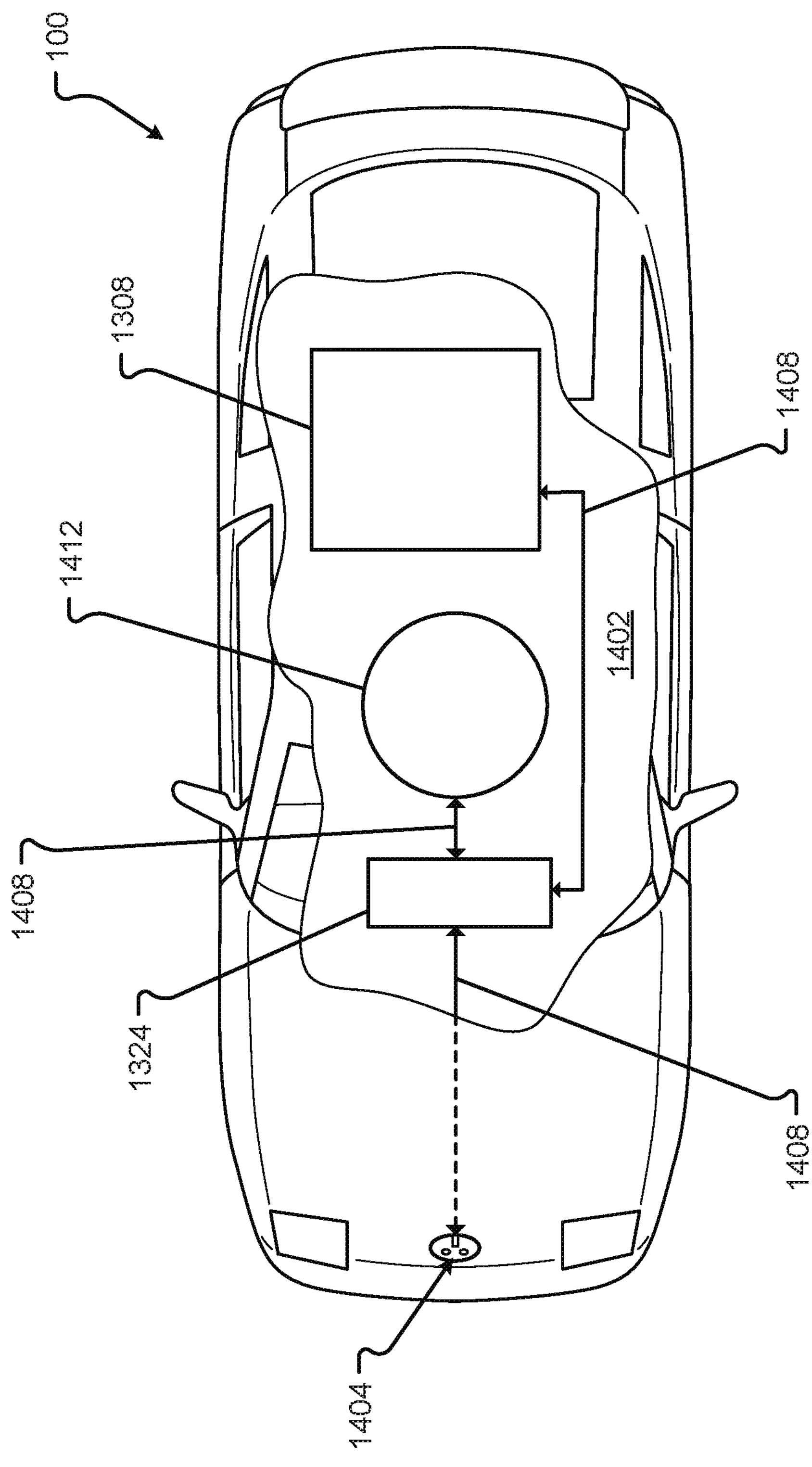

Fig. 14

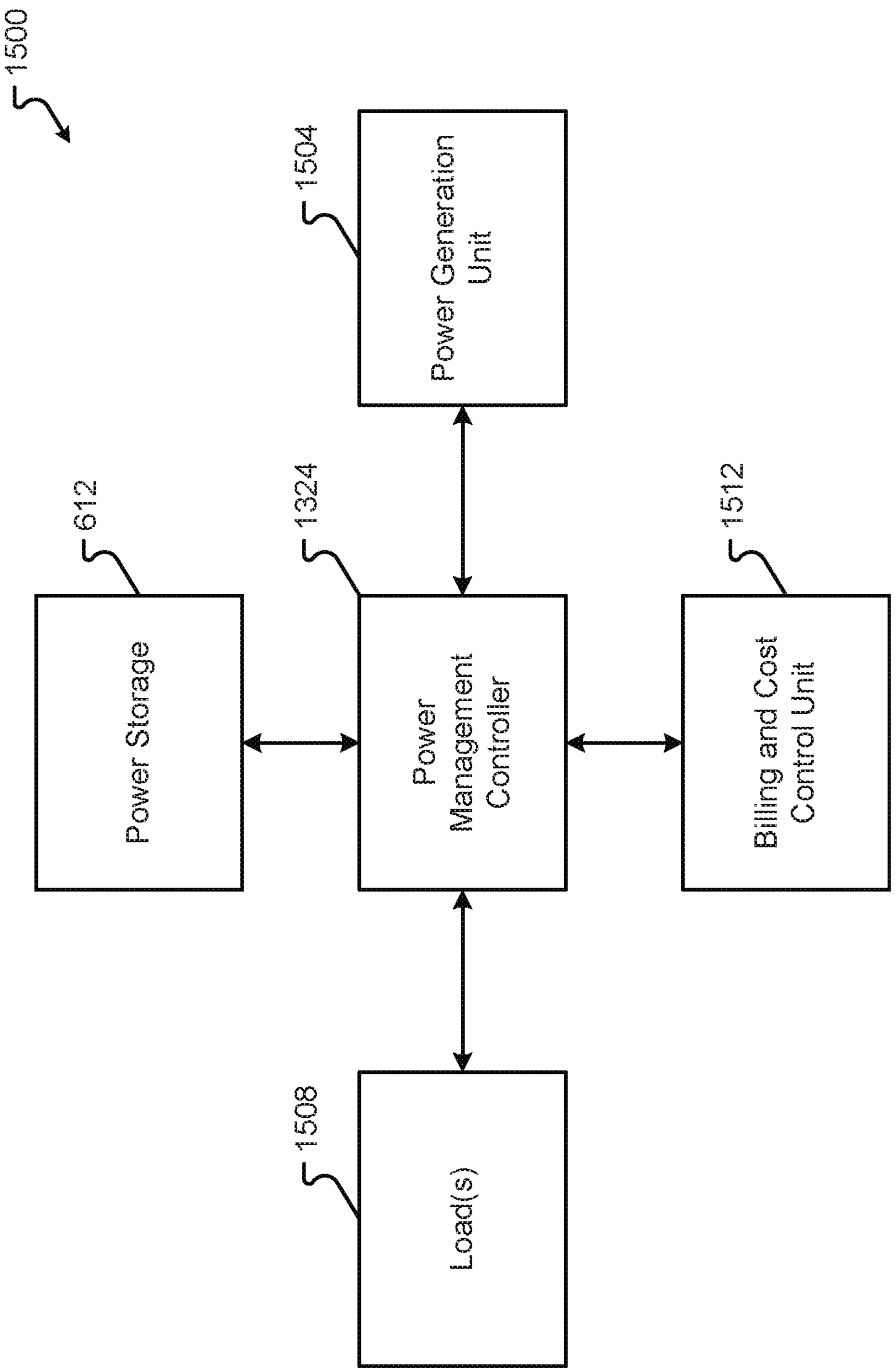
1500
1504
Power Generation Unit
612
1324
1512
Power Storage
Power Management Controller
Billing and Cost Control Unit
1508
Load(s)

Fig. 15

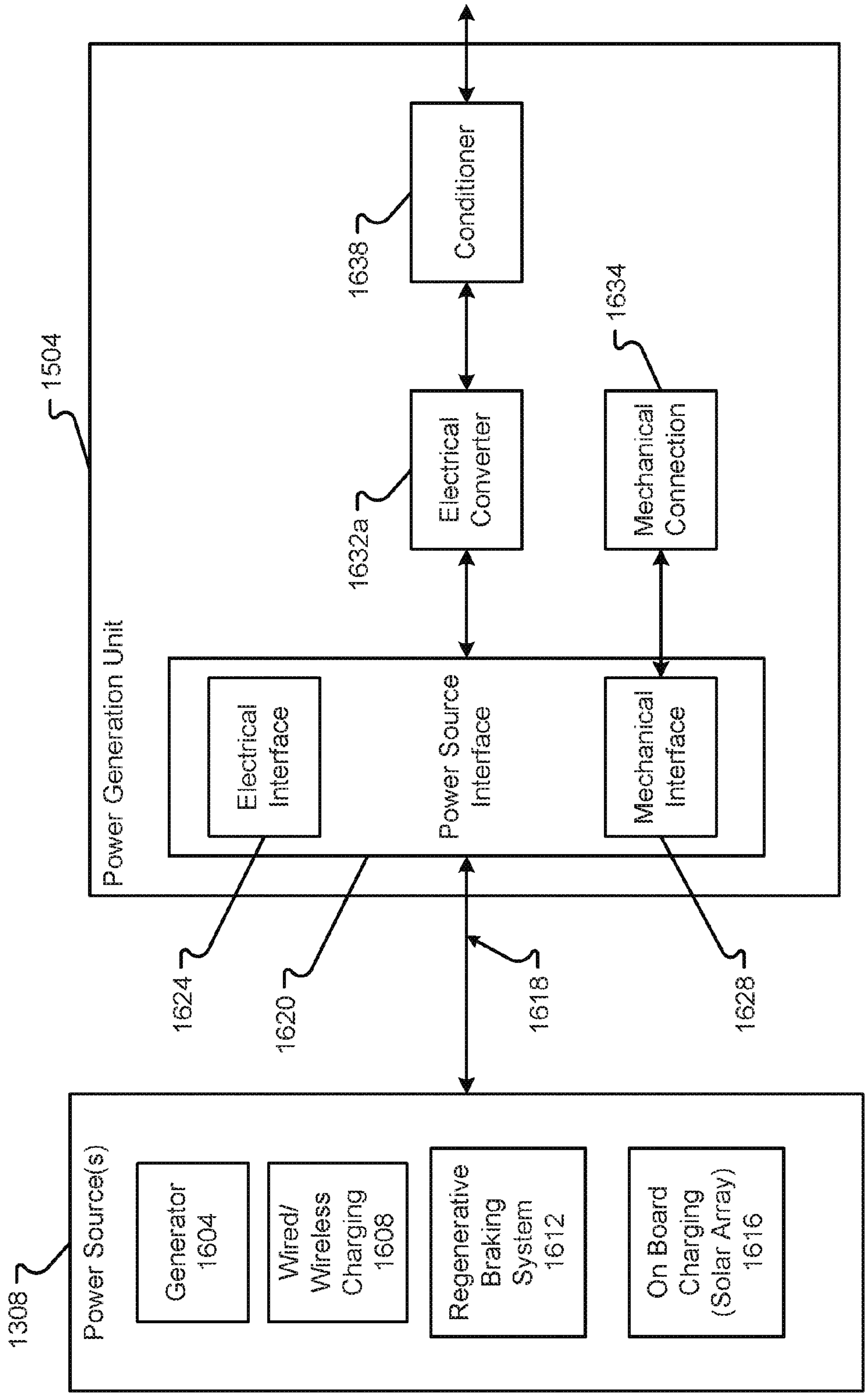
1504
Power Generation Unit
Conditioner
1638
Electrical Converter
1632a
Mechanical Connection
1634
Electrical Interface
Power Source Interface
Mechanical Interface
1624
1620
1618
1628
1308
Power Source(s)
Generator 1604
Wired/ Wireless Charging 1608
Regenerative Braking System 1612
On Board Charging (Solar Array) 1616

Fig. 16

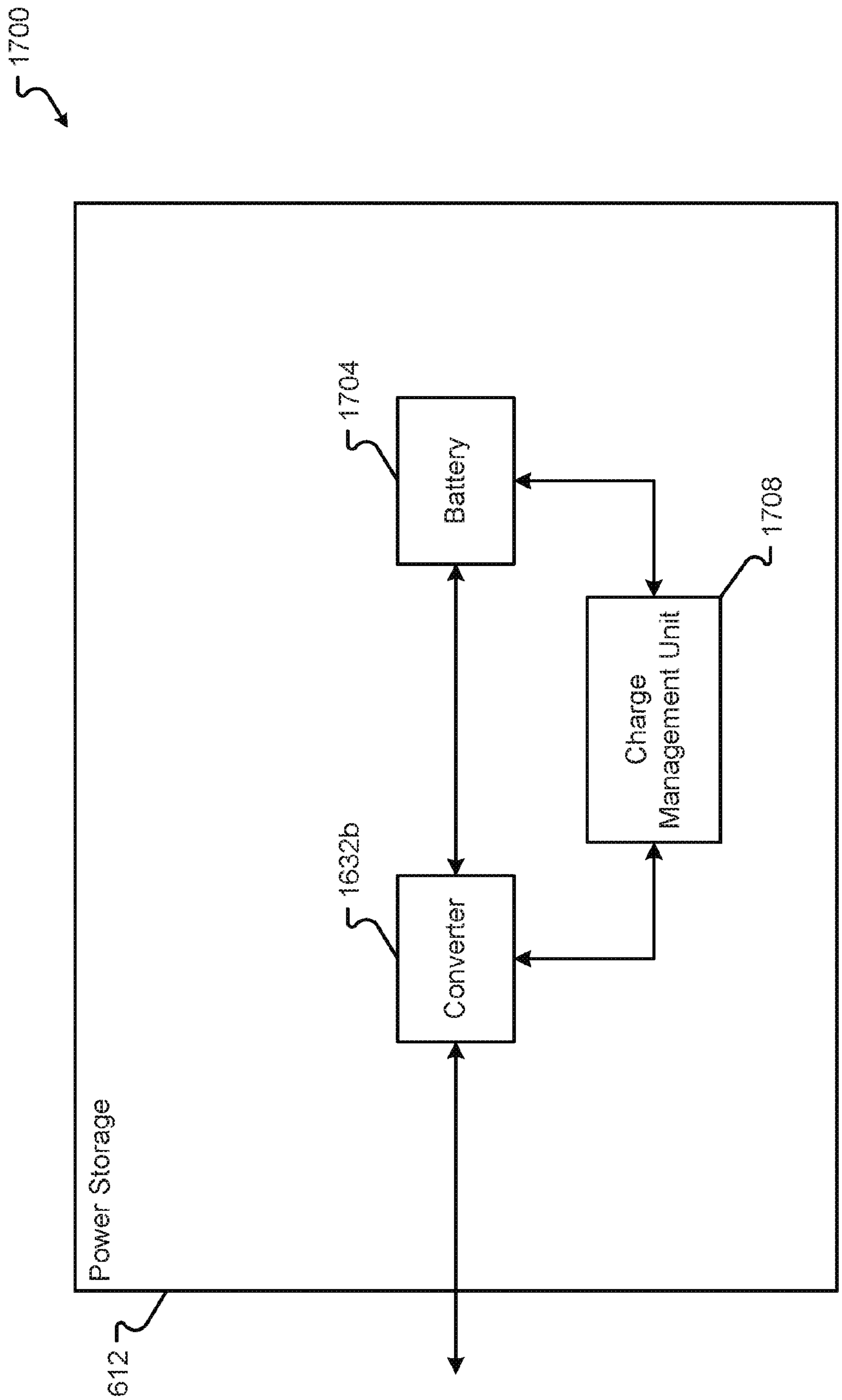
1700
Power Storage
612
Battery
1704
Converter
1632b
Charge
Management Unit
1708

Fig. 17

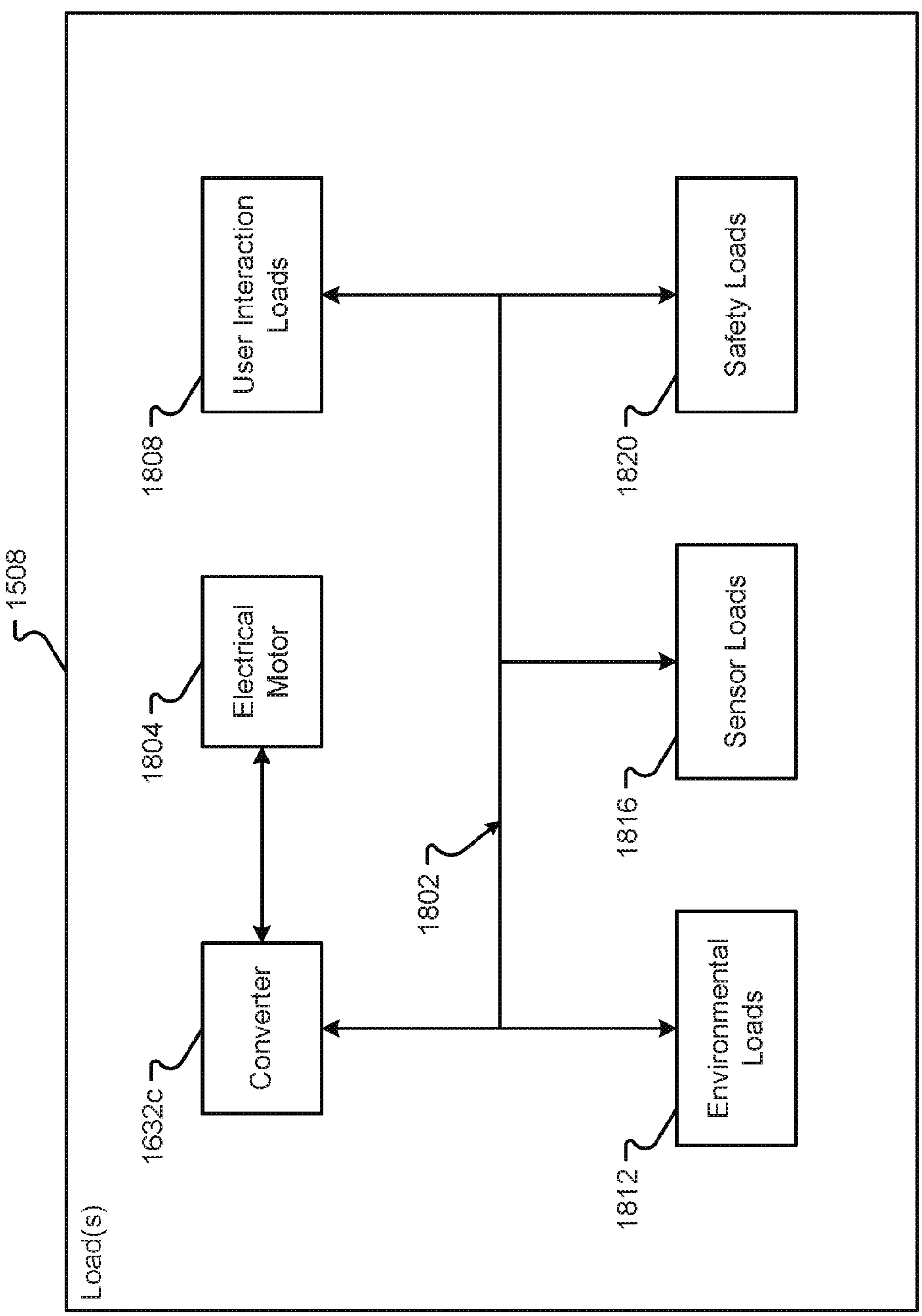
1508
Load(s)
Converter
1632c
Electrical Motor
1804
User Interaction Loads
1808
1802
Environmental Loads
1812
Sensor Loads
1816
Safety Loads
1820

Fig. 18

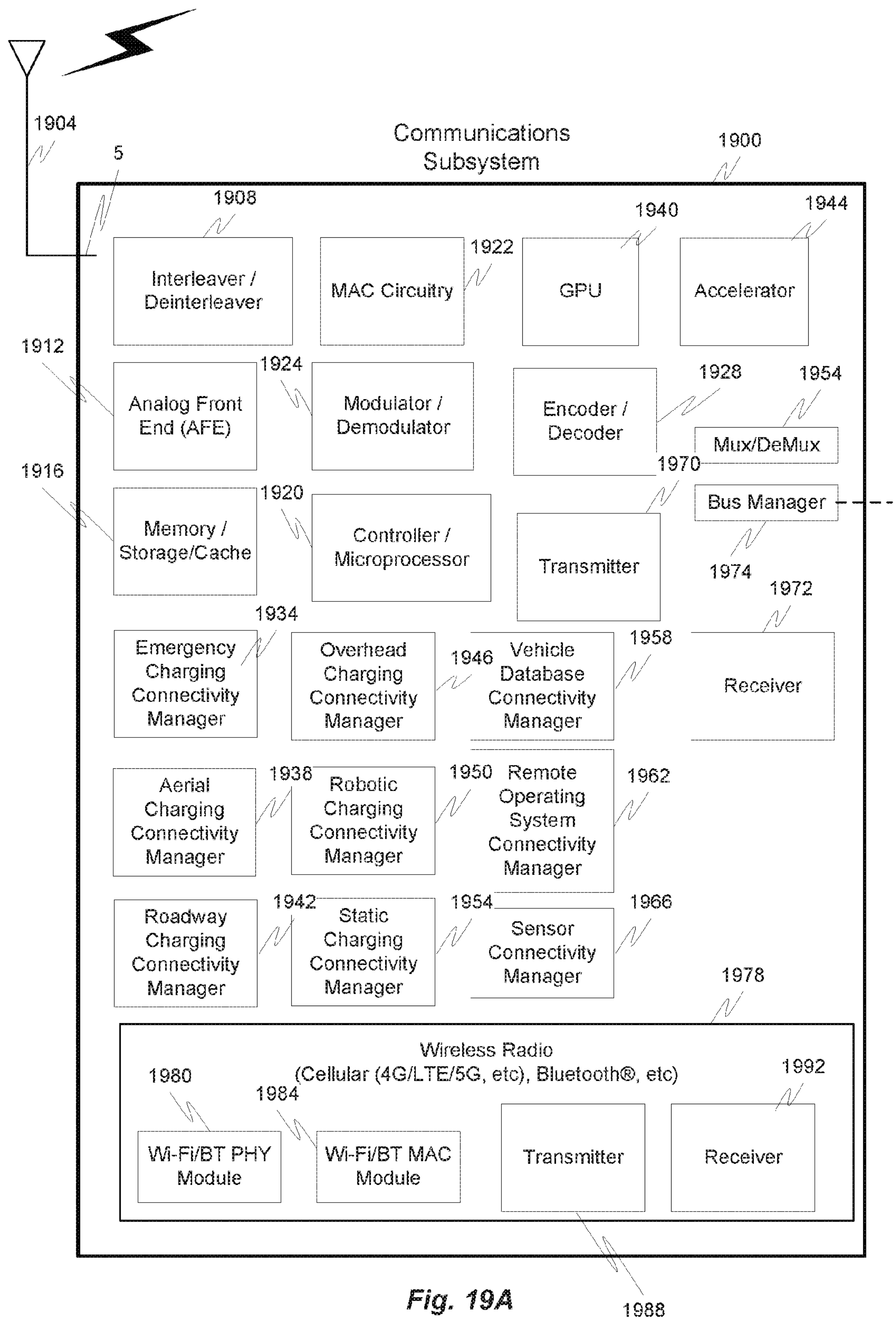
1904
5
Communications Subsystem
1900
1908
Interleaver / Deinterleaver
MAC Circuitry
1922
1940
GPU
1944
Accelerator
1912
Analog Front End (AFE)
1924
Modulator / Demodulator
Encoder / Decoder
1928
1954
Mux/DeMux
1970
Bus Manager
1916
Memory / Storage/Cache
1920
Controller / Microprocessor
Transmitter
1974
1972
1934
Emergency Charging Connectivity Manager
Overhead Charging Connectivity Manager
1946
Vehicle Database Connectivity Manager
1958
Receiver
Aerial Charging Connectivity Manager
1938
Robotic Charging Connectivity Manager
1950
Remote Operating System Connectivity Manager
1962
Roadway Charging Connectivity Manager
1942
Static Charging Connectivity Manager
1954
Sensor Connectivity Manager
1966
1978
Wireless Radio
(Cellular (4G/LTE/5G, etc), Bluetooth®, etc)
1980
1984
1992
Wi-Fi/BT PHY Module
Wi-Fi/BT MAC Module
Transmitter
Receiver
1988

Fig. 19A

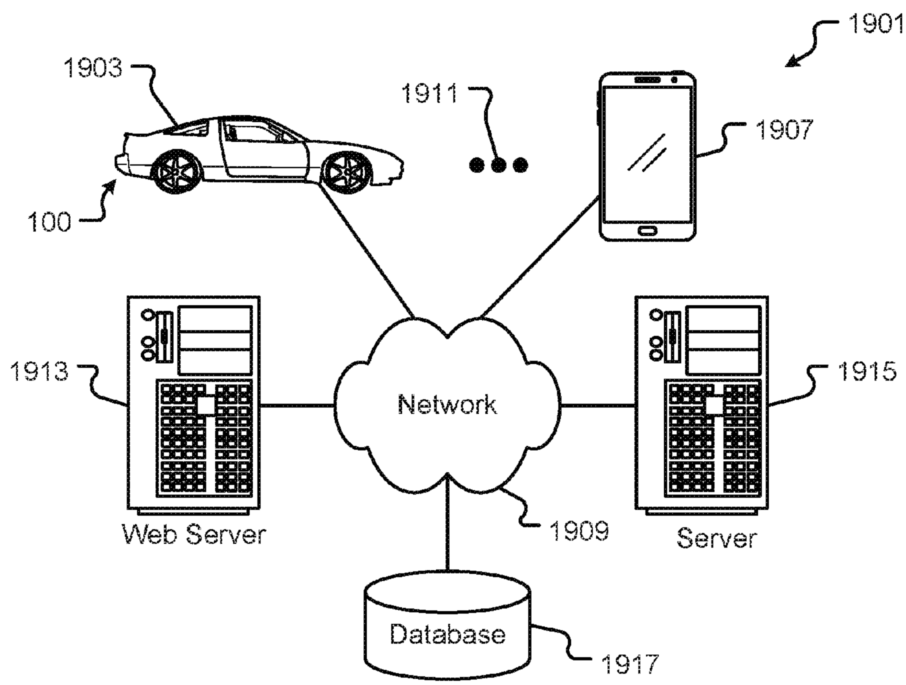

Fig. 19B

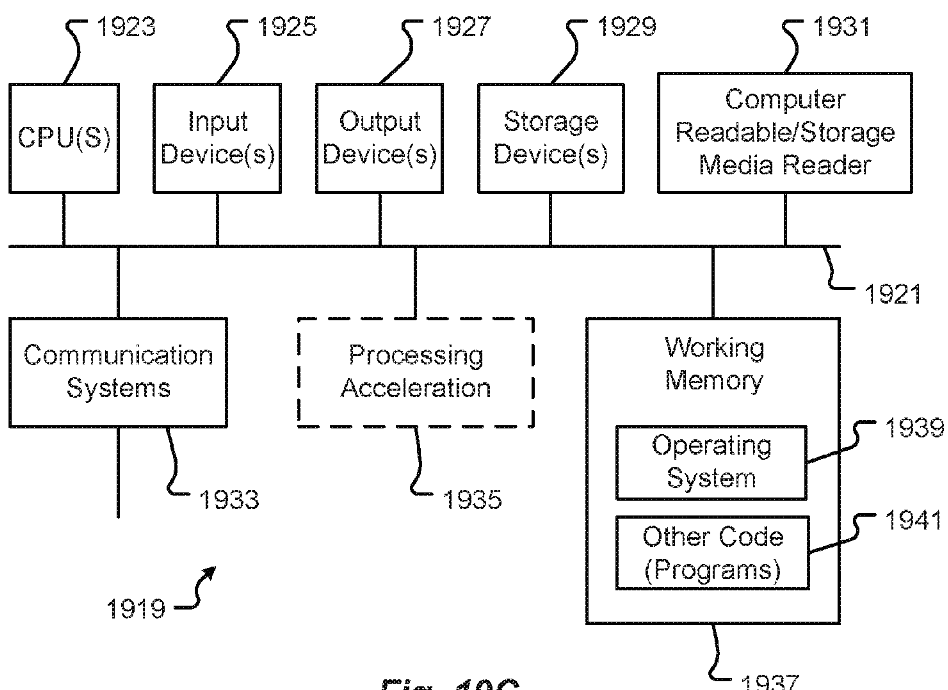

Fig. 19C

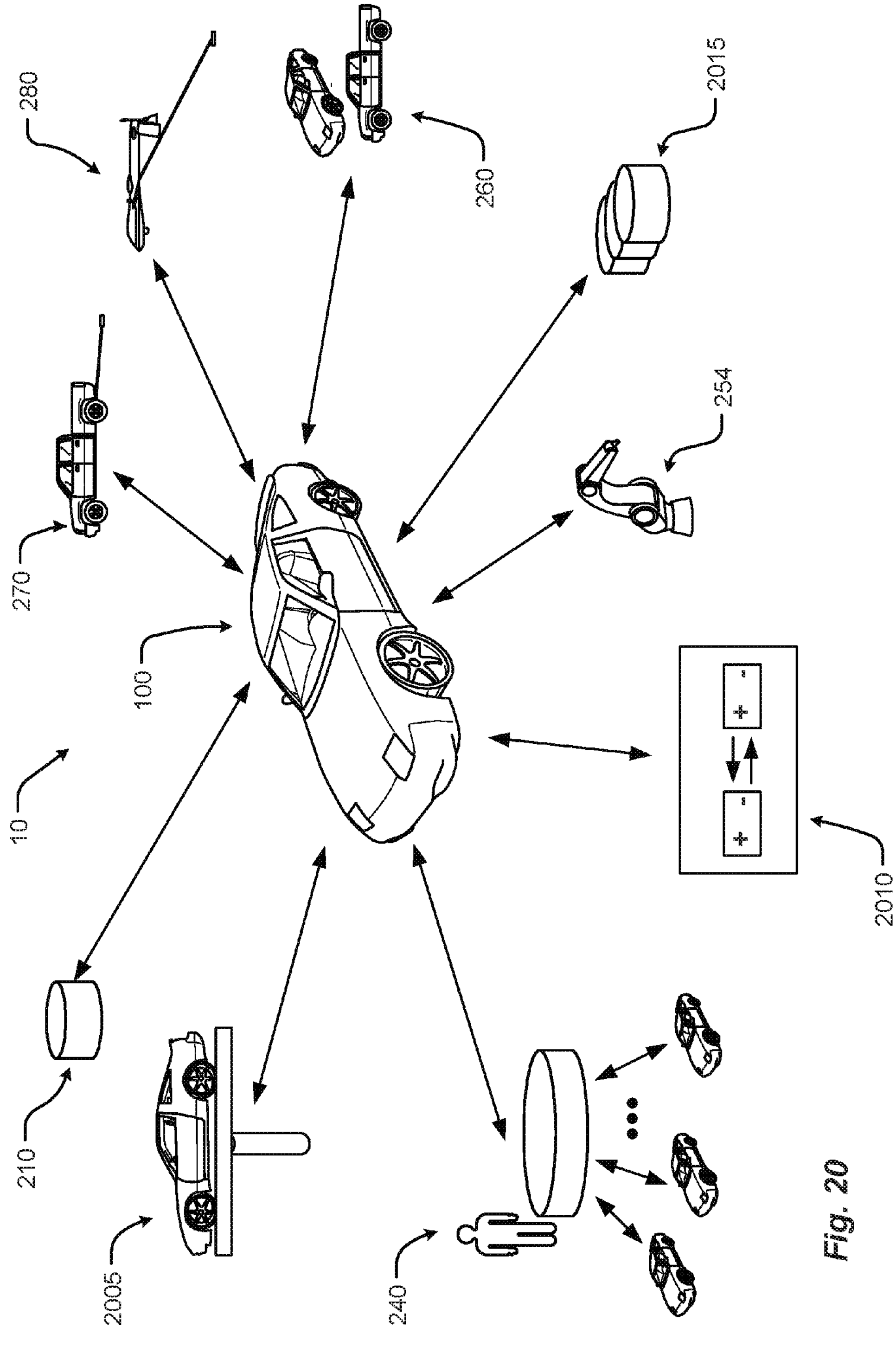

Fig. 20

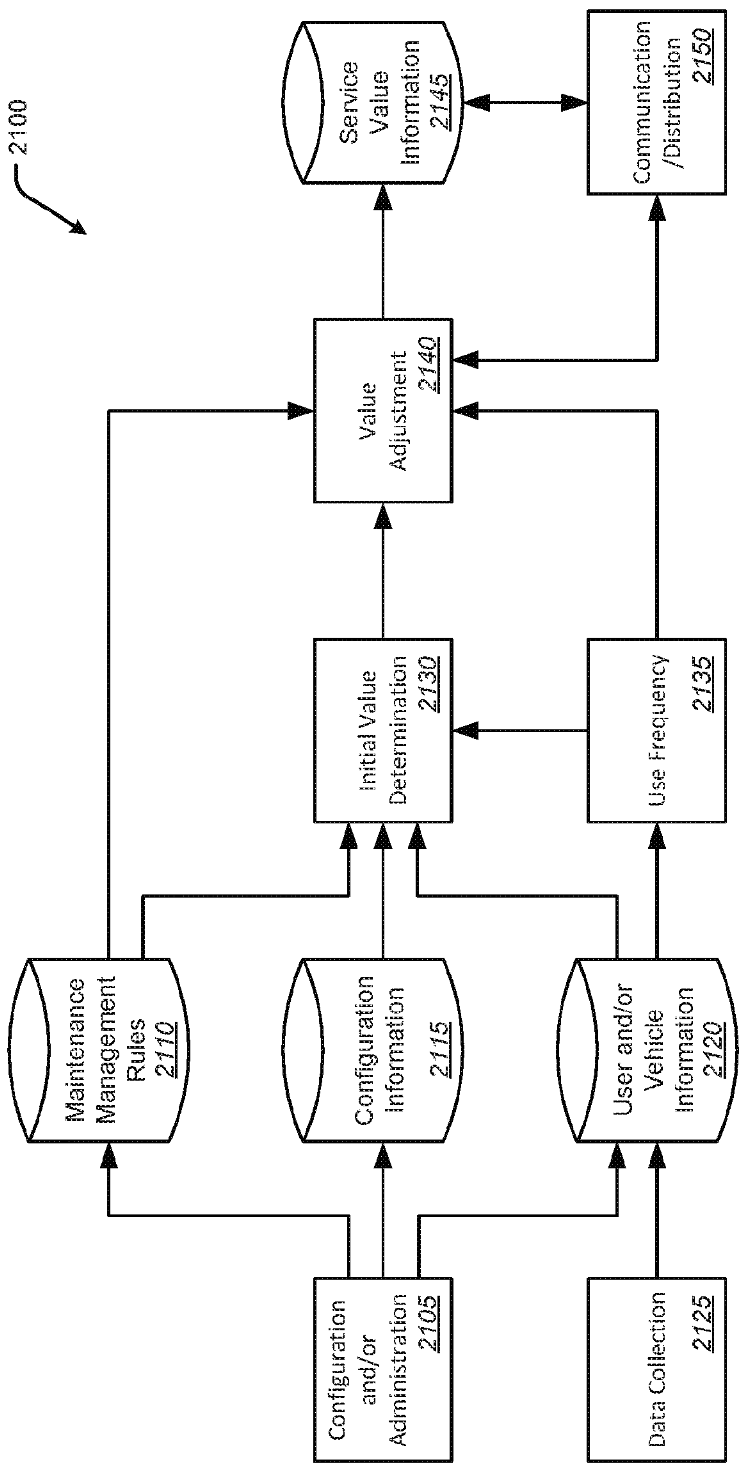
2100
Configuration and/or Administration 2105
Maintenance Management Rules 2110
Configuration Information 2115
User and/or Vehicle Information 2120
Data Collection 2125
Initial Value Determination 2130
Use Frequency 2135
Value Adjustment 2140
Service Value Information 2145
Communication /Distribution 2150

Fig. 21

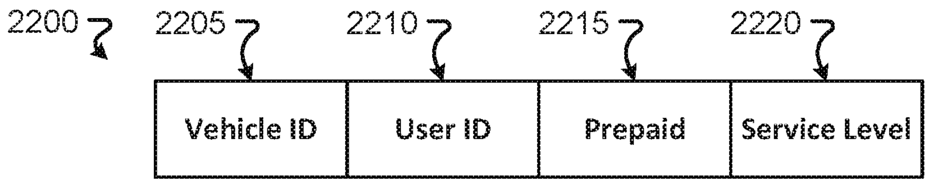
2200
2205
2210
2215
2220
Vehicle ID
User ID
Prepaid
Service Level

Fig. 22

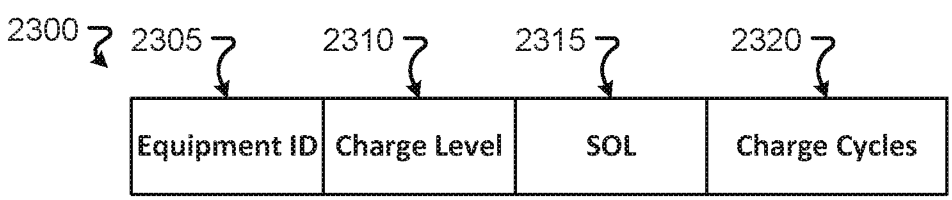
2300
2305
2310
2315
2320
Equipment ID
Charge Level
SOL
Charge Cycles

Fig. 23

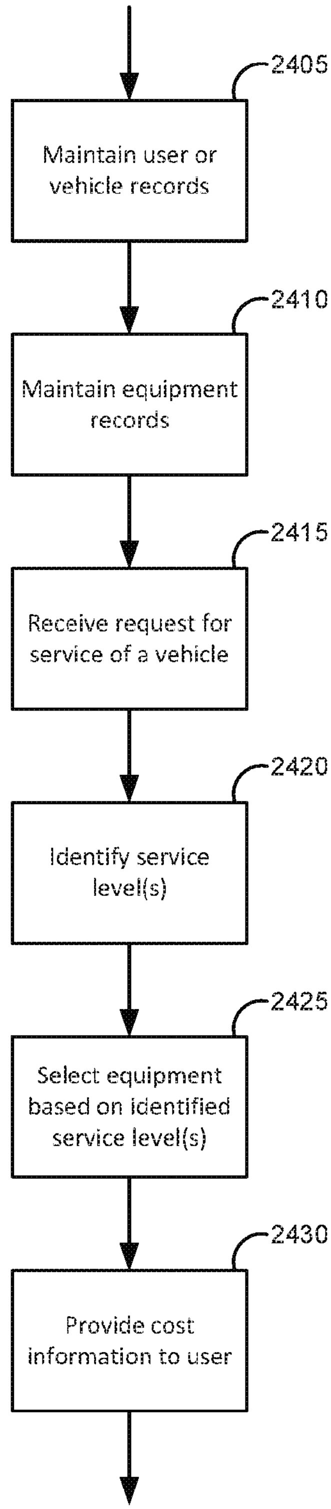
2405
Maintain user or vehicle records
2410
Maintain equipment records
2415
Receive request for service of a vehicle
2420
Identify service level(s)
2425
Select equipment based on identified service level(s)
2430
Provide cost information to user

Fig. 24

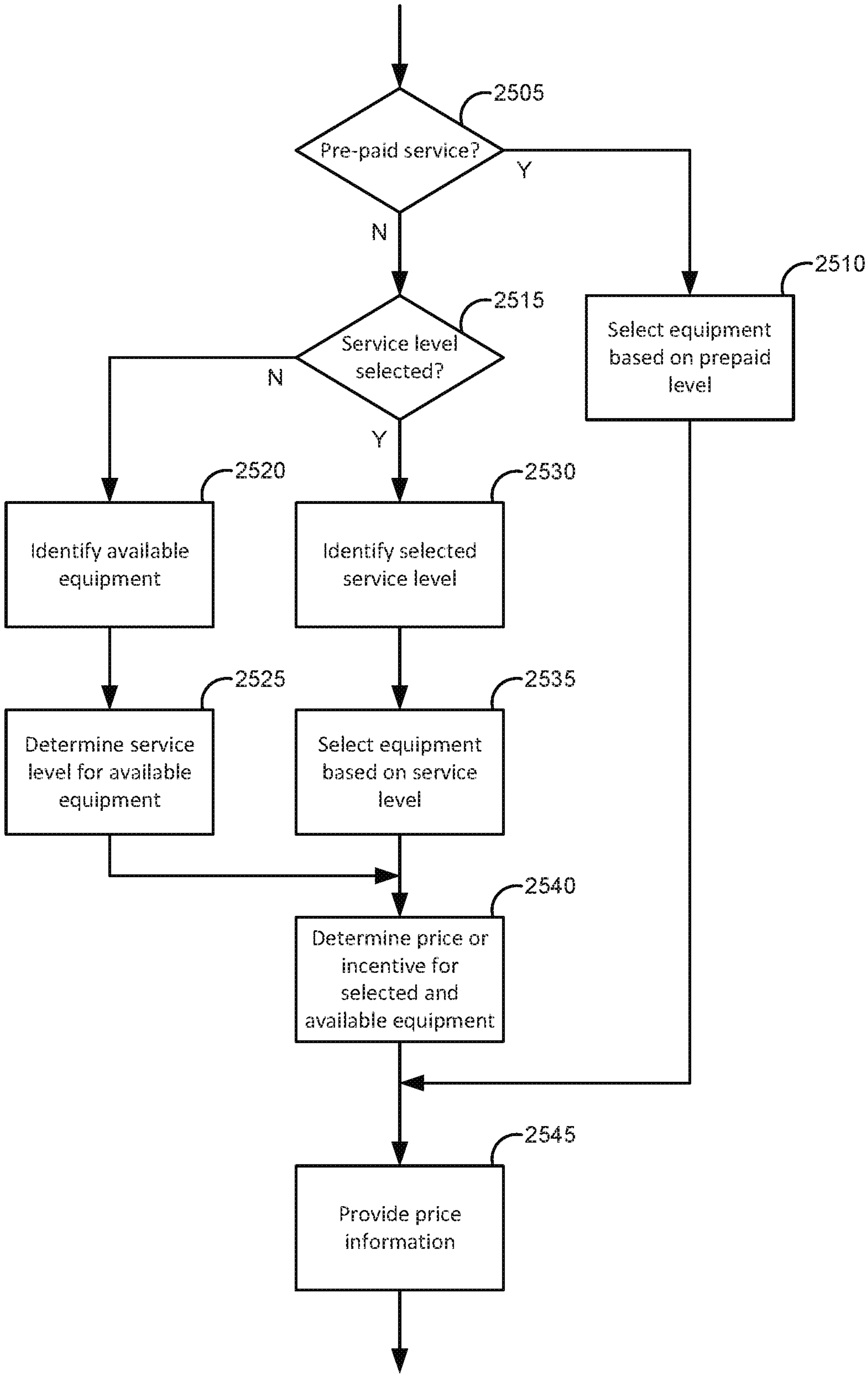
2505
Pre-paid service?
Y
N
2510
Select equipment based on prepaid level
2515
Service level selected?
N
Y
2520
Identify available equipment
2530
Identify selected service level
2525
Determine service level for available equipment
2535
Select equipment based on service level
2540
Determine price or incentive for selected and available equipment
2545
Provide price information

Fig. 25

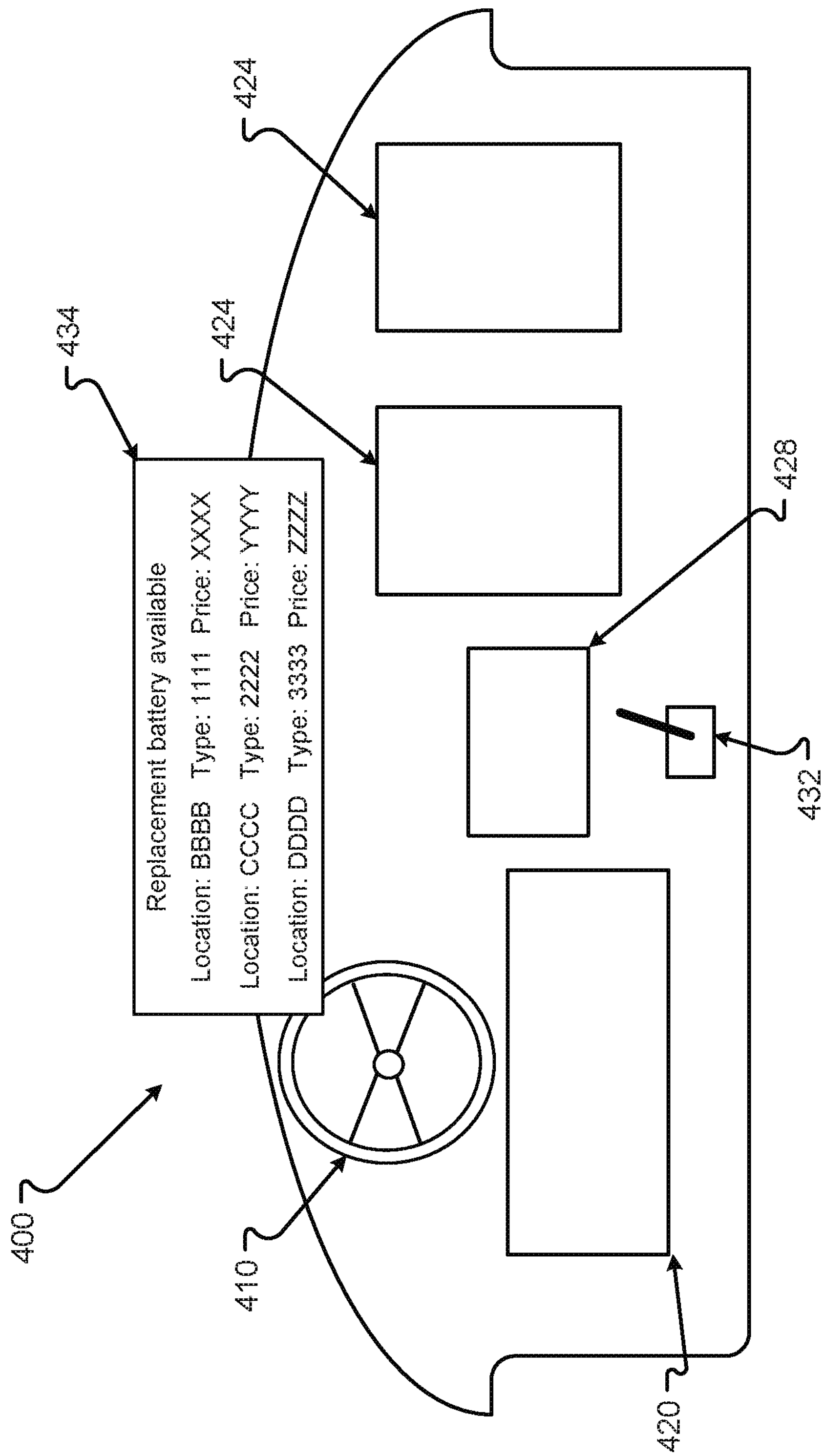
400
410
420
424
424
428
432
434
Replacement battery available
Location: BBBB Type: 1111 Price: XXXX
Location: CCCC Type: 2222 Price: YYYY
Location: DDDD Type: 3333 Price: ZZZZ

Fig. 26

BATTERY EXCHANGE LICENSING PROGRAM BASED ON STATE OF CHARGE OF BATTERY PACK

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefits of and priority, under 35 U.S.C. §119(e), to U.S. Provisional Application Ser. Nos. 62/255,214, filed on Nov. 13, 2015, entitled "Electric Vehicle Systems and Operation"; 62/259,536, filed Nov. 24, 2015, entitled "Charging Transmission Line Under Roadway for Moving Electric Vehicle"; 62/266,452, filed Dec. 11, 2015, entitled "Charging Transmission Line Under Roadway for Moving Electric Vehicle"; 62/269,764, filed Dec. 18, 2015, entitled "Conditional Progressive Degradation of Electric Vehicle Power Supply System"; 62/300,606, filed Feb. 26, 2016, entitled "Charging Transmission Line Under Roadway for Moving Electric Vehicle"; 62/310,387, filed Mar. 18, 2016, entitled "Distributed Processing Network for Rechargeable Electric Vehicle Tracking and Routing"; 62/359,563, filed Jul. 7, 2016, entitled "Next Generation Vehicle"; and 62/378,348, filed Aug. 23, 2016, entitled "Next Generation Vehicle." The entire disclosures of the applications listed above are hereby incorporated by reference, in their entirety, for all that they teach and for all purposes.

[0002] This application is also related to U.S. patent application Ser. No. 14/954,436 filed Nov. 30, 2015, entitled "Electric Vehicle Roadway Charging System and Method of Use" (Attorney's Ref. No. 8322-2); U.S. patent application Ser. No. 14/954,484 filed Nov. 30, 2015, entitled "Electric Vehicle Charging Device Positioning and Method of Use" (Attorney's Ref. No. 8322-3); U.S. patent application Ser. No. 14/979,158 filed Dec. 22, 2015, entitled "Electric Vehicle Charging Device Alignment and Method of Use" (Attorney's Ref. No. 8322-4); U.S. patent application Ser. No. 14/981,368 filed Dec. 28, 2015, entitled "Electric Vehicle Charging Device Obstacle Avoidance and Warning System and Method of Use" (Attorney's Ref. No. 8322-5); U.S. patent application Ser. No. 15/010,701 filed Jan. 29, 2016, entitled "Electric Vehicle Emergency Charging System and Method of Use" (Attorney's Ref. No. 8322-7); U.S. patent application Ser. No. 15/010,921 filed Jan. 29, 2016, entitled "Electric Vehicle Aerial Vehicle Charging System and Method of Use" (Attorney's Ref. No. 8322-8); U.S. patent application Ser. No. 15/044,940 filed Feb. 16, 2016, entitled "Electric Vehicle Overhead Charging System and Method of Use" (Attorney's Ref. No. 8322-11); U.S. patent application Ser. No. 15/048,307 filed Feb. 19, 2016, entitled "Electric Vehicle Charging Station System and Method of Use" (Attorney's Ref. No. 8322-10); U.S. patent application Ser. No. 15/055,345 filed Feb. 26, 2016, entitled "Charging Transmission Line Under Roadway For Moving Electric Vehicle" (Attorney's Ref. No. 8322-12); U.S. patent application Ser. No. 15/074,593 filed Mar. 18, 2016, entitled "Multi-Mode Rechargeable Electric Vehicle" (Attorney's Ref. No. 8322-13); U.S. patent application Ser. No. 15/074,624 filed Mar. 18, 2016, entitled "Distributed Processing Network for Rechargeable Electric Vehicle Tracking and Routing" (Attorney's Ref. No. 8322-14); U.S. patent application Ser. No. 15/143,083 filed Apr. 29, 2016, entitled "Vehicle To Vehicle Charging System and Method of Use" (Attorney's Ref. No. 8322-16); U.S. patent application Ser. No. 15/145,416 filed May 3, 2016, entitled "Electric Vehicle Optical Charging System and Method of Use" (Attorney's Ref. No. 8322-15); U.S. patent application Ser. No. 15/169,073 filed May 31, 2016, entitled "Vehicle Charge Exchange System and Method of Use" (Attorney's Ref. No. 8322-17); U.S. patent application Ser. No. 15/170,406 filed Jun. 1, 2016, entitled "Vehicle Group Charging System and Method of Use" (Attorney's Ref. No. 8322-18); U.S. patent application Ser. No. 15/196,898 filed Jun. 29, 2016, entitled "Predictive Charging System and Method of Use" (Attorney's Ref. No. 8322-19); U.S. patent application Ser. No. 15/198,034 filed Jun. 30, 2016, entitled "Integrated Vehicle Charging Panel System and Method of Use" (Attorney's Ref. No. 8322-20); U.S. patent application Ser. No. 15/223,814 filed Jul. 29, 2016, entitled "Vehicle Skin Charging System and Method" (Attorney's Ref. No. 8322-22); U.S. patent application Ser. No. 15/226,446 filed Aug. 2, 2016, entitled "Vehicle Capacitive Charging System and Method of Use" (Attorney's Ref. No. 8322-23); U.S. patent application Ser. No. 15/237,937 filed Aug. 16, 2016, entitled "Smart Grid Management" (Attorney's Ref. No. 8322-28); U.S. patent application Ser. No. 15/246,867 filed Aug. 25, 2016, entitled "Electric Contact Device for Electric Vehicles and Method of Use" (Attorney's Ref. No. 8322-25); and U.S. patent application Ser. No. 15/254,915 filed Sep. 1, 2016, entitled "Multi-Vehicle Communications and Control System" (Attorney's Ref. No. 8322-27). The entire disclosures of the applications listed above are hereby incorporated by reference, in their entirety, for all that they teach and for all purposes.

FIELD

[0003] The present disclosure is generally directed to vehicle systems, in particular, toward electric and/or hybrid-electric vehicles.

BACKGROUND

[0004] In recent years, transportation methods have changed substantially. This change is due in part to a concern over the limited availability of natural resources, a proliferation in personal technology, and a societal shift to adopt more environmentally friendly transportation solutions. These considerations have encouraged the development of a number of new flexible-fuel vehicles, hybrid-electric vehicles, and electric vehicles.

[0005] While these vehicles appear to be new they are generally implemented as a number of traditional subsystems that are merely tied to an alternative power source. In fact, the design and construction of the vehicles is limited to standard frame sizes, shapes, materials, and transportation concepts. Among other things, these limitations fail to take advantage of the benefits of new technology, power sources, and support infrastructure.

SUMMARY

[0006] A model can be defined for managing a service in which a benefit or incentive can be provided to a vehicle operator for exchanging parts or receiving a service at a particular service level. The model may be prepaid or paid upon service being rendered. The service level may be preselected or selected at the time of service delivery. For example, the vehicle owner or operator may receive a credit or discount for exchanging a current battery pack or other power source of the vehicle for a lower charged battery pack

or power source which can be later charged by the operator. In such cases, when a user initially purchases and/or licenses a battery pack, for instance, the user can specify and perhaps prepay for an acceptable stored charge range for exchanged battery packs. For example, a user at a high service level can pay a higher amount for a replacement with a high, e.g., 60%-100%, charge level while a user at a lower service level can pay a lower amount for a replacement with a low, e.g., 40%-100%, charge level. This lower level might be attractive, for example, to hybrid vehicle users exchanging battery packs with electric vehicle users.

[0007] In another example, the service level can additionally or alternatively be based on the State of Life (SOL) of the replacement. That is, instead of charge, the service levels can be distinguished based on the SOL of the equipment used for the exchange and the user can specify and pay a premium based on the age of a battery pack and/or battery pack usage level, e.g., historic charging cycle number. For example, in a battery pack exchange, a high service level user can receive the newest available battery pack or battery pack having the lowest use, e.g., lowest historic charging cycles, relative to a lower service level user.

[0008] According to one embodiment, managing an exchange of a vehicle power source can comprise maintaining a set of user or vehicle records for each of one or more users or vehicles and maintaining a set of equipment records for each of a plurality of pieces of equipment. A request for service of a vehicle can be received. The service can comprise at least an exchange of a power source of the vehicle. At least one service level of a plurality of service levels can be identified for the requested service based at least in part on the set of user or vehicle records. At least one available power source can be selected for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records. Identifying the at least one service level for the requested service and selecting at least one available power source can further comprise determining a value or price for the selected power source. The determined value or price for the selected power source can then be provided to the vehicle and/or the user.

[0009] For example, the vehicle power source can comprise a battery. The plurality of service levels can be defined based on a level of charge of a battery used for the exchange of the vehicle power source. In such cases, a first service level of the plurality of service levels can be defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and a cost for the first service level is higher than a cost for the second service level. In another example, the plurality of service levels can be defined based on a state of life of a battery used for the exchange of the vehicle power source. In such cases, a first service level of the plurality of service levels can be defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and a cost for the first service level is higher than a cost for the second service level.

[0010] As noted, the model can be prepaid in some cases. According to one embodiment, determining a value or price for a replacement part or service can comprise determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels. This determination can be made, for example, based on the maintained set of user or vehicle records. In response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, an available power source selected for the exchange of the power source of the vehicle based on the pre-elected service level. In this case, further determination of the value or price of the replacement part need not be performed since the service was prepaid.

[0011] As noted, even if not prepaid, the model can allow the user to preselect a service level. Thus, in response to determining the requested service is not a prepaid service at a preselected service level of a plurality of service levels, a further determination can be made as to whether the at least one service level has been preselected. This determination can be made, for example, based on the maintained set of user or vehicle records. In other cases, the determination may be made based on information in the request for service or by querying the user. In response to determining the at least one service level has been preselected, the preselected service level can be identified and at least one available power source can be selected for the exchange of the power source of the vehicle based on the preselected service level. A value or price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle can be determined and provided to the user.

In response to determining a service level has not been preselected, one or more available power sources for the exchange of the power source of the vehicle identifying and a service level for each of the identified one or more available power sources can be determined. A value or price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle can be determined and provided to a user. At this point, the user may be able to select which available equipment or level of service to be used for the exchange or service.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** shows a vehicle in accordance with embodiments of the present disclosure;

[0013] FIG. **2** shows a vehicle in an environment in accordance with embodiments of the present disclosure;

[0014] FIG. **3** is a diagram of an embodiment of a data structure for storing information about a vehicle in an environment;

[0015] FIG. **4**A shows a vehicle in a user environment in accordance with embodiments of the present disclosure;

[0016] FIG. **4**B shows a vehicle in a fleet management and automated operation environment in accordance with embodiments of the present disclosure;

[0017] FIG. **4**C shows an embodiment of the instrument panel of the vehicle according to one embodiment of the present disclosure;

[0018] FIG. **5** shows charging areas associated with an environment in accordance with embodiments of the present disclosure;

[0019] FIG. **6** shows a vehicle in a roadway charging environment in accordance with embodiments of the present disclosure;

[0020] FIG. **7** shows a vehicle in a robotic charging station environment in accordance with another embodiment of the present disclosure;

[0021] FIG. **8** shows a vehicle in an overhead charging environment in accordance with another embodiment of the present disclosure;

[0022] FIG. **9** shows a vehicle in a roadway environment comprising roadway vehicles in accordance with another embodiment of the present disclosure;

[0023] FIG. **10** shows a vehicle in an aerial vehicle charging environment in accordance with another embodiment of the present disclosure;

[0024] FIG. **11** shows a vehicle in an emergency charging environment in accordance with embodiments of the present disclosure;

[0025] FIG. **12** is a perspective view of a vehicle in accordance with embodiments of the present disclosure;

[0026] FIG. **13** is a plan view of a vehicle in accordance with at least some embodiments of the present disclosure;

[0027] FIG. **14** is a plan view of a vehicle in accordance with embodiments of the present disclosure;

[0028] FIG. **15** is a block diagram of an embodiment of an electrical system of the vehicle;

[0029] FIG. **16** is a block diagram of an embodiment of a power generation unit associated with the electrical system of the vehicle;

[0030] FIG. **17** is a block diagram of an embodiment of power storage associated with the electrical system of the vehicle;

[0031] FIG. **18** is a block diagram of an embodiment of loads associated with the electrical system of the vehicle;

[0032] FIG. **19**A is a block diagram of an exemplary embodiment of a communications subsystem of the vehicle;

[0033] FIG. **19**B is a block diagram of a computing environment associated with the embodiments presented herein;

[0034] FIG. **19**C is a block diagram of a computing device associated with one or more components described herein;

[0035] FIG. **20** is a diagram illustrating a vehicle in an exemplary environment according to one embodiment of the present disclosure;

[0036] FIG. **21** is a block diagram illustrating components of a system for applying provider or seller rules to a service according to one embodiment of the present disclosure;

[0037] FIG. **22** is a diagram illustrating an exemplary data structure of records for storing vehicle or user information according to one embodiment of the present disclosure;

[0038] FIG. **23** is a diagram illustrating an exemplary data structure of records for storing equipment information according to one embodiment of the present disclosure;

[0039] FIG. **24** is a flowchart illustrating an exemplary process for applying provider or seller rules to a service according to one embodiment of the present disclosure;

[0040] FIG. **25** is a flowchart illustrating an exemplary process for determining a value for a replacement part or service according to one embodiment of the present disclosure; and

[0041] FIG. **26** is a diagram illustrating an exemplary instrument panel of a vehicle according to one embodiment of the present disclosure.

DETAILED DESCRIPTION

[0042] Embodiments of the present disclosure will be described in connection with a vehicle, and in accordance with one exemplary embodiment an electric vehicle and/or hybrid-electric vehicle and associated systems.

[0043] With attention to FIGS. **1-11**, embodiments of the electric vehicle system **10** and method of use are depicted.

[0044] Referring to FIG. **1**, the electric vehicle system comprises electric vehicle **100**. The electric vehicle **100** comprises vehicle front **110**, vehicle aft **120**, vehicle roof **130**, vehicle side **160**, vehicle undercarriage **140** and vehicle interior **150**.

[0045] Referring to FIG. **2**, the vehicle **100** is depicted in a plurality of exemplary environments. The vehicle **100** may operate in any one or more of the depicted environments in any combination. Other embodiments are possible but are not depicted in FIG. **2**. Generally, the vehicle **100** may operate in environments which enable charging of the vehicle **100** and/or operation of the vehicle **100**. More specifically, the vehicle **100** may receive a charge via one or more means comprising emergency charging vehicle system **270**, aerial vehicle charging system **280**, roadway system **250**, robotic charging system **254** and overhead charging system **258**. The vehicle **100** may interact and/or operate in an environment comprising one or more other roadway vehicles **260**. The vehicle **100** may engage with elements within the vehicle **100** comprising vehicle driver **220**, vehicle passengers **220** and vehicle database **210**. In one embodiment, vehicle database **210** does not physically reside in the vehicle **100** but is instead accessed remotely, e.g. by wireless communication, and resides in another location such as a residence or business location. Vehicle **100** may operate autonomously and/or semi-autonomously in an autonomous environment **290** (here, depicted as a roadway environment presenting a roadway obstacle of which the vehicle **100** autonomously identifies and steers the vehicle **100** clear of the obstacle). Furthermore, the vehicle **100** may engage with a remote operator system **240**, which may provide fleet management instructions or control.

[0046] FIG. **3** is a diagram of an embodiment of a data structure **300** for storing information about a vehicle **100** in an environment. The data structure may be stored in vehicle database **210**. Generally, data structure **300** identifies operational data associated with charging types **310**A. The data structures **300** may be accessible by a vehicle controller. The data contained in data structure **300** enables, among other things, for the vehicle **100** to receive a charge from a given charging type.

[0047] Data may comprise charging type **310**A comprising a manual charging station **310**J, robotic charging station **310**K such as robotic charging system **254**, a roadway charging system **310**L such as those of roadway system **250**, an emergency charging system **310**M such as that of emergency charging vehicle system **270**, an emergency charging system **310**N such as that of aerial vehicle charging system **280**, and overhead charging type **3100** such as that of overhead charging system **258**.

[0048] Compatible vehicle charging panel types **310**B comprise locations on vehicle **100** wherein charging may be received, such as vehicle roof **130**, vehicle side **160** and vehicle lower or undercarriage **140**. Compatible vehicle storage units **310**C data indicates storage units types that may receive power from a given charging type **310**A. Available automation level **310**D data indicates the degree of automation available for a given charging type; a high level may indicate full automation, allowing the vehicle driver **220** and/or vehicle passengers **230** to not involve themselves in charging operations, while a low level of automation may require the driver **220** and/or occupant **230** to manipulate/position a vehicle charging device to engage with a particular charging type **310**A to receive charging. Charging status **310**E indicates whether a charging type **310**A is available for charging (i.e. is "up") or is unavailable for charging (i.e. is "down"). Charge rate **310**F provides a relative value for time to charge, while Cost **310**G indicates the cost to vehicle **100** to receive a given charge. The Other data element **310**H may provide additional data relevant to a given charging type **310**A, such as a recommended separation distance between a vehicle charging plate and the charging source. The Shielding data element **310**I indicates if electromagnetic shielding is recommended for a given charging type **310**A and/or charging configuration. Further data fields **310**P, **310**Q are possible.

[0049] FIG. **4**A depicts the vehicle **100** in a user environment comprising vehicle database **210**, vehicle driver **220** and vehicle passengers **230**. Vehicle **100** further comprises vehicle instrument panel **400** to facilitate or enable interactions with one or more of vehicle database **210**, vehicle driver **220** and vehicle passengers **230**. In one embodiment, driver **210** interacts with instrument panel **400** to query database **210** so as to locate available charging options and to consider or weigh associated terms and conditions of the charging options. Once a charging option is selected, driver **210** may engage or operate a manual control device (e.g., a joystick) to position a vehicle charging receiver panel so as to receive a charge.

[0050] FIG. **4**B depicts the vehicle **100** in a user environment comprising a remote operator system **240** and an autonomous driving environment **290**. In the remote operator system **240** environment, a fleet of electric vehicles **100** (or mixture of electric and non-electric vehicles) is managed and/or controlled remotely. For example, a human operator may dictate that only certain types of charging types are to be used, or only those charging types below a certain price point are to be used. The remote operator system **240** may comprise a database comprising operational data, such as fleet-wide operational data. In another example, the vehicle **100** may operate in an autonomous driving environment **290** wherein the vehicle **100** is operated with some degree of autonomy, ranging from complete autonomous operation to semi-automation wherein only specific driving parameters (e.g., speed control or obstacle avoidance) are maintained or controlled autonomously. In FIG. **4**B, autonomous driving environment **290** depicts an oil slick roadway hazard that triggers that triggers the vehicle **100**, while in an automated obstacle avoidance mode, to automatically steer around the roadway hazard.

[0051] FIG. **4**C shows one embodiment of the vehicle instrument panel **400** of vehicle **100**. Instrument panel **400** of vehicle **100** comprises steering wheel **410**, vehicle operational display **420** (which would provide basic driving data such as speed), one or more auxiliary displays **424** (which may display, e.g., entertainment applications such as music or radio selections), heads-up display **434** (which may provide, e.g., guidance information such as route to destination, or obstacle warning information to warn of a potential collision, or some or all primary vehicle operational data such as speed), power management display **428** (which may provide, e.g., data as to electric power levels of vehicle **100**), and charging manual controller **432** (which provides a physical input, e.g. a joystick, to manual maneuver, e.g., a vehicle charging plate to a desired separation distance). One or more of displays of instrument panel **400** may be touch-screen displays. One or more displays of instrument panel **400** may be mobile devices and/or applications residing on a mobile device such as a smart phone.

[0052] FIG. **5** depicts a charging environment of a roadway charging system **250**. The charging area may be in the roadway **504**, on the roadway **504**, or otherwise adjacent to the roadway **504**, and/or combinations thereof. This static charging area **520**B may allow a charge to be transferred even while the electrical vehicle **100** is moving. For example, the static charging area **520**B may include a charging transmitter (e.g., conductor, etc.) that provides a transfer of energy when in a suitable range of a receiving unit (e.g., an inductor pick up, etc.). In this example, the receiving unit may be a part of the charging panel associated with the electrical vehicle **100**.

[0053] The static charging areas **520**A, **520**B may be positioned a static area such as a designated spot, pad, parking space **540**A, **540**B, traffic controlled space (e.g., an area adjacent to a stop sign, traffic light, gate, etc.), portion of a building, portion of a structure, etc., and/or combinations thereof. Some static charging areas may require that the electric vehicle **100** is stationary before a charge, or electrical energy transfer, is initiated. The charging of vehicle **100** may occur by any of several means comprising a plug or other protruding feature. The power source **516**A, **516**B may include a receptacle or other receiving feature, and/or vice versa.

[0054] The charging area may be a moving charging area **520**C. Moving charging areas **520**C may include charging areas associated with one or more portions of a vehicle, a robotic charging device, a tracked charging device, a rail charging device, etc., and/or combinations thereof. In a moving charging area **520**C, the electrical vehicle **100** may be configured to receive a charge, via a charging panel, while the vehicle **100** is moving and/or while the vehicle **100** is stationary. In some embodiments, the electrical vehicle **100** may synchronize to move at the same speed, acceleration, and/or path as the moving charging area **520**C. In one embodiment, the moving charging area **520**C may synchronize to move at the same speed, acceleration, and/or path as the electrical vehicle **100**. In any event, the synchronization may be based on an exchange of information communicated across a communications channel between the electric vehicle **100** and the charging area **520**C. Additionally or alternatively, the synchronization may be based on information associated with a movement of the electric vehicle **100** and/or the moving charging area **520**C. In some embodiments, the moving charging area **520**C may be configured to move along a direction or path **532** from an origin position to a destination position **520**C'.

[0055] In some embodiments, a transformer may be included to convert a power setting associated with a main power supply to a power supply used by the charging areas **520**A-C. For example, the transformer may increase or decrease a voltage associated with power supplied via one or more power transmission lines.

[0056] Referring to FIG. **6**, a vehicle **100** is shown in a charging environment in accordance with embodiments of the present disclosure. The system **10** comprises a vehicle **100**, an electrical storage unit **612**, an external power source **516** able to provide a charge to the vehicle **100**, a charging panel **608** mounted on the vehicle **100** and in electrical communication with the electrical storage unit **612**, and a vehicle charging panel controller **610**. The charging panel controller **610** may determine if the electrical storage unit requires charging and if conditions allow for deployment of a charging panel. The vehicle charging panel **608** may operate in at least a retracted state and a deployed state (**608** and **608**' as shown is FIG. **6**), and is movable by way of an armature.

[0057] The charging panel controller **610** may receive signals from vehicle sensors **626** to determine, for example, if a hazard is present in the path of the vehicle **100** such that deployment of the vehicle charging panel **608** is inadvisable. The charging panel controller **610** may also query vehicle database **210** comprising data structures **300** to establish other required conditions for deployment. For example, the database may provide that a particular roadway does not provide a charging service or the charging service is inactive, wherein the charging panel **108** would not be deployed.

[0058] The power source **516** may include at least one electrical transmission line **624** and at least one power transmitter or charging area **520**. During a charge, the charging panel **608** may serve to transfer energy from the power source **516** to at least one energy storage unit **612** (e.g., battery, capacitor, power cell, etc.) of the electric vehicle **100**.

[0059] FIG. **7** shows a vehicle **100** in a charging station environment **254** in accordance with another embodiment of the present disclosure. Generally, in this embodiment of the disclosure, charging occurs from a robotic unit **700**.

[0060] Robotic charging unit **700** comprises one or more robotic unit arms **704**, at least one robotic unit arm **704** interconnected with charging plate **520**. The one or more robotic unit arms **704** manoeuver charging plate **520** relative to charging panel **608** of vehicle **100**. Charging plate **520** is positioned to a desired or selectable separation distance, as assisted by a separation distance sensor disposed on charging plate **520**. Charging plate **520** may remain at a finite separation distance from charging panel **608**, or may directly contact charging panel (i.e. such that separation distance is zero). Charging may be by induction. In alternative embodiments, separation distance sensor is alternatively or additionally disposed on robotic arm **704**. Vehicle **100** receives charging via charging panel **608** which in turn charges energy storage unit **612**. Charging panel controller **610** is in communication with energy storage unit **612**, charging panel **608**, vehicle database **300**, charge provider controller **622**, and/or any one of elements of instrument panel **400**.

[0061] Robotic unit further comprises, is in communication with and/or is interconnected with charge provider controller **622**, power source **516** and a robotic unit database. Power source **516** supplies power, such as electrical power, to charge plate **520** to enable charging of vehicle **100** via charging panel **608**. Controller **622** manoeuvers or operates robotic unit **704**, either directly and/or completely or with assistance from a remote user, such as a driver or passenger in vehicle **100** by way of, in one embodiment, charging manual controller **432**.

[0062] FIG. **8** shows a vehicle **100** in an overhead charging environment in accordance with another embodiment of the present disclosure. Generally, in this embodiment of the disclosure, charging occurs from an overhead towered charging system **258**, similar to existing commuter rail systems. Such an overhead towered system **258** may be easier to build and repair compared to in-roadway systems. Generally, the disclosure includes a specially-designed overhead roadway charging system comprising an overhead charging cable or first wire **814** that is configured to engage an overhead contact **824** which provides charge to charging panel **608** which provides charge to vehicle energy storage unit **612**. The overhead towered charging system **258** may further comprise second wire **818** to provide stability and structural strength to the roadway charging system **800**. The first wire **814** and second wire **818** are strung between towers **810**.

[0063] The overhead charging cable or first wire **814** is analogous to a contact wire used to provide charging to electric trains or other vehicles. An external source provides or supplies electrical power to the first wire **814**. The charge provider comprises an energy source i.e. a provider battery and a provider charge circuit or controller in communication with the provider battery. The overhead charging cable or first wire **814** engages the overhead contact **824** which is in electrical communication with charge receiver panel **108**. The overhead contact **824** may comprise any known means to connect to overhead electrical power cables, such as a pantograph **820**, a bow collector, a trolley pole or any means known to those skilled in the art. Further disclosure regarding electrical power or energy transfer via overhead systems is found in US Pat. Publ. No. 2013/0105264 to Ruth entitled "Pantograph Assembly," the entire contents of which are incorporated by reference for all purposes. In one embodiment, the charging of vehicle **100** by overhead charging system **800** via overhead contact **824** is by any means know to those skilled in the art, to include those described in the above-referenced US Pat. Publ. No. 2013/0105264 to Ruth.

[0064] The overhead contact **824** presses against the underside of the lowest overhead wire of the overhead charging system, i.e. the overhead charging cable or first wire **814**, aka the contact wire. The overhead contact **824** may be electrically conductive. Alternatively or additionally, the overhead contact **824** may be adapted to receive electrical power from overhead charging cable or first wire **814** by inductive charging.

[0065] In one embodiment, the receipt and/or control of the energy provided via overhead contact **824** (as connected to the energy storage unit **612**) is provided by receiver charge circuit or charging panel controller **110**.

[0066] Overhead contact **824** and/or charging panel **608** may be located anywhere on vehicle **100**, to include, for example, the roof, side panel, trunk, hood, front or rear bumper of the charge receiver **100** vehicle, as long as the overhead contact **824** may engage the overhead charging cable or first wire **814**. Charging panel **108** may be stationary (e.g. disposed on the roof of vehicle **100**) or may be moveable, e.g. moveable with the pantograph **820**. Pantograph **820** may be positioned in at least two states comprising retracted and extended. In the extended state pantograph **820** engages first wire **814** by way of the overhead contact **824**. In the retracted state, pantograph **820** may typically reside flush with the roof of vehicle **100** and extend only when required for charging. Control of the charging and/or positioning of the charging plate **608**, pantograph **820** and/or overhead contact **824** may be manual, automatic or semi-automatic (such as via controller **610**); said control may be performed through a GUI engaged by driver or occupant of receiving vehicle **100** and/or driver or occupant of charging vehicle.

[0067] FIG. **9** shows a vehicle in a roadway environment comprising roadway vehicles **260** in accordance with another embodiment of the present disclosure. Roadway vehicles **260** comprise roadway passive vehicles **910** and roadway active vehicles **920**. Roadway passive vehicles **910** comprise vehicles that are operating on the roadway of vehicle **100** but do no cooperatively or actively engage with vehicle **100**. Stated another way, roadway passive vehicles **910** are simply other vehicles operating on the roadway with the vehicle **100** and must be, among other things, avoided (e.g., to include when vehicle **100** is operating in an autonomous or semi-autonomous manner). In contrast, roadway active vehicles **920** comprise vehicles that are operating on the roadway of vehicle **100** and have the capability to, or actually are, actively engaging with vehicle **100**. For example, the emergency charging vehicle system **270** is a roadway active vehicle **920** in that it may cooperate or engage with vehicle **100** to provide charging. In some embodiments, vehicle **100** may exchange data with a roadway active vehicle **920** such as, for example, data regarding charging types available to the roadway active vehicle **920**.

[0068] FIG. **10** shows a vehicle in an aerial vehicle charging environment in accordance with another embodiment of the present disclosure. Generally, this embodiment involves an aerial vehicle ("AV"), such as an Unmanned Aerial Vehicle (UAV), flying over or near a vehicle to provide a charge. The UAV may also land on the car to provide an emergency (or routine) charge. Such a charging scheme may be particularly suited for operations in remote areas, in high traffic situations, and/or when the car is moving. The AV may be a specially-designed UAV, aka RPV or drone, with a charging panel that can extend from the AV to provide a charge. The AV may include a battery pack and a charging circuit to deliver a charge to the vehicle. The AV may be a manned aerial vehicle, such as a piloted general aviation aircraft, such as a Cessna **172**.

[0069] With reference to FIG. **10**, an exemplar embodiment of a vehicle charging system **100** comprising a charge provider configured as an aerial vehicle **280**, the aerial vehicle **280** comprising a power source **516** and charge provider controller **622**. The AV may be semi-autonomous or fully autonomous. The AV may have a remote pilot/operator providing control inputs. The power source **516** is configured to provide a charge to a charging panel **608** of vehicle **100**. The power source **516** is in communication with the charge provider controller **622**. The aerial vehicle **280** provides a tether **1010** to deploy or extend charging plate **520** near to charging panel **608**. The tether **1010** may comprise a chain, rope, rigid or semi-rigid tow bar or any means to position charging plate **520** near charging panel **608**. For example, tether **1010** may be similar to a refueling probe used by airborne tanker aircraft when refueling another aircraft.

[0070] In one embodiment, the charging plate **520** is not in physical interconnection to AV **280**, that is, there is no tether **1010**. In this embodiment, the charging plate **520** is positioned and controlled by AV **280** by way of a controller on AV **280** or in communication with AV **280**.

[0071] In one embodiment, the charging plate **520** position and/or characteristics (e.g. charging power level, flying separation distance, physical engagement on/off) are controlled by vehicle **100** and/or a user in or driver of vehicle **100**.

[0072] Charge or power output of power source **516** is provided or transmitted to charger plate **620** by way of a charging cable or wire, which may be integral to tether **1010**. In one embodiment, the charging cable is non-structural, that is, it provides zero or little structural support to the connection between AV **280** and charger plate **520**.

[0073] Charging panel **608** of vehicle **100** receives power from charger plate **520**. Charging panel **608** and charger plate **520** may be in direct physical contact (termed a "contact" charger configuration) or not in direct physical contact (termed a "flyer" charger configuration), but must be at or below a threshold (separation) distance to enable charging, such as by induction. Energy transfer or charging from the charger plate **520** to the charging panel **608** is inductive charging (i.e. use of an EM field to transfer energy between two objects). The charging panel **608** provides received power to energy storage unit **612** by way of charging panel controller **610**. Charging panel controller **610** is in communication with vehicle database **210**, vehicle database **210** comprising an AV charging data structure.

[0074] Charging panel **508** may be located anywhere on vehicle **100**, to include, for example, the roof, side panel, trunk, hood, front or rear bumper and wheel hub of vehicle **100**. Charging panel **608** is mounted on the roof of vehicle **100** in the embodiment of FIG. **10**. In some embodiments, charging panel **608** may be deployable, i.e. may extend or deploy only when charging is needed. For example, charging panel **608** may typically reside flush with the roof of vehicle **100** and extend when required for charging. Similarly, charger plate **520** may, in one embodiment, not be connected to AV **280** by way of tether **1010** and may instead be mounted directly on the AV **280**, to include, for example, the wing, empennage, undercarriage to include landing gear, and may be deployable or extendable when required. Tether **1010** may be configured to maneuver charging plate **520** to any position on vehicle **100** so as to enable charging. In one embodiment, the AV **280** may land on the vehicle **100** so as to enable charging through direct contact (i.e. the aforementioned contact charging configuration) between the charging plate **520** and the charging panel **608** of vehicle **100**. Charging may occur while both AV **280** and vehicle **100** are moving, while both vehicle **100** and AV **280** are not moving (i.e., vehicle **100** is parked and AV **280** lands on top of vehicle **100**), or while vehicle **100** is parked and AV **280** is hovering or circling above. Control of the charging and/or positioning of the charging plate **520** may be manual, automatic or semi-automatic; said control may be performed through a GUI engaged by driver or occupant of receiving vehicle **100** and/or driver or occupant of charging AV **280**.

[0075] FIG. **11** is an embodiment of a vehicle emergency charging system comprising an emergency charging vehicle **270** and charge receiver vehicle **100** is disclosed. The emergency charging vehicle **270** is a road vehicle, such as a pick-up truck, as shown in FIG. **11**. The emergency charging vehicle **270** is configured to provide a charge to a charge receiver vehicle **100**, such as an automobile. The emergency charging vehicle **270** comprises an energy source i.e. a charging power source **516** and a charge provider controller **622** in communication with the charging power source **516**. The emergency charging vehicle **270** provides a towed and/or articulated charger plate **520**, as connected to the emergency charging vehicle **270** by connector **1150**. The connector **1150** may comprise a chain, rope, rigid or semi-rigid tow bar or any means to position charger plate **520** near the charging panel **608** of vehicle **100**. Charge or power output of charging power source **516** is provided or transmitted to charger plate **520** by way of charging cable or wire **1140**. In one embodiment, the charging cable **1140** is non-structural, that is, it provides little or no structural support to the connection between emergency charging vehicle **270** and charging panel **608**. Charging panel **608** (of vehicle **100**) receives power from charger plate **520**. Charger plate **520** and charging panel **608** may be in direct physical contact or not in direct physical contact, but must be at or below a threshold separation distance to enable charging, such as by induction. Charger plate **520** may comprise wheels or rollers so as to roll along roadway surface. Charger plate **520** may also not contact the ground surface and instead be suspended above the ground; such a configuration may be termed a "flying" configuration. In the flying configuration, charger plate may form an aerodynamic surface to, for example, facilitate stability and control of the positioning of the charging plate **520**. Energy transfer or charging from the charger plate **520** to the charge receiver panel **608** is through inductive charging (i.e. use of an EM field to transfer energy between two objects). The charging panel **608** provides received power to energy storage unit **612** directly or by way of charging panel controller **610**. In one embodiment, the receipt and/or control of the energy provided via the charging panel **608** is provided by charging panel controller **610**.

[0076] Charging panel controller **610** may be located anywhere on charge receiver vehicle **100**, to include, for example, the roof, side panel, trunk, hood, front or rear bumper and wheel hub of charge receiver **100** vehicle. In some embodiments, charging panel **608** may be deployable, i.e. may extend or deploy only when charging is needed. For example, charging panel **608** may typically stow flush with the lower plane of vehicle **100** and extend when required for charging. Similarly, charger plate **520** may, in one embodiment, not be connected to the lower rear of the emergency charging vehicle **270** by way of connector **1150** and may instead be mounted on the emergency charging vehicle **270**, to include, for example, the roof, side panel, trunk, hood, front or rear bumper and wheel hub of emergency charging vehicle **270**. Connector **1150** may be configured to maneuver connector plate **520** to any position on emergency charging vehicle **270** so as to enable charging. Control of the charging and/or positioning of the charging plate may be manual, automatic or semi-automatic; said control may be performed through a GUI engaged by driver or occupant of receiving vehicle and/or driver or occupant of charging vehicle.

[0077] FIG. **12** shows a perspective view of a vehicle **100** in accordance with embodiments of the present disclosure. Although shown in the form of a car, it should be appreciated that the vehicle **100** described herein may include any conveyance or model of a conveyance, where the conveyance was designed for the purpose of moving one or more tangible objects, such as people, animals, cargo, and the like. The term "vehicle" does not require that a conveyance moves or is capable of movement. Typical vehicles may include but are in no way limited to cars, trucks, motorcycles, busses, automobiles, trains, railed conveyances, boats, ships, marine conveyances, submarine conveyances, airplanes, space craft, flying machines, human-powered conveyances, and the like. In any event, the vehicle **100** may include a frame **1204** and one or more body panels **1208** mounted or affixed thereto. The vehicle **100** may include one or more interior components (e.g., components inside an interior space **150**, or user space, of a vehicle **100**, etc.), exterior components (e.g., components outside of the interior space **150**, or user space, of a vehicle **100**, etc.), drive systems, controls systems, structural components.

[0078] Referring now to FIG. **13**, a plan view of a vehicle **100** will be described in accordance with embodiments of the present disclosure. As provided above, the vehicle **100** may comprise a number of electrical and/or mechanical systems, subsystems, etc. The mechanical systems of the vehicle **100** can include structural, power, safety, and communications subsystems, to name a few. While each subsystem may be described separately, it should be appreciated that the components of a particular subsystem may be shared between one or more other subsystems of the vehicle **100**.

[0079] The structural subsystem includes the frame **1204** of the vehicle **100**. The frame **1204** may comprise a separate frame and body construction (i.e., body-on-frame construction), a unitary frame and body construction (i.e., a unibody construction), or any other construction defining the structure of the vehicle **100**. The frame **1204** may be made from one or more materials including, but in no way limited to steel, titanium, aluminum, carbon fiber, plastic, polymers, etc., and/or combinations thereof. In some embodiments, the frame **1204** may be formed, welded, fused, fastened, pressed, etc., combinations thereof, or otherwise shaped to define a physical structure and strength of the vehicle **100**. In any event, the frame **1204** may comprise one or more surfaces, connections, protrusions, cavities, mounting points, tabs, slots, or other features that are configured to receive other components that make up the vehicle **100**. For example, the body panels, powertrain subsystem, controls systems, interior components, communications subsystem, and safety subsystem may interconnect with, or attach to, the frame **1204** of the vehicle **100**.

[0080] The frame **1204** may include one or more modular system and/or subsystem connection mechanisms. These mechanisms may include features that are configured to provide a selectively interchangeable interface for one or more of the systems and/or subsystems described herein. The mechanisms may provide for a quick exchange, or swapping, of components while providing enhanced security and adaptability over conventional manufacturing or attachment. For instance, the ability to selectively interchange systems and/or subsystems in the vehicle **100** allow the vehicle **100** to adapt to the ever-changing technological demands of society and advances in safety. Among other things, the mechanisms may provide for the quick exchange of batteries, capacitors, power sources **1308**A, **1308**B, motors **1312**, engines, safety equipment, controllers, user interfaces, interiors exterior components, body panels **1208**, bumpers **1316**, sensors, etc., and/or combinations thereof. Additionally or alternatively, the mechanisms may provide unique security hardware and/or software embedded therein that, among other things, can prevent fraudulent or low quality construction replacements from being used in the vehicle **100**. Similarly, the mechanisms, subsystems, and/or receiving features in the vehicle **100** may employ poka-yoke, or mistake-proofing, features that ensure a particular mechanism is always interconnected with the vehicle **100** in a correct position, function, etc.

[0081] By way of example, complete systems or subsystems may be removed and/or replaced from a vehicle **100** utilizing a single minute exchange principle. In some embodiments, the frame **1204** may include slides, receptacles, cavities, protrusions, and/or a number of other features that allow for quick exchange of system components.

In one embodiment, the frame **1204** may include tray or ledge features, mechanical interconnection features, locking mechanisms, retaining mechanisms, etc., and/or combinations thereof. In some embodiments, it may be beneficial to quickly remove a used power source **1308**A, **1308**B (e.g., battery unit, capacitor unit, etc.) from the vehicle **100** and replace the used power source **1308**A, **1308**B with a charged power source. Continuing this example, the power source **1308**A, **1308**B may include selectively interchangeable features that interconnect with the frame **1204** or other portion of the vehicle **100**. For instance, in a power source **1308**A, **1308**B replacement, the quick release features may be configured to release the power source **1308**A, **1308**B from an engaged position and slide or move away from the frame **1204** of a vehicle **100**. Once removed, the power source **1308**A, **1308**B may be replaced (e.g., with a new power source, a charged power source, etc.) by engaging the replacement power source into a system receiving position adjacent to the vehicle **100**. In some embodiments, the vehicle **100** may include one or more actuators configured to position, lift, slide, or otherwise engage the replacement power source with the vehicle **100**. In one embodiment, the replacement power source may be inserted into the vehicle **100** or vehicle frame **1204** with mechanisms and/or machines that are external or separate from the vehicle **100**.

[0082] In some embodiments, the frame **1204** may include one or more features configured to selectively interconnect with other vehicles and/or portions of vehicles. These selectively interconnecting features can allow for one or more vehicles to selectively couple together and decouple for a variety of purposes. For example, it is an aspect of the present disclosure that a number of vehicles may be selectively coupled together to share energy, increase power output, provide security, decrease power consumption, provide towing services, and/or provide a range of other benefits. Continuing this example, the vehicles may be coupled together based on travel route, destination, preferences, settings, sensor information, and/or some other data. The coupling may be initiated by at least one controller of the vehicle and/or traffic control system upon determining that a coupling is beneficial to one or more vehicles in a group of vehicles or a traffic system. As can be appreciated, the power consumption for a group of vehicles traveling in a same direction may be reduced or decreased by removing any aerodynamic separation between vehicles. In this case, the vehicles may be coupled together to subject only the foremost vehicle in the coupling to air and/or wind resistance during travel. In one embodiment, the power output by the group of vehicles may be proportionally or selectively controlled to provide a specific output from each of the one or more of the vehicles in the group.

[0083] The interconnecting, or coupling, features may be configured as electromagnetic mechanisms, mechanical couplings, electromechanical coupling mechanisms, etc., and/or combinations thereof. The features may be selectively deployed from a portion of the frame **1204** and/or body of the vehicle **100**. In some cases, the features may be built into the frame **1204** and/or body of the vehicle **100**. In any event, the features may deploy from an unexposed position to an exposed position or may be configured to selectively engage/disengage without requiring an exposure or deployment of the mechanism from the frame **1204** and/or body. In some embodiments, the interconnecting features may be configured to interconnect one or more of power, communications, electrical energy, fuel, and/or the like. One or more of the power, mechanical, and/or communications connections between vehicles may be part of a single interconnection mechanism. In some embodiments, the interconnection mechanism may include multiple connection mechanisms. In any event, the single interconnection mechanism or the interconnection mechanism may employ the poka-yoke features as described above.

[0084] The power system of the vehicle **100** may include the powertrain, power distribution system, accessory power system, and/or any other components that store power, provide power, convert power, and/or distribute power to one or more portions of the vehicle **100**. The powertrain may include the one or more electric motors **1312** of the vehicle **100**. The electric motors **1312** are configured to convert electrical energy provided by a power source into mechanical energy. This mechanical energy may be in the form of a rotational or other output force that is configured to propel or otherwise provide a motive force for the vehicle **100**.

[0085] In some embodiments, the vehicle **100** may include one or more drive wheels **1320** that are driven by the one or more electric motors **1312** and motor controllers **1314**. In some cases, the vehicle **100** may include an electric motor **1312** configured to provide a driving force for each drive wheel **1320**. In other cases, a single electric motor **1312** may be configured to share an output force between two or more drive wheels **1320** via one or more power transmission components. It is an aspect of the present disclosure that the powertrain include one or more power transmission components, motor controllers **1314**, and/or power controllers that can provide a controlled output of power to one or more of the drive wheels **1320** of the vehicle **100**. The power transmission components, power controllers, or motor controllers **1314** may be controlled by at least one other vehicle controller described herein.

[0086] As provided above, the powertrain of the vehicle **100** may include one or more power sources **1308**A, **1308**B. These one or more power sources **1308**A, **1308**B may be configured to provide drive power, system and/or subsystem power, accessory power, etc. While described herein as a single power source **1308** for sake of clarity, embodiments of the present disclosure are not so limited. For example, it should be appreciated that independent, different, or separate power sources **1308**A, **1308**B may provide power to various systems of the vehicle **100**. For instance, a drive power source may be configured to provide the power for the one or more electric motors **1312** of the vehicle **100**, while a system power source may be configured to provide the power for one or more other systems and/or subsystems of the vehicle **100**. Other power sources may include an accessory power source, a backup power source, a critical system power source, and/or other separate power sources. Separating the power sources **1308**A, **1308**B in this manner may provide a number of benefits over conventional vehicle systems. For example, separating the power sources **1308**A, **1308**B allow one power source **1308** to be removed and/or replaced independently without requiring that power be removed from all systems and/or subsystems of the vehicle **100** during a power source **1308** removal/replacement. For instance, one or more of the accessories, communications, safety equipment, and/or backup power systems, etc., may be maintained even when a particular power source **1308**A, **1308**B is depleted, removed, or becomes otherwise inoperable.

[0087] In some embodiments, the drive power source may be separated into two or more cells, units, sources, and/or systems. By way of example, a vehicle **100** may include a first drive power source **1308**A and a second drive power source **1308**B. The first drive power source **1308**A may be operated independently from or in conjunction with the second drive power source **1308**B and vice versa. Continuing this example, the first drive power source **1308**A may be removed from a vehicle while a second drive power source **1308**B can be maintained in the vehicle **100** to provide drive power. This approach allows the vehicle **100** to significantly reduce weight (e.g., of the first drive power source **1308**A, etc.) and improve power consumption, even if only for a temporary period of time. In some cases, a vehicle **100** running low on power may automatically determine that pulling over to a rest area, emergency lane, and removing, or "dropping off," at least one power source **1308**A, **1308**B may reduce enough weight of the vehicle **100** to allow the vehicle **100** to navigate to the closest power source replacement and/or charging area. In some embodiments, the removed, or "dropped off," power source **1308**A may be collected by a collection service, vehicle mechanic, tow truck, or even another vehicle or individual.

[0088] The power source **1308** may include a GPS or other geographical location system that may be configured to emit a location signal to one or more receiving entities. For instance, the signal may be broadcast or targeted to a specific receiving party. Additionally or alternatively, the power source **1308** may include a unique identifier that may be used to associate the power source **1308** with a particular vehicle **100** or vehicle user. This unique identifier may allow an efficient recovery of the power source **1308** dropped off. In some embodiments, the unique identifier may provide information for the particular vehicle **100** or vehicle user to be billed or charged with a cost of recovery for the power source **1308**.

[0089] The power source **1308** may include a charge controller **1324** that may be configured to determine charge levels of the power source **1308**, control a rate at which charge is drawn from the power source **1308**, control a rate at which charge is added to the power source **1308**, and/or monitor a health of the power source **1308** (e.g., one or more cells, portions, etc.). In some embodiments, the charge controller **1324** or the power source **1308** may include a communication interface. The communication interface can allow the charge controller **1324** to report a state of the power source **1308** to one or more other controllers of the vehicle **100** or even communicate with a communication device separate and/or apart from the vehicle **100**. Additionally or alternatively, the communication interface may be configured to receive instructions (e.g., control instructions, charge instructions, communication instructions, etc.) from one or more other controllers of the vehicle **100** or a communication device that is separate and/or apart from the vehicle **100**.

[0090] The powertrain includes one or more power distribution systems configured to transmit power from the power source **1308** to one or more electric motors **1312** in the vehicle **100**. The power distribution system may include electrical interconnections **1328** in the form of cables, wires, traces, wireless power transmission systems, etc., and/or combinations thereof. It is an aspect of the present disclosure that the vehicle **100** include one or more redundant electrical interconnections **1332** of the power distribution system. The redundant electrical interconnections **1332** can allow power to be distributed to one or more systems and/or subsystems of the vehicle **100** even in the event of a failure of an electrical interconnection portion of the vehicle **100** (e.g., due to an accident, mishap, tampering, or other harm to a particular electrical interconnection, etc.). In some embodiments, a user of a vehicle **100** may be alerted via a user interface associated with the vehicle **100** that a redundant electrical interconnection **1332** is being used and/or damage has occurred to a particular area of the vehicle electrical system. In any event, the one or more redundant electrical interconnections **1332** may be configured along completely different routes than the electrical interconnections **1328** and/or include different modes of failure than the electrical interconnections **1328** to, among other things, prevent a total interruption power distribution in the event of a failure.

[0091] In some embodiments, the power distribution system may include an energy recovery system **1336**. This energy recovery system **1336**, or kinetic energy recovery system, may be configured to recover energy produced by the movement of a vehicle **100**. The recovered energy may be stored as electrical and/or mechanical energy. For instance, as a vehicle **100** travels or moves, a certain amount of energy is required to accelerate, maintain a speed, stop, or slow the vehicle **100**. In any event, a moving vehicle has a certain amount of kinetic energy. When brakes are applied in a typical moving vehicle, most of the kinetic energy of the vehicle is lost as the generation of heat in the braking mechanism. In an energy recovery system **1336**, when a vehicle **100** brakes, at least a portion of the kinetic energy is converted into electrical and/or mechanical energy for storage. Mechanical energy may be stored as mechanical movement (e.g., in a flywheel, etc.) and electrical energy may be stored in batteries, capacitors, and/or some other electrical storage system. In some embodiments, electrical energy recovered may be stored in the power source **1308**. For example, the recovered electrical energy may be used to charge the power source **1308** of the vehicle **100**.

[0092] The vehicle **100** may include one or more safety systems. Vehicle safety systems can include a variety of mechanical and/or electrical components including, but in no way limited to, low impact or energy-absorbing bumpers **1316**A, **1316**B, crumple zones, reinforced body panels, reinforced frame components, impact bars, power source containment zones, safety glass, seatbelts, supplemental restraint systems, air bags, escape hatches, removable access panels, impact sensors, accelerometers, vision systems, radar systems, etc., and/or the like. In some embodiments, the one or more of the safety components may include a safety sensor or group of safety sensors associated with the one or more of the safety components. For example, a crumple zone may include one or more strain gages, impact sensors, pressure transducers, etc. These sensors may be configured to detect or determine whether a portion of the vehicle **100** has been subjected to a particular force, deformation, or other impact. Once detected, the information collected by the sensors may be transmitted or sent to one or more of a controller of the vehicle **100** (e.g., a safety controller, vehicle controller, etc.) or a communication device associated with the vehicle **100** (e.g., across a communication network, etc.).

[0093] FIG. **14** shows a plan view of the vehicle **100** in accordance with embodiments of the present disclosure. In particular, FIG. **14** shows a broken section **1402** of a charging system for the vehicle **100**. The charging system may include a plug or receptacle **1404** configured to receive power from an external power source (e.g., a source of power that is external to and/or separate from the vehicle **100**, etc.). An example of an external power source may include the standard industrial, commercial, or residential power that is provided across power lines. Another example of an external power source may include a proprietary power system configured to provide power to the vehicle **100**. In any event, power received at the plug/receptacle **1404** may be transferred via at least one power transmission interconnection **1408**. Similar, if not identical, to the electrical interconnections **1328** described above, the at least one power transmission interconnection **1408** may be one or more cables, wires, traces, wireless power transmission systems, etc., and/or combinations thereof. Electrical energy in the form of charge can be transferred from the external power source to the charge controller **1324**. As provided above, the charge controller **1324** may regulate the addition of charge to the power source **1308** of the vehicle **100** (e.g., until the power source **1308** is full or at a capacity, etc.).

[0094] In some embodiments, the vehicle **100** may include an inductive charging system and inductive charger **1412**. The inductive charger **1412** may be configured to receive electrical energy from an inductive power source external to the vehicle **100**. In one embodiment, when the vehicle **100** and/or the inductive charger **1412** is positioned over an inductive power source external to the vehicle **100**, electrical energy can be transferred from the inductive power source to the vehicle **100**. For example, the inductive charger **1412** may receive the charge and transfer the charge via at least one power transmission interconnection **1408** to the charge controller **1324** and/or the power source **1308** of the vehicle **100**. The inductive charger **1412** may be concealed in a portion of the vehicle **100** (e.g., at least partially protected by the frame **1204**, one or more body panels **1208**, a shroud, a shield, a protective cover, etc., and/or combinations thereof) and/or may be deployed from the vehicle **100**. In some embodiments, the inductive charger **1412** may be configured to receive charge only when the inductive charger **1412** is deployed from the vehicle **100**. In other embodiments, the inductive charger **1412** may be configured to receive charge while concealed in the portion of the vehicle **100**.

[0095] In addition to the mechanical components described herein, the vehicle **100** may include a number of user interface devices. The user interface devices receive and translate human input into a mechanical movement or electrical signal or stimulus. The human input may be one or more of motion (e.g., body movement, body part movement, in two-dimensional or three-dimensional space, etc.), voice, touch, and/or physical interaction with the components of the vehicle **100**. In some embodiments, the human input may be configured to control one or more functions of the vehicle **100** and/or systems of the vehicle **100** described herein. User interfaces may include, but are in no way limited to, at least one graphical user interface of a display device, steering wheel or mechanism, transmission lever or button (e.g., including park, neutral, reverse, and/or drive positions, etc.), throttle control pedal or mechanism, brake control pedal or mechanism, power control switch, communications equipment, etc.

[0096] An embodiment of the electrical system **1500** associated with the vehicle **100** may be as shown in FIG. **15**. The electrical system **1500** can include power source(s) that generate power, power storage that stores power, and/or load(s) that consume power. Power sources may be associated with a power generation unit **1504**. Power storage may be associated with a power storage system **612**. Loads may be associated with loads **1508**. The electrical system **1500** may be managed by a power management controller **1324**. Further, the electrical system **1500** can include one or more other interfaces or controllers, which can include the billing and cost control unit **1512**.

[0097] The power generation unit **1504** may be as described in conjunction with FIG. **16**. The power storage component **612** may be as described in conjunction with FIG. **17**. The loads **1508** may be as described in conjunction with FIG. **18**.

[0098] The billing and cost control unit **1512** may interface with the power management controller **1324** to determine the amount of charge or power provided to the power storage **612** through the power generation unit **1504**. The billing and cost control unit **1512** can then provide information for billing the vehicle owner. Thus, the billing and cost control unit **1512** can receive and/or send power information to third party system(s) regarding the received charge from an external source. The information provided can help determine an amount of money required, from the owner of the vehicle, as payment for the provided power. Alternatively, or in addition, if the owner of the vehicle provided power to another vehicle (or another device/system), that owner may be owed compensation for the provided power or energy, e.g., a credit.

[0099] The power management controller **1324** can be a computer or computing system(s) and/or electrical system with associated components, as described herein, capable of managing the power generation unit **1504** to receive power, routing the power to the power storage **612**, and then providing the power from either the power generation unit **1504** and/or the power storage **612** to the loads **1508**. Thus, the power management controller **1324** may execute programming that controls switches, devices, components, etc. involved in the reception, storage, and provision of the power in the electrical system **1500**.

[0100] An embodiment of the power generation unit **1504** may be as shown in FIG. **16**. Generally, the power generation unit **1504** may be electrically coupled to one or more power sources **1308**. The power sources **1308** can include power sources internal and/or associated with the vehicle **100** and/or power sources external to the vehicle **100** to which the vehicle **100** electrically connects. One of the internal power sources can include an on board generator **1604**. The generator **1604** may be an alternating current (AC) generator, a direct current (DC) generator or a self-excited generator. The AC generators can include induction generators, linear electric generators, and/or other types of generators. The DC generators can include homopolar generators and/or other types of generators. The generator **1604** can be brushless or include brush contacts and generate the electric field with permanent magnets or through induction. The generator **1604** may be mechanically coupled to a source of kinetic energy, such as an axle or some other power take-off. The generator **1604** may also have another mechanical coupling to an exterior source of kinetic energy, for example, a wind turbine.

[0101] Another power source **1308** may include wired or wireless charging **1608**. The wireless charging system **1608** may include inductive and/or resonant frequency inductive charging systems that can include coils, frequency generators, controllers, etc. Wired charging may be any kind of grid-connected charging that has a physical connection, although, the wireless charging may be grid connected through a wireless interface. The wired charging system can include an connectors, wired interconnections, the controllers, etc. The wired and wireless charging systems **1608** can provide power to the power generation unit **1504** from external power sources **1308**.

[0102] Internal sources for power may include a regenerative braking system **1612**. The regenerative braking system **1612** can convert the kinetic energy of the moving car into electrical energy through a generation system mounted within the wheels, axle, and/or braking system of the vehicle **100**. The regenerative braking system **1612** can include any coils, magnets, electrical interconnections, converters, controllers, etc. required to convert the kinetic energy into electrical energy.

[0103] Another source of power **1308**, internal to or associated with the vehicle **100**, may be a solar array **1616**. The solar array **1616** may include any system or device of one or more solar cells mounted on the exterior of the vehicle **100** or integrated within the body panels of the vehicle **100** that provides or converts solar energy into electrical energy to provide to the power generation unit **1504**.

[0104] The power sources **1308** may be connected to the power generation unit **1504** through an electrical interconnection **1618**. The electrical interconnection **1618** can include any wire, interface, bus, etc. between the one or more power sources **1308** and the power generation unit **1504**.

[0105] The power generation unit **1504** can also include a power source interface **1620**. The power source interface **1620** can be any type of physical and/or electrical interface used to receive the electrical energy from the one or more power sources **1308**; thus, the power source interface **1620** can include an electrical interface **1624** that receives the electrical energy and a mechanical interface **1628** which may include wires, connectors, or other types of devices or physical connections. The mechanical interface **1608** can also include a physical/electrical connection **1634** to the power generation unit **1504**.

[0106] The electrical energy from the power source **1308** can be processed through the power source interface **1624** to an electric converter **1632**. The electric converter **1632** may convert the characteristics of the power from one of the power sources into a useable form that may be used either by the power storage **612** or one or more loads **1508** within the vehicle **100**. The electrical converter **1624** may include any electronics or electrical devices and/or component that can change electrical characteristics, e.g., AC frequency, amplitude, phase, etc. associated with the electrical energy provided by the power source **1308**. The converted electrical energy may then be provided to an optional conditioner **1638**. The conditioner **1638** may include any electronics or electrical devices and/or component that may further condition the converted electrical energy by removing harmonics, noise, etc. from the electrical energy to provide a more stable and effective form of power to the vehicle **100**.

[0107] An embodiment of the power storage **1612** may be as shown in FIG. **17**. The power storage unit can include an electrical converter **1632***b*, one or more batteries, one or more rechargeable batteries, one or more capacitors, one or more accumulators, one or more supercapacitors, one or more ultrabatteries, and/or superconducting magnetics **1704**, and/or a charge management unit **1708**. The converter **1632***b* may be the same or similar to the electrical converter **1632***a* shown in FIG. **16**. The converter **1632***b* may be a replacement for the electric converter **1632***a* shown in FIG. **16** and thus eliminate the need for the electrical converter **1632***a* as shown in FIG. **16**. However, if the electrical converter **1632***a* is provided in the power generation unit **1504**, the converter **1632***b*, as shown in the power storage unit **612**, may be eliminated. The converter **1632***b* can also be redundant or different from the electrical converter **1632***a* shown in FIG. **16** and may provide a different form of energy to the battery and/or capacitors **1704**. Thus, the converter **1632***b* can change the energy characteristics specifically for the battery/capacitor **1704**.

[0108] The battery **1704** can be any type of battery for storing electrical energy, for example, a lithium ion battery, a lead acid battery, a nickel cadmium battery, etc. Further, the battery **1704** may include different types of power storage systems, such as, ionic fluids or other types of fuel cell systems. The energy storage **1704** may also include one or more high-capacity capacitors **1704**. The capacitors **1704** may be used for long-term or short-term storage of electrical energy. The input into the battery or capacitor **1704** may be different from the output, and thus, the capacitor **1704** may be charged quickly but drain slowly. The functioning of the converter **1632** and battery capacitor **1704** may be monitored or managed by a charge management unit **1708**.

[0109] The charge management unit **1708** can include any hardware (e.g., any electronics or electrical devices and/or components), software, or firmware operable to adjust the operations of the converter **1632** or batteries/capacitors **1704**. The charge management unit **1708** can receive inputs or periodically monitor the converter **1632** and/or battery/capacitor **1704** from this information; the charge management unit **1708** may then adjust settings or inputs into the converter **1632** or battery/capacitor **1704** to control the operation of the power storage system **612**.

[0110] An embodiment of one or more loads **1508** associated with the vehicle **100** may be as shown in FIG. **18**. The loads **1508** may include a bus or electrical interconnection system **1802**, which provides electrical energy to one or more different loads within the vehicle **100**. The bus **1802** can be any number of wires or interfaces used to connect the power generation unit **1504** and/or power storage **1612** to the one or more loads **1508**. The converter **1632***c* may be an interface from the power generation unit **1504** or the power storage **612** into the loads **1508**. The converter **1632***c* may be the same or similar to electric converter **1632***a* as shown in FIG. **16**. Similar to the discussion of the converter **1632***b* in FIG. **17**, the converter **1632***c* may be eliminated, if the electric converter **1632***a*, shown in FIG. **16**, is present. However, the converter **1632***c* may further condition or change the energy characteristics for the bus **1802** for use by the loads **1508**. The converter **1632***c* may also provide electrical energy to electric motor **1804**, which may power the vehicle **100**.

[0111] The electric motor **1804** can be any type of DC or AC electric motor. The electric motor may be a direct drive or induction motor using permanent magnets and/or winding either on the stator or rotor. The electric motor **1804** may also be wireless or include brush contacts. The electric motor **1804** may be capable of providing a torque and enough kinetic energy to move the vehicle **100** in traffic.

[0112] The different loads **1508** may also include environmental loads **1812**, sensor loads **1816**, safety loads **1820**, user interaction loads **1808**, etc. User interaction loads **1808** can be any energy used by user interfaces or systems that interact with the driver and/or passenger(s). These loads **1808** may include, for example, the heads up display, the dash display, the radio, user interfaces on the head unit, lights, radio, and/or other types of loads that provide or receive information from the occupants of the vehicle **100**. The environmental loads **1812** can be any loads used to control the environment within the vehicle **100**. For example, the air conditioning or heating unit of the vehicle **100** can be environmental loads **1812**. Other environmental loads can include lights, fans, and/or defrosting units, etc. that may control the environment within the vehicle **100**. The sensor loads **1816** can be any loads used by sensors, for example, air bag sensors, GPS, and other such sensors used to either manage or control the vehicle **100** and/or provide information or feedback to the vehicle occupants. The safety loads **1820** can include any safety equipment, for example, seat belt alarms, airbags, headlights, blinkers, etc. that may be used to manage the safety of the occupants. There may be more or fewer loads than those described herein, although they may not be shown in FIG. **18**.

[0113] FIG. **19** illustrates an exemplary hardware diagram of communications componentry that can be optionally associated with the vehicle.

[0114] The communications componentry can include one or more wired or wireless devices such as a transceiver(s) and/or modem that allows communications not only between the various systems disclosed herein but also with other devices, such as devices on a network, and/or on a distributed network such as the Internet and/or in the cloud.

[0115] The communications subsystem can also include inter- and intra-vehicle communications capabilities such as hotspot and/or access point connectivity for any one or more of the vehicle occupants and/or vehicle-to-vehicle communications.

[0116] Additionally, and while not specifically illustrated, the communications subsystem can include one or more communications links (that can be wired or wireless) and/or communications busses (managed by the bus manager **1974**), including one or more of CANbus, OBD-II, ARCINC 429, Byteflight, CAN (Controller Area Network), D2B (Domestic Digital Bus), FlexRay, DC-BUS, IDB-1394, IEBus, I^2C, ISO 9141-1/-2, J1708, J1587, J1850, J1939, ISO 11783, Keyword Protocol 2000, LIN (Local Interconnect Network), MOST (Media Oriended Systems Transport), Multifunction Vehicle Bus, SMARTwireX, SPI, VAN (Vehicle Area Network), and the like or in general any communications protocol and/or standard.

[0117] The various protocols and communications can be communicated one or more of wirelessly and/or over transmission media such as single wire, twisted pair, fibre optic, IEEE 1394, MIL-STD-1553, MIL-STD-1773, power-line communication, or the like. (All of the above standards and protocols are incorporated herein by reference in their entirety)

[0118] As discussed, the communications subsystem enables communications between any if the inter-vehicle systems and subsystems as well as communications with non-collocated resources, such as those reachable over a network such as the Internet.

[0119] The communications subsystem, in addition to well-known componentry (which has been omitted for clarity), the device communications subsystem **1900** includes interconnected elements including one or more of: one or more antennas **1904**, an interleaver/deinterleaver **1908**, an analog front end (AFE) **1912**, memory/storage/cache **1916**, controller/microprocessor **1920**, MAC circuitry **1922**, modulator/demodulator **1924**, encoder/decoder **1928**, a plurality of connectivity managers **1934-1966**, GPU **1940**, accelerator **1944**, a multiplexer/demultiplexer **1954**, transmitter **1970**, receiver **1972** and wireless radio **1978** components such as a Wi-Fi PHY/Bluetooth® module **1980**, a Wi-Fi/BT MAC module **1984**, transmitter **1988** and receiver **1992**. The various elements in the device **1900** are connected by one or more links/busses 5 (not shown, again for sake of clarity).

[0120] The device **400** can have one more antennas **1904**, for use in wireless communications such as multi-input multi-output (MIMO) communications, multi-user multi-input multi-output (MU-MIMO) communications Bluetooth®, LTE, 4G, 5G, Near-Field Communication (NFC), etc. The antenna(s) **1904** can include, but are not limited to one or more of directional antennas, omnidirectional antennas, monopoles, patch antennas, loop antennas, microstrip antennas, dipoles, and any other antenna(s) suitable for communication transmission/reception. In an exemplary embodiment, transmission/reception using MIMO may require particular antenna spacing. In another exemplary embodiment, MIMO transmission/reception can enable spatial diversity allowing for different channel characteristics at each of the antennas. In yet another embodiment, MIMO transmission/reception can be used to distribute resources to multiple users for example within the vehicle and/or in another vehicle.

[0121] Antenna(s) **1904** generally interact with the Analog Front End (AFE) **1912**, which is needed to enable the correct processing of the received modulated signal and signal conditioning for a transmitted signal. The AFE **1912** can be functionally located between the antenna and a digital baseband system in order to convert the analog signal into a digital signal for processing and vice-versa.

[0122] The subsystem **1900** can also include a controller/microprocessor **1920** and a memory/storage/cache **1916**. The subsystem **1900** can interact with the memory/storage/cache **1916** which may store information and operations necessary for configuring and transmitting or receiving the information described herein. The memory/storage/cache **1916** may also be used in connection with the execution of application programming or instructions by the controller/microprocessor **1920**, and for temporary or long term storage of program instructions and/or data. As examples, the memory/storage/cache **1920** may comprise a computer-readable device, RAM, ROM, DRAM, SDRAM, and/or other storage device(s) and media.

[0123] The controller/microprocessor **1920** may comprise a general purpose programmable processor or controller for executing application programming or instructions related to the subsystem **1900**. Furthermore, the controller/microprocessor **1920** can perform operations for configuring and transmitting/receiving information as described herein. The controller/microprocessor **1920** may include multiple processor cores, and/or implement multiple virtual processors. Optionally, the controller/microprocessor **1920** may include multiple physical processors. By way of example, the controller/microprocessor **1920** may comprise a specially configured Application Specific Integrated Circuit (ASIC) or other integrated circuit, a digital signal processor(s), a controller, a hardwired electronic or logic circuit, a programmable logic device or gate array, a special purpose computer, or the like.

[0124] The subsystem **1900** can further include a transmitter **1970** and receiver **1972** which can transmit and receive signals, respectively, to and from other devices, subsystems and/or other destinations using the one or more antennas **1904** and/or links/busses. Included in the subsystem **1900** circuitry is the medium access control or MAC Circuitry **1922**. MAC circuitry **1922** provides for controlling access to the wireless medium. In an exemplary embodiment, the MAC circuitry **1922** may be arranged to contend for the wireless medium and configure frames or packets for communicating over the wireless medium.

[0125] The subsystem **1900** can also optionally contain a security module (not shown). This security module can contain information regarding but not limited to, security parameters required to connect the device to one or more other devices or other available network(s), and can include WEP or WPA/WPA-2 (optionally+AES and/or TKIP) security access keys, network keys, etc. The WEP security access key is a security password used by Wi-Fi networks. Knowledge of this code can enable a wireless device to exchange information with an access point and/or another device. The information exchange can occur through encoded messages with the WEP access code often being chosen by the network administrator. WPA is an added security standard that is also used in conjunction with network connectivity with stronger encryption than WEP.

[0126] The exemplary subsystem **1900** also includes a GPU **1940**, an accelerator **1944**, a Wi-Fi/BT/BLE PHY module **1980** and a Wi-Fi/BT/BLE MAC module **1984** and wireless transmitter **1988** and receiver **1992**. In some embodiments, the GPU **1940** may be a graphics processing unit, or visual processing unit, comprising at least one circuit and/or chip that manipulates and changes memory to accelerate the creation of images in a frame buffer for output to at least one display device. The GPU **1940** may include one or more of a display device connection port, printed circuit board (PCB), a GPU chip, a metal-oxide-semiconductor field-effect transistor (MOSFET), memory (e.g., single data rate random-access memory (SDRAM), double data rate random-access memory (DDR) RAM, etc., and/or combinations thereof), a secondary processing chip (e.g., handling video out capabilities, processing, and/or other functions in addition to the GPU chip, etc.), a capacitor, heatsink, temperature control or cooling fan, motherboard connection, shielding, and the like.

[0127] The various connectivity managers **1934-1966** (even) manage and/or coordinate communications between the subsystem **1900** and one or more of the systems disclosed herein and one or more other devices/systems. The connectivity managers include an emergency charging connectivity manager **1934**, an aerial charging connectivity manager **1938**, a roadway charging connectivity manager **1942**, an overhead charging connectivity manager **1946**, a robotic charging connectivity manager **1950**, a static charging connectivity manager **1954**, a vehicle database connectivity manager **1958**, a remote operating system connectivity manager **1962** and a sensor connectivity manager **1966**.

[0128] The emergency charging connectivity manager **1934** can coordinate not only the physical connectivity between the vehicle and the emergency charging device/vehicle, but can also communicate with one or more of the power management controller, one or more third parties and optionally a billing system(s). As an example, the vehicle can establish communications with the emergency charging device/vehicle to one or more of coordinate interconnectivity between the two (e.g., by spatially aligning the charging receptacle on the vehicle with the charger on the emergency charging vehicle) and optionally share navigation information. Once charging is complete, the amount of charge provided can be tracked and optionally forwarded to, for example, a third party for billing. In addition to being able to manage connectivity for the exchange of power, the emergency charging connectivity manager **1934** can also communicate information, such as billing information to the emergency charging vehicle and/or a third party. This billing information could be, for example, the owner of the vehicle, the driver of the vehicle, company information, or in general any information usable to charge the appropriate entity for the power received.

[0129] The aerial charging connectivity manager **1938** can coordinate not only the physical connectivity between the vehicle and the aerial charging device/vehicle, but can also communicate with one or more of the power management controller, one or more third parties and optionally a billing system(s). As an example, the vehicle can establish communications with the aerial charging device/vehicle to one or more of coordinate interconnectivity between the two (e.g., by spatially aligning the charging receptacle on the vehicle with the charger on the emergency charging vehicle) and optionally share navigation information. Once charging is complete, the amount of charge provided can be tracked and optionally forwarded to, for example, a third party for billing. In addition to being able to manage connectivity for the exchange of power, the aerial charging connectivity manager **1938** can similarly communicate information, such as billing information to the aerial charging vehicle and/or a third party. This billing information could be, for example, the owner of the vehicle, the driver of the vehicle, company information, or in general any information usable to charge the appropriate entity for the power received etc., as discussed.

[0130] The roadway charging connectivity manager **1942** and overhead charging connectivity manager **1946** can coordinate not only the physical connectivity between the vehicle and the charging device/system, but can also communicate with one or more of the power management controller, one or more third parties and optionally a billing system(s). As one example, the vehicle can request a charge from the charging system when, for example, the vehicle needs or is predicted to need power. As an example, the vehicle can establish communications with the charging device/vehicle to one or more of coordinate interconnectivity between the two for charging and share information for billing. Once charging is complete, the amount of charge provided can be tracked and optionally forwarded to, for example, a third party for billing. This billing information could be, for example, the owner of the vehicle, the driver of the vehicle, company information, or in general any information usable to charge the appropriate entity for the power received etc., as discussed. The person responsible for paying for the charge could also receive a copy of the billing information as is customary. The robotic charging connectivity manager **1950** and static charging connectivity manager **1954** can operate in a similar manner to that described herein.

[0131] The vehicle database connectivity manager **1958** allows the subsystem to receive and/or share information stored in the vehicle database. This information can be shared with other vehicle components/subsystems and/or other entities, such as third parties and/or charging systems. The information can also be shared with one or more vehicle occupant devices, such as an app on a mobile device the driver uses to track information about the vehicle and/or a dealer or service/maintenance provider. In general any information stored in the vehicle database can optionally be shared with any one or more other devices optionally subject to any privacy or confidentially restrictions.

[0132] The remote operating system connectivity manager **1962** facilitates communications between the vehicle and any one or more autonomous vehicle systems. These communications can include one or more of navigation information, vehicle information, occupant information, or in general any information related to the remote operation of the vehicle.

[0133] The sensor connectivity manager **1966** facilitates communications between any one or more of the vehicle sensors and any one or more of the other vehicle systems. The sensor connectivity manager **1966** can also facilitate communications between any one or more of the sensors and/or vehicle systems and any other destination, such as a service company, app, or in general to any destination where sensor data is needed.

[0134] In accordance with one exemplary embodiment, any of the communications discussed herein can be communicated via the conductor(s) used for charging. One exemplary protocol usable for these communications is Power-line communication (PLC). PLC is a communication protocol that uses electrical wiring to simultaneously carry both data, and Alternating Current (AC) electric power transmission or electric power distribution. It is also known as power-line carrier, power-line digital subscriber line (PDSL), mains communication, power-line telecommunications, or power-line networking (PLN). For DC environments in vehicles PLC can be used in conjunction with CAN-bus, LIN-bus over power line (DC-LIN) and DC-BUS.

[0135] The communications subsystem can also optionally manage one or more identifiers, such as an IP (internet protocol) address(es), associated with the vehicle and one or other system or subsystems or components therein. These identifiers can be used in conjunction with any one or more of the connectivity managers as discussed herein.

[0136] FIG. **19**B illustrates a block diagram of a computing environment **1901** that may function as the servers, user computers, or other systems provided and described above. The environment **1901** includes one or more user computers, or computing devices, such as a vehicle computing device **1903**, a communication device **1907**, and/or more **1911**. The computing devices **1903**, **1907**, **1911** may include general purpose personal computers (including, merely by way of example, personal computers, and/or laptop computers running various versions of Microsoft Corp.'s Windows® and/or Apple Corp.'s Macintosh® operating systems) and/or workstation computers running any of a variety of commercially-available UNIX® or UNIX-like operating systems. These computing devices **1903**, **1907**, **1911** may also have any of a variety of applications, including for example, database client and/or server applications, and web browser applications. Alternatively, the computing devices **1903**, **1907**, **1911** may be any other electronic device, such as a thin-client computer, Internet-enabled mobile telephone, and/or personal digital assistant, capable of communicating via a network **1909** and/or displaying and navigating web pages or other types of electronic documents. Although the exemplary computer environment **1901** is shown with two computing devices, any number of user computers or computing devices may be supported.

[0137] Environment **1901** further includes a network **1909**. The network **1909** may can be any type of network familiar to those skilled in the art that can support data communications using any of a variety of commercially-available protocols, including without limitation SIP, TCP/IP, SNA, IPX, AppleTalk, and the like. Merely by way of example, the network **1909** maybe a local area network ("LAN"), such as an Ethernet network, a Token-Ring network and/or the like; a wide-area network; a virtual network, including without limitation a virtual private network ("VPN"); the Internet; an intranet; an extranet; a public switched telephone network ("PSTN"); an infra-red network; a wireless network (e.g., a network operating under any of the IEEE 802.9 suite of protocols, the Bluetooth® protocol known in the art, and/or any other wireless protocol); and/or any combination of these and/or other networks.

[0138] The system may also include one or more servers **1913**, **1915**. In this example, server **1913** is shown as a web server and server **1915** is shown as an application server. The web server **1913**, which may be used to process requests for web pages or other electronic documents from computing devices **1903**, **1907**, **1911**. The web server **1913** can be running an operating system including any of those discussed above, as well as any commercially-available server operating systems. The web server **1913** can also run a variety of server applications, including SIP servers, HTTP servers, FTP servers, CGI servers, database servers, Java servers, and the like. In some instances, the web server **1913** may publish operations available operations as one or more web services.

[0139] The environment **1901** may also include one or more file and or/application servers **1915**, which can, in addition to an operating system, include one or more applications accessible by a client running on one or more of the computing devices **1903**, **1907**, **1911**. The server(s) **1915** and/or **1913** may be one or more general purpose computers capable of executing programs or scripts in response to the computing devices **1903**, **1907**, **1911**. As one example, the server **1915**, **1913** may execute one or more web applications. The web application may be implemented as one or more scripts or programs written in any programming language, such as Java™, C, C#®, or C++, and/or any scripting language, such as Perl, Python, or TCL, as well as combinations of any programming/scripting languages. The application server(s) **1915** may also include database servers, including without limitation those commercially available from Oracle, Microsoft, Sybase™, IBM™ and the like, which can process requests from database clients running on a computing device **1903**, **1907**, **1911**.

[0140] The web pages created by the server **1913** and/or **1915** may be forwarded to a computing device **1903**, **1907**, **1911** via a web (file) server **1913**, **1915**. Similarly, the web server **1913** may be able to receive web page requests, web services invocations, and/or input data from a computing device **1903**, **1907**, **1911** (e.g., a user computer, etc.) and can forward the web page requests and/or input data to the web (application) server **1915**. In further embodiments, the server **1915** may function as a file server. Although for ease of description, FIG. **19**B illustrates a separate web server **1913** and file/application server **1915**, those skilled in the art will recognize that the functions described with respect to servers **1913**, **1915** may be performed by a single server and/or a plurality of specialized servers, depending on implementation-specific needs and parameters. The computer systems **1903**, **1907**, **1911**, web (file) server **1913** and/or web (application) server **1915** may function as the system, devices, or components described in FIGS. **1-19**A.

[0141] The environment **1901** may also include a database **1917**. The database **1917** may reside in a variety of locations. By way of example, database **1917** may reside on a storage medium local to (and/or resident in) one or more of the computers **1903**, **1907**, **1911**, **1913**, **1915**. Alternatively, it may be remote from any or all of the computers **1903**, **1907**, **1911**, **1913**, **1915**, and in communication (e.g., via the network **1909**) with one or more of these. The database **1917** may reside in a storage-area network ("SAN") familiar to those skilled in the art. Similarly, any necessary files for performing the functions attributed to the computers **1903**, **1907**, **1911**, **1913**, **1915** may be stored locally on the respective computer and/or remotely, as appropriate. The database **1917** may be a relational database, such as Oracle 20i®, that is adapted to store, update, and retrieve data in response to SQL-formatted commands.

[0142] FIG. **19**C illustrates one embodiment of a computer system **1919** upon which the servers, user computers, computing devices, or other systems or components described above may be deployed or executed. The computer system **1919** is shown comprising hardware elements that may be electrically coupled via a bus **1921**. The hardware elements may include one or more central processing units (CPUs) **1923**; one or more input devices **1925** (e.g., a mouse, a keyboard, etc.); and one or more output devices **1927** (e.g., a display device, a printer, etc.). The computer system **1919** may also include one or more storage devices **1929**. By way of example, storage device(s) **1929** may be disk drives, optical storage devices, solid-state storage devices such as a random access memory ("RAM") and/or a read-only memory ("ROM"), which can be programmable, flash-updateable and/or the like.

[0143] The computer system **1919** may additionally include a computer-readable storage media reader **1931**; a communications system **1933** (e.g., a modem, a network card (wireless or wired), an infra-red communication device, etc.); and working memory **1937**, which may include RAM and ROM devices as described above. The computer system **1919** may also include a processing acceleration unit **1935**, which can include a DSP, a special-purpose processor, and/or the like.

[0144] The computer-readable storage media reader **1931** can further be connected to a computer-readable storage medium, together (and, optionally, in combination with storage device(s) **1929**) comprehensively representing remote, local, fixed, and/or removable storage devices plus storage media for temporarily and/or more permanently containing computer-readable information. The communications system **1933** may permit data to be exchanged with a network and/or any other computer described above with respect to the computer environments described herein. Moreover, as disclosed herein, the term "storage medium" may represent one or more devices for storing data, including read only memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine readable mediums for storing information.

[0145] The computer system **1919** may also comprise software elements, shown as being currently located within a working memory **1937**, including an operating system **1939** and/or other code **1941**. It should be appreciated that alternate embodiments of a computer system **1919** may have numerous variations from that described above. For example, customized hardware might also be used and/or particular elements might be implemented in hardware, software (including portable software, such as applets), or both. Further, connection to other computing devices such as network input/output devices may be employed.

[0146] Examples of the processors **1923** as described herein may include, but are not limited to, at least one of Qualcomm® Snapdragon® 800 and 801, Qualcomm® Snapdragon® 620 and 615 with 4G LTE Integration and 64-bit computing, Apple® A7 processor with 64-bit architecture, Apple® M7 motion coprocessors, Samsung® Exynos® series, the Intel® Core™ family of processors, the Intel® Xeon® family of processors, the Intel® Atom™ family of processors, the Intel Itanium® family of processors, Intel® Core® i5-4670K and i7-4770K 22 nm Haswell, Intel® Core® i5-3570K 22 nm Ivy Bridge, the AMD® FX™ family of processors, AMD® FX-4300, FX-6300, and FX-8350 32 nm Vishera, AMD® Kaveri processors, Texas Instruments® Jacinto C6000™ automotive infotainment processors, Texas Instruments® OMAP™ automotive-grade mobile processors, ARM® Cortex™M processors, ARM® Cortex-A and ARM926EJ-S™ processors, other industry-equivalent processors, and may perform computational functions using any known or future-developed standard, instruction set, libraries, and/or architecture.

[0147] FIG. **20** is a diagram illustrating a vehicle in an exemplary environment according to one embodiment of the present disclosure. As described above with reference to FIG. **2**, the vehicle **100** may operate in environments which enable charging of the vehicle **100** and/or operation of the vehicle **100**. More specifically, the vehicle **100** may receive a charge via one or more means comprising emergency charging vehicle system **270**, aerial vehicle charging system **280**, robotic charging system **254** and others as described above. The vehicle **100** may interact and/or operate in an environment comprising one or more other roadway vehicles **260**. The vehicle **100** may engage with elements within the vehicle **100** comprising vehicle driver **220**, vehicle passengers **220** and vehicle database **210**. In one embodiment, vehicle database **210** does not physically reside in the vehicle **100** but is instead accessed remotely, e.g. by wireless communication, and resides in another location such as a residence or business location. Vehicle **100** may operate autonomously and/or semi-autonomously in an autonomous environment also as described above. Furthermore, the vehicle **100** may engage with a remote operator system **240**, which may provide fleet management instructions or control.

[0148] The vehicle **100** may also engage with one or more service provider systems including but not limited to a repair facility **2005**, a power source exchange facility **2010**, and/or a third party service provider system **2015** such as an advertiser or other information exchange system. According to one embodiment, one or more of the environments in which the vehicle **100** operates may apply service provider rules to manage or influence services provided to or interactions with the vehicle **100**. For example, the repair facility **2005** can set fees for vehicle repair services based on business rules defining a pricing model or structure and applying those rules based on certain conditions defined by the repair facility operator and/or specific to the vehicle **100** and/or vehicle driver or user. Similarly, the power source exchange facility **2010** can apply business rules defining a pricing model for services to exchange vehicle batteries or other power sources. Any one or more of the remote operator system **240**, robotic charging system **254**, emergency charging vehicle system **270**, aerial vehicle charging system **280**, and/or other systems described above may similarly apply service provider rules to manage services provided when interacting with the vehicle **100**. Additionally or alternatively, a third party service provider system **2015** such as an advertiser may apply rules specific to another service provider system including but not limited to the remote operator system **240**, robotic charging system **254**, emergency charging vehicle system **270**, aerial vehicle charging system **280**, etc., to determine a value or price for a service, for example, and communicate that determined value or price to the vehicle **100**. It should be noted that the terms value and price, while used together here, need not be considered to be synonymous. As used herein, the term price is intended to mean a monetary amount for services can be exchanged. The term value is intended to mean not only a monetary amount but any other exchange for services such as an exchange of earned credits, i.e., not necessarily monetary credits, an exchange of other tokens having some intrinsic or other agreed upon worth, etc.

[0149] Generally speaking, a service provider can, for example using a graphical or other user interface provided by the configuration and/or administration component **2105**, define a set of rules saved in the repository of maintenance management rules **2110** and/or a set of configuration parameters saved in the repository of configuration parameters **2115**. In some cases, the service provider may also be able, through the configuration and/or administration component **2105**, defined, modify, or view a set of vehicle or user information saved in the repository of vehicle and/or user specific information **2120**. Additionally or alternatively, the data collection component **2125** can collect vehicle and/or user information from the vehicle, from one or more elements interacting with the vehicle, from the user via the vehicle, a mobile device, a laptop or other computer system, or through other means and save the collected information in the vehicle and/or user specific information **2120**. The value determination component **2130** can apply the rules of the repository of maintenance management rules **2110** using the set of configuration parameters saved in the repository of configuration parameters **2115** and the vehicle or user information saved in the repository of vehicle and/or user specific information **2120** to determine or generate a value or price for a service available from the service provider to the vehicle. This value or price can be saved in the repository of service value information **2135** for access by the service provider, the vehicle, the user, other service providers, etc. Additionally or alternatively, the determined value or price can be sent by the communication component **2140** to the vehicle or other system, for example, via a cellular or other wireless connection.

[0150] More specifically, the service provider or seller of a particular service can set fees for the services provided by configuring, through the configuration and/or administration component **2105**, business rules defining a pricing model or structure. The set of rules can be implemented in any common rule definition language such as, for example, Business Process Execution Language (BPEL) or similar language, and can comprise a set of conditions and associated actions to be applied upon satisfaction of those conditions. The actions can, in some cases, be calculations or other operations to determine the price for the service, adjust the price for the service, perform automated negotiations, etc. For example, a business rule for a battery exchange facility for electric or hybrid vehicles may define the fee for an exchange of a low battery for a fully charged battery to be higher in a city center rather than along a highway. Therefore, the set of maintenance management rules defined through the configuration and/or administration component **2105** and stored in the repository of maintenance management rules **2110** can comprise at least one rule defining a value for the service based on a location at which the service is delivered. The location can be selected from a plurality of different and geographically diverse locations. The maintenance management rules can define a first location of the plurality of locations, e.g., a city center or urban location, as having a higher cost than at least one second location of the plurality of locations, e.g., or rural or highway location outside of city or municipal limits. In another example, a rule may define a higher value or price during certain peak times such as lunchtime, e.g., noon-1:00 pm or business hours, e.g., 8:00 am-5:00 pm and a reduced value or price during certain low demand hours, e.g., 2:00 am-4:00 pm. Thus, the set of maintenance management rules defined through the configuration and/or administration component **2105** and stored in the repository of maintenance management rules **2110** can comprise at least one rule defining a value for the service based on a time of day at which the service is delivered. The time of day at which the service is delivered can fall within one of a plurality of time periods. The maintenance management rules can define a first time period of the plurality of time periods, i.e., a peak period, as having a higher cost than a second time period of the plurality of time periods. Any number and variety of other rules can be implemented at the service provider's discretion and are considered to be within the scope of the present disclosure.

[0151] The service provider can, for example, through the graphical or other user interface of the configuration and/or administration component **2105**, define and/or adjust selectable or configurable parameters stored in the repository of configuration parameters **2115** to be used by the business rules in order to implement a dynamic pricing model adaptable to current conditions. These parameters can comprise, for example, values for variables defined in the calculations or actions of the rules. In other cases, the parameters can comprise switches, flags, or other values for the conditions of the rules. The terms or parameters stored in the repository of configuration parameters **2115** may be varied by the service provider through the configuration and/or administration component **2105** depending on, for example, local demand, to apply premium pricing during periodic or temporary high-demand periods. For example, a competing nearby charging station suffering a worker strike or local protest may trigger increased demand at a service provider's charging station thereby allowing that service provider to temporarily charge higher fees while the strike or protest is occurring. In other examples, when there are not enough charger stations or facilities to service the number of vehicles in a particular area or when the electric utility company is struggling to keep up with demand, temporarily higher prices for services may be supported and can be implemented through the configurable parameters set by the service provider. Thus, the set of service configuration information comprises one or more dynamic pricing parameters. The one or more dynamic pricing parameters relate to one or more of a current demand for the service, a current availability of the service, or one or more factors adjusting the price of the service. The dynamic pricing parameters can comprise, for example, multipliers, divisors, additional charges, discounts amounts, and/or other factors that can be applied by the service rules to adjust a price up or down for given conditions. Any number and variety of other parameters can be implemented in different ways at the service provider's discretion and are considered to be within the scope of the present disclosure.

[0152] The repository of vehicle or user specific information **2120** can comprise information for one or more vehicles defined by the service provider through the configuration and/or administration component. Additionally or alternatively, this information may be collected from the vehicle, the user, other service providers, other elements interacting with the vehicle etc. through the data collection component interfacing with those elements. The information stored in the repository of vehicle or user specific information **2120** can comprise values for variables defined in the calculations or actions of the rules. In other cases, the information can comprise switches, flags, or other values for the conditions of the rules. For example, use of a particular service or facility may be tracked and frequent users of that service or facility may be provided a discount or special terms. Therefore, the set of user or vehicle specific maintenance and use information stored in the repository of vehicle or user specific information **2120** can comprise user loyalty information, i.e., use of a particular service or facility may be tracked and frequent users of that service or facility may be provided a discount or special terms. In another example, use data may be collected related to and indicating how a particular user charges his vehicle. Since leaving the vehicle on the charger beyond the time when the battery is fully or adequately charged needlessly consumes electricity, an effective pricing model could charge users more for charging longer and possibly less or crediting them for charging for a shorter time. Therefore, the set of user or vehicle specific maintenance and use information stored in the repository of vehicle or user specific information **2120** can comprise historical information related to use of the service, i.e., the value determination or pricing rules could apply higher charges to users for charging longer and possibly less or crediting them for charging for a shorter time. Any amount and variety of other data can be implemented in different ways at the service provider's discretion and is considered to be within the scope of the present disclosure.

[0153] The value determination component **2130** can then determine a value or price for the service performed on the vehicle based on applying the maintenance management rules stored in the repository maintenance management rules **2110** and using the set of service configuration parameters stored in the repository of configuration parameters **2115** and the set of user or vehicle specific maintenance and use information stored in the repository of vehicle or user information **2120**. That is, once the variables of the rules are populated with the values defined in the service configuration parameters and/or the vehicle or user specific information, the rules can be executed by the value determination component **2130** and the actions defined for the rules can be performed by the value determination component **2130** based on the populated conditions.

[0154] The determined value or price for the service can then be provided to the one or more vehicles. For example, the determined value or price may be saved by the value determination component **2130** in the repository of service value information **2135** which can be accessible by the vehicle, by the user through other means such as a mobile device or computer, by other service providers, or by other elements interacting with the vehicle. Additionally or alternatively, the determined value or price may be transmitted by the communication component **2140** over a cellular or other wireless connection to the vehicle, user, other service provider or element, etc. Once received by the vehicle, this information may be presented to the user or driver of the vehicle, e.g., via a heads up or other display within the vehicle. In some cases, automated negotiation between user and service provider may occur. For example, the initial price may be provided to the user, e.g., through a heads up or other display in the vehicle, and the user may be given a choice to accept that initial price, reject, the initial price, or make a counteroffer to the initial price. This choice may be provided through the communication component **2140** back to the value determination component **2130** of the service provider system **2100** which may then, again depending upon the rules, configurable parameters, and user or vehicle specific maintenance and use information, adjust or update the initial price or leave the initial price as originally determined.

[0155] According to one embodiment, using the maintenance management rules, configuration parameters, and vehicle and/or user specific information described above, a model can be implemented for managing a service in which a benefit or incentive can be provided to a vehicle operator for exchanging parts or receiving a service at a particular service level. The model may be prepaid or paid upon service being rendered. The service level may be preselected or selected at the time of service delivery. For example, the vehicle owner or operator may receive a credit or discount for exchanging a current battery pack or other power source of the vehicle for a lower charged battery pack or power source which can be later charged by the operator. In such cases, when a user initially purchases and/or licenses a battery pack, for instance, the user can specify and perhaps prepay for an acceptable stored charge range for exchanged battery packs. For example, a user at a high service level can pay a higher amount for a replacement with a high, e.g., 60%-100%, charge level while a user at a lower service level can pay a lower amount for a replacement with a low, e.g., 40%-100%, charge level. This lower level might be attractive, for example, to hybrid vehicle users exchanging battery packs with electric vehicle users.

[0156] In another example, the service level can additionally or alternatively be based on the State of Life (SOL) of the replacement. That is, instead of charge, the service levels can be distinguished based on the SOL of the equipment used for the exchange and the user can specify and pay a premium based on the age of a battery pack and/or battery pack usage level, e.g., historic charging cycle number. For example, in a battery pack exchange, a high service level user can receive the newest available battery pack or battery pack having the lowest use, e.g., lowest historic charging cycles, relative to a lower service level user.

[0157] FIG. **22** is a diagram illustrating an exemplary data structure of records for storing vehicle or user information according to one embodiment of the present disclosure. As illustrated in this example, a vehicle or user information record **2200** can store a vehicle identifier field **2205** and user identifier field **2210**. The vehicle identifier field **2205** can comprise a VIN or other identifier unique to the vehicle. Similarly, the user identifier field **2210** can store a name, social security number, customer number, or other identifier uniquely identifying the user. The record **2200** can also include a prepaid indicator field **2215** indicating whether the service for this vehicle and/or user has been prepaid. Additionally or alternatively, the record **2200** can include a service level indicator field **2220** storing an indication of a preselected service level, if any. According to one embodiment, the service level may be selected when the service is prepaid or may be selected even if not prepaid but rather, will be paid upon completion of the service. It should be understood that, while only one record **2200** is illustrated here for the sake of simplicity and clarity, any number of records can be maintained for each of any number of vehicles and/or users. Furthermore, the exemplary fields **2205**, **2210**, **2215**, and **2220** described here are offered for illustrative purposes and are not intended to limit the scope of the present disclosure. Rather, more or fewer fields may be used depending upon the exact implementation.

[0158] FIG. **23** is a diagram illustrating an exemplary data structure of records for storing equipment information according to one embodiment of the present disclosure. As illustrated in this example, an equipment information record **2300** can store an equipment identifier field **2305** and charge level field **2310**. The equipment identifier field **2305** can store any number, string of characters, code, or other information uniquely identifying the battery. The charge level field **2310** can store an indication of a current charge level for the battery. For example, this field **2310** can be updated each time the battery is charged. The record **2300** can also include a SOL field **2315** which can store an indication of the estimated state of life of the battery based, for example, on the number of charges, the environment in which the battery has been operated (if know), the types of charging cycles the battery has been subjected to (if know), etc. This field **2315** can be updated, for example, each time the battery is charged. The record can also include a charge cycle field **2320** storing a number indicating the number of times the battery has been charged. For example, this field **2320** can be updated each time the battery is charged. It should be understood that, while only one record **2200** is illustrated here for the sake of simplicity and clarity, any number of records can be maintained for each of any number of vehicles and/or users. Furthermore, the exemplary fields **2305**, **2310**, **2315**, and **2320** described here are offered for illustrative purposes and are not intended to limit the scope of the present disclosure. Rather, more or fewer fields may be used depending upon the exact implementation.

[0159] FIG. **24** is a flowchart illustrating an exemplary process for applying provider or seller rules to a service according to one embodiment of the present disclosure. As illustrated in this example, managing an exchange of a vehicle power source can comprise maintaining **2405** a set of user or vehicle records for each of one or more users or vehicles and maintaining **2410** a set of equipment records for each of a plurality of pieces of equipment. A request for service of a vehicle can be received **2415**. The service can comprise at least an exchange of a power source of the vehicle. At least one service level of a plurality of service levels can be identified **2420** for the requested service based at least in part on the set of user or vehicle records. At least one available power source can be selected **2425** for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records. Identifying the at least one service level for the requested service and selecting at least one available power source can further comprise determining a value or price for the selected power source. Additional details of determining the value or price will be described in greater detail below with reference to FIG. **25**. The determined value or price for the selected power source can then be provided **2430** to the vehicle and/or the user.

[0160] For example, the vehicle power source can comprise a battery. The plurality of service levels can be defined based on a level of charge of a battery used for the exchange of the vehicle power source. In such cases, a first service level of the plurality of service levels can be defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and a cost for the first service level is higher than a cost for the second service level. In another example, the plurality of service levels can be defined based on a state of life of a battery used for the exchange of the vehicle power source. In such cases, a first service level of the plurality of service levels can be defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and a cost for the first service level is higher than a cost for the second service level.

[0161] FIG. **25** is a flowchart illustrating an exemplary process for determining a value for a replacement part or service according to one embodiment of the present disclosure. As illustrated in this example, determining a value or price for a replacement part or service can comprise determining **2505** whether the requested service is a prepaid service at a preselected service level of a plurality of service levels. This determination can be made, for example, based on the maintained set of user or vehicle records. In response to determining **2505** the requested service is a prepaid service at a preselected service level of a plurality of service levels, an available power source selected **2510** for the exchange of the power source of the vehicle based on the pre-elected service level. In this case, further determination of the value or price of the replacement part need not be performed since the service was prepaid.

[0162] In response to determining **2505** the requested service is not a prepaid service at a preselected service level of a plurality of service levels, a further determination **2515**

can be made as to whether the at least one service level has been preselected. This determination **2515** can be made, for example, based on the maintained set of user or vehicle records. In other cases, the determination **2515** may be made based on information in the request for service or by querying the user. In response to determining **2515** the at least one service level has been preselected, the preselected service level can be identified **2530** and at least one available power source can be selected **2535** for the exchange of the power source of the vehicle based on the preselected service level. A value or price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle can be determined **2540** and provided **2545** to the user.

[0163] In response to determining **2515** a service level has not been preselected, one or more available power sources for the exchange of the power source of the vehicle identifying **2520** and a service level for each of the identified one or more available power sources can be determined **2525**. A value or price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle can be determined **2540** and provided **2545** to a user. At this point, the user may be able to select which available equipment or level of service to be used for the exchange or service.

[0164] FIG. **26** is a diagram illustrating an exemplary instrument panel of a vehicle according to one embodiment of the present disclosure. As described above with reference for FIG. **4**C, the instrument panel **400** of vehicle **100** can comprise steering wheel **410**, vehicle operational display **420**, one or more auxiliary displays **424**, heads-up display **434**, power management display **428**, and charging manual controller **432** (which provides a physical input, e.g. a joystick, to manual maneuver, e.g., a vehicle charging plate to a desired separation distance). One or more of displays of instrument panel **400** may be touch-screen displays. One or more displays of instrument panel **400** may be mobile devices and/or applications residing on a mobile device such as a smart phone. As described herein, the determined value or price for a service can be provided to the vehicle and presented on one of the displays. In this example, service level and price information is presented on the heads-up display **434** as a list of available replacements at a number of locations with an indication of an associated type or service level and price for each. It should be noted that in other implementations this information can be presented on any one or more of the other displays such as the vehicle operational display **420**, one or more auxiliary displays **424**, power management display **428**, etc. or may be played out in audio form through the sound system of the vehicle. In yet other implementations, the information may be presented on a mobile device or computer of the user coupled with the vehicle, e.g., through a Blue Tooth or other communication means.

[0165] According to one embodiment, the service level and price information may be presented to the vehicle in response to a query from the vehicle. This query may be generated automatically by the vehicle based on a detected condition. For example, when a battery or other power source of the vehicle reaches a certain charge level that is predefined as being low, the vehicle may begin searching for a charging facility or an exchange facility. In other cases, the driver may initiate the query. Additionally or alternatively, the information may be presented whenever received by the vehicle from the service. For example, a service may generate and send the information to vehicles in a specific geographic range of a service facility or periodically send value and price information, perhaps at discounted rates or with another incentive, to one or more vehicles as an advertisement for the service.

[0166] Any of the steps, functions, and operations discussed herein can be performed continuously and automatically.

[0167] The exemplary systems and methods of this disclosure have been described in relation to vehicle systems and electric vehicles. However, to avoid unnecessarily obscuring the present disclosure, the preceding description omits a number of known structures and devices. This omission is not to be construed as a limitation of the scope of the claimed disclosure. Specific details are set forth to provide an understanding of the present disclosure. It should, however, be appreciated that the present disclosure may be practiced in a variety of ways beyond the specific detail set forth herein.

[0168] Furthermore, while the exemplary embodiments illustrated herein show the various components of the system collocated, certain components of the system can be located remotely, at distant portions of a distributed network, such as a LAN and/or the Internet, or within a dedicated system. Thus, it should be appreciated, that the components of the system can be combined into one or more devices, such as a server, communication device, or collocated on a particular node of a distributed network, such as an analog and/or digital telecommunications network, a packet-switched network, or a circuit-switched network. It will be appreciated from the preceding description, and for reasons of computational efficiency, that the components of the system can be arranged at any location within a distributed network of components without affecting the operation of the system.

[0169] Furthermore, it should be appreciated that the various links connecting the elements can be wired or wireless links, or any combination thereof, or any other known or later developed element(s) that is capable of supplying and/or communicating data to and from the connected elements. These wired or wireless links can also be secure links and may be capable of communicating encrypted information. Transmission media used as links, for example, can be any suitable carrier for electrical signals, including coaxial cables, copper wire, and fiber optics, and may take the form of acoustic or light waves, such as those generated during radio-wave and infra-red data communications.

[0170] While the flowcharts have been discussed and illustrated in relation to a particular sequence of events, it should be appreciated that changes, additions, and omissions to this sequence can occur without materially affecting the operation of the disclosed embodiments, configuration, and aspects.

[0171] A number of variations and modifications of the disclosure can be used. It would be possible to provide for some features of the disclosure without providing others.

[0172] In yet another embodiment, the systems and methods of this disclosure can be implemented in conjunction with a special purpose computer, a programmed microprocessor or microcontroller and peripheral integrated circuit element(s), an ASIC or other integrated circuit, a digital signal processor, a hard-wired electronic or logic circuit such as discrete element circuit, a programmable logic device or gate array such as PLD, PLA, FPGA, PAL, special purpose computer, any comparable means, or the like. In general, any device(s) or means capable of implementing the methodology illustrated herein can be used to implement the various aspects of this disclosure. Exemplary hardware that can be used for the present disclosure includes computers, handheld devices, telephones (e.g., cellular, Internet enabled, digital, analog, hybrids, and others), and other hardware known in the art. Some of these devices include processors (e.g., a single or multiple microprocessors), memory, nonvolatile storage, input devices, and output devices. Furthermore, alternative software implementations including, but not limited to, distributed processing or component/object distributed processing, parallel processing, or virtual machine processing can also be constructed to implement the methods described herein.

[0173] In yet another embodiment, the disclosed methods may be readily implemented in conjunction with software using object or object-oriented software development environments that provide portable source code that can be used on a variety of computer or workstation platforms. Alternatively, the disclosed system may be implemented partially or fully in hardware using standard logic circuits or VLSI design. Whether software or hardware is used to implement the systems in accordance with this disclosure is dependent on the speed and/or efficiency requirements of the system, the particular function, and the particular software or hardware systems or microprocessor or microcomputer systems being utilized.

[0174] In yet another embodiment, the disclosed methods may be partially implemented in software that can be stored on a storage medium, executed on programmed general-purpose computer with the cooperation of a controller and memory, a special purpose computer, a microprocessor, or the like. In these instances, the systems and methods of this disclosure can be implemented as a program embedded on a personal computer such as an applet, JAVA® or CGI script, as a resource residing on a server or computer workstation, as a routine embedded in a dedicated measurement system, system component, or the like. The system can also be implemented by physically incorporating the system and/or method into a software and/or hardware system.

[0175] Although the present disclosure describes components and functions implemented in the embodiments with reference to particular standards and protocols, the disclosure is not limited to such standards and protocols. Other similar standards and protocols not mentioned herein are in existence and are considered to be included in the present disclosure. Moreover, the standards and protocols mentioned herein and other similar standards and protocols not mentioned herein are periodically superseded by faster or more effective equivalents having essentially the same functions. Such replacement standards and protocols having the same functions are considered equivalents included in the present disclosure.

[0176] The present disclosure, in various embodiments, configurations, and aspects, includes components, methods, processes, systems and/or apparatus substantially as depicted and described herein, including various embodiments, subcombinations, and subsets thereof. Those of skill in the art will understand how to make and use the systems and methods disclosed herein after understanding the present disclosure. The present disclosure, in various embodiments, configurations, and aspects, includes providing devices and processes in the absence of items not depicted and/or described herein or in various embodiments, configurations, or aspects hereof, including in the absence of such items as may have been used in previous devices or processes, e.g., for improving performance, achieving ease, and/or reducing cost of implementation.

[0177] The foregoing discussion of the disclosure has been presented for purposes of illustration and description. The foregoing is not intended to limit the disclosure to the form or forms disclosed herein. In the foregoing Detailed Description for example, various features of the disclosure are grouped together in one or more embodiments, configurations, or aspects for the purpose of streamlining the disclosure. The features of the embodiments, configurations, or aspects of the disclosure may be combined in alternate embodiments, configurations, or aspects other than those discussed above. This method of disclosure is not to be interpreted as reflecting an intention that the claimed disclosure requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment, configuration, or aspect. Thus, the following claims are hereby incorporated into this Detailed Description, with each claim standing on its own as a separate preferred embodiment of the disclosure.

[0178] Moreover, though the description of the disclosure has included description of one or more embodiments, configurations, or aspects and certain variations and modifications, other variations, combinations, and modifications are within the scope of the disclosure, e.g., as may be within the skill and knowledge of those in the art, after understanding the present disclosure. It is intended to obtain rights, which include alternative embodiments, configurations, or aspects to the extent permitted, including alternate, interchangeable and/or equivalent structures, functions, ranges, or steps to those claimed, whether or not such alternate, interchangeable and/or equivalent structures, functions, ranges, or steps are disclosed herein, and without intending to publicly dedicate any patentable subject matter.

[0179] Embodiments include a method for managing an exchange of a vehicle power source, the method comprising: maintaining a set of user or vehicle records for each of one or more users or vehicles; maintaining a set of equipment records for each of a plurality of pieces of equipment; receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle; identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

[0180] Aspects of the above method include wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

[0181] Aspects of the above method further include: determining whether the at least one service level has been preselected; and in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

[0182] Aspects of the above method further include, in response to determining a service level has been preselected: identifying one or more available power sources for the exchange of the power source of the vehicle; determining a service level for each of the identified one or more available power sources; determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and providing the determined price or incentive for using each of the identified available power sources to a user.

[0183] Aspects of the above method include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0184] Aspects of the above method include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a state of life of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0185] Aspects of the above method include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0186] Embodiments include a system comprising: a processor; and a memory coupled with and readable by the processor and storing therein a set of instructions which, when executed by the processor, causes the processor to manage an exchange of a vehicle power source by: maintaining a set of user or vehicle records for each of one or more users or vehicles; maintaining a set of equipment records for each of a plurality of pieces of equipment; receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle; identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

[0187] Aspects of the above system include wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

[0188] Aspects of the above system include wherein managing an exchange of a vehicle power source further comprises: determining whether the at least one service level has been preselected; and in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

[0189] Aspects of the above system further include, in response to determining a service level has been preselected: identifying one or more available power sources for the exchange of the power source of the vehicle; determining a service level for each of the identified one or more available power sources; determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and providing the determined price or incentive for using each of the identified available power sources to a user.

[0190] Aspects of the above system include wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0191] Aspects of the above system include wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a state of life of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0192] Aspects of the above system include wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0193] Embodiments include a non-transitory computer readable medium comprising a set of instructions stored therein which, when executed by a processor, causes the processor to manage an exchange of a vehicle power source by: maintaining a set of user or vehicle records for each of one or more users or vehicles; maintaining a set of equipment records for each of a plurality of pieces of equipment; receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle; identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

[0194] Aspects of the above non-transitory computer readable medium include wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

[0195] Aspects of the above non-transitory computer readable medium include wherein managing an exchange of a vehicle power source further comprises: determining whether the at least one service level has been preselected; and in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

[0196] Aspects of the above non-transitory computer readable medium further include, in response to determining a service level has been preselected: identifying one or more available power sources for the exchange of the power source of the vehicle; determining a service level for each of the identified one or more available power sources; determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and providing the determined price or incentive for using each of the identified available power sources to a user.

[0197] Aspects of the above non-transitory computer readable medium include wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0198] Aspects of the above non-transitory computer readable medium include wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0199] Embodiments include a system for managing an exchange of a vehicle power source, the method comprising: means for maintaining a set of user or vehicle records for each of one or more users or vehicles; means for maintaining a set of equipment records for each of a plurality of pieces of equipment; means for receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle; means for identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and means for selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

[0200] Aspects of the above system include means for wherein identifying the at least one service level of the plurality of service levels for the requested service comprises means for determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein means for selecting at least one available power source for the exchange of the power source of the vehicle comprises, means for in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, means for selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

[0201] Aspects of the above system further include: means for determining whether the at least one service level has been preselected; and means for in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

[0202] Aspects of the above system further include, means for in response to determining a service level has been preselected: means for identifying one or more available power sources for the exchange of the power source of the vehicle; means for determining a service level for each of the identified one or more available power sources; means for determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and means for providing the determined price or incentive for using each of the identified available power sources to a user.

[0203] Aspects of the above system include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0204] Aspects of the above system include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a state of life of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0205] Aspects of the above system include, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

[0206] The phrases "at least one," "one or more," "or," and "and/or" are open-ended expressions that are both conjunctive and disjunctive in operation. For example, each of the expressions "at least one of A, B and C," "at least one of A, B, or C," "one or more of A, B, and C," "one or more of A, B, or C," "A, B, and/or C," and "A, B, or C" means A alone, B alone, C alone, A and B together, A and C together, B and C together, or A, B and C together.

[0207] The term "a" or "an" entity refers to one or more of that entity. As such, the terms "a" (or "an"), "one or more," and "at least one" can be used interchangeably herein. It is also to be noted that the terms "comprising," "including," and "having" can be used interchangeably.

[0208] The term "automatic" and variations thereof, as used herein, refers to any process or operation, which is typically continuous or semi-continuous, done without material human input when the process or operation is performed. However, a process or operation can be automatic, even though performance of the process or operation uses material or immaterial human input, if the input is received before performance of the process or operation. Human input is deemed to be material if such input influences how the process or operation will be performed. Human input that consents to the performance of the process or operation is not deemed to be "material."

[0209] Aspects of the present disclosure may take the form of an embodiment that is entirely hardware, an embodiment that is entirely software (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module," or "system." Any combination of one or more computer-readable medium(s) may be utilized. The computer-readable medium may be a computer-readable signal medium or a computer-readable storage medium.

[0210] A computer-readable storage medium may be, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples (a non-exhaustive list) of the computer-readable storage medium would include the following: an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing. In the context of this document, a computer-readable storage medium may be any tangible medium that can contain or store a program for use by or in connection with an instruction execution system, apparatus, or device.

[0211] A computer-readable signal medium may include a propagated data signal with computer-readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electromagnetic, optical, or any suitable combination thereof. A computer-readable signal medium may be any computer-readable medium that is not a computer-readable storage medium and that can communicate, propagate, or transport a program for use by or in connection with an instruction execution system, apparatus, or device. Program code embodied on a computer-readable medium may be transmitted using any appropriate medium, including, but not limited to, wireless, wireline, optical fiber cable, RF, etc., or any suitable combination of the foregoing.

[0212] The terms "determine," "calculate," "compute," and variations thereof, as used herein, are used interchangeably and include any type of methodology, process, mathematical operation or technique.

[0213] The term "electric vehicle" (EV), also referred to herein as an electric drive vehicle, may use one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery or generator to convert fuel to electricity. An electric vehicle generally includes a rechargeable electricity storage system (RESS) (also called Full Electric Vehicles (FEV)). Power storage methods may include: chemical energy stored on the vehicle in on-board batteries (e.g., battery electric vehicle or BEV), on board kinetic energy storage (e.g., flywheels), and/or static energy (e.g., by on-board double-layer capacitors). Batteries, electric double-layer capacitors, and flywheel energy storage may be forms of rechargeable on-board electrical storage.

[0214] The term "hybrid electric vehicle" refers to a vehicle that may combine a conventional (usually fossil fuel-powered) powertrain with some form of electric propulsion. Most hybrid electric vehicles combine a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system (hybrid vehicle drivetrain). In parallel hybrids, the ICE and the electric motor are both connected to the mechanical transmission and can simultaneously transmit power to drive the wheels, usually through a conventional transmission. In series hybrids, only the electric motor drives the drivetrain, and a smaller ICE works as a generator to power the electric motor or to recharge the batteries. Power-split hybrids combine series and parallel characteristics. A full hybrid, sometimes also called a strong hybrid, is a vehicle that can run on just the engine, just the batteries, or a combination of both. A mid hybrid is a vehicle that cannot be driven solely on its electric motor, because the electric motor does not have enough power to propel the vehicle on its own.

[0215] The term "rechargeable electric vehicle" or "REV" refers to a vehicle with on board rechargeable energy storage, including electric vehicles and hybrid electric vehicles.

What is claimed is:

1. A method for managing an exchange of a vehicle power source, the method comprising:

maintaining a set of user or vehicle records for each of one or more users or vehicles;

maintaining a set of equipment records for each of a plurality of pieces of equipment;

receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle;

identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and

selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

2. The method of claim **1**, wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

3. The method of claim **1**, further comprising:

determining whether the at least one service level has been preselected; and

in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

4. The method of claim **3**, further comprising, in response to determining a service level has been preselected:

identifying one or more available power sources for the exchange of the power source of the vehicle;

determining a service level for each of the identified one or more available power sources;

determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and

providing the determined price or incentive for using each of the identified available power sources to a user.

5. The method of claim **1**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

6. The method of claim **1**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a state of life of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

7. The method of claim **1**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

8. A system comprising:

a processor; and

a memory coupled with and readable by the processor and storing therein a set of instructions which, when executed by the processor, causes the processor to manage an exchange of a vehicle power source by:

maintaining a set of user or vehicle records for each of one or more users or vehicles;

maintaining a set of equipment records for each of a plurality of pieces of equipment;

receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle;

identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and

selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

9. The system of claim **8**, wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

10. The system of claim **8**, wherein managing an exchange of a vehicle power source further comprises:

determining whether the at least one service level has been preselected; and

in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

11. The system of claim **10**, further comprising, in response to determining a service level has been preselected:

identifying one or more available power sources for the exchange of the power source of the vehicle;

determining a service level for each of the identified one or more available power sources;

determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and

providing the determined price or incentive for using each of the identified available power sources to a user.

12. The system of claim **8**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

13. The system of claim **8**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a state of life of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a state of life that is newer than a state of life defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

14. The system of claim **8**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

15. A non-transitory computer readable medium comprising a set of instructions stored therein which, when executed by a processor, causes the processor to manage an exchange of a vehicle power source by:

maintaining a set of user or vehicle records for each of one or more users or vehicles;

maintaining a set of equipment records for each of a plurality of pieces of equipment;

receiving a request for service of a vehicle, the service comprising at least an exchange of a power source of the vehicle;

identifying at least one service level of a plurality of service levels for the requested service based at least in part on the set of user or vehicle records; and

selecting at least one available power source for the exchange of the power source of the vehicle based on the identified at least one service level and the set of equipment records.

16. The non-transitory computer readable medium of claim **15**, wherein identifying the at least one service level of the plurality of service levels for the requested service comprises determining whether the requested service is a prepaid service at a preselected service level of a plurality of service levels and wherein selecting at least one available power source for the exchange of the power source of the vehicle comprises, in response to determining the requested service is a prepaid service at a preselected service level of a plurality of service levels, selecting an available power source for the exchange of the power source of the vehicle based on the pre-elected service level.

17. The non-transitory computer readable medium of claim **15**, wherein managing an exchange of a vehicle power source further comprises:

determining whether the at least one service level has been preselected; and

in response to determining the at least one service level has been preselected, identifying the preselected service level, selecting the at least one available power source for the exchange of the power source of the vehicle based on the preselected service level, determining a price or an incentive for using the at least one selected available power source for the exchange of the power source of the vehicle, and providing the determined price or incentive to a user.

18. The non-transitory computer readable medium of claim **17**, further comprising, in response to determining a service level has been preselected:

identifying one or more available power sources for the exchange of the power source of the vehicle;

determining a service level for each of the identified one or more available power sources;

determining a price or an incentive for using each of the identified available power sources for the exchange of the power source of the vehicle; and

providing the determined price or incentive for using each of the identified available power sources to a user.

19. The non-transitory computer readable medium of claim **15**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a level of charge of a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a level of charge that is higher than a level of charge defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

20. The non-transitory computer readable medium of claim **15**, wherein the vehicle power source comprises a battery, wherein the plurality of service levels are defined based on a historic number of charging cycles on a battery used for the exchange of the vehicle power source, wherein a first service level of the plurality of service levels is defined based on a higher number of charging cycles than a number of charging cycles defined for a second service level of the plurality of service levels, and wherein a cost for the first service level is higher than a cost for the second service level.

* * * * *