、前後サイドメンバ結合部7a,8aより前方におけるバッテリ2の車体取り付け点数（6個）を、これら前後サイドメンバ結合部7a,8aより後方におけるバッテリ2の車体取り付け点数（2個）よりも多くしたため、以下の作用効果が奏し得られる。

【００９１】

つまり上記の構成によれば、車体フロア5に対するバッテリ2の取り付け強度を、前後サイドメンバ結合部7a,8aより後方の低強度な車体フロア後側部分よりも、前後サイドメンバ結合部7a,8aより前方の高強度な車体フロア5の前側部分で多く分担させることとなる。

かかるバッテリ2の前後取り付け強度分担割合により、高強度な車体フロア5の前側部分が車体フロア5に対するバッテリ2の取り付け面精度を高めることができ、この高い取り付け面精度によってバッテリ2の取り付けを容易に自動化し得ると共に、バッテリ2に変形荷重が加わったり、バッテリ2の支持姿勢が不安定になるなどの問題を回避することができる。

【００９２】

また、前側における6個のねじ式ロック機構22のうち、バッテリ2（バッテリフレーム2a）の前側における車幅方向両側に配置した2個ずつのねじ式ロック機構22で、バッテリ2の前側における車幅方向両側を対応する側のフロントサイドメンバ7,8に取り付けるようにしたため、

この取り付けが車体フロア5の骨格部材である頑丈なフロントサイドメンバ7,8への取り付けとなって、上記の作用効果を更に顕著なものにすることができる。

【００９３】

更に、前側における6個のねじ式ロック機構22のうち、残りの2個を、バッテリ2（バッテリフレーム2a）の車両前後方向前端に車幅方向へ相互離間させて配置し、バッテリ2の前端をフロントサイドメンバ7,8およびトンネル部材6間の橋絡部材15,16に取り付けるようにしたため、以下の作用効果が得られる。

つまり、バッテリ2の前端におけるこれら2個のねじ式ロック機構22が、バッテリ2（バッテリフレーム2a）の前部分の車幅方向両側に2個ずつ配置した4個のねじ式ロック機構22によるバッテリ2の車体フロア前側部分への取り付け強度を補佐して、高強度な車体フロア前側部分に対するバッテリ2の取り付け強度分担割合を更に高めるよう機能し、前記の作用効果を更に顕著なものにすることができる。

【００９４】

そして、バッテリ2の前端における2個のねじ式ロック機構22による取り付けも、車体フロア5の骨格部材である頑丈なフロントサイドメンバ7,8およびトンネル部材6間の橋絡部材15,16への取り付けであって、前記の作用効果を一層顕著なものにすることができる。

【００９５】

＜その他の実施例＞

なお図示の実施例では、ねじ式ロック機構22によるバッテリ2の車体フロア取り付け点を、合計8個とし、前後サイドメンバ結合部7a，8aよりも前方に6個、前後サイドメンバ結合部7a,8aよりも後方に2個、それぞれ配置したが、ねじ式ロック機構22によるバッテリ2の車体フロア取り付け点の合計数は任意でよく、要は、前後サイドメンバ結合部7a，8aより前方におけるバッテリ2の車体フロア取り付け点数を、前後サイドメンバ結合部7a,8aより後方におけるバッテリ2の車体フロア取り付け点数よりも多くすれば、前記した作用効果を達成することができる。

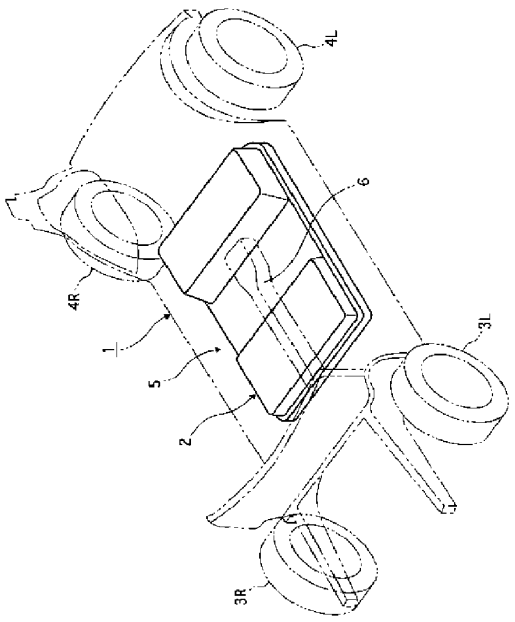
【００９６】

また図示例では、バッテリ2の前部分の車幅方向両側にねじ式ロック機構22を設けて、ここにバッテリ2の車体フロア取り付け点を設定すると共に、バッテリ2の前端にねじ式ロック機構22を設けて、ここにもバッテリ2の車体フロア取り付け点を設定したが、

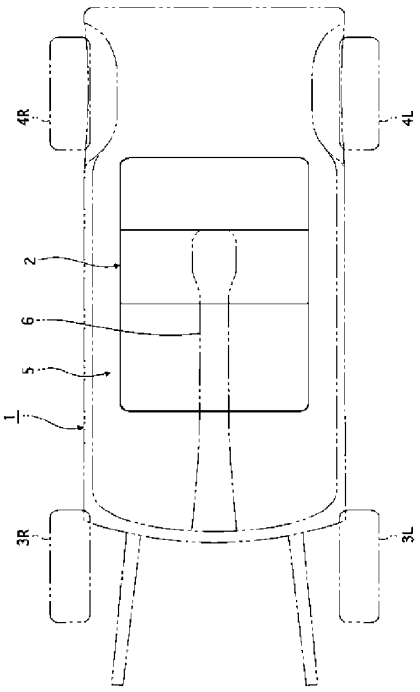
必ずしもバッテリ2の前部分の車幅方向両側と、バッテリ2の前端との双方にねじ式ロック機構22を設ける必要はなく、バッテリ2の取り付け強度要求を勘案し、いずれか一方のみにねじ式ロック機構22を設けてバッテリ2の車体フロア取り付け点を設定することも可能である。

【００９７】
更に図示例ではバッテリ2が、多数のバッテリシェルを相互に接続して1ユニットに構成したものである場合に付き説明したが、
バッテリ2が、その他バッテリモジュールと称せられるようなものなど、如何なる型式のものである場合も、前記した本発明の着想を適用して同様な作用効果を奏し得るのは言うまでもない。
【符号の説明】
【００９８】
1　車体
2　バッテリ
2a　バッテリフレーム
3L,3R　左右前輪（駆動輪）
4L,4R　左右後輪
5　車体フロア
6　トンネル部材
7,8　左右フロントサイドメンバ
7a,8a　左右の前後サイドメンバ結合部
7b,8b　ロケートホール
9,10　左右サイドシル
11,12　左右リヤサイドメンバ
13　フロントフロアパネル
14　リヤフロアパネル
15,16　橋絡部材
21　バッテリガイド手段
22　ねじ式ロック機構
23　コネクタユニット
24　ブラケット
25　ロケートピン本体
26　ロケートスリーブ
27　ロックプレート
27a　矩形開口
27b　円形開口
31　ロックベース
31b,31c　ストッパ
32　ボルト
33　ロックナット
33a　ロックナット長辺側テーパ面
33b　ロックナット短辺側テーパ面
34　ロックナット強制連れ回し部材
34a　板状部材
34b　脚部
34c　平坦カム面
35　バネ
36　バネ座
41　車体側コネクタ部材
42　バッテリ側コネクタ部材
43,44　ブラケット

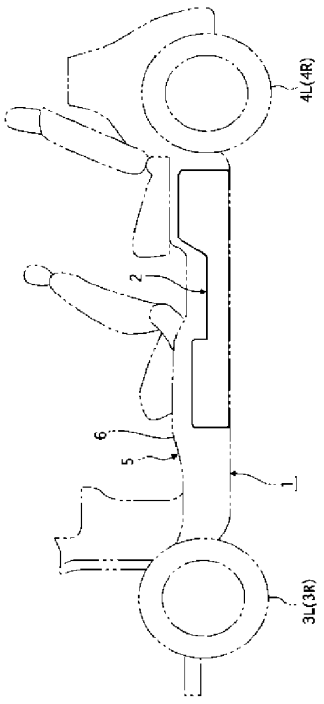
【図１】


4L
6
4R
1
5
2
3L
3R

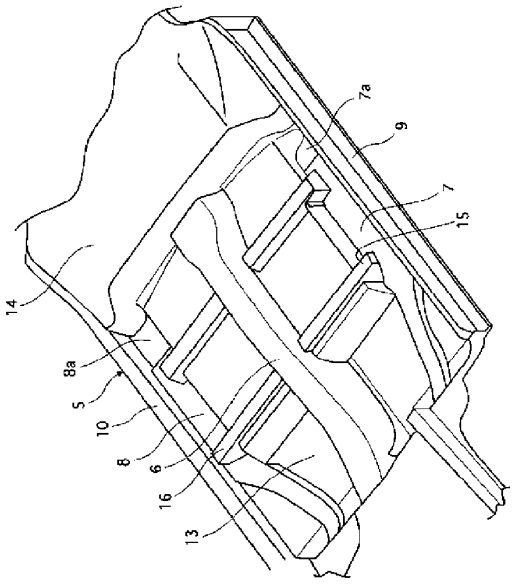
【図２】


4R
4L
2
6
5
1
3R
3L

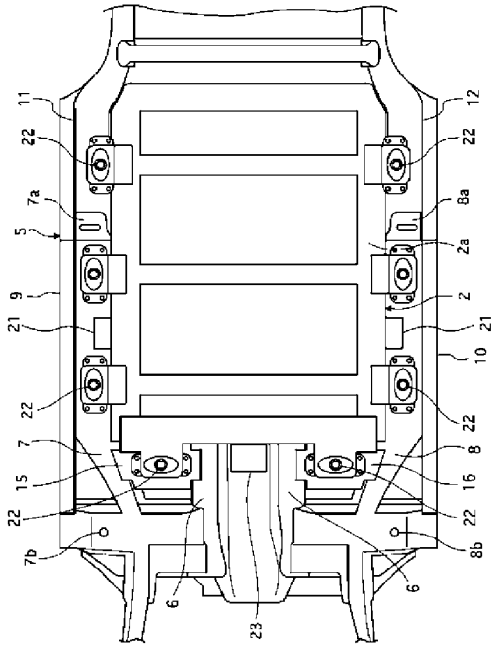
【図３】


4L(4R)
2
6
5
1
3L(3R)

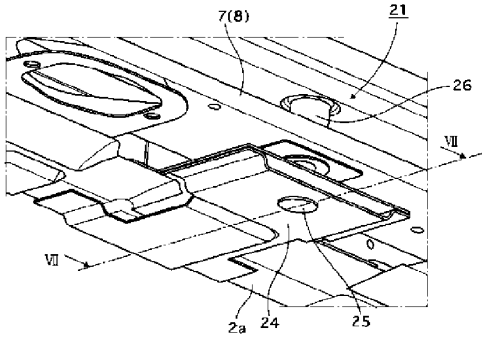
【図４】


7a
9
7
15
14
8a
5
10
8
6
16
13

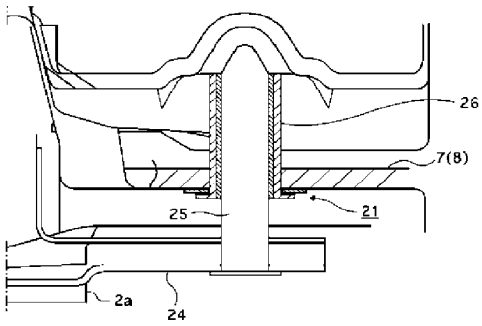
【図５】



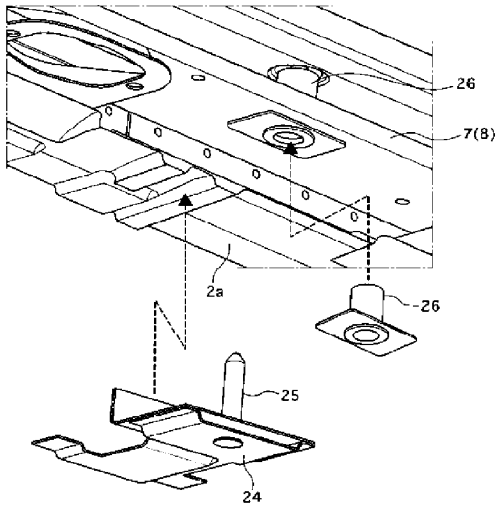
【図６】



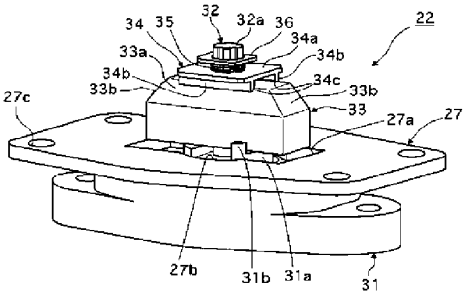
【図７】



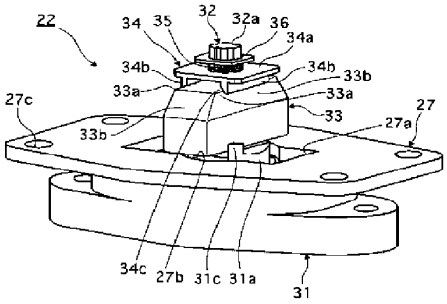
【図８】



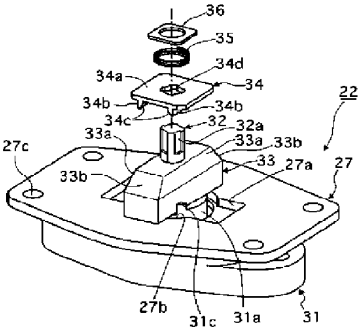
【図９】



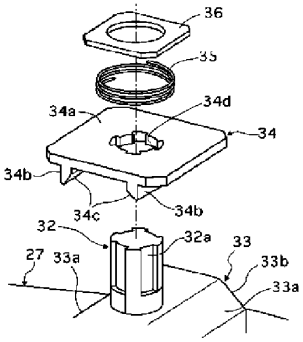
【図１０】



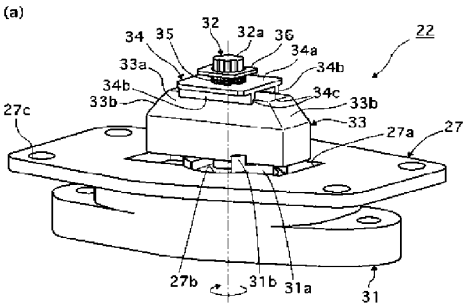
【図１１】



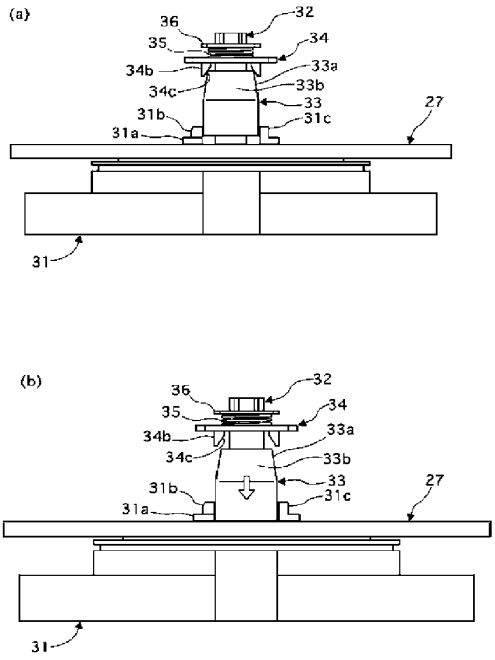
【図１２】



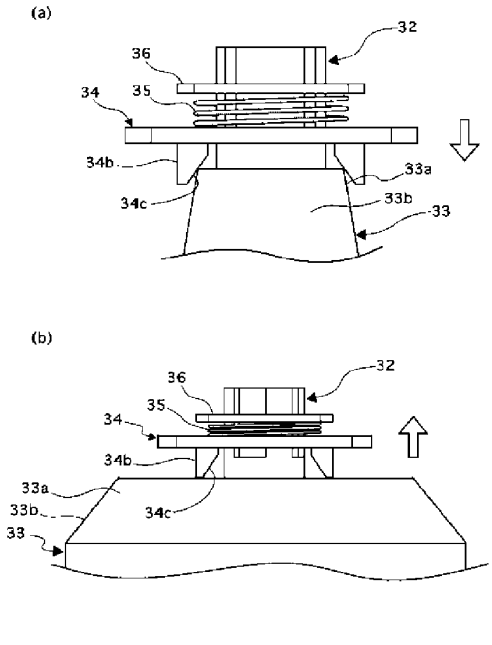
【図１３】



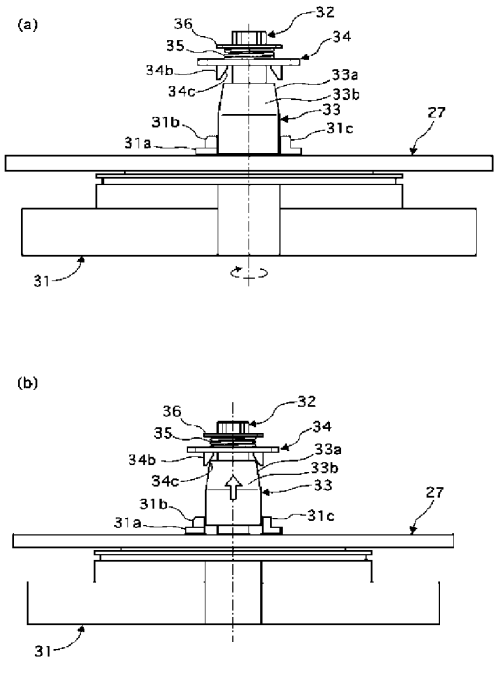
【図１４】



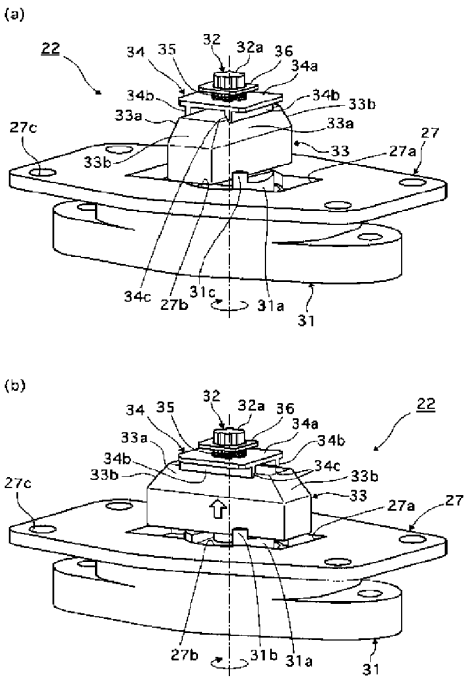
【図１５】



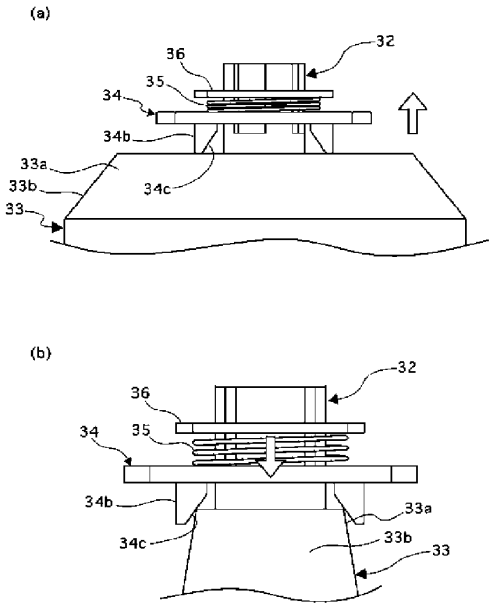
【図１６】



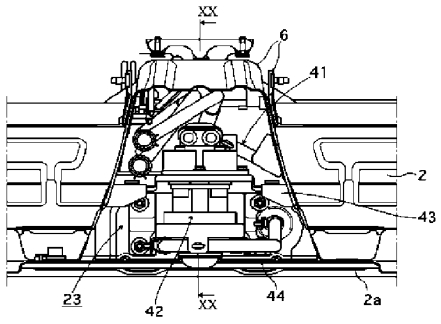
【図１７】



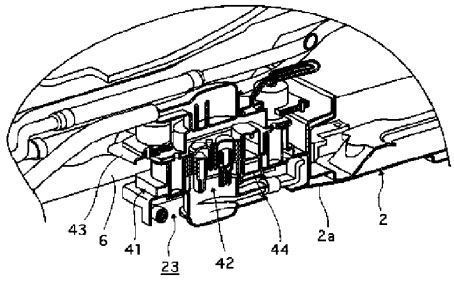
【図１８】



【図１９】



【図２０】



フロントページの続き

Ｆターム(参考) 3D235 AA02 BB20 BB25 CC15 DD35 EE63 EE64 FF02 FF06 FF07
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No documents available for this priority number.

Espacenet

Bibliographic data: KR20100012401 (A) — 2010-02-08

APPARATUS AND METHOD FOR DIAGNOSING CAR

Inventor(s): KIM HAN CIN [KR]; KWAK SOON KEUN [KR] ± (KIM, HAN CIN, ; KWAK, SOON KEUN)

Applicant(s): CONTINENTAL AUTOMOTIVE SYSTEMS [KR] ± (CONTINENTAL AUTOMOTIVE SYSTEMS CO., LTD)

Classification: **- international:** ***F02D41/02; F02D41/04; F02D41/22***
- cooperative: Y02T10/40

Application number: KR20080073765 20080728

Priority number (s): KR20080073765 20080728

Abstract of KR20100012401 (A)

PURPOSE: A vehicle failure diagnostic method and a device thereof are provided to prevent the misjudgement of the fuel leak due to the stuck diagnosis of a pressure sensor. CONSTITUTION: A vehicle failure diagnostic device comprises a pressure sensor, a canister purge valve, a purge control valve and an engine control unit. The pressure sensor detects and outputs the inside pressure of a tank as an electric signal. The canister purge valve and the purge control valve are opened and closed in order to form the negative pressure of the fuel tank. The engine control unit sets and stores the fuel leak diagnosis condition and the stuck diagnosis condition of the pressure sensor. The engine control unit executes the diagnosis corresponding to the diagnosis condition which satisfies one of the fuel leak diagnosis condition and the stuck diagnosis condition. The fuel leak due to opening of a fuel cap or the stuck of the pressure sensor is judged by the engine control unit according to the result of the fuel leak diagnosis and the stuck diagnosis.

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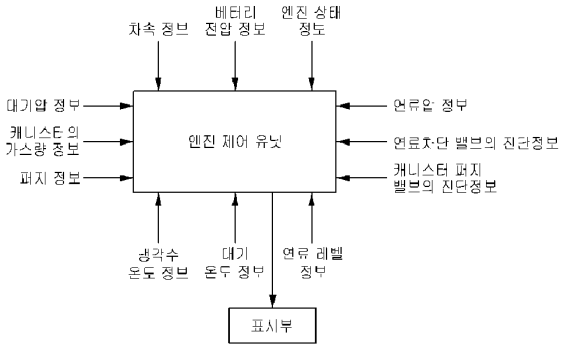
전체 청구항 수 : 총 13 항

(54) 자동차의 고장 진단 방법 및 장치

(57) 요 약

연료 압력 센서의 고착 진단과 연료 캡 열림 진단을 실행하여 자동차의 안전성을 더욱 향상시킬 수 있는 자동차의 고장 진단 방법 및 장치가 개시되어 있다. 이러한 본 발명은, 연료 탱크 내의 압력을 감지하여 전기적 신호로 출력하는 압력 센서와, 연료 탱크 내에 부압을 형성하기 위해 열림/닫힘을 제어하는 캐니스터 퍼지 밸브 및 퍼지 제어 밸브와, 압력 센서의 고착 진단 조건 및 연료 누설 진단 조건을 각각 설정하여 저장하고 설정된 압력 센서의 고착 진단 조건 또는 연료 누설 진단 조건 중 만족한 진단 조건의 해당 진단을 실행하며, 압력 센서 고착 및 연료 누설 진단 결과에 따라 압력 센서의 고착 및 연료 캡의 열림으로 인한 연료 누설을 판정하는 것을 엔진 제어 유닛을 포함한다.

대 표 도 - 도3



특허청구의 범위

청구항 1

연료 탱크 내의 압력을 감지하여 전기적 신호로 출력하는 압력 센서와,

연료 탱크 내에 부압을 형성하기 위해 열림/닫힘을 제어하는 캐니스터 퍼지 밸브 및 퍼지 제어 밸브와,

압력 센서의 고착 진단 조건 및 연료 누설 진단 조건을 각각 설정하여 저장하고 설정된 압력 센서의 고착 진단 조건 또는 연료 누설 진단 조건 중 만족한 진단 조건의 해당 진단을 실행하며, 압력 센서 고착 및 연료 누설 진단 결과에 따라 압력 센서의 고착 및 연료 캡의 열림으로 인한 연료 누설을 판정하는 것을 엔진 제어 유닛을 포함하는 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 2

제1항에 있어서, 상기 압력 센서 고착 진단 조건은 연료 탱크의 압력 정보, 캐니스터 퍼지 밸브의 진단 정보, 연료 차단 밸브의 진단 정보, 대기 온도 정보, 연료 레벨 정보, 연료 레벨 센서의 진단 정보를 근거하여 설정되는 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 3

제1항 또는 제2항에 있어서, 상기 연료 누설 진단 조건은 외부로부터 공급되는 차속 정보, 배터리 전압 정보, 엔진 상태 정보, 대기압 정보, 캐니스터 가스량 정보, 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 각 종 센서들이 진단 정보를 기초로 설정되는 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 4

제2항에 있어서, 압력 센서의 고착 진단 조건은,

압력 센서의 출력 전압이 제1 소정치 이상 제2 소정치 이하의 값을 가지는 경우, 캐니스터 퍼지 밸브가 에러가 없는 경우 연료 탱크의 연료 차단 밸브의 에러가 없는 경우 대기 온도가 제3 소정치 이상인 경우 연료 탱크의 연료 레벨이 제4 소정치 이하인 경우 상기 연료 탱크의 연료 량을 측정하는 연료 레벨 센서에 이상이 없는 경우인 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 5

제3항에 있어서, 상기 연료 누설 진단 조건은,

차속이 미리 정해진 제5 소정치 이하인 경우, 배터리 전압이 제6 소정치 이상 제7 소정치 이하인 경우, 람다 제어를 통해 공급된 연료가 엔진에서 연소되는 경우, 대기압이 미리 정해진 제8 소정치 이상인 경우 캐니스터 내에 가스가 미리 정해진 제9 소정치 이하인 경우, 냉각수 온도가 제10 소정치 이상 제11 소정치 이하 범위 내에 존재하는 경우, 대기 온도가 미리 정해진 제12 이상 제13이하의 범위 내에 존재하는 경우, 연료 탱크 내의 연료 레벨이 미리 정해진 제14 소정치 이하인 경우, 퍼시가 수행된 경우, 각 센서들의 이상이 없는 경우인 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 6

제1항에 있어서, 상기 엔진 제어 유닛은,

압력 센서의 고착 진단 조건을 만족하는 지를 판단하여 상기의 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서의 고착 진단을 실행한 후 상기의 압력 센서 고착 진단 조건을 만족하지 아니한 경우 상기의 연료 누설 진단 조건을 만족하는 경우 연료 누설 진단을 실행하고, ,

상기 압력 센서의 고착 진단 실행 후 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상인 지를 판단하여 최대값 및 최소값의 차가 설정치 이상인 경우 압력 센서를 정상으로 판정하며,

상기의 최대값 및 최소값의 차가 설정치 이상이 아닌 경우 압력 센서를 고착으로 판정하고,

상기 압력 센서의 고착 판정 후 상기 연료 누설 진단 결과 연료 누설이 발생한 경우 캡의 열림으로 인해 연료 대규모 누설이 발생한 것으로 판정하며,

상기 연료 탱크의 누설 연료 누설 진단 결과 연료 누설이 발생하지 아니한 경우 연료 누설이 없는 것으로 판정하는 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 7

제6항에 있어서, 상기 설정치는 0.5 hPa인 것을 특징으로 하는 자동차의 고장 진단 장치.

청구항 8

a) 연료 누설 진단 조건과 압력 센서 고착 진단 조건을 각각 설정하여 엔진 제어 유닛에 저장하는 단계;

b) 상기 a) 단계의 진단 조건 중 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서 고착 진단을 실행하는 단계;

c) 상기 a) 단계의 진단 조건 중 연료 누설 진단 조건을 만족하는 경우 연료 누설 진단을 실행하는 단계; 및

d) 상기 b) 단계 및 c) 단계의 진단 결과에 따라 압력 센서 고착 및 캡의 열림으로 인한 연료 대규모 누설을 판정하는 단계를 포함하는 것을 특징으로 하는 자동차의 고장 진단 방법.

청구항 9

제8항에 있어서, 상기 d) 단계는,

d-1) 상기 압력 센서의 고착 진단 및 연료 누설 진단 실행 후 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상인 지를 판단하여 최대값 및 최소값의 차가 설정치 이상인 경우 압력 센서를 정상으로 판정하고,

d-2) 최대값 및 최소값의 차가 설정치 이상이 아닌 경우 압력 센서를 고착으로 판정하며,

d-3) 상기 d-2)의 이후에 연료 누설 진단 결과 연료 누설이 발생한 경우 캡의 열림으로 인해 연료 대규모 누설이 발생한 것으로 판정하고,

d-4) 상기 d-3)의 판정 결과 연료 누설이 발생하지 아니한 경우 연료 누설이 없는 것으로 판정하는 것을 특징으로 하는 자동차의 고장 진단 방법.

청구항 10

제8항 또는 제 9항 중 한 항에 있어서, 상기 압력 센서 고착 진단 조건은 연료 탱크의 압력 정보, 캐니스터 퍼지 밸브의 진단 정보, 연료 차단 밸브의 진단 정보, 대기 온도 정보, 연료 레벨 정보, 연료 레벨 센서의 진단 정보를 근거하여 설정되는 것을 특징으로 하는 자동차의 고장 진단 방법.

청구항 11

제10항에 있어서, 상기 연료 누설 진단 조건은 외부로부터 공급되는 차속 정보, 배터리 전압 정보, 엔진 상태 정보, 대기압 정보, 캐니스터 가스량 정보, 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 각종 센서들이 진단 정보를 기초로 설정되는 것을 특징으로 하는 자동차의 고장 진단 방법.

청구항 12

제10항에 있어서, 상기 압력 센서 고착 진단 조건은,

압력 센서의 출력 전압이 제1 소정치 이상 제2 소정치 이하의 값을 가지는 경우, 캐니스터 퍼지 밸브가 에러가 없는 경우 연료 탱크의 연료 차단 밸브의 에러가 없는 경우 대기 온도가 제3 소정치 이상인 경우 연료 탱크의 연료 레벨이 제4 소정치 이하인 경우 상기 연료 탱크의 연료 량을 측정하는 연료 레벨 센서에 이상이 없는 경우인 것을 특징으로 하는 자동차의 고장 진단 방법.

청구항 13

제11항에 있어서, 연료 누설 진단 조건은,

차속이 미리 정해진 제5 소정치 이하인 경우, 배터리 전압이 제6 소정치 이상 제7 소정치 이하인 경우, 럼다 제어를 통해 공급된 연료가 엔진에서 연소되는 경우, 대기압이 미리 정해진 제8 소정치 이상인 경우 캐니스터 내

에 가스가 미리 정해진 제9 소정치 이하인 경우, 냉각수 온도가 제10 소정치 이상 제11 소정치 이하 범위 내에 존재하는 경우, 대기 온도가 미리 정해진 제12 이상 제13이하의 범위 내에 존재하는 경우, 연료 탱크 내의 연료 레벨이 미리 정해진 제14 소정치 이하인 경우, 퍼지가 수행된 경우, 각 센서들의 이상이 없는 경우인 것을 특징으로 하는 자동차의 고장 진단 방법.

명 세 서

발명의 상세한 설명

기 술 분 야

[0001] 본 발명은 자동차의 고장 진단 방법 및 장치에 관한 것으로서, 보다 상세하게는, 연료 압력 센서의 고착 및 연료 탱크 캡 열림 진단을 실행하여 고장 진단을 정확하게 실행할 수 있도록 한 방법 및 장치에 관한 것이다.

배 경 기 술

[0002] 주지하는 바와 같이, 내연 기관의 엔진은 연료와 공기를 엔진에서 연소시킴으로써 동력을 발생하는 장치이다.

[0003] 일반적인 가솔린 차량은 도 1에 도시된 바와 같이, 엔진(5)에 시동을 걸면, 연료 탱크(1)에서 발생된 연료 증발 가스가 호스를 통해 캐니스터(4)에 유입되고, 이 연료 증발 가스가 유입된 캐니스터(4)는 솔레노이드 밸브에 의해 유입된 연료 가스를 포집하여 연료 호스를 통해 퍼지 제어 밸브(3)로 유입한다. 상기 퍼지 제어 밸브(3)는 유입된 연료 가스를 균등하게 분배하여 엔진(5)의 연소실로 유입한다.

[0004] 한편 엔진 전자 제어기는 퍼지 시스템의 누설 여부를 검진하는 단계를 거치는 데 가솔린 차량에서 누설을 검출하는 방식은 가압식 진단 방식과 연료탱크에 압력센서를 설치하고 엔진 흡기계의 부압을 이용하여 연료 탱크 내 부압을 형성시켜 압력 변동치를 측정하는 부압식 진단 방식이 있다.

[0005] 상기한 부압식 리크 진단은 아이들 상태에서 실시하며, 연료 탱크(1)의 주유구 캡(2)이 정상적으로 닫혀 있는 경우 연료 탱크(1)에 충분한 부압을 공급하기 위한 퍼지 제어 밸브(3)의 작동 듀티를 일정량 이상(약 20% 이상)으로 작동시킨다.

[0006] 이는 엔진이 공회전 상태에서 캐니스터 차단 밸브를 닫아 퍼지 시스템 전체를 외부 대기압과 밀폐시키면 연료 탱크 내부는 진공이 형성되고 일정 시간 동안 진공 상태가 형성된 후 엔진 전자 제어기는 퍼지 제어 밸브를 제어하여 닫아주고 연료 탱크 내의 압력 변화를 체크하게 된다. 이 압력 변화를 엔진 전자 제어기가 계산하여 퍼지 시스템의 누설 여부를 판정하는데 이때 연료 탱크 내의 압력 센서가 압력을 감지하는 역할을 한다.

[0007] 따라서 엔진 전자 제어기는 이 누설 진단 단계 이전에 연료 탱크(1)의 압력 센서가 정상인지 아닌 지의 고장 유무를 사전에 먼저 판단할 필요가 있다.

[0008] 상기에서 설명한 바와 같이, 퍼지 시스템의 이상 유무를 감지하기 위한 부품 중 하나는 연료 탱크(1) 내의 압력을 감지는 압력 센서이며, 상기 압력 센서는 통상의 센서 소자인 다이어프램으로 구비되며, 연료 탱크 안의 압력은 다이어프램의 위쪽 방향을 작용하고, 대기압은 반대 방향으로 작용한다. 이 다이어프램의 편향은 압력 차이에 의해 감지된다. 예를 들어 연료 탱크내의 압력이 통상 대기압인 경우 압력 센서는 2.5V의 감지 신호를 출력하고, 대기압보다 부압인 경우 2.5V 이하의 감지 신호를, 가압인 경우 2.5V 이상이 감지 신호를 출력한다.

[0009] 그러나, 연료 레벨이 매우 낮은 상태에서 도 2에 도시된 바와 같이, 연료 탱크(1)의 캡(2)의 열리면, 캐니스터 퍼지를 수행하여 연료 탱크(1) 내의 연료를 엔진(5)으로 공급한다고 하더라도 연료 탱크(1) 내의 압력이 원하는 량으로 부압 형성되지 않는다. 따라서, 낮은 연료 레벨의 조건에서 연료 탱크의 캡(2)이 열려 있는 경우 캡(2)의 열림을 감지하지 못하고 압력 센서의 고착으로만 진단하게 됩니다.

[0010] 즉, 상기의 경우 연료의 대규모 누설이 발생하였음에도 불구하고 압력 센서의 고착으로 판정하는 문제점이 있었다.

발명의 내용

해결 하고자하는 과제

[0011] 본 발명은 이와 같은 문제점을 해결하기 위해 창출된 것으로, 본 발명의 목적은 압력 센서 고착 진단 및 연료

누설 진단 각각에 대한 진단 조건을 설정하고 상기의 진단 조건에 만족한 해당 진단을 실행한 후 진단 결과에 따라 압력 센서 고착 및 연료 누설을 판정함으로써, 압력 센서의 고착 진단 및 연료 누설 진단의 오판정을 방지하여 자동차의 안전성을 더욱 향상시킬 수 있는 자동차의 고장 진단 장치 및 방법을 제공하고자 함에 있다.

과제 해결수단

[0012] 상기 목적을 달성하기 위한 본 발명의 관점에 따른 기술적 과제는,

[0013] 연료 탱크 내의 압력을 감지하여 전기적 신호로 출력하는 압력 센서와,

[0014] 연료 탱크 내에 부압을 형성하기 위해 열림/닫힘을 제어하는 캐니스터 퍼지 밸브 및 퍼지 제어 밸브와,

[0015] 압력 센서의 고착 진단 조건 및 연료 누설 진단 조건을 각각 설정하고 설정된 압력 센서의 고착 진단 조건 또는 연료 누설 진단 조건 중 만족한 진단 조건의 해당 진단을 실행하며 진단 결과에 따라 압력 센서의 고착 및 연료 캡의 열림으로 인한 연료 대규모 누설을 판정하는 것을 엔진 제어 유닛을 포함하고,

[0016] 여기서,상기 압력 센서 고착 진단 조건은 연료 탱크의 압력 정보, 캐니스터 퍼지 밸브의 진단 정보, 연료 차단 밸브의 진단 정보, 대기 온도 정보, 연료 레벨 정보, 연료 레벨 센서의 진단 정보를 근거하여 설정되고,

[0017] 상기 연료 누설 진단 조건은 외부로부터 공급되는 차속 정보, 배터리 전압 정보, 엔진 상태 정보, 대기압 정보, 캐니스터 가스량 정보, 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 각 종 센서들이 진단 정보를 기초로 설정된다.

[0018] 즉, 압력 센서의 고착 진단 조건은,

[0019] 압력 센서의 출력 전압이 제1 소정치 이상 제2 소정치 이하의 값을 가지는 경우, 캐니스터 퍼지 밸브가 에러가 없는 경우 연료 탱크의 연료 차단 밸브의 에러가 없는 경우 대기 온도가 제3 소정치 이상인 경우 연료 탱크의 연료 레벨이 제4 소정치 이하인 경우 상기 연료 탱크의 연료 량을 측정하는 연료 레벨 센서에 이상이 없는 경우인 것을 특징으로 하고,

[0020] 또한, 연료 누설 진단 조건은,

[0021] 차속이 미리 정해진 제5 소정치 이하인 경우, 배터리 전압이 제6 소정치 이상 제7 소정치 이하인 경우, 람다 제어를 통해 공급된 연료가 엔진에서 연소되는 경우, 대기압이 미리 정해진 제8 소정치 이상인 경우 캐니스터 내에 가스가 미리 정해진 제9 소정치 이하인 경우, 냉각수 온도가 제10 소정치 이상 제11 소정치 이하 범위 내에 존재하는 경우, 대기 온도가 미리 정해진 제12 이상 제13이하의 범위 내에 존재하는 경우, 연료 탱크 내의 연료 레벨이 미리 정해진 제14 소정치 이하인 경우, 퍼지가 수행된 경우, 각 센서들의 이상이 없는 경우인 것을 특징으로 한다.

[0022] 상기 엔진 제어 유닛은,

[0023] 상기의 연료 누설 진단 조건을 만족하는 경우 누설 진단을 실행하고, 상기의 연료 누설 진단 조건을 만족하지 아니한 경우 압력 센서의 고착 진단 조건을 만족하는 지를 판단하여 상기의 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서의 고착 진단을 실행하고,

[0024] 상기 압력 센서의 고착 진단 및 연료 누설 진단 실행 후 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상인 지를 판단하여 최대값 및 최소값의 차가 설정치 이상이고, 연료 누설 진단 결과 연료 누설이 발생한 경우 캡의 열림으로 인해 연료 대규모 누설이 발생한 것으로 판정하고,

[0025] 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상이고, 상기 연료 탱크의 누설 연료 누설 진단 결과 연료 누설이 발생하지 아니한 경우 연료 누설이 없는 것으로 판정하고,

[0026] 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 상기 설정치 이상이 아닌 경우 압력 센서의 고착으로 판정하는 것을 특징으로 한다.

[0027] 상기 설정치는 0.5 hPa인 것을 특징으로 한다.

[0028] 또한, 상기 목적을 달성하기 위한 본 발명의 다른 관점에 따른 기술적 과제는,

[0029] a) 연료 누설 진단 조건과 압력 센서 고착 진단 조건을 엔진 제어 유닛에 저장하는 단계;

[0030] b) 상기 a) 단계의 진단 조건 중 연료 누설 진단 조건을 만족하는 경우 연료 누설 진단을 실행하는 단계;

[0031] c) 상기 a) 단계의 진단 조건 중 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서 고착 진단을 실행하는 단계;

[0032] d) 상기 b) 단계 및 c) 단계의 진단 결과에 따라 압력 센서 고착 및 캡의 열림으로 인한 연료 대규모 누설을 판정하는 단계를 포함하되,

[0033] 상기 d) 단계는,

[0034] d-1) 상기 압력 센서의 고착 진단 및 연료 누설 진단 실행 후 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상인 지를 판단하여 최대값 및 최소값의 차가 설정치 이상이고, 연료 누설 진단 결과 연료 누설이 발생한 경우 캡의 열림으로 인해 연료 대규모 누설이 발생한 것으로 판정하고,

[0035] d-2) 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상이고, 상기 연료 탱크의 누설 연료 누설 진단 결과 연료 누설이 발생하지 아니한 경우 연료 누설이 없는 것으로 판정하며,

[0036] d-3) 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 상기 설정치 이상이 아닌 경우 압력 센서의 고착으로 판정하는 것을 특징으로 한다.

[0037] 그에 더하여,

[0038] 상기 d-1) 내지 d-2) 단계의 조건을 만족하지 아니한 경우 압력 센서를 정상으로 판정하는 단계를 더 포함한다.

[0039] 여기서,상기 압력 센서 고착 진단 조건은 연료 탱크의 압력 정보, 캐니스터 퍼지 밸브의 진단 정보, 연료 차단 밸브의 진단 정보, 대기 온도 정보, 연료 레벨 정보, 연료 레벨 센서의 진단 정보를 근거하여 설정되고,

[0040] 상기 연료 누설 진단 조건은 외부로부터 공급되는 차속 정보, 배터리 전압 정보, 엔진 상태 정보, 대기압 정보, 캐니스터 가스량 정보, 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 각 종 센서들이 진단 정보를 기초로 설정된다.

[0041] 즉, 상기 압력 센서 고착 진단 조건은,

[0042] 압력 센서의 출력 전압이 제1 소정치 이상 제2 소정치 이하의 값을 가지는 경우, 캐니스터 퍼지 밸브가 에러가 없는 경우 연료 탱크의 연료 차단 밸브의 에러가 없는 경우 대기 온도가 제3 소정치 이상인 경우 연료 탱크의 연료 레벨이 제4 소정치 이하인 경우 상기 연료 탱크의 연료 량을 측정하는 연료 레벨 센서에 이상이 없는 경우인 것을 특징으로 하고,

[0043] 또한, 연료 누설 진단 조건은,

[0044] 차속이 미리 정해진 제5 소정치 이하인 경우, 배터리 전압이 제6 소정치 이상 제7 소정치 이하인 경우, 람다 제어를 통해 공급된 연료가 엔진에서 연소되는 경우, 대기압이 미리 정해진 제8 소정치 이상인 경우 캐니스티 내에 가스가 미리 정해진 제9 소정치 이하인 경우, 냉각수 온도가 제10 소정치 이상 제11 소정치 이하 범위 내에 존재하는 경우, 대기 온도가 미리 정해진 제12 이상 제13이하의 범위 내에 존재하는 경우, 연료 탱크 내의 연료 레벨이 미리 정해진 제14 소정치 이하인 경우, 퍼지가 수행된 경우, 각 센서들의 이상이 없는 경우인 것을 특징으로 한다.

효 과

[0045] 이상에서 설명한 바와 같이, 본 발명에 의하면, 압력 센서 고착 진단 및 연료 누설 진단 각각에 대한 진단 조건을 설정하고 상기의 진단 조건에 만족한 해당 진단을 실행한 후 진단 결과에 따라 압력 센서 고착 및 연료 누설을 판정함으로써, 압력 센서의 고착 진단 및 연료 누설 진단의 오판정을 방지하여 자동차의 안전성을 더욱 향상시킬 수 있는 효과를 얻는다.

발명의 실시를 위한 구체적인 내용

[0046] 이하 본 발명의 실시 예를 첨부된 도면에 의거하여 보다 상세하게 설명한다.

[0047] 도 3은 본 발명에 따른 자동차의 고장 진단 장치의 구성을 보인 블럭도이다. 이를 참조하면 본 발명에 따른 자동차의 고장 진단 장치는, 연료 탱크의 압력 정보, 캐니스터 퍼지 밸브의 진단 정보, 연료 차단 밸브의 진단 정보, 대기 온도 정보, 연료 레벨 정보, 연료 레벨 센서의 진단 정보를 기초로 압력 센서 고착 진단 조건을 설정하는 엔진 제어 유닛을 포함한다.

[0048] 그에 더하여 상기 엔진 제어 유닛은, 외부로부터 공급되는 차속 정보, 배터리 전압 정보, 엔진 상태 정보, 대기압 정보, 캐니스터 가스량 정보, 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 각 종 센서들이 진단 정보를 기초로 연료 누설 진단 조건을 설정하여 저장하는 엔진 제어 유닛을 포함한다.

[0049] 즉, 상기 압력 센서 고착 진단 조건은, 압력 센서의 출력 전압이 제1 소정치(0.01V) 이상 제2 소정치(4.9V) 이하의 값을 가지는 경우, 캐니스터 퍼지 밸브가 에러가 없는 경우 연료 탱크의 연료 차단 밸브의 에러가 없는 경우 대기 온도가 제3 소정치(-8도씨) 이상인 경우 연료 탱크의 연료 레벨이 제4 소정치(85%) 이하인 경우 상기 연료 탱크의 연료 량을 측정하는 연료 레벨 센서에 이상이 없는 경우로 설정된다.

[0050] 또한, 연료 누설 진단 조건은, 차속이 미리 정해진 제5 소정치(10Km/h) 이하인 경우, 배터리 전압이 제6 소정치(10V) 이상 제7 소정치(16V) 이하인 경우, 람다 제어를 통해 공급된 연료가 엔진에서 연소되는 경우, 대기압이 미리 정해진 제8 소정치(750hPa) 이상인 경우 캐니스터 내에 가스가 미리 정해진 제9 소정치(0.38) 이하인 경우, 냉각수 온도가 제10 소정치(50도씨) 이상 제11 소정치(142도씨) 이하 범위 내에 존재하는 경우, 대기 온도가 미리 정해진 제12 소정치(-8도씨)이상 제13소정치(62도씨)이하의 범위 내에 존재하는 경우, 연료 탱크 내의 연료 레벨이 미리 정해진 제14 소정치(80%) 이하인 경우, 퍼지가 수행된 경우, 각 센서들의 이상이 없는 경우로 설정된다. 여기서, 상기 제1 소정치 내지 제14 소정치 각각의 값은 다수의 실험을 통해 최적의 엔진을 유지하기 위한 실험값으로 미리 엔진 제어 유닛에 설정되어 있다.

[0051] 또한, 상기 엔진 제어 유닛은, 상기의 연료 누설 진단 조건을 만족하는 경우 누설 진단을 실행하고 상기의 연료 누설 진단 조건을 만족하지 아니한 경우 압력 센서의 고착 진단 조건을 만족하는 지를 판단하여 상기의 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서의 고착 진단을 실행하고, 상기 압력 센서의 고착 진단 및 연료 누설 진단 실행 후 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 설정치 이상인 지를 판단하여 최대값 및 최소값의 차가 설정치 이상이고 연료 누설 진단 결과 연료 누설이 발생한 경우 캡의 열림으로 인해 연료 누설이 발생한 것으로 판정하고, 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 미리 정해진 실정치 이상이고 상기 연료 탱크의 누실 연료 누실 진단 결과 연료 누실이 발생하지 아니한 경우 연료 누설이 없는 것으로 판정하며, 상기 압력 센서의 출력 신호에 대한 최대값 및 최소값의 차가 상기 설정치 이상이 아닌 경우 압력 센서의 고착으로 판정한다.

[0052] 상기의 과정을 보다 구체적으로 설명하기 위해 첨부된 도면을 참조한다. 도 4는 도 3에 도시된 엔진 제어 유닛의 압력 센서 고착 진단 및 캡의 열림으로 인한 연료 누설 진단 과정을 설명하기 위한 플로우차트이다. 본 발명에서 적용되는 엔진 제어 유닛은 미리 압력 센서 고착 진단 조건 및 연료 누설 진단 조건이 설정되어 저장되어 있다.

[0053] 단계(101)에서 상기 각 진단 조건에 해당되는 정보들을 수신하고, 단계(103)에서 수신된 정보들을 기초로 상기 압력 센서 고착 진단 조건을 만족하는 지를 판단한다. 상기 단계(101)의 정보들은 차속 정보, 배터리 전압 정보, 엔진 연소 여부를 나타내는 엔진 상태 정보, 대기압 정보, 캐니스터의 가스량 정보, 퍼지가 이루어지는 지를 나타내는 퍼지 정보, 냉각수 온도 정보, 대기 온도 정보, 연료 레벨 정보, 연료압 정보, 연료 차단 밸브의 진단 정보, 및 캐니스터 퍼지 밸브의 진단 정보이다.

[0054] 이후 엔진 제어 유닛은 단계(105)를 통해 상기 단계(103)의 판단 결과 압력 센서 고착 진단 조건을 만족하는 경우 압력 센서 고착 진단을 실행한다. 이는 엔진 제어 유닛에서 단계(107)를 통해 압력 센서의 연료압에 대한 최대값과 최소값의 차를 연산하고, 이 후 단계(109)에서 연산된 최대값과 최소값의 차가 미리 정해진 설정치(0.5hPa) 이상인 경우 압력 센서를 정상으로 판정한다(119).

[0055] 한편, 상기 단계(103)의 판단 결과 압력 센서 고착 진단 조건을 만족하지 아니한 경우 단계(121)를 통해 연료 누설 진단 조건을 만족하는 지를 판단하고, 연료 누설 진단 조건을 만족하는 경우 단계(123)에서 연료 누설 진단을 실행한다.

[0056] 또한, 상기 단계(107)에서 압력 센서의 연료압에 대한 최대값과 최소값의 차가 상기의 설정치 이상이 아닌 경우 단계(125)에서 압력 센서의 열림 고착으로 판정하고, 이 후 단계(127)로 진행한다.

[0057] 상기 단계(127)에서 상기 단계(123)에서 실행된 연료 누설이 발생하였는 지를 판단한다 이 판단 결과 연료 누설이 발생된 경우 단계(129)에서 연료 누설이 발생한 것으로 판정한 후 판정 결과를 표시한다.

[0058] 그러나, 단계(127)에서 연료 누설이 발생하지 아니한 경우 단계(131)에서 연료 누설이 없는 것으로 판정한 후 판정 결과를 표시부에 표시한다.

[0059] 이와 같이 본 발명이 속하는 기술 분야의 당업자는 본 발명의 그 기술적 사상이나 필수적 특징으로 변경하지 않고서 다른 구체적인 형태로 실시될 수 있다는 것을 이해할 수 있을 것이다. 그러므로, 이상에서 기술한 실시 예들은 모든 면에서 예시적인 것이며, 한정적인 것이 아닌 것으로서 이해해야만 한다. 본 발명의 범위는 상기 상세한 설명보다는 후술하는 특허 청구범위 의해 나타내어지며, 특히 청구범위의 의미 및 범위 그리고 그 등가 개념으로부터 도출되는 모든 변경 또는 변형된 형태가 본 발명의 범위에 포함되는 것으로 해석되어야 한다.

도면의 간단한 설명

[0060] 도 1은 일반적인 자동차의 구성을 보인 도이다.

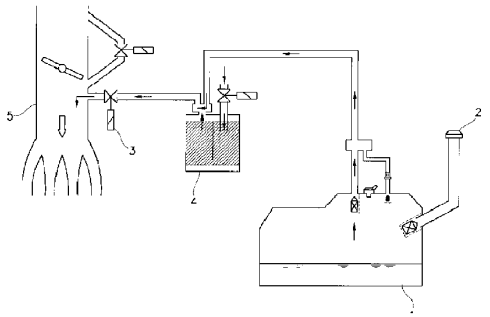
[0061] 도 2는 도 1에 도시된 연료 캡이 열린 상태를 보인 도이다.

[0062] 도 3은 본 발명에 따른 자동차의 고장 진단 장치의 구성을 보인 도이다.

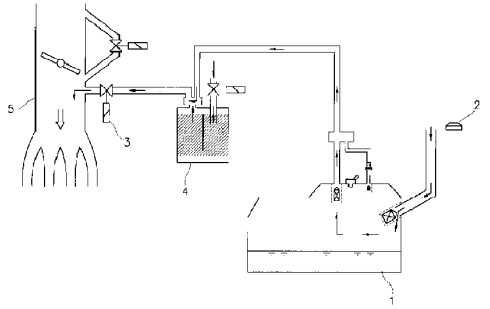
[0063] 도 4는 본 발명에 따른 자동차의 고장 진단 과정을 보인 플로우챠트이다.

도면

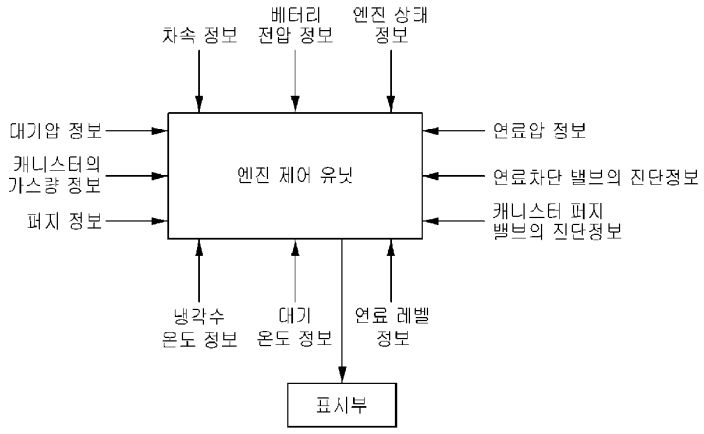
도면1



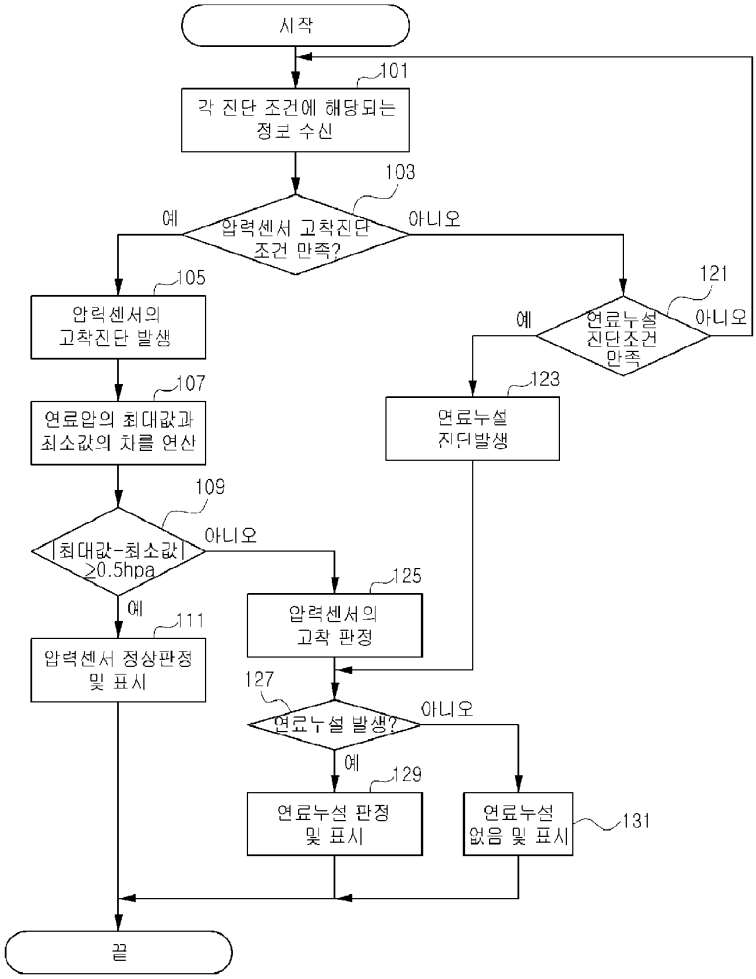
도면2



도면3


차속 정보
배터리 전압 정보
엔진 상태 정보
대기압 정보
캐니스터의 가스량 정보
퍼지 정보
엔진 제어 유닛
연료압 정보
연료차단 밸브의 진단정보
캐니스터 퍼지 밸브의 진단정보
냉각수 온도 정보
대기 온도 정보
연료 레벨 정보
표시부

도면4


시작
101
각 진단 조건에 해당되는 정보 수신
103
압력센서 고착진단 조건 만족?
예
아니오
105
압력센서의 고착진단 발생
107
연료압의 최대값과 최소값의 차를 연산
109
|최대값-최소값| ≥0.5hpa
아니오
예
111
압력센서 정상판정 및 표시
121
연료누설 진단조건 만족
예
아니오
123
연료누설 진단발생
125
압력센서의 고착 판정
127
연료누설 발생?
예
아니오
129
연료누설 판정 및 표시
연료누설 없음 및 표시
131
끝

No documents available for this priority number.

Espacenet

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ANTI-THEFT METHOD AND SYSTEM FOR MOTORCYCLE

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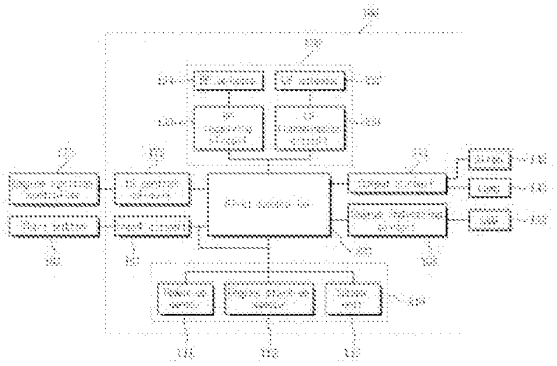
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Abstract of KR100971278 (B1)



PURPOSE: A method and a system for preventing a motorcycle from being robbed are provided to enable a user to rapidly and conveniently start a motorcycle without inserting a key into a key cylinder. CONSTITUTION: A method for preventing a motorcycle from being robbed is as follows. An electronic control unit senses power connection and engine starting (S310). The electronic control unit transfers an electronic identifier to a smart remote controller through wireless communications(S320). If an answering signal to the electronic identifier is not received to a motorcycle, the motorcycle stops engine starting (S330). The electronic control unit generates an alarm signal(S352).

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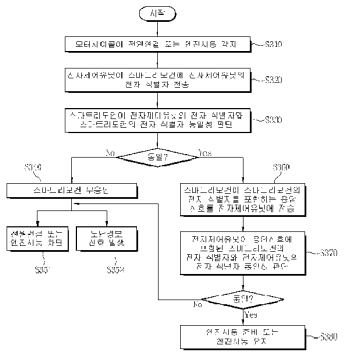
심사관 : 김재왕

(54) 모터사이클 도난 방지 방법 및 시스템

(57) 요 약

본 발명은 모터사이클 도난 방지 방법 및 시스템에 관한 것이다. 본 발명의 도난 방지 방법 및 시스템은 전자제어유닛이 모터사이클의 전원 연결 또는 엔진 시동을 감지하는 경우 전자 식별자를 검증하여, 인증 없는(또는 인증 전) 전원 연결 또는 엔진 시동인 경우에는 이를 차단한다. 또한 전자제어유닛은 인증 없는 전원 연결 또는 엔진 시동인 경우 도난 경보 신호를 발생할 수 있다. 본 발명에 따르면, 비정상적인 방법으로 모터사이클의 엔진 시동을 걸려고 하는 경우 자동으로 엔진 시동을 차단하여 모터사이클의 도난을 방지할 수 있다. 또한 사용자는 물리적인 키를 키실린더에 꽂지 않아도 전자 식별자를 확인하여 시동을 걸 수 있기 때문에, 신속하고 간편하게 시동을 걸 수 있다.

대 표 도 - 도3



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특허청구의 범위

청구항 1

전자제어유닛이 인증 전 전원 연결 또는 엔진 시동을 감지하는 감지 단계;

상기 전자제어유닛이 무선통신을 통해 스마트 리모컨에 상기 전자제어유닛의 전자 식별자를 전송하는 전송 단계; 및

상기 전자제어유닛이 일정 시간 동안 상기 스마트 리모컨으로부터 전송한 상기 전자제어유닛의 전자 식별자에 대한 응답 신호를 수신하지 못하면, 상기 전원 연결 또는 엔진 시동을 차단하는 차단 단계;

를 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 2

전자제어유닛이 인증 전 전원 연결 또는 엔진 시동을 감지하는 감지 단계;

상기 전자제어유닛이 무선통신을 통해 스마트 리모컨에 상기 스마트 리모컨의 전자 식별자 전송을 요청하는 요청 단계;

상기 전자제어유닛이 일정 시간 동안 상기 스마트 리모컨의 전자 식별자를 수신하지 못하면, 상기 전원 연결 또는 엔진 시동을 차단하는 차단 단계;

를 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 3

제1항 또는 제2항에 있어서, 상기 차단 단계에서,

상기 전자제어유닛이 도난 경보 신호를 발생시키는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 4

제1항 또는 제2항에 있어서, 상기 차단 단계에서,

상기 전자제어유닛이 IG 제어회로의 출력을 그라운드로 접지시켜 모터사이클의 엔진 점화 제어 장치로 공급되는 교류 전원을 그라운드로 접지시키거나, 상기 엔진 점화 제어 장치로 공급되는 직류전원을 차단하여 엔진 시동을 차단하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 5

제1항에 있어서,

상기 스마트 리모컨이 수신한 상기 전자제어유닛의 전자 식별자와 상기 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단하는 동일성 판단 단계;

상기 동일성 판단 결과 동일하지 않는 경우에는 상기 스마트 리모컨은 응답하지 않는 단계;

를 포함하는 더 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 6

제5항에 있어서,

상기 동일성 판단 결과 동일한 경우에는

상기 스마트 리모컨이 상기 스마트 리모컨의 전자 식별자를 포함하는 응답 신호를 상기 전자제어유닛에 전송하는 단계; 및

상기 전자제어유닛이 상기 응답 신호에 포함된 상기 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자가 동일한지 여부를 판단하여 동일하면 엔진 시동을 준비하거나 엔진 시동을 유지하는 단계;

를 더 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 7

제5항에 있어서,

상기 동일성 판단 결과 동일하지 않는 경우, 상기 전자제어유닛이 기 설정된 핸들록 상태를 유지하는 단계;

상기 동일성 판단 결과 동일한 경우, 상기 전자제어유닛이 기 설정된 핸들록을 해제하는 단계;

를 더 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 8

제1항에 있어서, 상기 차단 단계에서,

상기 응답 신호를 수신하지 못하거나 상기 스마트 리모컨의 전자 식별자를 수신하지 못하는 상기 일정 시간 이내에 스타트 버튼을 누르면, 상기 전자제어유닛은 엔진 시동을 수행하지 않는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 9

제2항에 있어서,

상기 전자제어유닛이 상기 스마트 리모컨으로부터 상기 스마트 리모컨의 전자 식별자를 수신하는 단계;

상기 전자제어유닛이 상기 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자의 동일성을 판단하는 동일성 판단 단계; 및

상기 동일성 판단 결과 동일하지 않은 경우에는 상기 차단 단계를 수행하고, 동일한 경우에는 상기 전자제어유닛이 엔진 시동을 준비하거나 엔진 시동을 유지하는 단계;

를 더 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 10

제1항에 있어서, 상기 전송 단계는,

상기 모터사이클의 시트에 설치된 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 상기 전자제어유닛이 무선통신을 통해 상기 스마트 리모컨에 상기 전자제어유닛의 전자 식별자를 전송하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 11

제2항에 있어서, 상기 요청 단계는,

상기 모터사이클의 시트에 설치된 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 상기 전자제어유닛이 무선통신을 통해 상기 스마트 리모컨에 상기 스마트 리모컨의 전자 식별자 전송을 요청하는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 12

제1항 또는 제2항에 있어서, 상기 감지 단계에서,

상기 전자제어유닛이 모터사이클이 좌우로 일정 각도 이상 기울어지거나, 앞바퀴 또는 뒷바퀴가 일정 각도 이상 들었음을 감지하는 단계;를 더 포함하며,

상기 차단 단계에서 상기 전자제어유닛이 도난 경보 신호를 발생시키는 것을 특징으로 하는 모터사이클 도난 방지 방법.

청구항 13

제1항 또는 제2항에 있어서, 상기 차단 단계에서,

상기 전자제어유닛은 도난 경보 신호를 인증된 스마트 리모컨으로 전송하여 도난 경보를 출력시키는 것을 특징

으로 하는 모터사이클 도난 방지 방법.

청구항 14

모터사이클의 인증 전 전원 연결 또는 엔진 시동을 감지할 수 있으며, 전자 식별자를 송수신할 수 있는 전자제어유닛; 및

상기 전자제어유닛으로부터 전자 식별자를 수신하며 응답 신호를 송신할 수 있고, 수신된 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단할 수 있는 스마트 리모컨;을 포함하고,

상기 전자제어유닛은 전원 연결 또는 엔진 시동을 감지하는 경우 전자제어유닛의 전자 식별자를 상기 스마트 리모컨에 송신하고,

상기 스마트 리모컨은 상기 전자제어유닛의 전자 식별자를 수신하고, 수신된 상기 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단하여, 동일하지 않은 경우에는 응답하지 않으며, 동일한 경우에는 상기 스마트 리모컨의 전자 식별자를 포함하는 응답 신호를 상기 전자제어유닛에 송신하고,

상기 전자제어유닛은 일정 시간 동안 상기 응답 신호를 수신하지 못하면 전원 연결 또는 엔진 시동을 차단하고, 상기 응답 신호를 수신하면 상기 응답 신호에 포함된 상기 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자가 동일한지 여부를 판단하여 동일하면 엔진 시동을 준비하거나 엔진 시동을 유지하는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 15

제14항에 있어서,

상기 전자제어유닛은 일정 시간 동안 응답 신호를 수신하지 못하면 도난 경보 신호를 발생시키는 것을 특징으로 하는 도난 방지 시스템.

청구항 16

제14항 또는 제15항에 있어서,

상기 전자제어유닛은 모터사이클의 전원 연결 또는 엔진 시동을 감지할 수 있는 감지부와, 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자가 동일한지 여부를 판단할 수 있는 제1 제어부와, 전자 식별자를 송수신할 수 있는 제1 무선통신부를 구비하는 것을 특징으로 하는 도난 방지 시스템.

청구항 17

제14항 또는 제15항에 있어서,

상기 스마트 리모컨은 전자 식별자를 수신하며 응답 신호를 송신할 수 있는 제2 무선통신부와, 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단할 수 있는 제2 제어부를 구비하는 것을 특징으로 하는 도난 방지 시스템.

청구항 18

제14항 또는 제15항에 있어서,

상기 전자제어유닛은 IG 제어회로의 출력을 그라운드로 접지시켜 모터사이클의 엔진 점화 제어 장치로 공급되는 교류 전원을 그라운드로 접지시키거나, 상기 엔진 점화 제어 장치로 공급되는 직류전원을 차단하여 엔진 시동을 차단하는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 19

제14항에 있어서,

상기 전자제어유닛은 상기 모터사이클의 시동이 꺼져 있는 동안 슬립(sleep) 상태를 유지하는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 20

제14항에 있어서,

상기 전자제어유닛은 상기 모터사이클의 배터리 전압을 체크하여 상기 배터리의 교체시기를 알리는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 21

제14항에 있어서,

상기 스마트 리모컨은 상기 전자제어유닛으로부터 전자 식별자 요청 신호를 수신하기 전까지 슬립 상태를 유지하는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 22

제14항에 있어서,

상기 스마트 리모컨은 인증된 전자제어유닛 이외의 전자제어유닛으로부터 전자 식별자를 요청받으면 응답하지 않는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

청구항 23

제14항에 있어서,

상기 스마트 리모컨은 상기 스마트 리모컨의 배터리 전압을 체크하여 상기 배터리의 교체시기를 알리는 것을 특징으로 하는 모터사이클 도난 방지 시스템.

명 세 서

발명의 상세한 설명

기 술 분 야

[0001] 본 발명은 모터사이클 도난 방지 방법 및 시스템에 관한 것으로, 더욱 상세하게는 물리적인 키가 없더라도 신속하게 시동을 수행할 수 있고, 인증 없는 진원 연결 또는 엔진 시동이 감지되는 경우 이를 차단하여 모터사이클의 도난을 방지할 수 있는 모터사이클 도난 방지 방법 및 시스템에 관한 것이다.

배 경 기 술

[0002] 일반적으로 모터사이클의 시동을 걸기 위해서는 키실린더에 키를 삽입하고 회전시킨 후 스타트 버튼을 누르거나 킥스타트를 밟아야 시동을 걸 수 있다. 하지만 이러한 방법은 사용자가 반드시 키를 소지하여 키를 키실린더에 삽입하고 키실린더를 'ON' 위치로 돌려야 하는 번거로움이 있다.

[0003] 모터사이클은 외부인의 접근을 막을 수 있는 문이 없다. 따라서 모터사이클은 항상 도난의 위험에 노출되어 있다. 또한 대부분의 모터사이클이 무정한 방법으로 배선을 간단히 조작하면 강제적으로 엔진 시동을 걸 수 있는 문제점이 있다. 예를 들어, 키실린더와 하네스들을 연결시켜 주는 커넥터를 분리시키고 킥스타트를 밟거나, 와이어 하네스 전체를 절단하고 킥스타트를 밟거나, 이그니션 그라운드 또는 이그니션 와이어 중 하나를 절단하고 킥스타트를 밟으면 시동이 걸린다.

[0004] 최근에는 이러한 번거로움과 도난 방지 기술을 개선한 스마트키 시스템을 모터사이클에 적용한 사례들이 늘고 있다. 그러나 대부분 제작 단계에서만 스마트키 시스템이 적용가능하며, 시스템의 복잡성과 많은 구성품들로 인해 단가가 상승하는 문제점이 있다. 또한 일부 부정한 방법으로 모터사이클의 차체 배선을 조작하여 시동을 거는 경우 이를 감지하기 어려운 문제점이 있다.

발명의 내용

해결 하고자하는 과제

[0005] 본 발명의 목적은 부정한 방법으로 모터사이클의 선원을 연결하거나 엔진을 시동하는 경우 이를 감지하여 선원 연결 또는 엔진 시동을 차단하는 모터사이클 도난 방지 방법 및 시스템을 제공하는 것이다.

[0006] 본 발명의 다른 목적은 인증 없는 전원 연결 또는 엔진 시동이 있는 경우 도난 경보를 신호를 발생할 수 있는 모터사이클 도난 방지 방법 및 시스템을 제공하는 것이다.

[0007] 본 발명의 또 다른 목적은 사용자가 물리적인 키를 키실린더에 꽂지 않아도 전자 식별자를 확인하여 신속하고 간편하게 시동을 걸 수 있는 모터사이클 도난 방지 방법 및 시스템을 제공하는 것이다.

과제 해결수단

[0008] 위와 같은 목적을 달성하기 위하여, 본 발명은 전자제어유닛이 인증 전 전원 연결 또는 엔진 시동을 감지하는 감지 단계; 상기 전자제어유닛이 무선통신을 통해 스마트 리모컨에 상기 전자제어유닛의 전자 식별자를 전송하는 전송 단계; 및 상기 전자제어유닛이 일정 시간 동안 상기 스마트 리모컨으로부터 전송한 상기 전자제어유닛의 전자 식별자에 대한 응답 신호를 수신하지 못하면, 상기 전원 연결 또는 엔진 시동을 차단하는 차단 단계;를 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법을 제공한다.

[0009] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 차단 단계에서 상기 전자제어유닛이 도난 경보 신호를 발생시킬 수 있다.

[0010] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 차단 단계에서 상기 전자제어유닛이 IG 제어회로의 출력을 그라운드로 접지시켜 모터사이클의 엔진 점화 제어 장치로 공급되는 교류 전원을 그라운드로 접지시키거나, 상기 엔진 점화 제어 장치로 공급되는 직류전원을 차단하여 엔진 시동을 차단할 수 있다.

[0011] 본 발명에 따른 모터사이클 도난 방지 방법은, 상기 스마트 리모컨이 수신한 상기 전자제어유닛의 전자 식별자와 상기 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단하는 동일성 판단 단계; 및 상기 동일성 판단 결과 동일하지 않는 경우에는 상기 스마트 리모컨은 응답하지 않는 단계;를 더 포함할 수 있다.

[0012] 본 발명에 따른 모터사이클 도난 방지 방법은, 상기 동일성 판단 결과 동일한 경우에는, 상기 스마트 리모컨이 상기 스마트 리모컨의 전자 식별자를 포함하는 응답 신호를 상기 전자제어유닛에 전송하는 단계; 및 상기 전자제어유닛이 상기 응답 신호에 포함된 상기 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자가 동일한지 여부를 판단하여 동일하면 엔진 시동을 준비하거나 엔진 시동을 유지하는 단계;를 더 포함할 수 있다.

[0013] 본 발명에 따른 모터사이클 도난 방지 방법은, 상기 동일성 판단 결과 동일하지 않는 경우, 상기 전자제어유닛이 기 설정된 핸들록 상태를 유지하는 단계; 상기 동일성 판단 결과 동일한 경우, 상기 전자제어유닛이 기 설정된 핸들록을 해제하는 단계;를 더 포함할 수 있다.

[0014] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 전송 단계는 상기 모터사이클의 시트에 설치된 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 상기 전자제어유닛이 무선통신을 통해 상기 스마트 리모컨에 상기 전자제어유닛의 전자 식별자를 전송할 수 있다.

[0015] 본 발명은 또한, 전자제어유닛이 인증 전 전원 연결 또는 엔진 시동을 감지하는 감지 단계; 상기 전자제어유닛이 무선통신을 통해 스마트 리모컨에 상기 스마트 리모컨의 전자 식별자 전송을 요청하는 요청 단계; 및 상기 전자제어유닛이 일정 시간 동안 상기 스마트 리모컨의 전자 식별자를 수신하지 못하면, 상기 전원 연결 또는 엔진 시동을 차단하는 차단 단계;를 포함하는 것을 특징으로 하는 모터사이클 도난 방지 방법을 제공한다.

[0016] 본 발명에 따른 모터사이클 도난 방지 방법은, 상기 전자제어유닛이 상기 스마트 리모컨으로부터 상기 스마트 리모컨의 전자 식별자를 수신하는 단계; 상기 전자제어유닛이 상기 스마트 리모컨의 전자 식별자와 상기 전자제어유닛의 전자 식별자의 동일성을 판단하는 동일성 판단 단계; 및 상기 동일성 판단 결과 동일하지 않은 경우에는 상기 차단 단계를 수행하고, 동일한 경우에는 상기 전자제어유닛이 엔진 시동을 준비하거나 엔진 시동을 유지하는 단계;를 더 포함할 수 있다.

[0017] 본 발명에 따른 모터사이클 도난 방지 방법은 상기 차단 단계에서, 상기 응답 신호를 수신하지 못하거나 상기 스마트 리모컨의 전자 식별자를 수신하지 못하는 상기 일정 시간 이내에 스타트 버튼을 누르면, 상기 전자제어유닛은 엔진 시동을 수행하지 않을 수 있다.

[0018] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 요청 단계는 상기 모터사이클의 시트에 설치된 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 상기 전자제어유닛이 무선통신을 통해 상기 스마트 리모컨에 상기 스마트 리모컨의 전자 식별자 전송을 요청할 수 있다.

[0019] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 감지 단계는 상기 전자제어유닛이 모터사이클이 좌

우로 일정 각도 이상 기울어지거나, 앞바퀴 또는 뒷바퀴가 일정 각도 이상 들였음을 감지하는 단계를 더 포함하며, 상기 차단 단계에서 상기 전자제어유닛이 도난 경보 신호를 발생시킨다.

[0020] 본 발명에 따른 모터사이클 도난 방지 방법에 있어서, 상기 차단 단계에서 상기 전자제어유닛은 도난 경보 신호를 인증된 스마트 리모컨으로 전송하여 도난 경보를 출력시킨다.

[0021] 본 발명에 따른 모터사이클 도난 방지 시스템은 전자제어유닛 및 스마트 리모컨을 포함한다. 전자제어유닛은 모터사이클의 인증 전 전원 연결 또는 엔진 시동을 감지할 수 있으며, 전자 식별자를 송수신할 수 있다. 스마트 리모컨은 전자제어유닛으로부터 전자 식별자를 수신하며 응답 신호를 송신할 수 있고, 수신된 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단할 수 있다. 전자제어유닛은 인증 전 전원 연결 또는 엔진 시동을 감지하는 경우 전자제어유닛의 전자 식별자를 스마트 리모컨에 송신한다. 스마트 리모컨은 전자제어유닛의 전자 식별자를 수신하고, 수신된 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단하여, 동일하지 않은 경우에는 응답하지 않으며, 동일한 경우에는 상기 스마트 리모컨의 전자 식별자를 포함하는 응답 신호를 상기 전자제어유닛에 송신한다. 전자제어유닛은 일정 시간 동안 상기 응답 신호를 수신하지 못하면 전원 또는 엔진 시동을 차단하고, 응답 신호를 수신하면 응답 신호에 포함된 스마트 리모컨의 전자 식별자와 전자제어유닛의 전자 식별자가 동일한지 여부를 판단하여 동일하면 엔진 시동을 준비하거나 엔진 시동을 유지할 수 있다. 전자제어유닛은 일정 시간 동안 응답 신호를 수신하지 못하면 도난 경보 신호를 발생시킬 수 있다.

[0022] 본 발명에 따른 모터사이클 도난 방지 시스템은 전자제어유닛의 감지부, 제1 제어부, 제1 무선통신부를 구비한다. 감지부는 모터사이클의 전원 연결 또는 엔진 시동을 감지할 수 있다. 제1 제어부는 스마트 리모컨의 전자 식별자와 전자제어유닛의 전자 식별자가 동일한지 여부를 판단할 수 있다. 제1 무선통신부는 전자 식별자를 송수신할 수 있다.

[0023] 본 발명에 따른 모터사이클 도난 방지 시스템은 스마트 리모컨이 제2 무선통신부 및 제2 제어부를 구비한다. 제2 무선통신부는 전자 식별자를 수신하며 응답 신호를 송신할 수 있다. 제2 제어부는 전자제어유닛의 전자 식별자와 스마트 리모컨의 전자 식별자가 동일한지 여부를 판단할 수 있다.

[0024] 본 발명에 따른 모터사이클 도난 방지 시스템은 전자제어유닛이 IG 제어회로의 출력을 그라운드로 접지시켜 모터사이클의 엔진 점화 제어 장치로 공급되는 교류 전원을 그라운드로 접지시키거나, 상기 엔진 점화 제어 장치로 공급되는 직류전원을 차단하여 엔진 시동을 차단할 수 있다.

[0025] 본 발명에 따른 모터사이클 도난 방지 시스템은 전자제어유닛이 모터사이클의 시동이 꺼져 있는 동안 슬립(sleep) 상태를 유지할 수 있다.

[0026] 본 발명에 따른 모터사이클 도난 방지 시스템은 전자제어유닛이 모터사이클의 배터리 전압을 체크하여 배터리의 교체시기를 알릴 수 있다.

[0027] 본 발명에 따른 모터사이클 도난 방지 시스템은 스마트 리모컨이 전자제어유닛으로부터 전자 식별자 요청 신호를 수신하기 전까지 슬립 상태를 유지할 수 있다.

[0028] 본 발명에 따른 모터사이클 도난 방지 시스템은 스마트 리모컨이 인증된 전자제어유닛 이외의 전자제어유닛으로부터 전자 식별자를 요청받으면 응답하지 않을 수 있다.

[0029] 그리고 본 발명에 따른 모터사이클 도난 방지 시스템은 스마트 리모컨이 스마트 리모컨의 배터리 전압을 체크하여 배터리의 교체시기를 알릴 수 있다.

효 과

[0030] 본 발명에 따른 모터사이클 도난 방지 방법 및 시스템은 부정한 방법으로 모터사이클의 전원을 연결하거나 엔진을 시동하는 경우 이를 감지하여 전원 연결 또는 엔진 시동을 차단할 수 있다. 또한 인증 없는 전원 연결 또는 엔진 시동이 있는 경우 도난 경보를 신호를 발생할 수 있다. 따라서 모터사이클의 도난을 방지할 수 있다.

[0031] 또한 본 발명에 따른 모터사이클 도난 방지 방법 및 시스템은 물리적인 키를 키실린더에 꽂지 않아도 전자 식별자를 확인하여 시동을 걸 수 있기 때문에, 사용자가 신속하고 간편하게 시동을 걸 수 있다.

발명의 실시를 위한 구체적인 내용

[0032] 이하, 첨부된 도면을 참조하여 본 발명의 바람직한 실시예들을 상세히 설명한다. 이 때, 첨부된 도면에서 동일

한 구성 요소는 가능한 동일한 부호로 나타내고 있음에 유의한다. 또한, 본 발명의 요지를 흐리게 할 수 있는 공지 기능 및 구성에 대한 상세한 설명은 생략할 것이다. 마찬가지 이유로 첨부 도면에 있어서 일부 구성요소는 과장되거나 생략되거나 개략적으로 도시되었다.

[0033] 여기서 "인증 전 전원 연결 또는 엔진 시동"은 전자제어유닛과 스마트 리모컨 간에 인증 과정을 수행하지 않은 상태에서의 전원 연결 또는 엔진 시동을 의미한다.

[0034] 도 1은 본 발명의 실시예에 따른 전자제어유닛을 나타내는 도면이고, 도 2는 본 발명의 실시예에 따른 스마트 리모컨을 나타내는 도면이다.

[0035] 본 발명의 실시예에 따른 전자제어유닛(100)은, 도 1에 도시된 바와 같이, 감지부(110), 제1 제어부(120) 및 제1 무선통신부(130)를 포함하여 구성되며, 인증 전 전원 연결 또는 엔진 시동이 부정적인 방법으로 이루어진 경우에는 이를 차단한다.

[0036] 감지부(110)는 전원 연결 감지부(111), 엔진 시동 감지부(112) 및 센서부(113)를 구비한다. 전원 연결 감지부(111)는 모터사이클의 전원이 연결되는지 여부를 감지한다. 엔진 시동 감지부(112)는 모터사이클의 엔진 시동이 있는지를 감지한다. 그리고 센서부(113)는 압력 센서, 모션 센서 등을 포함한다. 압력 센서는 모터사이클의 시트에 작용하는 압력이나 무게를 감지하여 사람이 시트에 앉는 지의 여부를 감지한다. 모션 센서는 모터사이클이 좌우로 일정 각도 이상 기울어지는 지, 앞바퀴 또는 뒷바퀴가 일정 각도 이상 들였는 지의 여부를 감지한다. 이때 모션센서로는 가속도 센서, 각속도 센서, 지자기 센서 및 자이로 센서 중 적어도 하나를 포함하며, 이에 한정되는 것은 아니다. 감지부(110)는 인증 전 전원 연결 또는 엔진 시동이 감지되면, 이를 제1 제어부(120)에 알린다. 아울러 센서부(113)는 감지한 감지 신호를 제1 제어부(120)로 전송한다.

[0037] 제1 무선통신부(130)는 LF 송신회로(131), LF 안테나(132), RF 수신회로(133), RF 안테나(134)를 구비한다. LF 송신회로(131)는 전자제어유닛(100)의 전자 식별자를 LF 안테나(132)를 통해 스마트 리모컨(200)으로 송신한다. 다른 실시예에서 LF 송신회로(131)는 스마트 리모컨(200)의 전자 식별자 전송 요청 신호를 송신할 수 있다. RF 수신회로(133)는 RF 안테나(134)를 통해 스마트 리모컨(200)으로부터 응답 신호를 수신한다.

[0038] 한편 본 실시예에서는 전자제어유닛(100)이 LF로 송신하고, RF로 수신하는 예를 개시하였지만 이에 한정되는 것은 아니다. 예컨대 전자제어유닛(100)은 LF로 송수신하거나, RF로 송수신하거나, RF로 송신하고 LF로 수신할 수도 있다.

[0039] 제1 제어부(120)가 인증 없는 전원 연결 또는 엔진 시동이라는 판단을 하는 경우, 출력회로(141)는 도난 경보 신호를 발생시킬 수 있다. 도난 경보 신호는 사이렌(142) 또는 램프(143) 등을 이용하여 발생시킬 수 있다. 아울러 복제키를 이용한다던지 비정상적인 방법으로 키실린더를 온(ON)시켜 모터사이클의 각 전자장치에 전원이 공급되더라도, 제1 제어부(120)가 인증을 통과하기 전까지 스타트 버튼(162)을 눌러도 엔진 시동을 수행하지 않는다.

[0040] 제1 제어부(120)는 경보 모드에서 센서부(113) 중 모션 센서로부터 감지 신호를 수신하면, 출력회로(141)로 도난 경보 신호를 발생시킬 수 있다. 모터사이클이 좌우로 일정 각도 이상 기울어지거나, 앞바퀴 또는 뒷바퀴가 일정 각도 이상 들였음을 모션 센서가 감지하면, 모션 센서는 감지 신호를 제1 제어부(120)로 출력한다. 제1 제어부(120)는 출력회로(141)로 도난 경보 신호를 발생시킨다.

[0041] 제1 제어부(120)는 제1 무선통신부(130)를 통하여 스마트 리모컨(200)과의 무선 통신을 통하여 경보, 경보해제, 전원연결 및 시동을 자동으로 수행할 수 있다. 물론 제1 제어부(120)는 인증을 통과한 스마트 리모컨(200)과의 무선통신을 진술된 바와 같은 기능을 자동으로 수행한다. 스마트 리모컨(200)을 통한 인증을 통과하면, 제1 제어부(120)는 자동으로 기 설정된 핸들록을 해제한다. 시동을 끄고 경보 모드로 진입하면, 제1 제어부(120)는 핸들록을 설정한다.

[0042] 제1 제어부(120)는 센서부(113)의 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 스마트 리모컨(200)에 대한 인증 과정을 시작할 수 있다. 예컨대 제1 제어부(120)는 전자제어유닛(100)의 전자 식별자를 스마트 리모컨(200)으로 전송하거나, 스마트 리모컨(200)의 전자 식별자를 스마트 리모컨(200)에 요청할 수 있다.

[0043] 한편으로 제1 제어부(120)는 모터사이클의 시동이 꺼져 있는 동안 슬립(sleep) 상태를 유지한다. 즉 모터사이클의 시동이 꺼져 있는 모터사이클의 배터리의 방전 위험이 있는 시간 동안, 제1 제어부(120)는 슬립 상태를 유지한다. 그리고 제1 제어부(120)는 모터사이클의 배터리 전압을 체크하여 배터리 방전의 위험이 있을 경우 사이렌

(142), 램프(143) 또는 LED(152) 등으로 외부로 알릴 수 있다.

[0044] LED(152)는 모터사이클의 작동 상태를 나타낸다. 제1 제어부(120)는 상태표시회로(151)를 제어하여 LED(152)를 조절할 수 있다.

[0045] 본 실시예에 따른 전자제어유닛(100)은 모터사이클의 제조시부터 장착이 가능하다. 만약 완성된 모터사이클에 전자제어유닛(100)을 장착하는 경우, 램프(143), 스타트 버튼(162) 및 사이렌은 추가로 장착할 필요 없이 이미 모터사이클에 장착되어 있는 것을 이용할 수 있다. 따라서 전자제어유닛(100)을 편리하게 장착할 수 있다.

[0046] 본 발명의 실시예에 따른 스마트 리모컨(200)은, 도 2에 도시된 바와 같이, 제2 무선통신부(210), 제2 제어부(220), 배터리(230), 버저(Buzzer; 242) 및 램프(243)를 포함한다. 제2 무선통신부는 LF 수신부(211)와 RF 송신부(212)를 구비한다. LF 수신부(211)는 전자제어유닛(100)으로부터 송신된 전자제어유닛(100)의 전자 식별자를 수신한다. 다른 실시예에서 LF 수신부(211)는 스마트 리모컨(200)의 전자 식별자 전송 요청 신호를 수신할 수 있다. RF 송신부(212)는 스마트 리모컨(200)의 응답 신호를 전자제어유닛(100)에 전송한다.

[0047] 제2 제어부(220)는 LF 수신부(211)를 통해 수신한 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(200)의 전자 식별자가 동일한지 여부를 판단한다. 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(200)의 전자 식별자가 동일하지 않은 경우에는 제2 제어부(220)는 응답하지 않는다. 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(200)의 전자 식별자가 동일한 경우에는 제2 제어부(220)는 RF 송신부(212)가 스마트 리모컨(200)의 전자 식별자를 포함하는 응답 신호를 전자제어유닛(100)에 송신하도록 제어한다.

[0048] 한편으로 제2 제어부(220)는 전자제어유닛(100)으로부터 전자 식별자 요청 신호를 수신하기 전까지 슬립 상태를 유지한다. 제2 제어부(220)는 스마트 리모컨(200)의 배터리(230) 전압을 체크하여 배터리(230) 교체시기가 다가옴을 램프(143)를 통하여 사용자에게 알려줄 수 있다. 제2 제어부(220)는 인증된 모터사이클의 전자제어유닛(100) 이외의 모터사이클의 전자제어유닛(100)으로부터 전자 식별자를 요청받더라도 불필요한 응답을 수행하지 않기 때문에, 상호간 신호의 충돌을 방지할 수 있다. 제2 제어부(220)는 LF 수신부(211)를 통하여 전자제어유닛(100)으로부터 도난 경보 신호를 수신하여 도난 경보를 출력할 수 있다. 예컨대 제2 제어부(220)는 버저(242) 또는 램프(243)를 통하여 사용자에게 알려 줄 수 있다. 이때 램프(243)로는 LED가 사용될 수 있다.

[0049] 사용자가 모터사이클을 이용하고자 하는 경우 스마트 리모컨(200)을 몸에 소지한 채로 스타트 버튼(162)을 누른다. 다른 실시예에서는 키를 키실린더에 삽입하여 키실린더를 'ON'위치로 회전시킨 후, 스타트 버튼(162)을 누르거나 킥스타트를 밟아 시동을 걸 수도 있다. 이때 키실린더는 2핀 방식 또는 4핀 방식 중에 하나일 수 있다.

[0050] 스타트 버튼(162)의 신호는 입력회로(161)를 통해 제1 제어부(120)에 전달된다. 감지부(110)는 전원 연결 또는 엔진 시동을 감지한다. 만약 부정한 방법으로 모터사이클의 전원을 연결하거나 엔진 시동을 거는 경우라도, 감지부(110)가 이를 감지한다. 감지부(110)에서 전원 연결 또는 엔진 시동이 감지되는 경우, 제1 제어부(120)는 제1 무선통신부(130)를 통해 전자제어유닛(100)의 전자 식별자를 스마트 리모컨(200)에 전송한다.

[0051] 스마트 리모컨(200)은 LF 수신부(211)를 통해 전자제어유닛(100)의 전자 식별자를 수신한다. 제2 제어부(220)는 수신된 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(200)의 전자 식별자가 동일한지 여부를 판단한다. 판단 결과 동일하지 않은 경우에는 제2 제어부(220)는 응답을 하지 않는다. 판단 결과 동일한 경우에는 제2 제어부(220)는 RF 송신부(212)를 통해 스마트 리모컨(200)의 전자 식별자를 포함하는 응답 신호를 전자제어유닛(100)에 송신한다. 이와 같이 스마트 리모컨(200)이 동일한 전자 식별자를 가진 전자제어유닛(100)에만 반응하게 함으로써 불필요한 동작을 사전에 방지할 수 있다.

[0052] 전자제어유닛(100)의 제1 제어부(120)는 제1 무선통신부(130)를 통해 일정 시간 동안 응답 신호를 수신하지 못하면, 부정한 전원 연결 또는 엔진 시동으로 간주하고 이를 차단한다. 엔진 시동 차단을 위해 제1 제어부(120)는 IG 제어회로(171)의 출력을 그라운드로 접지시킬 수 있다. 즉 전자제어유닛(100)은 IG 제어회로(171)의 출력을 그라운드로 접지시킴으로써, 발전기에서 엔진 점화 제어 장치(173)로 공급되는 교류 전원을 그라운드로 빠져나가게 하여 엔진 시동을 차단하거나 엔진 점화 제어 장치(173)에 공급되는 직류 전원을 차단하여 엔진 시동을 차단할 수 있다. 예컨대 엔진 점화 제어 장치(173)는 CDI(Capacitor Discharge Ignition) 방식, DC-CDI 방식 및 전자제어유닛(100)을 이용한 인젝션(injection) 방식 중에 하나의 엔진 점화 방식을 사용할 수 있다.

[0053] CDI 방식의 엔진 점화 제어 장치(173)를 이용하는 모터사이클의 경우, 엔진 점화 제어 장치(173)에 공급되는 교류전원 혹은 점화코일에 공급되는 교류전원을 그라운드로 접지시켜 시동을 차단할 수 있다. CDI 방식은 키실린더가 4PIN으로 구성될 수 있다.

[0054] DC-CDI 방식의 엔진 점화 제어 장치(173)를 이용하는 모터사이클의 경우, 엔진 점화 제어 장치(173)에 공급되는 직류전원을 스위치 또는 릴레이를 이용하여 차단함으로써, 엔진 시동을 차단할 수 있다. DC-CDI 방식은 키실린더가 2PIN으로 구성될 수 있다. 한편 DC-CDI 방식의 엔진 점화 제어 장치(173)는 그 종류에 따라서 특정 핀을 GND로 접지시키면 시동이 차단되는 기능을 수행한다.

[0055] 그리고 전자제어유닛(100)을 이용한 인젝션 방식의 엔진 점화 제어 장치(173)를 이용하는 모터사이클의 경우, 점화코일에 공급되는 직류전원을 스위치 또는 릴레이를 이용하여 차단함으로써 시동을 차단할 수 있다. 인젝션 방식은 키실린더가 2PIN으로 구성될 수 있다.

[0056] 이와 같이 모터사이클의 종류에 따라서, IG 제어회로(171)와 엔진 점화 제어 장치(173) 간에 릴레이나 스위치를 추가 장착함으로써, IG 제어회로(171)를 이용하여 전술된 3가지 방식의 엔진 점화 제어 장치(173)의 시동을 제어할 수 있다.

[0057] 제1 제어부(120)는 출력회로(141)를 제어하여 도난 경보 신호를 발생시킬 수 있다. 도난 경보 신호는 사이렌(142) 또는 램프(143)의 불빛 등이 될 수 있다.

[0058] 제1 제어부(120)는 제1 무선통신부(130)를 통해 응답 신호를 수신하면, 응답 신호에 포함된 스마트 리모컨(200)의 전자 식별자와 전자제어유닛(100)의 전자 식별자가 동일한지 여부를 판단한다. 판단 결과 전자 식별자가 동일하면 엔진 시동을 유지한다.

[0059] 모터사이클의 운행을 완료한 후에는 모터사이클의 시동을 차단하여야 한다. 모터사이클은 시동 차단을 위해서 정지 버튼을 구비할 수 있다. 사용자는 운행을 완료한 후 정지 버튼을 눌러서 시동을 차단할 수 있다.

[0060] 모터사이클의 시동을 차단하는 또 다른 방법으로는 엔진 시동이 감지되고 있는 상태에서 스타트 버튼(162)을 일정시간 이상 길게 누를 경우, 사용자의 시동 차단의지로 판단하고 시동을 차단할 수 있다. 이 경우 별도의 정지 버튼을 구비하지 않아도 되는 장점이 있다.

[0061] 도 3은 본 발명의 실시예에 따른 모터사이클 도난 방지 방법을 나타내는 순서도이다.

[0062] 도 1 내지 도 3에 도시된 바와 같이, 본 발명의 실시예에 따른 모터사이클 도난 방지 방법은 모터사이클의 전자제어유닛이(100) 모터사이클의 인증 전 전원 연결 또는 엔진 시동을 감지한다(S310). 모터사이클의 전원 연결 또는 엔진 시동을 감지는 감지부(110)에 의해 이루어 질 수 있다. 전원 연결 또는 엔진 시동이 감지되면, 전자제어유닛(100)은 스마트 리모컨(200)에 전자제어유닛(100)의 전자 식별자를 전송한다(S320). 전자제어유닛(100)의 전자 식별자는 LF 송신회로(131)와 LF 안테나(132)를 통해 전송될 수 있다. 스마트 리모컨(210)은 LF 수신부(211)를 통해 전자제어유닛(100)의 전자 식별자를 송신할 수 있다. 스마트 리모컨(210)은 수신한 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(210)의 전자 식별자의 동일성을 판단한다(S330).

[0063] 이때 S320단계에서 모터사이클의 시트에 설치된 압력 센시로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 전자제어유닛(100)이 무선통신을 통해 스마트 리모컨(200)으로 전자제어유닛(100)의 전자 식별자를 전송할 수 있다.

[0064] 동일성 판단 결과 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(210)의 전자 식별자가 동일하지 않은 경우에는 스마트 리모컨(210)은 응답하지 않는다(S340). 이와 같이 스마트 리모컨(210)이 동일한 전자 식별자를 가진 전자제어유닛(100)에만 반응하게 함으로써 불필요한 동작을 사전에 방지할 수 있다. 따라서 신호들 간의 충돌을 방지할 수 있다. 스마트 리모컨(210)이 응답하지 않으면 전자제어유닛(100)은 일정 시간 이내에 응답 신호를 수신하지 못한다. 전자제어유닛(210)은 응답 신호를 수신하지 못하면, 모터사이클의 전원 연결 또는 엔진 시동을 차단한다(S351). 본 실시예에서 전자제어유닛(100)은 IG 제어회로(171)의 출력을 그라운드로 접지시킴으로써 발전기에서 점화 제어 장치에 공급되는 교류 전원을 그라운드로 빠져나가게 하여 엔진 시동을 차단하거나 점화 제어 장치에 공급되는 직류 전원을 차단하여 엔진 시동을 차단할 수 있다. 다른 실시 예에서는 다른 방법으로 엔진 시동을 차단할 수도 있다. 이와 같은 전원 연결 또는 엔진 시동을 차단을 통해 부정한 목적으로 모터사이클에 시동을 거는 것을 막을 수 있다. 또한 전자제어유닛(100)은 도난 경보 신호를 발생시킬 수 있다(S352). 도난 경보 신호는 사이렌(142) 또는 램프(143)의 깜빡임 등이 될 수 있다. 도난 경보 신호가 발생되면 도난 위험이 있음이 외부로 알려지게 되므로 부정한 목적을 가진 자를 멀리 쫓을 수 있다.

[0065] 이때 S340단계에서 전자제어유닛(100)은 기 설정된 핸들록 상태를 유지한다.

[0066] 동일성 판단 결과 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(210)의 전자 식별자가 동일한 경우에는, 스마트 리모컨(210)이 응답 신호를 전자제어유닛(100)에 전송한다(S360). 응답 신호에는 스마트 리모컨(210)의

전자 식별자가 포함되어 있다. 응답 신호의 전송은 RF 송신부(212)에 의해 이루어질 수 있다. 전자제어유닛(100)은 RF 안테나(134)와 RF 수신회로(133)를 통해 응답 신호를 수신할 수 있다. 전자제어유닛(100)은 응답 신호에 포함된 스마트 리모컨(210)의 전자 식별자와 전자제어유닛(100)의 전자 식별자의 동일성을 판단한다(S370). 이와 같이 전자제어유닛(100)에서도 전자 식별자의 동일성을 판단함으로써 보다 확실한 보안이 이루어질 수 있다. 예를 들어, 스마트 리모컨(210)에서만 동일성을 판단하는 경우 부정한 목적을 가진 자가 스마트 리모컨(210)을 조작하면 쉽게 모터사이클을 훔칠 수 있다. 이를 방지하기 위해서 전자제어유닛(100)에서도 전자 식별자의 동일성을 판단할 필요가 있다.

[0067] 동일성 판단 결과 동일하지 않으면 전자제어유닛(100)은 모터사이클의 전원 연결 또는 엔진 시동을 차단한다(S351). 또한 전자제어유닛(100)은 도난 경보 신호를 발생시킬 수 있다(S352). 동일성 판단 결과 동일하면, 전자제어유닛(100)은 엔진 시동을 준비하거나 엔진 시동을 유지한다(S380). 이때 동일성 판단 결과 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(210)의 전자 식별자가 동일하지 않는 경우, 전자제어유닛(100)은 기 설정된 핸들록 상태를 유지한다. 반대로 동일한 경우, S380단계에서 전자제어유닛(100)은 기 설정된 핸들록 상태를 해제한다.

[0068] 한편으로 S310단계에서 전자제어유닛(100)은 모터사이클이 좌우로 일정 각도 이상 기울어지거나, 앞바퀴 또는 뒷바퀴가 일정 각도 이상 들었음을 센서부(113)의 모션센서가 감지하면, 모션 센서는 감지 신호를 전자제어유닛(100)으로 출력한다. 감지 신호를 수신한 전자제어유닛(100)은 출력회로(141)로 도난 경보 신호를 발생시킬 수 있다.

[0069] S352단계에서 전자제어유닛(100)은 도난 경보 신호를 인증된 스마트 리모컨(200)으로 전송할 수 있다. 도난 경보 신호를 수신한 스마트 리모컨(200)은 버저(242) 또는 램프(243)를 통하여 도난 경보를 출력하여 사용자에게 알려 줄 수 있다.

[0070] 도 4는 본 발명의 다른 실시예에 따른 모터사이클 도난 방지 방법을 나타내는 순서도이다.

[0071] 도 4에 도시된 바와 같이, 본 발명의 다른 실시예에 따른 모터사이클 도난 방지 방법은 모터사이클의 전자제어유닛(100)이 모터사이클의 인증 전 전원 연결 또는 엔진 시동을 감지한다(S410). 모터사이클의 전원 연결 또는 엔진 시동을 감지는 감지부(110)에 의해 이루어 질 수 있다. 전원 연결 또는 엔진 시동이 감지되면, 전자제어유닛(100)은 스마트 리모컨(210)에 스마트 리모컨(210)의 전자 식별자를 전송해 줄 것을 요청한다(S420). 전송 요청은 전자제어유닛(100)의 제1 무선통신부(130)에 의해 이루어질 수 있다. 이러한 요청에 따라 스마트 리모컨(210)은 자신의 전자 식별자를 전자제어유닛(100)에 전송한다(S430). 스마트 리모컨(210)은 제2 무선통신부(130)를 이용하여 전자 식별자를 전송한 수 있다. 전자제어유닛(100)은 스마트 리모컨(210)의 전자 식별자를 수신하여, 전자제어유닛(100)의 전자 식별자와 스마트 리모컨(210)의 전자 식별자의 동일성을 판단한다(S440).

[0072] 한편 S420단계에서 모터사이클의 시트에 설치된 압력 센서로부터 압력 감지 신호를 수신하거나 브레이크 조작을 감지하면, 전자제어유닛(100)이 무선통신을 통해 스마트 리모컨(200)으로 스마트 리모컨(200)의 전자 식별자를 전송을 요청할 수 있다.

[0073] 동일성 판단 결과 스마트 리모컨(210)의 전자 식별자와 전자제어유닛(100)의 전자 식별자가 동일하지 않은 경우에는 전자제어유닛(100)은 모터사이클의 전원 연결 또는 엔진 시동을 차단한다(S451). 또한 전자제어유닛(100)은 도난 경보 신호를 발생시킬 수 있다(S452). 동일성 판단 결과 스마트 리모컨(210)의 전자 식별자와 전자제어유닛(100)의 전자 식별자가 동일한 경우에는 전자제어유닛(100)은 엔진 시동을 준비하거나 엔진 시동을 유지한다(S460).

[0074] 본 실시예에 따른 모터사이클 도난 방지 방법은 도 3에서 설명한 방법과 비교하여 빠른 인증이 가능하다.

[0075] 한편, 본 명세서와 도면에 개시된 본 발명의 실시예들은 본 발명이 기술 내용을 쉽게 설명하고 본 발명의 이해를 돕기 위해 특정 예를 제시한 것일 뿐이며, 본 발명의 범위를 한정하고자 하는 것은 아니다. 여기에 개시된 실시예들 이외에도 본 발명의 기술적 사상에 바탕을 둔 다른 변형예들이 실시 가능하다는 것은 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자에게 자명한 것이다.

도면의 간단한 설명

[0076] 도 1은 본 발명의 실시예에 따른 전자제어유닛을 나타내는 도면.

[0077] 도 2는 본 발명의 실시예에 따른 스마트 리모컨을 나타내는 도면.

[0078] 도 3은 본 발명의 실시예에 따른 모터사이클 도난 방지 방법을 나타내는 순서도.

[0079] 도 4는 본 발명의 다른 실시예에 따른 모터사이클 도난 방지 방법을 나타내는 순서도.

[0080] <도면의 주요 부분에 대한 설명>

[0081] 100 : 전자제어유닛 110 : 감지부

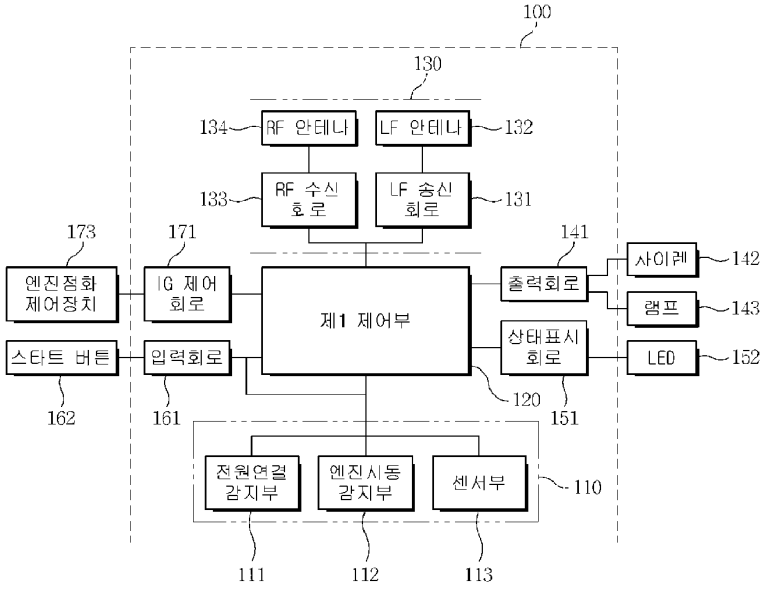
[0082] 120 : 제1 제어부 130 : 제1 무선통신부

[0083] 200 : 스마트 리모컨 210 : 제2 무선통신부

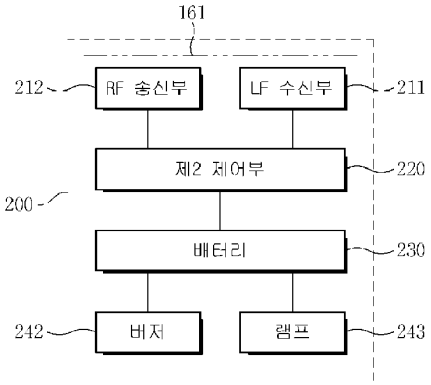
[0084] 220 : 제2 제어부

도면

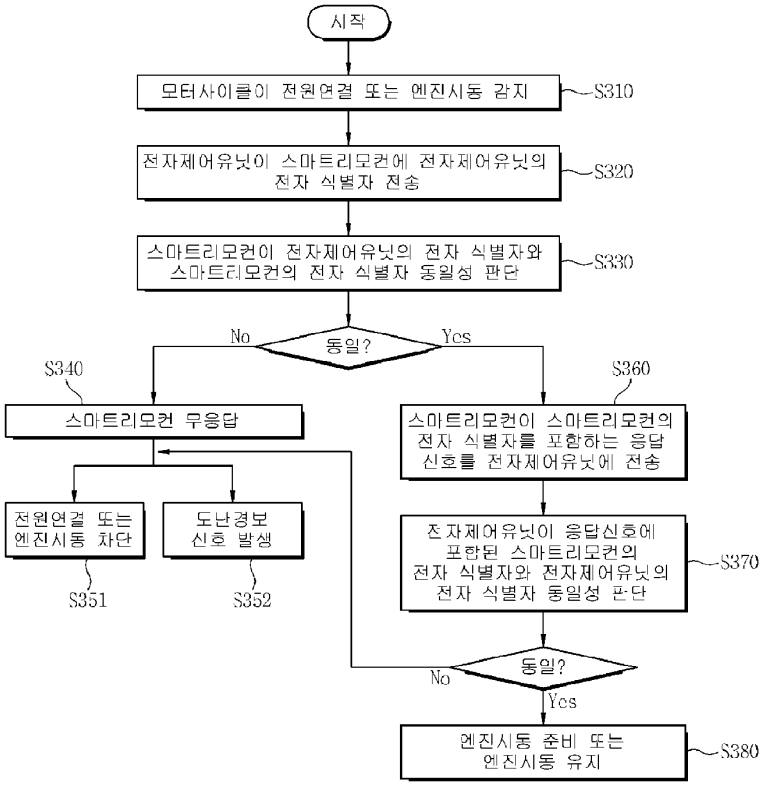
도면1



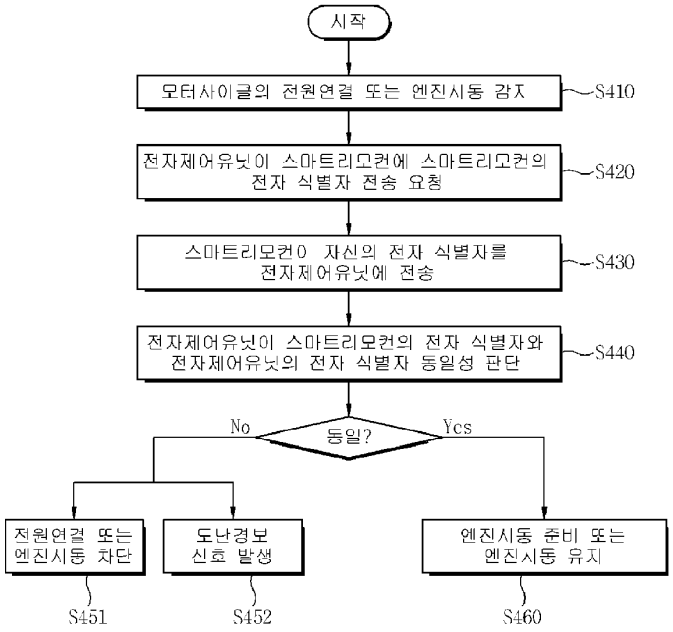
도면2


161
212
RF 송신부
LF 수신부
211
제2 제어부
220
200
배터리
230
242
버저
램프
243

도면3


시작
모터사이클이 전원연결 또는 엔진시동 감지
S310
전자제어유닛이 스마트리모컨에 전자제어유닛의 전자 식별자 전송
S320
스마트리모컨이 전자제어유닛의 전자 식별자와 스마트리모컨의 전자 식별자 동일성 판단
S330
No
동일?
Yes
S340
스마트리모컨 무응답
S360
스마트리모컨이 스마트리모컨의 전자 식별자를 포함하는 응답 신호를 전자제어유닛에 전송
전원연결 또는 엔진시동 차단
도난경보 신호 발생
S351
S352
전자제어유닛이 응답신호에 포함된 스마트리모컨의 전자 식별자와 전자제어유닛의 전자 식별자 동일성 판단
S370
No
동일?
Yes
엔진시동 준비 또는 엔진시동 유지
S380

도면4


시작
모터사이클의 전원연결 또는 엔진시동 감지
S410
전자제어유닛이 스마트리모컨에 스마트리모컨의 전자 식별자 전송 요청
S420
스마트리모컨이 자신의 전자 식별자를 전자제어유닛에 전송
S430
전자제어유닛이 스마트리모컨의 전자 식별자와 전자제어유닛의 전자 식별자 등일성 판단
S440
No
등일?
Yes
전원연결 또는 엔진시동 차단
도난경보 신호 발생
엔진시동 준비 또는 엔진시동 유지
S451
S452
S460

No documents available for this priority number.

Espacenet

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SYSTEM AND METHOD FOR PROVIDING ADDITIONAL SERVICE IN CHARGING BATTERY CHANGE OF ELECTRIC VEHICHE

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PURPOSE: A method for providing additional service according to the battery change charge of electric vehicle and a system thereof are provided to grasp the taste of consumer shape of a client filling a vehicle battery, thereby providing a personalized additional service to the client. CONSTITUTION: A battery has a memory connected to a vehicle system of electric vehicle. The charging stations(100) respectively has parking spaces for charging which electric vehicle parks. The charging stations exchanges and charges a battery of the parked electric vehicle. Through the memory of the battery, a charging station server(200) provides an additional service suitable for a taste of consuming shape of each client. A capacitor unit stores an inputted electric energy.

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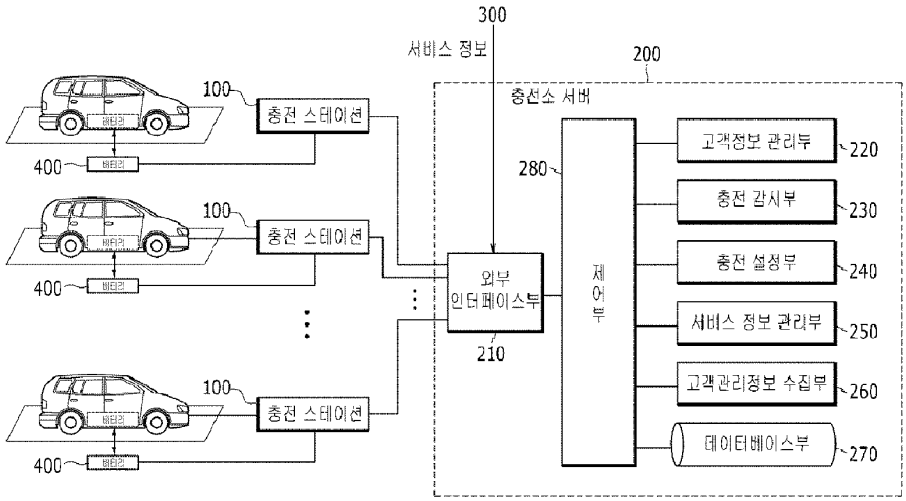
(54) 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템

(57) 요 약

본 발명은 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템에 관한 것이다.

이러한 본 발명에 따르면, 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 시스템은 상기 전기자동차의 차량 시스템과 연결되는 메모리가 구비된 배터리, 상기 전기자동차가 주차하는 충전용 주차공간에 각각 구비되어 주차되는 상기 전기자동차의 배터리를 교체 충전하는 스테이션, 그리고 상기 배터리의 메모리를 통해 고객별 소비형태 및 취향에 맞는 부가서비스를 제공하는 충전소 서버를 포함한다.

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특허청구의 범위

청구항 1

전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 시스템에 있어서,

상기 전기자동차의 차량 시스템과 연결되는 메모리가 구비된 배터리;

상기 전기자동차가 주차하는 충전용 주차공간에 각각 구비되어 주차되는 상기 전기자동차의 배터리를 교체 충전하는 스테이션; 및

상기 배터리의 메모리를 통해 고객별 소비형태 및 취향에 맞는 부가서비스를 제공하는 충전소 서버

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 2

제 1 항에 있어서,

상기 배터리는,

입력되는 전기에너지를 저장하는 축전부;

상기 부가서비스를 제공하기 위한 컨텐츠가 저장되는 메모리;

상기 전기에너지를 상기 공급하기 위해 상기 전기자동차와 연결되는 배터리 연결부; 및

상기 전기에너지를 상기 차량 시스템으로 제공하기 위해 연결되는 메모리 연결부

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 3

제 1 항 또는 제 2 항에 있어서,

상기 배터리는,

상기 메모리의 외부를 커버하여 상기 배터리에서 발생되는 전기적 특성으로부터 보호하는 차폐부를 더 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 4

제 3 항에 있어서,

상기 충전 스테이션은,

상기 전기자동차의 고객 인식정보와 고객 CRM(Customer Relationship Management) 데이터를 획득하여 상기 충전소 서버로 전송하는 인식부;

유선 혹은 무선 중 적어도 하나의 통신수단을 통해 상기 충전소 서버 및 상기 전기자동차와 통신을 수행하고, 상기 충전소 서버와 전기자동차간의 통신을 중계하는 통신부;

상기 메모리에 상기 부가서비스를 제공하기 위한 컨텐츠를 저장하는 컨텐츠 업데이트부; 및

충전이 필요한 배터리를 충전하는 배터리 충전부

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 5

제 4 항에 있어서,

상기 배터리 충전부는,

충전이 완료되는 완충 배터리의 고유정보를 상기 충전소 서버로 전달하는 것을 특징으로 하는 교체 충전에 따른

부가서비스 제공 시스템.

청구항 6

제 4 항에 있어서,

상기 CRM 데이터는,

고객의 운전이력정보, 소비행태정보, 고객관심정보, 컨텐츠 재생 정보 중 적어도 하나를 포함하는 것을 특징으로 하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 7

제 4 항에 있어서,

상기 충전소 서버는,

상기 부가서비스에 기초되는 상기 컨텐츠를 제공하는 제휴사 서버와 통신하고, 상기 충전 스테이션을 통해 접속되는 상기 전기자동차와 통신하는 외부인터페이스;

상기 제휴사 서버로부터 수집되는 컨텐츠를 관리하는 서비스 정보 관리부;

상기 충전 스테이션에서 수신되는 상기 CRM 데이터를 수집하는 고객관리정보 수집부;

상기 충전 스테이션에서 충전중인 배터리와 충전용량을 감시하며, 충전 가능한 유휴 충전용량을 파악하는 충전 감시부;

고객 인식정보에 따른 상기 CRM 데이터를 통계화하여 고객관리정보로 관리하며 상기 고객관리정보에 상응하는 상기 컨텐츠를 매칭하는 고객정보 관리부; 및

상기 고객 인식정보에 대응하는 상기 전기자동차의 차량 시스템 업그레이드 정보, 개인화된 컨텐츠 정보 및 충전상태정보 중 적어도 하나를 제공하는 제어부

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 8

제 5 항에 있어서,

상기 배터리 충전부에 인가되는 전기에너지를 스위칭 제어하고, 상기 배터리 충전부의 충전레벨을 조절하여 급충전을 수행하는 충전 설정부를 더 포함하는 배터리 교체 충전에 따른 부가서비스 제공 시스템.

청구항 9

전기자동차 충전 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공 하는 방법에 있어서,

a) 상기 전기자동차가 주차하는 충전용 주차공간에 구비되는 충전 스테이션이 상기 전기자동차에 장착중인 방전 배터리를 분리하여 회수하는 단계;

b) 상기 충전 스테이션이 상기 전기자동차의 차량 시스템과 연결되는 메모리가 구비된 배터리를 상기 전기자동차에 장착하는 단계; 및

c) 상기 전기자동차의 차량 시스템을 통해 상기 메모리에 미리 저장된 부가서비스 정보를 제공하는 단계

를 포함하는 배터리 교체 충진에 따른 부가서비스 제공 방법.

청구항 10

제 9 항에 있어서,

상기 a) 단계 이전에,

a-1) 상기 충전 스테이션이 상기 전기자동차의 고객 인식정보와 CRM(Customer Relationship Management) 데이터를 획득하여 충진소 서버로 진송하는 단계;

a-2) 상기 충전소 서버가 상기 고객 인식정보와 CRM 데이터를 토대로 개인화된 부가서비스 정보를 생성하는 단

계; 및

a-3) 상기 충전소 서버가 상기 개인화된 부가서비스 정보를 상기 충전 스테이션으로 전송하는 단계

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

청구항 11

제 9 항에 있어서,

상기 충전소 서버는,

상기 배터리의 교체 충전 상황정보를 상기 전기자동차에 제공하는 것을 특징으로 하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

청구항 12

제 9 항에 있어서,

상기 c) 단계이전에,

상기 부가서비스에 대한 과금결제를 수행하여 상기 메모리의 비밀번호를 부여하는 단계; 및

상기 배터리의 메모리가 상기 비밀번호를 인증하여 상기 차량 시스템의 접속을 허가하는 단계

를 더 포함하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

청구항 13

제 9 항에 있어서,

상기 부가서비스는,

상기 차량 시스템 업데이트 정보, 음원원 정보, 동영상 정보, 쇼핑 정보, 금융 정보, 스포츠 정보, 여행정보, 날씨정보 중 적어도 하나를 포함하는 것을 특징으로 하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

청구항 14

전기자동차의 차량 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공 하는 방법에 있어서,

a) 교체 장착되는 배터리에 구비된 메모리를 인식하는 단계;

b) 사용중인 적어도 하나의 프로그램 버전과 상기 메모리에 저장된 업데이트 파일의 버전을 비교하여 업데이트 목록을 생성하는 단계; 및

c) 상기 업데이트 목록에 따른 프로그램 업데이트를 수행하는 단계

를 포함하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

청구항 15

제 14 항에 있어서,

상기 메모리에 저장된 음악 및 동영상 컨텐츠 목록을 제공하고, 선택되는 적어도 하나의 음악 및 동영상 컨텐츠를 재생하는 단계를 더 포함하는 배터리 교체 충전에 따른 부가서비스 제공 방법.

명 세 서

기 술 분 야

[0001] 본 발명은 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템에 관한 것이다. 특히 본 발명은 배터리교체방식의 충전 스테이션에서 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템에 관한 것이다.

[0002] 본 발명은 지식경제부의 진력산업 연구개발 사업의 일환으로 수행한 연구로부터 도출된 것이다[과제관리번호:

R-2005-1-369-001, 과제명: 고부가 전력서비스용 수용가 통합자원 관리 시스템 개발].

배경기술

[0003] 최근의 세계적인 환경규제 강화 및 에너지 비용 절감 추세에 따라 환경 친화적인 전기자동차(EV, Electric Vehicle)에 대한 요구가 증가 되고 있다. 미국과 유럽의 경우 대기보존법 제정에 의하여 EV의 보급이 의무화되고 있는 상황이며, 국내에서도 저탄소 녹색성장의 일환으로 그린카(친환경 자동차)에 대한 관심과 연구가 활발히 진행되고 있다.

[0004] 전기자동차(EV)의 보급 확대를 위해서는 충전 인프라의 구축이 필수적이다. 가정용 충전설비를 비롯하여 언제 어디서나 EV를 충전할 수 있도록 많은 충전소가 설치되어야 한다.

[0005] 그러나, 충전소에서 전기자동차를 충전해야 하는 경우 기존의 주유소나 가스충전소와는 달리 긴 충전시간이 소요되기 때문에 차량에서 대기하는 고객의 지루함과 불만이 유발되는 문제점이 있다.

[0006] 한편, 이러한 문제점을 해결하기 위하여 전기자동차의 배터리교체 방식의 충전 기술이 개발되었다. 배터리 교체 방식의 충전이 필요한 고객의 전기자동차 배터리를 미리 완충된 배터리와 교체하여 장착함으로써 기존의 충전을 위한 시간을 절약할 수 있는 장점이 있다. 그러나, 배터리 교체방식의 충전이 기존의 충전 스테이션의 연결을 통한 충전에 비해 시간을 단축할 수 있더라도 기존의 주유소나 가스충전소에 비해 다소 지체될 수 있음은 자명하다.

[0007] 또한, 전기자동차는 기계적/전기적인 구동을 위해 엔진, 오토브레이크 시스템, 에어백 시스템, 도어개폐시스템, 차간거리유지 시스템, 차선이탈방지시스템 등수 많은 부품 및 장치들이 연동하며, 이들을 제어하기 위해 다양한 제어 프로그램이 차량의 내부 시스템을 통해 운영되고 있다. 또한, 전기자동차의 안전한 운행을 고려한 네비게이션, 멀티미디어/오디오장치, 자동주차시스템, 후방감지 시스템 등 다양한 편의장치들이 장착되는데 반해 이를 일일이 관리하는 것이 불편할 뿐 아니라 전문가의 도움 없이 어려운 문제점이 있었다.

[0008] 따라서, 배터리 교체 시간 동안 다양한 컨텐츠를 제공하여 고객의 지루함을 달래고, 차량의 내부 시스템 및 편의장치의 관리를 지원하는 다양한 부가 서비스가 요구된다.

발명의 내용

해결하려는 과제

[0009] 따라서 본 발명은 상기 문제점을 해결하기 위한 것으로 배터리 교체 충전 방식 충전 스테이션에 연결된 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템을 제공하기 위한 것이다.

과제의 해결 수단

[0010] 전술한 기술 과제를 해결하기 위한, 본 발명의 실시 예에 따른 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 시스템은,

[0011] 상기 전기자동차의 차량 시스템과 연결되는 메모리가 구비된 배터리; 상기 전기자동차가 주차하는 충전용 주차공간에 각각 구비되어 주차되는 상기 전기자동차의 배터리를 교체 충전하는 스테이션; 및 상기 배터리의 메모리를 통해 고객별 소비형태 및 취향에 맞는 부가서비스를 제공하는 충전소 서버를 포함한다.

[0012] 상기 배터리는 외부에서 입력되는 전기에너지를 저장하는 축전부; 상기 부가서비스를 제공하기 위한 컨텐츠가 저장되는 메모리; 상기 전기에너지를 상기 공급하기 위해 상기 전기자동차와 연결되는 배터리 연결부; 및 상기 전기에너지를 상기 차량 시스템으로 제공하기 위해 연결되는 메모리 연결부를 포함한다.

[0013] 여기에, 상기 배터리는 상기 메모리의 외부를 커버하여 상기 배터리에서 발생되는 전기적 특성으로부터 보호하는 차폐부를 더 포함한다.

[0014] 한편, 본 발명의 실시 예에 따른 전기자동차 충전 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공 하는 방법은,

[0015] a) 상기 전기자동차가 주차하는 충전용 주차공간에 구비되는 충전 스테이션이 상기 전기자동차에 장착중인 방전 배터리를 분리하여 회수하는 단계; b) 상기 충전 스테이션이 상기 전기자동차의 차량 시스템과 연결되는 메모리가 구비된 배터리를 상기 전기자동차에 장착하는 단계; 및 c) 상기 전기자동차의 차량 시스템을 통해 상기 메모

리에 미리 저장된 부가서비스 정보를 제공하는 단계를 포함한다.

[0016] 그리고, 상기 a) 단계 이전에, a-1) 상기 충전 스테이션이 상기 전기자동차의 고객 인식정보와 CRM(Customer Relationship Management) 데이터를 획득하여 충전소 서버로 전송하는 단계; a-2) 상기 충전소 서버가 상기 고객 인식정보와 CRM 데이터를 토대로 개인화된 부가서비스 정보를 생성하는 단계; 및 a-3) 상기 충전소 서버가 상기 개인화된 부가서비스 정보를 상기 충전 스테이션으로 전송하는 단계를 더 포함한다.

[0017] 한편, 본 발명의 실시 예에 따른 전기자동차의 차량 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공 하는 방법은,

[0018] a) 교체 장착되는 배터리에 구비된 메모리를 인식하는 단계; b) 사용중인 적어도 하나의 프로그램 버전과 상기 메모리에 저장된 업데이트 파일의 버전을 비교하여 업데이트 목록을 생성하는 단계; 및 c) 상기 업데이트 목록에 따른 프로그램 업데이트를 수행하는 단계를 포함한다.

[0019] 여기에, 상기 메모리에 저장된 음악 및 동영상 컨텐츠 목록을 제공하고, 선택되는 적어도 하나의 음악 및 동영상 컨텐츠를 재생하는 단계를 더 포함한다.

발명의 효과

[0020] 이와 같이 본 발명의 실시 예에 따르면, 배터리 교체 충전을 위하여 충전소에 들린 차량으로 교체 충전하는 시간 동안 고객의 소비형태/취향을 파악하고 그에 따른 개인화된 맞춤형 부가서비스(영화, 음악, 차량 시스템, 네비게이션 업데이트)들을 제공함으로써 고객의 지루함을 달래고 편의를 향상시키는 효과가 있다.

[0021] 또한, 충전소 사업자 측면에서는 충전중인 고객에게 다양한 부가서비스를 제공함으로써 고객에 특화된 서비스 제공에 따른 친화력과 서비스의 향상 및 부가수익을 창출할 수 있는 효과가 기대된다.

도면의 간단한 설명

[0022] 도 1은 본 발명의 실시 예에 따른 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 시스템의 네트워크 구성을 나타낸다.

도 2는 본 발명의 실시 예에 따른 전기자동차 배터리 교체 충전소 시스템을 나타낸 블록도이다.

도 3은 본 발명의 실시 예에 따른 충전 스테이션과 전기자동차의 구성을 나타낸 블록도이다.

도 4는 본 발명의 실시 예에 따른 저장수단을 갖는 배터리의 구성을 나타낸다.

도 5는 본 발명의 제1 실시 예에 따른 충전 스테이션이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 방법을 나타낸 흐름도이다.

도 6은 본 발명의 제2 실시 예에 따른 충전 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 방법을 나타낸 흐름도이다.

발명을 실시하기 위한 구체적인 내용

[0023] 아래에서는 첨부한 도면을 참고로 하여 본 발명의 실시 예에 대하여 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자가 용이하게 실시할 수 있도록 상세히 설명한다. 그러나 본 발명은 여러 가지 상이한 형태로 구현될 수 있으며 여기에서 설명하는 실시 예에 한정되지 않는다. 그리고 도면에서 본 발명을 명확하게 설명하기 위해서 설명과 관계없는 부분은 생략하였으며, 명세서 전체를 통하여 유사한 부분에 대해서는 유사한 도면 부호를 붙였다.

[0024] 명세서 전체에서, 어떤 부분이 어떤 구성요소를 "포함"한다고 할 때, 이는 특별히 반대되는 기재가 없는 한 다른 구성요소를 제외하는 것이 아니라 다른 구성요소를 더 포함할 수 있는 것을 의미한다. 또한, 명세서에 기재된 "…부", "…기", "모듈" 등의 용어는 적어도 하나의 기능이나 동작을 처리하는 단위를 의미하며, 이는 하드웨어나 소프트웨어 또는 하드웨어 및 소프트웨어의 결합으로 구현될 수 있다.

[0025] 이제 본 발명의 실시 예에 따른 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법 및 시스템에 대하여 도면을 참조로 하여 상세하게 설명한다.

[0026] 도 1은 본 발명의 실시 예에 따른 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 시스템의 네트워크 구

싱을 나타낸다.

[0027] 첨부된 도 1을 참조하면, 본 발명의 실시 예에 따른 전기자동차 배터리교체충전에 따른 부가서비스 제공 시스템의 네트워크 구성은 충전 스테이션(100), 충전소 서버(200) 및 제휴 서버(300)를 포함한다.

[0028] 충전 스테이션(100)은 전기자동차의 배터리 교체 충전을 위한 주차공간에 각각 구비되어 주차되는 전기자동차의 방전 배터리를 회수하고, 완충된 배터리를 장착하는 1:1 배터리 교체 역할을 수행 한다. 이 때, 충전 스테이션(100)은 접속되는 전기자동차의 내부 차량 시스템으로부터 고객의 인증정보를 수집한다. 또한, 전기자동차에서 고객의 운전이력 및 관심정보 등을 포함하는 고객관계관리 데이터(Customer Relationship Management, CRM)를 수집하는 역할을 한다. 이하, 설명의 편의상 고객의 인증정보 및 CRM 데이터를 고객정보라 명명한다.

[0029] 그리고, 충전 스테이션(100)은 수집되는 고객정보에 상응하는 다양한 부가서비스를 교환되는 배터리에 장착되는 저장수단을 통해 전기자동차로 제공한다. 여기서, 배터리에 장착되는 저장수단에 대한 설명은 뒤에서 자세히 설명하도록 한다.

[0030] 충전소 서버(200)는 상기 충전 스테이션(100)을 통해 인식되는 전기자동차의 배터리 교체 충전여부를 제어하고, 상기 전기자동차의 배터리 교체 충전시간 동안 차량 시스템 업데이트와 컨텐츠 등의 다양한 부가서비스의 제공을 위한 충전 스테이션(100)의 동작을 제어한다.

[0031] 제휴 서버(300)는 상기 다양한 부가서비스에 상응하는 서비스 정보를 상기 충전소 서버(200)로 제공하며, 예컨대, 제조사 서버(310), 컨텐츠 서버(320) 및 쇼핑몰 서버(330) 등일 수 있다.

[0032] 제조사 서버(310)는 전기자동차의 제조사, 전기자동차의 내부에 적용되는 차량 시스템 제조사, 네비게이션 및 카오디오와 같은 편의 시스템/장치 제조사 등일 수 있으며, 전기자동차의 모델 혹은 적용된 차량 시스템에 따른 업데이트 정보를 제공한다. 여기서, 업데이트 정보는 펌웨어 업데이트, 어플리케이션 업데이트, 패치파일, 버전 업데이트 중 적어도 하나일 수 있다.

[0033] 컨텐츠 서버(320)는 MP3와 같은 오디오 음원 컨텐츠에서부터, DMB, VOD와 같은 멀티미디어 동영상 컨텐츠를 제공하는 역할을 한다.

[0034] 쇼핑몰 서버(330)는 신상품 정보, 세일정보, 알뜰 쇼핑정보, 이벤트 정보 등 쇼핑과 관련된 유용한 정보를 제공하는 역할을 한다. 이 밖에도 충전소 서버(200)는 다양한 제휴사로부터 각종 정보를 수집하여 고객의 니즈(Needs)에 맞는 정보를 수집하고, 그에 따라 제공할 수 있다.

[0035] 한편, 도 2 내지 도 4를 통하여 본 발명의 실시 예에 따른 전기자동차 배터리 교체 충전소 시스템의 구성을 구체적으로 설명한다.

[0036] 도 2는 본 발명의 실시 예에 따른 전기자동차 배터리 교체 충전소 시스템을 나타낸 블록도이다.

[0037] 도 3은 본 발명의 실시 예에 따른 충전 스테이션과 전기자동차의 구성을 나타낸 블록도이다.

[0038] 도 4는 본 발명의 실시 예에 따른 저장수단을 갖는 배터리의 구성을 나타낸다.

[0039] 먼저, 첨부된 도 2를 참조하면, 본 발명의 실시 예에 따른 전기자동차 배터리 교체 충전소 시스템은 복수의 충전 스테이션(100)과 각 충전 스테이션(100)에 구비되는 배터리(400) 및 충전 스테이션(100)의 전체적인 동작을 제어하는 충전소 서버(200)를 포함한다.

[0040] 본 발명의 실시 예에 따르면 배터리 교체 방식의 충전 스테이션(100)에서 배터리를 교체하는 전기자동차(10)로부터 다양한 고객정보를 수집한 후, 그 고객정보를 바탕으로 하는 고객별 개인화된 부가서비스를 제공할 수 있다.

[0041] 첨부된 도 3을 참조하면, 충전 스테이션(100)은 충전을 위하여 주차된 전기자동차(10)의 배터리 교체시간 동안 고객의 운전이력, 자동차 시스템 및 네비게이션 버전, Gps Tracking등 고객정보를 연결되는 무선통신을 통해 수집한 후 고객의 사용 행태에 맞추어 맞춤형 데이터, 즉 개인화된 부가서비스를 고객에게 제공한다.

[0042] 먼저, 전기자동차(10)는 구동모터, 자동변속기, 자동브레이크시스템, 조향장치, 배터리 등의 전기자동차의 구동을 위한 전반적인 상태를 전기적으로 제어하는 차량 시스템(11)과 차량의 구동을 위한 충전에너지를 공급하는 배터리 장착부(12)를 포함한다.

[0043] 차량 시스템(11)은 전기자동차(10)의 구동을 위해 전반적인 동작을 제어하는 차량 내부 시스템으로 배터리 장착부(12)에 장착되는 배터리(400)의 충방전 상태를 체크하여 표시할 수 있으며, 네비게이션, 오디오 시스템과 같

이 차량내부에 장착되는 편의장치와 연동할 수 있다. 여기서, 네비게이션 장치와 오디오 시스템은 고객이 본 발명의 실시 예에 따른 다양한 부가서비스를 이용하기 위한 입출력 수단으로 활용될 수 있다.

[0044] 특히, 차량 시스템(11)은 부가서비스의 이용을 위한 어플리케이션이 설치되어, 충전 스테이션(100)과의 통신 연결시 고객/차량의 식별정보와 수집된 고객정보를 전달하기 위해 활성화 될 수 있다. 또한, 교체 장착되는 배터리(400)와 연결되는 메모리를 사용 가능한 하드디스크로 인식하여 차량 시스템(11) 및 편의 장치의 업데이트를 수행하고 음악 및 동영상과 같은 컨텐츠를 재생할 수 있다.

[0045] 충전 스테이션(100)은 통신부(110), 인식부(120), 컨텐츠 업데이트부(130) 및 배터리 충전부(140)를 포함한다.

[0046] 통신부(110)는 유선 혹은 무선통신수단을 통해 충전소 서버(200)와 통신하는 한편 해당 주차공간에 주차된 전기자동차(10)와 연결하여 통신을 수행한다. 여기에 통신부(110)는 충전소 서버(200)와 전기자동차(10)간의 통신을 중계하는 역할을 수행할 수도 있다. 통신부(110)는 충전소 서버(200) 및 전기자동차(10)와의 통신을 위해 각 충전 스테이션 별로 고유한 식별정보(ID)를 가진다. 그리고, 상기 유선 혹은 무선 통신수단은 유선랜, 무선랜, 직비(ZigBee) 및 블루투스 통신 중 적어도 하나일 수 있다. 그래서, 충전대기/진행 시간 동안 전기자동차(10)의 차량 시스템(11)으로부터 고객의 운전이력, 사용자 소비정보, GPS 위치추적(Tracking)정보, 음악/동영상 재생정보(횟수) 등의 CRM(Customer Relationship Management) 데이터를 수집하여 충전소 서버(200)로 전달할 수 있다.

[0047] 또한, 차량 시스템(11)으로 교체 충전 스케줄(충전 대기/시작 여부) 정보, 교체 충전상태정보, 기상정보 업데이트, 차계부 업데이트를 제공할 뿐 아니라 고객의 PDA, 노트북, 핸드폰, 스마트폰 등과 같은 휴대단말기를 통해서도 원격으로 제공할 수 있다.

[0048] 인식부(120)는 차량의 고유 식별정보와 미리 등록되거나 혹은 발급된 고객의 ID 카드 중 적어도 하나를 통해 고객의 인식정보를 획득하여 통신부(110)로 전달한다.

[0049] 인식부(120)는 차량의 고유 식별정보(차량 ID)를 차량의 고유정보가 저장된 차량 시스템과 캔(Controller Area Network, CAN)통신을 수행하여 수집하거나, 카메라(미도시)를 통해 촬영되는 차량번호를 인식하여 획득할 수 있다. 그리고, 고객의 등급별로 ID 카드를 발급하거나 고객이 소지한 ID 카드를 고객정보에 매칭하여 등록함으로써 인식이 가능하다. 여기서, 캔 통신을 수행한다는 것은 차량의 기능을 제어하기 위한 차량 시스템의 통신 네트워크로 통신부(110)가 차량 시스템과 연결되었음을 의미한다.

[0050] 컨텐츠 업데이트부(130)는 배터리(400)에 장착된 메모리(420)에 고객에게 부가서비스를 제공하기 위한 다양한 컨텐츠를 저장, 수정 및 삭제하는 역할을 한다. 컨텐츠 업데이트부(130)는 각 배터리(400)의 식별정보에 따라 해당 메모리(420)에 저장된 데이터(파일/컨텐츠)의 목록을 관리하며, 제휴 서버(300)에서 새로이 추가되거나 업데이트되는 파일을 각 메모리(420)에 업데이트한다.

[0051] 배터리 충전부(140)는 전기자동차(10)에서 회수되거나 충전이 필요한 배터리(400)를 완충상태로 충전하는 역할을 한다. 배터리 충전부(140)는 충전이 완료되면 완충된 배터리(400)의 고유정보를 충전소 서버(200)로 전달하여 충전소 서버(200)가 활용 가능한 배터리자원을 관리할 수 있도록 한다.

[0052] 이 밖에도 도면에서는 생략되었으나 충전 스테이션(100)에는 전기자동차(100)의 방전된 배터리(400)를 회수 및 장착하기 위한 이송 및 승강 수단과 그 제어장치가 더 구비될 수 있다.

[0053] 배터리(400)는 전기자동차(10)의 구동을 위한 에너지원으로 전기에너지를 공급하는 한편, 본 발명의 실시 예에 따른 다양한 부가서비스를 전기자동차(10)에 제공하는 역할을 한다.

[0054] 첨부된 도 4를 참조하면, 본 발명의 실시 예에 따른 배터리(400)는 축전부(410), 메모리(420), 배터리 연결부(430), 메모리 연결부(440) 및 차폐부(450)를 포함한다.

[0055] 축전부(410) 충전 스테이션(100)의 배터리 충전부(130)에서 인입되는 전기에너지를 저장하는 역할을 한다. 전기자동차(10)는 전기에너지를 원동력으로 구동되는 만큼 크고 무거운 배터리가 장착된다. 즉, 일반적인 자동차의 성능 특성이 엔진에서 비롯된다면 전기자동차(10)의 성능은 배터리에 달려있다고 해도 과언이 아니다. 축전부(410)는 배터리(400)의 성능에 가장 큰 영향을 주는 구성으로 충전율, 무게, 온도와 같은 외부환경, 생산가격 등을 고려하여 예컨데, 리튬이온 축전지, Zn/Air 축전지, Zn/Ni 축전지, Ni/Cd 축전지, 납축전지 등을 재료로 구성될 수 있다.

[0056] 메모리(420)는 하드디스크 및 플래시 메모리 등과 같은 저장수단으로 본 발명의 실시 예에 따른 부가서비스를

제공하기 위한 각종 데이터가 저장된다. 즉, 메모리(420)는 배터리(400)가 전기자동차(10)에 장착됨과 동시에 차량 시스템(11) 연결되어 전기자동차(10)의 차량 시스템 업데이트, 네비게이션 및 오디오와 같은 차량 편의 장치 업데이트, 동영상 및 음원(예; mp3) 등과 같은 다양한 부가 서비스들을 제공할 수 있다.

[0057] 이 때, 충전 스테이션(100)이 전기자동차(10)에서 수집되는 고객정보를 바탕으로 하는 고객별 개인화된 부가서비스를 메모리(420)에 저장하여 공급하는 경우 고객별 개인화된 부가서비스를 제공할 수 있는 장점이 있다.

[0058] 배터리 연결부(430)는 배터리(400)에 축적된 전기에너지를 전기자동차(10)로 공급하기 위해 연결되며, 메모리 연결부(440)는 USB 메모리와 같이 메모리에 저장된 데이터를 차량 시스템(11)으로 제공하기 위해 연결된다. 배터리 연결부(430)와 메모리 연결부(440)는 일정 간격을 두고 형성하여 상호 간섭을 최소화 한다.

[0059] 이 때, 배터리(400)가 전기자동차(100)에 장착시 배터리 연결부(430)와 메모리 연결부(440)가 연결되기 위해서는, 전기자동차용 배터리(400)가 단일 표준모델로 통일되는 것이 바람직하다. 즉, 배터리(400)의 연결 인터페이스를 규격화하여 배터리 연결부(430)와 메모리 연결부(440)가 함께 연결될 수 있도록 전기자동차(100)와 배터리(400)간의 연결규격을 표준화하는 것이 바람직하다.

[0060] 차폐부(450)는 배터리(400)에서 발생하는 전기적 특성(예; 전자파 등)에 의해 메모리(420)가 손상되는 것을 방지하기 위하여 메모리(420)를 커버하여 보호한다.

[0061] 한편, 충전소 서버(200)는 외부인터페이스부(210), 고객정보 관리부(220), 충전 감시부(230), 충전 설정부(240), 서비스 정보 관리부(250), 고객관리정보 수집부(260), 데이터베이스부(270) 및 제어부(280)를 포함한다.

[0062] 외부인터페이스부(210)는 제휴 서버(300) 및 각 충전 스테이션(100) 그리고 각 충전 스테이션(100)을 통해 접속되는 고객과 연결되어 통신을 수행한다. 외부인터페이스부(210)는 유선 혹은 무선 통신 수단을 통해 충전 주차 공간에 구비된 충전 스테이션(100)과 통신을 수행하여 접속된 차량의 고유 식별정보와 고객의 ID 카드 중 적어도 하나의 고객 인식정보를 수신한다.

[0063] 고객정보 관리부(220) 충전 스테이션(100)에서 수신된 고객 인식정보에 기초하여 해당 고객에 상응하는 부가서비스를 제공할 수 있도록 제어부(280)로 전달한다.

[0064] 또한, 고객정보 관리부(220)는 고객(차량)의 식별정보에 따라 고객의 운전이력정보, 소비행태/취향정보, 고객관심정보 등의 CRM 데이터를 통계화하여 고객관리정보로 관리하며, 고객관리정보에 해당 고객별로 개인화된 다양한 부가서비스를 매칭하여 관리한다.

[0065] 충전 감시부(230)는 충전소 내에 현재 충전중인 배터리(400)와 충전용량을 감시하며, 충전 가능한 충전용량을 파악한다.

[0066] 충전 설정부(240)는 각 충전 스테이션(100)의 배터리 충전부(130)에 연결되는 방전 배터리에 충전할 수 있도록 전기 에너지를 인가하는 스위칭 기능을 수행하며, 완충 배터리의 공급이 부족한 경우 배터리 충전부(130)의 충전레벨을 조절하여 급충전을 수행하도록 설정 한다.

[0067] 서비스 정보 관리부(250)는 제휴 서버(300)로부터 각종 서비스 정보를 수집하여 관리하는 역할을 한다. 상기 서비스 정보는 차량 시스템에 대한 업데이트 정보, 음원 및 동영상과 같은 각종 컨텐츠 정보, 쇼핑 정보, 금융 정보, 스포츠 정보, 여행정보, 날씨정보 등일 수 있다. 이러한 서비스 정보들은 고객관리정보를 토대로 개인화된 부가서비스 정보로 가공되어 해당고객의 배터리(400) 교체 충전시 메모리(420)를 통해 제공된다.

[0068] 고객관리정보 수집부(260)는 충전 스테이션(100)을 통해 연결된 전기자동차(10)로부터 고객의 운전이력정보, 소비행태정보, 고객관심정보 등의 CRM 데이터를 수집한다. 수집된 CRM 데이터는 고객별 개인화된 부가서비스 정보의 가공을 위해 활용되며, 전기자동차 충전소가 체인망인경우 본사의 중앙 서버로 전송하여 고객관계관리를 위한 데이터로 활용될 수도 있다.

[0069] 데이터베이스부(270)는 전기자동차 충전소의 운영을 위한 각종 데이터와 프로그램이 저장되며, 자동차 충전소의 이용에 따라 고객별로 발생되는 데이터를 저장하는 역할을 한다.

[0070] 제어부(280)는 충전소 서버(200)의 전반적인 운용을 위한 상기 각부의 동작을 제어하며, 특히, 제어부(280)는 충전 스테이션(100)에 연결된 고객의 인식정보에 대응하는 배터리(400)의 선택 및 충전진행상황정보, 개인화된 부가서비스 정보 및 차량 시스템 업데이트 정보를 제공하는 역할을 한다. 즉, 부가서비스 제공부(270)는 충전 스테이션(100)을 통해 연결되는 차량 시스템(11) 또는 고객 단말로 교체 충전 진행 상황 정보, 네비게이션 업데이트, 영화, 오락프로, MP3등의 컨텐츠 서비스, 차량정보 업데이트(차량의 구동버전) 및 차량관리(에너지, 소모

품 관리등의 차계부) 등의 각종 부가서비스를 제공할 수 있다.

[0071] 한편, 도 5 및 도 6을 통하여 본 발명의 실시 예에 따른 전기자동차의 배터리교체 충전에 따른 부가서비스 제공 방법을 설명한다.

[0072] 먼저, 도 5는 본 발명의 제1 실시 예에 따른 충전 스테이션이 전기자동차의배터리 교체 충전에 따른 부가서비스를 제공하는 방법을 나타낸 흐름도이다.

[0073] 첨부된 도 5를 참조하면, 본 발명의 실시 예에 다른 충전 스테이션(100)이 해당 주차공간에 주차한 전기자동차(10)가 접속되면, 연결되는 차량 시스템(11)을 통해 고객정보를 인식한다(S101, S102). 이후, 충전 스테이션(100)은 배터리 교체 충전에 따른 상황정보를 이하 설명되는 단계별로 제공한다(S103).

[0074] 충전 스테이션(100)은 전기자동차(10)에 장착중인 방전 배터리를 분리하여 회수하고(S104), 회수된 방전 배터리에 상응하는 완충 배터리를 선정한다(S105).

[0075] 여기서, 완충 배터리의 선정 단계는 배터리의 교환이 1:1로 대등하게 이루어지는 것이 바람직하므로 배터리의 종류 및 충전용량이 동일한 레벨의 배터리를 선택하는 것이다. 본 발명의 실시 예에 따른 배터리(400) 교환 충전 방식에서 고객은 고가의 배터리를 개인적으로 구입할 필요가 없으며 소정의 보증금(배터리에 따라 차등될 수 있음)을 지불하고 지속적으로 배터리를 교환충전 할 수 있다. 즉, 고객의 입장에서는 과거의 배달용 LPG 가스를 이용하는 것과 같이 배터리(400)의 비용 없이 전기에너지의 충전비용만 지불하면 되는 이점이 있고, 전기자동차 충전소 사업자 입장에서는 고정고객을 확보하는 이점이 있다.

[0076] 충전 스테이션(100)은 선정된 완충된 배터리(400)를 전기자동차(10)에 장착한다(S106).

[0077] 전기자동차(10)는 배터리(400)의 장착으로 배터리에 장착된 메모리(420)를 인식하여(S107), 메모리에 미리 저장된 부가서비스정보에 따른 차량 시스템 업데이트 및 음악/동영상 컨텐츠를 실행할 수 있다(S108). 예컨대, 전기자동차(100)의 차량 시스템은 사용중인 적어도 하나의 프로그램 버전과 상기 메모리에 저장된 업데이트 파일의 버전을 비교하여 업데이트 목록을 생성하고, 상기 업데이트 목록에 따른 프로그램 업데이트를 수행할 수 있다. 또한, 메모리(420)에 저장된 음악 및 동영상 컨텐츠 목록을 제공하고, 선택되는 적어도 하나의 음악 및 동영상 컨텐츠를 재생할 수도 있다.

[0078] 이어서, 충전 스테이션(100)이 배터리(400) 교체 충전 작업이 완료되었음을 확인하면(S109), 배터리 교체 충전이 완료 되었음을 전기자동차(10)에 알리고 충전진행 상황정보 제공을 종료한다(S110).

[0079] 한편, 도 6은 본 발명의 제2 실시 예에 따른 충전 시스템이 전기자동차의 배터리 교체 충전에 따른 부가서비스를 제공하는 방법을 나타낸 흐름도이다.

[0080] 첨부된 도 6을 참조하면, 본 발명의 실시 예에 따른 전기자동차(10)가 충전 스테이션(100)에 접속하고, 고객정보를 전송하여 배터리 교체 충전을 요청한다(S201). 충전 스테이션(100)은 해당 주차공간에 주차한 전기자동차(10)로부터 차량(고객) 인식정보 및 고객정보를 수집하여(S202), 충전소 서버(200)로 전달한다(S203). 이 때, 고객정보는 고객의 인식정보에 매칭되는 고객의 운전이력, 사용자 소비정보, GPS 위치추적(Tracking)정보, 음악/동영상 재생정보(횟수) 등의 CRM 데이터가 포함된다.

[0081] 이후, 충전소 서버(200)는 충전 스테이션(100)을 통해 배터리 교체 충전에 따른 상황정보를 이하 설명되는 단계별로 제공한다(S204). 이 때, 상기 배터리 교체 충전에 따른 상황정보는 차량 시스템(11) 또는 고객단말로 전송될 수 있다.

[0082] 충전소 서버(200)는 수신된 고객의 인식정보와 고객정보를 파악하고(S205), 파악된 CRM 데이터를 토대로 개인화된 부가서비스 정보를 생성한다(S206). 여기서, 개인화된 부가서비스 정보는 전기자동차(10)의 차량 시스템과 네비게이션/오디오 시스템과 같은 각종 편의장치에 대한 업데이트 정보와, 고객의 소비행태/취향에 따른 동영상(영화, 뮤직비디오 등), 음악 등의 컨텐츠 정보를 포함한다.

[0083] 그리고, 충전소 서버(200)는 고객에 맞게 개인화된 부가서비스를 전기자동차(10)에 장착되는 배터리(400)에 포함된 메모리(420)에 저장한다(S207).

[0084] 다음, 충전 스테이션(100)는 배터리 교체 충전을 위해 전기자동차(10)에서 방전 배터리를 분리하여 회수한다(S208). 그리고, 메모리(420)에 상기 개인화된 부가서비스가 저장된 완충 배터리(400)를 전기자동차(10)에 장착한다(S209).

[0085] 전기자동차(10)는 완충 배터리(400)가 장착되면 메모리(420)를 인식하고(S210), 차량 시스템(11) 업데이트 및 컨텐츠를 실행한다(S211). 여기서, 차량 시스템(11)에 미리 설치된 부가서비스의 이용을 위한 어플리케이션이 차량 시스템(11)의 각종 시스템 버전과 메모리에 대응되는 버전을 비교하여 업데이트 되어야 할 최신 버전이 있는 경우 이를 고객에 알려 업데이트를 수행할 수 있다. 또한, 네비게이션 및 오디오 시스템과 같은 미디어 재생 장치를 통해 음악/동영상 컨텐츠를 재생할 수 있다.

[0086] 충전소 서버(200)는 충전 스테이션(100)의 배터리 교체 충전작업이 완료되었음을 확인하면(S212), 배터리 교체 충전이 완료 되었음을 전기자동차(10)에 알리고 충전진행 상황정보 제공을 종료한다(S213).

[0087] 이와 같이 본 발명의 실시 예에 따르면, 배터리 교체 충전을 위하여 충전소에 들린 차량으로 교체 충전하는 시간 동안 고객의 소비형태/취향을 파악하고 그에 따른 개인화된 맞춤형 부가서비스(영화, 음악, 차량 시스템, 네비게이션 업데이트)들을 제공함으로써 고객의 지루함을 달래고 편의를 향상시키는 효과가 있다.

[0088] 또한, 충전소 사업자 측면에서는 충전중인 고객에게 다양한 부가서비스를 제공함으로써 고객에 특화된 서비스 제공에 따른 친화력과 서비스의 향상 및 부가수익을 창출할 수 있는 효과가 기대된다.

[0089] 이상에서는 본 발명의 실시 예에 대하여 설명하였으나, 본 발명은 상기한 실시 예에만 한정되는 것은 아니며 그 외의 다양한 변경이 가능하다.

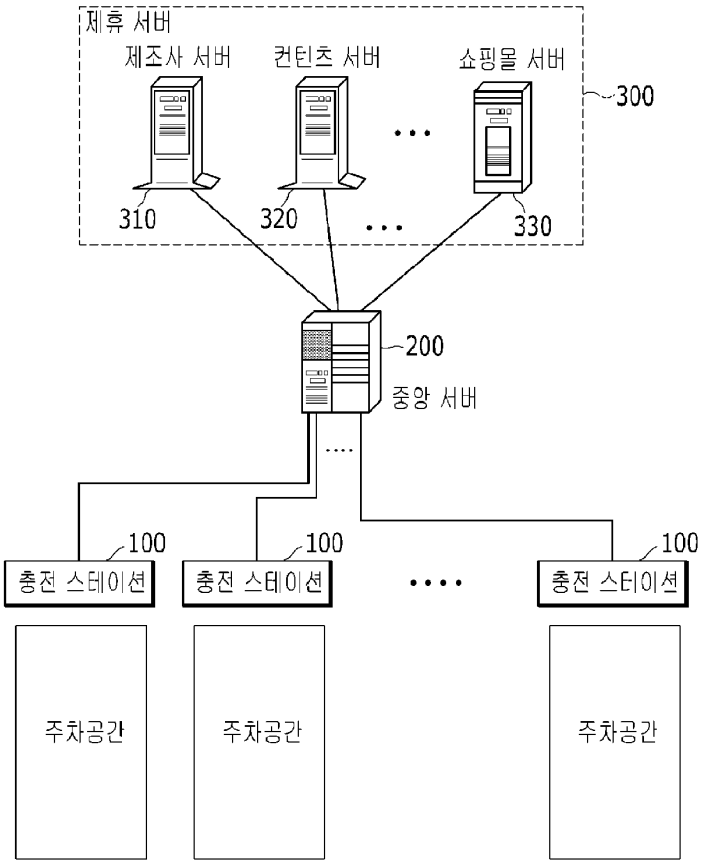
[0090] 예컨대, 도 5 및 도 6에 도시한 본 발명의 실시 예에서는 전기자동차(10)가 배터리가 장착되면 메모리(420)를 인식하고 부가서비스를 이용하는 것으로 설명하였으나 이에 한정되지 않으며, 과금결제 단계와 메모리(420) 접근을 위해 인증하는 단계를 더 포함할 수 있다. 즉, 메모리(420)에 저장된 부가서비스 이용을 위한 과금을 결제하는 단계를 더 포함하고, 과금결제를 통해 부여된 인증정보(예; 비밀번호)를 이용하여 사용자 인증을 통해서만 부가서비스를 이용을 허락는 단계를 더 포함할 수 있다. 여기서, 과금결제와는 무관하게 차량 시스템(11)의 어플리케이션이 업데이트 목록 및 컨텐츠 목록을 제공하여 고객의 부가서비스 이용에 대한 관심도를 높일 수 있다. 이로써, 전기자동차 충전소 및 복수의 충전소를 체인으로 운영하는 사업자가 다양한 부가서비스 제공에 따른 수익을 창출할 수 있는 이점이 있다.

[0091] 본 발명의 실시 예는 이상에서 설명한 장치 및/또는 방법을 통해서만 구현이 되는 것은 아니며, 본 발명의 실시 예의 구성에 대응하는 기능을 실현하기 위한 프로그램, 그 프로그램이 기록된 기록 매체 등을 통해 구현될 수도 있으며, 이러한 구현은 앞서 설명한 실시 예의 기재로부터 본 발명이 속하는 기술분야의 전문가라면 쉽게 구현할 수 있는 것이다.

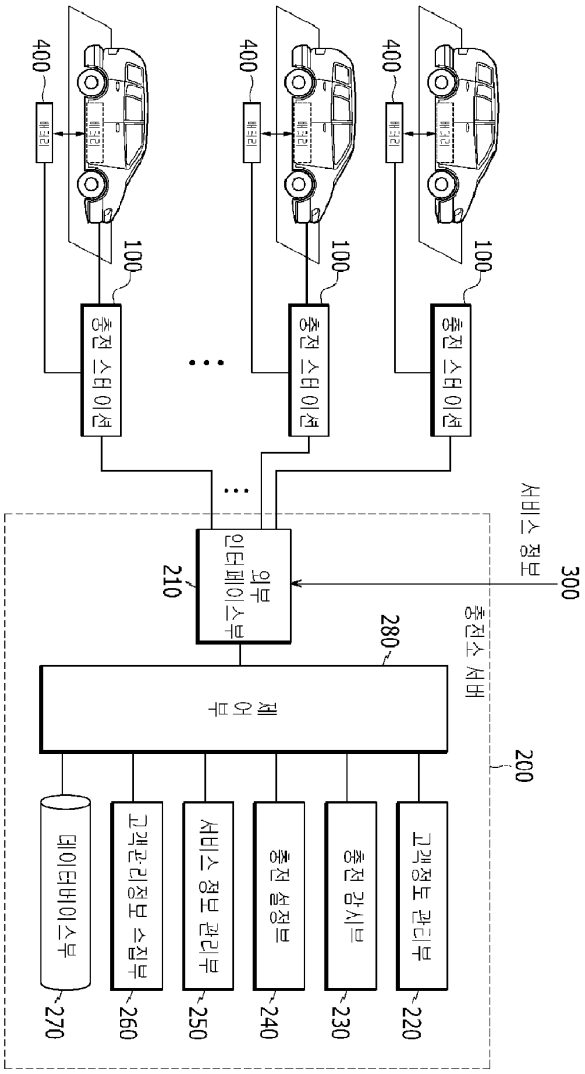
[0092] 이상에서 본 발명의 실시 예에 대하여 상세하게 설명하였지만 본 발명의 권리범위는 이에 한정되는 것은 아니고 다음의 청구범위에서 정의하고 있는 본 발명의 기본 개념을 이용한 당업자의 여러 변형 및 개량 형태 또한 본 발명의 권리범위에 속하는 것이다.

도면

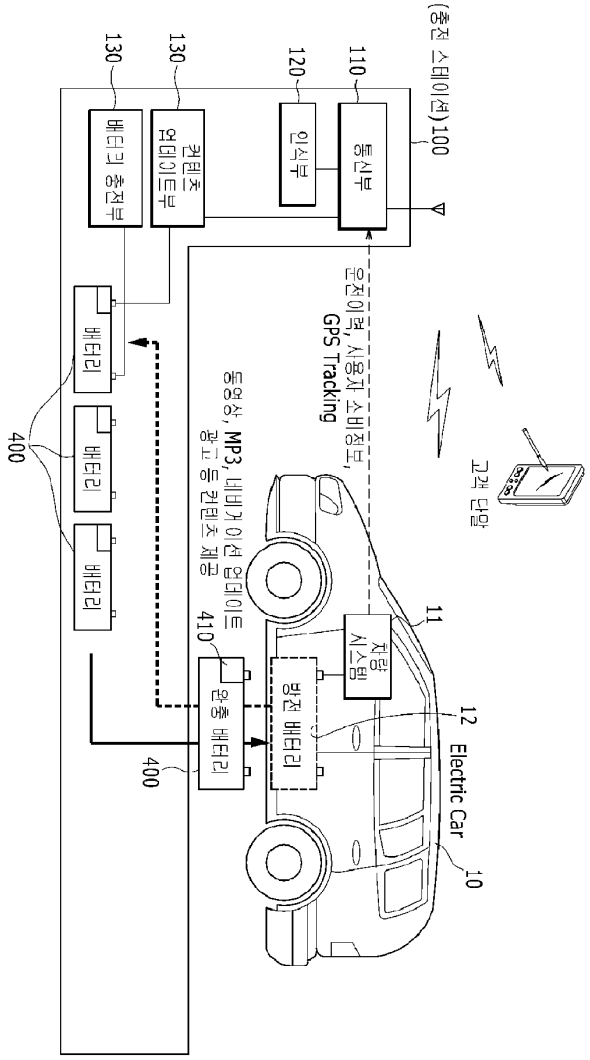
도면1


제휴 서버
제조사 서버
컨텐츠 서버
쇼핑몰 서버
300
310
320
330
200
중앙 서버
100
100
100
충전 스테이션
충전 스테이션
충전 스테이션
주차공간
주차공간
주차공간

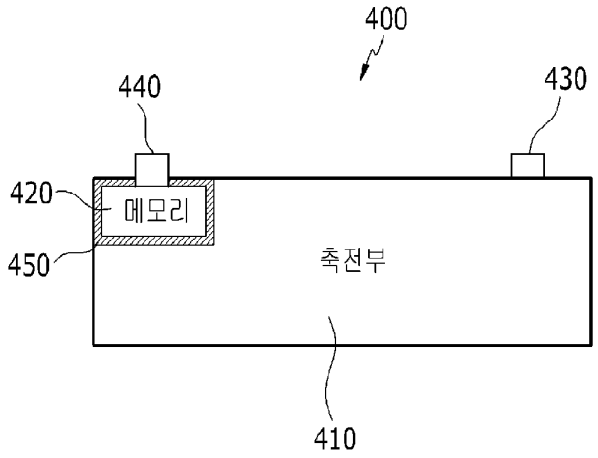
도면2


400
배터리
100
충전 스테이션
서비스 정보
300
충전소 서버
200
외부 인터페이스부
210
제어부
280
고객정보 관리부
220
충전 감시부
230
충전 설정부
240
서비스 정보 관리부
250
고객관리정보 수집부
260
데이터베이스부
270

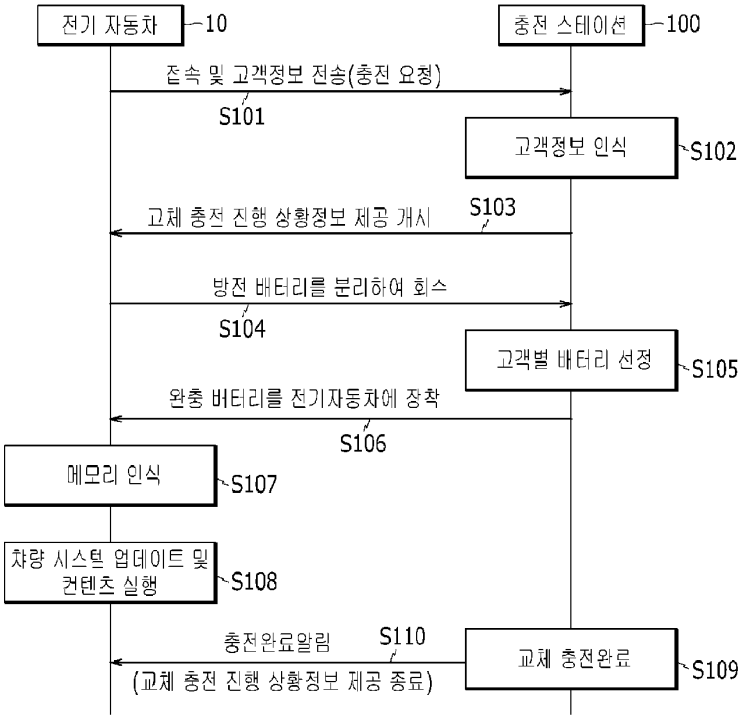
도면3


(충전 스테이션)100
130
130
120
110
배터리 충전부
컨텐츠 업데이트부
인식부
통신부
운전이력, 사용자 소비정보, GPS Tracking
고객 단말
동영상, MP3, 네비게이션 업데이트 광고 등 컨텐츠 제공
400
배터리
배터리
배터리
410
완충 배터리
400
11
차량 시스템
방전 배터리
12
Electric Car
10

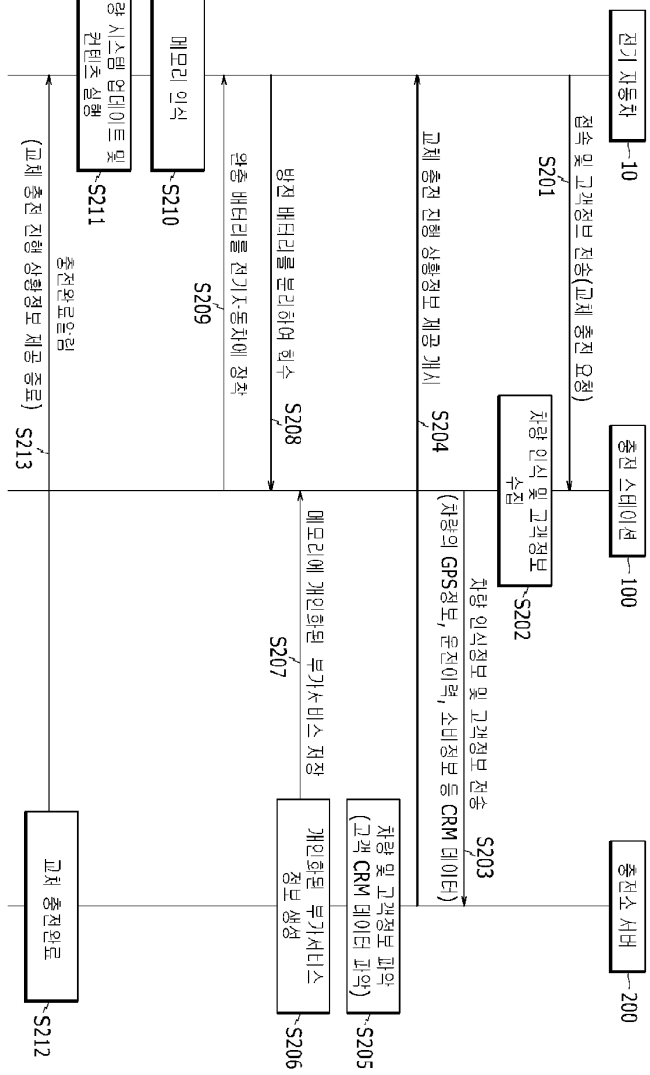
도면4


400
440
430
420
메모리
450
축전부
410

도면5


전기 자동차
10
충전 스테이션
100
접속 및 고객정보 전송(충전 요청)
S101
고객정보 인식
S102
고체 충전 진행 상황정보 제공 개시
S103
방전 배터리를 분리하여 회수
S104
고객별 배터리 선정
S105
완충 버터리를 전기자동차에 장착
S106
메모리 인식
S107
차량 시스템 업데이트 및 컨텐츠 실행
S108
충전완료알림
S110
(교체 충전 진행 상황정보 제공 종료)
교체 충전완료
S109

도면


전기 자동차
10
충전 스테이션
100
충전소 서버
200
접속 및 고객정보 전송(교체 충전 요청)
S201
차량 인식 및 고객정보 수집
S202
교체 충전 진행 상황정보 제공 개시
S204
차량 인식정보 및 고객정보 전송
S203
(차량의 GPS정보, 운전이력, 소비정보 등 CRM 데이터)
차량 및 고객정보 파악
(고객 CRM 데이터 파악)
S205
개인화된 부가서비스 정보 생성
S206
메모리에 개인화된 부가서비스 저장
S207
방전 배터리를 분리하여 회수
S208
완충 배터리를 전기자동차에 장착
S209
메모리 인식
S210
차량 시스템 업데이트 및 컨텐츠 실행
S211
교체 충전완료
S212
충전완료을림
(교체 충전 진행 상황정보 제공 종료)
S213

No documents available for this priority number.

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ENERGY-SAVING CONTROL SYSTEM AND CONTROL METHOD FOR ELECTRIC DRIVEN MOVING BODY

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Applicant(s): KOREA ADVANCED INST SCI & TECH [KR] + (KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY)

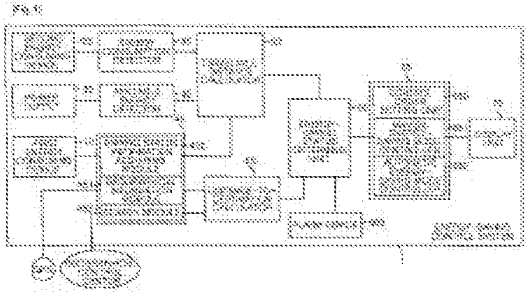
Classification: **- international:** ***B60L15/00; B60L9/00***
- cooperative: Y02T10/7005

Application number: KR20090098768 20091016

Priority number (s): KR20090098768 20091016

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Abstract of KR20110041783 (A)



PURPOSE: An energy saving control system of an electric moving object and control method thereof are provided to quickly control and save energy consumption. CONSTITUTION: An energy saving control system of an electric moving object comprises a consumed energy detecting unit(25), a supply energy detecting unit(40), a driving information obtaining unit(45), a driving distance calculating unit(50), a destination distance calculating unit(55), a power saving state determining unit(60), and a power saving mode controller(65). The consumed energy detecting unit calculates the consumed energy amount of first and second energy consumption devices. The supply energy detecting unit calculates the amount of power supplied to an energy supply device which supplies power to a moving object.

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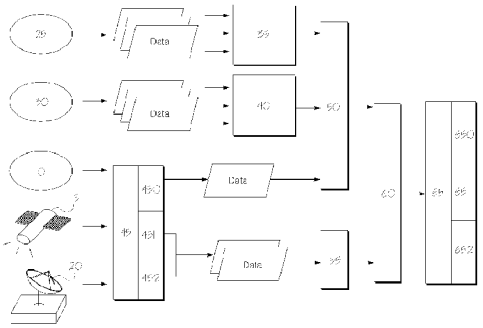
전체 청구항 수 : 총 13 항

(54) 전기 구동 이동체의 에너지 절약 제어시스템 및 제어방법

(57) 요 약

본 발명은 전기 구동 이동체의 에너지 절약 제어시스템 및 제어방법에 관한 것으로서, 구체적으로 에너지 소비장치의 소비 전력량을 산출하는 소비 에너지 검출부와, 공급 가능한 전력량을 산출하는 공급가능 에너지 검출부와, 이동체나 급전장치의 지리정보 및 구동 상태 정보를 취득하는 주행 정보 취득부와, 이동체의 주행가능 거리 산출부와, 이동체와 급전장치 간의 목적지 거리 산출부와, 이동체의 절전 주행 상태여부를 판단하는 절전 상태판단부와, 및 절전 주행 상태시 상기 제2 에너지 소비장치에 대한 전력 공급을 제어하는 절전모드 제어부가 전기로 구동되는 이동체에 실치되고, 상기 소비 전력량, 공급 가능한 전력량, 이동체의 구동 상태에 관한 정보로부터 이동체의 이동가능한 거리를 추정하는 단계와, 이동체와 최단거리 내에 있는 급전장치의 위치 및 지리정보를 검색하고 거리를 추정하는 단계와, 상기 주행가능 거리와 목적지 거리를 비교하여 이동체의 절전 주행 상태여부를 판단하는 단계와, 및 상기 이동체가 절전 주행 상태로 판단된 경우 에너지 소비장치에 대한 전력 공급을 중단하거나 조절하는 단계를 포함한다.

대 표 도 - 도1



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특허청구의 범위

청구항 1

전기로 구동되는 이동체의 이동에 전력을 소모하는 제1 에너지 소비장치와, 상기 이동체의 이동을 제외한 이동체의 운용에 전력을 소모하는 제2 에너지 소비장치의 소비 전력량을 산출하는 소비 에너지 검출부;

상기 이동체의 소비장치에 전력을 공급하는 에너지 공급장치의 공급 가능한 전력량을 산출하는 공급가능 에너지 검출부;

상기 이동체의 위치 및 구동 상태에 관한 정보를 실시간 획득하고, 상기 이동체에 전력을 공급하는 급전장치의 위치 및 지리정보를 획득하여 저장하는 주행 정보 취득부;

상기 소비 전력량, 공급 가능한 전력량, 및 이동체의 구동 상태에 관한 정보로부터 이동체의 이동가능한 거리를 추정하는 주행가능 거리 산출부;

상기 이동체의 위치에 관한 정보, 급전장치의 위치 및 지리정보로부터 이동체와 최단거리 내에 있는 급전장치의 위치 및 지리정보를 검색하여 이동체와 급전장치 간의 거리를 추정하는 목적지 거리 산출부;

상기 주행가능 거리와 목적지 거리를 비교하여 이동체의 절전 주행 상태여부를 판단하는 절전 상태판단부; 및

상기 이동체의 절전 주행 상태로 판단된 경우, 상기 에너지 공급장치의 제2 에너지 소비장치에 대한 전력 공급을 중단하거나 조절하여 제어하는 절전모드 제어부를 포함하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 2

제 1항에 있어서,

상기 이동체는 충전식 전기자동차, 하이브리드 전기자동차, 온라인 전기자동차, 전동식 자전거, 전동식 모터사이클, 철도 차량, 선박, 비행기, 로켓 중에서 선택된 어느 하나인 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 3

제 1항에 있어서,

제1 에너지 소비장치는 이동체의 구동 모터이고, 제2 에너지 소비장치는 이동체에 장착되는 조명수단, 온도조절수단, 음향수단, 디스플레이 수단, 네비게이션, 전동식 개폐수단, 내장 컴퓨터 중 어느 하나 이상인 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 4

제 1항에 있어서,

상기 에너지 공급장치는 충전식 또는 비충전식 배터리, 집전장치, 커패시터, 슈퍼커패시터 중 어느 하나 이상인 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 5

제 1항에 있어서,

상기 주행 정보 취득부는,

상기 이동체의 구동 상태에 관한 정보를 실시간 획득하여 저장하는 구동 상태정보 획득 모듈;

상기 이동체의 위치 및 이동체에 전력을 공급하는 급전장치의 위치를 수신하거나 지리정보를 획득하여 저장하는 지리정보 모듈; 및

상기 지리정보를 기반으로 특정 위치를 검색하는 검색 모듈을 포함하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 6

제 1항에 있어서,

상기 절전 상태판단부는,

상기 주행가능 거리가 상기 목적지 거리 또는 상기 목적지 거리보다 소정의 거리를 더한 거리보다 짧거나 같은 경우를 절전 주행 상태로 판단하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 7

제 6항에 있어서,

상기 소정의 거리는, 상기 목적지 거리의 5% 내지 10%에 해당하는 거리인 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 8

제 1항에 있어서,

상기 절전 상태판단부는,

상기 이동체의 절전 주행 상태로 판단된 경우, 이동체의 운전자 또는 상기 절전모드 제어부에 전달되는 알림 메시지 신호를 생성하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 9

제 1항에 있어서,

상기 절전모드 제어부는,

소비 전력량, 중요도, 주행 연관성 또는 주행 환경 조건에 따른 상기 제2 에너지 소비장치의 제어순서와 공급 전력량의 조절을 결정하는 제어순서 설정부;

이동체 운전자의 입력신호에 의해 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 수동 절전모드 제어부; 및

상기 설정된 제2 에너지 소비장치의 제어순서에 따라 자동으로 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 자동 절전모드 제어부를 포함하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어시스템.

청구항 10

이동체의 이동에 전력을 소모하는 제1 에너지 소비장치와 이동을 제외한 이동체의 운용에 전력을 소모하는 제2 에너지 소비장치의 소비 전력량을 산출하는 소비 에너지 검출부와, 공급 가능한 전력량을 산출하는 공급가능 에너지 검출부와, 이동체나 급전장치의 위치, 지리정보, 및 구동 상태의 정보를 취득하는 주행 정보 취득부와, 이동체의 이동가능한 거리를 추정하는 주행가능 거리 산출부와, 이동체와 급전장치 간의 거리를 추정하는 목적지 거리 산출부와, 이동체의 절전 주행 상태여부를 판단하는 절전 상태판단부와, 및 절전 주행 상태시 상기 제2 에너지 소비장치에 대한 전력 공급을 제어하는 절전모드 제어부가 전기로 구동되는 이동체에 설치되고,

상기 주행가능 거리 산출부에서 상기 제1 에너지 소비장치와 제2 에너지 소비장치의 소비 전력량과, 공급 가능한 전력량과, 이동체의 구동 상태에 관한 정보로부터 이동체의 이동가능한 거리를 추정하는 단계;

상기 목적지 거리 산출부에서 상기 이동체의 위치에 관한 정보, 이동체에 전력을 공급하는 급전장치의 위치 및 지리정보로부터 이동체와 최단거리 내에 있는 급전장치의 위치 및 지리정보를 검색하고 이동체와 급전장치 간의 거리를 추정하는 단계;

상기 절전 상태판단부에서 상기 주행가능 거리와 목적지 거리를 비교하여 이동체의 절전 주행 상태여부를 판단하는 단계; 및

상기 이동체가 절전 주행 상태로 판단된 경우, 상기 절전모드 제어부가 제2 에너지 소비장치에 대한 전력 공급을 중단하거나 조절하는 단계를 포함하는 전기 구동 이동체의 에너지 절약 제어방법.

청구항 11

제 10항에 있어서,

상기 이동체의 절전 주행 상태여부를 판단하는 단계는, 상기 주행가능 거리가 상기 목적지 거리 또는 상기 목적지 거리에 목적지 거리의 5% 내지 10%에 해당하는 거리를 더한 거리보다 짧거나 같은 경우를 절전 주행 상태로 판단하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어방법.

청구항 12

제 10항에 있어서,

상기 이동체가 절전 주행 상태로 판단된 경우, 상기 절전 상태판단부가 이동체의 운전자 또는 상기 절전모드 제어부에 전달되는 알림 메시지 신호를 생성하는 단계를 추가로 더 포함하는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어방법.

청구항 13

제 10항에 있어서,

상기 절전모드 제어부의 제2 에너지 소비장치에 대한 전력 공급의 중단 또는 조절 단계가, 소비 전력량, 중요도, 주행 연관성 또는 주행 환경 조건에 따라 기결정된 제2 에너지 소비장치의 제어순서와 공급 전력량을 기반으로 이루어지는 것을 특징으로 하는 전기 구동 이동체의 에너지 절약 제어방법.

명 세 서

발명의 상세한 설명

기 술 분 야

[0001] 본 발명은 전기에너지를 공급 및 소비하여 구동되는 이동체가 에너지를 공급하는 급전장치까지 이동함에 있어 이동체의 에너지 절약 제어시스템 및 제어방법에 관한 것으로서, 상세하게는 이동체의 주행 가능 거리와 목적지까지의 거리를 비교하여 절전모드 상태에서 에너지 소비장치의 전력 공급을 제어하는 제어시스템과 제어방법이다.

배 경 기 술

[0002] 일반적으로 전기에너지의 공급과 소모에 의해 구동되는 이동체는 여러가지가 있을 수 있으며, 특히 최근들어 전기 자동차, 하이브리드 전기자동차와 온라인 전기자동차와 같은 이동체에 대한 연구가 활발하다.

[0003] 그러나, 이러한 전기에너지로 구동되는 이동체의 경우 전기 에너지의 공급이 충분하지 않을 수 있으며, 방전 또는 소비에 의해 전기에너지의 충전 상태가 주행함에 있어 충분하지 않을 염려가 있기 때문에 이러한 전기에너지의 부족은 사율주행과 주행 안정성을 해치는 요인이 된다.

[0004] 따라서, 전기에너지의 공급이 가능한 장치 또는 설비에 대한 정보를 바탕으로 하여 전기 구동 이동체의 에너지 소비장치와 에너지 공급장치를 제어하는 에너지 절약과 관리 시스템이 필요하다.

[0005] 특히 전기 자동차, 하이브리드 전기자동차와 온라인 전기자동차와 같은 이동체의 자율 주행과 주행 안정성을 위하여, 충전 또는 급전을 위한 설비로의 이동과 관련한 단계적인 에너지 제어시스템이 필요하고 에너지 소비장치의 특성에 맞도록 전력량의 조절과 제어가 배분되는 신개념의 에너지 제어 시스템이나 제어방법이 요구된다.

발명의 내용

해결 하고자하는 과제

[0006] 본 발명은 상기와 같은 문제점을 해결하기 위하여 안출된 것으로서, 전기 자동차, 하이브리드 전기자동차와 온라인 전기자동차와 같이 전기 에너지로 구동되는 이동체의 자율 주행과 주행 안정성을 확보하기 위하여 충전 또는 급전 설비로의 이동과 에너지 소모의 제어를 신속하게 판단하고 절약하는 시스템과 방법을 제공하는데 목적이 있다.

[0007] 또한 본 발명은 일반적으로 주행이나 이동 경로상에 제한적으로만 존재할 수 밖에 없는 충전 또는 급전설비의

한계로 인해 전기 구동 이동체의 도로 운행 상황이 악화되거나 다른 운전자에게 피해가 가지 않도록 이동체의 에너지 소비를 상황에 맞추어 단계적으로 혹은 소비장치에 맞추어 배분적으로 소비 전력량의 제한을 할당하는 에너지 관리장치와 방법을 제공하는데 또다른 목적이 있다.

[0008] 본 발명에서는 실시간으로 전기 구동 이동체의 에너지 소모 상태와 잔여 전력량을 검출하여 다음의 충전 또는 급전설비까지 에너지를 효율적으로 운영하기 위한 기술을 제안한다.

[0009] 본 발명이 이루고자 하는 기술적 과제들은 이상에서 언급한 기술적 과제들로 제한되지 않으며, 언급되지 않은 또 다른 기술적 과제들은 본 발명의 기재로부터 당해 분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

과제 해결수단

[0010] 상기 목적을 달성하기 위한 본 발명의 일 실시예에 따른 전기 구동 이동체의 에너지 절약 제어시스템은 전기로 구동되는 이동체에 적용된다.

[0011] 이하에서 이동체는 충전식 전기자동차, 하이브리드 전기자동차, 온라인 전기자동차, 전동식 자전거, 전동식 모터사이클, 철도 차량, 선박, 비행기, 로켓 중에서 선택된 어느 하나일 수 있으며, 특히 충전식 전기자동차, 하이브리드 전기자동차, 온라인 전기자동차 등에 적용될 수 있다.

[0012] 또한 이하에서 언급되는 이동체의 구동을 위한 에너지는 전기에너지를 지칭하며, 공급되는 전력량으로 전기에너지의 크기가 결정된다.

[0013] 본 발명에서 상기 이동체는 이동체의 구동 또는 이동에 전력을 소모하는 에너지 소비장치와, 상기 소비장치에 에너지를 공급하는 에너지 공급장치를 포함한다.

[0014] 상기 에너지 소비장치는 이동체의 이동에 전력을 소모하는 제1 에너지 소비장치와, 상기 이동체의 이동을 제외한 이동체의 운용에 전력을 소모하는 제2 에너지 소비장치로 크게 구분할 수 있다.

[0015] 또한 상기 에너지 공급장치는 전기 에너지 저장부로서 역할을 하는 충전식 또는 비충전식 배터리, 집전장치, 커패시터, 슈퍼커패시터 중 어느 하나 이상일 수 있으며, 연료전지, 또는 전기 에너지 발전부로서 역할하는 전기 에너지 발전기 등을 포함할 수 있다.

[0016] 본 발명에서 상기 이동체의 에너지 절약을 위한 절약 제어 시스템은 이동체의 이동에 전력을 소모하는 제1 에너지 소비장치와, 상기 이동체의 이동을 제외한 이동체의 운용에 전력을 소모하는 제2 에너지 소비장치의 소비 전력량을 산출하는 소비 에너지 검출부와, 상기 이동체의 소비장치에 전력을 공급하는 에너지 공급장치의 공급 가능한 전력량을 산출하는 공급가능 에너지 검출부와, 상기 이동체의 위치 및 구동 상태에 관한 정보를 실시간 획득하고, 상기 이동체에 전력을 공급하는 급전장치의 위치 및 지리정보를 획득하여 저장하는 주행 정보 취득부와, 상기 소비 전력량, 공급 가능한 전력량, 및 이동체의 구동 상태에 관한 정보로부터 이동체의 이동가능한 거리를 추정하는 주행가능 거리 산출부와, 상기 이동체의 위치에 관한 정보, 급전장치의 위치 및 지리정보로부터 이동체와 최단거리 내에 있는 급전장치의 위치 및 지리정보를 검색하여 이동체와 급전장치 간의 거리를 추정하는 목적지 거리 산출부와, 상기 주행가능 거리와 목적지 거리를 비교하여 이동체의 절전 주행 상태여부를 판단하는 절전 상태판단부와, 및 상기 이동체의 절전 주행 상태로 판단된 경우, 상기 에너지 공급장치의 제2 에너지 소비장치에 대한 전력 공급을 중단하거나 조절하여 제어하는 절전모드 제어부를 포함한다.

[0017] 본 발명에서 상기 제1 에너지 소비장치는 이동체의 구동 모터이고, 상기 제2 에너지 소비장치는 이동체에 장착되는 조명수단, 온도조절 수단, 음향수단, 디스플레이 수단, 네비게이션, 전동식 개폐수단, 내장 컴퓨터 중 어느 하나 이상 일 수 있으나, 이에 반드시 제한되는 것은 아니며 이동체의 구동에 기능하면서 전기에너지를 소비하는 장치는 제1 에너지 소비장치로서, 또한 그 외의 기능을 수행하면서 전기에너지를 소비하는 장치는 제2 에너지 소비장치로 정의된다.

[0018] 상기 조명수단은 실내등, 외부조명등, 전조등 등의 발광수단이며, 상기 온도조절 수단은 에어컨과 같은 냉방수단, 또는 히터와 같은 난방수단일 수 있다.

[0019] 또한 상기 음향수단은 라디오, CD 플레이어와 같은 오디오가 될 수 있으며, 상기 디스플레이 수단은 이동체의 운전자에게 각종 데이터나 정보를 현시할 수 있는 표시부로서 LCD,PDP 등일 수 있다. 또한 전동식 개폐수단은 이동체의 문 또는 썬루프 등을 개폐하는 전자식 자동 수단일 수 있으며, 내장 컴퓨터는 이동체에 장착되어 전기에너지를 소비하는 컴퓨터를 의미한다.

[0020] 본 발명에서 상기 주행 정보 취득부는, 상기 이동체의 구동 상태에 관한 정보를 실시간 획득하여 저장하는 구동 상태정보 획득 모듈과, 상기 이동체의 위치 및 이동체에 전력을 공급하는 급전장치의 위치를 수신하거나 지리정보를 획득하여 저장하는 지리정보 모듈과, 및 상기 지리정보를 기반으로 특정 위치를 검색하는 검색 모듈을 포함하지만 이에 반드시 제한되는 것은 아니다.

[0021] 상기 이동체 또는 급전장치의 위치 정보나 지리정보는 GPS 위치수신장치 또는 네비게이션 시스템 등을 통하여 획득될 수 있다.

[0022] 특히 상기 검색 모듈은 주행 정보 취득부가 아닌 상기 목적지 거리 산출부에 포함되어 구성될 수도 있다.

[0023] 상기 주행 정보 취득부는 상기 주행가능 거리 산출부와 목적지 거리 산출부와 연동되어 취득되는 각종 정보 데이터와 저장된 지리정보 데이터를 공유할 수 있으며, 따라서 이를 활용하는 특정 위치의 검색모듈은 목적지 거리 산출부나 주행가능 거리 산출부에도 구성되어 소정의 위치를 검색할 수 있다.

[0024] 본 발명에서 상기 절전 상태판단부는, 상기 주행가능 거리가 상기 목적지 거리 또는 상기 목적지 거리보다 소정의 거리를 더한 거리보다 짧거나 같은 경우를 절전 주행 상태로 판단하는 것을 특징으로 한다.

[0025] 이 때 상기 소정의 거리는 특별히 제한되지 않으나, 상기 목적지 거리의 5% 내지 10%에 해당하는 거리일 수 있다.

[0026] 또한 상기 절전 상태판단부는, 상기 이동체의 절전 주행 상태로 판단된 경우, 이동체의 운전자 또는 상기 절전모드 제어부에 전달되는 알림 메시지 신호를 생성할 수 있다.

[0027] 이러한 상기 알림 메시지 신호 역시 상기 이동체의 디스플레이 수단을 통하여 이동체의 운전자가 인지할 수 있음은 물론이다.

[0028] 또한 상기 절전모드 제어부는 상기 알림 메시지 신호를 전달받은 후에 비로서 에너지 소비장치의 절전모드를 수행할 수 있도록 설정될 수 있다.

[0029] 본 발명에서 상기 절전모드 제어부는, 소비 전력량, 중요도, 주행 연관성 또는 주행 환경 조건에 따른 상기 제2 에너지 소비장치의 제어순서와 공급 전력량의 조절을 결정하는 제어순서 설정부, 이동체 운전자의 입력신호에 의해 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 수동 절전모드 제어부, 및 상기 설정된 제2 에너지 소비장치의 제어순서에 따라 자동으로 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 자동 절전모드 제어부를 포함할 수 있다.

[0030] 상기 목적을 달성하기 위한 본 발명의 전기 구동 이동체의 에너지 절약 제어방법은 이동체의 이동에 전력을 소모하는 제1 에너지 소비장치와 이동을 제외한 이동체의 운용에 전력을 소모하는 제2 에너지 소비장치의 소비 전력량을 산출하는 소비 에너지 검출부와, 공급 가능한 전력량을 산출하는 공급가능 에너지 검출부와, 이동체나 급전장치의 위치, 지리정보, 및 구동 상태의 정보를 취득하는 주행 정보 취득부와, 이동체의 이동가능한 거리를 추정하는 주행가능 거리 산출부와, 이동체와 급전장치 간의 거리를 추정하는 목적지 거리 산출부와, 이동체의 절전 주행 상태여부를 판단하는 절전 상태판단부와, 및 절전 주행 상태시 상기 제2 에너지 소비장치에 대한 전력 공급을 제어하는 절전모드 제어부가 전기로 구동되는 이동체에 설치되는 것을 전제로 한다.

[0031] 전기 구동 이동체의 에너지 절약 제어방법으로서, 상기 주행가능 거리 산출부에서 상기 제1 에너지 소비장치와 제2 에너지 소비장치의 소비 전력량과, 공급 가능한 전력량과, 이동체의 구동 상태에 관한 정보로부터 이동체의 이동가능한 거리를 추정하는 단계와, 상기 목적지 거리 산출부에서 상기 이동체의 위치에 관한 정보, 이동체에 전력을 공급하는 급전장치의 위치 및 지리정보로부터 이동체와 최단거리 내에 있는 급전장치의 위치 및 지리정보를 검색하고 이동체와 급전장치 간의 거리를 추정하는 단계와, 상기 절전 상태판단부에서 상기 주행가능 거리와 목적지 거리를 비교하여 이동체의 절전 주행 상태여부를 판단하는 단계와, 및 상기 이동체가 절전 주행 상태로 판단된 경우, 상기 절전모드 제어부가 제2 에너지 소비장치에 대한 전력 공급을 중단하거나 조절하는 단계를 포함한다.

[0032] 본 발명에서 상기 이동체의 절전 주행 상태여부를 판단하는 단계는, 상기 주행가능 거리가 상기 목적지 거리 또는 상기 목적지 거리에 목적지 거리의 5% 내지 10%에 해당하는 거리를 더한 거리보다 짧거나 같은 경우를 절전 주행 상태로 판단할 수 있다.

[0033] 또한 상기 이동체가 절전 주행 상태로 판단된 경우라면, 상기 절전 상태판단부가 이동체의 운전자 또는 상기 절전모드 제어부에 전달되는 알림 메시지 신호를 생성하는 단계를 추가로 더 포함할 수 있다.

[0034] 본 발명에서 상기 절전모드 제어부의 제2 에너지 소비장치에 대한 전력 공급의 중단 또는 조절 단계가, 소비 전력량, 중요도, 주행 연관성 또는 주행 환경 조건에 따라 기결정된 제2 에너지 소비장치의 제어순서와 공급 전력량을 기반으로 이루어지는 것을 특징으로 한다.

효 과

[0035] 본 발명에 의하면 전기자동차, 하이브리드 전기자동차와 온라인 전기자동차와 같이 전기 에너지로 구동되는 이동체의 충진 또는 급진 설비로의 이동과 에너지 소모의 제어를 신속하게 판단하고 절약할 수 있다.

[0036] 또한 본 발명의 에너지 절약 제어 시스템이나 제어방법에 의하면 일반적으로 주행이나 이동 경로상에 제한적으로만 존재할 수 밖에 없는 충전 또는 급전설비의 한계로 인해 전기 구동 이동체의 도로 운행 상황이 악화되거나 다른 운전자의 피해를 막을 수 있어, 전기자동차와 같은 전기 구동 이동체의 자율 주행과 주행 안정성을 확보할 수 있다.

[0037] 따라서 이를 통해 궁극적으로 전기 구동 이동체의 에너지 수급을 조절하고, 불필요한 에너지 낭비를 막아 국가 경제에 이바지하는 에너지 관리 제어시스템과 방법을 공급할 수 있다.

발명의 실시를 위한 구체적인 내용

[0038] 본 발명의 일 실시예에 따른 전기 구동 이동체의 에너지 절약 제어시스템 및 제어방법은 바람직하게는 전기에너지로 구동되는 차량(전기자동차, 하이브리드 전기자동차, 온라인 전기자동차 등)에 적용될 수 있으므로 이하 이동체는 차량으로 한정하도록 한다.

[0039] 전력의 추가 공급을 위하여 충전소나 급전도로와 같은 급전설비를 이용하는 전기구동 차량의 경우, 이런 시설의 설치장소는 고정되어 있기 때문에 차량이 보유한 전력량으로 다음 설비까지 주행가능한지의 여부를 판단하는 것은 지속적인 에너지의 공급과 차량이 보유한 에너지의 효율적 관리를 위하여 매우 중요한 일이다.

[0040] 본 발명의 일 실시예에서는, 충전소나 급전도로와 같은 급전설비가 이용하는 전기구동 차량의 효율적 에너지 관리를 위해, 현재 소모중인 전력량과 공급 가능한 전력량을 실시간으로 검출하여 차량 운전자에게 제공하고, 공급 가능한 전력량으로 주행할 수 있는 거리를 산출하고, 차량에서 가장 가까운 거리에 있는 급전설비와의 거리를 산출한 후, 두 거리를 비교하여, 필요한 경우 에너지 절약모드 주행이 가능하도록 제어하는 방법과 시스템을 제공한다.

[0041] 이하, 본 발명의 바람직한 실시예를 첨부한 도면을 참조하여 설명하기로 한다. 설명의 명확함과 간결함을 위하여 주지되어 있거나 배경기술과 중복되는 기술 설명은 생략하거나 압축하기로 한다.

[0042] 도 1은 본 발명의 일 실시예에 따른 전기 구동 차량의 에너지 절약 제어시스템의 구성 및 처리관계를 나타내는 블록도이다.

[0043] 전기 구동 차량의 에너지 절약 제어시스템의 구성은 차량의 에너지 소비상태를 검출하는 소모 에너지 검출부(35), 추가로 공급할 수 있는 에너지를 검출하는 공급가능 에너지 검출부(40); 상기 차량의 위치 및 구동 상태에 관한 정보를 실시간 획득하고, 상기 차량에 전력을 공급하는 급전장치의 위치 및 지리정보를 획득하여 저장하는 주행 정보 취득부(45); 현재의 에너지 소모 패턴으로 주행할 수 있는 거리를 산출하는 주행가능 거리 산출부(50); 지리정보를 이용하여 현재 차량과 차량에 에너지를 공급하는 에너지 공급장치와의 거리를 산출하는 목적지 거리 산출부(55); 산출된 주행가능 거리와 목적지 거리를 비교하여 에너지 절약모드의 주행이 필요한지의 여부를 판별하는 절진 상태 판단부(60); 에너지 절약모드의 주행이 필요한 경우 필요한 정보의 제공과 제어를 수행하는 절전모드 제어부(66)를 포함한다.

[0044] 먼저, 상기 소모 에너지 검출부(35)와 공급가능 에너지 검출부(40)와, 주행 정보 취득부(45)는 차량에 장착된 각종 에너지 소비장치 및 에너지 공급장치와 위치수신장치, 또는 외부로부터 산출의 근거가 되는 다양한 정보들을 획득한다.

[0045] 즉, 상기 소모 에너지 검출부(35)는 제2 에너지 소비장치(25)부터 에너지 소모 정보 데이터 또는 부하 정보 데이터를 검출한다. 전기 에너지를 절전하는 것은 기본적으로 차량을 구동시키는 제1 에너지 소비장치는 제외되어야 하는 것이므로, 제2 에너지 소비장치(25)에 대한 부하 정보만을 취득하는 것이다.

[0046] 소모에너지 검출부(35)는 차량의 소비장치 중에서 차량의 이동과 무관한 장치가 사용하고 있는 전력량을 실시간

으로 탐지하여 차량이 소모중인 전력($P_{\cdots}$ [kW])을 계산한다.

[0047] 차량의 제2 소비장치(25)에는 에어컨/히터, 라디오, CD 플레이어, 네비게이션, 실내등, 전조등, 구동모터 등이 있다. 이중 차량의 이동과 무관한 소비장치는 에어컨/히터, 라디오, CD 플레이어, 네비게이션, 실내등, 전조등 이며, 차량의 이동과 직접적으로 관련이 있는 소비장치는 구동모터이다.

[0048] 각 소비장치의 소모 전력의 산출은 각 장치의 입력전압과 전류 값에 의해 계산되며 전압과 전류의 검출은 센서와 장치의 통신수단에 의해 얻어진다.

[0049] 차량 이동에 필요한 소비장치 이외의 소비장치가 m개 있을 경우 각 소비장치의 소비전력을 PL1, PL2, ..., PL3이라 할 때, 총 소비전력 P_{Load} [kW] = PL1 + PL2 + ... + PLm가 된다.

[0050] 또한 공급가능 에너지 검출부(40)는 에너지 공급장치(30)으로부터 전원 정보 데이터 등을 검출한다.

[0051] 즉 공급 가능 전력 검출부(40)는 차량의 각종 전원 장치가 공급하고 있는 전력량을 실시간으로 탐지하여 차량의 공급 가능한 전력량을 산출한다. 각 전원 장치에는 출력전압과 전류 값을 감지하는 센서 혹은 통신장치가 구비되어 공급 가능 전력 검출부(40)로 전압과 전류 값이 전달된다.

[0052] 전기구동 차량에 구비되는 전원 장치에는 배터리, 집전장치, 슈퍼커패시터 등이 있다. 배터리의 경우, SOC(State of Charge)의 값과 배터리의 최대 공급가능 전력량을 기반으로 배터리의 공급가능 전력량 (PS1)이 산출된다.

[0053] 전기구동 차량의 일 예인 온라인 전기자동차의 경우 급전라인으로부터 공급되는 전력을 집진하는 집진장치로부터 1차적인 전력이 공급된다. 집전장치로부터의 공급가능 전력량(PS2)은 차량이 급전라인 상에 있는 경우에는 집전장치의 출력전압과 출력전류 값으로 산출되고 급전라인이 상에 있지 않은 경우에는 집전장치의 공급전력량은 0이다.

[0054] 기타 다른 종류의 공급장치도 장치의 특성에 따라 공급가능 전력량을 측정하는 방법이 다소 차이가 있을 수 있으나 전력량의 계산에는 대부분 전류/전압값이 이용된다.

[0055] 만일 차량의 공급장치의 종류가 n개가 있을 경우 각 장치로부터의 공급가능 전력량을 PS1, PS2, ..., PSn이라 하면 총 공급 가능 전력량 P_{Source} [kWh] = PS1 + PS2 + ... + PSn이 된다.

[0056] 또한 주행 정보 취득부(45)는 제1 에너지 소비장치(10)와, 외부 GPS 송신장치(15)나 지리정보 관제센터(20)로부터 차량의 구동 상태 정보나, 현재 차량의 GPS 위치정보, 네비게이션 시스템에 의한 지리정보 데이터, 주행 도로의 위치 정보나 지리정보, 거리 정보 등을 획득한다.

[0057] 상기 주행 정보 취득부(45)는 취득된 데이터 정보에 따라 구동 상태정보 획득모듈(450), 지리정보 모듈(451), 및 검색모듈(452)로 나뉠 수 있다.

[0058] 도 1에 따른 본 발명의 일 실시예에서 주행 가능 거리 산출부(50)은 상기 구동 상태정보 획득모듈(450)로부터 얻어지는 차량의 구동 상태 정보와, 차량의 총 소모 전력량(P_{load})과 공급 가능 총 전력량(P_{source})을 바탕으로 주행 가능 거리를 산출한다.

[0059] 주행 가능 거리 산출부는 먼저, 주행정보를 제공받는다. 주행정보는 모터의 구동상태를 말하며, 모터의 구동토크 τ [kgm], 회전속도 ω [rpm], 구동효율 η를 포함한다.

[0060] 모터의 소모 전력이 PMotor [kW]라 할 때, 소모 전력 PMotor [kW]의 계산은 다음과 같은 예시로 수행될 수 있다.

[0061] 모터 소모 전력 계산 예: 모터의 제동 마력(BHP: Break Horse Power)은 $(2 \times \pi \times \tau \times \omega \times \eta)/(75 \times 60)$이며, 모터의 소모 전력 PMotor [kW]은 대략 $(2 \times \pi \times \tau \times \omega \times \eta)/(75 \times 60)$에 0.7457을 곱한 값이 된다.

[0062] 모터의 주행정보는 MCU(Motor Control Unit)으로부터 CAN 통신과 같은 차량 통신 방식을 이용하여 수집할 수 있다.

[0063] 주행 가능 거리 산출부(50)는 산출된 차량의 소모 전력 PLoad [kW]와 주행상태 PMotor [kW], 공급 가능 전력량 PSource [kWh]로부터 먼저 다음과 같이 주행 가능 시간 T를 산출한다.

[0064] T [h] = PSource [kWh] / (PLoad [kW] + PMotor [kW]).

[0065] 주행 가능 시간 T로부터 다음과 같이 주행 가능 거리 S [km]를 산출한다.

[0066] S [km] = T x V, V는 차량의 속도[km/h].

[0067] 도 1의 실시예에 따른 목적지 거리 산출부(55)는 지리정보 모듈(451) 및 검색모듈(452)에 의한 지리정보나 위치정보를 바탕으로 차량의 현 위치에서 주행경로 상에 있는 가장 가까운 급전설비까지의 최단거리를 검색하고 산출한다.

[0068] 다른 실시예로서 급전설비 및 도로 정보는 지리정보 관제센터(20) 등에 지리정보시스템으로 구축되어 있을 수 있고 차량에서 무선통신으로 원격에 있는 지리정보시스템으로 질의를 보낸다. 지리정보시스템은 주행경로를 탐색하면서 수신한 차량의 위치와 가장 가까운 급전설비를 찾은 다음 급전설비의 시작 위치와 차량의 위치 사이의 거리 D를 산출한다. 원격의 지리정보시스템은 산출한 결과를 차량에 무선통신으로 보내고 목적지 거리 산출부(4)가 이를 수신하여 상태 판단부(5)로 보낼 수도 있다.

[0069] 상기 상태 판단부(60)는 주행 가능 거리 산출부(50)와 목적지 거리 산출부(55)로부터 각각 주행가능 거리 S와 다음 급전설비까지의 거리 D를 수신하여 두 거리 사이의 관계를 판단한다.

[0070] 주행가능 거리가 급전설비까지의 거리보다 작은 경우 즉, S < D인 경우, 운전자에게 이를 알리고 절약모드로 주행하기 위하여 절전모드 제어부(65)에 알림 메시지 신호를 보낼 수도 있다.

[0071] 이 때 운전자에게 미리 준비를 할 수 있도록 주행가능 거리가 급전설비까지의 거리를 단순비교하지 않고, 주행가능 거리가 급전설비까지의 거리보다 큰 경우라도, 목적지까지의 거리 D에 덧붙여 D 거리의 5% 내지 10%의 거리만큼 여유거리가 있는 경우에도 미리 경고 메시지 신호를 생성 및 전달하고 절전모드 제어부(65)에 신호를 보낼 수도 있다.

[0072] 상기 절전모드 알림 메시지 신호는 운전자에게 디스플레이수단과 같은 표시부를 통하여 인식하도록 할 수 있다.

[0073] 한편 절전모드 제어부(65)는 상태 판단부(60)로부터 제어신호를 수신한 경우, 차량이 에너지 절약 모드로 수행할 수 있도록 차량 소비장치의 상태를 조절하기 위한 준비를 한다. 여기서의 소비장치는 차량의 이동과 직접적인 관련이 없는 제 2 소비장치를 말한다.

[0074] 상기 절전모드 제어부(65)는 소비 전력량, 중요도, 주행 연관성 또는 주행 환경 조건에 따른 상기 제2 에너지 소비장치의 제어순서와 공급 전력량의 조절을 결정하는 제어순서 설정부(650)와, 이동체 운전자의 입력신호에 의해 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 수동 절전모드 제어부(651)와, 상기 설정된 제2 에너지 소비장치의 제어순서에 따라 자동으로 제2 에너지 소비장치에 대한 전력 공급을 차단하거나 전력량을 조절하는 자동 절전모드 제어부(652)로 구성된다.

[0075] 소비장치의 상태조절 목적은 주행에 불필요한 소비장치의 전원공급을 차단하거나 전력 공급량을 줄이기 위한 것이다. 차단 및 조절을 위해, 상기 제어순서 설정부(650)에서 소비장치의 전력소모량과 주행에 대한 필요성에 따라 소비장치를 중요도가 낮은 순으로 정렬하거나 설정할 수 있다.

[0076] 그런 다음 운전자 화면에 정보를 제공하고 운전자가 각각을 확인한 후 전원공급 차단 혹은 조절을 개시할 수 있도록 한다.

[0077] 수동 절전모드 제어부(651)에서는 운전자의 입력을 받아 제어를 수행하며, 자동 절전모드 제어부(652)에서는 자동모드에서 운전자의 입력신호 없이 정렬 순서에 따라 필요한 만큼 전원을 자동적으로 차단한다.

[0078] 중요도에 따른 소비장치의 정렬은 중요성이 낮은 장치가 앞으로 오며 중요성이 높은 장치는 뒤에 온다. 중요도의 결정은 주행과의 관련성과 에너지 소모량의 크기, 주행 환경 등이 주요 결정요소(factor)가 된다.

[0079] 사용 중인 소비장치에 전조등, 실내등, 라디오, CD 플레이어, 에어컨이 있을 경우, 정렬순서의 일 예로서, 주간 주행 시, 에어컨 - 전조등 - 실내등 - CD 플레이어 - 라디오 순으로 설정될 수 있다.

[0080] 도 2는 본 발명의 일 실시예에 따른 전기 구동 이동체의 에너지 절약 제어방법을 순차로 나타내는 흐름도이다.

[0081] 먼저 S10 단계에서 소모 에너지 검출부가 차량의 이동과 무관한 차량의 에너지 소비장치로부터 정보를 수신받아 차량의 에너지 소비상태를 검출한다.

[0082] 다음으로 S11 단계에서 공급가능 에너지 검출부가 차량에 에너지를 공급하는 장치로부터 정보를 입력받아 추가로 공급할 수 있는 공급 가능 전력량을 산출한다.

[0083] S12 단계에서는 주행 정보 취득부로부터 차량을 구동시키는 구동 장치의 구동 상태 정보와 차량의 위치 및 급전 설비 또는 장치의 위치, 지리정보를 획득한다.

[0084] 다음으로 S13 단계에서 주행가능 거리 산출부는 차량 구동에 소비되는 에너지 소비장치가 소모하고 있는 에너지와 소모 에너지 검출부의 소비 에너지 정보를 입력받아서 현재의 에너지 소모 패턴으로 주행할 수 있는 거리를 산출한다.

[0085] 또한 목적지 거리 산출부는 지리정보를 이용하여 현재 차량과 차량의 외부장치로서 차량에 추가로 에너지를 공급하는 장치와의 거리를 산출한다. 차량의 외부장치로서 차량에 에너지를 공급하는 장치의 일 예는, 전기구동 차량인 경우 충전소나 온라인 전기자동차용 급전라인이 될 수 있다.

[0086] S14 단계에서는 절전 상태 판단부가 산출된 주행가능 거리와 목적지 거리를 비교하여 에너지 절약모드의 주행이 필요한지의 여부를 판별한다.

[0087] 즉, S15 단계에서와 같이 주행가능 거리가 목적지 거리와 같거나 짧은 경우인지 혹은 주행가능 거리가 목적지 거리에 목적지 거리의 소정의 비율에 해당하는 거리만큼 더한 거리보다 짧거나 같은 경우인지 문의한다.

[0088] 상기와 같은 주행 가능 거리가 충분한 임계범위 내인지 판단하여 만일 임계 범위 내에 포함되면 S16 과 같이 비절전 모드로 주행할 수 있다.

[0089] 다시 말하여, 주행 가능 거리가 목적지 거리 또는 목적지 거리에 목적지 거리의 소정의 비율에 해당하는 거리만큼 더한 거리 이상일 경우가 임계 범위 또는 한계 범위 내에 포함되는 것이므로 이에 해당하는 경우는 비절전 모드인 것이다.

[0090] 만일 그렇지 않고 S17 단계에서와 같이 주행 가능 정도가 임계범위에 포함되지 않는다면, 즉 주행 가능 거리가 목적지 거리 또는 목적지 거리에 목적지 거리의 소정의 비율에 해당하는 거리만큼 더한 거리보다 짧거나 같다면 절전모드로 진행될 수 있다.

[0091] 상기 절전모드로 진행되는 경우에는 알림 메시지 신호를 생성하여 운전자 또는 절전모드 제어부에 전달하는 과정이 추가될 수도 있음은 상술한 바와 같다.

[0092] 만일 절전 주행 모드로 판정된다면 S18 단계에서 절약모드 제어부는 에너지 절약 모드 설정을 수행하는데, 구체적으로 제어모드를 수행하기 위한 에너지 소비장치의 절전 순서나 절전의 정도, 전력량의 차단 또는 소정의 수준까지 전력량을 줄이는 등에 대한 정보를 생성하고 장치에 대한 제어를 수행한다.

[0093] 수동 절전모드 제어부에서는 운전자에게 부하의 정도와 주행시 필요성 여부에 따라 소비장치를 정렬하여 화면에 표시해주고 운전자가 각 장치의 전원을 끄거나 줄일 수 있는 메뉴를 제공한다. 자동 절전모드 제어부에서는 운전자의 입력없이 자동 절전 모드 제어부가 직접 장치의 전원을 차단하거나 소정의 수준으로 줄여서 필요한 조치를 취한다(S19).

[0094] 상기와 같이 필요에 따라 자동 또는 수동 절전모드 제어부에 의해 에너지 소비장치가 제어되고, 제어되는 순서나 제어 정도를 미리 설정할 수 있어 운전자의 절전 선택의 폭이 크고 차량의 에너지 수준에 따라 다양하게 적용할 수 있는 에너지 절전 관리가 이루어질 수 있는 장점이 있다.

[0095] 이상 본 발명의 구체적 실시형태와 관련하여 본 발명을 설명하였으나 이는 예시에 불과하며 본 발명은 이에 제한되지 않는다. 당업자는 본 발명의 범위를 벗어나지 않고 설명된 실시형태를 변경 또는 변형할 수 있으며, 이러한 변경 또는 변형도 본 발명의 범위에 속한다. 또한, 본 명세서에서 설명한 각 구성요소의 물질은 당업자가 공지된 다양한 물질로부터 용이하게 선택하여 대체할 수 있다. 또한 당업자는 본 명세서에서 설명된 구성요소 중 일부를 성능의 열화 없이 생략하거나 성능을 개선하기 위해 구성요소를 추가할 수 있다. 뿐만 아니라, 당업자는 공정 환경이나 장비에 따라 본 명세서에서 설명한 방법 단계의 순서를 변경할 수도 있다. 따라서 본 발명의 범위는 설명된 실시형태가 아니라 특허청구범위 및 그 균등물에 의해 결정되어야 한다.

도면의 간단한 설명

[0096] 도 1은 본 발명의 일 실시예에 따른 전기 구동 이동체의 에너지 절약 제어시스템의 구성 및 처리관계를 나타내는 블록도.

[0097] 도 2는 본 발명의 일 실시예에 따른 전기 구동 이동체의 에너지 절약 제어방법을 순차로 나타내는 흐름도.

[0098] {도면의 주요부호에 대한 설명}

[0099] 10 : 제1 에너지 소비장치 15 : GPS 송신장치

[0100] 20 : 지리정보 관제센터 25 : 제2 에너지 소비장치

[0101] 30 : 에너지 공급장치 35 : 소모 에너지 검출부

[0102] 40 : 공급가능 에너지 검출부 45 : 주행 정보 취득부

[0103] 450 : 구동 상태정보 획득 모듈 451 : 지리정보 모듈

[0104] 452 : 검색 모듈

[0105] 50 : 주행가능 거리 산출부 55 : 목적지 거리 산출부

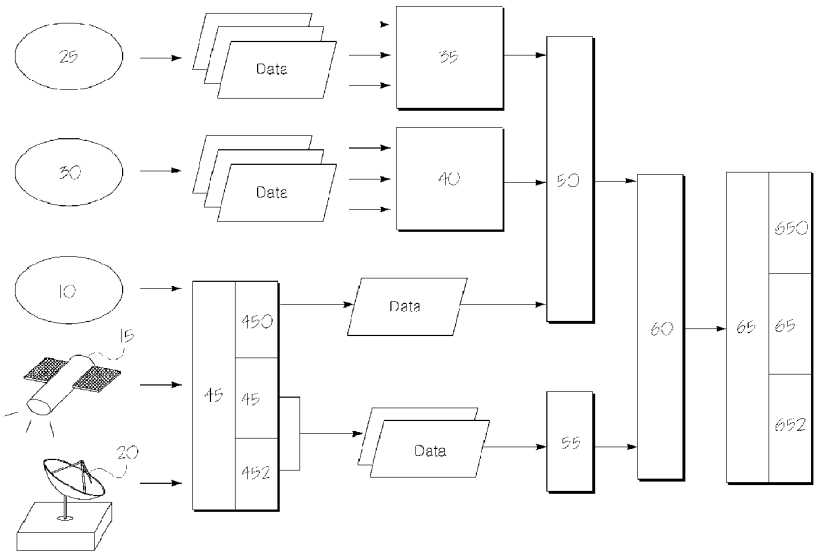
[0106] 60 : 절전 상태판단부 65 : 절전모드 제어부

[0107] 650 : 제어순서 설정부 651 : 수동 절전모드 제어부

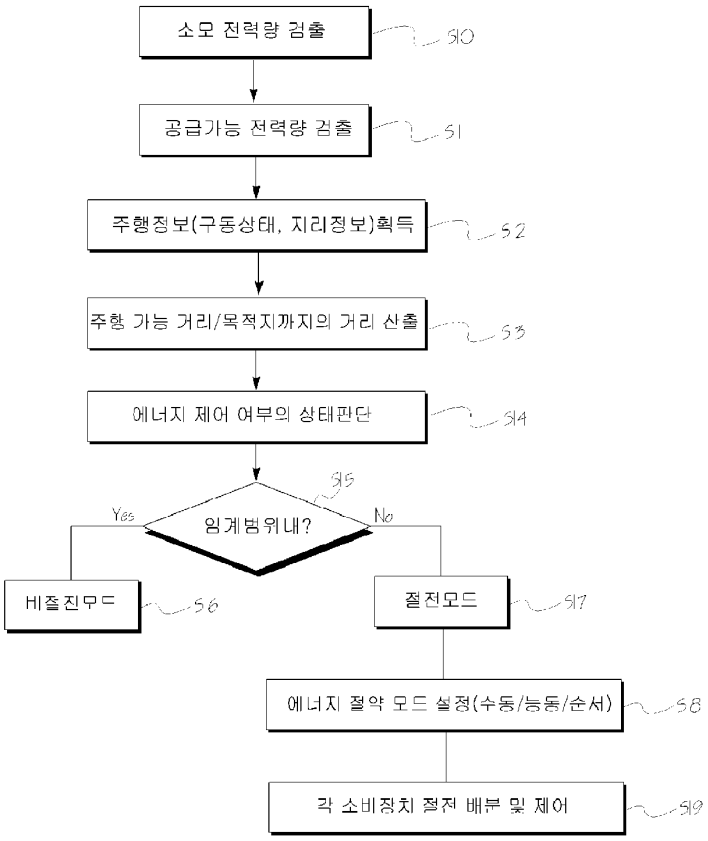
[0108] 652 : 자동 절전모드 제어부

도면

도면1



도면2


소모 전력량 검출
S10
공급가능 전력량 검출
S1
주행정보(구동상태, 지리정보)획득
S2
주행 가능 거리/목적지까지의 거리 산출
S3
에너지 제어 여부의 상태판단
S14
S15
임계범위내?
Yes
No
비절전모드
S6
절전모드
S17
에너지 절약 모드 설정(수동/능동/순서)
S8
각 소비장치 절전 배분 및 제어
S19

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Record 9/25 TW200836452A Appropriate battery exchange

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Application Date: 2007-11-29
Abstract (English):

In a battery exchange system for facilitating exchange at appropriate intervals of a chargeable battery with another fully charged chargeable battery for charging, a user device having characteristic identification information reads a serial number from a battery when the battery is installed and transmits to a control device correspondence information in which the identification information and the serial number have been placed in correspondence with each other. A charging device reads the serial number from a battery when charging of the battery has been completed and transmits the serial number to the control device. The control device calculates a scheduled charging time of the battery having the serial number that has been transmitted from the charging device based on the time of reception of the correspondence information that was transmitted from user device and, before the, calculated scheduled charging time, carries out notification prompting battery exchange.
Abstract - DWPI:

Abstract - DWPI Novelty:
A serial number, transmitted from a charger (102), and a plan charging time are matched and stored as charging information. A notification process is performed by displaying identification information corresponding to the stored charging information to promote battery exchange.

Abstract - DWPI Detailed Description:

INDEPENDENT CLAIMS are also included for: a user apparatus;a charging device;a management apparatus; anda battery-exchanging method.

Abstract - DWPI Use:

Battery exchange system used with portable terminals used by elderly people.

Abstract - DWPI Advantage:

Facilitates timely charging of battery, and allows easy replacement of battery being charged with already charged batteries.

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發明專利說明書

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一、發明名稱：（中文/英文）

適當的電池交換

APPROPRIATE BATTERY EXCHANGE

二、申 請 人：（共 1 人）

姓名或名稱：（中文/英文）

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四、聲明事項：

☐ 主張專利法第二十二條第二項☐第一款或☐第二款規定之事實，其事實發生日期為：　年　月　日。

☑ 申請前已向下列國家（地區）申請專利：

【格式請依：受理國家（地區）、申請日、申請案號　順序註記】

☑ 有主張專利法第二十七條第一項國際優先權：

日本　　2006 年 11 月 30 日　　特願 2006-323928

☐ 無主張專利法第二十七條第一項國際優先權：

☐ 主張專利法第二十九條第一項國內優先權：

【格式請依：申請日、申請案號　順序註記】

☐ 主張專利法第三十條生物材料：

☐ 須寄存生物材料者：

國內生物材料　【格式請依：寄存機構、日期、號碼　順序註記】

國外生物材料　【格式請依：寄存國家、機構、日期、號碼　順序註記】

☐ 不須寄存生物材料者：

所屬技術領域中具有通常知識者易於獲得時，不須寄存。

國　籍：(中文/英文)

1.～4.日本/Japan

5.中華民國,台灣省/Taiwan, Republic of China

四、聲明事項：

☐ 主張專利法第二十二條第二項☐第一款或☐第二款規定之事實，其事實發生日期為：　年　月　日。

☑ 申請前已向下列國家（地區）申請專利：

【格式請依：受理國家（地區）、申請日、申請案號　順序註記】

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日本　　2006 年 11 月 30 日　　特願 2006-323928

☐ 無主張專利法第二十七條第一項國際優先權：

☐ 主張專利法第二十九條第一項國內優先權：

【格式請依：申請日、申請案號　順序註記】

☐ 主張專利法第三十條生物材料：

☐ 須寄存生物材料者：

國內生物材料　【格式請依：寄存機構、日期、號碼　順序註記】

國外生物材料　【格式請依：寄存國家、機構、日期、號碼　順序註記】

☐ 不須寄存生物材料者：

所屬技術領域中具有通常知識者易於獲得時，不須寄存。

九、發明說明：

本申請案基於並主張2006年11月30日申請之日本專利申請案第2006-323928號之優先權權益，在此將其全文併入參照。

【發明所屬之技術領域】

本發明係關於一種用以交換電池之電池交換系統、使用者裝置、充電裝置、控制裝置、方法、及記錄媒體，並更特別地，係關於一種用以交換所需充電之電池的電池交換系統、使用者裝置、充電裝置、控制裝置、方法、及記錄媒體。

【先前技術】

近年來，日本正見證其隨著需要照顧的許多年長居民與人民的老化人口逐年增加。許多此等個體(此後稱爲年長居民)係單獨生活，以及適合用以查明個體是否需要照顧之通訊裝置因而至關重要。

私人住所內之固定電話可提供作爲一般通訊裝置，但即使是在私人住所中，若年長居民他或她在諸如遠離固定電話的浴室之場所變得無法移動而要打一通電話時，仍具有困難。因此，年長居民通常攜有可攜式終端機，使得他們能夠保持聯繫。

然而，對於諸如可攜式終端機之電子設備，係使用電池作爲電源供應裝置，並且藉由對電池充電而可再使用的可充電電池成爲主流。

該等可充電電池必須在取決於使用狀態的規則間隔或

不規則間隔下充電。許多可攜式終端機設有顯示可充電電池的剩餘百分比的能力，致使該可攜式終端機的持有人將察覺可攜式終端機的電池必需充電之時間間隔。

關於該可攜式終端機上顯示的可充電電池之電池剩餘百分比及判定必須充電之可攜式終端機的電池，使用特殊充電設備以對電池充電。

近年來，即使在諸如旅行期間無法利用充電設備，允許可攜式終端機電池之充電的系統已被考量。更特別地，已考量多個系統，其中具有用以對可攜式終端機充電的充電設備之充電站係於指定場所建立，並且可攜式終端機可在該等充電站上被充電。

然而，由於關於該等充電站之空間與場所資訊的缺乏，故該問題讓使用者在使用上述充電站時，會遭遇許多困難。

然而，JP-A-2003-348757A 中已揭露一種方法，其中可攜式終端機中的剩餘功率係被監控，當該剩餘功率降至指定門檻值時，通知控制伺服器，並接著於控制伺服器中儲備適當的充電站。

然而，此一方法具有下列缺失：即使年長居民設置可攜式終端機，其考量的技術讓年長居民無法習慣使用電子設備，並因而會讓電池在沒有對可充電電池充電下損耗。

回應上述技術，可考量一種方法，其中使用 JP-2003-348757A 所揭露之方法，該控制伺服器監控該可攜式終端機之剩餘電池功率，並當該剩餘電池功率降至指定

門檻值以下時，派遣諸如協助者等人至擁有可攜式終端機之年長居民的住所，以對可攜式終端機之可充電電池充電。

然而，上述方法具有下列缺失：監控剩餘電池功率的能力必須設於該可攜式終端機中才行。該方法更具有下列問題：必須基於可攜式終端機之使用狀態計算剩餘電池功率，因而增加可攜式終端機在作爲一裝置時之大小。另一問題會增加處理可攜式終端機之負擔。

【發明內容】

本發明之目的，係提供一種電池交換系統、使用者裝置、充電裝置、控制裝置、一種方法、及以在適當間隔充電之另一充電電池有助於可充電電池之交換的記錄媒體。

爲達成上述目的，依照本發明之電池交換系統包含：屬於使用者的使用者裝置，該使用者裝置係自具有特徵序號之電池供應電力；充電裝置，用以對該電池充電；及控制裝置，用以控制該電池充電的狀態；其中，

該使用者裝置具有特徵識別資訊，當安裝該電池時，自該電池讀取該序號，並且彼此互相對應配置該識別資訊與該序號及將該等資訊作爲對應資訊傳送至該控制裝置；

當已完成該電池充電時，該充電裝置從該電池讀取該序號並傳送此序號至該控制裝置；及

該控制裝置接收並儲存已從該使用者裝置傳送之對應資訊，接收已從該充電裝置傳送之序號，計算預定充電時間，該預定充電時間係基於已從該使用者裝置傳送之對應資訊的接收時間，而預定下一個具有該序號之電池，儲存

從該充電裝置傳送之序號並將彼此互相對應之預定充電時間作爲充電資訊，且在已儲存該預定充電時間前，顯示依照該電池之序號而儲存之該識別資訊，以實行提示電池交換的通知。

在本發明之上述架構中，使用者裝置係從具有特徵序號之電池供應電力並具有特徵識別資訊：當安裝該電池時，從該電池讀取該序號，該識別資訊及該序號係互相對應配置，並作爲對應資訊傳送至控制裝置；充電裝置係實行電池的充電：當完成該電池的充電並將該序號傳送至該控制裝置時，從該電池讀取該序號；及控制裝置係控制電池充電的狀態：接收及儲存已從該使用者裝置傳送之該對應資訊，接收已從該充電裝置傳送之該序號，基於自該使用者裝置傳送之對應資訊的接收時間，對具有該序號之電池計算預定充電時間，從該充電裝置傳送之該序號及該預定充電時間係彼此互相對應儲存爲充電資訊，及在儲存預定充電時間前，實行提示電池交換的通知。

在此方式下，電池的預定充電時間基於使用者裝置中之電池的安裝時間而計算，並接著在該預定充電時間前實行通知，因此可輕易地防止使用者裝置之電池中斷。

因此，電池可在適當時間輕易地與另一充電電池交換充電。

本發明之上述及其它目的、特徵、及優點在參照用以說明本發明之範例的隨附圖式，對於下述說明將變得顯而易見。

【實施方式】

第一實施例

參照第 1 圖，其顯示電池交換系統之第一實施例，該電池交換系統係由終端機 101、充電器 102、及控制裝置 103 所構成。該終端機 101 爲諸如可攜式終端機(屬於利用此系統之使用者)之使用者裝置。充電器 102 爲用以對安裝在終端機 101 中之可充電電池充電之充電裝置。控制裝置 103 控制安裝於終端機 101 中之該可充電電池的充電狀態，並配置以致能終端機 101 與充電器 102 之間資訊的傳送與接收。

此外，終端機 101 備有：電池 111、序號讀取器 112、記憶體 113、識別資訊讀取器 114、及傳送器 115。電池 111 爲用以對終端機 101 供應電力以操作終端機 101 之可充電電池，電池 111 可進一步被卸下。

第 1 圖中所示之電池 111 係顯示於第 2 圖中，電池 111 係由電力供應單元 116 及記憶體單元 117 構成。電力供應單元 116 對終端機 101 供應電力，以使終端機運作。記憶體單元 117 儲存用以識別電池 111 之特徵序號。

序號讀取器 112 讀取預先儲存於電池 111 中之序號。記憶體 113 爲記憶單元，用以儲存識別終端機 101 之特徵識別資訊。識別資訊讀取器 114 讀取儲存於記憶體 113 中之識別資訊。傳送器 115 傳送已被序號讀取器 112 讀取之序號及已被識別資訊讀取器 114 讀取之識別資訊至控制裝置 103。該傳送意指可使用諸如 PHS 之無線電傳送。

此外，充電器 102 係備有充電單元 121、序號讀取器 122、及傳送器 123。充電單元 121 對已從終端機 101 卸下之電池 111 進行充電。序號讀取器 122 讀取已被充電單元 121 充電之電池 111 的序號。傳送器 123 傳送被序號讀取器 122 讀取之序號至控制裝置 103。

控制裝置 103 更備有電池資訊資料庫 131 及終端機資訊資料庫 132。電池資訊資料庫 131 爲用以儲存電池 111 之資訊的第一資料庫。此構成之結構將於稍後做更詳細說明。終端機資訊資料庫 132 爲用以儲存終端機 101 之資訊的第二資料庫。此構成之結構也將於下述做更詳細說明。

接著參照第 3 圖說明關於上述架構之電池交換系統中交換電池之方法。

首先，在步驟 1 中，電池 111 之充電係於充電器 102 之充電單元 121 中實行。此時，電池 111 係安裝在充電單元 121 中並正實行充電。

當已於充電器 102 之充電單元 121 中完成電池 111 之充電時，在步驟 2 中，藉由序號讀取器 122 從安裝在充電單元 121 中之電池 111 讀取序號。從電池 111 讀取之序號爲當電池 111 一開始被製造時之可識別電池 111 之特徵號碼，且預先儲存於記憶體單元 117 中。

在步驟 3 中，當已藉由序號讀取器 122 從安裝於充電單元 121 中之電池 111 讀取序號時，已被讀取之序號係從傳送器 123 傳送至控制裝置 103。

在步驟 4 中，當接收從傳送器 123 傳送之序號至控制

裝置 103 中時，已接收之序號係儲存於電池資訊資料庫 132(在步驟 5 中)。

如第 4 圖中所示，充電資訊(其中該序號及下一個預定充電時間係彼此互相對應配置)係儲存於第 1 圖中所示之電池資訊資料庫 131 中。爲了便於說明起見，該預定充電時間將以預定充電時間來說明。該序號爲從充電器 102 傳送及接收於控制裝置 103 中的序號。此外，該預定充電日期表示電池變得已快要耗盡且需要充電之日期(亦即，電池應被充電的日期，或者電池應被已完成充電之電池交換的日期)，及此預定充電日期將於下述中做更詳細說明。在初始充電完成的階段，只有儲存該序號。

在步驟 6 中，當電池 111 接著安裝於終端機 101 中時，藉由序號讀取器 112 從電池 111 讀取該序號(在步驟 7 中)。在此同時，預先儲存於記憶體 113 中之識別資訊係藉由識別資訊讀取器 114 讀取(在步驟 8 中)。預先儲存於記憶體 113 中之識別資訊可爲可識別終端機 101 之特徵資訊，或者可爲終端機 101 之電話號碼。

已被序號讀取器 112 從電池 111 讀取之序號及已被識別資訊讀取器 114 從記憶體 113 讀取之識別資訊係接著彼此互相對應配置，並從傳送器 115 傳送至控制裝置 103，作爲對應資訊(在步驟 9 中)。

當接收已從終端機 101 之傳送器 115 傳送的該對應資訊至控制裝置 103 中時(在步驟 10 中)，該已接收之對應資訊係儲存於終端機資訊資料庫 132 中(在步驟 11 中)。

如第 5 圖中所示，該序號及識別資訊係彼此互相對應配置，並儲存於第 1 圖中所示之終端機資訊資料庫 132 中。該等資訊構成已從終端機 101 傳送之對應資訊。換言之，儲存的資訊表示哪個電池 111 已被安裝在哪個終端機 101 中。例如，儲存序號爲"00000001"之電池 111 係安裝在識別資訊爲"090-1234-5678"的終端機 101 中的資訊。此外，序號爲"11111111"之電池 111 安裝在識別資訊爲"080-2222-3333"之終端機 101 中的資訊也被儲存於終端機 101 中。更甚者，序號爲"55555555"之電池 111 安裝在識別資訊爲"090-7777-8888"之終端機 101 中的資訊也被儲存於終端機 101 中。

在步驟 10 中，當已於控制裝置 103 中接收已從終端機 101 之傳送器 115 所傳送的該對應資訊時，查詢控制裝置 103 中之電池資訊資料庫 131。更特別地，對於在控制裝置 103 中所接收之對應資訊中所包含之該序號是否已儲存於電池資訊資料庫 131 中做成判定。

若在控制裝置 103 中所接收之該對應資訊中所包含之該序號被判定爲已儲存於電池資訊資料庫 131 中，則實行步驟 11 之程序。接著從電池資訊資料庫 131 刪除表示該序號及已對應此序號而配置之預定充電日期的充電資訊。

另一方面，若在控制裝置 103 中所接收之該對應資訊中所包含之該序號被判定爲沒有儲存於電池資訊資料庫 131 中，則識別安裝於終端機 101 中之電池 111 沒有完成充電，並且藉由控制裝置 103 顯示此狀態。此時，該表示資

訊也可以是其中安裝具有此序號之電池 111 的終端機 101 之識別資訊。

或者，在步驟 11 中，若對應資訊(具有包含於控制裝置 103 中所接收之該對應資訊中的識別資訊)已儲存於終端機資訊資料庫 132 中時，則刪除已儲存的對應資訊。此外，已接收之對應資訊係儲存於終端機資訊資料庫 132 中，藉以防止於終端機資訊資料庫 132 中存在複數個包含相同識別資訊之對應資訊。

當從終端機 101 之傳送器 115 傳送之對應資訊接收至控制裝置 103 中時，計算電池 111 之預定充電日期(在步驟 12 中)。

該預定充電日期係基於步驟 10 中從終端機 101 之傳送器 115 傳送對應資訊至控制裝置 103 中接收的時間來計算，換言之，基於該時間，將電池 111 安裝至終端機 101 中。爲便於說明，在此說明之預定充電日期係基於電池 111 安裝至終端機 101 之日期而計算。例如，假設電池 111 之平均壽命爲一個月，若電池 111 於 8 月 1 日安裝至終端機 101 中，則該預定充電日期被計算爲 9 月 1 日。

此時，該預定充電日期可考量步驟 4 中接收序號的接收時間來計算。換言之，當從步驟 4 中接收序號之接收時間到步驟 10 中接收對應資訊之時間(在此之後稱爲"保留時間(save time)")比預先設定之時間還長時，可計算該預定充電時間作爲比預先設定之時間還短之該保留時間的情況下還早的時間。當該保留時間比預先設定之時間還長時，此

規定考量到由自我放電導致之低殘餘量。當藉由任何手段防止自我放電時，在步驟 4 中接收序號之接收時間不需被考量。或者，該預定充電日期可僅使用步驟 4 中接收序號之接收時間來計算。

當諸如使用頻率之使用狀態係到達某些相同於所有終端機 101 之範圍時，可使用上述計算方法，但可基於使用狀態來計算該預定充電時間(預定充電日期)。

第 6 圖顯示利用狀態資訊資料庫之結構，其中每一終端機 101 之識別資訊係對應通信時間配置，該識別資訊爲利用狀態資訊。此利用狀態資訊資料庫係設於控制裝置 103 中。例如，其中識別資訊爲"090-1234-5678"之終端機 101 的通信時間係儲存作爲"10 分 45 秒"之資訊。其中識別資訊爲"080-2222-3333"之終端機 101 的通信時間係儲存作爲"2 分 10 秒"之資訊。其中識別資訊爲"090-7777-8888"之終端機 101 的通信時間係儲存作爲"3 分 32 秒"之資訊。該等利用狀態資訊係於每次實行通信時收集於控制裝置 103 中。當計算上述預定充電日期時，可考慮到這些資訊。當然，安裝在終端機 101(其中通信時間是短的)中之電池 111 的預定充電日期將落在一日期上，其在安裝在終端機 101(其中通信時間是長的)中之電池 111 的預定充電日期之後。在此情況中之通信時間爲終端機 101 與控制裝置通信之時間，及終端機 101 與另一個不被考量之裝置通信的時間。因此，終端機 101 較佳地爲可僅與控制裝置 103 通信之裝置。

諸如電池 111 之使用長度或使用頻率的使用狀態可在

計算預定充電日期時被列入考慮。

第 7 圖顯示使用狀態資訊資料庫之結構，其中電池 111 之製造日期與電池 111 在過去已充電之次數構成電池 111 之使用狀態資訊，其係對應電池 111 之序號配置。此使用狀態資訊資料庫設在控制裝置 103 中。例如，儲存具有序號"00000001"之電池 111 的資訊，表示製造日期爲 2005 年 10 月及電池 111 在過去已充電之次數爲"8"次。儲存具有序號"11111111"之電池 111 的資訊，表示製造日期爲"2004 年 12 月"及在過去充電之次數爲"12"次。儲存具有序號"55555555"之電池 111 的資訊，表示製造日期爲"2006 年 1 月"及在過去充電之次數爲"3"次。這些使用狀態資訊於每次充電時係實行預先收集並更新於控制裝置 103 中。上述預定充電日期可藉由考量該等資訊而被計算。當然，具有較早的製造日期及在過去具有較長充電情況之電池 111 的預定充電日期，將在具有較晚的製造日期及在過去具有較短充電情況之電池 111 的預定充電日期之前出現日期。

在步驟 13 中，如上述計算之預定充電日期係儲存在電池資訊資料庫 131 中。在此情況下，該預定充電日期係儲存在第 4 圖中所示之電池資訊資料庫 131 之結構的預定充電日期中。例如，如第 4 圖中所示，資訊"2006 年 9 月 22 日"係儲存爲具有序號"00000001"之電池 111 的預定充電日期。此外，資訊"2006 年 11 月 11 日"係儲存爲具有序號"11111111"之電池 111 的預定充電日期。資訊"2006 年 10 月 3 日"係儲存爲具有序號"55555555"之電池 111 的預定充

電日期。該預定充電日期在此表示安裝在終端機 101 中之電池 111 已經耗損並需要充電的日期，及也表示電池 111 應被另一個已充好電之電池交換的交換日期。

接著，在步驟 14 中，根據控制裝置 103 中到達預定通知日期之識別，在步驟 15 中實行電池的提示充電或交換的通知，其中該通知日期爲比該預定充電日期還早之預設日期數。此通知可於配置在控制裝置 103 中之顯示單元(沒有顯示)上顯示。使用該電池 111 之序號作爲檢索線索(key)，終端機 101(其中目標電池 111 係於此情況下安裝)之識別資訊可於其中被檢索並從終端機資訊資料庫 132 讀取，及可接著顯示已被讀取之終端機 101 之識別資訊。例如，若接下來充電日期爲"10 月 1 日"且已被預先設定的日期數爲"3"，則預定通知日期將爲 9 月 28 日，其爲"10 月 1 日"前的三天，及應實行之通知應爲 9 月 28 日。

上前述說明，該電池 111 之預定充電日期，或者以另一個電池 111 來替代之日期係基於安裝在終端機 101 中之電池 111 的時間來計算，及在此日期前實行的通知可輕易地防止終端機 101 之電池中斷。

接下來關於藉由上述方法使用其中安裝已充電電池 111 的終端機 101 之範例之說明。在此說明關於屬於需要照顧之年長居民的終端機 101 的範例。

第 8 圖顯示由連接鈕 1001、中斷鈕 1002、揚聲器 1003、麥克風 1004、螺釘 1005、及外蓋 1006 構成之第 1 圖中所示之終端機 101 之外部外觀。連接鈕 1001 爲當做成一通來

電至其中設有控制裝置 103 之中心區時，或當響應自該中心區收到的來電時而被按壓的鈕。中斷鈕 1002 爲當完成中斷通信時被按壓的鈕。揚聲器 1003 爲用以傳送已從通信伙伴所傳送之聲音之典型聲音輸出裝置。麥克風 1004 爲典型收音裝置。螺釘 1005 爲可僅使用特殊工具而轉動使得使用者無法輕易開啓外蓋 1006 之螺釘。外蓋 1006 爲當電池 111 已安裝在終端機 101 中時所蓋上之外蓋。

如第 9 圖中所示，顯示於第 8 圖中之終端機 101 包含：連接鈕 1001；揚聲器 1003；麥克風 1004；接收器 1014；來電偵測器 1015；來電號碼檢查單元 1016；計時器 1017、1022 及 1028；來電號碼保持單元 1018 及 1026；解調變器 1019；連接單元 1020、放大器 1021 及 1024；放大率控制單元 1023；調變器 1025；及傳送器 1027。接收器 1014 接收該中心區之來電。來電偵測器 1015 偵測由接收器 1014 所接收之來電。來電號碼檢查單元 1016 檢查由來電偵測器 1015 所偵測到之來電的來電號碼。計時器 1017、1022 及 1028 爲其已預先設定截止時間之計時器。來電號碼保持單元 1018 預先保持可連接至來電目的之來電號碼。解調變器 1019 解調變已連接之聲音。連接單元 1020 內掛在終端機 101 上。放大器 1021 及 1024 放大聲音。放大率控制單元 1023 控制放大器 1024 之放大率。調變器 1025 調變由放大器 1024 所放大的聲音。來電號碼保持單元 1026 保持終端機 101 可通話之來電者號碼。傳送器 1027 傳送由調變器 1025 調變之聲音至通話目的地。

參照第 10 圖，接下來說明關於具有第 9 圖中所示之架構的終端機 101 中的連接程序。

當於接收器 1014 中接收來自中心區之來電時，於步驟 21 中刪除來電偵測器 1015 中之來電。用以刪除來電之來電號碼藉由來電號碼檢查單元 1016 來檢查。此時，於步驟 22 中判定來電號碼是否爲於來電號碼保持單元 1018 中已預先登記之號碼。

若該來電號碼並非來電號碼保持單元 1018 中已預先登記之號碼，則程序結束。換言之，拒絕連接。

另一方面，若判定該來電號碼爲來電號碼保持單元 1018 中已預先登記之號碼，則提示音(響鈴音調)於步驟 23 中開始及於步驟 24 中啓動計時器 1017。

接下來在步驟 25 中判定是否已按下連接鈕 1001。當判定連接鈕 1001 已被按下時，則於步驟 26 中停止計時器 1017。接著藉由連接單元 1020 執行連接，因而於解調變器 1019 中解調變自中心區傳送的聲音。該解調變聲音藉由放大器 1021 放大，接著該放大器之後，於步驟 27 中自揚聲器 1003 傳送該已放大之聲音。此外，設定麥克風 1004 爲”有效的”，藉由麥克風 1004 收集使用者的聲音。已收集之聲音藉由放大率控制單元 1023 所控制之放大率於放大器 1024 中放大。已放大之聲音藉由調變器 1025 調變。已調變之聲音於步驟 28 中接著從傳送器 1027 傳送至該中心區。

另一方面，若使用者沒有於步驟 25 中按下判定連接鈕 1001，則於步驟 29 中判定計時器 1017 是否已逾時。

若判定計時器 1017 沒有逾時，則實施步驟 25 之程序。

另一方面，當判定該計算器 1017 已逾時，則藉由連接單元 1020 實行來電連接，藉以由解調變器 1019 解調變自該中心區傳送之聲音。藉由放大器 1021 放大該已解調變之聲音。接著於步驟 30 中自揚聲器 1003 傳送已放大之聲音。在此同時，計時器 1022 於步驟 31 中啓動。

接著再次於步驟 32 中判定連接鈕 1001 是否已被按下。若判定連接鈕 1001 已被按下，則於步驟 33 中停止計時器 1022。麥克風 1004 接著設定爲"有效的"，因而藉由麥克風 1004 收集使用者的聲音。已收集之聲音藉由放大器 1024 以被放大率控制單元 1023 所控制之放大率來放大。已放大之聲音藉由調變器 1025 調變。已調變之聲音接著於步驟 28 中從傳送器 1027 傳送至該中心區。

另一方面，若於步驟 32 中判定使用者未按下連接鈕 1001，則接著於步驟 34 中判定計時器 1022 是否已逾時。

若判定計時器 1022 沒有逾時，則實行步驟 32 之程序。

另一方面，若判定計時器 1022 已逾時，則設定麥克風 1004 爲"有效的"，因而藉由麥克風 1004 收集使用者的聲音。已收集之聲音係藉由放大率控制單元 1023 所控制之放大率以放大器 1024 放大。已放大之聲音藉由調變器 1025 調變。已調變之聲音接著於步驟 35 中從傳送器 1027 傳送至該中心區。在此同時，於步驟 36 中啓動計時器 1028。

接著在步驟 37 判定經由麥克風 1004 所通過之聲音是否已於中心區中被識別。若判定該聲音沒有被識別，則接

著於步驟 38 中判定計時器 1028 是否逾時。

若判定計時器 1028 沒有逾時，則實行步驟 37 之程序。

另一方面，若判定計時器 1028 已逾時，則放大器 1024 之放大率藉由步驟 39 中之放大率控制單元 1023 來改變。換言之，提高已被麥克風 1004 收集之聲音的放大率，使得即使小聲音也可於中心區中被識別。

計時器 1017、1022 及 1028 之逾時值及由放大率控制單元 1023 所控制之放大率可爲事先設定之值，或可爲被中心區改變之值。第 11 圖中所示之架構爲第 9 圖中所示之架構，其中可增設放大率改變指令偵測器 1029。當從中心區傳送放大率改變指令，藉由放大率改變指令偵測器 1029 偵測該指令，且接著基於已偵測指令藉由放大率控制單元 1023 設定放大率。

第二實施例

接著說明關於本發明之電池交換系統之第二實施例。

本實施例係關於一種電池之充電，其中該電池用於在夜晚點亮自行車的燈，及讓使用自行車之使用者從居家通勤到火車站、學校、或工作場所(此後稱爲站台(station))。

第 12 圖顯示電池交換系統之第二實施例，其中該交換系統係由自行車 201、充電器 202、及控制裝置 203 構成。自行車 201 爲由使用此系統之使用者所使用之使用者裝置。充電器 202 爲用以對已安裝於自行車 201 中之可充電電池充電之充電裝置，並設在站台之自行車停車區中。控制裝置 203 控制安裝於自行車 201 中之該可充電電池之充

電狀態，及連接至自行車 201 與充電器 202，以允許自行車 201 與充電器 202 之間資訊的傳送與接收。此外，自行車 201 具有藉由安裝之電池來發光的燈。

自行車 201 係設置：電池 211、序號讀取器 212、記憶體 213、使用者資訊讀取器 214、傳送器 215、及燈 216。電池 211 爲可用以供應電力至燈 216 之可充電電池，使燈 216 發亮並可並拆卸。電池 211 之結構類似於在第一實施例中所述之電池 111 之結構。序號讀取器 212 讀取預先儲存於電池 211 中之序號。記憶體 213 爲用以儲存使用自行車 201 之使用者(或持有者)之使用者資訊的記憶體。使用者資訊讀取器 214 讀取儲存於記憶體 213 之使用者資訊。傳送器 215 將已被序號讀取器 212 讀取之序號及由使用者資訊讀取器 214 讀取之使用者資訊，傳送至控制裝置 203。沒有特別規定在此情況下所應用之傳送方法。

充電器 202 係具備：充電單元 221、序號讀取器 222、及收發器 223。充電單元 221 對已從自行車 201 拆卸之電池 211 充電。序號讀取器 222 讀取由充電單元 221 所充電之電池 211 的序號。收發器 223 傳送已被序號讀取器 222 讀取之序號至控制裝置 203，及接收關於已從控制裝置 203 傳送之充電量之資訊。

控制裝置 203 係更具備有使用者資訊資料庫 231、自行車資訊資料庫 232、及充電量資訊資料庫 233。使用者資訊資料庫 231 儲存關於使用者之資訊。該結構將於下述做更詳細的說明。自行車資訊資料庫 232 儲存關於自行車 201

之資訊。此外，此資料庫將更明確地於下述中說明。充電量資訊資料庫 233 儲存自行車 201 之行進距離，其與此行進距離所需之電池 211 之充電量一致。

接下來說明關於參照第 13 圖上述架構之電池交換系統中之電池交換方法。

關於使用者之使用者資訊係首先儲存於記憶體 213 中。此使用者資訊爲可識別使用者(例如，使用者之名字)之識別資訊的資訊，及關於彼此互相對應設置之自行車 201 之行進距離(例如，從住所到站台之距離)的資訊。

此外，當首先使用自行車停車區時，也需要自行車 201 之使用者的登記。

已預先儲存於電池 211 中之序號係首先於步驟 51 中被序號讀取器 212 讀取。此外，已預先儲存於記憶體 213 中之使用者資訊係於步驟 52 中藉由使用者資訊讀取器 214 讀取。

接著，已藉由序號讀取器 212 從電池 211 讀取之序號及已被使用者資訊讀取器 214 從記憶體 213 讀取之使用者資訊，係於步驟 53 中從傳送器 215 傳送至控制裝置 203。

當於步驟 54 中接收已從自行車 201 之傳送器 215 傳送該序號及使用者資訊至控制裝置 203 中時，該使用者資訊係儲存於使用者資訊資料庫 231 中，及儲存於使用者資訊中之該序號與使用者名字係於步驟 55 中儲存於自行車資訊資料庫 232 中。

如第 14 圖中所示，該使用者名字與行進距離係彼此互

相對應儲存於第 12 圖之使用者資訊資料庫 231 中。這些資訊爲從自行車 201 傳送之使用者資訊。例如，儲存屬於 Fukuzawa Yukichi 先生之自行車 201 之行進距離爲 4.3km 的資訊。此外，儲存屬於 Higuchi Ichiyo 小姐之自行車 201 之行進距離爲 2.1km 的資訊。再者，儲存屬於 Noguchi Hideyo 先生之自行車 201 之行進距離爲 1.7km 的資訊。

如第 15 圖中所示，電池 211 之序號及使用者名字係彼此互相對應儲存於第 12 圖中所示之自行車資訊資料庫 232 中。這些資訊爲從自行車 201 傳送之序號及於使用者資訊中所包含之使用者名字之資訊。例如，儲存標示自行車 201 爲屬於 Fukuzawa Yukichi 先生之自行車 201 之資訊，其中該自行車內安裝具有序號"10000834"之電池 211。也儲存標示自行車 201 爲屬於 Higuchi Ichiyo 小姐之自行車 201 之資訊，其中該自行車內安裝具有序號"05000872"之電池 211。再者，儲存標示自行車 201 爲屬於 Noguchi Hideyo 先生之自行車 201 之資訊，其中該自行車內安裝具有序號"01000876"之電池 211。

接著，當電池 211 安裝於充電器 202 之充電單元 221 中以對電池 211 充電時，於步驟 56 中藉由序號讀取器 222 從電池 211 讀取序號。藉由序號讀取器 222 從電池 211 讀取之序號係於步驟 57 中從收發器 223 傳送至控制裝置 203。

當於步驟 58 中接收從充電器 202 之收發器 223 所傳送之序號於控制裝置 203 中時，於步驟 59 中基於所接收之序號計算電池之充電量。下述說明特殊計算方法。

如第 16 圖中所示，行進距離及充電量係彼此互相對應儲存於第 12 圖中所示之充電量資訊資料庫 233 中。在此，當行進特定行進距離時，於步驟中分配點亮燈所需之充電量。例如，當行進從 0.0 到 1.9km 之特定行進距離時，儲存標示所需之充電量以點亮燈之資訊爲"1"。此外，當行進從 2.0 到 3.9km 之特定行進距離時，儲存標示所需之充電量以點亮燈之資訊爲"3"。再者，當行進從 4.0 到 5.9km 之特定行進距離時，儲存標示所需之充電量以點亮燈之資訊爲"6"。這些資訊係預先被儲存。此外，雖然針對第 16 圖中所示之充電量爲了便於說明已使用簡單之整數值，但充電量也可爲測量單元。

使用於控制裝置 203 中所接收之序號作爲檢索線索(search key)，該使用者名字係於自行車資訊資料庫 232 內檢索。接著，使用所獲得之該使用者名字作爲檢索線索來檢索，於使用者資訊資料庫 231 中檢索行進距離。接著，使用所獲得之行進距離作爲檢索線索來檢索，於充電量資訊資料庫 233 中檢索充電量。

例如，若於控制裝置 203 中所接收之序號爲"10000834"，則於第 15 圖中所示之自行車資訊資料庫 232 中對應序號"10000834"之使用者名字爲 Fukuzawa Yukichi 先生。接著，於第 14 圖中所示之使用者資訊資料庫 231 中對應 Fukuzawa Yukichi 先生之行進距離爲 4.3km。接著，於第 16 圖中所示之充電量資訊資料庫 233 中對應 4.3km 之行進距離的充電量爲"6"。其因而計算得到序號爲"10000834"

之電池 211 中將被充電之充電量爲"6"。

同樣地，當於控制裝置 203 中所接收之序號爲"05000872"時，則於自行車資訊資料庫 232 中對應序號"05000872"之使用者名字爲 Higuchi Ichiyo 小姐。接著，於第 14 圖中所示之使用者資訊資料庫 231 中對應 Higuchi Ichiyo 小姐之行進距離爲 2.1km。最後，於第 16 圖中所示之充電量資訊資料庫 233 中對應 2.1km 之行進距離的充電量爲"3"。其可因而計算得到序號爲"05000872"之電池 211 中將被充電之充電量爲"3"。

以相同方式，當於控制裝置 203 中所接收之序號爲"01000876"時，則於第 15 圖中所示之自行車資訊資料庫 232 中對應序號"01000876"之使用者名字爲"Noguchi Hideyo 先生"。接著，於第 14 圖中所示之使用者資訊資料庫 231 中對應 Noguchi Hideyo 先生之行進距離爲 1.7km。於第 16 圖中所示之充電量資訊資料庫 233 中對應 1.7km 之行進距離的充電量爲"1"。其可因而計算得到序號爲"01000876"之電池 211 中將被充電之充電量爲"1"。

當如上述基於已於控制裝置 203 中所接收之序號計算電池之充電量時，於步驟 60 中將該已計算之充電量傳送至充電器 202。

當於步驟 61 中接收從控制裝置 203 傳送充電量至充電器 202 於充電器 202 之收發器 223 中時，於步驟 62 中以所接收之充電量於充電單元 221 中對電池 211 充電。

已充電之電池 211 接著於步驟 63 中安裝於自行車 201

中。

雖然已使用其中以一日充電量來充電作爲充電量之情況的說明，但關於長期充電(例如，一個月)之類似方法也可被考量。在此一情況下，類似於該第一實施例之提示充電通知可於控制裝置 203 中顯示一日期，其中該日期爲預設比設定成將持續一個月之充電天數還早之天數。再者，可藉由同時顯示使用者名字實行通知。

此外，該使用者名字不需實際爲使用者之名字，而可爲某些其它資訊或可識別使用者之數字。

除了可於本發明中藉由上述專用硬體於該使用者裝置、該充電裝置、及控制裝置中執行程序之構成外，實現本發明功能的程式可被記錄至藉由使用者裝置、充電裝置、及控制裝置而可讀取之記錄媒體上，且已被記錄至記錄媒體上之該等程式可接著被讀取至該使用者裝置、該充電裝置、及控制裝置及接著執行。藉由使用者裝置、充電裝置、及控制裝置而可讀取之記錄媒體可爲諸如軟碟、電磁光碟、DVD、或 CD 之可移除記錄媒體，或可爲併入使用者裝置、充電裝置、及控制裝置中之 HDD。儲存於此記錄媒體中之該等程式可爲讀取至屬於各自裝置之控制單元(沒有顯示)及等同於那些上述之程序，接著於控制單元之控制下執行。在此情況下，屬於該等裝置之每一裝置之該等控制單元爲當作電腦而操作之構成，其中該電腦執行已從記錄媒體(程式已被記錄於其上)讀取之程式。

然而，依照本發明，在電池交換系統中，其包含：使

用者裝置，其屬於使用者及自具有特徵序號之電池供應電力；充電裝置，用以對該電池充電；及控制裝置，用以控制該電池充電的狀態，該控制裝置在每次先於儲存之預定充電時間一預設間隔前，實行提示電池交換之通知。

此外，當已從使用者裝置傳送之對應資訊的序號存於充電資訊中時，該控制裝置刪除該序號及對應來自充電資訊之序號的預定充電時間。

或者，當包含於已從使用者裝置傳送之對應資訊中的序號沒有存在於該充電資訊中時，則該控制裝置顯示已儲存於與電池之序號相對應之識別資訊，以實行標示充電沒有被全部安裝之電池的通知。

基於已從使用者裝置傳送之對應資訊的接收時間，及已於利用狀態資訊資料庫中所收集之使用者裝置之利用狀態資訊，該控制裝置計算具有序號之電池之預定充電時間。

基於已從使用者裝置傳送之對應資訊的接收時間，及已於使用狀態資訊資料庫中所收集之電池之利用狀態資訊，該控制裝置計算具有序號之電池之預定充電時間。

再者，基於使用者資訊(其爲關於使用者之資訊)，該控制裝置計算充電量，其中該充電量係於具有已從該充電裝置傳送之序號之電池中充電，及傳送已計算之充電量至該充電裝置；及當開始電池之充電時，該充電裝置接著讀取來自電池之序號，傳送該序號至控制裝置，及對電池充電到已從該控制裝置傳送所計算之充電量。

此外，該電池包含電力供應單元，用以供應電力至使

用者裝置；及記憶體單元，用以儲存該序號。

該識別資訊爲該使用裝置之電話號碼。

此外，該使用者裝置具有特徵識別資訊，並依照具有特徵序號之電池的安裝，讀取來自電池之序號並彼此互相對應配置該識別資訊及序號，及將其作爲對應資訊以傳送至控制電池充電之狀態的控制裝置。

該充電裝置實行具有特徵序號之電池的充電，其中該特徵序號已安裝於屬於使用者之使用者裝置中，當已完成電池充電時，讀取來自電池之序號，及傳送該序號至管理電池充電之狀態的控制裝置。

此外，當開始電池之充電時，該充電裝置讀取來自電池之序號，傳送該序號至該控制裝置，及接著對具有該序號之電池充電至該充電量，此充電量已基於使用者資訊而於該控制裝置中被計算，其中該使用者資訊係爲使用者之資訊。

此外，該控制裝置：從使用者裝置接收及儲存對應資訊，其中使用者裝置之電力係自具有特徵序號之電池所供應，此對應資訊爲其中已彼此互相對應配置之使用者裝置的序號與識別資訊特徵的資訊；接收已從實行電池充電之該充電裝置所傳送之序號；基於從使用者裝置傳送之該對應資訊之接收時間，計算爲預定下個具有序號之電池的預定充電時間；儲存來自該充電裝置所傳送之序號及彼此互相對應之預定充電時間作爲充電資訊；及，在該預定充電時間被儲存前，顯示已對應該電池之序號所儲存之識別資

訊，以實行提示電池交換之通知。

該控制裝置每次先於已儲存預定充電時間一預設間隔前，更實行提示電池交換之通知。

當包含於已從使用者裝置傳送之該對應資訊中的序號存於充電資訊中時，該控制裝置從該充電資訊刪除該序號及與該序號對應配置之預定充電時間。

當於充電資訊中，不存在有包含於從使用者裝置傳送之該對應資訊中的序號時，該控制裝置顯示識別資訊(其係儲存以對應該電池之序號)，以實行電池充電沒有完成安裝之通知。

基於已從使用者裝置傳送之對應資訊的接收時間，及已於利用狀態資訊資料庫中所收集之使用者裝置之利用狀態資訊，該控制裝置更計算具有序號之電池之預定充電時間。

基於已從使用者裝置傳送之對應資訊的接收時間，及已於使用狀態資訊資料庫中所收集之電池之利用狀態資訊，該控制裝置更計算具有序號之電池之預定充電時間。

基於使用者資訊(其爲關於使用者之資訊)，該控制裝置更計算用以對具有從該充電裝置傳送序號的電池充電之充電量。

此外，本發明之方法爲一種電池交換系統之方法，其中該電池交換系統包含屬於使用者之使用者裝置，及其電力係由具有特徵序號之電池供應；充電裝置，實行電池之充電；及控制裝置，控制電流充電之狀態；該方法包含下

列步驟，其中：

當完成電池之充電時，該充電裝置讀取來自電池之序號；

該充電裝置傳送該序號至該控制裝置；當安裝該電池時，該使用者裝置讀取來自該電池之序號；

該使用者裝置配置彼此互相對應之屬於使用者裝置的特徵識別資訊及該序號，及將其作爲對應資訊傳送至該控制裝置；

該控制裝置基於接收自該使用者裝置所傳送之對應資訊的接收時間，計算預定下個具有從該充電裝置所傳送之序號之電池的預定充電時間；

該控制裝置彼此互相對應配置自該充電裝置傳送的序號與該預定充電時間，及將其儲存作爲充電資訊；及

在該預定充電時間前，該控制裝置顯示已與電池之序號對應配置之識別資訊，以實行提示電池交換之通知。

包含進一步之步驟，其中每次先於預定充電時間一預設間隔前，該控制裝置實行提示電池交換之通知。

包含進一步之步驟，其中當包含於自使用者裝置傳送之對應資訊中的序號存於該充電資訊中時，該控制裝置從該充電資訊刪除該序號及配置對應該序號之預定充電時間。

包含進一步之步驟，其中當包含於自使用者裝置傳送之對應資訊中的序號不存在於該充電資訊中時，該控制裝置顯示配置與該電池之序號相對應的識別資訊，以實行標

示沒有完成安裝充電電池之通知。

包含進一步之步驟，其中基於已從使用者裝置傳送之對應資訊的接收時間，及已於利用狀態資訊資料庫中所收集之使用者裝置之利用狀態資訊，該控制裝置計算具有序號之電池之預定充電時間。

包含進一步之步驟，其中基於已從使用者裝置傳送之對應資訊的接收時間，及已於使用狀態資訊資料庫中所收集之電池之利用狀態資訊，該控制裝置計算具有序號之電池之預定充電時間。

此外，更包含下列步驟，其中：

當開始該電池的充電時該充電裝置自電池讀取該序號；

該充電裝置傳送已被讀取之該序號至該控制裝置；

該控制裝置計算充電量，基於爲關於使用者之資訊的使用者資訊，以具有自該充電裝置所傳送之序號的電池充電；

該控制裝置將已計算之充電量傳送至該充電裝置；及

該充電裝置對電池充電以達到自該控制裝置傳送之已計算充電量。

本發明之記錄媒體爲一種用以記錄驅動使用者裝置之程式的記錄媒體，用以執行下列程序，其中該使用者裝置係自具有特徵序號之電池供應電力，且其被製造以允許連接至控制電池充電之狀態的控制裝置，及其具有特徵識別資訊：

當已安裝該電池時從該電池讀取序號；

對應該序號來配置識別資訊；及

將已彼此對應互相配置之資訊作爲對應資訊傳送至該控制裝置。

此外，本發明之記錄媒體爲一種用以記錄使充電裝置運作之程式的記錄媒體，其中被製造以允許連接至控制裝置且實行電池的充電，其中該控制裝置控制具有特徵序號之電池充電的狀態，且其係安裝於屬於使用者之使用者裝置中，用以執行下列程序：

當已完成電池的充電時，自該電池讀取序號；及

傳送該序號至該控制裝置。

此外，本發明之記錄媒體記錄一種程式，用以進一步使該充電裝置執行下列程序：

當開始該電池的充電時，自該電池讀取序號；

傳送該序號至該控制裝置；及

對具有該序號之電池充電至基於使用者資訊(其爲關於使用者之資訊)於控制裝置中所計算出之充電量。

此外，本發明之記錄媒體爲一種用以記錄使控制裝置運作之程式的記錄媒體，其被製造使得連接至使用者裝置成爲可行，其中該使用者裝置係由具有特徵序號之電池供應電力，及使得連接至實行電池充電之充電裝置成爲可行，及該控制裝置控制電池充電之狀態，以執行下列程序：

接收及儲存已從該使用者裝置傳送之對應資訊；

接收已從該充電裝置傳送之該序號；

基於已從該使用者裝置傳送之對應資訊的接收時間，

計算預定下個具有序號之電池的預定充電時間；

彼此互相對應配置已從該充電裝置傳送之序號及預定充電時間，且將其儲存爲充電資訊；及

在已儲存該預定充電時間前，顯示對應電池序號之已被儲存的識別資訊，以實行提示電池交換通知。

此外，本發明之記錄媒體記錄一種程式，進一步使控制裝置在每次先於已儲存之預定充電時間一預設間隔前，執行一種實行提示電池交換之通知的程序。

此外，本發明之記錄媒體記錄一種程式，其進一步使控制裝置在包含於已從使用者裝置傳送之對應資訊中之序號存於充電資訊中時，執行一種自充電資訊刪除彼此互相對應配置之序號與預定充電時間之程序。

此外，本發明之記錄媒體記錄一種程式，其進一步使控制裝置在包含於已從使用者裝置傳送之對應資訊中之序號不存在於充電資訊中時，執行一種顯示儲存於對應該電池之序號的識別資訊，以實行標示沒有完成安裝充電電池之通知的程序。

此外，本發明之記錄媒體記錄一種程式，其進一步使控制裝置基於已從使用者裝置傳送之對應資訊之接收時間，及已於利用狀態資訊資料庫中收集之關於使用者裝置的利用狀態資訊，執行一種計算具有序號之電池的預定充電時間之程序。

此外，本發明之記錄媒體記錄一種程式，其進一步使控制裝置基於已從使用者裝置傳送之對應資訊之接收時

間，及已於使用狀態資訊資料庫中收集之電池的使用狀態資訊，執行一種計算具有序號之電池的預定充電時間之程序。

此外，本發明之記錄媒體記錄一種程式，其進一步使控制裝置執行一種計算充電量之程序，用以基於使用者資訊對具有已從該充電裝置傳送之序號的電池充電，其中該使用者資訊爲關於使用者之資訊。

雖然本發明之例示實施例已於特定章節中說明，但此說明爲僅針對例示說明用，且其可被了解的是，本發明可達成許多改變與變化而仍不脫離下述申請專利範圍之精神或範圍。

【圖式簡單說明】

第 1 圖顯示本發明之電池交換系統之第一實施例；

第 2 圖顯示第 1 圖中所示之電池之架構之範例；

第 3 圖爲第 1 與 2 圖中所示之電池交換系統中用以說明電池交換方法之次序圖；

第 4 圖爲第 1 圖中所示之電池資訊資料庫之結構之範例；

第 5 圖爲第 1 圖中所示之終端機資訊資料庫之結構之範例；

第 6 圖顯示終端機之識別資訊及終端機之利用狀態資訊之間儲存對應關係之利用狀態資訊資訊庫(沒有顯示)之結構之範例；

第 7 圖顯示電池之序號與電池之使用狀態資訊之間儲

存對應關係之使用狀態資訊資訊庫(沒有顯示)之結構之範例；

第8圖顯示第1圖中所示之終端機之外部架構之範例；

第9圖顯示第8圖中所示之終端機之架構之範例；

第10圖爲具有第9圖中所示之架構的終端機中用以說明連接程序之流程圖；

第11圖顯示可自中央改變之架構之範例，其中放大等級係由第9圖中所示之放大率控制單元控制；

第12圖顯示本發明之電池交換系統之第二實施例；

第13圖爲第12圖中所示之電池交換系統中用以說明電池交換方法之次序圖；

第14圖顯示第12圖中所示之使用者資訊資料庫之結構之範例；

第15圖顯示第12圖中所示之自行車資訊資料庫之結構之範例；

第16圖顯示第12圖中所示之充電量資訊資料庫之結構之範例。

【主要元件符號說明】

101	終端機
102	充電器
103	控制裝置
111	電池
112	序號讀取器
113	記憶體

114	識別資訊讀取器
115	傳送器
116	電力供應單元
117	記憶體單元
121	充電單元
122	序號
123	傳送器
131	電池
132	終端機
1～15、21～39、51～63	步驟
1001	連接鈕
1002	中斷鈕
1003	揚聲器
1004	麥克風
1005	螺釘
1006	外蓋
1014	接收器
1015	來電偵測器
1016	來電號碼檢查單元
1017	計時器
1018	來電號碼保持單元
1019	解調變器
1020	連接單元
1021	放大器

1022	計時器
1023	放大率控制單元
1024	放大器
1025	調變器
1026	來電號碼保持單元
1027	傳送器
1028	計時器
1029	放大率充電指令偵測器
201	自行車
202	充電器
203	控制裝置
211	電池
212	序號讀取器
213	記憶體
214	使用者資訊讀取器
215	傳送器
216	燈
221	充電單元
222	序號讀取器
223	收發器
231	使用者資訊資料庫
232	自行車資訊資料庫
233	充電量資訊資料庫

五、中文發明摘要：

在電池交換系統中，在適當的間隔上有助於可充電電池之交換，其中該可充電電池係以另一個完全充電的可充電電池來充電，當安裝電池時，具有特徵識別資訊之使用者裝置從電池讀取序號並傳送至控制裝置對應資訊，其中該對應資訊係彼此互相對應配置識別資訊與該序號。當已完成電池充電時，充電裝置從電池讀取該序號並傳送該序號至控制裝置。該控制裝置基於從使用者傳送之對應資訊的接收時間，計算具有序號之電池的預定充電時間，其中該序號已從該充電裝置傳送，並且在計算預定充電時間之前，實行提示電池交換的通知。

六、英文發明摘要：

In a battery exchange system for facilitating exchange at appropriate intervals of a chargeable battery with another fully charged chargeable battery for charging, a user device having characteristic identification information reads a serial number from a battery when the battery is installed and transmits to a control device correspondence information in which the identification information and the serial number have been placed in correspondence with each other. A charging device reads the serial number from a battery when charging of the battery has been completed and transmits the serial number to the control device. The control device calculates a scheduled charging time of the battery having the serial number that has been transmitted from the charging device based on the time of reception of the correspondence information that was transmitted from user device and, before the calculated scheduled charging time, carries out notification prompting battery exchange.

十、申請專利範圍：

1.一種電池交換系統，包含：

屬於使用者的使用者裝置，以自具有特徵序號之電池來對該使用者裝置供應電力；

充電裝置，用以對該電池充電；及

控制裝置，用以管理該電池充電的狀態；其中：

該使用者裝置具有特徵識別資訊，當安裝該電池時，自該電池讀取該序號，並彼此互相對應而配置該識別資訊與該序號並且作爲對應資訊而傳送至該控制裝置；

當已完成該電池的充電時，該充電裝置從該電池讀取該序號並傳送此序號至該控制裝置；及

該控制裝置接收並儲存已從該使用者裝置傳送之對應資訊，接收已從該充電裝置傳送之序號，計算預定充電時間，該預定充電時間係基於已從該使用者裝置傳送之對應資訊的接收時間，而預定下一個具有該序號之電池，彼此互相對應配置已從該充電裝置傳送之序號與該預定充電時間，並將其儲存成爲充電資訊，且在已儲存該預定充電時間前，顯示依照該電池之序號而儲存之該識別資訊，以實行提示電池交換的通知。

2.如申請專利範圍第 1 項之電池交換系統，其中該控制裝置係在領先該已儲存的預定充電時間一個預設間隔的時候，實行提示電池交換的通知。

3.如申請專利範圍第 1 項之電池交換系統，其中當包含於

已從該使用者裝置傳送的對應資訊中的序號存在於該充電資訊中時，該控制裝置從該充電資訊刪除該序號以及已依照該序號而配置之預定充電時間。

4.如申請專利範圍第 3 項之電池交換系統，其中當包含於已從該使用者裝置傳送的對應資訊中的序號不存在於該充電資訊中時，則該控制裝置顯示依照該電池之序號而儲存的該識別資訊，以實行已安裝之電池未完全充電的通知。

5.如申請專利範圍第 1 項之電池交換系統，其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該使用者裝置於利用狀態資訊資料庫中已收集之利用狀態資訊，來計算具有該序號之電池的預定充電時間。

6.如申請專利範圍第 1 項之電池交換系統，其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該電池於使用狀態資訊資料庫中已收集之使用狀態資訊，來計算具有該序號之電池的預定充電時間。

7.如申請專利範圍第 1 項之電池交換系統，其中：

該控制裝置基於關於該使用者之資訊的使用者資訊，計算對具有序號之電池充電的充電量，其中該序號從該充電裝置傳送，並將該已計算的充電量傳送至該充電裝置；及

當開始對該電池充電時，該充電裝置從該電池讀取該序號，將該序號至傳送至該控制裝置，並對該電池充電以達到從該控制裝置傳送的充電量。

8.如申請專利範圍第 1 項之電池交換系統，其中該電池包含：

電源供應單元，用以對該使用者裝置供應電力；及

記憶體單元，用以儲存該序號。

9.如申請專利範圍第 1 項之電池交換系統，其中該識別資訊爲該使用者裝置之電話號碼。

10.一種具有特徵識別資訊之使用者裝置；亦即，依據具有特徵識別號碼之電池的安裝，從該電池讀取該序號；及彼此互相對應而配置該識別資訊與該序號，並將其作爲對應資訊而傳送至管理該電池充電之狀態的控制裝置。

11.一種實行電池充電之充電裝置，該電池具有安裝於屬於使用者的使用者裝置中之特徵序號，其當該電池已完成充電時，從該電池讀取該序號，以及其將該序號傳送至管理該電池充電狀態之控制裝置。

12.如申請專利範圍第 11 項之充電裝置，其中該充電裝置：當開始對該電池充電時，從該電池讀取該序號；將該序號傳送至該控制裝置；及對具有序號之該電池充電以達到充電量，於該控制裝置中基於爲該使用者之資訊的使用者資訊，來計算此充電量。

13.一種控制裝置，其

接收並儲存其中彼此互相對應而配置序號與識別資訊並從使用者裝置傳送之對應資訊，該序號爲屬於供應電力至該使用者裝置之電池的特徵序號，且該識別資訊爲該使用者裝置之資訊特徵；

接收已從實行對該電池充電之充電裝置所傳送的該序號；

計算預定充電時間，該預定充電時間係基於已從該使用者裝置傳送之對應資訊的接收時間，而預定下一個具有該序號之電池；

彼此互相對應而配置已從該充電裝置傳送之序號與該預定充電時間，並將其儲存作爲充電資訊；及

在已儲存該預定充電時間前，顯示依照電池之序號而儲存之該識別資訊，以實行提示電池交換的通知。

14. 如申請專利範圍第 13 項之控制裝置，其中該控制裝置係在領先該已儲存的預定充電時間一個預設間隔的時候，實行提示電池交換的通知。

15. 如申請專利範圍第 13 項之控制裝置，其中當包含於已從該使用者裝置傳送的對應資訊中的序號存在於該充電資訊中時，該控制裝置從該充電資訊刪除該序號以及已依照該序號而配置之預定充電時間。

16. 如申請專利範圍第 15 項之控制裝置，其中當包含於已從該使用者裝置傳送的對應資訊中的序號不存在於該充電資訊中時，則該控制裝置顯示與依照該電池之序號而儲存的該識別資訊，以實行已安裝之電池未完全充電的通知。

17. 如申請專利範圍第 13 項之控制裝置，其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該使用者裝置於利用狀態資訊資料庫中已收集之利用狀

態資訊，來計算具有該序號之電池的預定充電時間。

18. 如申請專利範圍第 13 項之控制裝置，其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該電池於使用狀態資訊資料庫中已收集之使用狀態資訊，來計算具有該序號之電池的預定充電時間。

19. 如申請專利範圍第 13 項之控制裝置，其中該控制裝置基於關於該使用者之資訊的使用者資訊，來計算對具有序號之電池充電所需的充電量，其中該序號已從該充電裝置傳送。

20. 一種於電池交換系統中操作的方法，其中該電池交換系統係由使用者裝置、充電裝置及控制裝置組成，其中該使用者裝置屬於一使用者並從具有特徵序號之電池供應電力；該充電裝置用以實行對該電池的充電；該控制裝置用以管理該電池充電的狀態；該方法包含下列步驟：

當已完成該電池的充電時，該充電裝置從該電池讀取該序號；

該充電裝置傳送該序號至該控制裝置；

當安裝該電池時，該使用者裝置從該電池讀取該序號；

該使用者裝置彼此互相對應而配置屬於該使用者裝置之特徵識別資訊與該序號，並將其作爲對應資訊而傳送至該控制裝置；

該控制裝置計算預定充電時間，該預定充電時間係基於接收從該使用者裝置所傳送之對應資訊的接收時

間，而預定下一個具有從該充電裝置傳送之該序號的電池；

該控制裝置彼此互相對應而配置從該充電裝置傳送之序號與該預定充電時間，並將其儲存作爲充電資訊；及

該控制裝置，在該預定充電時間前，顯示已依照電池之序號而配置之該識別資訊，以實行提示電池交換的通知。

21. 如申請專利範圍第 20 項之方法，更包含一步驟：其中該控制裝置係在領先該已儲存的預定充電時間一個預設間隔的時候，實行提示電池交換的通知。

22. 如申請專利範圍第 20 項之方法，更包含一步驟：其中當包含於已從該使用者裝置傳送的對應資訊中的序號存在於該充電資訊中時，該控制裝置從該充電資訊刪除該序號以及已依照該序號而配置之預定充電時間。

23. 如申請專利範圍第 22 項之方法，更包含一步驟：其中當包含於已從該使用者裝置傳送的對應資訊中的序號不存在於該充電資訊中時，則該控制裝置顯示與依照該電池之序號而配置的該識別資訊，以實行已安裝之電池未完全充電的通知指示。

24. 如申請專利範圍第 20 項之方法，更包含一步驟：其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該使用者裝置於利用狀態資訊資料庫中已收集之利用狀態資訊，來計算具有該序號之電池的預定充

電時間。

25. 如申請專利範圍第 20 項之方法，更包含一步驟：其中該控制裝置基於已從該使用者裝置傳送之對應資訊的接收時間，以及該電池於使用狀態資訊資料庫中已收集之使用狀態資訊，來計算具有該序號之電池的預定充電時間。

26. 如申請專利範圍第 20 項之方法，更包含下列步驟，其中：

當開始對該電池充電時，該充電裝置從該電池讀取該序號；

該充電裝置傳送已被讀取之該序號至該控制裝置；

該控制裝置基於關於該使用者之資訊的使用者資訊，來計算對具有序號之電池充電所需的充電量，其中該序號已從該充電裝置傳送；

該控制裝置傳送該已計算的充電量至該充電裝置；及

該充電裝置對該電池充電以達到從該控制裝置傳送之充電量。

27. 一種記錄程式的記錄媒體，該程式用以控制使用者裝置，其係由具有特徵序號之電池所供電，並且被製造爲允許與控制該電池之狀態的控制裝置連接，且具有特徵識別資訊，該程式使該使用者裝置執行下列程序：

當安裝該電池時，從該電池讀取該序號；

彼此互相對應而配置該識別資訊與該序號；及

將已彼此互相對應而配置之該識別資訊以及該序號的資訊作爲對應資訊而傳送至該控制裝置。

28. 一種記錄程式的記錄媒體，該程式用以控制充電裝置，其被製造爲允許與控制具有特徵序號的電池充電之狀態的控制裝置連接，且安裝在屬於使用者之使用者裝置中並且其實行該電池的充電，該程式使該充電裝置執行下列程序：

當完成該電池的充電時，從該電池讀取該序號；及

將該序號傳送至該控制裝置。

29. 如申請專利範圍第 28 項之記錄媒體，所記錄之程式進一步使該充電裝置執行下列程序：

當開始該電池的充電時，從該電池讀取該序號；

傳送該序號至該控制裝置；及

對具有該序號之該電池充電以達到充電量，該充電量係基於關於該使用者之資訊的使用者資訊，而於該控制裝置中被計算。

30. 一種記錄程式的記錄媒體，該程式用以操控控制裝置，其被製造爲允許與從具有特徵序號之電池供應電力之使用裝置連接，並與實行該電池充電之充電裝置連接，且其控制該電池充電的狀態，該程式使該控制裝置執行下列程序：

接收並儲存已從該使用者裝置傳送之對應資訊；

接收已從該充電裝置傳送之該序號；

計算預定充電時間，該預定充電時間係基於已從該使用者裝置傳送之對應資訊的接收時間，而預定下一個具有該序號之電池；

彼此互相對應而配置已從該充電裝置傳送之序號與該預定充電時間，並將其儲存作爲充電資訊；及

在該已儲存之預定充電時間前，顯示依照該電池之序號而已被儲存之該識別資訊，以實行提示電池交換的通知。

31. 如申請專利範圍第 30 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：在領先該已儲存的預定充電時間一個預設間隔的時候，實行提示電池交換的通知。

32. 如申請專利範圍第 30 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：當包含於已從該使用者裝置傳送的對應資訊中的序號存在於該充電資訊中時，從該充電資訊刪除該序號以及已依照該序號而配置之預定充電時間。

33. 申請專利範圍第 32 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：當包含於已從該使用者裝置傳送的對應資訊中的序號不存在於該充電資訊中時，則顯示與依照該電池之序號而儲存的該識別資訊，以實行已安裝之電池未完全充電的通知指示。

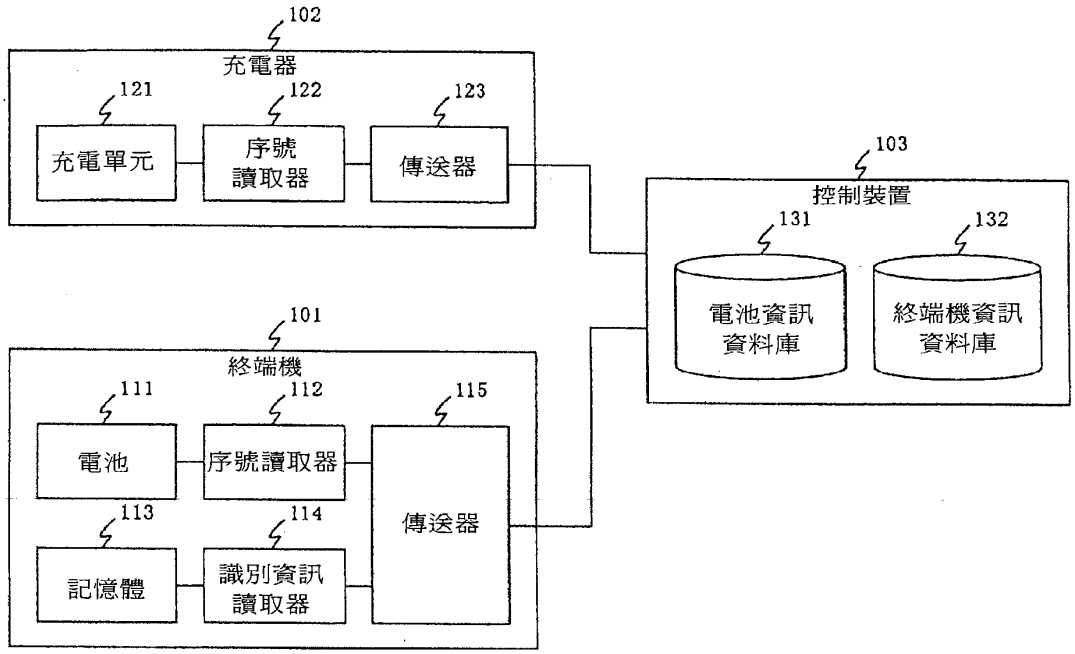
34. 如申請專利範圍第 30 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：基於已從該使用者裝置傳送之對應資訊的接收時間，以及關於該使用者裝置於利用狀態資訊資料庫中已收集之利用狀態資訊，來計算具有該序號之電池的預定充電時間。

35. 如申請專利範圍第 30 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：基於已從該使用者裝置傳送之對應資訊的接收時間，以及該電池於使用狀態資訊資料庫中已收集之使用狀態資訊，來計算具有該序號之電池的預定充電時間。

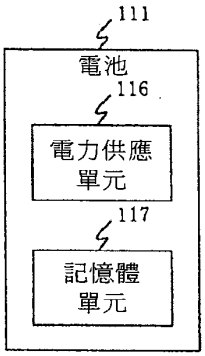
36. 如申請專利範圍第 30 項之記錄媒體，所記錄之程式進一步使該控制裝置執行下列程序：基於關於該使用者之資訊的使用者資訊，來計算對具有序號之電池充電所需的充電量，其中該序號已從該充電裝置被傳送。

十一、圖式：

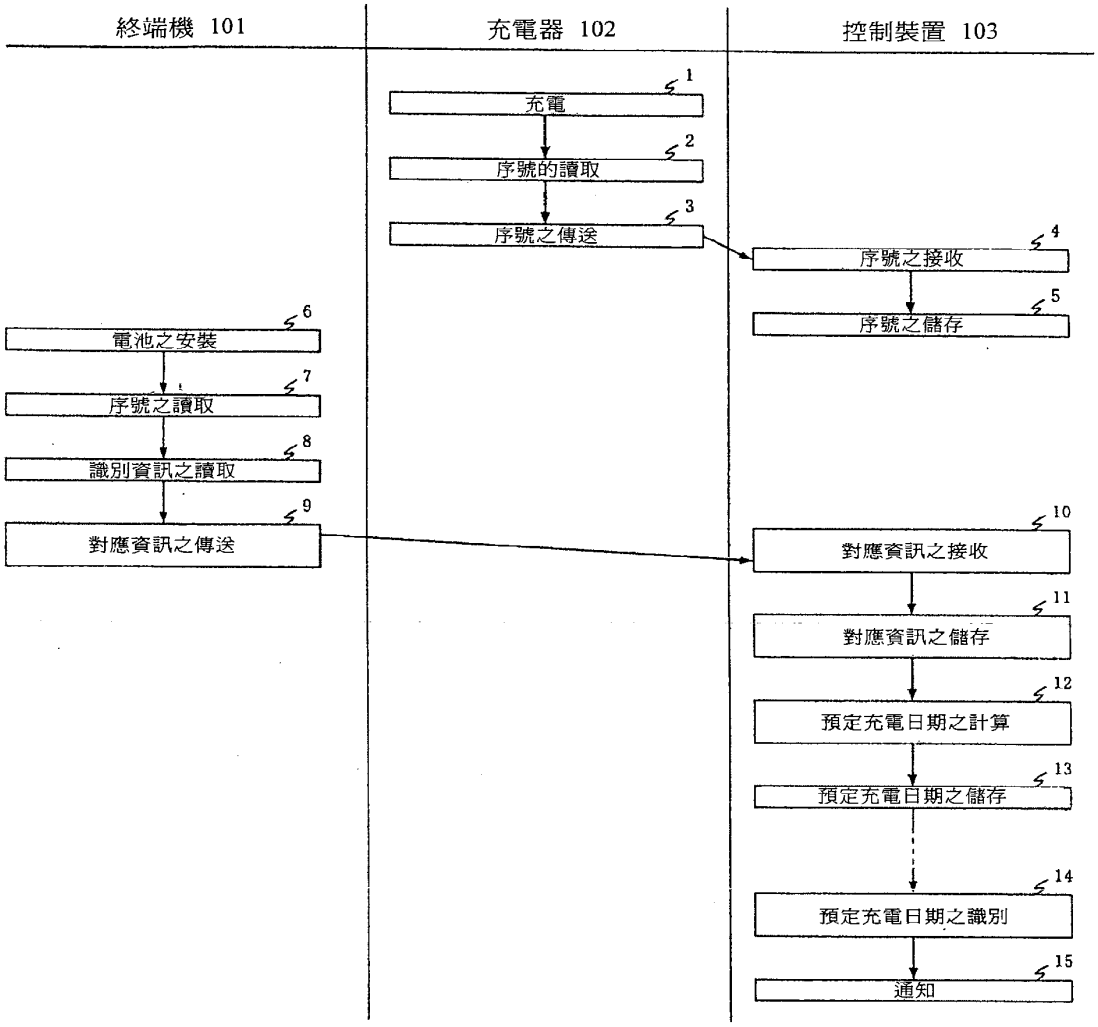
第 1 圖


102
充電器
121
充電單元
122
序號
讀取器
123
傳送器
103
控制裝置
131
電池資訊
資料庫
132
終端機資訊
資料庫
101
終端機
111
電池
112
序號讀取器
115
傳送器
113
記憶體
114
識別資訊
讀取器

第 2 圖



第 3 圖


終端機 101
充電器 102
控制裝置 103
1
充電
2
序號的讀取
3
序號之傳送
4
序號之接收
5
序號之儲存
6
電池之安裝
7
序號之讀取
8
識別資訊之讀取
9
對應資訊之傳送
10
對應資訊之接收
11
對應資訊之儲存
12
預定充電日期之計算
13
預定充電日期之儲存
14
預定充電日期之識別
15
通知

第 4 圖

序號	預定充電日期
00000001	2006.9.22
11111111	2006.11.11
55555555	2006.10.3
⋮	⋮

第 5 圖

序號	識別資訊
00000001	090-1234-5678
11111111	080-2222-3333
55555555	090-7777-8888
⋮	⋮

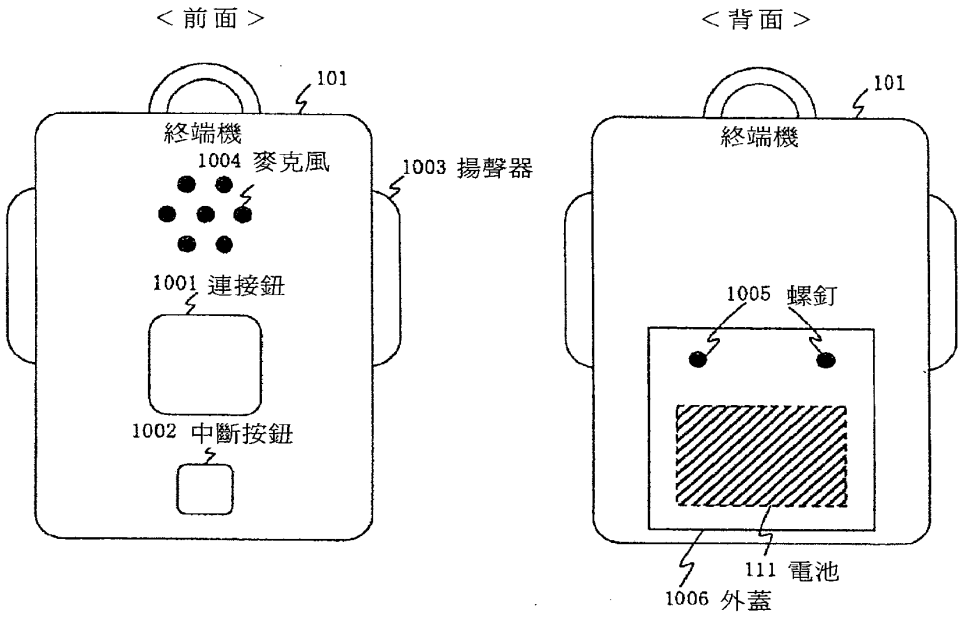
第 6 圖

識別資訊	通信時間
090-1234-5678	10m45s
080-2222-3333	2m10s
090-7777-8888	3m32s
⋮	⋮

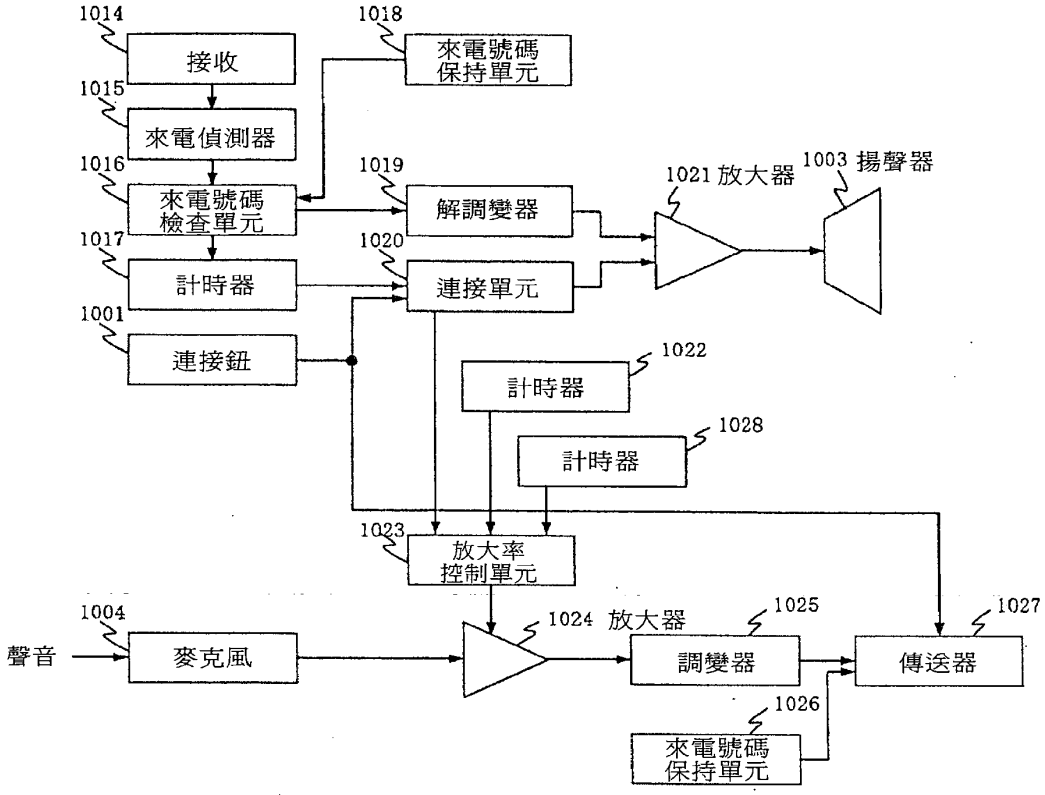
第 7 圖

序號	製造日期	充電時間之編號
00000001	October.2005.	8
11111111	December.2004	12
55555555	January.2006	3
⋮	⋮	⋮

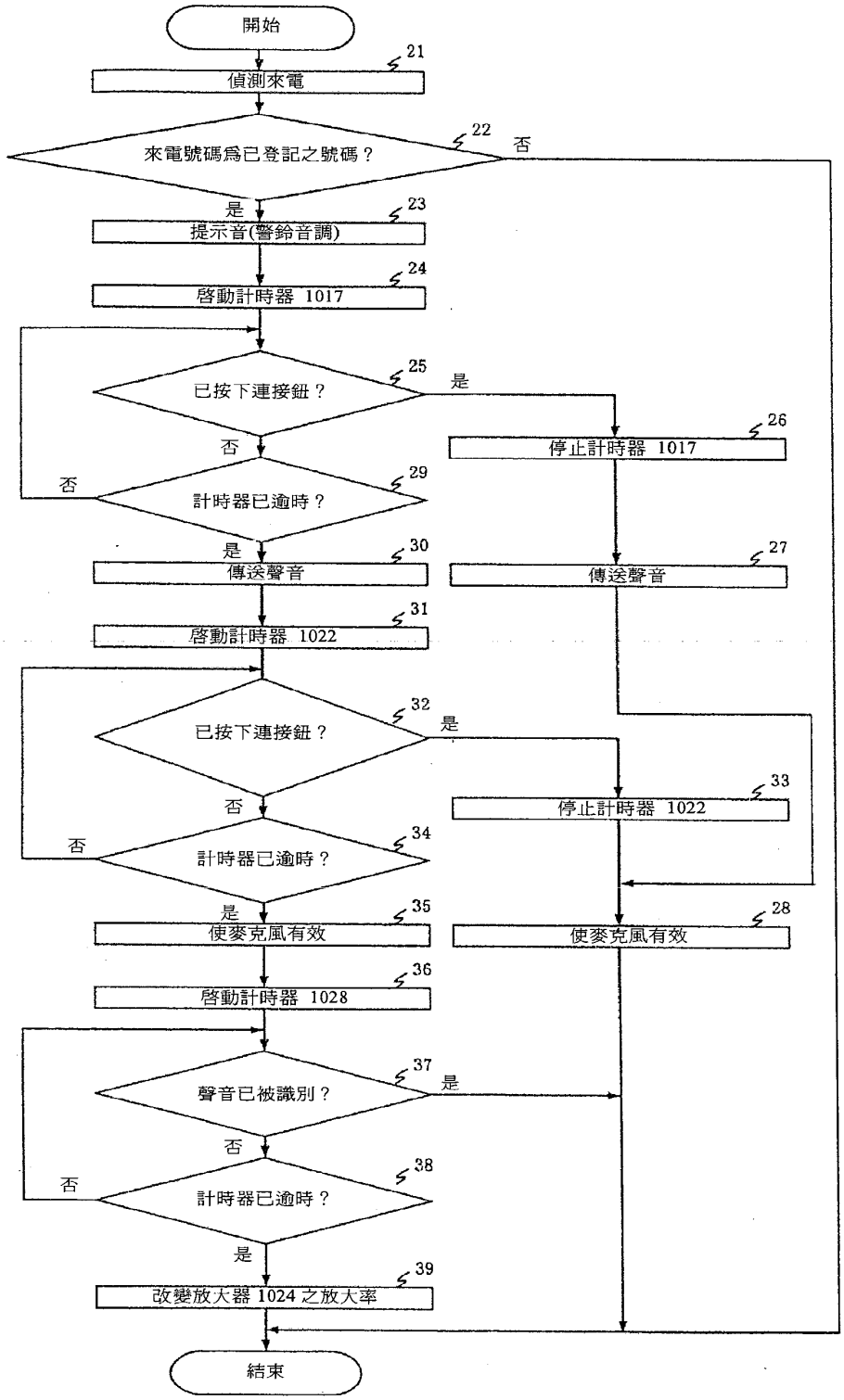
第 8 圖


＜前面＞
＜背面＞
101
終端機
1004 麥克風
1003 揚聲器
1001 連接鈕
1002 中斷按鈕
101
終端機
1005 螺釘
111 電池
1006 外蓋

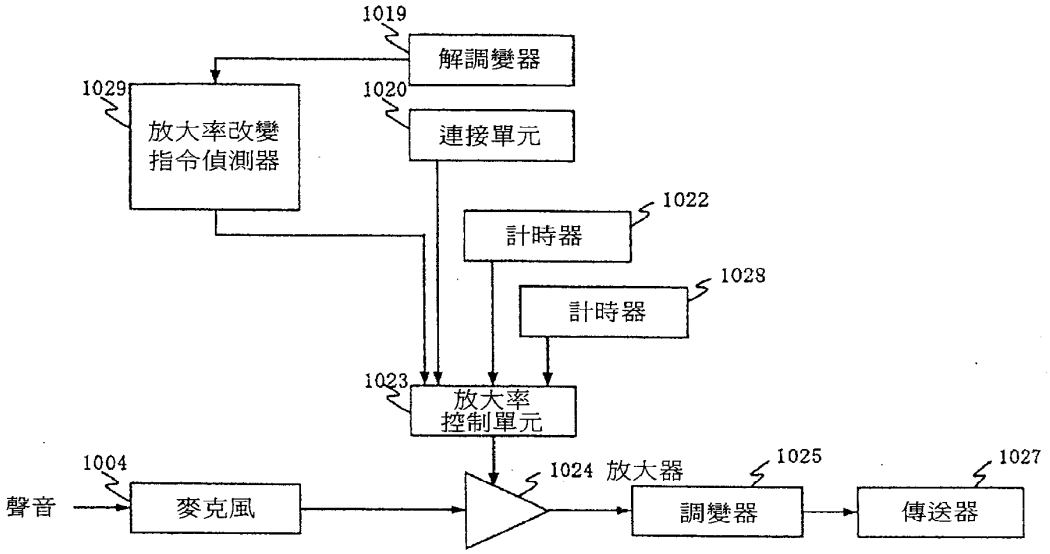
第 9 圖


1014
接收
1018
來電號碼
保持單元
1015
來電偵測器
1016
來電號碼
檢查單元
1019
解調變器
1021 放大器
1003 揚聲器
1017
計時器
1020
連接單元
1001
連接鈕
1022
計時器
1028
計時器
1023
放大率
控制單元
1004
聲音
麥克風
1024 放大器
1025
調變器
1027
傳送器
1026
來電號碼
保持單元

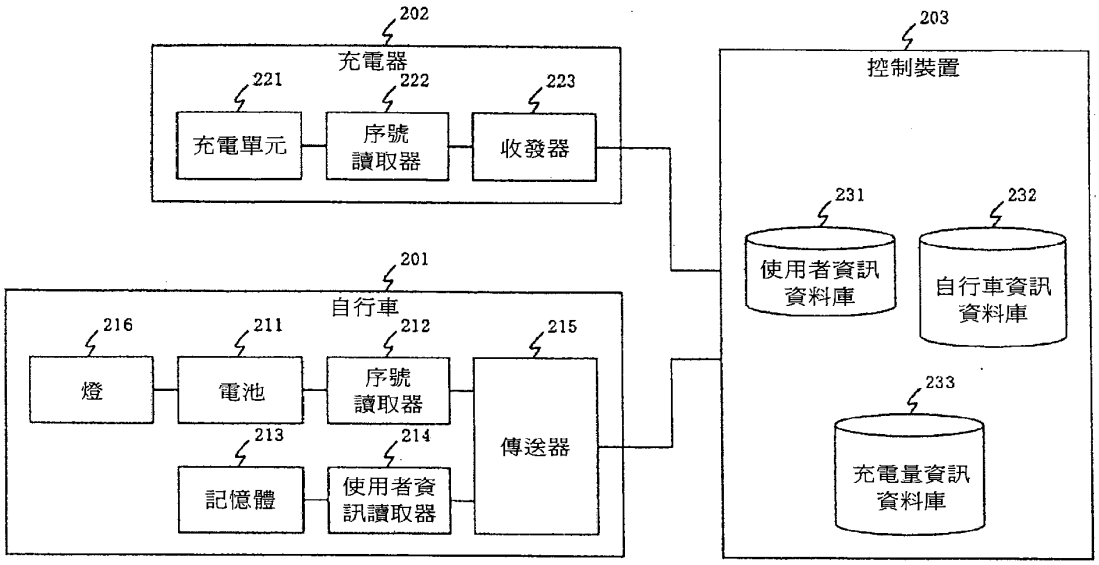
第 10 圖


開始
21
偵測來電
22
來電號碼爲已登記之號碼？
否
是
23
提示音(警鈴音調)
24
啓動計時器 1017
25
已按下連接鈕？
是
否
26
停止計時器 1017
否
29
計時器已逾時？
是
30
傳送聲音
27
傳送聲音
31
啓動計時器 1022
32
已按下連接鈕？
是
否
33
停止計時器 1022
否
34
計時器已逾時？
是
35
使麥克風有效
28
使麥克風有效
36
啓動計時器 1028
37
聲音已被識別？
是
否
38
計時器已逾時？
否
是
39
改變放大器 1024 之放大率
結束

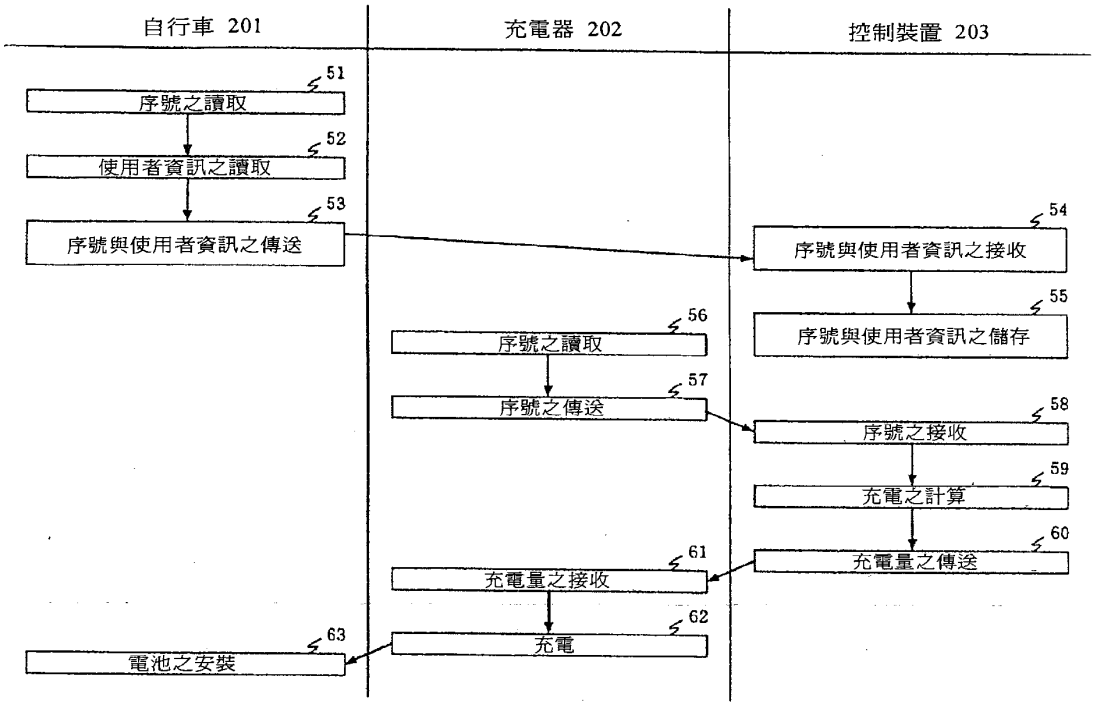
第 11 圖


1019
解調變器
1029
放大率改變
指令偵測器
1020
連接單元
1022
計時器
1028
計時器
1023
放大率
控制單元
1004
聲音
麥克風
1024 放大器
1025
調變器
1027
傳送器

第 12 圖


202
充電器
221
充電單元
222
序號
讀取器
223
收發器
203
控制裝置
231
使用者資訊
資料庫
232
自行車資訊
資料庫
233
充電量資訊
資料庫
201
自行車
216
燈
211
電池
212
序號
讀取器
215
傳送器
213
記憶體
214
使用者資
訊讀取器

第 13 圖


自行車 201
充電器 202
控制裝置 203
51
序號之讀取
52
使用者資訊之讀取
53
序號與使用者資訊之傳送
54
序號與使用者資訊之接收
55
序號與使用者資訊之儲存
56
序號之讀取
57
序號之傳送
58
序號之接收
59
充電之計算
60
充電量之傳送
61
充電量之接收
62
充電
63
電池之安裝

第 14 圖

使用者名字	行進距離 (km)
Fukuzawa Yukichi	4.3
Higuchi Ichiyo	2.1
Noguchi Hideyo	1.7
⋮	⋮

第 15 圖

序號	使用者名字
10000834	Fukuzawa Yukichi
05000872	Higuchi Ichiyo
01000876	Noguchi Hideyo
⋮	⋮

第 16 圖

行進距離 (km)	充電量
0.0～1.9	1
2.0～3.9	3
4.0～5.9	6
⋮	⋮

七、指定代表圖：

(一)本案指定代表圖為：第 1 圖。

(二)本代表圖之元件符號簡單說明：

101	終端機
102	充電器
103	控制裝置
111	電池
112	序號讀取器
113	記憶體
114	識別資訊讀取器
115	傳送器
121	充電單元
122	序號
123	傳送器
131	電池
132	終端機

八、本案若有化學式時，請揭示最能顯示發明特徵的化學式：

Thomson Innovation Patent Export, 2013-05-09 18:30:28 -0500

Record 6/25 TWI315116B Battery exchange/recharge apparatus with renewable energy and wireless communication abilities and the management system thereof

Publication Number: TWI315116B
Publication Date: 2009-09-21
Title: Battery exchange/recharge apparatus with renewable energy and wireless communication abilities and the management system thereof
Application Number: TW2006116353A
Application Date: 2006-05-09
Abstract (English):
Abstract - DWPI:

Abstract - DWPI Novelty:
A battery exchange/recharge apparatus with renewable energy and wireless communication abilities and the management system thereof are disclosed, the apparatus comprising: a renewable energy device; a power storage device; a power supply device; and a battery exchange device; wherein, a power management module is enable to detect statuses of the power supply device and the power storage device while transmitting the detected data to a wireless transmitting/receiving module arranged in the power supply device; and further a battery management module is enabled to detect statuses of the battery exchange device while transmitting the detected data to a wireless transmitting/receiving module arranged in the battery exchange module. In a preferred aspect, as the wireless transmitting/receiving modules of both the power supply device and the battery exchange module are enabled to communicate with a wireless communication system, a control center can monitor the status of the power supply device and the battery exchange module such that an operation center can manage the battery exchange/recharge apparatus dynamically and in real time while keeping the same in an optimal condition.

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四、聲明事項：

☐ 主張專利法第二十二條第二項☐第一款或☐第二款規定之事實，其事實發生日期為：　年　月　日。

☐ 申請前已向下列國家（地區）申請專利：

【格式請依：受理國家（地區）、申請日、申請案號　順序註記】

☐ 有主張專利法第二十七條第一項國際優先權：

☐ 無主張專利法第二十七條第一項國際優先權：

☐ 主張專利法第二十九條第一項國內優先權：

【格式請依：申請日、申請案號　順序註記】

☐ 主張專利法第三十條生物材料：

☐ 須寄存生物材料者：

國內生物材料　【格式請依：寄存機構、日期、號碼　順序註記】

國外生物材料　【格式請依：寄存國家、機構、日期、號碼　順序註記】

☐ 不須寄存生物材料者：

所屬技術領域中具有通常知識者易於獲得時，不須寄存。

九、發明說明：

【發明所屬之技術領域】

本發明係有關一種結合再生能源與無線通訊之供電裝置及電池交換與充電裝置及管理系統，尤指一種藉由再生能源發電，提供蓄電池充電與電池交換裝置及其管理系統，經由無線收發系統及中控中心進行即時監控，進行資料之識別追溯、營運管理、緊急程序之判斷、供電順序控制、生命週期管理以及供電元素之補給，尤適於電動車之蓄電池充電或蓄電池交換與管理。

【先前技術】

目前全球的交通工具舉凡車輛、飛機、船舶大多使用石化燃料為其動力來源，然其引發之溫室效應與自然資源耗盡等因素，迫使人類不得不往無污染、低耗能之電動車輛(EV，Electric Vehicle)以及使用混合式動力之電動車輛(HEV，Hybrid Electric Vehicle)方向發展，但不論是使用純蓄電池供電之電動車輛或是搭配汽油、燃料電池、蓄電池之混合動力電動車輛，都需要仰賴蓄電池將電能儲存後，透過馬達驅動來使電動車輛前進，因此蓄電池之單位能量密度的高低、充放電性能的優劣以及充放電方便與否等…，均為電動車輛發展之關鍵。

以往的電動車輛受限於電池容量的限制，因此續航力大受影響，充電不方便的結果，導致消費者必須返回住家或市電所及之特定場所方可進行電動車輛之電能補給；此

外電動車輛電池充電須耗費冗長的時間(4-8 小時)，故常給予消費者不方便與不安心的刻板印象。

已知美國專利第 6624616 及 6441589 號「Portable battery recharge station」，該兩案均揭露一種使用可攜式電池充電之方法及裝置，惟該法仍須在市電所能及之特定場所或住家方可使用，在市電中斷(地震、火災或者是異常斷電)以及市電無法到達之觀光景點、山林小徑，仍有其不方便性；再者，該兩案不具監控功能，因此不適合設置於偏遠地區，否則發生故障時不易得知，無法及時提供維修，嚴格而言，該兩案所提供之充電站(recharge station)之結構有如一台單純之販賣機，其與傳統電動車充電站之不同也僅僅在於利用再生能源發電。

又如美國專利第 6166515 號「Electrical power supply circuit having a solar generator and a battery」所揭露之技術係為蓄電池結合太陽能板之裝置，但整體裝置並無無線通訊之能力以及無線識別標籤對於蓄電池之狀態進行記錄，進而提供給中控中心進行管理。

再如美國專利第 6704567 號「Wireless communications device and method」，該案揭露一種無線收發裝置(Wireless Access Point)之電源供應裝置及方法，將無線區域網路(WLAN，Wireless Local Area Networks)之節點(Node)裝置設置於電線桿上，與電線桿之電力系統結合，藉由電線桿提供電源以供應無線收發裝置運作所需電力，惟電線桿之設置受地形地物、道路與市電範圍所限，

並不適用於活動範圍不定之電動車，且該案無法提供蓄電池即時交換或充電功能。

【發明內容】

有鑑於習知技術之缺失，本發明之主要目的在於提供一種結合再生能源與無線通訊之供電及蓄電池交換裝置，尤指一種藉由再生能源發電，提供蓄電池充電與電池交換裝置及其管理系統，經由無線收發系統及中控中心進行即時監控，以進行資料之識別追溯、營運管理、緊急程序之判斷、供電順序控制、生命週期管理以及供電元素之補給，尤適於電動車之蓄電池充電或蓄電池交換與管理。

為達上述目的，本發明提出一種結合再生能源與無線通訊之供電及蓄電池交換裝置，其包括：

一再生能源裝置，係用以產生電能；

一電能儲存裝置，係用以儲存該再生能源裝置所產生之電能；

一供電裝置，係用以將該電能儲存裝置之電力提供作為外界電池充電；

一供電裝置管理模組，係用以感測該電能儲存裝置及該供電裝置之狀態；

一供電裝置無線收發模組，係用以接收及傳送該管理模組所感測之資訊；

一蓄電池交換裝置，係包含：

一欲充電之蓄電池容置部，係用以接收外界欲充電之蓄電池；

至少一蓄電池充電裝置，係用以提供外界欲充電之蓄電池充電；

一已完成充電之蓄電池容置部，係用以放置已完成充電之蓄電池；

一蓄電池交換裝置管理模組，係用以感測該蓄電池交換裝置之資訊；

一蓄電池交換裝置無線收發模組，係用以接收並傳送該蓄電池交換裝置管理模組所感測之該蓄電池交換裝置資訊；

無線收發系統，係用以接收供電裝置無線收發模組以及該蓄電池交換裝置無線收發模組所傳送之資訊。

較佳地，該無線收發系統可為 Wireless AP(無線網路基地台)、GPRS(總體分組無線服務)、GPS(全球定位系統)其中之一或其組合。

較佳地，其更包括一中控中心，該中控中心係用以接收該無線收發系統所傳輸之資訊。

較佳地，該中控中心可進行資料之識別追溯、營運管理、緊急程序之判斷與供電順序控制、以及生命週期管理，以及掌握各個再生能源電池交換、充電系統之電力與供電元素之補給。

較佳地，該電力與供電元素之補給包括燃料電池所使用之氫氣、水、醇類、液化石油氣、天然氣、酵素以及有

機化合物其中之一或其組合。

較佳地，該再生能源裝置可為太陽能、風能、燃料電池以及生質能等再生能源裝置其中之一或其組合。

較佳地，該無線收發系統係包含：

至少一無線收發裝置，其係分布於一區域內而形成無線通訊網域，用以接收及傳送該無線收發模組所傳送之資訊；

一中控中心，係用以接收該些無線收發裝置所傳送之資訊，以隨時監控該區域內之該些供電裝置之狀況。

較佳地，其更包括一顯示裝置，係用以顯示該供電裝置管理模組及蓄電池交換裝置管理模組所感測之資訊。

為使　貴審查委員對於本發明之結構目的和功效有更進一步之了解與認同，茲配合圖示詳細說明如后。

【實施方式】

以下將參照隨附之圖式來描述本發明為達成目的所使用的技術手段與功效，而以下圖式所列舉之實施例僅為輔助說明，以利　貴審查委員瞭解，但本案之技術手段並不限於所列舉圖式。

請參閱圖一所示本發明較佳實施例方塊組合示意圖，本發明所提供之一種結合再生能源與無線通訊之供電及蓄電池交換裝置，其包括一用以產生電能之再生能源裝置 1，該再生能源裝置 1 可為太陽能、風能、燃料電池以及生質能等再生能源裝置其中之一或其組合，其產生之電能則係

儲存於一電能儲存裝置2。

前述該電能儲存裝置2所儲存之電能係可提供一供電裝置3以及一蓄電池交換裝置6使用，該供電裝置3係用以將該電能儲存裝置2之電力提供作為外界充電，藉由一供電裝置管理模組4感測該電能儲存裝置2及該供電裝置3之狀態，以及一供電裝置無線收發模組5用以接收及傳送該供電裝置管理模組4所感測之資訊；該蓄電池交換裝置6包含一欲充電之蓄電池容置部61，其係用以接收外界欲充電之蓄電池，以及至少一蓄電池充電裝置62，其係用以提供外界欲充電之蓄電池充電，以及一已完成充電之蓄電池容置部63，其係用以放置已完成充電之蓄電池，綜合該欲充電之蓄電池容置部61、蓄電池充電裝置62及已完成充電之蓄電池容置部63，可將該蓄電池交換裝置6視為一有如蓄電池販賣機之結構，使用者可將電源耗盡之蓄電池置放於該欲充電之蓄電池容置部61內，而後由該已完成充電之蓄電池容置部63拿取一滿電之蓄電池，或可將電源耗盡之電池直接置放於該蓄電池充電裝置62內充電，而該蓄電池充電裝置62可為一插槽或插座型態，視實際蓄電池之外型或配置不同而定；再者，藉由一蓄電池交換裝置管理模組64感測該蓄電池交換裝置6之資訊，以及一蓄電池交換裝置無線收發模組65用以接收並傳送該蓄電池交換裝置管理模組64所感測之該蓄電池交換裝置6資訊；前述該供電裝置管理模組4及蓄電池交換裝置管理模組64所感測之資訊，可顯示於一顯示裝置9上。

前述該供電裝置無線收發模組 5 及蓄電池交換裝置無線收發模組 65 係可與一無線收發系統 7 進行無線訊號接收及傳送，該無線收發系統 7 可為 Wireless AP(無線網路基地台)、GPRS(總體分組無線服務)、GPS(全球定位系統)其中之一或其組合，其具有至少一無線收發裝置 71，亦可於一區域內設置複數之無線收發裝置 71 而形成無線通訊網域，該無線收發裝置 71 所接收之資訊可傳送至一中控中心 8，該中控中心 8 可進行資料之識別追溯、營運管理、緊急程序之判斷與供電順序控制、以及生命週期管理，以及掌握各個再生能源電池交換、充電系統之電力與供電元素之補給，該電力與供電元素之補給包括燃料電池所使用之氫氣、水、醇類、液化石油氣、天然氣、酵素以及有機化合物其中之一或其組合，藉此可達到隨時監控該供電裝置 3 及蓄電池交換裝置 6 之狀況並提出警訊之目的。

補充說明的是，關於上述本發明所提供之供電與蓄電池交換裝置，尤適用於一種具有無線收發功能之蓄電池模組，該類蓄電池模組具有一感測裝置以及第一無線識別標籤，該感測裝置可為壓力感測器、溫度感測器、電池液位偵測器電壓感測器及濃度感測器等其中之一或其組合，其係與該第一無線識別標籤耦接，以提供感測資訊並紀錄於該第一無線識別標籤，再由該第一無線識別標籤將所紀錄之該蓄電池模組之狀態傳送至一電源系統管理單元，該電源系統管理單元具有一無線讀寫器以及一第二無線識別標籤，藉由該無線讀寫器讀取該第一無線識別標籤之資訊以

寫入至該第二無線識別標籤內，再將相關資訊送至一中央處理器進行分析，如此，可對該蓄電池模組之供電狀況、殘留電力、生命週期資訊、保養資訊、電力消耗等狀態進行即時監控；前述有關該類蓄電池模組之結構屬於已知技術，故在此不再予以贅述，至於該蓄電池模組之狀態則可顯示於本發明所具有之顯示裝置9上，以增加使用之便利。

綜上所述，本發明藉由再生能源發電，提供一種便利之供電與蓄電池交換之裝置，並經由無線收發系統及中控中心進行即時監控，尤適於電動車充電或蓄電池交換，並可進行資料之識別追溯、營運管理、緊急程序之判斷、供電順序控制、生命週期管理以及供電元素之補給。

惟以上所述者，僅為本發明之最佳實施例而已，當不能以之限定本發明所實施之範圍。即大凡依本發明申請專利範圍所作之均等變化與修飾，皆應仍屬於本發明專利涵蓋之範圍內，謹請　貴審查委員明鑑，並祈惠准，是所至禱。

五、中文發明摘要：

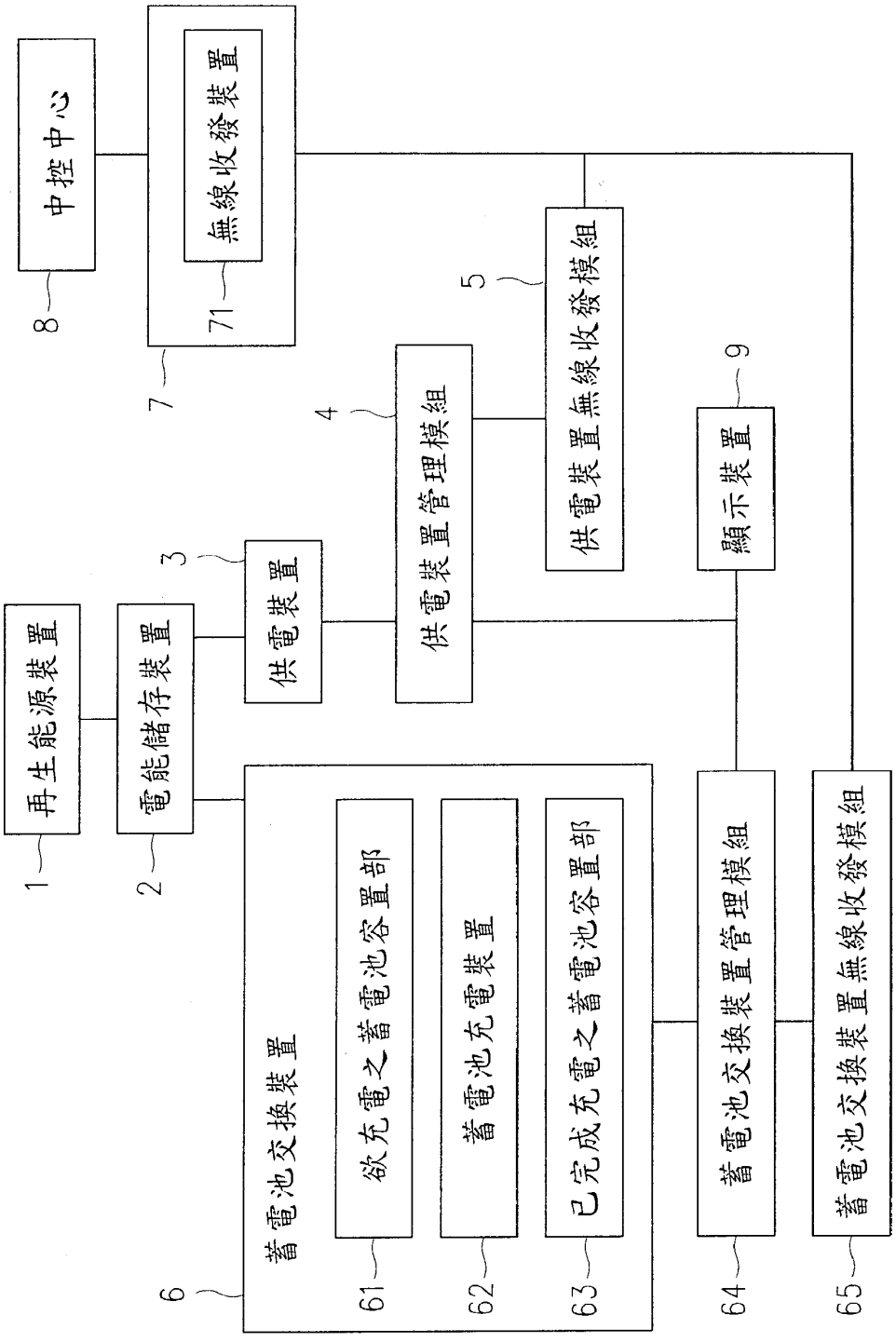
一種結合再生能源與無線通訊之供電與蓄電池交換裝置，包括一再生能源裝置、一電能儲存裝置、一供電裝置或一蓄電池交換裝置，藉由一供電裝置管理模組感測該電能儲存裝置及該供電裝置之狀況並將資訊傳送至一供電裝置無線收發模組，或藉由蓄電池交換裝置管理模組感測該蓄電池交換裝置狀況並將資訊傳送至一蓄電池交換裝置無線收發模組；該供電裝置無線收發模組及蓄電池交換裝置無線收發模組可與一無線收發系統進行無線訊號接收及傳送，並由一中控中心監控該供電及蓄電池交換裝置之狀況並即時掌握動態訊息與狀況，使該裝置及系統保持最佳供電狀態。

六、英文發明摘要：

BATTERY EXCHANGE/RECHARGE APPARATUS WITH RENEWABLE ENERGY AND WIRELESS COMMUNICATION ABILITIES AND THE MANAGEMENT SYSTEM THEREOF

A battery exchange/recharge apparatus with renewable energy and wireless communication abilities and the management system thereof are disclosed, the apparatus comprising: a renewable energy device; a power storage device; a power supply device; and a battery exchange device; wherein, a power management module is enable to detect statuses of the power supply device and the power storage device while transmitting the

detected data to a wireless transmitting/receiving module arranged in the power supply device; and further a battery management module is enabled to detect statuses of the battery exchange device while transmitting the detected data to a wireless transmitting/receiving module arranged in the battery exchange module. In a preferred aspect, as the wireless transmitting/receiving modules of both the power supply device and the battery exchange module are enabled to communicate with a wireless communication system, a control center can monitor the status of the power supply device and the battery exchange module such that an operation center can manage the battery exchange/recharge apparatus dynamically and in real time while keeping the same in an optimal condition.


再生能源裝置
1
電能儲存裝置
2
供電裝置
3
供電裝置管理模組
4
供電裝置無線收發模組
5
蓄電池交換裝置
6
欲充電之蓄電池容置部
61
蓄電池充電裝置
62
已完成充電之蓄電池容置部
63
無線收發裝置
7
71
中控中心
8
顯示裝置
9
蓄電池交換裝置管理模組
64
蓄電池交換裝置無線收發模組
65

圖一

I315116

（案號第 095116353 號專利案之說明書修正）

年 月 日修正替換頁
98. 5 15

公告本

發明專利說明書

（本說明書格式、順序及粗體字，請勿任意更動，※記號部分請勿填寫）

※ 申請案號：P5116353

※ 申請日期：P5.5.P　　※IPC 分類：H02J 4/00 (2006.01)
H04B 1/38 (2006.01)

一、發明名稱：（中文/英文）

結合再生能源與無線通訊之電池交換與充電裝置及管理系統

BATTERY EXCHANGE/RECHARGE APPARATUS WITH RENEWABLE ENERGY AND WIRELESS COMMUNICATION ABILITIES AND THE MANAGEMENT SYSTEM THEREOF

二、申請人：（共 1 人）

姓名或名稱：（中文/英文）

財團法人工業技術研究院

INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE

代表人：（中文/英文）張進福　　CHANG, JIN-FU

住居所或營業所地址：（中文/英文）

新竹縣竹東鎮中興路四段 195 號

NO. 195, SEC. 4, CHUNG-HSING ROAD, CHU-TUNG, HSIN-CHU, TAIWAN, R.O.C.

國　籍：（中文/英文）中華民國 ROC

三、發明人：（共 4 人）

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國　籍：（中文/英文）1-4：中華民國/R.O.C.

年 月 日修正替換頁
98. 5. 15

【圖式簡單說明】

圖一係本發明較佳實施例方塊組合示意圖。

【主要元件符號說明】

1-再生能源裝置

2-電能儲存裝置

3-供電裝置

4-供電裝置管理模組

5-供電裝置無線收發模組

6-蓄電池交換裝置

61-欲充電之蓄電池容置部

62-蓄電池充電裝置

63-已完成充電之蓄電池容置部

64-蓄電池交換裝置管理模組

65-蓄電池交換裝置無線收發模組

7-無線收發系統

71-無線收發裝置

8-中控中心

9-顯示裝置

十、申請專利範圍：

1. 一種結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其包括：

一再生能源裝置，係用以產生電能；

一電能儲存裝置，係用以儲存該再生能源裝置所產生之電能；

一供電裝置，係用以將該電能儲存裝置之電力提供作為外界電池充電；

一管理模組，係用以感測該電能儲存裝置及該供電裝置之狀態；

一中控中心，係用以進行資料之識別追溯、營運管理、緊急程序之判斷與供電順序控制、以及生命週期管理，以及掌握各個再生能源電池交換、充電系統之電力與供電元素之補給，其中該電力與供電元素之補給包括燃料電池所使用之氫氣、水、醇類、液化石油氣、天然氣、酵素以及有機化合物其中之一或其組合。

2. 如申請專利範圍第 1 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括：

一無線收發模組，係用以接收及傳送該管理模組所感測之資訊；

無線收發系統，係用以接收供電裝置無線收發模組所傳輸之資訊，且該無線收發系統可將所接收之資訊傳輸至該中控中心。

3. 如申請專利範圍第 2 項所述之結合再生能源與無線通

訊之電池交換與充電裝置及管理系統，其中該無線收發系統可為 Wireless AP(無線網路基地台)、GPRS(總體分組無線服務)、GPS(全球定位系統)其中之一或其組合。

4. 如申請專利範圍第 1 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該再生能源裝置可為太陽能、風能、燃料電池以及生質能等再生能源裝置其中之一或其組合。

5. 如申請專利範圍第 2 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該無線收發系統係包含至少一無線收發裝置，其係分布於一區域內而形成無線通訊網域，用以接收及傳送該無線收發模組所傳送之資訊。

6. 如申請專利範圍第 1 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括一顯示裝置，係用以顯示該管理模組所感測之資訊。

7. 一種結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其包括：

一再生能源裝置，係用以產生電能；

一電能儲存裝置，係用以儲存該再生能源裝置所產生之電能；

一蓄電池交換裝置，係包含：

一欲充電之蓄電池容置部，係用以接收外界欲充電之蓄電池；

至少一蓄電池充電裝置，係用以提供該欲充電之蓄電池充電；

一已完成充電之蓄電池容置部，係用以放置已完成充電之蓄電池；

一管理模組，係用以感測該蓄電池交換裝置之資訊。

8. 如申請專利範圍第 7 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括：

一無線收發模組，係用以接收及傳送該管理模組所感測之資訊；

無線收發系統，係用以接收供電裝置無線收發模組所傳輸之資訊。

9. 如申請專利範圍第 8 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該無線收發系統可為 Wireless AP(無線網路基地台)、GPRS(總體分組無線服務)、GPS(全球定位系統)其中之一或其組合。

10. 如申請專利範圍第 8 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括一中控中心，該中控中心係用以接收該無線收發系統所傳輸之資訊。

11. 如申請專利範圍第 10 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該中控中心可進行資料之識別追溯、營運管理、緊急程序之判斷與供電順序控制、以及生命週期管理，以及掌握各個再

生能源電池交換、充電系統之電力與供電元素之補給。

12. 如申請專利範圍第 11 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該電力與供電元素之補給包括燃料電池所使用之氫氣、水、醇類、液化石油氣、天然氣、酵素以及有機化合物其中之一或其組合。

13. 如申請專利範圍第 7 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該再生能源裝置可為太陽能、風能、燃料電池以及生質能等再生能源裝置其中之一或其組合。

14. 如申請專利範圍第 8 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該無線收發系統係包含至少一無線收發裝置，其係分布於一區域內而形成無線通訊網域，用以接收及傳送該無線收發模組所傳送之資訊。

15. 如申請專利範圍第 7 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括一顯示裝置，係用以顯示該管理模組所感測之資訊。

16. 一種結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其包括：

一再生能源裝置，係用以產生電能；

一電能儲存裝置，係用以儲存該再生能源裝置所產生之電能；

一供電裝置，係用以將該電能儲存裝置之電力提供作為

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外界電池充電；

一供電裝置管理模組，係用以感測該電能儲存裝置及該供電裝置之狀態；

一蓄電池交換裝置，係包含：

一欲充電之蓄電池容置部，係用以接收外界欲充電之蓄電池；

至少一蓄電池充電裝置，係用以提供該欲充電之蓄電池充電；

一已完成充電之蓄電池容置部，係用以放置已完成充電之蓄電池；

一蓄電池交換裝置管理模組，係用以感測該蓄電池交換裝置之資訊。

17. 如申請專利範圍第 16 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括：

一供電裝置無線收發模組，係用以接收及傳送該供電裝置管理模組所感測之資訊；

一蓄電池交換裝置無線收發模組，係用以接收並傳送該蓄電池交換裝置管理模組所感測之資訊；

無線收發系統，係用以接收供電裝置無線收發模組以及該蓄電池交換裝置無線收發模組所傳送之資訊。

18. 如申請專利範圍第 17 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該無線收發系統可為 Wireless AP(無線網路基地台)、GPRS(總體分組無線服務)、GPS(全球定位系統)其中之一或其組

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合。

19. 如申請專利範圍第 17 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括一中控中心，該中控中心係用以接收該無線收發系統所傳輸之資訊。

20. 如申請專利範圍第 19 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該中控中心可進行資料之識別追溯、營運管理、緊急程序之判斷與供電順序控制、以及生命週期管理，以及掌握各個再生能源電池交換、充電系統之電力與供電元素之補給。

21. 如申請專利範圍第 20 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該電力與供電元素之補給包括燃料電池所使用之氫氣、水、醇類、液化石油氣、天然氣、酵素以及有機化合物其中之一或其組合。

22. 如申請專利範圍第 16 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該再生能源裝置可為太陽能、風能、燃料電池以及生質能等再生能源裝置其中之一或其組合。

23. 如申請專利範圍第 17 項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其中該無線收發系統係包含至少一無線收發裝置，其係分布於一區域內而形成無線通訊網域，用以接收及傳送該無線收發模組所傳送之資訊。

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24. 如申請專利範圍第16項所述之結合再生能源與無線通訊之電池交換與充電裝置及管理系統，其更包括一顯示裝置，係用以顯示該供電裝置管理模組及該蓄電池交換裝置管理模組所感測之資訊。

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七、指定代表圖：

（一）本案指定代表圖為：第（一）圖。

（二）本代表圖之元件符號簡單說明：

1-再生能源裝置

2-電能儲存裝置

3-供電裝置

4-供電裝置管理模組

5-供電裝置無線收發模組

6-蓄電池交換裝置

61-欲充電之蓄電池容置部

62-蓄電池充電裝置

63-已完成充電之蓄電池容置部

64-蓄電池交換裝置管理模組

65-蓄電池交換裝置無線收發模組

7-無線收發系統

71-無線收發裝置

8-中控中心

9-顯示裝置

八、本案若有化學式時，請揭示最能顯示發明特徵的化學式：

M371880

(19)中華民國智慧財產局

(12)新型說明書公告本 **(11)證書號數：TW M371880U1**

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(21)申請案號：098209922 (22)申請日： 中華民國 98 (2009) 年 06 月 05 日

(51)Int. Cl.： ***G01R31/28 (2006.01)***

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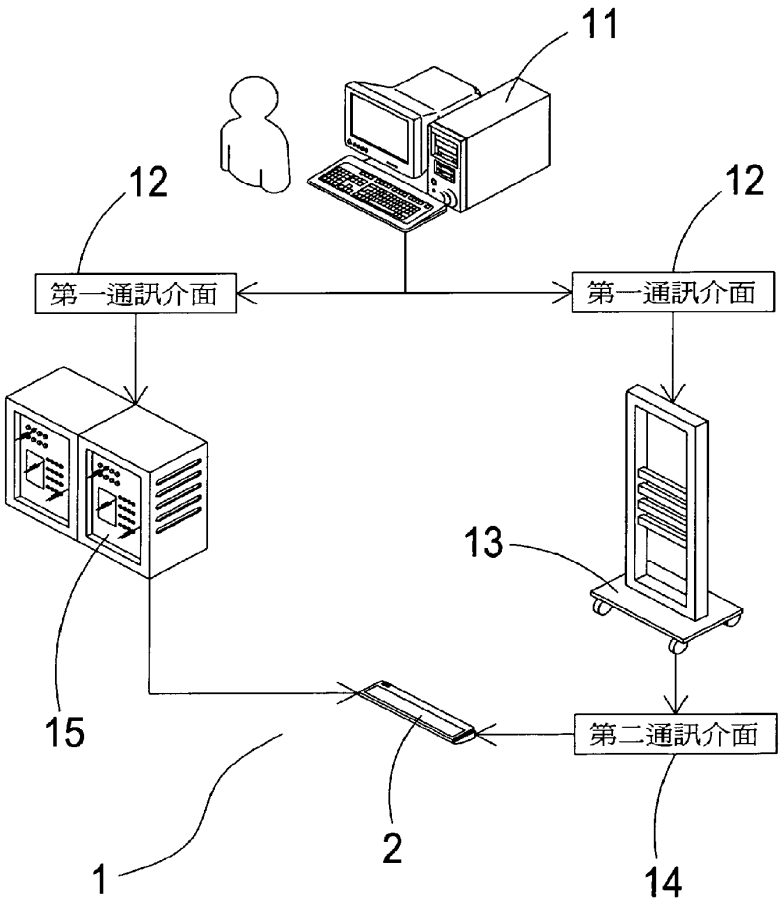
申請專利範圍項數：6 項 圖式數：2 共 9 頁

(54)名稱

抗雜訊之電池偵測裝置

(57)摘要

本創作為有關於一種抗雜訊之電池偵測裝置，所述電池偵測裝置係由一電子裝置、一通訊裝置及一控制裝置所構成，該電子裝置係經由一第一通訊介面將一訊息傳遞至該通訊裝置，而該第一通訊介面即為 RS485，係達到具有抗雜訊之功能，同時，該通訊裝置係透過一第二通訊介面與欲待測之電池單元相連接，而電池單元係電性耦接該控制裝置，該控制裝置透過一第一通訊介面與該電子裝置連接，藉此，透過該通訊裝置、電池單元與該電子裝置的連接，即可藉由該通訊裝置讀取該等電池單元相關資料，且同時因採用 RS485，而達到抗雜訊之功能。



1・・・電池偵測裝置
11・・・電子裝置
12・・・第一通訊介面
13・・・通訊裝置
14・・・第二通訊介面
15・・・控制裝置
2・・・電池單元

第一圖

公告本

新型專利說明書

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

※ 申請案號：98209922

※ 申請日：98.6.5 ※IPC分類：G01R31/28 (2006.01)

一、新型名稱：（中文/英文）

抗雜訊之電池偵測裝置

二、中文新型摘要：

本創作為有關於一種抗雜訊之電池偵測裝置，所述電池偵測裝置係由一電子裝置、一通訊裝置及一控制裝置所構成，該電子裝置係經由一第一通訊介面將一訊息傳遞至該通訊裝置，而該第一通訊介面即為ＲＳ４８５，係達到具有抗雜訊之功能，同時，該通訊裝置係透過一第二通訊介面與欲待測之電池單元相連接，而電池單元係電性耦接該控制裝置，該控制裝置透過一第一通訊介面與該電子裝置連接，藉此，透過該通訊裝置、電池單元與該電子裝置的連接，即可藉由該通訊裝置讀取該等電池單元相關資料，且同時因採用ＲＳ４８５，而達到抗雜訊之功能。

三、英文新型摘要：

四、指定代表圖：

（一）本創作指定代表圖為：第一圖。

（二）本代表圖之元件符號簡單說明：

電池偵測裝置・・・1

電子裝置・・・・・11

第一通訊介面・・・12

通訊裝置・・・・・13

第二通訊介面・・・14

控制裝置・・・・・15

電池單元・・・・・2

五、新型說明：

【新型所屬之技術領域】

本創作為提供一種電池偵測裝置，尤指一種具有良好抗雜訊能力通訊界面的抗雜訊之電池偵測裝置。

【先前技術】

按，一般電池偵測裝置的通訊介面（ＳＭＢｕｓ）其通訊距離多有一定的距離，且處理資料的控制裝置通常係與欲控制之裝置有一距離，於該距離的長度往往影響實驗結果，而通訊介面（ＳＭＢｕｓ）其本身的雜訊電容量有一官方統一規格，俾當電池跟測試系統間的通訊線超過４００ｐｆ，其通訊即產生出問題，即是雜訊電容量的一個現象，再者，於實際測試中，電池必須做一高、中、低位的測試，因此，電池必須置於裝置內，進而進行充放電測試實驗，但，機台一般都置於外面，因此，其通訊即開始產生出問題，當拉線過長時，雜散電容量就會變大，導致實驗就沒辦法做。

是以，要如何解決上述習用之問題與缺失，即為本創作之創作人與從事此行業之相關廠商所亟欲研究改善之方向所在者。

【新型內容】

故，本創作之創作人有鑑於上述缺失，乃搜集相關資料，經由多方評估及考量，並以從事於此行業累積之多年經驗，經由不斷試作及修改，始設計出此種具有良好抗雜訊能力通訊界面的抗雜訊之電池偵測裝置新型專利者。

本創作之主要目的在於：所述電池偵測裝置主要係包括一電子裝置，該電子裝置係可控制至少一電池單元，而該電池單元係與一通訊裝置相組接，且該通訊裝置係藉由一抗雜訊之第一通訊介面與該電子裝置相接，再該通訊裝置係透過一第二通訊介面與該電池單元耦接，並且，該電子裝置係經由一第一通訊介面接設一控制裝置，而該控制裝置係電性連接該電池單元，藉此，俾當使用者欲偵測該電池單元時，亦可將該通訊裝置拆卸移至鄰近該控制裝置，且藉由該第一通訊介面及第二通訊介面做為傳輸媒介，得以達到良好抗雜訊比；藉由上述

技術，可針對習用電池偵測裝置所存在之當電池跟測試系統間的通訊線超過４００ｐｆ，其通訊即產生出問題，即是雜訊電容量的一個現象，而於實際測試中，電池必須做一高、中、低位的測試，也因此電池必須置於裝置內，進而進行充放電測試實驗，不過一般機台都置於外面，使其通訊即開始產生出問題，當拉線過長時，雜散電容量就會變大，導致實驗就沒辦法做的問題點加以突破，達到藉由可外掛移動式的通訊裝置，並且採用ＲＳ４８５做為通訊介面，因此，不僅達到抗雜訊能力，並且只要把通訊裝置拆裝下來之後移至控制裝置旁，即可接設該等電池單元之實用進步性。

【實施方式】

為達成上述目的及功效，本創作所採用之技術手段及構造，茲繪圖就本創作較佳實施例詳加說明其特徵與功能如下，俾利完全了解。

請參閱第一圖所示，係為本創作較佳實施例之流程示意圖，由圖中可清楚看出本創作電池偵測裝置１係包括：

一電子裝置１１，該電子裝置１１係可控制至少一電池單元２，並且係可為電腦；

一通訊裝置１３，係透過一第一通訊介面１２與該電子裝置１１相連接，而該第一通訊介面１２係為一具有抗雜訊功能之ＲＳ４８５，並且該通訊裝置１３係透過第二通訊介面１４與該電池單元２相組接，該第二通訊介面１４為一通訊介面ＳＭＢｕｓ，再者，該通訊裝置１３係可為一活動式架體；及

一控制裝置１５，係透過一第一通訊介面１２與該電子裝置１１連接，且與該電池單元２電性耦接，其中，該控制裝置１５係為一充放電控制裝置。

藉由上述之結構、組成設計，茲就本創作之使用作動情形說明如下，請同時配合參閱第一圖及第二圖所示，係為本創作較佳實施例之流程示意圖及方塊示意圖，由圖中可清楚看出，該電池偵測裝置１主要係藉由一電子裝置１１對該等電池單元２進行相關資料控制，而該電子裝置１１透過一通訊轉接裝置１６與一第一通訊介面１２做連結

，該第一通訊介面１２即為ＲＳ４８５，其ＲＳ４８５具有良好的抗雜訊能力與大面積長距離傳輸的距離，且可提供高速之數據通信速率，再者，該第一通訊介面１２係連接一通訊裝置１３，而該通訊裝置１３係藉由一第二通訊介面１４與該電池單元２連接，進而得以透過該通訊裝置１３讀取該電池單元２內部參數值以作為電池單元２品質的判定與相關資料收集，而於進行上述過程中，該電池單元２係透過一控制裝置１５對該電池單元２做充放電動作，藉此，可得知該電池單元２之實驗結果，再者，該控制裝置１５係透過一第一通訊介面１２與該電子裝置１１連接，使該電子裝置１１得以對該控制裝置１５做控制。

惟，以上所述僅為本創作之較佳實施例而已，非因此即侷限本創作之專利範圍，故舉凡運用本創作說明書及圖式內容所為之簡易修飾及等效結構變化，均應同理包含於本創作之專利範圍內，合予陳明。

故，請參閱全部附圖所示，本創作使用時，與習用技術相較，著實存在下列優點：

透過該通訊裝置１３亦可解決通訊距離上因受迴路上雜散電容量的限制，並無法有太長的通訊距離之問題，再者，該通訊裝置１３與該電子裝置１１係藉由具有抗雜訊功能的第一通訊介面１２（ＲＳ４８５）做連接傳輸，使其於延長該通訊裝置１３時，數據還能保持正確的判讀。

又者，該通訊裝置１３係為可活動式架體，使得使用者得以將該通訊裝置１３移動至鄰近該控制裝置１５處。

綜上所述，本創作之抗雜訊之電池偵測裝置於使用時，為確實能達到其功效及目的，故本創作誠為一實用性優異之創作，為符合新型專利之申請要件，爰依法提出申請，盼　審委早日賜准本創作，以保障創作人之辛苦創作，倘若　鈞局審委有任何稽疑，請不吝來函指示，創作人定當竭力配合，實感德便。

【圖式簡單說明】

第一圖　係為本創作較佳實施例之流程示意圖。

第二圖　係為本創作較佳實施例之方塊示意圖。

【主要元件符號說明】

電池偵測裝置・・・1

電子裝置・・・・・11

第一通訊介面・・・12

通訊裝置・・・・・13

第二通訊介面・・・14

控制裝置・・・・・15

通訊轉接裝置・・・16

電池單元・・・・・2

六、申請專利範圍：

1、一種抗雜訊之電池偵測裝置，所述電池偵測裝置主要係包括：

一電子裝置，係可控制至少一電池單元；

一通訊裝置，係透過一第一通訊介面與該電子裝置相連接，並且該通訊裝置係透過一第二通訊介面與該電池單元相連接；及

一控制裝置，係透過一第一通訊介面與該電子裝置連接，且與該電池單元電性耦接。

2、如申請專利範圍第1項所述之抗雜訊之電池偵測裝置，其中該通訊裝置係可為一活動式架體。

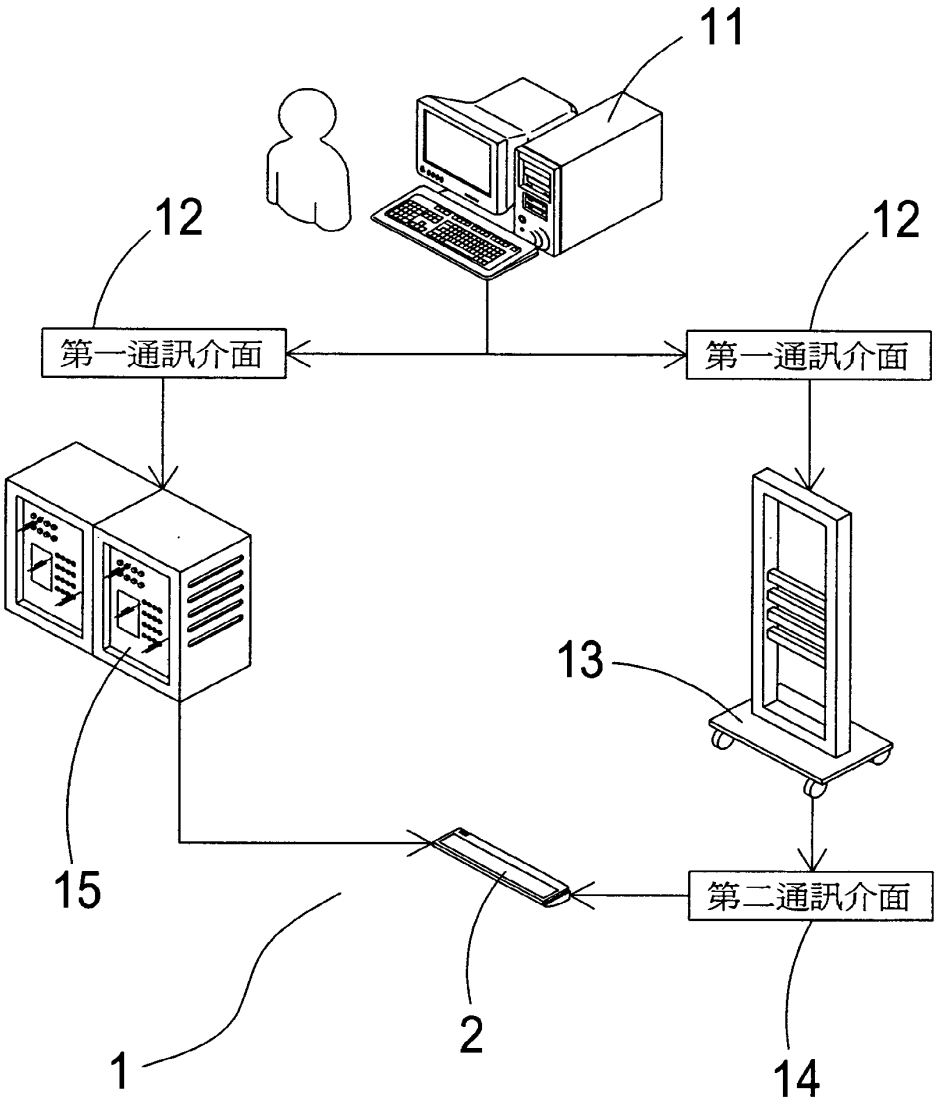
3、如申請專利範圍第1項所述之抗雜訊之電池偵測裝置，其中該電子裝置係可為電腦。

4、如申請專利範圍第1項所述之抗雜訊之電池偵測裝置，其中該通訊介面係為一ＲＳ４８５。

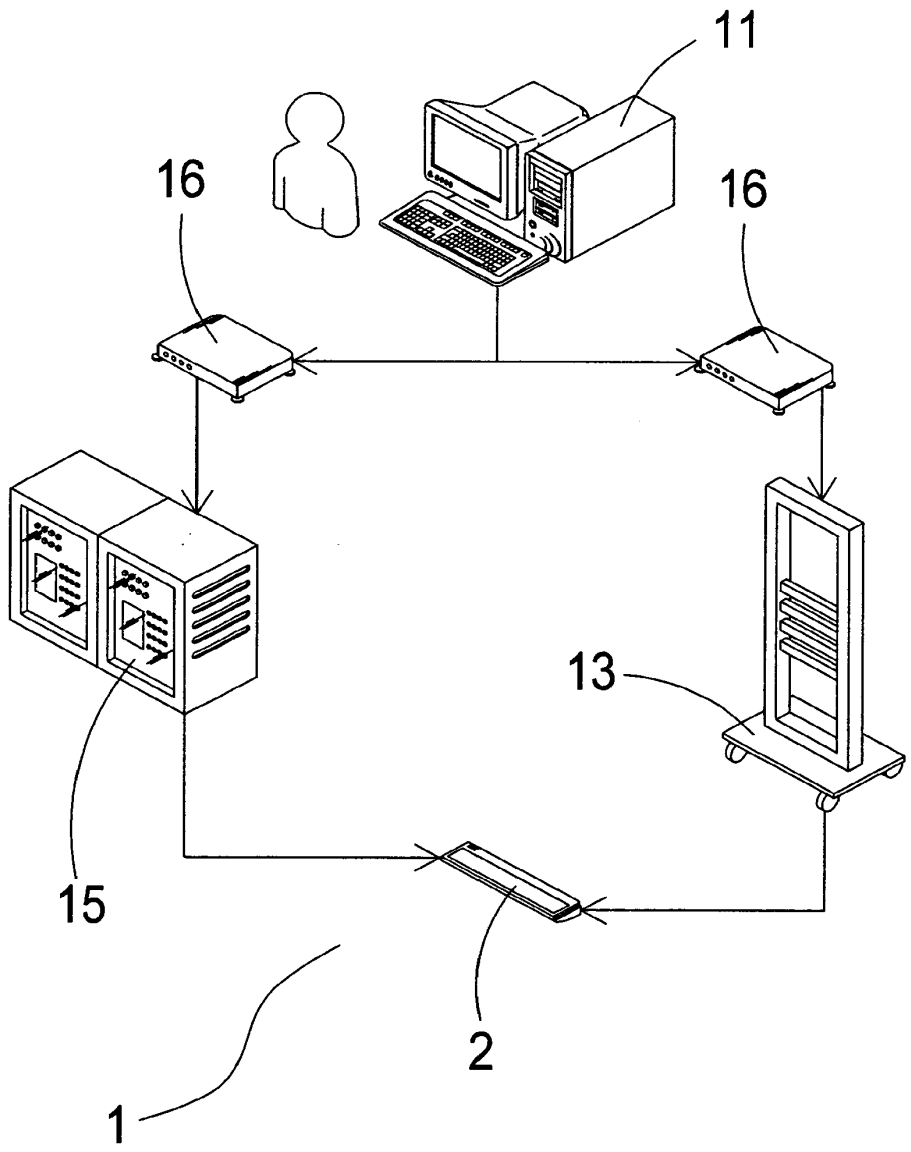
5、如申請專利範圍第1項所述之抗雜訊之電池偵測裝置，其中該第二通訊介面為一ＳＭＢｕｓ。

6、如申請專利範圍第1項所述之抗雜訊之電池偵測裝置，其中該控制裝置係為一充放電控制裝置。

七、圖式：



第一圖



第二圖

(19)中華民國智慧財產局

(12)新型說明書公告本 **(11)證書號數：TW M379269U1**

(43)公告日： 中華民國 99 (2010) 年 04 月 21 日

(21)申請案號：098219689 (22)申請日： 中華民國 98 (2009) 年 10 月 26 日

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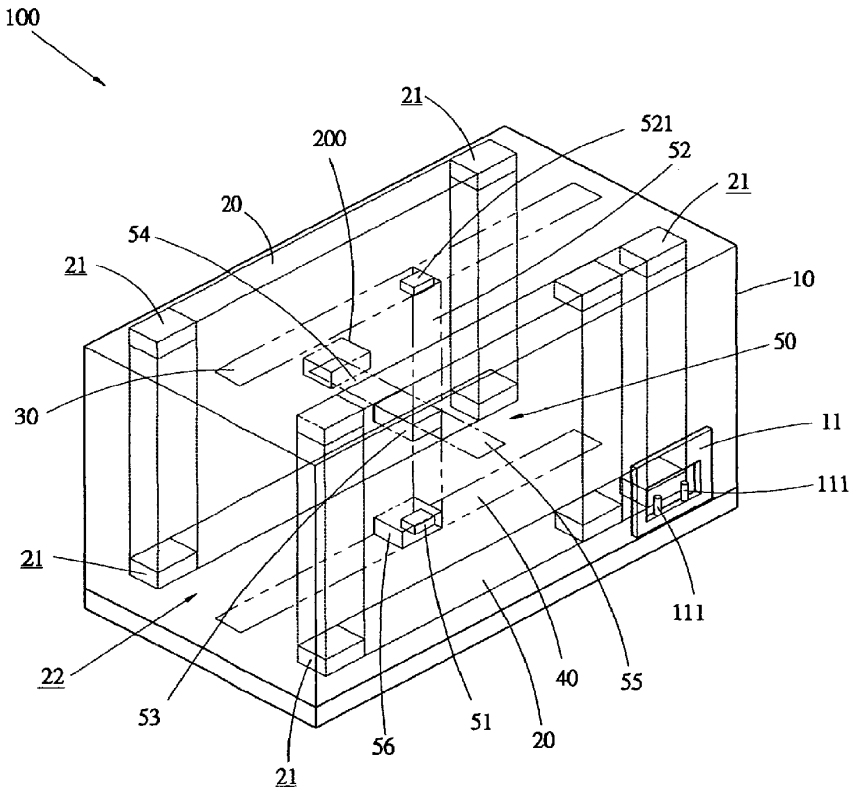
申請專利範圍項數：22 項 圖式數：14 共 37 頁

(54)名稱

定點式電池交換裝置

(57)摘要

本創作係為一種定點式電池交換裝置，包含至少一固定式電池充電容置櫃，設有至少一電池交換口，供至少一個充電電池納置及交換，至少一對電池容置格架模組分列設置於固定式電池充電容置櫃內，並形成一通道，各電池容置格架模組內分設有若干電池容置槽，供交換充電電池容置，該電池容置槽內設有至少一充電座，至少一對移動軌道分設於該通道上、下端，至少一電池移位插拔手臂連結於兩移動軌道之間，使該電池移位插拔手臂沿該移動軌道位移至各電池容置格架模組之對應電池容置槽位置，再由電池移位插拔手臂作上或下或前或後的位置控制，將該充電電池推入各電池容置櫃或自電池容置櫃中取出移動至其他電池容置櫃或電池交換口，至少一電池交換管理器控制該電池移位插拔手臂之位移操作及電池容置櫃中之充電座充電操作。



第一圖

100・・・定點式電池交換裝置

10・・・固定式電池充電容置櫃

11・・・電池交換口

111・・・托柱

20・・・電池容置格架模組

21・・・電池容置槽

22・・・通道

30・・・移動軌道

40・・・移動軌道

50・・・電池移位插拔手臂

51・・・底座

52・・・垂直軌道

521・・・軌道連接器

53・・・第一驅動器

54 及 55・・・插拔臂

56・・・第二驅動器

200・・・充電電池

公告本

新型專利說明書

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

※申請案號：98219689

※申請日：98.10.26 ※IPC 分類：H02J 7/00 (2006.01)

一、新型名稱：(中文/英文)

定點式電池交換裝置

二、中文新型摘要：

本創作係為一種定點式電池交換裝置，包含至少一固定式電池充電容置櫃，設有至少一電池交換口，供至少一個充電電池納置及交換，至少一對電池容置格架模組分列設置於固定式電池充電容置櫃內，並形成一通道，各電池容置格架模組內分設有若干電池容置槽，供交換充電電池容置，該電池容置槽內設有至少一充電座，至少一對移動軌道分設於該通道上、下端，至少一電池移位插拔手臂連結於兩移動軌道之間，使該電池移位插拔手臂沿該移動軌道位移至各電池容置格架模組之對應電池容置槽位置，再由電池移位插拔手臂作上或下或前或後的位置控制，將該充電電池推入各電池容置櫃或自電池容置櫃中取出移動至其他電池容置櫃或電池交換口，至少一電池交換管理器控制該電池移位插拔手臂之位移操作及電池容置櫃中之充電座充電操作。

三、英文新型摘要：

四、指定代表圖：

(一)本案指定代表圖為：第（一）圖。

(二)本代表圖之元件符號簡單說明：

100 定點式電池交換裝置	10 固定式電池充電容置櫃
11 電池交換口	111 托柱
20 電池容置格架模組	21 電池容置槽
22 通道	30 移動軌道
40 移動軌道	50 電池移位插拔手臂
51 底座	52 垂直軌道
521 軌道連接器	53 第一驅動器
54 及 55 插拔臂	56 第二驅動器
200 充電電池	

五、新型說明：

【新型所屬之技術領域】

本創作係關於一種定點式電池交換裝置，特別是一種應用於電動車輛電池定點交換，及具有移動軌道及充電電池移動機械手臂存取與交換充電電池操作之裝置。

【先前技術】

電動車輛為極欲取代高污及耗油汽車之綠能代步交通工具之一，但無論是電動機車或電動汽車，最主要的關鍵組件即為作為行駛動力能源之充電電池，有鑒於設置充電站的設備及土地成本太高，電動車輛充電站無法普及與大量設置，是阻滯電動車輛普遍化之問題根源。

因此，有許多解決的方案因此因運而生，諸如中華民國專利公報第 412095 號「移動式電池充電及交換裝置」新型專利案，則初步揭示關於充電電池交換的雛型技術，但諸如此類習知之車載式移動電池交換站的硬體結構，單就整台 20 呎或 40 呎長之充電箱在作移動時，因行駛路面之顛簸不平產生震動，導致箱內用來移動充電電池的機械手臂(robot arm)進行充電電池之位移操作時，易失去精準度，爾後在對每一儲存格作存或取之動作時，將會產生誤動作，即使在每一次停到定位，作初始化(initialization)之動作時，將因上述機械手臂本身之移位，而無法以調整誤差方式來對準(alignment)操作，故此種習知車載式移動電池交換站之設計，在機械操作精準度及防震度之問題，在無法被作有效及低成本解決之前，並不易被大量應用及提供給產業利用。

此外，在相關的先前專利文獻方面，如本申請人前向　鈞局申請在案之第 098208685 號「移動式電池充電交換裝置」新型專利申請案，已初步揭示關於車載移動式充電電池交換站的進一步改善技術與方案。

【新型內容】

習知電動車輛之充電電池因電池儲能容量或充電站不普及，以及，習知車載移動式充電電池交換站的機械手臂易因車載移動產生震動而失去精準度及誤動作之問題與缺點，而無法被大量應用及提供給產業利用。

緣此，本創作之目的，係在於提供一種定點式電池交換裝置，包含至少一固定式電池充電容置櫃，設有至少一電池交換口，供至少一個充電電池納置及交換，至少一對電池容置格架模組分列設置於固定式電池充電容置櫃內，並形成一通道，各電池容置格架模組內分設有若干電池容置槽，供交換充電電池容置，該電池容置槽內設有至少一充電座，至少一對移動軌道分設於該通道上、下端，至少一電池移位插拔手臂連結於兩移動軌道之間，使該電池移位插拔手臂沿該移動軌道位移至各電池容置格架模組之對應電池容置槽位置，再由電池移位插拔手臂作上或下或前或後的位置控制，將該充電電池推入各電池容置櫃或自電池容置櫃中取出移動至其他電池容置櫃或電池交換口，至少一電池交換管理器控制該電池移位插拔手臂之位移操作及電池容置櫃中之充電座充電操作，以構成一精準度佳及低成本的電池交換裝置。

本創作之定點式電池交換裝置之功效，在於藉由固定式電池充電容置櫃、電池容置格架模組、電池移位插拔手臂及電池交換管理器，讓充電電池交換、充電操作時，不會受到震動因素影響電池移位插拔手臂操作精準度，並且，不會產生任何誤動作之問題與缺點，可以確保其充電電池交換操作之精準度與品質，進而讓充電電池交換站大量普及設置，以解決電動車輛長久以來積存之充電電池充電與交換之問題。

【實施方式】

請參閱第一圖、第二圖、第三圖及第四圖所示，為本創作之定點式電池交換裝置 100 的第一實施例，其中，該定點式電池交換裝置 100 係包括至少一固定式電池充電容置櫃 10，該固定式電池充電容置櫃 10 之型式不限，在本創作中係以固定式貨櫃為例，該固定式電池充電容置櫃 10 可以由一車輛拖至交換定點放置，該固定式電池充電容置櫃 10 中至少設有一電池交換口 11，該電池交換口 11 內設有至少一對托柱 111，該托柱 111 供一充電電池 200(如第二圖所示)定位容置進行交換。

至少一對電池容置格架模組 20，分列設置於固定式電池充電容置櫃 10 內部，各電池容置格架模組 20 內並設有若干電池容置槽 21，各電池容置槽 21 中可儲放容置至少一充電電池 200，容置槽該電池容置槽 21 內設有至少一充電座 211，該充電座 211 設有至少一對充電連接器 211a 及 211b，該充電連接器 211a 及 211b 之型態不限，在第一實施例中係為母插座，該電池容置槽 21 內並設有至少一對托柱 212，每一托拄 212 係供至少一充電電池 200 容置固定定位，上述兩電池容置格架模組 20 之間並形成一通道 22。

至少一對移動軌道 30 及 40，分別設於分別設於該電池容置格架模組 20 間之通道 22 的上、下端，為相互上、下平行對應之軌道。

至少一電池移位插拔手臂 50，設於上述移動軌道 30 及 40 之間，可以沿該移動軌道 30 及 40 位移，以移動至固定式電池充電容置櫃 10 之電池交換口 11 或該電池容置格架模組 20 之各電池容置槽 21 位置，該電池移位插拔手臂 50 之型態不限，在本創作中係列舉包括一底座 51、垂直軌道 52、第一驅動器 53、一對插拔臂 54、55、第二驅動器 56 及一第三驅動器 57 為例，其中，該底座 51 固定於位於通道 22 下端之移動軌道 40，且底座 51 並設有至少一驅動件 511，該驅動件 511 之型式不限，例如：電動馬達，以驅動底座 51 沿移動軌道 40 移動。

該垂直軌道 52 連結於底座 51 上方及移動軌道 30 之間，該垂直軌道 52 上方係設有至少一軌道連接器 521，該軌道連接器 521 用來連結該移動軌道 30，以使該垂直軌道 52 隨底座 51 於移動軌道 30 及 40 間作位移。

該第一驅動器 53 連結於垂直軌道 52 上，可沿該垂直軌道 52 作上、下位移操作，該第一驅動器 53 可驅動左、右兩側水平軸向運動，在本創作中係列舉以水平雙軸驅動之氣壓缸為例，其他等效之液壓或電動驅動設備當不脫其範疇。

該兩插拔臂 54 及 55 分別連結於該第一驅動器 53 之左、右水平軸向位置，以受該第一驅動器 53 驅動而作向外伸展或向內縮之操作，該插拔臂 54 及 55 之末端分別設有至少一對定位擋子 541 及 551，該兩定位擋子 541 及 551 為一前一後及一上一下之位置設置，且該定位擋子 541 及 551 高度低於各電池容置槽 21 之托柱 212 之高度，以使兩插拔臂 54 及 55 可受第一驅動器 53 之水平驅動而伸入各電池容置槽 21 之托柱 212 間。

第二驅動器 56 設於底座 51 上方，且該第二驅動器 56 連結該第一驅動器 53 及兩插拔臂 54 及 55，以驅動該第一驅動器 53 及兩插拔臂 54 及 55 沿該垂直軌道 52 作上、下位移，該第二驅動器 56 之型式不限，在本創作中係以伺服馬達為例，使該兩插拔臂 54 及 55 得以藉由第二驅動器 56 及第一驅動器 53 分別作上、下垂直軸向及左、右水平軸向位移，讓兩插拔臂位 54 及 55 均可到達固定式電池充電容置櫃 10 之電池交換口 11 或各電池容置格架模組 20 之各電池容置槽 21 位置。

第三驅動器 57 設於底座 51 內部，該第三驅動器 57 連結該垂直軌道 52，以驅動旋轉該垂直軌道 52 作 180 度之旋轉，同樣也控制該插拔臂 54 及 55 作相反 180 度位置旋轉對調操作，該第三驅動器 57 之型式不限，在本創作中係以一伺服馬達為例。

至少一電池交換管理器 60，設於固定式電池充電容置櫃 10 內，該電池交換管理器 60 具有充電電池 200 之整流充電與交換操作控制功能，該電池交換管理器 60 連結各電池容置格架模組 20 之各電池容置槽 21 之各充電器 211、電池移位插拔手臂 50 之底座 51 的驅動件 511、第一驅動器 53、第二驅動器 56 及第三驅動器 57，以控制各充電電池 200 之充電與交換位移操作，且該電池交換管理器 60 可向外連結一交流充電電源 61 或其他直流充電電源，整流後作為各電池容置格架模組 20 之電池容置槽 21 內之充電電池 200 的充電電源，以及，該電池移位插拔手臂 50 與電池交換管理器 60 所需之工作電源，當外部交流充電電源 61 或其他直流充電電源被切斷或故障停電時，該電池交換管理器 60 可以控制該充電座 211，使某些指定或預設的電池容置格架模組 20 之電池容置槽 21 內之充電電池 200 反向提供直流工作電源給上述的電池交換管理器 60、電池移位插拔手臂 50 所需的工作電源，猶如不斷電系統(UPS)功能一般，易言之，該電池交換管理器 60 可以控制各充電座 211 的電流順向充電及逆向緊急不斷電供電之雙向中之任一方向輸送。

該電池交換管理器 60 對各充電電池 200 間之交換、驗證與充電控制機制不限，諸如申請人前向　鈞局申請在案之第 098208685 號「移動式電池充電交換裝置」新型專利申請案中即已清楚揭示以 RF ID 為主的驗證交換與充電控制機制，換言之，該電池交換管理器 60 並具備有電池交換操作控制、電池 ID 驗證、電池交換週期、電池與標準電量樣本比對、計算交換費用、管理交換點及資料遠距傳送等功能，以達到以最少人力與成本管理之功效。

請再配合第五圖、第六圖及第七圖所示，為本創作之定點式電池交換裝置 100 較佳應用例，其中，顯示該移動軌道 30 及 40 間以一組電池移位插拔手臂 50，其中該電池移位插拔手臂 50 的插拔臂 54 負責

將充電電池200進行插入或推入各電池容置格架模組20之各電池容置槽21之操作，該插拔臂54之一定位擋子541設置在充電電池200之後(如第六圖所示)；該電池移位插拔手臂50之插拔臂55則負責將充電電池200進行拔出或拉出各電池容置格架模組20之各電池容置槽21之操作，該插拔臂55之一定位擋子551設置在充電電池200之前(如第七圖所示)。

藉由該電池交換管理器60控制電池移位插拔手臂50於該移動軌道30及40間位移至固定式電池充電容置櫃10的電池交換口11進行回收交換之充電電池200的交換操作，由該負責插入或推入操作之電池移位插拔手臂50之插拔臂54，穿過該電池交換口11的托柱111間，將該容置於托柱111上交換之充電電池200移動至任一電池容置格架模組20之一空閒的電池容置槽21位置，將該充電電池200插入或推入該充電座211，使該充電電池200之兩電極210及220分別對應插入該充電座211之充電連接器211a及211b中進行充電操作；另外，再由該負責拔出或拉出操作之電池移位插拔手臂50之插拔臂55，自該任一電池容置格架模組20之任一容納有已充滿電量之充電電池200之電池容置槽21中，將該已充滿電量的充電電池200拔出或拉出，並再由電池移位插拔手臂50沿移動軌道30及40位移，將該充滿電量之充電電池200送至固定式電池充電容置櫃10的電池交換口11進行回送交換，當該插拔臂54中欲插入充電的充電電池200或插拔臂55中已拔出之充電飽滿之交換充電電池200，因電池容置格架模組20之電池容置槽21或電池交換口11的位置位於相反方向時，則由第三驅動器57驅動旋轉垂直軌道52，使該插拔臂54與插拔臂55之位置作180度相反位置之對換(如第五圖中虛線部份所示)，以利該充電電池200進行充電操作或交換操作。

請再配合第八圖所示，為本創作之定點式電池交換裝置100的第

二實施例，其中，顯示該電池容置格架模組 20 之各電池容置槽 21 內設有至少一對導板 213，該兩導板 213 間形成一前端開口口徑大而後端口徑小且如同喇叭口的導引口 214，以藉由該導板 213 與導引口 214 精準導引充電電池 200 插入充電座 211 或將充電電池 200 自充電座 211 中拔出。

請再參閱第九圖及第十圖所示，為本創作之定點式電池交換裝置 100 的第三實施例，其中，顯示該電池移位插拔手臂 50 之插拔臂 54 的定位擋子 541 內側形成有至少一嵌槽 541a，該嵌槽 541a 內嵌置至少一滾珠 541b，以及，該插拔臂 55 的定位擋子 551 內側形成有至少一嵌槽 551a，該嵌槽 551a 內嵌置至少一滾珠 551b，使充電電池 200 在進行推入電池容置格架模組 20 之各電池容置槽 21 內時，可具有上、下、左或右之活動間隙，以避免充電電池 200 在電池容置槽 21 內卡住或在第七圖所示之導引口 214 內卡住。

請再參閱第十一圖及第十二圖所示，為本創作之定點式電池交換裝置 100 的第四實施例，其中，顯示在第九圖及第十圖所示之第三實施例中定位擋子 541 的滾珠 541b 連結一對活動關節 541c，該兩活動關節 541c 末端再連結一推板 541d，以及，定位擋子 551 的滾珠 551b 連結一對活動關節 551c，該兩活動關節 551c 末端再連結一推板 551d，使該推板 541 或推板 551 可與電池容置槽 21 或第七圖之導引口 214 之壁面保持水平緊貼之靠位效果，讓推板 541 或推板 551 推動充電電池 200 至電池容置槽 21 或第七圖之導引口 214 時，可更加精準與平穩。請再配合第十三圖及第十四圖所示，為本創作之定點式電池交換裝置 100 的第五實施例，顯示應用於一具一對凹電極 230 及 240 的充電電池 220 之狀態，其中，該電池移位插拔手臂 50 之插拔臂 54 上設有至少一對轉接頭 542，該轉接頭 542 內具有一中心接桿 542a，該中心接桿 542a 兩端分別形成一第一接頭 542b 及第二接頭 542c，以及，該插

拔臂 55 上設有至少一對轉接頭 552，該轉接頭 552 內具有一中心接桿 552a，該中心接桿 552a 兩端分別形成一第一接頭 552b 及第二接頭 552c，該轉接頭 542 之第一接頭 542b 及轉接頭 552 之第一接頭 552b 分別供對應插接於該充電電池 200 的凹電極 230 及 240 中，即在該固定式電池充電容置櫃 10 的電池交換口 11 進行回收交換時，由使用者將充電電池 200 的凹電極 230 及 240 對準連接至該轉接頭 542 之第一接頭 542b 及轉接頭 552 之第一接頭 552b 中，當該充電電池 200 藉由該電池移位插拔手臂 50 之插拔臂 54 或插拔臂 55 推入該電池容置格架模組 20 之各電池容置槽 21 內時，經由該轉接頭 542 之第二接頭 542c 及轉接頭 552 之第二接頭 552c 對應插入充電座 211 之充電連接器 211a 及 211b 中，使該充電電池 200 可藉由轉接頭 542 及 552 中之第一接頭 542b 及 552b、第二接頭 542c 及 552c 間皆因為同一中心接桿 542a 及中心接桿 552a 具有同一軸心線，而得以讓充電電池 200 之凹電極 230 及 240 精準連結充電座 211 之充電連接器 211a 及 211b，而得以避免充電電池 200 之凹電極 230 及 240 直接推入充電座 211 中，所易產生之碰撞損壞問題。

上述之轉接頭 542 或轉接頭 552 與充電電池 200 之凹電極 230 與 240 間的連結狀態，亦可提供給電池交換管理器 60 作為充電電池 200 進行交換操作控制之安全機制，例如：將該轉接頭 542 或轉接頭 552 與充電電池 200 之凹電極 230 與 240 間的連結狀態以電氣訊號連結送入電池交換管理器 60，當該電池交換管理器 60 未收到轉接頭 542 或轉接頭 552 與充電電池 200 之凹電極 230 與 240 確認連結的電氣訊號時，則該電池交換管理器 60 暫停電池移位插拔手臂 50 交換操作動作，並以燈號或聲響發出警示訊息(圖未顯示)，以警示充電電池 200 與電池移位插拔手臂 50 之插拔臂 54 或 55 間的不良連結狀態。

綜上所述，本創作之定點式電池交換裝置 100 所列舉之各圖式及

說明，係為便於說明本創作之技術內容，所列舉之實施例之一隅，並非用以限制本創作之範疇，舉凡是針對本創作之結構細部或元件的等效變更與置換，當屬本創作之範疇，其範圍將由以下的申請專利範圍來界定之。

【圖式簡單說明】

第一圖為本創作定點式電池交換裝置第一實施例之立體外觀結構圖；

第二圖為第一圖之側視圖；

第三圖為本創作定點式電池交換裝置之系統方塊圖；

第四圖為一俯視圖，顯示該電池移位插拔手臂與兩移動軌道間之結構；

第五圖為本創作定點式電池交換裝置之較佳應用例圖；

第六圖為一側視圖，顯示本創作中負責充電電池插入或推入之電池移位插拔手臂進行充電電池插入之狀態；

第七圖為一側視圖，顯示本創作中負責充電電池拔出或拉出之電池移位插拔手臂進行充電電池拔出之狀態；

第八圖為本創作定點式電池交換裝置之第二實施例圖；

第九圖為本創作之定點式電池交換裝置的第三實施例圖；

第十圖為類同於第九圖之側視放大圖，顯示該另一插拔臂的結構；

第十一圖為本創作之定點式電池交換裝置的第四實施例圖；

第十二圖為為類同於第十一圖之側視放大圖，顯示該另一插拔臂的結構；

第十三圖為本創作之定點式電池交換裝置的第五實施例圖；

第十四圖為為類同於第十三圖之側視放大圖，顯示該另一插拔臂的結構。

【主要元件符號說明】

100	定點式電池交換裝置	10	固定式電池充電容置櫃
11	電池交換口	111	托柱
20	電池容置格架模組	21	電池容置槽
22	通道	30	移動軌道
40	移動軌道	50	電池移位插拔手臂
51	底座	52	垂直軌道
53	第一驅動器	56	第二驅動器
511	驅動件	521	軌道連接器
60	電池交換管理器	61	交流充電電源
200	充電電池	211	充電座
212	托柱	213	導板
214	導引口	211a	充電連接器
211b	充電連接器	54 及 55	插拔臂
230 及 240	凹電極	210 及 220	電極
541 及 551	定位擋子	542 及 552	轉接頭
541a 及 551a	嵌槽	541b 及 551b	滾珠
541c 及 551c	活動關節	541d 及 551d	推板
542a 及 552a	中心接桿	542b 及 552b	第一接頭
542c 及 552c	第二接頭		

99. 1. 22 修正補充
年 月 日

六、申請專利範圍：

1.一種定點式電池交換裝置，係包括：

至少一固定式電池充電容置櫃，至少設有一電池交換口，該電池交換口供交換之一充電電池容置交換；

至少一對電池容置格架模組，分列設置於固定式電池充電容置櫃內部，各電池容置格架模組內並設有若干電池容置槽，各電池容置槽中可儲放容置至少一充電電池，該電池容置槽內設有至少一充電座，該充電座供充電電池之電極插入充電；

至少一對移動軌道，分別設於該電池容置格架模組間之通道的上、下端，為相互上、下平行對應之軌道；

至少一電池移位插拔手臂，設於兩移動軌道之間，沿該移動軌道位移，以移動至固定式電池充電容置櫃之電池交換口或該電池容置格架模組之各電池容置槽位置，以將該交換之充電電池自固定式電池充電容置櫃之電池交換口插入該電池容置格架模組之各電池容置槽內之充電座，或自該電池容置格架模組之各電池容置槽內將充電電池拔出，移動至該固定式電池充電容置櫃之電池交換口進行充電電池交換；及

至少一電池交換管理器，設於固定式電池充電容置櫃內，該電池交換管理器連結各電池容置格架模組之各電池容置槽之各充電座、電池移位插拔手臂，以控制該充電座對各充電電池之充電，以及，控制該電池移位插拔手臂對各充電電池於固定式電池充電容置櫃之電池交換口與電池容置格架模組之各電池容置槽內的交換位移操作。

2.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該固定式電池充電容置櫃之電池交換口內設有至少一對托柱，該托柱供

充電電池容置固定。

3.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池容置格架模組之各電池容置槽中設有至少一對托柱，每一托柱供至少一充電電池容置固定定位。

4.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池容置格架模組之各電池容置槽中設有至少一對導板。

5.如申請專利範圍第 4 項所述之定點式電池交換裝置，其中，該兩導板間形成一導引口。

6.如申請專利範圍第 5 項所述之定點式電池交換裝置，其中，該導引口為一前端開口口徑大而後端口徑小之喇叭口。

7.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池容置格架模組之各電池容置槽中之充電座設有至少一對充電連接器。

8.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池移位插拔手臂係包括：

一底座，固定於電池容置格架模組間之通道下端之一移動軌道，沿該移動軌道移動；

一垂直軌道，連結於底座上方及另一固定於電池容置格架模組間之通道上端之移動軌道間，受底座帶動而沿該移動軌道位移；

一第一驅動器，連結於垂直軌道上，沿該垂直軌道作上、下位移，該第一驅動器可作驅動左、右兩側水平軸向運動；

兩插拔臂，分別連結於該第一驅動器之左、右水平軸向位置，以受該第一驅動器驅動而作向外伸展或向內縮之操作，以供納置充電電池並提供充電電池插入或拔出之交換操作；

一第二驅動器，設於底座上方，且該第二驅動器連結該第一驅動器及兩插拔臂，以驅動該第一驅動器及兩插拔臂沿該垂直軌道

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作上、下位移，使該兩插拔臂得以藉由第二驅動器及第一驅動器分別作上、下垂直軸向及左、右水平軸向位移，讓兩插拔臂均可到達固定式電池充電容置櫃之電池交換口或各電池容置格架模組之各電池容置槽位置；及

一第三驅動器，設於底座內部，該第三驅動器連結該垂直軌道，以驅動旋轉該垂直軌道作 180 度之旋轉，控制該兩插拔臂作相反 180 度位置旋轉對調操作。

9.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該底座設有至少一驅動件，以驅動底座位移。

10.如申請專利範圍第 9 項所述之定點式電池交換裝置，其中，該驅動件為電動馬達。

11.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該垂直軌道上方設有至少一軌道連接器，以連結移動軌道。

12.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該第一驅動器為氣壓缸。

13.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該插拔臂末端分別設有至少一對定位擋子。

14.如申請專利範圍第 13 項所述之定點式電池交換裝置，其中，該定位擋子內側形成有至少一嵌槽，該嵌槽中嵌置至少一滾珠。

15.如申請專利範圍第 14 項所述之定點式電池交換裝置，其中，該滾珠連結至少一對活動關節，該活動關節末端連結一推板。

16.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該插拔臂上設有至少一對轉接頭。

17.如申請專利範圍第 16 項所述之定點式電池交換裝置，其中，該轉接頭內具有一中心接桿。

18.如申請專利範圍第 17 項所述之定點式電池交換裝置，其中，該中

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心接桿兩端分別形一第一接頭及第二接頭。

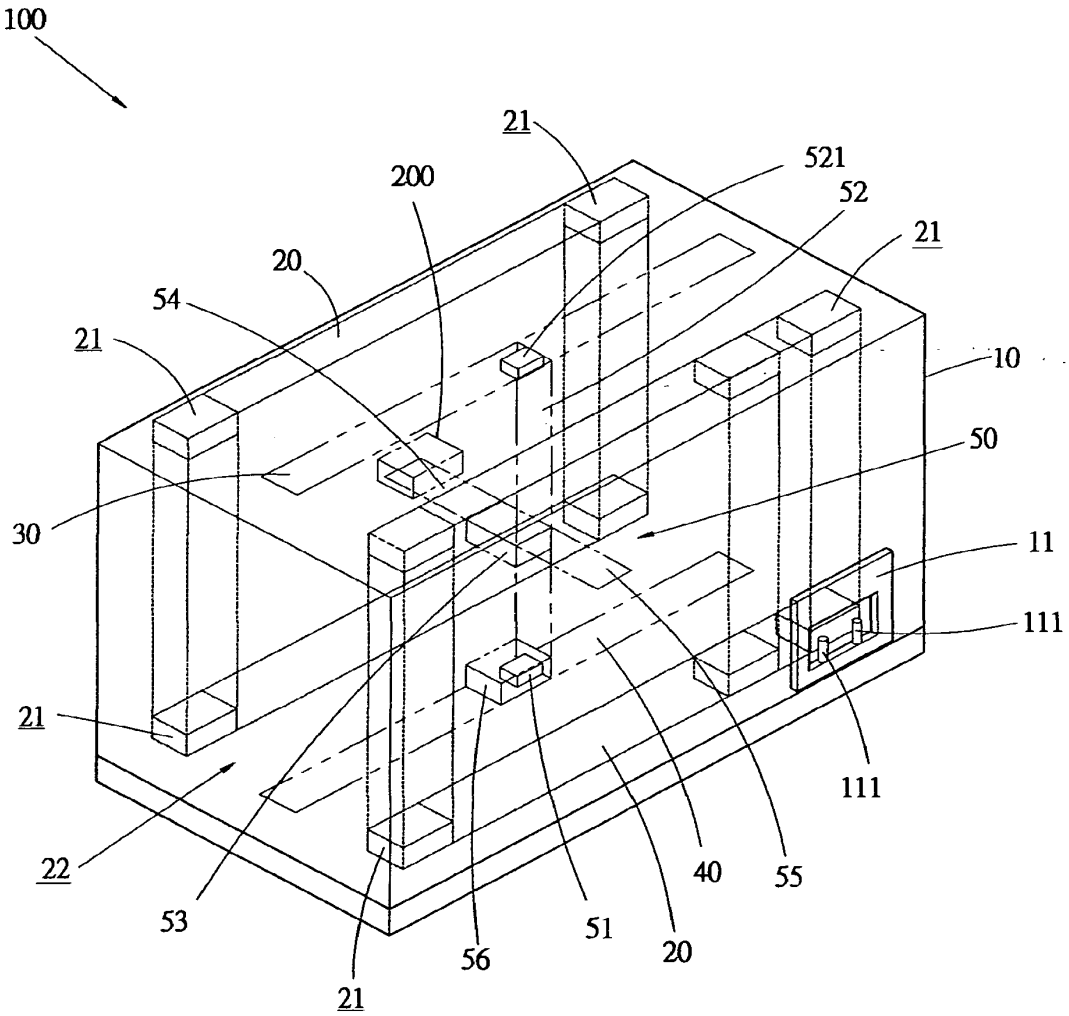
19.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該第二驅動器為一伺服馬達。

20.如申請專利範圍第 8 項所述之定點式電池交換裝置，其中，該第三驅動器為一伺服馬達。

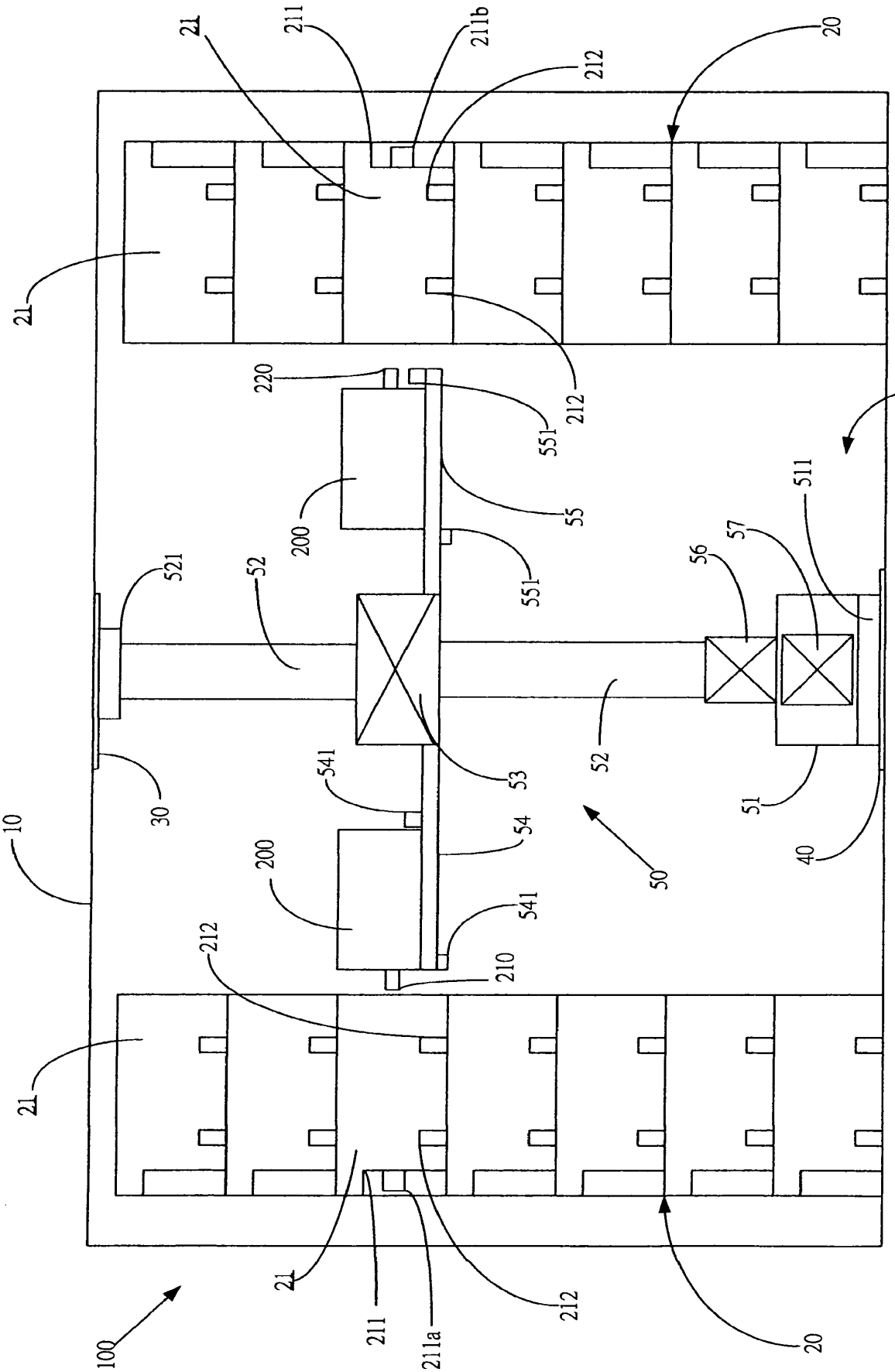
21.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池交換管理器對外連結一交流充電電源。

22.如申請專利範圍第 1 項所述之定點式電池交換裝置，其中，該電池交換管理器控制各電池容置格架模組之各電池容置槽之各充電座之電流順向充電及逆向供電之雙向中之任一方向輸送。

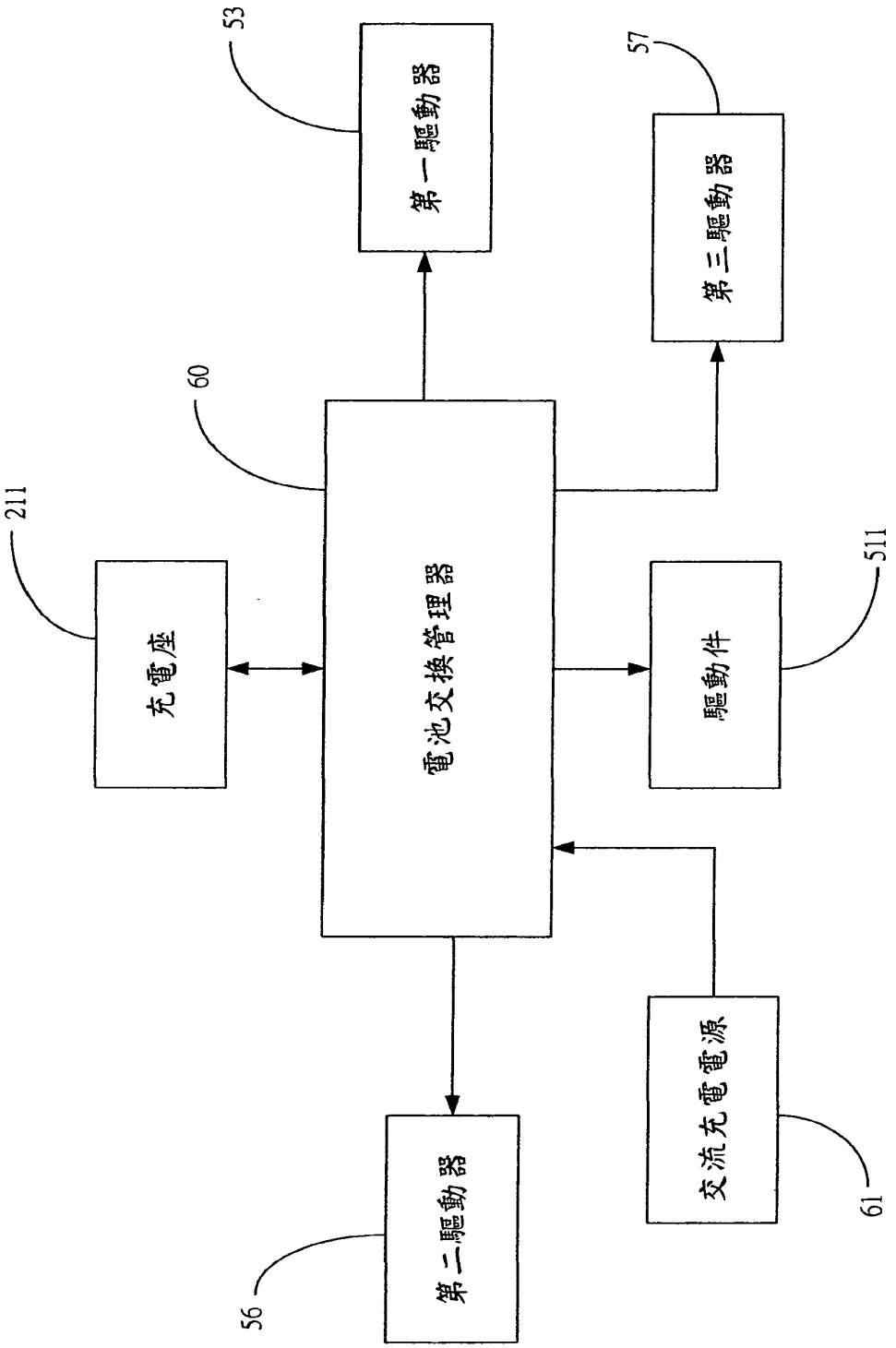
七、圖式：


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第一圖

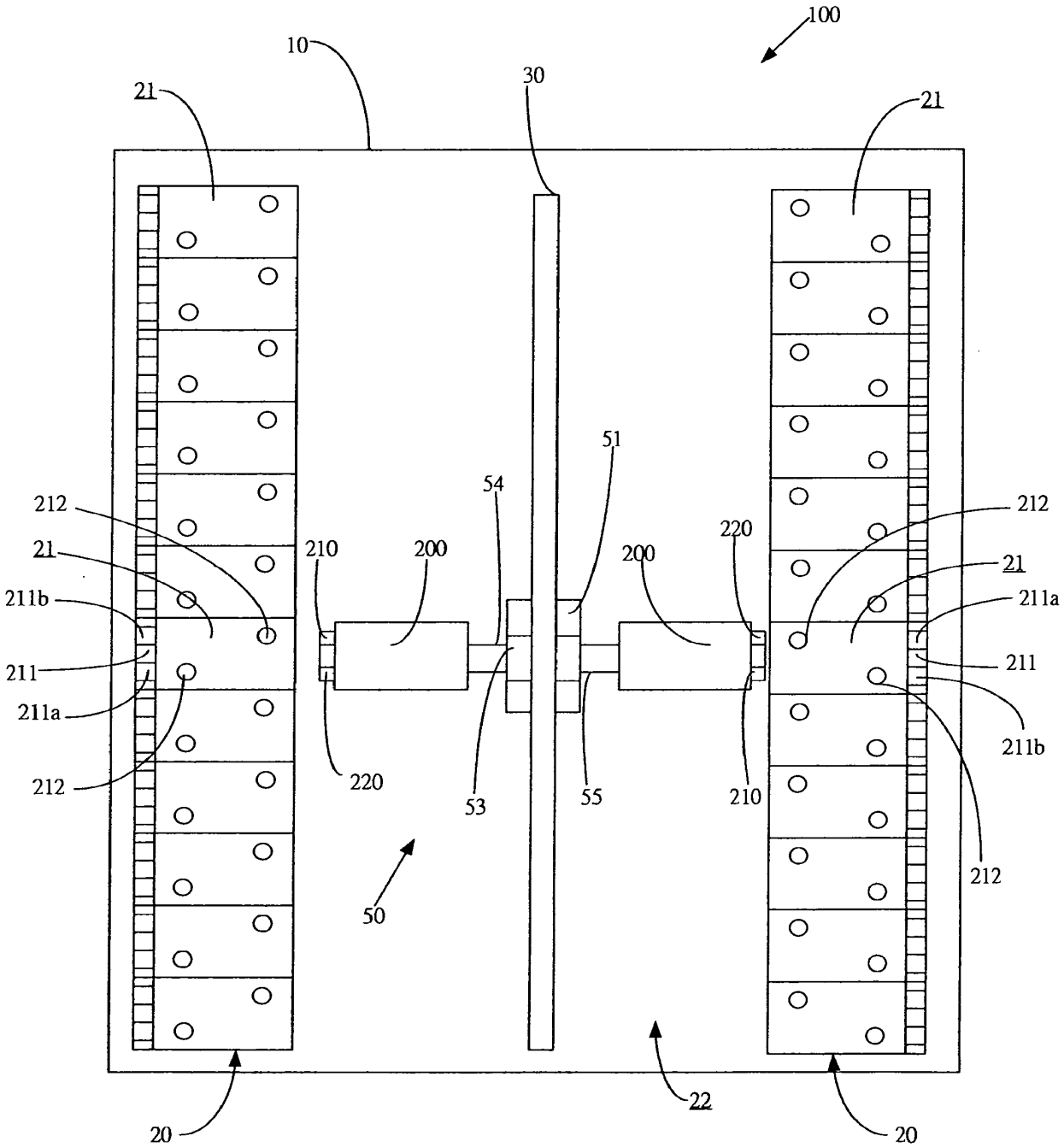

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211a
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第二圖


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第一驅動器
57
第三驅動器
60
211
充電座
電池交換管理器
驅動件
511
第二驅動器
56
交流充電電源
61

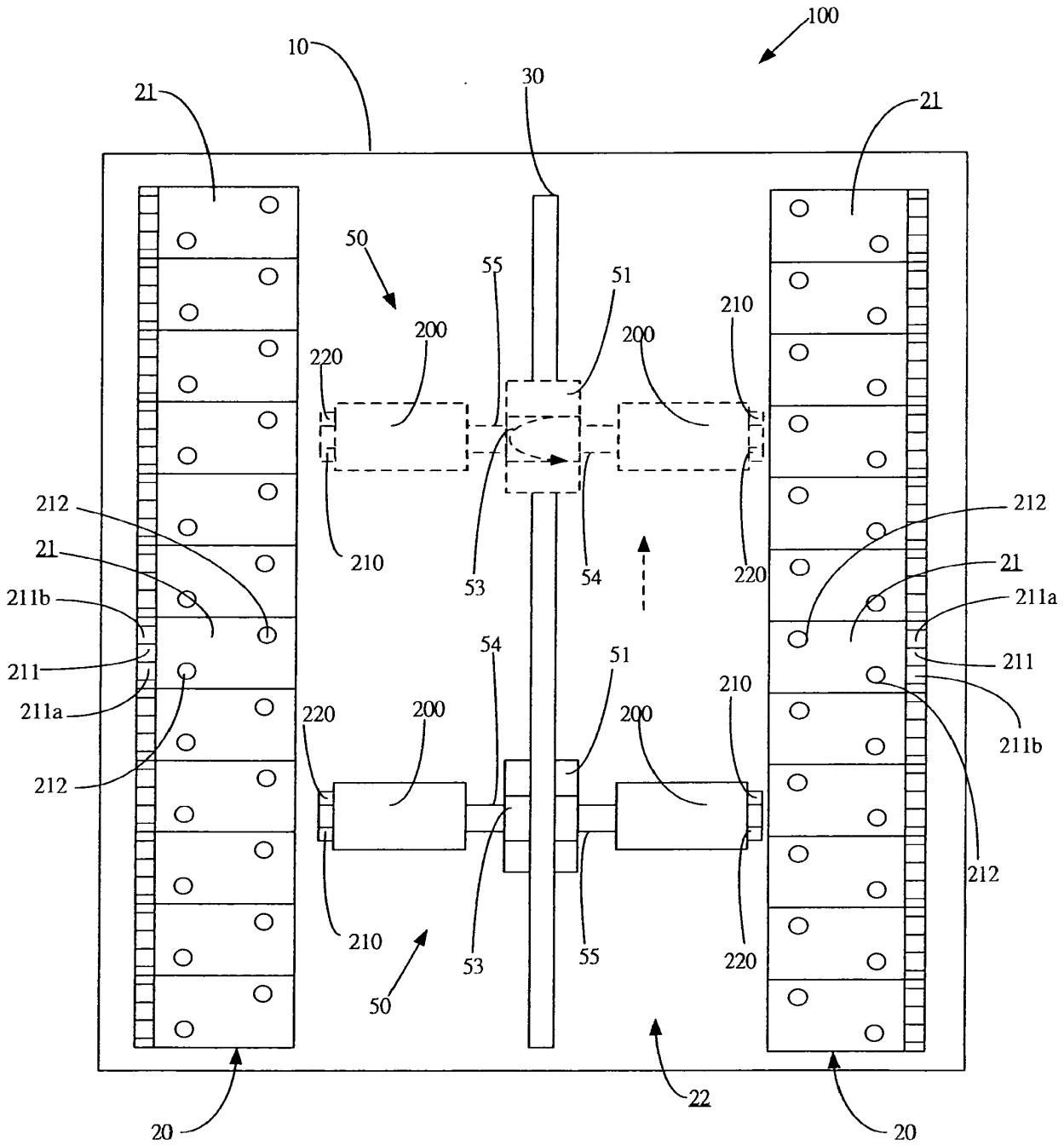
第三圖

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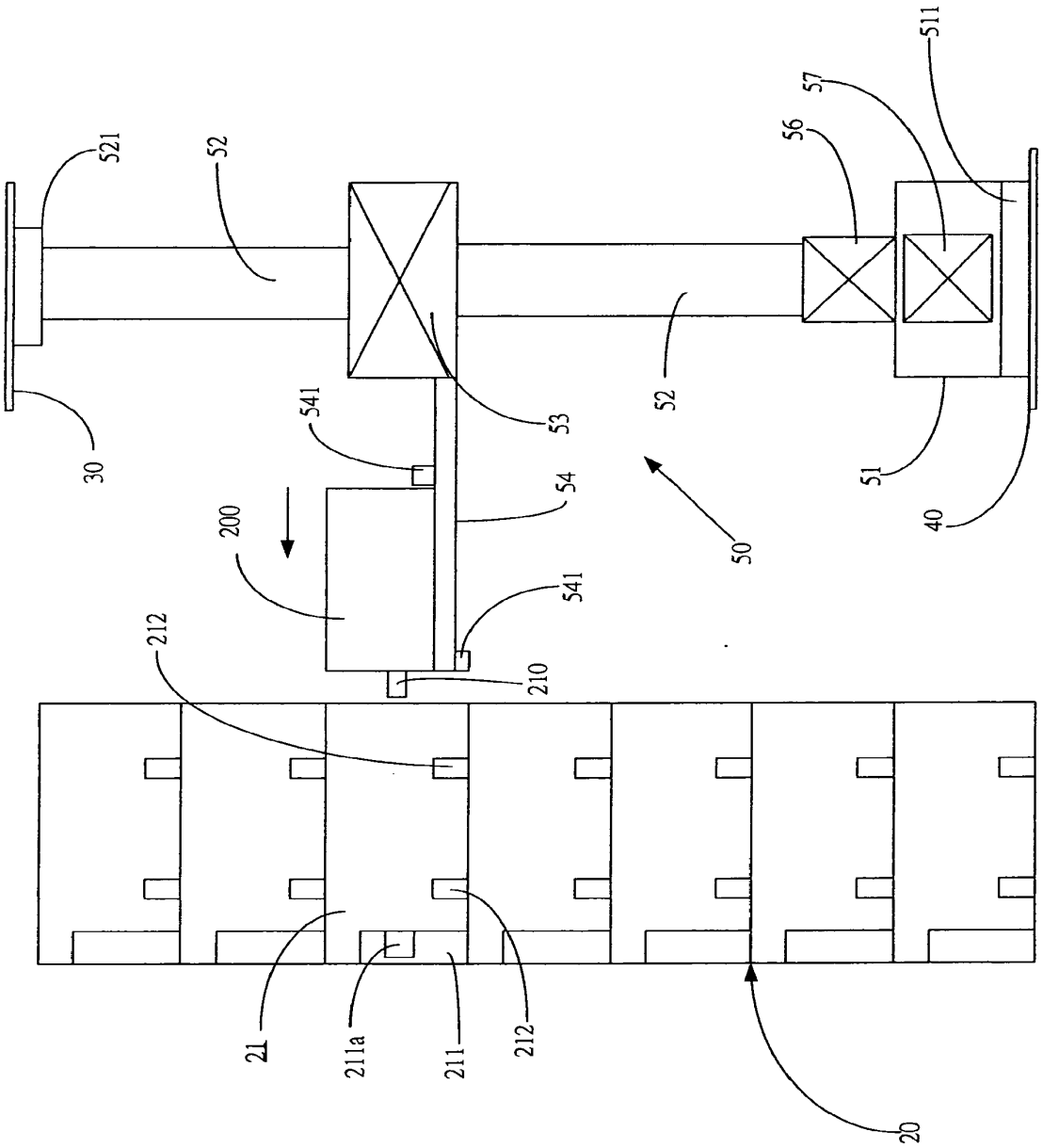
第四圖

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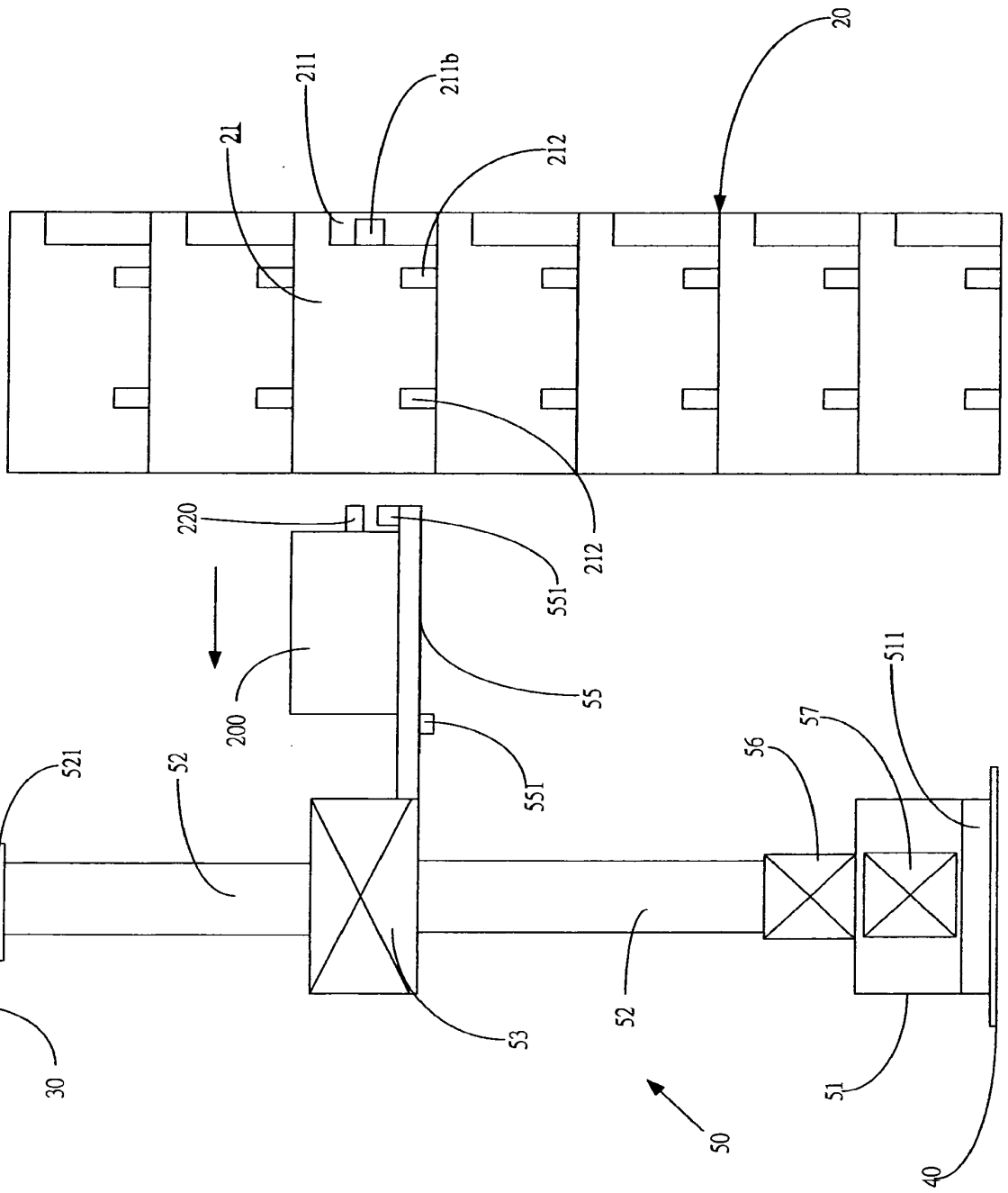
第五圖

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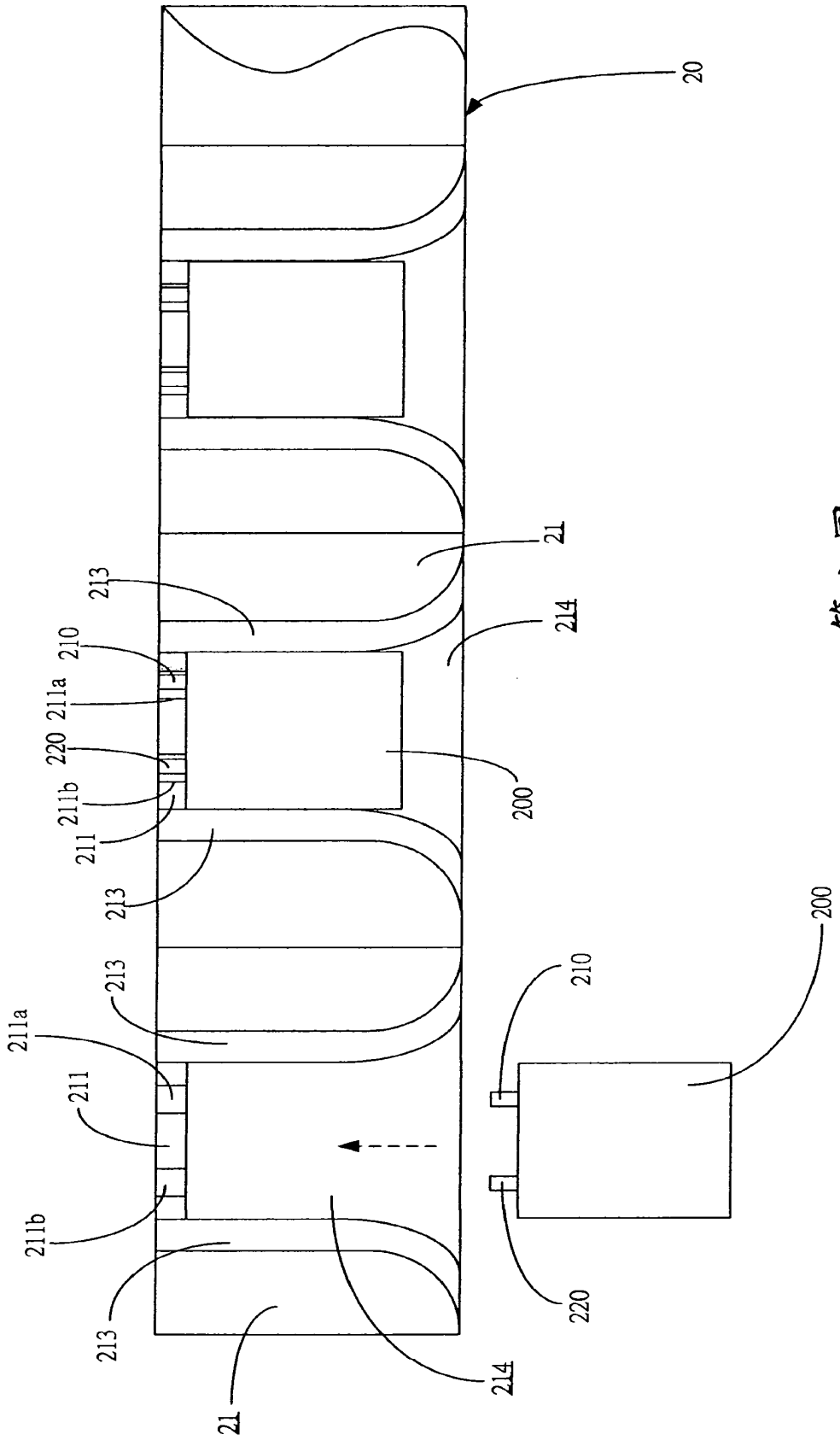


第六圖

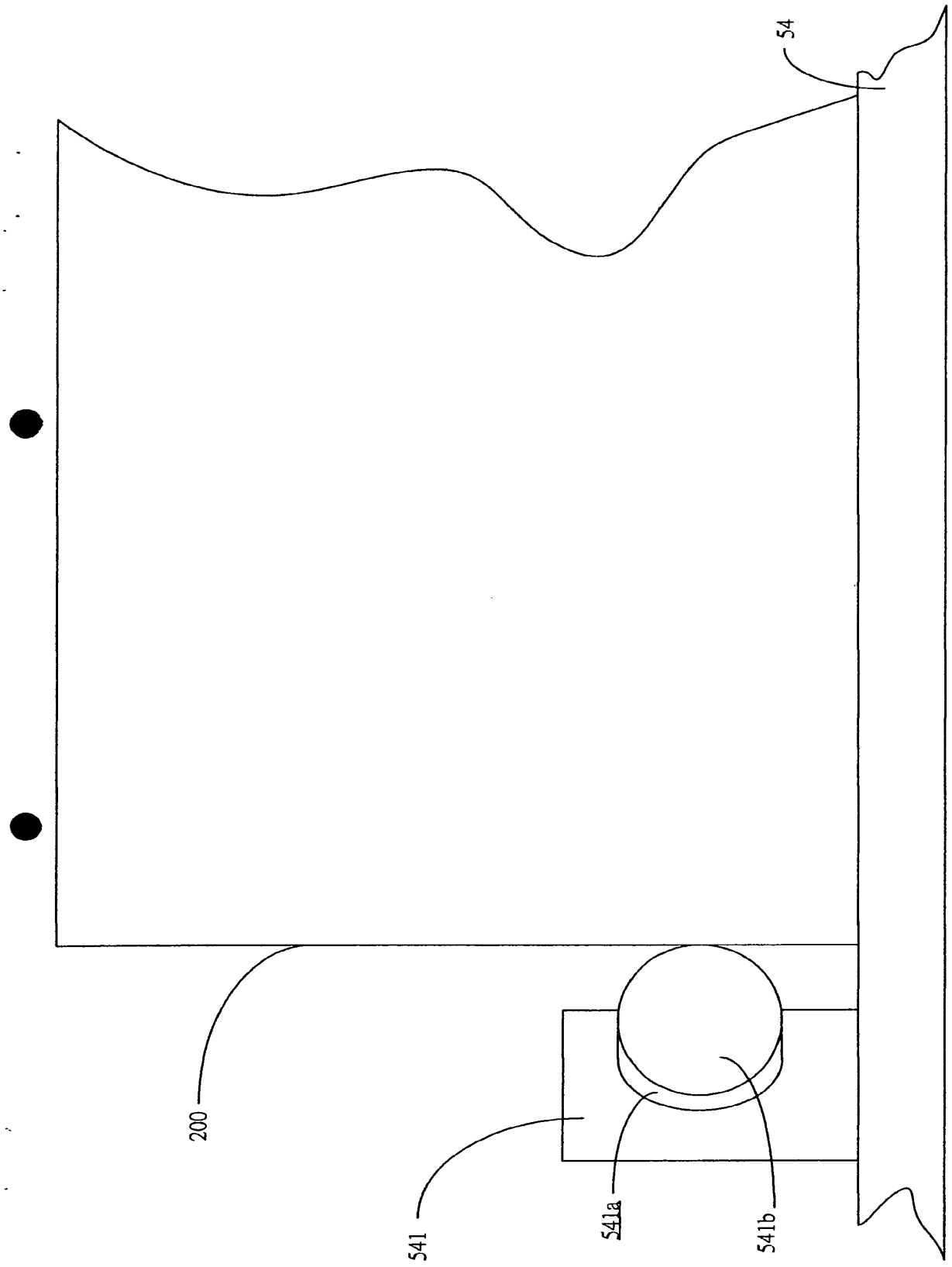
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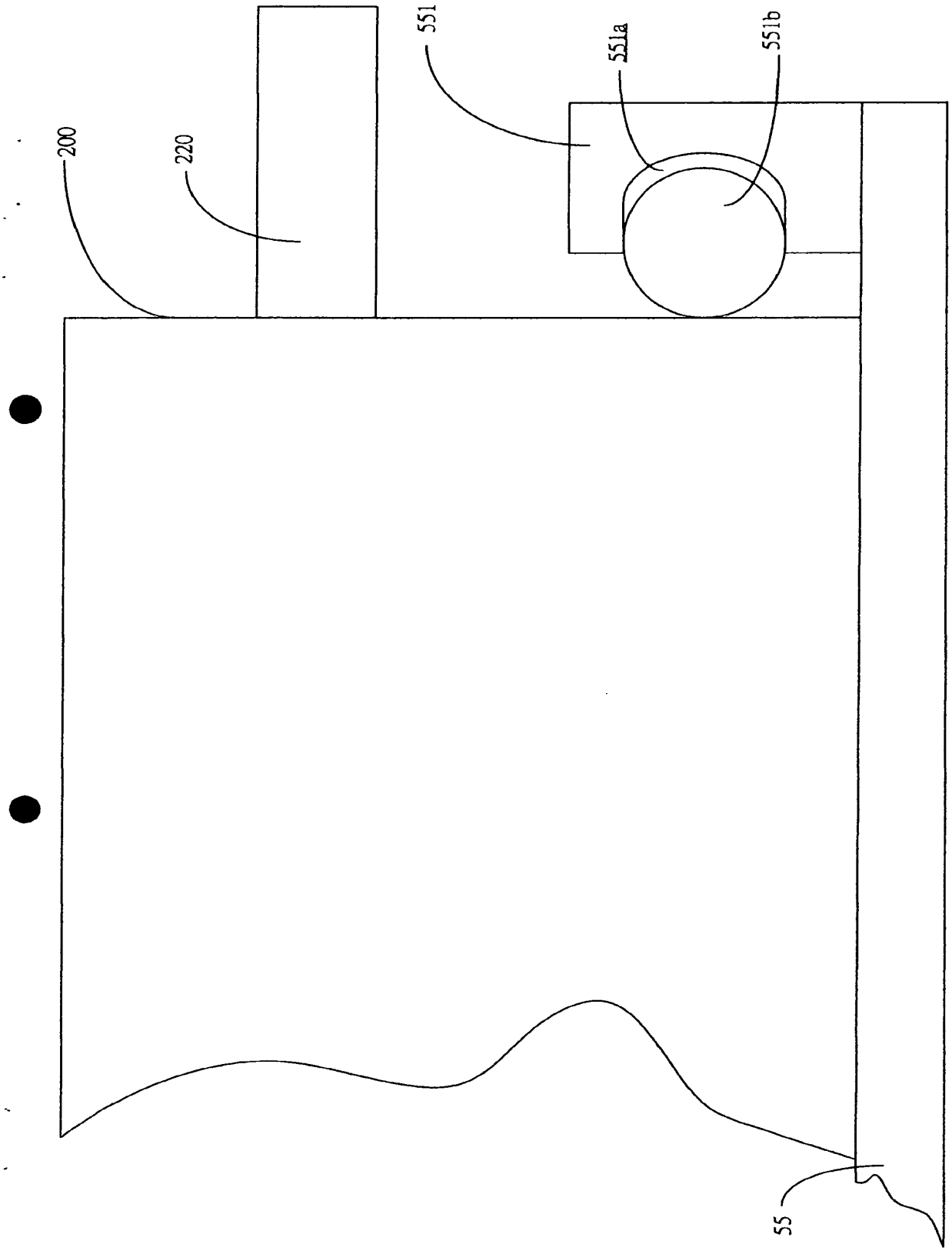
第七圖


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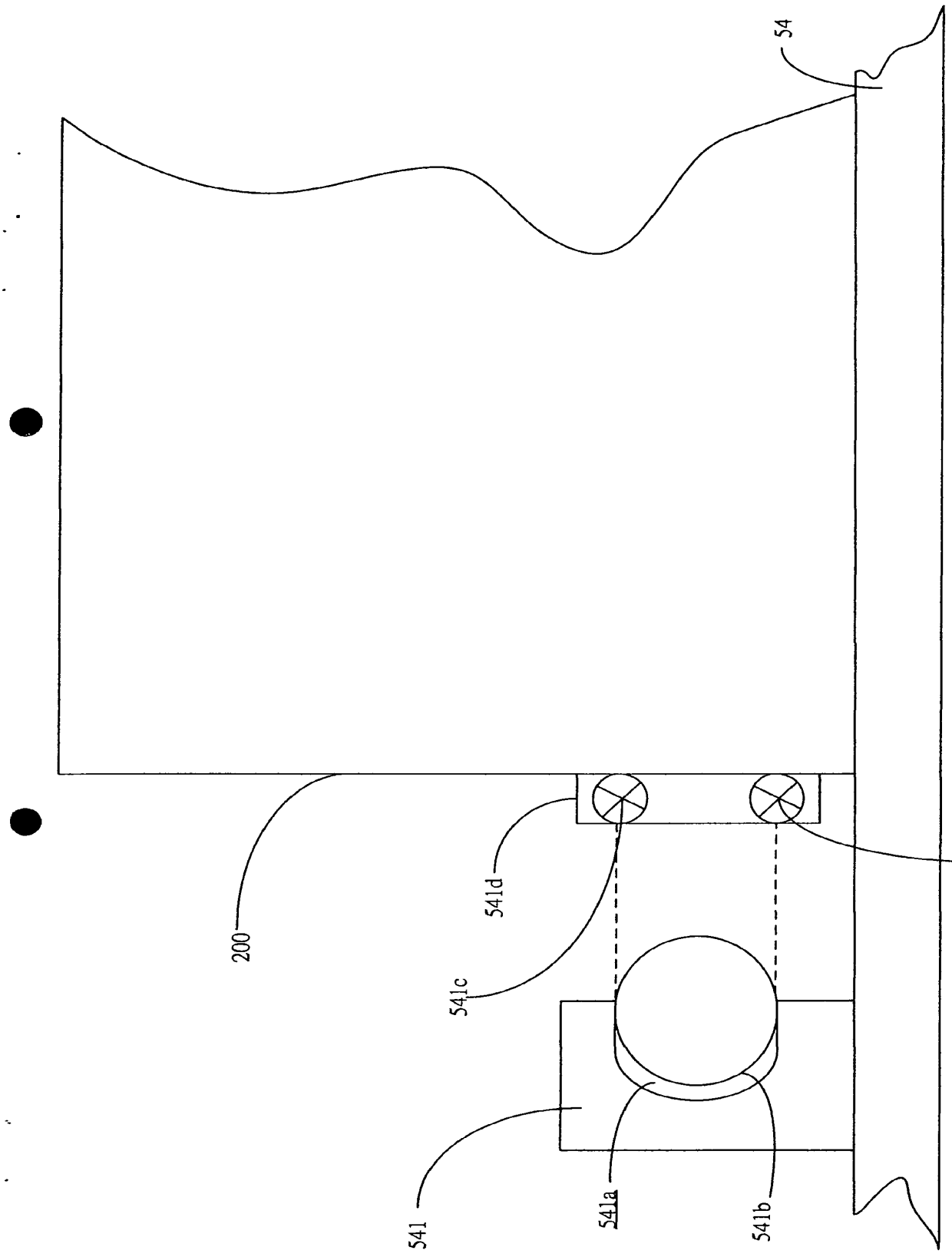
第八圖



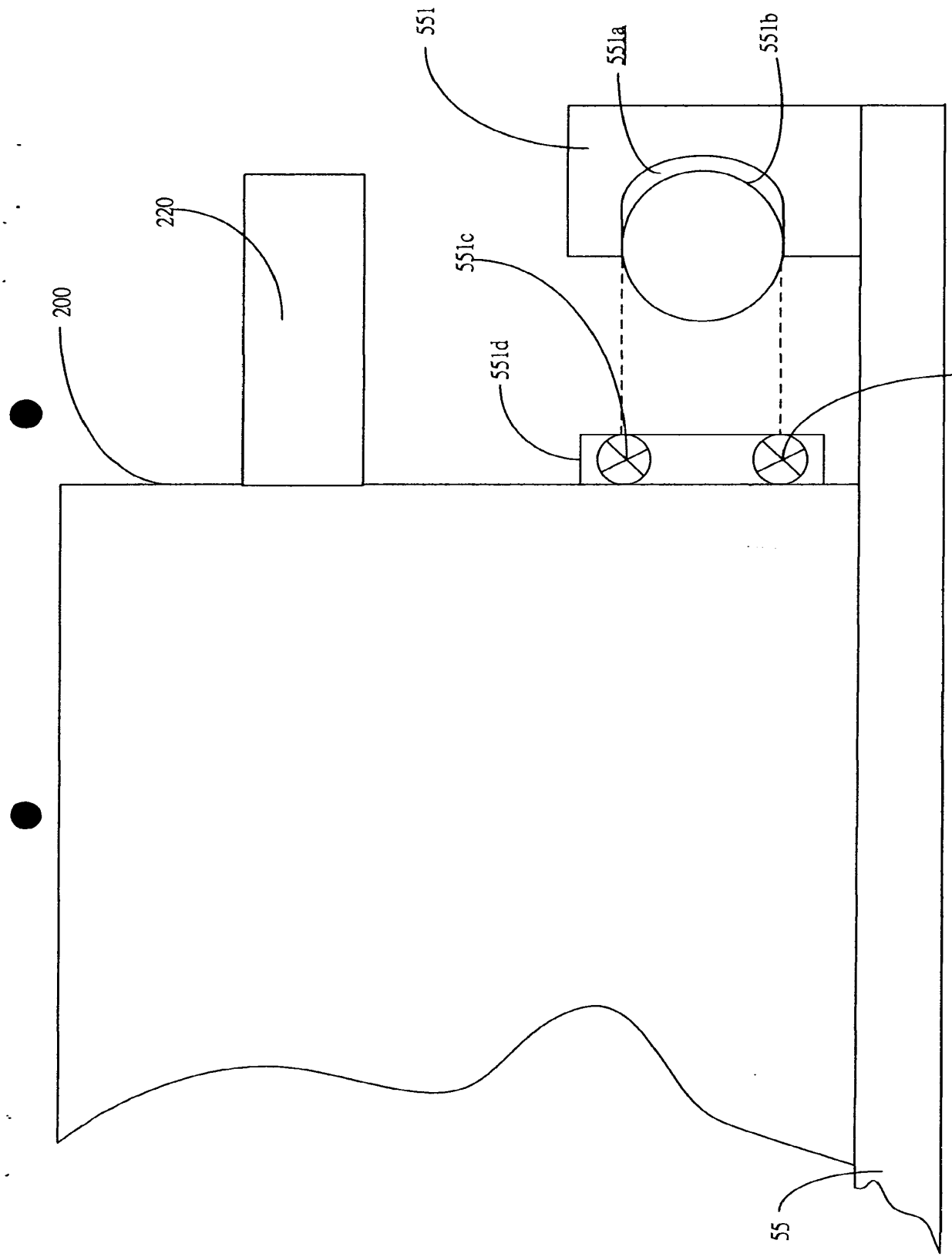
第九圖



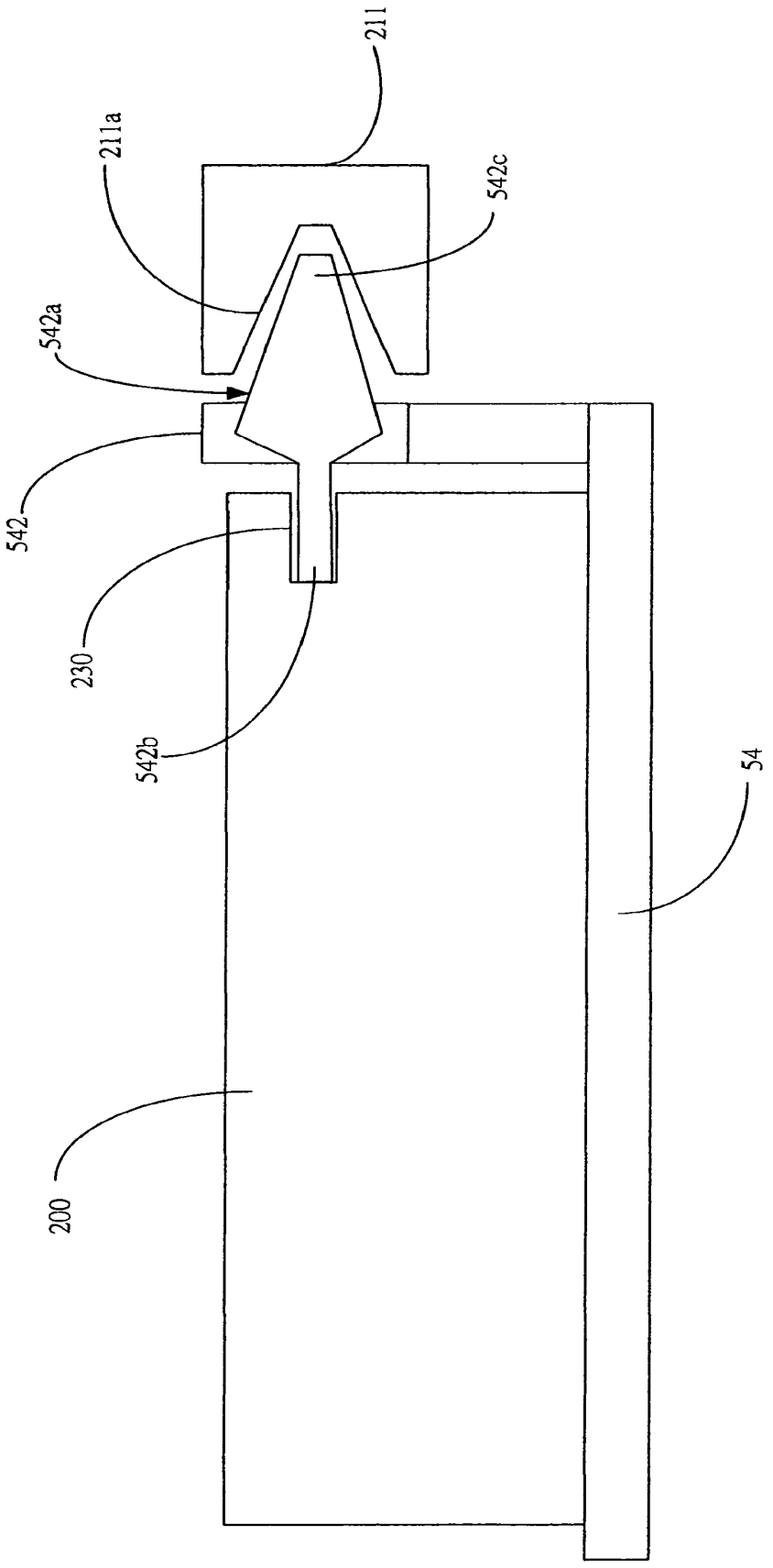
第十圖



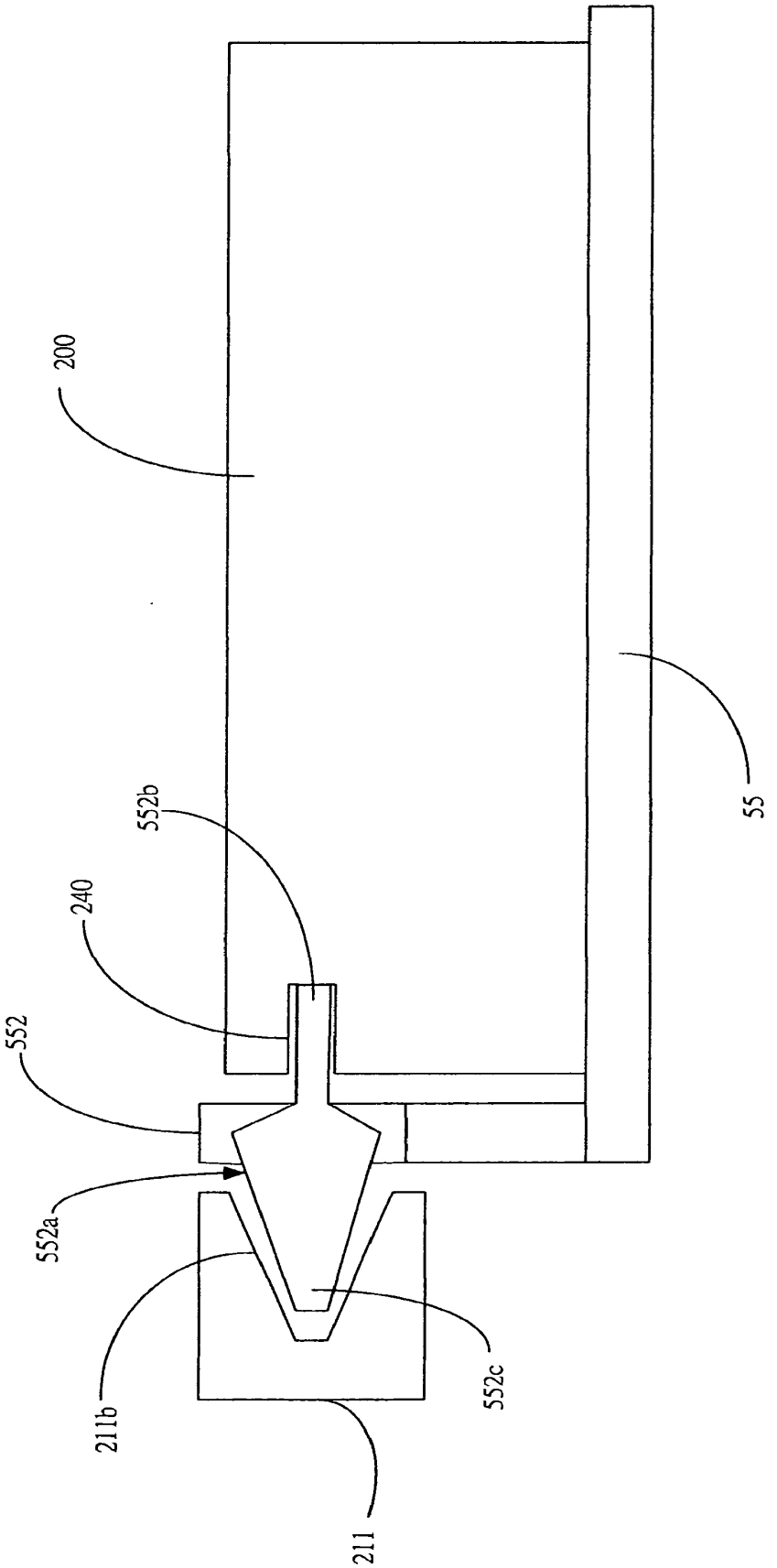
第十一圖



第十二圖



第十三圖



第十四圖

(19) Republic of China Intellectual Property Office
(12) Utility Model Description Notice

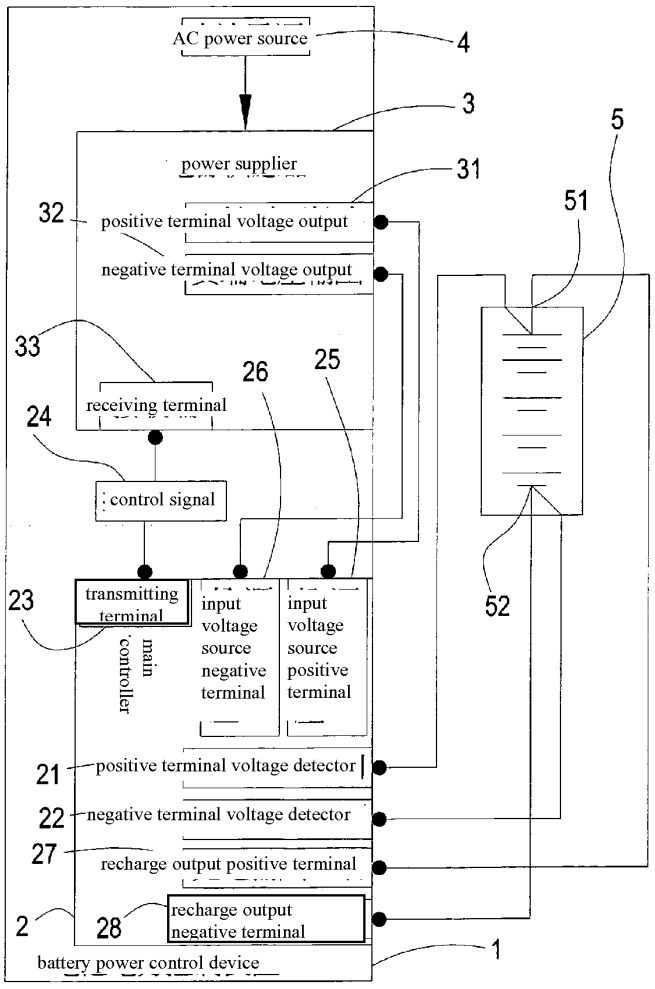
(11) Certificate no: TW M379789U1
(43) Notice date: May 1, 2010

(21) Application case no: 098209923 (22) Application date: March 12, 2010
(51) Int. Cl.: ***G06F1/30 (2006.01)***
(71) Applicant(s): Chen Tech Electric Mfg. Co., Ltd. (Republic of China)
No. 27, Lane 61, Section 1, Kuang Fu Road, San Chung City, Taipei County
(72) Creator(s): Hsu Yen Ah Chin (TW)
No. of patent claims: 4 No. of diagrams: 2 No. of pages: 10

(54) Name
A battery power control device with variable voltage output
(57) Summary

The present creation relates to a battery power control device with variable voltage output; the described battery power control device comprises a main controller, a power supplier, and an AC power source. Of these, the main controller comprises a positive terminal voltage detector that can be connected to the positive terminal of a battery and a negative terminal voltage detector that can be connected to the negative terminal of a battery. This main controller can detect the battery's voltage and, based on this voltage value, transmit a control signal. The power supplier can receive this control signal and produce a suitable voltage output based on the control signal. By means of the described structure, the present creation can detect a battery's voltage in advance and input a corresponding voltage value, thereby avoiding a situation in which the maximum voltage is used right away to charge the battery, and it makes the practical advance of saving energy.

TW M380890U1



1… battery power control device
2… main controller
21… positive terminal voltage detector
22… negative terminal voltage detector
23… transmitting terminal
24… control signal
25… input voltage source positive terminal
26… input voltage source negative terminal
27… recharge output positive terminal
28… recharge output negative terminal
3… power supplier
31… positive terminal voltage output
32… negative terminal voltage output
33… receiving terminal
4… AC power source
5… battery
51… positive terminal
52… negative terminal

Diagram 1

M379789

[Stamp: "Notice"]

Utility Model Description

(Please do not alter the format or sequence of this description; please do not fill in sections marked with ※)

※ Application case no.: 98209923

※ Application date: 98. 6. 5 ※ IPC classification: G06F1/30 (2006.01)

I. Utility model name: (Chinese / English)

A battery power control device with variable voltage output

II. Utility model summary in Chinese:

The present creation relates to a battery power control device with variable voltage output; the described battery power control device comprises a main controller, a power supplier, and an AC power source. Of these, the main controller comprises a positive terminal voltage detector that can be connected to the positive terminal of a battery and a negative terminal voltage detector that can be connected to the negative terminal of a battery. This main controller can detect the battery's voltage and, based on this voltage value, transmit a control signal. The power supplier can receive this control signal and produce a suitable voltage output based on the control signal. By means of the described structure, the present creation can detect a battery's voltage in advance and input a corresponding voltage value, thereby avoiding a situation in which the maximum voltage is used right away to charge the battery, and it makes the practical advance of saving energy.

III. Utility model summary in English:

IV. Designation of representative diagram:

(1) The designated representative diagram for the present creation is: Diagram 1.

(2) Brief explanation of the unit symbols of this representative diagram:

Battery power control device…	1
Main controller…	2
Positive terminal voltage detector…	21
Negative terminal voltage detector…	22
Transmitting terminal…	23
Control signal…	24
Input voltage source positive terminal…	25
Input voltage source negative terminal…	26
Recharge output positive terminal…	27
Recharge output negative terminal…	28
Power supplier…	3
Positive terminal voltage output…	31
Negative terminal voltage output…	32
Receiving terminal…	33
AC power source…	4
Battery…	5
Positive terminal…	51
Negative terminal…	52

V. Utility model description:
[Technical field to which the utility model belongs]

The present creation presents an energy-saving power control device, and more specifically, it is a variable voltage output battery power control device that can effectively reduce the power consumption of the lithium battery packs of notebook computers during recharge testing on the production line.

[Previous technologies]

With advances made in science and technology, a wide variety of electrical goods have deeply penetrate people's lives. Of these, the appearance of the computer has become even more tightly interwoven with people's current lives. Computers can help people manage and record the happenings, both large and small, in their lives and work. And because size of the personal computer was much too large, notebook computers have been researched and developed that are easy to carry.

In order to achieve the mobility of any-time use, all notebook computers come with a lithium battery as a power supply, and when a notebook computer is shipped, quality control personnel conduct tests and inspection of this lithium battery in order to ensure that there are no quality problems with the battery of the shipped notebook computer.

However, the following problems and shortcomings involved in the use of the described notebook computer lithium battery still require improvement:

When the notebook computer's lithium battery is undergoing testing and inspection, typically a positive terminal voltage output is connected to the positive pole of the battery, and a negative terminal voltage output is connected to the negative pole of the battery. After this connection has been made, a recharge function inspection test is conducted on the battery at the highest voltage output. However, because the highest voltage output is used for recharging right away, this gives rise to an unnecessary waste of energy.

Therefore, the question of how to solve the conventional problems and shortcomings mentioned above is something the creator of the present creation as well as companies in the industry urgently wish to pursue in their study of improvements.

[Details of the utility model]

Therefore, in view of the abovementioned shortcomings, the creator of the present creation gathered related materials, assessed and considered the issue from all sides, used the many years of experience he has accumulated in this industry, and made one attempt and modification after another. Then he designed the utility model patent for this battery power control device with variable voltage output that can effectively reduce the power consumption of a notebook computer's lithium battery pack during recharge testing on the production line.

The main goal of the present utility model is to provide an energy-saving battery power control device.

In order to achieve the abovementioned goal, the battery power control device of the present utility model comprises a main controller, a power supplier, and an AC power source. Of these, the main controller comprises a positive terminal voltage detector that can be connected to a the positive terminal of a preinstalled battery, a negative terminal voltage detector that can be connected to the battery's negative terminal, a recharge output positive terminal, a recharge output negative terminal, an input voltage source positive terminal, and an input voltage source negative terminal. This main controller can detect the voltage value of the battery and transmit a control signal based on this voltage value. The power supplier comprises a positive terminal voltage output that can be connected to the input voltage source positive terminal and a negative terminal voltage output that can be connected to the input voltage source negative terminal. This power supplier can receive the control signal and, based on the control signal, order the positive terminal voltage output and the negative terminal voltage output to generate a suitable voltage output. The AC power source can provide the power supplier with power. Of these, based on the input voltage source positive terminal and input voltage source negative terminal, the main controller can order the recharge output positive terminal and the recharge output negative terminal to generate a corresponding voltage output for this battery.

Here, because the battery power control device of the present creation comprises a main controller, and this main controller's positive terminal voltage detector and negative terminal voltage detector are connected to the battery's positive terminal and negative terminal, respectively, the positive terminal voltage detector and negative terminal voltage detector can detect the voltage of the battery, and this main controller can transmit a control signal to the power supplier based on this voltage value. The power supplier can generate a suitable voltage output based on this control signal. In this way, it is possible to avoid using the maximum voltage output when the power supplier starts up and to avoid an unnecessary waste of energy.

[Implementation mode]

Regarding the technical measures and composition employed by the present creation in order to achieve the abovementioned goals and effects, a preferred embodiment of the present creation is illustrated below through a careful description of its characteristics and functions, to facilitate a full understanding.

Please refer to Diagram 1. It is a block diagram of the preferred embodiment of the present creation; from this diagram, one can clearly see that this creation's battery 5 power control device 1 includes:

A main controller 2. This main controller 2 comprises a positive terminal voltage detector 21 that can be connected to the positive terminal 51 of a preinstalled battery 5 (for example: a lithium battery 5), a negative terminal voltage detector 22 that can be connected to this battery's 5 negative terminal 52, a recharge output positive terminal 27, a recharge output negative terminal 28, an input voltage source positive terminal 25, and an input voltage source negative terminal 26. This main controller 2 can use this positive terminal voltage detector 21 and negative terminal voltage detector 22 to detect the

voltage value of this battery 5, and can use the transmitting terminal 23 to transmit a control signal 24 based on this voltage value;

A power supplier 3. This power supplier 3 comprises a positive terminal voltage output 31 that can be connected to the input voltage source positive terminal 25 and a negative terminal voltage output 32 that can be connect to the input voltage source negative terminal 26. This power supplier can use the receiving terminal 33 to receive the control signal 24 and can order the positive terminal voltage output 31 and negative terminal voltage output 32 to generate a suitable voltage output based on this control signal 24;

AC power source 4 (for example: municipal power). This AC power source can provide the power supplier with power.

By means of the described structure and composition design, we will now give a dynamic description of the use of the present creation below. Please also refer to Diagram 1 and Diagram 2. These are a block diagram and a sketch of the preferred embodiment of the present creation. From these diagrams, one can clearly see that during inspection and testing of the recharge function on the production line when the battery 5 power control device 1 of the present creation is used as a notebook computer battery 5, the positive terminal voltage detector 21 and negative terminal voltage detector 22 of the main controller 2 are connected to the positive terminal 51 an negative terminal 52 of the battery 5, respectively, and the recharge output positive terminal 27 and recharge output negative terminal 28 of the main controller 2 are also connected to the positive terminal 51 and negative terminal 52 of the battery 5, respectively; in this way, the main control 2 can use the battery's 5 voltage value measured by the positive terminal voltage detector 21 and negative terminal voltage detector 22, and the main control 2 can use the transmitting terminal 23 to transmit a control signal 24 to the power supplier 3 based on this voltage value; this power supplier 3 can then use the receiving terminal 33 to receive the control signal 24, and can order the positive terminal voltage output 31 and negative terminal voltage output 32 to generate a suitable voltage output based on this control signal 24; the main controller 2 can then order the recharge output positive terminal 25 and recharge output negative terminal 28 to generate a corresponding voltage output for this battery 5 based on the input voltage source positive terminal 25 and input voltage source negative terminal 26.

In this way, the present creation uses the positive terminal voltage detector 21 and negative terminal voltage detector 22 to measure in advance the battery's 5 numbers to switch the output voltage values, and avoids recharging the battery 5 at the maximum voltage right away and unnecessarily wasting power. It makes the practical advance of saving energy.

Therefore, please refer to the full set of attached diagrams. The use of the present creation has the following advantages over conventional technologies:

The main controller 2 of the present creation's battery 5 power control device 1 comprises a positive terminal voltage detector 21 that can be connected to the positive

terminal 51 of a preinstalled battery 5 and a negative terminal voltage detector 22 that can be connected to the negative terminal 52 of the battery 5; using this positive terminal voltage detector 21 and negative terminal voltage detector 22, the power supplier 3 can learn the present voltage value of the battery 5 and can use the present voltage value of the battery 5 to switch the output voltage value, thus avoiding a situation in which the maximum voltage is provided right away to the main controller 2 to charge the battery 5, and it makes the practical advance of saving energy.

The preceding description is only the preferred embodiment of the present creation and does not limit the patent scope of the present creation. Therefore, it is clearly stated that all decorative and equivalent structural changes based on the description and diagrams of the present creation shall be included within the patent scope of the present creation.

In short, during the use of the variable voltage output battery power control device of the present creation is in use, it becomes an exceptionally practical creation in order to be truly capable of achieving its effects and goals. This application is submitted in accordance with the law in order to comply with utility model patent application requirements. We look forward to its quick approval by the review committee in order to protect the hard work and creation of the creator. If your review committee has any questions, please do not hesitate to give instructions. The creator will certainly cooperate to his fullest. Thank you for your help.

[Brief description of diagrams]

Diagram 1: Block diagram of the preferred embodiment of the present creation.

Diagram 2: Sketch of the preferred embodiment of the present creation.

[Explanation of the symbols for main units]

Battery power control device…	1
Main controller…	2
Positive terminal voltage detector…	21
Negative terminal voltage detector…	22
Transmitting terminal…	23
Control signal…	24
Input voltage source positive terminal…	25
Input voltage source negative terminal…	26
Recharge output positive terminal…	27
Recharge output negative terminal…	28
Power supplier…	3
Positive terminal voltage output…	31
Negative terminal voltage output…	32
Receiving terminal…	33
AC power source…	4
Battery…	5
Positive terminal…	51
Negative terminal…	52

VI. Claims:

1. A battery power control device with variable voltage output, with the described battery power control device comprising:
   A main controller, comprising a positive terminal voltage detector that can be connected to the positive terminal of a preinstalled battery, a negative terminal voltage detector that can be connected to the negative terminal of the battery, a recharge output positive terminal, a recharge output negative terminal, an input voltage source positive terminal, and an input voltage source negative terminal; this main controller can use the positive terminal voltage detector and negative terminal voltage detector to detect the voltage value of the battery, and can transmit a control signal based on this voltage value;
   A power supplier, comprising a positive terminal voltage output that can be connected to the input voltage source positive terminal and a negative terminal voltage output that can be connected to the input voltage source negative terminal; this power supplier can receive the control signal and can order the positive terminal voltage output and negative terminal voltage output to generate a suitable voltage output based on this control signal;
   An AC power source, capable of providing the power supplier with power;
   Of these, the main controller can order the recharge output positive terminal and recharge output negative terminal to generate a corresponding voltage output for the battery based on the input voltage source positive terminal and input voltage source negative terminal.
2. A battery power control device with variable voltage output as described in Claim 1, wherein the battery is a lithium battery pack.
3. A battery power control device with variable voltage output as described in Claim 1, wherein the main controller can be equipped with a transmitting terminal capable of transmitting the control signal.
4. A battery power control device with variable voltage output as described in Claim 1, wherein the power supplier can be equipped with a receiving terminal capable of receiving the control signal.

VII. Diagrams:

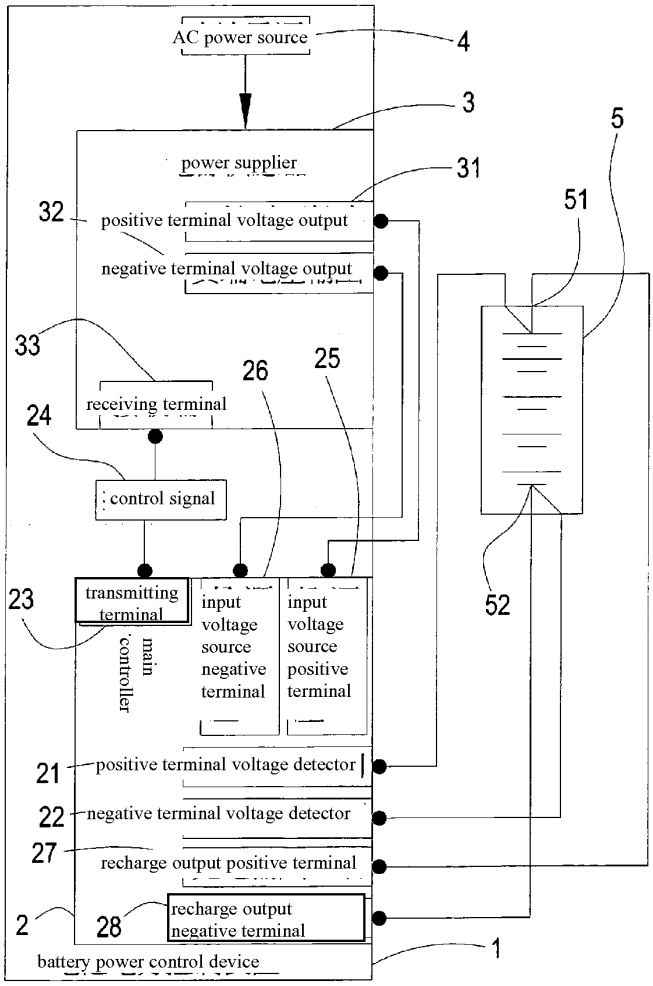


Diagram 1

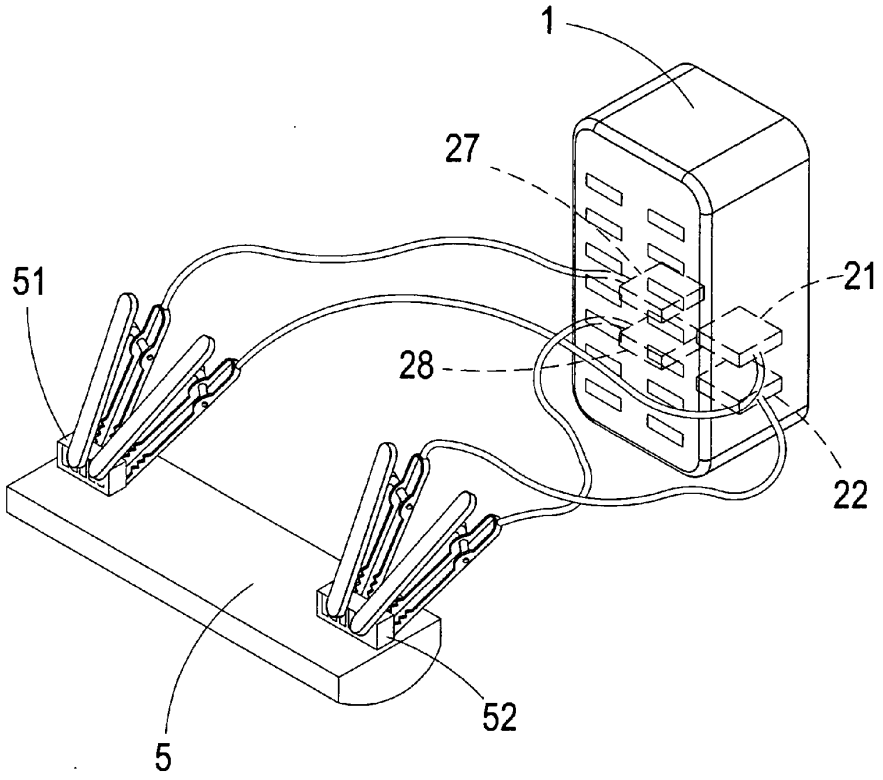


Diagram 2

(19)中華民國智慧財產局

(12)新型說明書公告本 **(11)證書號數：TW M379789U1**

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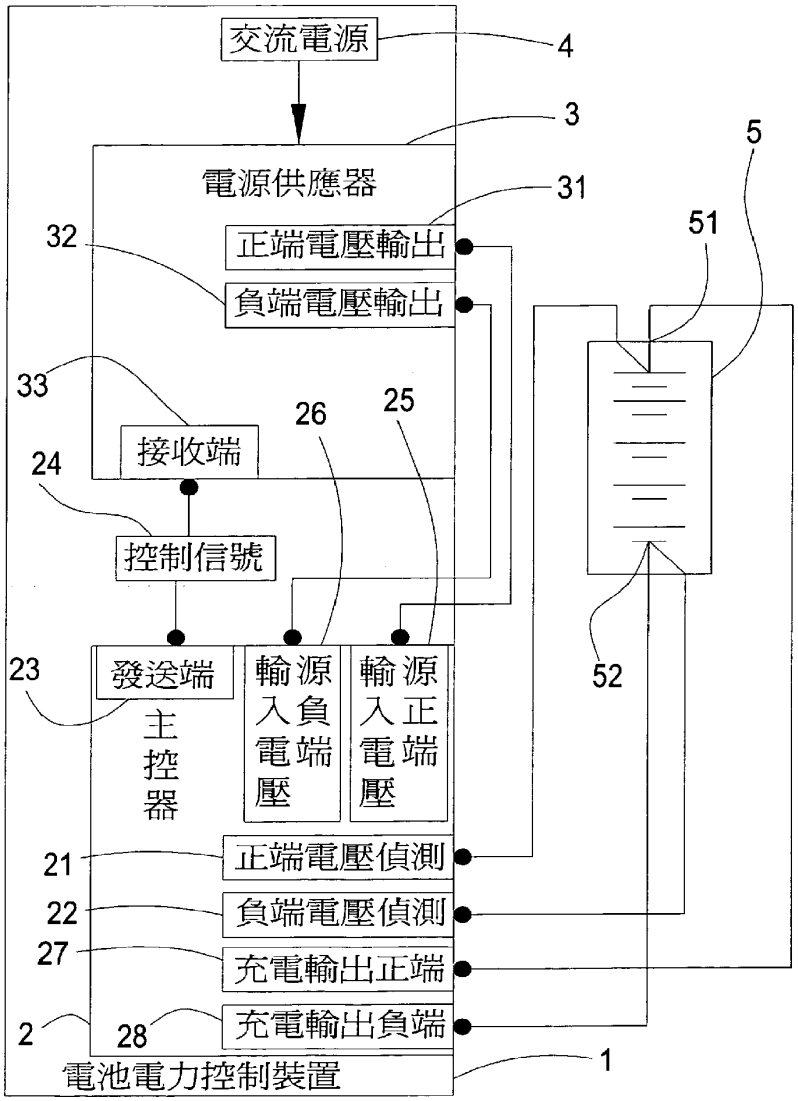
申請專利範圍項數：4 項 圖式數：2 共 10 頁

(54)名稱

可變電壓輸出之電池電力控制裝置

(57)摘要

本創作為有關一種可變電壓輸出之電池電力控制裝置，所述電池電力控制裝置包括有主控器、電源供應器與交流電源。其中，該主控器包括有可供連接至一電池正端之正端電壓偵測與一可供連接至該電池負端之負端電壓偵測，該主控器可供偵測該電池之電壓值並根據該電壓值傳送控制信號；而該電源供應器可接收該控制信號並根據該控制信號產生適當的電壓輸出，藉由上述結構，本創作可以預先偵測電池之電壓值並輸入相對應的電壓值，避免一開始就用最大電壓來對電池進行充電，具有節省能源之實用進步性。



第一圖

1・・・電池電力控制裝置

2・・・主控器

21・・・正端電壓偵測

22・・・負端電壓偵測

23・・・發送端

24・・・控制信號

25・・・輸入電壓源正端

26・・・輸入電壓源負端

27・・・充電輸出正端

28・・・充電輸出負端

3・・・電源供應器

31・・・正端電壓輸出

32・・・負端電壓輸出

33・・・接收端

4・・・交流電源

5・・・電池

51・・・正端

52・・・負端

新型專利說明書

公告本

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

※ 申請案號：98209923

※ 申請日：98.6.5 ※ IPC 分類：G06F1/30 (2006.01)

一、新型名稱：（中文/英文）

可變電壓輸出之電池電力控制裝置

二、中文新型摘要：

本創作為有關一種可變電壓輸出之電池電力控制裝置，所述電池電力控制裝置包括有主控器、電源供應器與交流電源。其中，該主控器包括有可供連接至一電池正端之正端電壓偵測與一可供連接至該電池負端之負端電壓偵測，該主控器可供偵測該電池之電壓值並根據該電壓值傳送控制信號；而該電源供應器可接收該控制信號並根據該控制信號產生適當的電壓輸出，藉由上述結構，本創作可以預先偵測電池之電壓值並輸入相對應的電壓值，避免一開始就用最大電壓來對電池進行充電，具有節省能源之實用進步性。

三、英文新型摘要：

四、指定代表圖：

（一）本創作指定代表圖為：第（一）圖。

（二）本代表圖之元件符號簡單說明：

電池電力控制裝置・1
主控器・・・・・・2
正端電壓偵測・・・21
負端電壓偵測・・・22
發送端・・・・・・23
控制信號・・・・・24
輸入電壓源正端・・25
輸入電壓源負端・・26
充電輸出正端・・・27
充電輸出負端・・・28
電源供應器・・・・3
正端電壓輸出・・・31
負端電壓輸出・・・32
接收端・・・・・・33
交流電源・・・・・4
電池・・・・・・・5
正端・・・・・・・51
負端・・・・・・・52

五、新型說明：

【新型所屬之技術領域】

本創作為提供一種電力節能控制裝置，尤指一種可有效降低筆記型電腦用鋰電池組於生產線充電測試時市電消耗的可變電壓輸出之電池電力控制裝置。

【先前技術】

按，隨著科技的進步，各式各樣的電子產品已經深入人們的生活了，其中，電腦的出現，更是與人們現在的生活密不可分，電腦可以幫人們處理、紀錄生活或工作的大大小小事，而由於個人電腦的體積過於龐大，更有業者研發出容易攜帶的筆記型電腦。

而筆記型電腦為了達到隨時使用的機動性，筆記型電腦一定都配備有一鋰電池來對筆記型電腦進行供電，而當筆記型電腦出貨時，品管人員都要對該鋰電池進行測試驗證，以確保出貨的筆記型電腦電池品質無虞。

然上述筆記型電腦鋰電池於使用時，為確實存在下列問題與缺失尚待改進：

當對筆記型電腦之鋰電池進行測試驗證時，通常都在電池的正極連接有一正端電壓輸出，而在電池的負極連接有一負端電壓輸出，當連接確實後，即對該電池以最高電壓輸出以進行充電功能驗證測試，但也因為一開始就以最高電壓輸出進行充電，卻也造成了不必要的虛功浪費。

是以，要如何解決上述習用之問題與缺失，即為本創作之創作人與從事此行業之相關廠商所亟欲研究改善之方向所在者。

【新型內容】

故，本創作之創作人有鑑於上述缺失，乃搜集相關資料，經由多方評估及考量，並以從事於此行業累積之多年經驗，經由不斷試作及修改，始設計出此種可有效降低筆記型電腦用鋰電池組於生產線充電測試時市電消耗的可變電壓輸出之電池電力控制裝置的新型專利者。

本新型之主要目的在於提供一種電力節能的電池電力控制裝置。

為了達到上述目的，本新型電池電力控制裝置包括有主控器、電源供應器與交流電源。其中，該主控器係包括有一可供連接至一預設電池正端之正端電壓偵測、一可供連接至該電池負端之負端電壓偵測、一充電輸出正端、一充電輸出負端、一輸入電壓源正端與一輸入電壓源負端，該主控器可供偵測該電池之電壓值，並根據該電壓值傳送一控制信號；該電源供應器係包括有一可供連接至該輸入電壓源正端之正端電壓輸出、一可供連接至該輸入電壓源負端之負端電壓輸出，該電源供應器可供接收該控制信號並根據該控制信號號令該正端電壓輸出與該負端電壓輸出產生適當的電壓輸出；該交流電源係可供應該電源供應器之電力；其中，該主控器可根據該輸入電壓源正端與該輸入電壓源負端並令該充電輸出正端與該充電輸出負端產生相對應的電壓輸出於該電池。

其中，由於本創作電池電力控制裝置包括有主控器，該主控器之正端電壓偵測與負端電壓偵測分別連接至電池之正端與負端，該正端電壓偵測與負端電壓偵測可供偵測該電池之電壓，而該主控器可根據該電壓值傳送控制信號至電源供應器，該電源供應器即可以根據該控制信號產生適當的電壓輸出，藉此，避免電源供應器一開始就以最高的電壓輸出，造成不必要的虛功浪費。

【實施方式】

為達成上述目的及功效，本創作所採用之技術手段及構造，茲繪圖就本創作較佳實施例詳加說明其特徵與功能如下，俾利完全了解。

請參閱第一圖所示，係為本創作較佳實施例之方塊圖，由圖中可清楚看出本創作電池５電力控制裝置１係包括：

主控器２，該主控器２係包括有一可供連接至一預設電池５（例如：鋰電池５）正端５１之正端電壓偵測２１、一可供連接至該電池５負端５２之負端電壓偵測２２，一充電輸出正端２７、一充電輸出負端２８、一輸入電壓源正端２５與一輸入電壓源負端２６，該主控器２可藉由該正端電壓偵測２１與該負端電壓偵測２２來偵測該電池

５之電壓值，並根據該電壓值利用發送端２３傳送一控制信號２４；

電源供應器３，該電源供應器３係包括有一可供連接至該輸入電壓源正端２５之正端電壓輸出３１、一可供連接至該輸入電壓源負端２６之負端電壓輸出３２，該電源供應器３可利用接收端３３接收該控制信號２４並根據該控制信號２４令該正端電壓輸出３１與該負端電壓輸出３２產生適當的電壓輸出；

交流電源４（例如：市電），該交流電源４係可供應該電源供應器３之電力。

藉由上述之結構、組成設計，茲就本創作之使用作動情形說明如下，請同時配合參閱第一圖與第二圖所示，係為本創作較佳實施例之方塊圖與實施示意圖，由圖中可清楚看出，當本創作電池５電力控制裝置１應用於筆記型電腦用之電池５於產線上進行充電功能驗證測試時，係將主控器２之正端電壓偵測２１與負端電壓偵測２２分別連接至電池５之正端５１與負端５２，再將主控器２之充電輸出正端２７與充電輸出負端２８分別連接電池５之正端５１與負端５２，藉此，該主控器２即可藉由該正端電壓偵測２１與該負端電壓偵測２２測得該電池５之電壓值，並且該主控器２可根據該電壓值利用發送端２３發送一控制信號２４至該電源供應器３，該電源供應器３即可以藉由該接收端３３接收該控制信號２４，並且根據該控制信號２４令該正端電壓輸出３１與該負端電壓輸出３２產生適當的電壓輸出，該主控器２即可根據該輸入電壓源正端２５與該輸入電壓源負端２６並令該充電輸出正端２７與該充電輸出負端２８產生相對應的電壓輸出於該電池５。。

藉此，本創作係預先利用正端電壓偵測２１與負端電壓偵測２２測得目前電池５串數來切換輸出的電壓值，避免一開始就用最大電壓來對電池５進行充電，造成不必要的虛功浪費，具有節省能源之實用進步性。

故，請參閱全部附圖所示，本創作使用時，與習用技術相較，著實存在下列優點：

本創作電池５電力控制裝置１之主控器２包括有連接至一預設電

池５正端５１之正端電壓偵測２１與連接至該電池５負端５２之負端電壓偵測２２，藉由該正端電壓偵測２１與該負端電壓偵測２２，電源供應器３可以得知目前電池５的電壓值，並根據目前電池５的電壓值來切換輸出的電壓值，避免一開始就用最大電壓提供主控器２來對電池５進行充電，具有節省能源之實用進步性。

惟，以上所述僅為本創作之較佳實施例而已，非因此即拘限本創作之專利範圍，故舉凡運用本創作說明書及圖式內容所為之簡易修飾及等效結構變化，均應同理包含於本創作之專利範圍內，合予陳明。

綜上所述，本創作之可變電壓輸出之電池電力控制裝置於使用時，為確實能達到其功效及目的，故本創作誠為一實用性優異之創作，為符合新型專利之申請要件，爰依法提出申請，盼　審委早日賜准本創作，以保障創作人之辛苦創作，倘若　鈞局審委有任何稽疑，請不吝來函指示，創作人定當竭力配合，實感公便。

【圖式簡單說明】

第一圖　係為本創作較佳實施例之方塊圖。

第二圖　係為本創作較佳實施例之實施示意圖。

【主要元件符號說明】

電池電力控制裝置．1
主控器．．．．．．2
正端電壓偵測．．．21
負端電壓偵測．．．22
發送端．．．．．．23
控制信號．．．．．24
輸入電壓源正端．．25
輸入電壓源負端．．26
充電輸出正端．．．27
充電輸出負端．．．28
電源供應器．．．．3
正端電壓輸出．．．31
負端電壓輸出．．．32
接收端．．．．．．33
交流電源．．．．．4
電池．．．．．．．5
正端．．．．．．．51
負端．．．．．．．52

六、申請專利範圍：

1、一種可變電壓輸出之電池電力控制裝置，所述電池電力控制裝置包括有：

一主控器，係包括有一可供連接至一預設電池正端之正端電壓偵測、一可供連接至該電池負端之負端電壓偵測、一充電輸出正端、一充電輸出負端、一輸入電壓源正端與一輸入電壓源負端，該主控器可藉由該正端電壓偵測與該負端電壓偵測來偵測該電池之電壓值，並根據該電壓值傳送一控制信號；

一電源供應器，係包括有一可供連接至該輸入電壓源正端之正端電壓輸出、一可供連接至該輸入電壓源負端之負端電壓輸出，該電源供應器可供接收該控制信號並根據該控制信號令該正端電壓輸出與該負端電壓輸出產生適當的電壓輸出；

一交流電源，係可供應該電源供應器之電力；

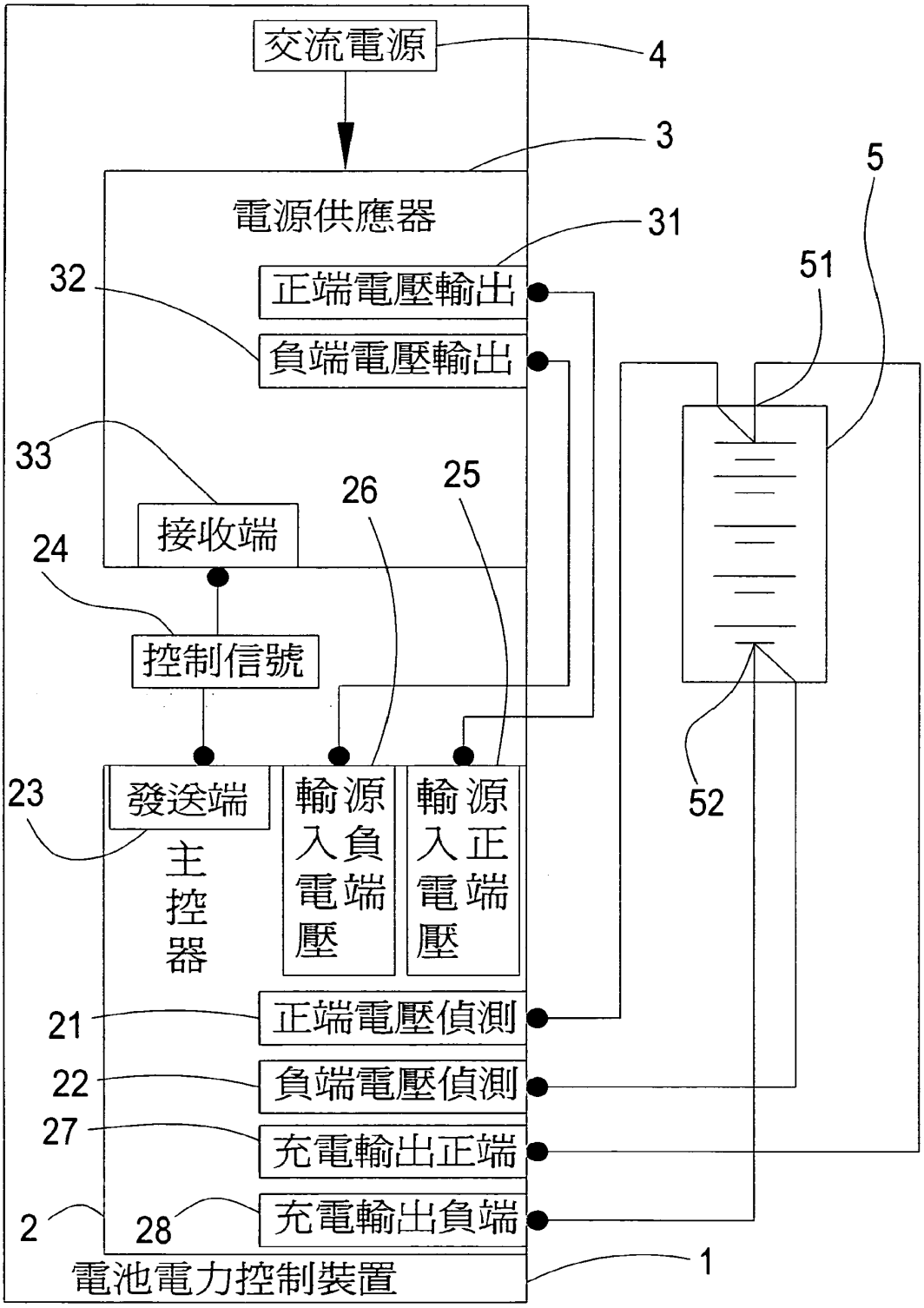
其中，該主控器可根據該輸入電壓源正端與該輸入電壓源負端並令該充電輸出正端與該充電輸出負端產生相對應的電壓輸出於該電池。

2、如申請專利範圍第1項所述之可變電壓輸出之電池電力控制裝置，其中該電池可為鋰電池組。

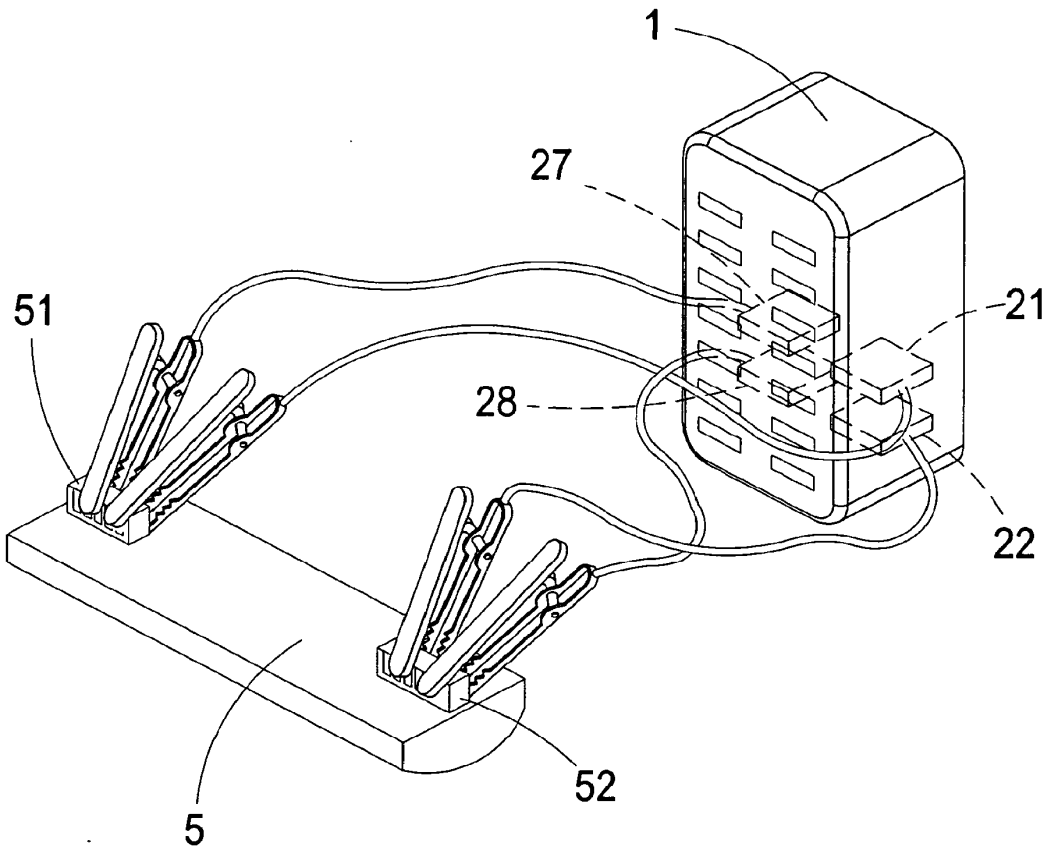
3、如申請專利範圍第1項所述之可變電壓輸出之電池電力控制裝置，其中該主控器內可設置有一可供發送該控制信號之發送端。

4、如申請專利範圍第1項所述之可變電壓輸出之電池電力控制裝置，其中該電源供應器內可設置有一可供接收該控制信號之接收端。

七、圖式：


交流電源
4
3
電源供應器
31
正端電壓輸出
32
負端電壓輸出
33
接收端
26
25
24
控制信號
發送端
23
主控器
輸入電源負端電壓
輸入電源正端電壓
21
正端電壓偵測
22
負端電壓偵測
27
充電輸出正端
2
28
充電輸出負端
電池電力控制裝置
1
5
51
52

第一圖



第二圖

M385047

(19)中華民國智慧財產局

(12)新型說明書公告本 **(11)證書號數：TW M385047U1**

(43)公告日： 中華民國 99 (2010) 年 07 月 21 日

(21)申請案號：099204441 (22)申請日： 中華民國 99 (2010) 年 03 月 12 日

(51)Int. Cl.： ***G06K19/067 (2006.01)*** ***H01Q21/00 (2006.01)***

(71)申請人：承德科技股份有限公司(中華民國) CHEN TECH ELECTRIC MFG. CO., LTD. (TW)
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(72)創作人：許顏阿錦 (TW)

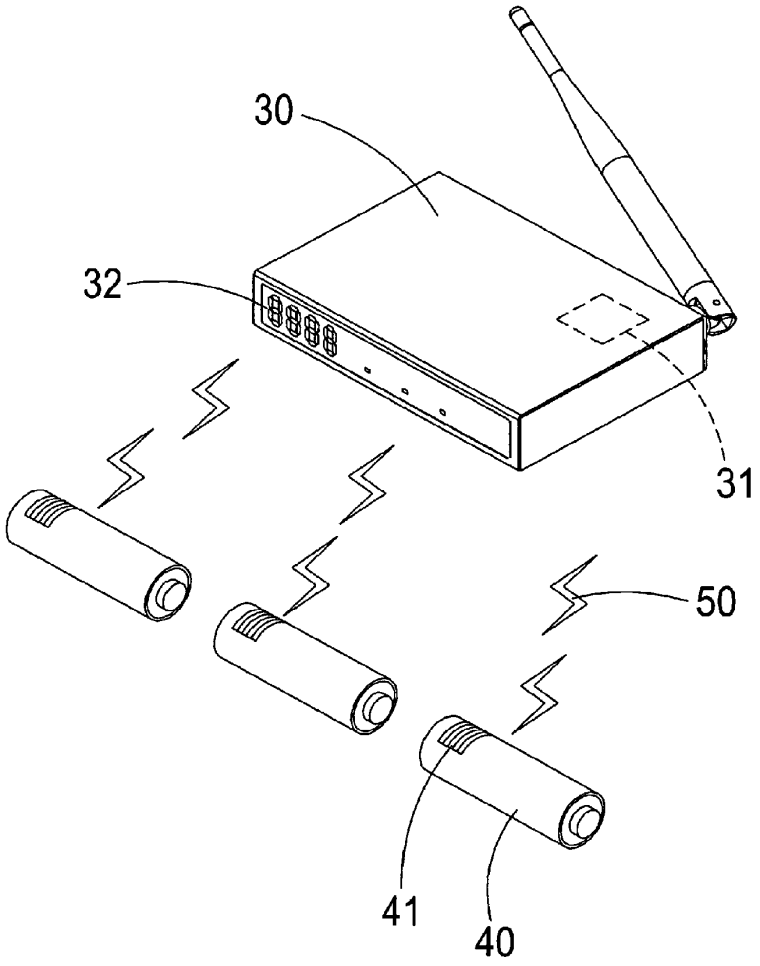
申請專利範圍項數：5 項 圖式數：3 共 11 頁

(54)名稱

ＲＦＩＤ無線辨識資料電池組之結構

(57)摘要

本創作為有關於一種 RFID 無線辨識資料電池組之結構，該 RFID 無線辨識資料電池組係包括有一無線感應讀取裝置及至少一電池單元，該電池單元上係界定有一 RFID 無線發送單元，而該無線感應讀取裝置內係界定有一可接收該 RFID 無線發送單元所發送之電池參數訊號的 RFID 無線接收單元，藉此，透過該無線單元的發送及接收該電池單元的相關訊號，讓使用者得以輕易的得知電池內部資料者，且不佔空間，以提升電池單元參數的辨識速度。



30・・・無線感應讀取裝置

31・・・RFID 無線接收單元

32・・・顯示單元

40・・・電池單元

41・・・RFID 無線發送單元

50・・・訊號

第三圖

公告本

新型專利說明書

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

※ 申請案號：99204441

※ 申請日：99.3.12 ※IPC分類：G06K 19/067 H01Q 21/00

一、新型名稱：（中文／英文）

RFID無線辨識資料電池組之結構

二、中文新型摘要：

本創作為有關於一種RFID無線辨識資料電池組之結構，該RFID無線辨識資料電池組係包括有一無線感應讀取裝置及至少一電池單元，該電池單元上係界定有一RFID無線發送單元，而該無線感應讀取裝置內係界定有一可接收該RFID無線發送單元所發送之電池參數訊號的RFID無線接收單元，藉此，透過該無線單元的發送及接收該電池單元的相關訊號，讓使用者得以輕易的得知電池內部資料者，且不佔空間，以提升電池單元參數的辨識速度。

三、英文新型摘要：

四、指定代表圖：

（一）本創作指定代表圖為：第三圖。

（二）本代表圖之元件符號簡單說明：

無線感應讀取裝置・・・３０

RFID無線接收單元・・・３１

顯示單元・・・・・・・３２

電池單元・・・・・・・４０

RFID無線發送單元・・・４１

訊號・・・・・・・・・５０

五、新型說明：

【新型所屬之技術領域】

本創作為提供一種 RFID 無線辨識資料裝置 ，尤指一種透過RFID進行無線辨識讀取電池相關參數資料的 RFID 無線辨識資料電池組之結構。

【先前技術】

按，目前市售的電池數十多種，對於目前電池的廣汎應用，初期一般電池，多為非再生電池，即為使用一次即丟棄，因此也大量造成環境的汙染，對此解決方案即為研發出二次電池（再生電池），二次電池的持續的多次充電，當使用到沒電後可再經由充電器繼續對其充電，以延長使用電力。

而對於電池充電的次數及電壓值，或是其它參數對一般使用者來說並不會特別在意，而往往這些不起眼的參數是攸關於電池的壽命，因此，為了有效清楚得知電池長期使用後的相關數值，欲有相關廠商開發出具有讀取電池使用後的相關數值的讀取裝置，如第一圖所示，係為習用讀取裝置之方塊示意圖，此種讀取裝置１０以電性連接方式得以讀出該電池２０的使用過後相關參數，如：充電次數、電壓、剩於電量等等。

然上述讀取裝置１０於使用時，為確實存在下列問題與缺失尚待改進：

此讀取裝置１０係採用接線讀取，以線路來電性連接進行讀取電池２０相關參數，然而利用此種有線式讀取裝置１０非常麻煩，必須在辨識系統與電池２０之間建立機械式或有線式接觸讀取裝置１０，於電池２０辨識速度來說並不快。

是以，要如何解決上述習用之問題與缺失，即為本創作之創作人與從事此行業之相關廠商所亟欲研究改善之方向所在者。

【新型內容】

故，本創作之創作人有鑑於上述缺失，乃搜集相關資料，經由多方評估及考量，並以從事於此行業累積之多年經驗，經由不斷試作及修改，始設計出此種透過RFID進行無線辨識讀取電池相關參數資料的RFID 無線辨識資料電池組之結構 新型專利者。

本創作之主要目的在於：該RFID無線接收單元係界定於該無線感應讀取裝置內，該RFID無線接收單元係用於接收來自該RFID無線發送單元所發送的訊號，而該RFID無線發送單元係界定於該電池單元，藉由該RFID無線發送單元可將該電池單元內的參數辨識出而將其無線傳遞至該RFID無線接收單元進行接收，藉由上述技術，可針對習用讀取裝置所存在之主要以線路來電性連接進行讀取電池相關參數，然而利用此種有線式讀取裝置非常麻煩，必須在辨識系統與電池之間建立機械式或有線式接觸讀取裝置，於電池辨識速度來說並不快的問題點加以突破，達到透過界定於該無線感應讀取裝置內的該RFID無線接收單元及界定於該電池單元上的該RFID無線發送單元得以進行無線資料傳遞，將可辨識出該電池單元的資料利用RFID無線傳輸，以有效改善以往必須利用機械式或有線式的麻煩，且辨識速度比前述舊有結構的快，且更有效率之實用進步性。

【實施方式】

為達成上述目的及功效，本創作所採用之技術手段及構造，茲繪圖就本創作較佳實施例詳加說明其特徵與功能如下，俾利完全了解。

請參閱第二圖及第三圖所示，係為本創作較佳實施例之立體圖及方塊示意圖，由圖中可清楚看出本創作主要係包括：

一無線感應讀取裝置３０，該無線感應讀取裝置３０內係界定有一RFID無線接收單元３１，且電性連接一顯示單元３２；及

至少一電池單元４０，該電池單元４０為鹼性電池、碳鋅電池、

鎳鎘電池、鎳氫電池其中之一者。其中該電池單元４０上係界定有一RFID無線發送單元４１，該RFID無線發送單元４１係發送提供該RFID無線接收單元３１可接收的無線訊號５０。

藉此，該無線感應讀取裝置３０係藉由該RFID無線接收單元３１接收來自該RFID無線發送單元４１所發送之訊號５０，以讀取該電池單元４０之相關參數，而該參數為電池已充電次數、電壓、電流、容量、溫度其中之一者。

俾當使用者欲檢查或辨識該電池單元４０之相關參數時（如上述所舉例參數，但並不限定該些參數值），透過該RFID無線發送單元４１讀取有關該電池單元４０的參數，再透過該RFID無線發送單元４１進行訊息５０發送，並且同時則經由該無線感應讀取裝置３０的該RFID無線接收單元３１進行接收，而將該無線訊號５０接收解讀後則予以顯示於該顯示單元３２上，因此，使用者亦可透過該顯示單元３２察看有關該電池單元４０的相關訊息。

惟，以上所述僅為本創作之較佳實施例而已，非因此即侷限本創作之專利範圍，故舉凡運用本創作說明書及圖式內容所為之簡易修飾及等效結構變化，均應同理包含於本創作之專利範圍內，合予陳明。

故，請參閱全部附圖所示，本創作使用時，與習用技術相較，著實存在下列優點：

本創作係利用RFID（Radio Frequency Identification）技術，亦透過無線訊號５０辨識電池單元４０的記錄資料等相關資訊，無須在讀取裝置１０與電池２０之間建立機械式或有線式接觸讀取裝置，並提升電池單元４０參數辨識的速度，以利該電池單元４０充電或放電，而藉由該RFID無線發送單元４１置入該電池單元４０之方式，來建立每一個電池單元４０的辨識資料，且與一般讀取電池２０資料得技術不同，具有RFID無線發送單元４１的電池單元４０不需要任何的接線即能辨識電池單元４０內部資料，且電池單元４０上的RFID無線發送單元４１不佔空間且無須電源，使用上完全不影響該電池單元４０的功能。

綜上所述，本創作之 RFID 無線辨識資料電池組之結構於使用時

，為確實能達到其功效及目的，故本創作誠為一實用性優異之創作，為符合新型專利之申請要件，爰依法提出申請，盼　審委早日賜准本創作，以保障創作人之辛苦創作，倘若　鈞局審委有任何稽疑，請不吝來函指示，創作人定當竭力配合，實感德便。

【圖式簡單說明】

第一圖　係為習用讀取裝置之方塊示意圖。

第二圖　係為本創作較佳實施例之立體圖。

第三圖　係為本創作較佳實施例之方塊示意圖。

【主要元件符號說明】

讀取裝置・・・・・・・・１０

電池・・・・・・・・・・２０

無線感應讀取裝置・・・３０

RFID無線接收單元・・・３１

顯示單元・・・・・・・・３２

電池單元・・・・・・・・４０

RFID無線發送單元・・・４１

訊號・・・・・・・・・・５０

六、申請專利範圍：

1、一種 RFID 無線辨識資料電池組之結構，主要包括有：

一無線感應讀取裝置，該無線感應讀取裝置內係界定有一RFID無線接收單元；及

至少一電池單元，該電池單元上係界定有一RFID無線發送單元，該RFID無線發送單元係發送提供該RFID無線接收單元可接收的無線訊號。

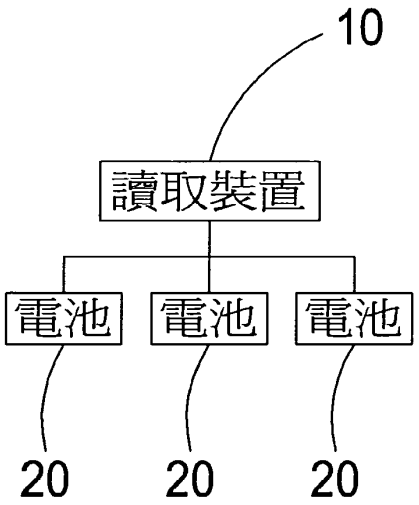
2、如申請專利範圍第 1 項所述之 RFID 無線辨識資料電池組之結構，其中該無線感應讀取裝置係藉由該RFID無線接收單元接收來自該RFID無線發送單元所發送之訊號，以讀取該電池單元之相關參數。

3、如申請專利範圍第 2 項所述之 RFID 無線辨識資料電池組之結構，其中該參數為電池已充電次數、電壓、電流、容量、溫度其中之一者。

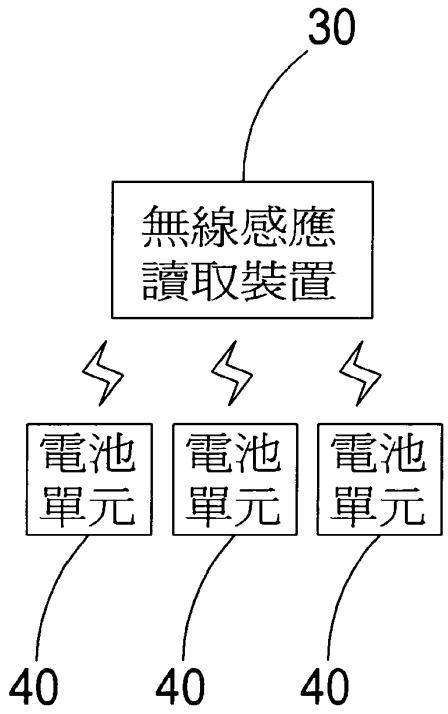
4、如申請專利範圍第 1 項所述之 RFID 無線辨識資料電池組之結構，其中該電池單元為鹼性電池、碳鋅電池、鎳鎘電池、鎳氫電池其中之一者。

5、如申請專利範圍第 1 項所述之 RFID 無線辨識資料電池組之結構，其中該無線感應讀取裝置係電性連接一顯示單元。

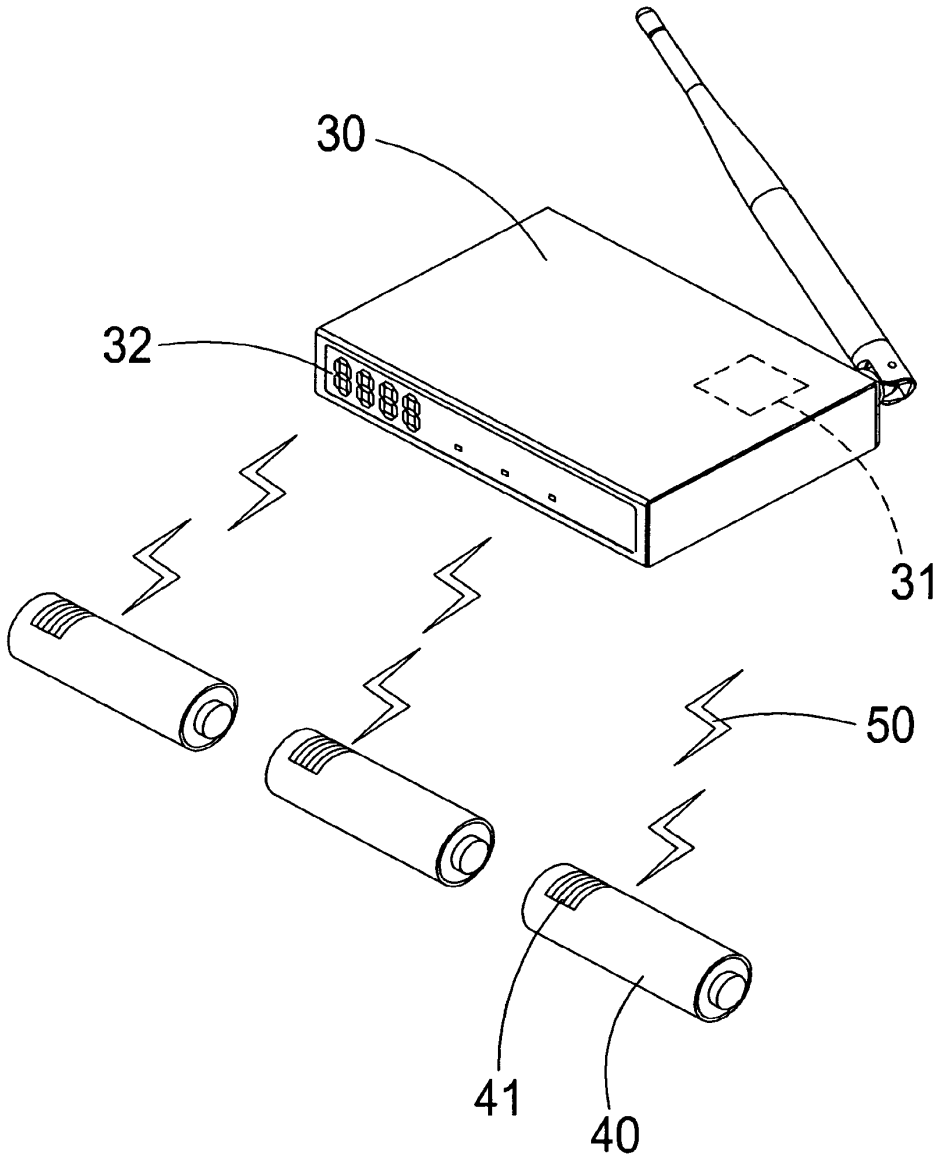
七、圖式：



第一圖



第二圖



第三圖

Thomson Innovation Patent Export, 2013-05-09 18:30:28 -0500

Record 8/25 TW201043986A Stand-alone battery detection device

Publication Number: TW201043986A
Publication Date: 2010-12-16
Title: Stand-alone battery detection device
Application Number: TW2009118746A
Application Date: 2009-06-05
Abstract (English):

The present invention relates to a stand-alone battery detection device, which mainly installs at the detection device connection ports that respectively connect to battery and computer, also installed at the detection is a computing module that will change the channel code in response to different types of batteries. A system management bus (SMbus) is used to connect the battery from one of the connection ports at the detection device in order to obtain relevant information inside the battery that can be used to determine battery quality and collect data, and then through the industrial communication interfaces (RS-485) to connect with the computer from one of the connection ports at the detection device, the collected data is computed and stored, thereby enhancing good anti-noise ability and increasing transmission distance through the RS-485, and random movement with the battery placement location can be made possible.
Abstract - DWPI:

Abstract - DWPI Novelty:
The present invention relates to a stand-alone battery detection device, which mainly installs at the detection device connection ports that respectively connect to battery and computer, also installed at the detection is a computing module that will change the channel code in response to different types of batteries. A system management bus (SMbus) is used to connect the battery from one of the connection ports at the detection device in order to obtain relevant information inside the battery that can be used to determine battery quality and collect data, and then through the industrial communication interfaces (RS-485) to connect with the computer from one of the connection ports at the detection device, the collected data is computed and stored, thereby enhancing good anti-noise ability and increasing transmission distance through the RS-485, and random movement with the battery placement location can be made possible.

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(19)中華民國智慧財產局
(12)發明說明書公開本 (11)公開編號：TW 201043986 A1
(43)公開日： 中華民國 99 (2010) 年 12 月 16 日

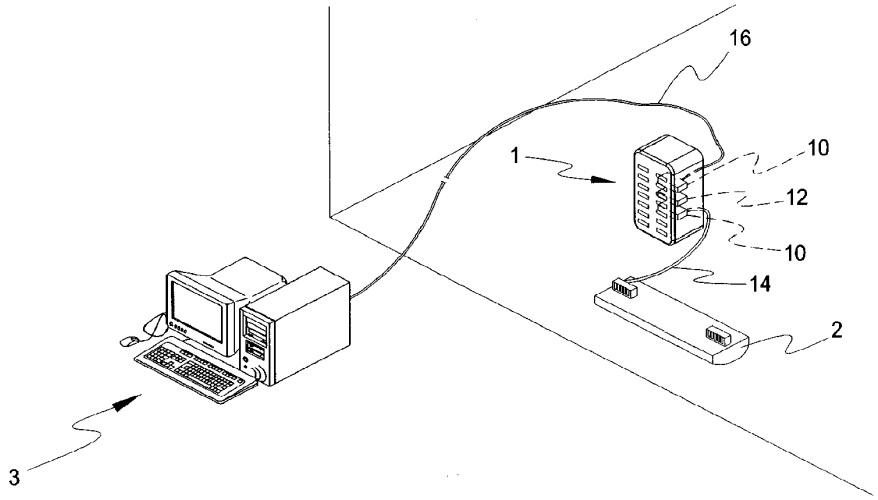
(21)申請案號：098118746 (22)申請日： 中華民國 98 (2009) 年 06 月 05 日
(51)Int. Cl.： *G01R31/36 (2006.01)* *G06F13/10 (2006.01)*
(71)申請人：承德科技股份有限公司 (中華民國) CHEN TECH ELECTRIC MFG. CO., LTD. (TW)
臺北縣三重市光復路 1 段 61 巷 27 號
(72)發明人：許顏阿錦 (TW)
申請實體審查：有 申請專利範圍項數：3 項 圖式數：2 共 11 頁

(54)名稱

獨立式電池偵測裝置

(57)摘要

本發明為有關於一種獨立式電池偵測裝置，其主要於偵測裝置上設置有分別與電池及電腦連接之連接埠，且於偵測裝置上裝設有供針對不同型式的電池而改變通道碼之運算模組，另利用系統管理匯流排（ＳＭｂｕｓ）由偵測裝置上其中之一連接埠連接至電池，並同時取得電池內部的相關資料，以作為電池品質的判定及資料的收集，而後再透過工業級通訊介面（ＲＳ－４８５）由偵測裝置上其中之一連接埠連接至電腦，將收集到的該些資料進行運算及儲存，如此，藉由該些ＲＳ－４８５可提升良好的抗雜訊能力及增加傳輸的距離，亦同時可隨電池所擺放位置而隨機移動。



２：電池
３：電腦
１０：連接埠
１２：運算模組
１４：系統管理匯流排
１６：工業級通訊介面

六、發明說明：

【發明所屬之技術領域】

本發明為提供一種電池偵測裝置，尤指一種能針對單一電池進行偵測，並增加通訊距離提升抗雜訊之獨立式電池偵測裝置。

【先前技術】

按，隨著科技的日益精進，讓以往桌上型電腦不斷創新，以創造出更易於攜帶且重量及體積更輕薄短小的筆記型電腦，由於為了讓筆記型電腦能被使用者走到那用到那，因此針對筆記型電腦所使用的電池品質則更加講究且安全規格的把關更加嚴格，而目前一般對於筆記型電腦的鋰電池所進行的測試，均係利用系統管理匯流排（ＳＭｂｕｓ）讀取電池內部的相關資訊，以作為電池品質的判定與相關資料的收集，由於系統管理匯流排（ＳＭｂｕｓ）的通訊距離會受到迴路上雜散電容的限制，並無法有太長的通訊距離，再者，針對單一電池的偵測並無法依照電池所需的測試環境而隨即調整擺放位置。

是以，要如何解決上述習用之問題與缺失，即為本發明之發明人與從事此行業之相關廠商所亟欲研究改善之方向所在者。

【發明內容】

故，本發明之發明人有鑑於上述缺失，乃搜集相關資料，經由多方評估及考量，並以從事於此行業累積之多年經驗，經由不斷試作及修改，始設計出此種能針對單一電池進行偵測，並增加通訊距離提升抗雜訊之獨立式電池偵測裝置的發明專利者。

本發明之主要目的在於：一種獨立式電池偵測裝置，其主要於偵測裝置上設置有分別與電池及電腦連接之連接埠，且於偵測裝置上裝設有供針對不同型式的電池而改變通道碼之運算模組，再者，利用系統管理匯流排（ＳＭｂｕｓ）由偵測裝置上其中之一連接埠連接至電池，並同時取得電池內部的相關資料，以作為電池品質的判定及資料的收集，而後再透過工業級通訊介面（ＲＳ－４８５）由偵測裝置上其中之一連接埠連接置電腦，將收集到的該些資料進行運算及儲存，如此，藉由工業級通訊介面（ＲＳ－４８５）可提升良好的抗雜訊能力及廣面積長距離傳輸的距離，以保持資料判讀的穩定性與正確性。

本發明之次要目的在於：同時可隨電池所擺放位置而隨機移動，大幅增加其機動性。

【實施方式】

為達成上述目的及功效，本發明所採用之技術手段及構造，茲繪圖就本發明較佳實施例詳加說明其特徵與功能如下，俾利完全了解。

請參閱第一圖所示，係為本發明較佳實施例之方塊配置示意圖，由圖中可清楚看出本發明其主要於偵測裝置１上設置有分別與電池２及電腦３連接之連接埠１０，且於偵測裝置１上裝設有供針對不同型式的電池２而改變通道碼之運算模組１２，再者，利用系統管理匯流排１４（ＳＭｂｕｓ）由偵測裝置１上其中之一連接埠１０連接至電池２，並同時取得電池２內部的相關資料，以作為電池２品質的判定及資料的收集，而後再透過工業級通訊介面１６（ＲＳ－４８５）由偵測裝置１上其中之一連接埠１０連接置電腦３，將收集到的該些資料進行運算及儲存。

請同時配合參閱第二圖所示，係為本發明較佳實施例之偵測狀態示意圖，由圖中可清楚看出，由於偵測裝置１上係利用系統管理匯流排１４（ＳＭｂｕｓ）插置於連接埠１０內並電池２成一連接，因此在資料的讀取上不僅能提升良好的抗雜訊能力，更可增加其傳輸的距離，以保持資料判讀的穩定性與正確性。

另外，於偵測裝置１上係利用工業級通訊

介面16（RS－485）插置於連接埠10內並電腦3成一連接，如此，當上述由電池中所取得之資料亦可經由工業級通訊介面16（RS－485）傳輸至電腦3，亦同樣地能提升良好的抗雜訊能力及大面積長距離的傳輸，以保持資料判讀的穩定性與正確性。

再者，因偵測裝置1係運用於偵測單一電池2所設計，由於在偵測裝置1內設有可供針對不同型式的電池2而改變通道碼之運算模組12，如此一來，偵測裝置1於讀取電池2時則無需限定其規格，同時可隨電池2所需測試之環境而隨其更換擺放場所。

惟，以上所述僅為本發明之較佳實施例而已，非因此即拘限本發明之專利範圍，故舉凡運用本發明說明書及圖式內容所為之簡易修飾及等效結構變化，均應同理包含於本發明之專利範圍內，合予陳明。

綜上所述，本發明之獨立式電池偵測裝置於使用時，為確實能達到其功效及目的，故本發明誠為一實用性優異之發明，為符合發明專利之申請要件，爰依法提出申請，盼　審委早日賜准本發明，以保障發明人之辛苦發明，倘若　鈞局審委有任何稽疑，請不吝來函指示，發明人定當竭力配合，實感公便。

【圖式簡單說明】

第一圖　係為本發明較佳實施例之方塊配置示意圖。

第二圖　係為本發明較佳實施例之使用狀態示意圖。

【主要元件符號說明】

偵測裝置　．．．．．1

連接埠　．．．．．10

運算模組　．．．．．12

系統管理匯流排　．．．．．14

工業級通訊介面　．．．．．16

電池　．．．．．2

電腦　．．．．．3

發明專利說明書

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

※申請案號：098118746

※申請日：98 6 5　　※IPC分類：G01R31/36 G06F13/110

一、發明名稱：（中文/英文）

獨立式電池偵測裝置

二、中文發明摘要：

本發明為有關於一種獨立式電池偵測裝置，其主要於偵測裝置上設置有分別與電池及電腦連接之連接埠，且於偵測裝置上裝設有供針對不同型式的電池而改變通道碼之運算模組，另利用系統管理匯流排（SMbus）由偵測裝置上其中之一連接埠連接至電池，並同時取得電池內部的相關資料，以作為電池品質的判定及資料的收集，而後再透過工業級通訊介面（RS－485）由偵測裝置上其中之一連接埠連接至電腦，將收集到的該些資料進行運算及儲存，如此，藉由該些RS－485可提升良好的抗雜訊能力及增加傳輸的距離，亦同時可隨電池所擺放位置而隨機移動。

三、英文發明摘要：

七、申請專利範圍：

1、一種獨立式電池偵測裝置，係包括：

一具複數分別與至少一電池及至少一電腦連接之連接埠的偵測裝置；

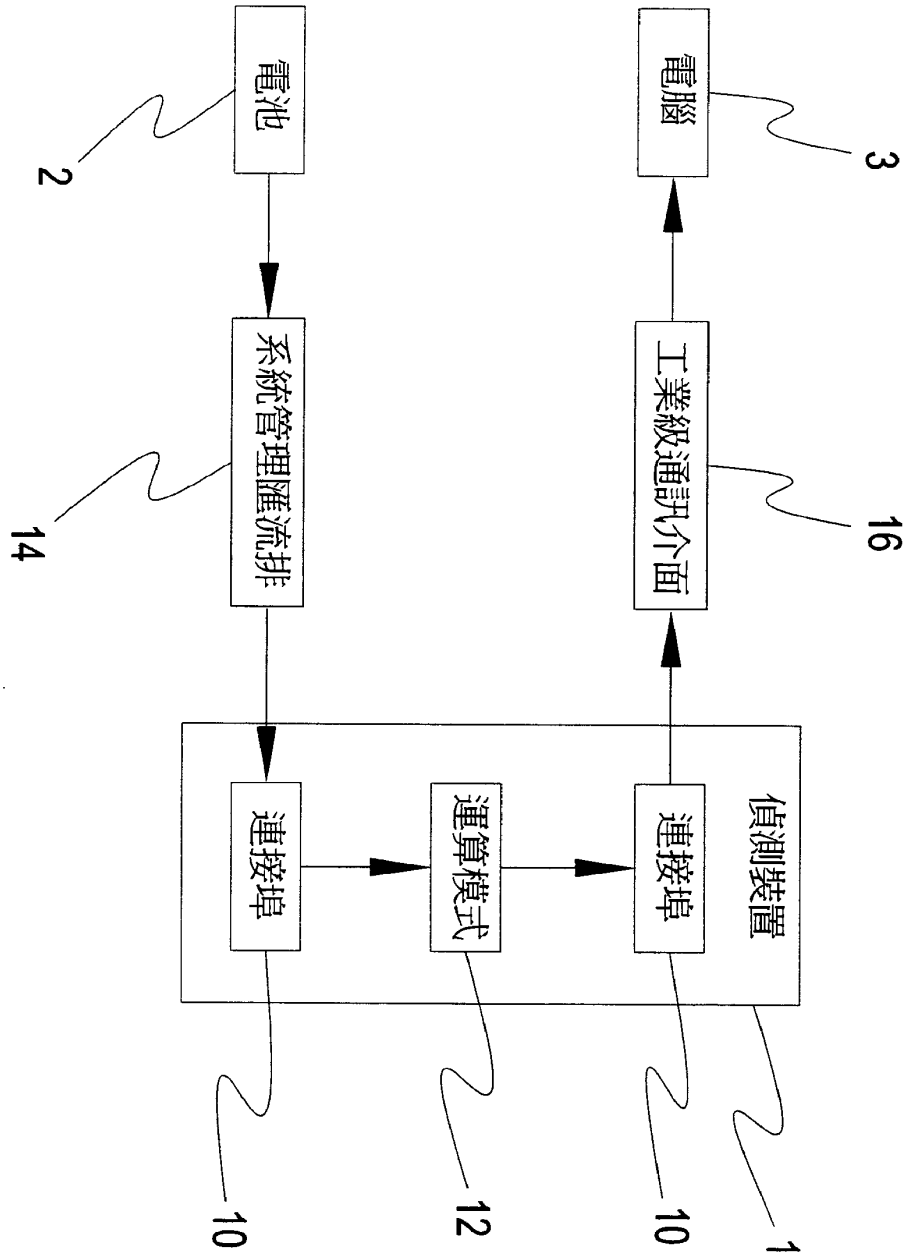
至少一由該連接埠連接至該電腦之工業級通訊介面（ＲＳ－４８５）；及

至少一由該連接埠連接至該電池之系統管理匯流排（ＳＭｂｕｓ）。

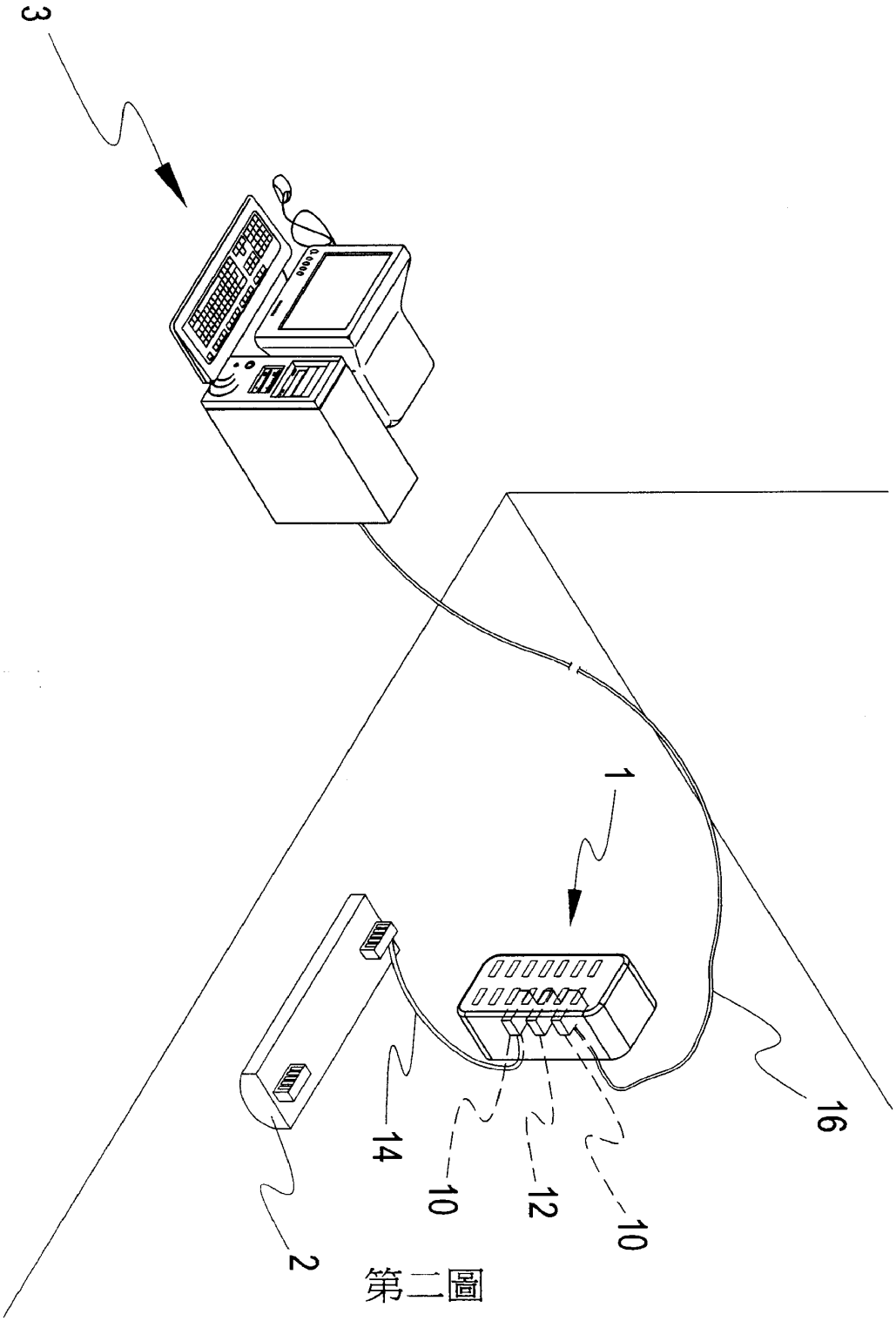
2、如申請專利範圍第1項所述之獨立式電池偵測裝置，其中該偵測裝置更包括一供針對不同型式的電池而改變通道碼之運算模組。

3、如申請專利範圍第1項所述之獨立式電池偵測裝置，其中該偵測裝置係可隨該電池所擺放位置而隨機移動。

201043986式：



第一圖



第二圖

四、指定代表圖：

(一)本發明指定代表圖為：第（二）圖。

(二)本代表圖之元件符號簡單說明：

連接埠 ．．．．．１０

運算模組 ．．．．．１２

系統管理匯流排 ．．．．．１４

工業級通訊介面 ．．．．．１６

電池 ．．．．．２

電腦 ．．．．．３

五、本案若有化學式時，請揭示最能顯示發明特徵的化學式：

Thomson Innovation Patent Export, 2013-05-09 18:30:28 -0500

Record 7/25 TW201044266A Coding system having battery parameter setting function

Publication Number: TW201044266A
Publication Date: 2010-12-16
Title: Coding system having battery parameter setting function
Application Number: TW2009118742A
Application Date: 2009-06-05
Abstract (English):

This invention relates to a coding system capable of setting battery parameter. The coding system is mainly capable of establishing at least a file unit having parameter data in a software list of an electronic device. A user can select a file unit and then upload the parameter data in the file unit to be stored in a memory unit of a control unit in an IC. The hardware unit reads the parameter data and then starts to operate. The process of the coding system is completed when the operation of the hardware unit ends and at the same time the parameter data is confirmed to be correct after comparing with the hardware unit again. Thus, the user can directly refresh the IC or modify the parameter data anytime via the coding system. Advantageously, the modification can be repeated without repeated burning or changing the hardware unit.
Abstract - DWPI:

Abstract - DWPI Novelty:
This invention relates to a coding system capable of setting battery parameter. The coding system is mainly capable of establishing at least a file unit having parameter data in a software list of an electronic device. A user can select a file unit and then upload the parameter data in the file unit to be stored in a memory unit of a control unit in an IC. The hardware unit reads the parameter data and then starts to operate. The process of the coding system is completed when the operation of the hardware unit ends and at the same time the parameter data is confirmed to be correct after comparing with the hardware unit again. Thus, the user can directly refresh the IC or modify the parameter data anytime via the coding system. Advantageously, the modification can be repeated without repeated burning or changing the hardware unit.

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(19)中華民國智慧財產局
(12)發明說明書公開本 (11)公開編號：TW 201044266 A1
(43)公開日： 中華民國 99 (2010) 年 12 月 16 日

(21)申請案號：098118742 (22)申請日： 中華民國 98 (2009) 年 06 月 05 日
(51)Int. Cl.： *G06F9/06 (2006.01)* *G06F13/10 (2006.01)*
(71)申請人：承德科技股份有限公司 (中華民國) CHEN TECH ELECTRIC MFG. CO., LTD. (TW)
臺北縣三重市光復路 1 段 61 巷 27 號
(72)發明人：許顏阿錦 (TW)
申請實體審查：有 申請專利範圍項數：4 項 圖式數：2 共 13 頁

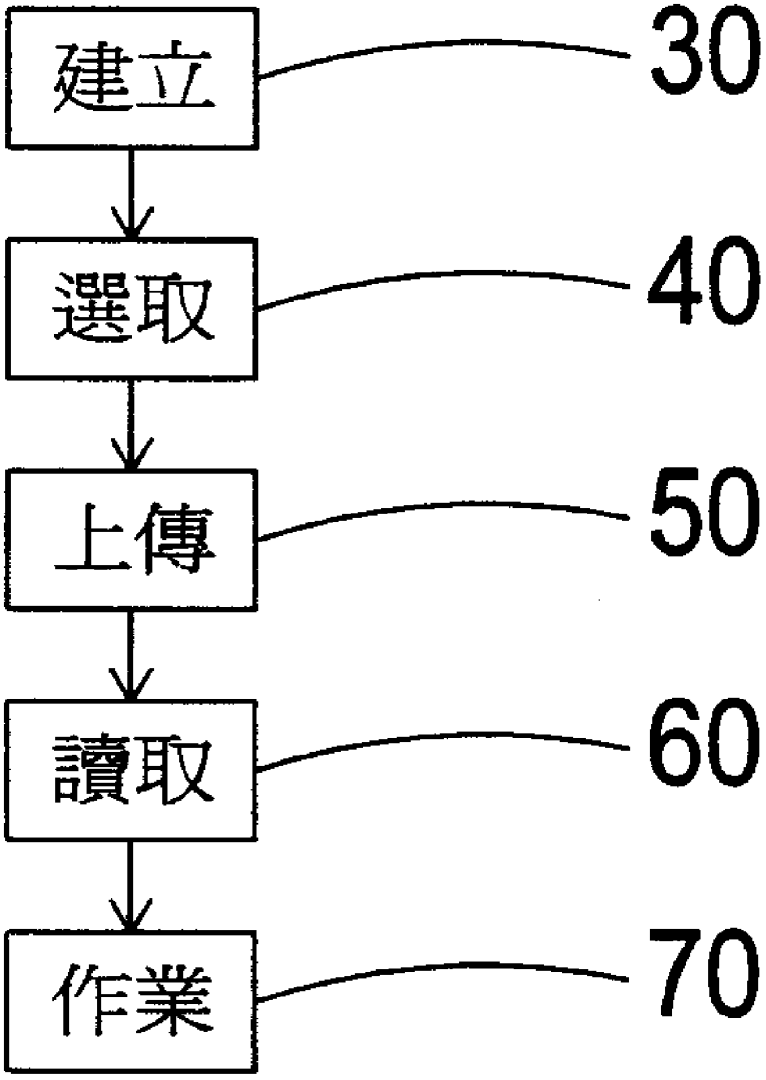
(54)名稱

可設定電池參數之編碼系統

(57)摘要

本發明為有關一種可設定電池參數之編碼系統，該編碼系統主要係可於一電子裝置內所屬的軟件列表中建立至少一具有參數資料之檔案單元，而使用者可選取欲選定之檔案單元，而後將該檔案單元內之參數資料上傳至一積體電路元件內之管控單元所屬的記憶單元做儲存，而該硬體單元則讀取該參數資料後開始作動，直到該作動結束且同時該參數資料再次與該硬體單元比對確認無誤後即完成該編碼系統流程，藉此，使用者透過該編碼系統亦可隨時直接對該積體電路單元進行更新或更改該參數資料，且可重複變更，無須重複燒錄或變動硬體單元之優勢。

３０：建立
４０：選取
５０：上傳
６０：讀取
７０：作業



六、發明說明：

【發明所屬之技術領域】

本發明為提供一種編碼系統，尤指一種可隨時更新或更換參數編碼，以及可依需求擴充的可設定電池參數之編碼系統。

【先前技術】

按，可攜式電子裝置的電源供應多以來自電池，而電池受限於可攜式裝置容積的關係，而使得其蓄積電量受到相當的限制，因此，可攜式電子裝置的耗電率從過去到現在一直都是設計者所注意的焦點之一。而目前電池於初期的參數編碼會以不同晶片廠商或版本不同或使用者需求不同等條件使其編碼不同，以現階段將參數編碼寫入晶片多以採用固定寫入方式，該種固定寫入方式無法隨使用者不同或其它因素而改變，換句話說，即是無法隨時做參數編碼之更新或更換，也因此造成許多使用者的不便利，而上述係採用特定模式之通訊協定外，亦藉由廠商本身所需求之參數編碼進行寫入，藉此，俾當寫入後即無法隨時做內容編碼之更動。

是以，要如何解決上述習用之問題與缺失，即為本發明之發明人與從事此行業之相關廠商所亟欲研究改善之方向所在者。

【發明內容】

故，本發明之發明人有鑑於上述缺失，乃搜集相關資料，經由多方評估及考量，並以從事於此行業累積之多年經驗，經由不斷試作及修改，始設計出此種可隨時更新或更換參數編碼，以及可依需求擴充的可設定電池參數之編碼系統的發明專利者。

本發明之主要目的在於：該編碼系統係供使用者便於隨時更新或更換積體電路元件內之參數資料，使被積體電路元件所控制之硬體單元得以依照參數資料而運作，俾當使用者欲變更或寫入該積體電路元件內之參數資料時，可透過一電子裝置於其軟件列表中建立一檔案單元，而於該檔案單元中輸入欲控制該硬體單元之參數資料，而後藉由該電子裝置選取該檔案單元，將該檔案單元上傳至該積體電路元件內

之管控單元所屬的記憶單元做儲存，當該硬體單元讀取該參數資料時，隨即按照該參數資料內容作動，並且該檔案單元亦可包括有數組，以供使用者選擇或編輯參數資料，使用者得以選定該等檔案單元做為該硬體單元欲執行之指令，藉由上述技術，可針對習用所存在之因採用固定寫入方式，使用者係無法隨時改變或更新，也因此造成許多使用者的不便利，而使用者寫入後即無法隨時做內容編碼之更動的問題點加以突破，達到本發明透過該編碼系統亦可隨時直接對該積體電路單元進行更新或更改該參數資料，且可重複變更，無須重複燒錄或變動硬體單元之實用進步性。

本發明之次要目的在於：該編碼系統係進一步具有數個可供使用者自行擴充之檔案單元，每一檔案單元內之參數資料亦可為不同參數，藉此，使用者可於該等檔案單元中選取欲上傳執行之參數資料，並且同時亦可自行輸入欲執行之參數資料的實用進步性。

【實施方式】

為達成上述目的及功效，本發明所採用之技術手段及構造，茲繪圖就本發明較佳實施例詳加說明其特徵與功能如下，俾利完全了解。

請參閱第一圖及第一Ａ圖所示，係為本發明較佳實施例之步驟流程圖一、二，由圖中可清楚看出本發明係包括至少一檔案單元，該等檔案單元內係分別設定有參數資料，透過該參數資料亦可控制一硬體單元進行作動，其主要流程大致分為建立３０、選取４０、上傳５０、讀取６０及作業７０，而主要步驟如下：

（ａ）於電子裝置內所屬的軟件列表中建立至少一具有參數資料之檔案單元；

（ｂ）該使用者選取欲選定之檔案單元；

（ｃ）將該檔案單元內之參數資料上傳至一積體電路元件內之管控單元所屬的記憶單元做儲存；及

（ｄ）被該積體電路元件所控制之硬體單元讀取該參數資料後開始作動。

而上述之電子裝置係為電腦或具有控制功能之機台其中之一者，

藉由該電子裝置亦可建立或選取檔案單元，及，亦可對該檔案單元進行輸入參數資料等，而該參數資料係可供數個不同之積體電路元件進行上傳，於上傳至該積體電路元件後，該硬體單元則藉由一指令資料與該參數資料做連結，使該硬體單元得以依照該參數資料進行正確作動。

請同時配合參閱第二圖所示，係為本發明較佳實施例之方塊示意圖，由圖中可清楚看出，所述編碼系統係供使用者便於隨時更新或更換積體電路元件２１內之參數資料１１１，使被積體電路元件２１所控制之硬體單元２０得以依照參數資料１１１而運作，而該編碼系統係包括有一電子裝置１０、至少一建立於該電子裝置１０內之檔案單元１１，一建立於該檔案單元１１內之參數資料１１１，一用於生產之硬體單元２０，一用於控制該硬體單元２０作動之積體電路元件２１，一設於該積體電路元件２１內部之管控單元２１１及一設於該管控單元２１１內用於儲存該參數資料１１１之記憶單元２１１１，俾當使用者欲寫入或更動該積體電路元件２１內之參數資料１１１時，首先於該電子裝置１０內建立至少一檔案單元１１，於該檔案單元１１內寫入參數資料１１１，而後將該已寫入參數資料１１１的檔案單元１１上傳至該積體電路元件２１內之管控單元２１１所屬的記憶單元２１１１做儲存，該硬體單元２０隨後依照該記憶單元２１１１內之參數資料１１１進行作動，直到該作動結束後即完成該編碼系統流程。

是以，本發明之可設定電池參數之編碼系統為可改善習用之技術關鍵在於：

一、使用者透過該編碼系統亦可隨時直接對該積體電路單元２１進行更新或更改該參數資料１１１。

二、該參數資料１１１可重複變更，無須重複燒錄或變動該硬體單元２０。

三、該編碼系統係具有數個可供使用者自行擴充之檔案單元１１。

惟，以上所述僅為本發明之較佳實施例而已，非因此即拘限本發

明之專利範圍，故舉凡運用本發明說明書及圖式內容所為之簡易修飾及等效結構變化，均應同理包含於本發明之專利範圍內，合予陳明。

綜上所述，本發明之可設定電池參數之編碼系統於使用時，為確實能達到其功效及目的，故本發明誠為一實用性優異之發明，為符合發明專利之申請要件，爰依法提出申請，盼　審委早日賜准本發明，以保障發明人之辛苦發明，倘若　鈞局審委有任何稽疑，請不吝來函指示，發明人定當竭力配合，實感公便。

【圖式簡單說明】

第一圖　係為本發明較佳實施例之步驟流程圖一。

第一Ａ圖　係為本發明較佳實施例之步驟流程圖二。

第二圖　係為本發明較佳實施例之方塊示意圖。

【主要元件符號說明】

電子裝置・・・・１０

檔案單元・・・・１１

參數資料・・・・１１１

硬體單元・・・・２０

積體電路元件・・２１

管控單元・・・・２１１

記憶單元・・・・２１１１

指令資料・・・・２２

建立・・・・・・３０

選取・・・・・・４０

上傳・・・・・・５０

讀取・・・・・・６０

作業・・・・・・７０

發明專利說明書

（本說明書格式、順序，請勿任意更動，※記號部分請勿填寫）

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G06F13/10 (2006.01)

一、發明名稱：（中文／英文）

可設定電池參數之編碼系統

二、中文發明摘要：

本發明為有關一種可設定電池參數之編碼系統，該編碼系統主要係可於一電子裝置內所屬的軟件列表中建立至少一具有參數資料之檔案單元，而使用者可選取欲選定之檔案單元，而後將該檔案單元內之參數資料上傳至一積體電路元件內之管控單元所屬的記憶單元做儲存，而該硬體單元則讀取該參數資料後開始作動，直到該作動結束且同時該參數資料再次與該硬體單元比對確認無誤後即完成該編碼系統流程，藉此，使用者透過該編碼系統亦可隨時直接對該積體電路單元進行更新或更改該參數資料，且可重複變更，無須重複燒錄或變動硬體單元之優勢。

三、英文發明摘要：

七、申請專利範圍：

1、一種可設定電池參數之編碼系統，所述編碼系統係供使用者便於隨時更新或更換積體電路元件內之參數資料，使被積體電路元件所控制之硬體單元得以依照參數資料而運作，且大致流程分為建立、選取、上傳、讀取及作業，其主要步驟流程如下：

（ａ）於電子裝置內所屬的軟件列表中建立至少一具有參數資料之檔案單元；

（ｂ）該使用者選取欲選定之檔案單元；

（ｃ）將該檔案單元內之參數資料上傳至一積體電路元件內之管控單元所屬的記憶單元做儲存；及

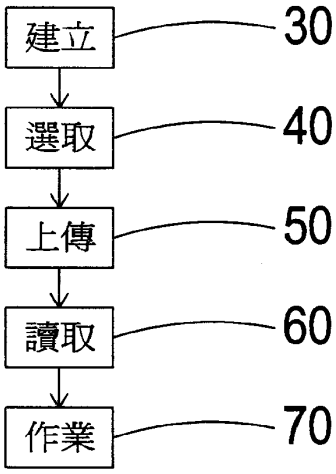
（ｄ）被該積體電路元件所控制之硬體單元讀取該參數資料後開始作動。

2、如申請專利範圍第１項所述之可設定電池參數之編碼系統，其中該電子裝置係為電腦或具有控制功能之機台其中之一者。

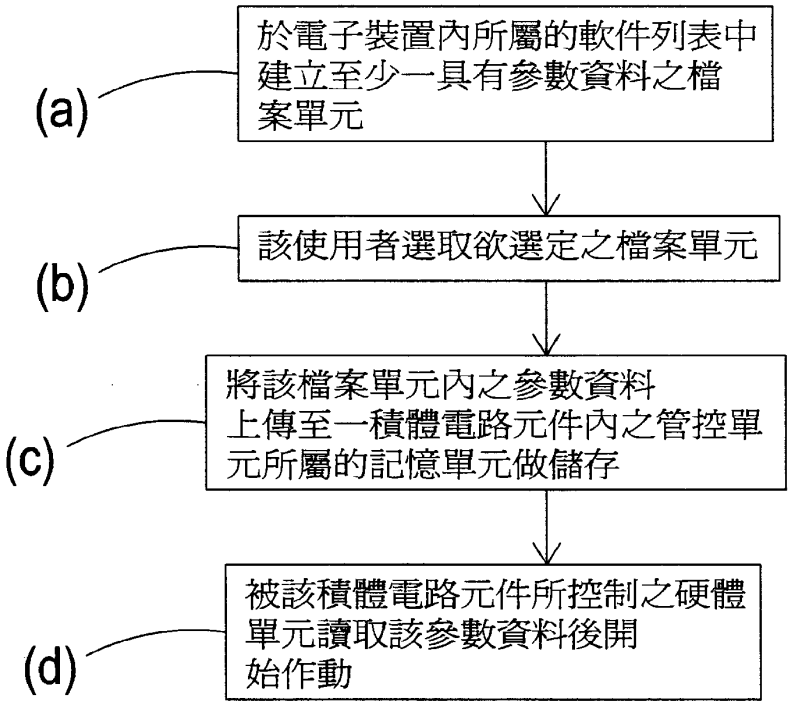
3、如申請專利範圍第１項所述之可設定電池參數之編碼系統，其中該參數資料係可供數個不同之積體電路元件進行上傳。

4、如申請專利範圍第１項所述之可設定電池參數之編碼系統，其中該硬體單元內係具有可與該等參數資料相互連結之指令資料。

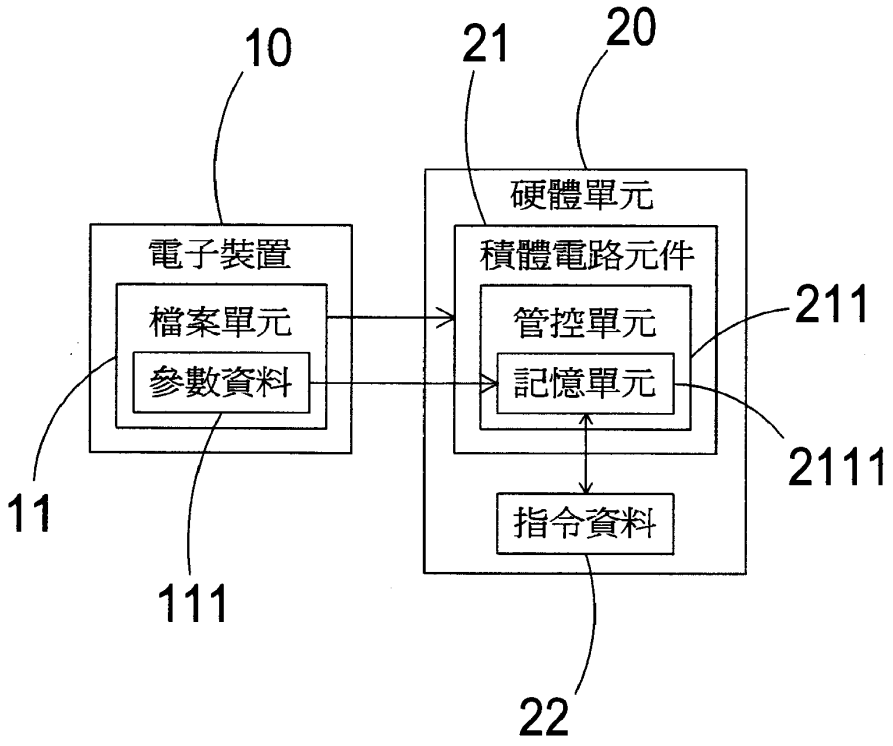
八、圖式：



第一圖


(a)
於電子裝置內所屬的軟件列表中建立至少一具有參數資料之檔案單元
(b)
該使用者選取欲選定之檔案單元
(c)
將該檔案單元內之參數資料上傳至一積體電路元件內之管控單元所屬的記憶單元做儲存
(d)
被該積體電路元件所控制之硬體單元讀取該參數資料後開始作動

第一A圖


10
21
20
硬體單元
電子裝置
積體電路元件
檔案單元
管控單元
211
參數資料
記憶單元
2111
11
指令資料
111
22

第二圖

四、指定代表圖：

（一）本發明指定代表圖為：第一圖。

（二）本代表圖之元件符號簡單說明：

建立・・・・・・30

選取・・・・・・40

上傳・・・・・・50

讀取・・・・・・60

作業・・・・・・70

五、本發明若有化學式時，請揭示最能顯示發明特徵的化學式：

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(54) **Title**: SYSTEM AND METHOD FOR OPERATING AN ELECTRIC VEHICLE

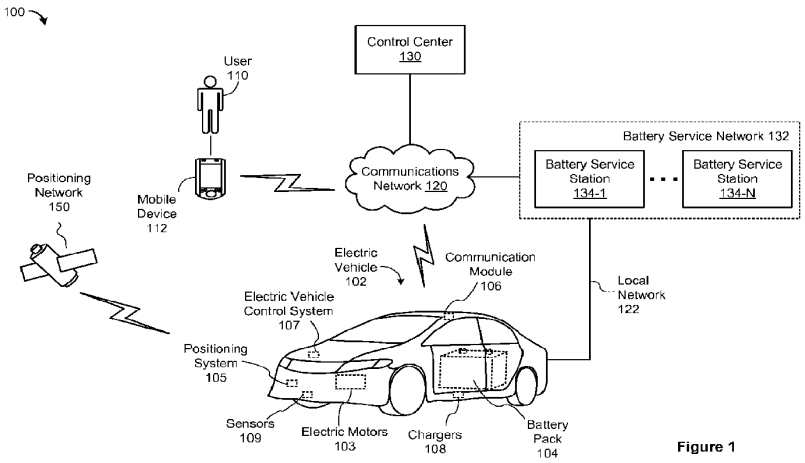


Figure 1

(57) **Abstract**: A system and method for managing energy usage in an electric vehicle. A charge level of at least one battery of the electric vehicle is received. A current location of the electric vehicle is received. A theoretical maximum range of the electric vehicle is determined based on the current location of the electric vehicle and the charge level of the at least one battery of the electric vehicle. An energy plan for the electric vehicle is generated.

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SYSTEM AND METHOD FOR OPERATING AN ELECTRIC VEHICLE

TECHNICAL FIELD

[0001] The disclosed embodiments relate generally to electric vehicles. More particularly, the disclosed embodiments relate to systems and methods for operating an electric vehicle.

BACKGROUND

[0002] Electric vehicles provide the promise of reducing dependence on foreign sources of fossil fuels and reducing pollution associated with the burning of these fossil fuels. Unfortunately, using present battery technologies, electric vehicles have a substantially shorter range than fossil fuel-based vehicles and the batteries require many hours to recharge. Thus, it is difficult for drivers of electric vehicles to go on trips longer than the range provided by a single charge of the batteries of the electric vehicle without spending a substantial amount of time recharging the batteries of the electric vehicle. Furthermore, the range of the electric vehicle may also be affected by environmental factors (*e.g.*, terrain, temperature, *etc.*), driving style, traffic, *etc.* Thus, it is difficult for a driver of an electric vehicle to plan a trip as the driver currently has no way of knowing whether the electric vehicle will be able to reach the destination based on the existing charge of the batteries of the electric vehicle. These drawbacks render electric vehicles inconvenient and impractical. Accordingly, it would be highly desirable to provide an electric vehicle that addresses the above described drawbacks.

SUMMARY

[0003] Some embodiments provide a system, a computer readable storage medium including instructions, and a computer-implemented method for managing energy usage in an at least partially electric vehicle. A charge level of at least one battery of the at least partially electric vehicle is received. A current location of the at least partially electric vehicle is received. A theoretical maximum range of the at least partially electric vehicle is determined based on the current location of the at least partially electric vehicle and the charge level of

the at least one battery of the at least partially electric vehicle. A geographic map including the current location of the at least partially electric vehicle is displayed on a display device of the at least partially electric vehicle. A first boundary is displayed on the geographic map indicating the maximum theoretical range of the at least partially electric vehicle.

[0004] In some embodiments, one or more visual indicators are displayed on the geographic map to indicate that locations outside of the first boundary are unreachable by the at least partially electric vehicle based at least in part on the current location and the theoretical maximum range of the at least partially electric vehicle.

[0005] In some embodiments, a second boundary that is a predetermined distance from a reference point is determined, wherein the predetermined distance is the farthest destination that the at least partially electric vehicle can travel to and still be able to return to the reference point. The second boundary is then displayed on the geographic map.

[0006] In some embodiments, the reference point is the point at which the at least partially electric vehicle spends the most time charging the at least one battery of the at least partially electric vehicle.

[0007] In some embodiments, the reference point is selected from the group consisting of a home of a user of the at least partially electric vehicle and an office of a user of the at least partially electric vehicle.

[0008] In some embodiments, an energy plan for the at least partially electric vehicle is generated.

[0009] In some embodiments, the energy plan includes one or more routes, a destination, and one or more battery service stations at which the at least one battery may be serviced.

[0010] In some embodiments, the energy plan for the at least partially electric vehicle is generated as follows. It is determined whether the at least partially electric vehicle can reach a predefined location based on the theoretical maximum range. In response to determining that the at least partially electric vehicle cannot reach the predefined location, a battery service station within the theoretical maximum range of the current location of the at least partially electric vehicle at which the at least one battery of the at least partially electric vehicle may be serviced is determined. The battery service station is added to the energy plan.

[0011] In some embodiments, time is scheduled at the battery service station to service the at least one battery of the at least partially electric vehicle after adding a battery service station to the energy plan.

[0012] In some embodiments, time is scheduled at the battery service station to service the at least one battery of the at least partially electric vehicle based on an estimated time that the at least partially electric vehicle will arrive at the battery service station.

[0013] In some embodiments, the predefined location is selected from the group consisting of a home of the user, a workplace of the user, and a location where the at least partially electric vehicle is charged.

[0014] In some embodiments, in response to determining that the at least partially electric vehicle can reach the predefined location, the operations of receiving a charge level of at least one battery of the at least partially electric vehicle, receiving a current location of the at least partially electric vehicle, determining a theoretical maximum range of the at least partially electric vehicle based on the current location of the at least partially electric vehicle and the charge level of the at least one battery of the at least partially electric vehicle, displaying on the display device a geographic map including the current location of the at least partially electric vehicle, and displaying a first boundary on the geographic map indicating the maximum theoretical range of the at least partially electric vehicle is repeated.

[0015] In some embodiments, a route from the current location of the at least partially electric vehicle to the battery service station is generated and is added to the energy plan.

[0016] In some embodiments, the battery service station is selected from the group consisting of charge stations that recharge the one or more battery packs of the vehicle, battery exchange stations that replace a spent battery of the vehicle with a charged battery, and any combination of the aforementioned battery service stations.

[0017] In some embodiments, the predefined location is selected from the group consisting of a user-specified destination, a battery service station, a destination determined based on a user profile, and a destination determined based on aggregate user profile data.

[0018] In some embodiments, the theoretical maximum range of the at least partially electric vehicle is determined after the at least one battery is serviced at the battery service station. It is determined whether the at least partially electric vehicle can reach the predefined location based on the theoretical maximum range. In response to determining that

the at least partially electric vehicle cannot reach the predefined location, a next battery service station within the theoretical maximum range of a previous battery service station in the energy plan and on a route to the predefined location is determined. The next battery service station is added to the energy plan. The aforementioned operations in these embodiments are repeated until the predefined location is reachable.

[0019] In some embodiments, a route from the current location of the at least partially electric vehicle to the destination is generated, wherein the route includes stops at the battery service stations in the energy plan. The route is added to the energy plan.

[0020] In some embodiments, in response to determining that the at least partially electric vehicle can reach the destination, a route from the current location of the at least partially electric vehicle to the destination is generated is added to the energy plan.

[0021] In some embodiments, the theoretical maximum range is based at least in part on the charge level of the at least one battery of the at least partially electric vehicle, the current location of the at least partially electric vehicle, a profile of the user, properties of at least one electric motor of the at least partially electric vehicle, types of terrain on which roads are situated, a speed of the at least partially electric vehicle, any combination of the aforementioned elements.

[0022] In some embodiments, the theoretical maximum range is adjusted to provide a margin of safety.

[0023] In some embodiments, it is determined whether a silent navigation mode is enabled. In response to determining that the silent navigation mode is not enabled, guidance based on the energy plan is provided.

[0024] In some embodiments, in response to determining that the silent navigation mode is enabled, guidance based on the energy plan is disabled.

[0025] In some embodiments, the guidance includes turn-by-turn guidance.

[0026] In some embodiments, the guidance is selected from the group consisting of visual guidance, audio guidance, and any combination of the aforementioned guidance.

[0027] In some embodiments, the current location of the at least partially electric vehicle is received from a global satellite navigation system.

[0028] In some embodiments, an energy plan for the at least partially electric vehicle is received. Guidance based on the energy plan is provided. It is periodically determined whether the energy plan is still valid.

[0029] In some embodiments, a request to service the at least one battery of the at least partially electric vehicle is received at a computer system remote from the at least partially electric vehicle. In response to the request, a service plan to service the at least one battery of the at least partially electric vehicle is generated.

[0030] In some embodiments, a request to service the at least one battery of the at least partially electric vehicle is transmitted to a server. In response to the request, a service plan is received from the server. The service plan is then managed.

[0031] In some embodiments, the service plan indicates that the at least one battery of the at least partially electric vehicle is to be exchanged for at least one charged battery. In these embodiments, the exchanging of the at least one battery for the at least one charged battery is facilitated.

[0032] Some embodiments provide a system, a computer readable storage medium including instructions, and a computer-implemented method for providing energy-aware navigation services to an electric vehicle. An energy plan for the electric vehicle is received. Guidance based on the energy plan is provided. Periodically, it is determined whether the energy plan is still valid.

[0033] In some embodiments, in response to determining that the energy plan is no longer valid, a new energy plan is generated and guidance based on the new energy plan is provided.

[0034] In some embodiments, in response to determining that the energy plan is still valid, guidance based on the energy plan is continued. Periodically, it is determined whether the energy plan is still valid.

[0035] In some embodiments, it is determined whether the energy plan is still valid as follows. A charge level of at least one battery of the electric vehicle and a current location of the electric vehicle are received. It is determined whether a waypoint in the energy plan is reachable based at least in part on the current location of the electric vehicle and the charge level of the at least one battery.

[0036] In some embodiments, the energy plan includes one or more waypoints.

[0037] In some embodiments, a waypoint is selected from the group consisting of a home of the user, a workplace of the user, a location where the electric vehicle is charged, a user-specified destination, a battery service station, a destination determined based on a user profile, and a destination determined based on aggregate user profile data.

[0038] In some embodiments, it is determined that a waypoint in the energy plan has been reached. It is then determined that the waypoint is a battery service station. It is then determined that at least one battery of the electric vehicle was serviced at the battery service station. Information about services performed on the at least one battery of the electric vehicle is recorded.

[0039] In some embodiments, the information about the services performed on the at least one battery is transmitted to a server.

[0040] In some embodiments, the guidance includes turn-by-turn guidance.

[0041] In some embodiments, the guidance is selected from the group consisting of visual guidance, audio guidance, and any combination of the aforementioned guidance.

[0042] Some embodiments provide a system, a computer readable storage medium including instructions, and a computer-implemented method for servicing a battery of an electric vehicle at a battery service station. A request to service at least one battery of the electric vehicle is received. In response to the request, a service plan to service the at least one battery of the electric vehicle is generated.

[0043] In some embodiments, the service plan is transmitted to the electric vehicle.

[0044] In some embodiments, the service plan is transmitted to the battery service station.

[0045] In some embodiments, the request is received from a battery service station.

[0046] In some embodiments, the request is received from the electric vehicle.

[0047] In some embodiments, the request includes battery identifiers for the battery packs, types of the battery packs, a user identifier, a vehicle identifier, and charge levels of the battery packs.

[0048] In some embodiments, the service plan is selected from the group consisting of a charge plan for recharging the battery packs of the electric vehicle, a battery exchange plan for exchanging the battery packs of the electric vehicle, and any combination of the aforementioned plans.

[0049] Some embodiments provide a system, a computer readable storage medium including instructions, and a computer-implemented method for servicing a battery of an electric vehicle at a battery service station. In some embodiments, a request to service at least one battery of the electric vehicle is transmitted to a server. In response to the request, a service plan is received from the server. The service plan is then managed.

[0050] In some embodiments, the request includes battery identifiers for the battery packs, types of the battery packs, a user identifier, a vehicle identifier, and charge levels of the battery packs.

[0051] In some embodiments, the battery service station is a battery exchange station and the service plan is managed as follows. It is determined that the at least one battery of the electric vehicle is supported by a platform of the battery exchange station. Battery locks that prevent the at least one battery from being decoupled from a battery bay of the electric vehicle are disengaged. The at least one battery is decoupled from the battery bay of the electric vehicle. It is determined that at least one new battery is ready to be coupled to the battery bay of the electric vehicle. The at least one new battery is coupled to the battery bay of the electric vehicle. The battery locks are then engaged.

[0052] In some embodiments, the battery service station is a charge station and the service plan is managed as follows. A charge level of the at least one battery of the electric vehicle is periodically determined. The charge level of the at least one battery of the electric vehicle is periodically transmitted to the charge station. Energy is received from the charge station based at least in part on the service plan and the charge level of the at least one battery.

[0053] In some embodiments, a report of the energy used is received from the charge station.

[0054] In some embodiments, the report is transmitted to a server.

[0055] In some embodiments, the charge level is transmitted to a mobile device of a user of the electric vehicle.

[0056] In some embodiments, the charge level is transmitted to a server.

[0057] Some embodiments provide a system, a computer readable storage medium including instructions, and a computer-implemented method for providing value-added services to an electric vehicle. A selected search result is received from a user of the electric vehicle. Offers with a specified distance of the selection are determined. The offers are then presented to the user in a user interface of the electric vehicle.

[0058] In some embodiments, a search query is selected from the group consisting of a point of interest, an address, a product, a service, and any combination of the aforementioned search queries.

[0059] In some embodiments, an offer is selected from the group consisting of a coupon, a sale price, promotional discount, and any combination of the aforementioned offers.

[0060] In some embodiments, prior to receiving the selected search result from the user, the following operations are performed. A search query from a user of the electric vehicle is received. Search results based on the search query are retrieved. The search results are presented to the user in the user interface of the electric vehicle.

[0061] In some embodiments, after presenting the offers, tracking information is sent to a server.

[0062] In some embodiments, a selected offer is received from the user of the electric vehicle. An energy plan for the electric vehicle is generated. Guidance based on the energy plan is provided.

[0063] In some embodiments, the guidance includes turn-by-turn guidance.

[0064] In some embodiments, the guidance is selected from the group consisting of visual guidance, audio guidance, and any combination of the aforementioned guidance.

[0065] In some embodiments, after receiving the selected offer from the user, tracking information is sent to the server.

[0066] In some embodiments, it is determined that the electric vehicle has reached a destination associated with the selected offer. Tracking information is then sent to the server.

BRIEF DESCRIPTION OF THE DRAWINGS

[0067] Figure 1 is a block diagram illustrating an electric vehicle network, according to some embodiments.

[0068] Figure 2 is a block diagram illustrating components of an electric vehicle, according to some embodiments.

[0069] Figure 3 is a block diagram illustrating an electric vehicle control system, according to some embodiments.

[0070] Figure 4 is a flow diagram of a method for providing energy-aware navigation services for an electric vehicle, according to some embodiments.

[0071] Figure 5 is a flow diagram of a method for managing energy usage for an electric vehicle when a destination has been specified, according to some embodiments.

[0072] Figure 6 is a flow diagram of a method for generating an energy plan from a current location of an electric vehicle to a destination, according to some embodiments.

[0073] Figure 7A illustrates an exemplary user interface of the electric vehicle displaying a map and a route for the electric vehicle, according to some embodiments.

[0074] Figure 7B illustrates another exemplary user interface of the electric vehicle displaying a map and a first route for the electric vehicle, according to some embodiments.

[0075] Figure 7C illustrates the user interface of Figure 7B displaying the map and a second route for the electric vehicle, according to some embodiments.

[0076] Figure 7D illustrates another exemplary user interface of the electric vehicle displaying a map and a destination for the electric vehicle, according to some embodiments.

[0077] Figure 7E illustrates the user interface of Figure 7D displaying the map and a first route for the electric vehicle, according to some embodiments.

[0078] Figure 7F illustrates the user interface of Figure 7D displaying the map and a second route for the electric vehicle, according to some embodiments.

[0079] Figure 7G illustrates the user interface of Figure 7D displaying the map and a third route for the electric vehicle, according to some embodiments.

[0080] Figure 7H illustrates the user interface of Figure 7D displaying the map and the route to the destination for the electric vehicle, according to some embodiments.

[0081] Figure 8 is a flow diagram of a method for managing energy usage for an electric vehicle when a destination has not been selected, according to some embodiments.

[0082] Figure 9 illustrates an exemplary user interface of the electric vehicle displaying a map and reachable destinations for the electric vehicle, according to some embodiments.

[0083] Figure 10 is a flow diagram of a method for executing an energy plan, according to some embodiments.

[0084] Figure 11 is a flow diagram of a method for providing "silent navigation," according to some embodiments.

[0085] Figure 12 is a flow diagram of a method for determining whether an electric vehicle is out-of-range of a battery service station, according to some embodiments.

[0086] Figure 13 is a flow diagram of a method for monitoring routes traveled by an electric vehicle, according to some embodiments.

[0087] Figure 14 is a flow diagram of a method for monitoring charge levels of battery packs of an electric vehicle, according to some embodiments.

[0088] Figure 15 is a flow diagram of a method for servicing a battery of an electric vehicle, according to some embodiments.

[0089] Figure 16 is a flow diagram of a method for servicing a battery of an electric vehicle at a battery exchange station, according to some embodiments.

[0090] Figure 17 is a flow diagram of a method for servicing a battery of an electric vehicle at a charge station, according to some embodiments.

[0091] Figure 18 is a block diagram illustrating data and energy flows for an electric vehicle being charged at a public charge station, according to some embodiments.

[0092] Figure 19 is a block diagram illustrating data and energy flows for an electric vehicle being charged at a public charge station, according to some embodiments.

[0093] Figure 20 is a block diagram illustrating data and energy flows for an electric vehicle being charged at a home charge station, according to some embodiments.

[0094] Figure 21 is a block diagram illustrating data and energy flows for an electric vehicle being charged at a home charge station, according to some embodiments.

[0095] Figure 22 is a flow diagram of a method for providing value-added services to an electric vehicle, according to some embodiments.

[0001] Like reference numerals refer to corresponding parts throughout the drawings.

DESCRIPTION OF EMBODIMENTS

Electric Vehicle

[0096] Figure 1 is a block diagram of an electric vehicle network 100, according to some embodiments. As illustrated in Figure 1, the electric vehicle network 100 includes at least one electric vehicle 102 having one or more electric motors 103, one or more battery packs 104 each including one or more batteries, a positioning system 105, a communication module 106, an electric vehicle control system 107, one or more chargers 108, one or more sensors 109, and any combination of the aforementioned components.

[0097] In some embodiments, the one or more electric motors 103 drive one or more wheels of the electric vehicle 102. In these embodiments, the one or more electric motors 103 receive energy from one or more battery packs 104 that is electrically and mechanically attached to the electric vehicle 102. The one or more battery packs 104 of the electric vehicle 102 may be charged at a home of a user 110. Alternatively, the one or more battery packs 104 may be serviced (*e.g.*, exchanged and/or charged, *etc.*) at a battery service station 134 (*e.g.*, battery service stations 134-1 to 134-N) within a battery service network 132. The battery service stations 134 may include charge stations for charging the one or more battery packs 104, battery exchange stations for exchanging the one or more battery packs 104, or the like (*e.g.*, see U.S. Patent Application Number 12/428,932, which is hereby

incorporated by reference in its entirety). For example, the one or more battery packs 104 of the electric vehicle 102 may be charged at one or more charge stations, which may be located on private property (*e.g.*, the home of the user 110, *etc.*) or on public property (*e.g.*, parking lots, curbside parking, *etc.*). Furthermore, in some embodiments, the one or more battery packs 104 of the electric vehicle 102 may be exchanged for charged battery packs at one or more battery exchange stations within the battery service network 132. Thus, if a user is traveling a distance beyond the range of a single charge of the one or more battery packs 104 of the electric vehicle 102, the spent (or partially spent) battery packs may be exchanged for charged battery packs so that the user can continue with his/her travels without waiting for the battery pack to be recharged. The term "battery service station" (*e.g.*, the battery service stations 134) is used herein to refer to battery exchange stations, which exchange spent (or partially spent) battery packs of the electric vehicle for charged battery packs, and/or charge stations, which provide energy to charge a battery pack of an electric vehicle. Furthermore, the term "charge spot" may also be used herein to refer to a "charge station."

[0098] In some embodiments, the electric vehicle 102 communicates with the battery service station 134 via the communication module 106, the communications network 120, and a control center 130. In some embodiments, while the one or more battery packs 104 of the electric vehicle 102 is being serviced by a battery service station, the electric vehicle 102 communicates with the battery service station 134-1 via the communications network 120. In some embodiments, while the one or more battery packs 104 of the electric vehicle 102 are being serviced (*e.g.*, exchanged or charged) at a battery service station, the electric vehicle 102 communicates with the battery service station 134 directly. For example, the electric vehicle 102 may communicate with the battery service station 134-1 via a local network 122 (*e.g.*, wired or wireless).

[0099] The communications network 120 may include any type of wired or wireless communication network capable of coupling together computing nodes. This includes, but is not limited to, a local area network, a wide area network, or a combination of networks. In some embodiments, the communications network 120 is a wireless data network including: a cellular network, a Wi-Fi network, a WiMAX network, an EDGE network, a GPRS network, an EV-DO network, an RTT network, a HSPA network, a UTMS network, a Flash-OFDM network, an iBurst network, and any combination of the aforementioned networks. In some embodiments, the communications network 120 includes the Internet.

[00100] In some embodiments, the electric vehicle 102 includes the positioning system 105. The positioning system 105 may include: a satellite positioning system, a radio tower positioning system, a Wi-Fi positioning system, and any combination of the aforementioned positioning systems. The positioning system 105 is used to determine the geographic location of the electric vehicle 102 based on information received from a positioning network 150. The positioning network 150 may include: a network of satellites in a global satellite navigation system (*e.g.*, GPS, GLONASS, Galileo, *etc.*), a network of beacons in a local positioning system (*e.g.*, using ultrasonic positioning, laser positioning, *etc.*), a network of radio towers, a network of Wi-Fi base stations, and any combination of the aforementioned positioning networks. Furthermore, the positioning system 105 may include a navigation system that generates routes and/or guidance (*e.g.*, turn-by-turn or point-by-point, *etc.*) between a current geographic location of the electric vehicle and a destination.

[00101] In some embodiments, the electric vehicle 102 includes the communication module 106, including hardware and software, that is used to communicate with the control center 130 (*e.g.*, a service provider) and/or other communication devices via a communications network (*e.g.*, the communications network 120).

[00102] In some embodiments, the electric vehicle 102 includes the electric vehicle control system 107. The electric vehicle control system 107 may provide services including: energy-aware navigation, energy management, value-added services, account management, battery service management, and any combination of the aforementioned services. These services are described in more detail below.

[00103] In some embodiments, the electric vehicle control system 107 provides information about the present status of the electric vehicle 102 to a mobile device 112 (*e.g.*, a mobile phone, a personal digital assistant (PDA), a laptop computer, *etc.*) of the user 110. For example, the status information may include the present charge level of the one or more battery packs 104, whether charging has completed, *etc.* This status information may also be provided via an on-board display screen.

[00104] In some embodiments, the electric vehicle 102 includes the one or more chargers 108 that are configured to charge the one or more battery packs 104. In some embodiments, the one or more chargers 108 are conductive chargers that receive energy from an energy source via conductive coupling (*e.g.*, a direct electrical connection, *etc.*). In some embodiments, the one or more chargers 108 are inductive chargers that receive energy from

an energy source via inductive coupling. In some embodiments, the electric vehicle 102 does not include the one or more chargers. In these embodiments, the charge stations include the one or more chargers.

[00105] In some embodiments, the electric vehicle 102 includes the one or more sensors 109. The one or more sensors 109 may include mechanical sensors (*e.g.*, accelerometers, pressure sensors, *etc.*), electromagnetic sensors (*e.g.*, magnetometers, voltage sensors, current sensors, *etc.*), optical sensors (*e.g.*, light, infrared, ultraviolet, *etc.*), acoustic sensors, temperature sensors, *etc.* In some embodiments, the one or more sensors 109 are used to detect whether the one or more battery packs 104 are mechanically and/or electrically coupled to the electric vehicle 102. In some embodiments, the one or more sensors 109 are used to detect whether a charging mechanism (*e.g.*, a charge cord, *etc.*) is mechanically and/or electrically coupled to the electric vehicle 102.

[00106] In some embodiments, the control center 130 periodically provides a list of suitable service stations (*e.g.*, within the maximum theoretical range of the electric vehicle, has the correct type of battery packs, *etc.*) and respective status information to the electric vehicle 102 via the communications network 120. The status of a battery service station may include: a number of charge stations of the respective battery service station that are occupied, a number of suitable charge stations of the respective battery service station that are free, an estimated time until charge completion for respective vehicles charging at respective charge stations, a number of suitable battery exchange bays of the respective battery service station that are occupied, a number of suitable battery exchange bays of the respective battery service station that are free, a number of suitable charged battery packs available at the respective battery service station, a number of spent battery packs at the respective battery service station, the types of battery packs available at the respective battery service station, an estimated time until a respective spent battery is recharged, an estimated time until a respective exchange bay will become free, a location of the battery service station, battery exchange times, and any combination of the aforementioned statuses.

[00107] In some embodiments, the control center 130 also provides access to the battery service stations to the electric vehicle 102. For example, the control center 130 may instruct a charge station to provide energy to recharge the one or more battery packs 104 after determining that an account for the user 110 allows the user 110 to receive energy from the charge station. Similarly, the control center 130 may instruct a battery exchange station to

commence the battery exchange process after determining that the account for the user 110 allows the user 110 to receive a fresh battery pack from the battery exchange station (*e.g.*, the account for the user 110 is in good standing). Furthermore, the control center 130 may reserve time at a battery exchange station and/or a charge station. The control center 130 obtains information about the electric vehicles and/or battery service stations by sending queries through the communications network 120 to the electric vehicle 102 and to the battery service stations 134 (*e.g.*, charge stations, battery exchange stations, *etc.*) within the battery service network 132. For example, the control center 130 can query the electric vehicle 102 to determine a geographic location of the electric vehicle and a status of the one or more battery packs 104 of the electric vehicle 102. Similarly, the control center 130 may query the battery service stations 134 to determine the status of the battery service stations 134. The control center 130 may also send information and/or commands through the communications network 120 to the electric vehicle 102 and the battery service stations 134. For example, the control center 130 may send information about a status of an account of the user 110, the locations of battery service stations, and/or a status of the battery service stations.

[00108] In some embodiments, the battery service stations 134 provide status information to the control center 130 via the communications network 120 directly (*e.g.*, via a wired or wireless connection using the communications network 120). In some embodiments, the battery service network 132 includes a separate communication network (*e.g.*, via a wired or wireless connection to the battery service network 132) coupling each of the battery service stations 134 to one or more servers of the battery service network 132. In these embodiments, the battery service stations 134 provide status information to the one or more servers of the battery service network, which in turn transmits the status information to the control center 130 via the communications network 120.

[00109] In some embodiments, the information transmitted between the battery service stations 134 and the control center 130 are transmitted in real-time. In some embodiments, the information transmitted between the battery service stations 134 and the control center 130 are transmitted periodically.

[00110] Figure 2 is a block diagram illustrating components of the electric vehicle 102, according to some embodiments. The electric vehicle 102 includes a battery management

system (BMS) 206, the positioning system 105, the electric vehicle control system 107, the communication module 106, a sensor module 212, one or more electric motors 103, a controller or engine control unit (ECU) 214, the one or more chargers 108, the one or more battery packs 104, a battery pack lock module 202, a user interface 210, one or more battery pack locks 204, the one or more sensors 109, and any combination of the aforementioned components. Note that while individual blocks are shown, these blocks may be separate or combined.

[00111] In some embodiments, the BMS 206, the positioning system 105, the electric vehicle control system 107, the communication module 106, the sensor module 212, the one or more electric motors 103, the controller/ECU 214, the one or more chargers 108, the battery pack lock module 202, and the user interface 210 all communicate with each other via a bus 230. In some embodiments, the bus 230 is a controller area network bus (CAN-bus). In some embodiments, a subset of these components communicate with each other via a separate connection (*e.g.*, another bus, a direct connection, a wireless connection, *etc.*). In some embodiments, the one or more battery packs 104 communicate with the BMS 206 via a separate connection (*e.g.*, another bus, direct connection, a wireless connection, *etc.*). In some embodiments, the battery pack lock module 202 communicates with the one or more battery pack locks 204 via a separate connection (*e.g.*, another bus, direct connection, a wireless connection, *etc.*). In some embodiments, the sensor module 212 communicates with the one or more sensors 109 via a separate connection (*e.g.*, another bus, direct connection, a wireless connection, *etc.*).

[00112] In some embodiments, the BMS 206 includes circuitry configured to manage the operation and/or monitor the state of one or more batteries of the one or more battery packs 104. The circuitry may include state-monitoring circuitry configured to monitor the state of the one or more battery packs 104 (*e.g.*, voltage meters, current meters, temperature sensors, *etc.*). For example, the state-monitoring circuitry may determine the present voltage output, current draw, and/or the temperature of the one or more battery packs 104. The circuitry may also include one or more processors, memory, and communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the BMS 206 may include programs, modules, data structures, or a subset thereof that manage the operation and/or monitor the state of the one or more battery packs. The programs and/or

modules may be stored in the memory of the BMS 206 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the BMS 206. The one or more processors of the BMS 206 may be configured to receive state data from the state-monitoring circuitry and to perform specified operations on the state data to determine the status of the one or more battery packs 104. For example, the one or more processors of the BMS 206 may execute instructions stored in the memory of the BMS 206 to determine the present charge levels of the one or more battery packs 104 based on the state data received from the state-monitoring circuitry. The one or more processors of the BMS 206 may also be configured to receive commands from other components on the bus 230 and to perform specified operations on the one or more battery packs 104 based on the received commands and the data received from the one or more battery packs 104. For example, the one or more processors of the BMS 206 may receive commands from the controller/ECU 214 via the bus 230 to determine whether the one or more battery packs 104 are operating within normal operating conditions. The one or more processors of the BMS 206 may then execute instructions stored in the memory of the BMS 206 to make this determination and to perform specified actions if the normal operating conditions are exceeded (*e.g.*, reducing the current draw from the one or more battery packs 104).

[00113] In some embodiments, the positioning system 105 includes circuitry configured to receive signals from a positioning network (*e.g.*, the positioning network 150 in Figure 1) and to determine the current location of the electric vehicle 102 based on the received signals. The circuitry may include antennas (*e.g.*, discrete or integrated, *etc.*), signal amplification circuits, signal processing circuitry, *etc.* The circuitry may also include one or more processors, memory, and communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the positioning system 105 may include programs, modules, data structures, or a subset thereof that determines the current location of the electric vehicle 102 based on the signals received from the positioning network. The programs and/or modules may be stored in the memory of the positioning system 105 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the positioning system 105. For example, the positioning system 105 may receive global positioning signals from a plurality of global navigation satellites. The processor of the positioning system 105 may then execute programs stored in

the memory of the positioning system 105 to calculate the position of the electric vehicle 102 based on the received signals. The processor of the positioning system 105 may then use the communication interfaces of the positioning system 105 to transmit the calculated position to other components of the electric vehicle 102 via the bus 230.

[00114] The electric vehicle control system 107 is described in more detail with respect to Figures 3-22 below.

[00115] In some embodiments, the communication module 106 includes circuitry configured to send and/or receive data and/or commands to/from other devices external to the electric vehicle 102. The circuitry may include antennas (*e.g.*, discrete or integrated, *etc.*), signal amplification circuits, signal processing circuitry, *etc.* The circuitry may also include one or more processors, memory, and communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the communication module 106 may include programs, modules, data structures, or a subset thereof that sends and/or receives data and/or commands to devices external to the electric vehicle 102. The programs and/or modules may be stored in the memory of the communication module 106 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the communication module 106. For example, the communication module 106 may receive data representing the battery status from the BMS 206 via the bus 230. The communication module 106 may then execute programs stored in the memory of the communication module 106 to packetize and to transmit the data representing the battery status to a device external to the electric vehicle 102 (*e.g.*, the control center 130 in Figure 1, *etc.*). In some embodiments the battery status of a battery pack includes a unique identifier of the battery pack, a manufacturer of the battery pack, a model number of the battery pack, a charge level of the battery pack, an age of the battery pack, the number of charge/discharge cycles of the battery pack, and a combination of the aforementioned statuses.

[00116] In some embodiments, the sensor module 212 includes circuitry configured to receive sensor signals from the one or more sensors 109 and to preprocess the received signals (*e.g.*, convert the signals from analog to digital form, amplify, filter, *etc.*). In some embodiments, the one or more sensors 109 include mechanical sensors (*e.g.*, accelerometers, pressure sensors, gear position sensors, handbrake position sensors, door lock sensors, air

conditioning sensors, or other vehicle sensors, *etc.*), electromagnetic sensors (*e.g.*, magnetometers, voltage sensors, current sensors, *etc.*), optical sensors (*e.g.*, light, infrared, ultraviolet, *etc.*), acoustic sensors, temperature sensors, *etc.* The circuitry may include signal amplification circuits, signal processing circuitry, *etc.* The circuitry may also include one or more processors, memory, and communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230 and/or to the one or more sensors 109. The memory of the sensor module 212 may include programs, modules, data structures, or a subset thereof that preprocesses the signals received from the one or more sensors 109. The programs and/or modules may be stored in the memory of the sensor module 212 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the sensor module 212. For example, the sensor module 212 may receive temperature signals from temperature sensors of the electric vehicle 102. The circuitry of the sensor module 212 may then amplify and/or filter the signals. The processor of the sensor module 212 may also execute instructions stored in the memory of the sensor module 212 to perform specified operations (*e.g.*, calculate a running average, store the temperature data, *etc.*). The processor of the sensor module 212 may then use the communication interfaces of the sensor module to transmit the results of the specified operations to other components on the bus 230.

[00117] In some embodiments, the controller/ECU 214 includes circuitry configured to manage the operation and/or monitor the state of the one or more electric motors 103. The circuitry may include one or more processors, memory, and/or communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the controller/ECU 214 may include programs, modules, data structures, and/or a subset thereof that manage the operation and/or monitor the state of the one or more electric motors 103. The programs and/or modules may be stored in the memory of the controller/ECU 214 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the controller/ECU 214. For example, the one or more processors of the controller/ECU 214 may receive various sensor measurements from the one or more sensors 109 (*e.g.*, a throttle position sensor, *etc.*) via the bus 230. The one or more processors of the controller/ECU 214 may then execute instructions stored in the memory of the

controller/ECU 214 to monitor and regulate the speed of the one or more electric motors 103 based on the received sensor measurements (*e.g.*, throttle position, *etc.*).

[00118] In some embodiments, the one or more chargers 108 include circuitry configured to receive energy from an energy source, regulate, and/or transform the energy so that the energy can be transferred to the one or more battery packs 104. The circuitry may also include one or more processors, memory, and communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the one or more chargers 108 may include programs, modules, data structures, or a subset thereof that manage and/or monitor the charging process. The programs and/or modules may be stored in the memory of the one or more chargers 108 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the one or more chargers 108. For example, the processor of the one or more chargers 108 may receive data indicating that the one or more battery packs 104 are almost fully charged from the BMS 206 via the bus 230. In response to the received data, the processors of the one or more chargers 108 may execute programs stored in the memory of the one or more chargers 108 to regulate the energy transfer and to terminate the charging process when the one or more battery packs 104 are fully charged to prevent overcharging of the one or more battery packs 104.

[00119] In some embodiments, the battery pack lock module 202 includes circuitry configured to engage and/or disengage the one or more battery pack locks 204 so that the one or more battery packs 104 may be coupled/decoupled to the frame or chassis of the electric vehicle 102. The circuitry may also include one or more processors, memory, and/or communication interfaces. The communication interfaces may be configured to send and receive data and/or commands to/from other components on the bus 230. The memory of the battery pack lock module 202 may include programs, modules, data structures, or a subset thereof that manage the coupling/decoupling of the one or more battery packs 104 from the chassis of the electric vehicle 102. The programs and/or modules may be stored in the memory of the battery pack lock module 202 and correspond to a set of instructions for performing the operations described herein when executed by the one or more processors of the battery pack lock module 202. For example, the electric vehicle control system 107 may send commands to the battery pack lock module 202 via the bus 230 instructing the battery

pack lock module 202 to disengage the one or more battery pack locks 204 of the one or more battery packs 104. The processor of the battery pack lock module 202 may then execute instructions stored in the memory of the battery pack lock module 202 to perform operations that release the one or more battery pack locks 204 (*e.g.*, sending signals to motors coupled to the one or more battery pack locks 204 so that the motors will release the locks, *etc.*)

[00120] In some embodiments, the user interface 210 includes input and output devices. For example, the input devices may include a mouse, a keyboard, a touchpad, a rotary joystick or knob, a touch screen display, microphones, a speech-recognition and/or command system, and the like, and the output devices may include a display screen, a touch screen display, a heads up display, dashboard indicators, audio speakers, a speech-synthesis system, and the like, and input devices. The user interface 210 may send and/or receive data and/or commands via the bus 230 to other components on the bus 230.

[00121] In some embodiments, a subset of the aforementioned components of the electric vehicle 102 may be combined with the electric vehicle control system 107. For example, the positioning system 105, the communication module 106, the sensor module 212, the battery pack lock module 202, and the user interface 210 may be included with the electric vehicle control system 107.

[00122] Figure 3 is a block diagram illustrating an electric vehicle control system 107 in accordance with some embodiments. The electric vehicle control system 107 typically includes one or more processing units (CPU's) 302, one or more networks or other communications interfaces 304 (*e.g.*, antennas, I/O interfaces, *etc.*), memory 310, and one or more communication buses 309 for interconnecting these components (*e.g.*, the bus 230 in Figure 2, *etc.*). The communication buses 309 may include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. The electric vehicle control system 107 optionally may include a user interface 305 comprising a display device 306, input devices 308 (*e.g.*, a mouse, a keyboard, a touchpad, a touch screen, microphone, *etc.*), and speakers. The memory 310 includes high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and may include non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. The memory 310 may optionally include one or more storage devices

located remotely from the CPU(s) 302. The memory 310, comprises a computer readable storage medium. In some embodiments, the memory 310 stores the following programs, modules and data structures, or a subset thereof:

- an operating system 312 that includes procedures for handling various basic system services and for performing hardware dependent tasks (*e.g.*, Windows, Linux, or the like);
- a communication module 314 that is used for connecting the electric vehicle control system 107 to a bus of an electric vehicle (*e.g.*, the bus 230 of the electric vehicle 102, *etc.*), to other computers or devices, and/or to one or more communication networks, such as the Internet, other wide area networks, local area networks, metropolitan area networks, and so on, via the one or more communication network interfaces 304 (wired or wireless);
- a user interface module 316 that receives commands from a user via the input devices 308 and generates user interface objects to be displayed on the display device 306;
- a vehicle identifier 318 that uniquely identifies the electric vehicle 102;
- a BMS module 320 that receives battery status data from a BMS (*e.g.*, the BMS 206 in Figure 2) on the bus of the electric vehicle (*e.g.*, the bus 230 in Figure 2) and transmits commands to the BMS to manage the operation of battery packs of the electric vehicle, as described herein;
- a positioning module 322 that receives position data, including a current location 324, from the a positioning system (*e.g.*, the positioning system 105 in Figure 1) on the bus of the electric vehicle and performs specified operations, as described herein;
- a sensor module 326 that receives sensor signals from a sensor module (*e.g.*, the sensor module 212 in Figure 2) on a bus of the electric vehicle;
- a controller/ECU module 328 that transmits commands to a controller/ECU (*e.g.*, the controller/ECU 214 in Figure 2) on the bus of the electric vehicle regulating the operation of the electric motors of the electric vehicle, the commands based at least in part on sensor signals received from the sensor module 326, battery status data

received from the BMS module 320, commands received from an energy management module 340, or a subset thereof, as described herein;

- a battery service module 330 that monitors and manages battery service operations (*e.g.*, sending a request to a charge station to receive energy to charge the one or more battery packs 104, instructing the battery pack lock module 202 to release the one or more battery pack 104 locks, *etc.*) performed on battery packs of the electric vehicle and that optionally includes handshaking and encryption functions that are used during communication between the electric vehicle and battery service stations, a control center, and/or other devices, as described herein;
- an energy-aware navigation module 332 that provides navigation services based at least in part on battery status data received from the BMS module 320, position data received from the positioning module 322, destinations 334 that are either user-selected or determined based at least in part on a profile 352 of the user of the electric vehicle, local conditions (*e.g.*, traffic, weather, road conditions, *etc.*) data included in a battery service station database 364 (*e.g.*, geographic locations of battery service stations, status of the battery service stations, *etc.*), and/or a subset thereof, as described herein; the energy-aware navigation module 332 determines routes 336 based on the destinations 334 and the current location 324 and displays graphical representations of destinations, routes, battery service stations, *etc.*, on maps 338 displayed on a display device of the electric vehicle 102 (*e.g.*, the display device 306);
- the energy management module 340 that provides commands to the controller/ECU of the electric vehicle via the controller/ECU module 328 based at least in part on battery status data received from the BMS module 320, position data received from the positioning module 322, the destinations 334, data included in the battery service station database 364, the profile 352 of a user of the electric vehicle, an energy plan 342, and/or a subset thereof, as described herein;
- a value-added services module 344 that provides value-added services based at least in part on battery status data received from the BMS module 320, position data received from the positioning module 322, the destination 360 selected by the user of the electric vehicle, data included in the battery service station database 364, the profile 352 of a user of the electric vehicle, and/or a subset thereof, as described herein;

- an user account module 346 that manages account information for the users of the electric vehicle 102 and includes user identifiers 348 that uniquely identify users of the electric vehicle 102, account data 350 that indicates the status of user accounts (*e.g.*, active, expired, cancelled, insufficient funds, *etc.*), profiles 352 (*e.g.*, including user identifier, driving history, driving style (*e.g.*, the user accelerates quickly from a stop, accelerates slowly from a stop, drives fast, drives slowly, *etc.*), historical information about destinations and/or points of interest visited by the user, routes driven by the users, one or more reference points associated with users, *etc.*), and/or a subset thereof;
- a database module 354 that interfaces with databases of the electric vehicle control system 107;
- a battery status database 356 that includes identifiers for the battery packs and present and/or historical information about the status of the battery packs of the electric vehicle 102;
- a geographic location database 358 of the electric vehicle that includes destinations 360 (*e.g.*, addresses, *etc.*) and/or points of interest 362 (*e.g.*, landmarks, businesses, *etc.*); and
- the battery service station database 364 that includes locations 366 and/or status information 368 about battery service stations.

[00123] In some embodiments, the geographic location database 358 is included in the energy-aware navigation module 332. In some embodiments, the battery service station database 364 is included in the energy-aware navigation module 332. In some embodiments, the battery service station database 364 is included in the geographic location database 358. In some embodiments, battery status database 356 is included in the energy-aware navigation module 332.

[00124] Each of the above identified elements may be stored in one or more of the previously mentioned memory devices, and corresponds to a set of instructions for performing a function described above. The set of instructions can be executed by one or more processors (*e.g.*, the CPUs 302). The above identified modules or programs (*i.e.*, sets of instructions) need not be implemented as separate software programs, procedures or modules,

and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, each of the above identified modules or programs are implemented using discrete circuitry. In some embodiments, subsets of the above identified modules or programs are implemented using respective discrete circuitry. In some embodiments, the memory 310 may store a subset of the modules and data structures identified above. Furthermore, the memory 310 may store additional modules and data structures not described above.

[00125] Although Figure 3 shows an "electric vehicle control system," Figure 3 is intended more as functional description of the various features which may be present in the electric vehicle control system than as a structural schematic of the embodiments described herein. In practice, and as recognized by those of ordinary skill in the art, items shown separately could be combined and some items could be separated. For example, the energy-aware navigation module 332 may be combined with the energy management module 340.

Energy Management

[00126] As discussed above, the theoretical maximum range of an electric vehicle may depend on several factors. For example, simply calculating the theoretical maximum range based on the charge levels of the battery packs of the electric vehicle and the average energy consumption of an electric motor of the electric vehicle may not be sufficient. It is often the case that external conditions such as environmental conditions (*e.g.*, weather, terrain, *etc.*) and traffic may substantially affect the theoretical maximum range of the electric vehicle. For example, extreme temperatures may degrade the performance of the battery packs of the electric vehicle. Similarly, traffic jams or slow traffic may prolong the overall amount of time that the electric vehicle is operating. Furthermore, the speed of the electric vehicle may affect the theoretical maximum range of the electric vehicle. For example, the energy required to overcome wind resistance increases as the speed of the electric vehicle increases, and accordingly, the amount of charge available to drive the electric motor may be decreased. Moreover, each battery pack may behave differently. For example, an older battery pack (*e.g.*, one that has experience many charge/discharge cycles) may not provide the same range as a new battery pack.

[00127] The embodiments describe below provide an energy management system for managing energy usage in an electric vehicle that addresses at least some of the above mentioned factors. For example, the energy management module 340 and/or the energy-aware navigation module 332 may provide energy management operations described below.

[00128] In some embodiments, the energy management system may supplement the functionality of a traditional navigation system. In some embodiments, in addition to providing route guidance, the energy management system provides information about the charge levels of the battery packs of the electric vehicle and/or information about locations and availabilities of battery service stations. For example, the energy management module 340 may provide this information to the traditional navigation system.

[00129] In some embodiments, the energy management system may be a standalone component within the electric vehicle. In these embodiments, the energy management system may include a navigation system that includes energy management capabilities (*e.g.*, the energy-aware navigation module 332, *etc.*).

[00130] Figure 4 is a flow diagram of a method 400 for providing energy-aware navigation services for an electric vehicle, according to some embodiments. The energy-aware navigation module 332 determines (402) whether an energy plan exists.

[00131] If an energy plan exists (404, yes), the energy-aware navigation module 332 executes (406) the energy plan. In some embodiments, energy plan includes a turn-by-turn and/or a point-by-point navigation plan (*e.g.*, a route plan) from a current location of the electric vehicle to one or more destinations/waypoints. In some embodiments, the destinations/waypoints include battery service stations (*e.g.*, charge stations, battery exchange stations, *etc.*). In some embodiments, the energy plan is generated by the energy-aware navigation module 332. The energy plan may be used by the energy-aware navigation module 332 to provide route guidance to the user. Note that step 406 is described in more detail with respect to Figure 10.

[00132] Note that during the execution of the energy plan, the user of the electric vehicle may change. For example, on a long trip, a first user may be a driver of the electric vehicle for a portion of the trip, while a second user may be the driver of the electric vehicle for the rest of the trip. In some embodiments, if there is a change in users during the

execution of the energy plan, the energy-aware navigation module 332 resets and recalculates the energy plan (*e.g.*, based on a profile of the user driving the vehicle, *etc.*). In doing so, the energy-aware navigation module 332 accounts for differences in preferences and/or driving styles of the users.

[00133] In some embodiments, if there is a change in users during the execution of the energy plan, the energy-aware navigation module 332 queries the new user to determine whether the new user desires to continue using the existing energy plan. If the new user wants to use the existing energy plan, the energy-aware navigation module 332 continues to execute the existing energy plan. Otherwise, the energy-aware navigation module 332 resets and recalculates the energy plan.

[00134] In some embodiments, if there is a change in users during the execution of the energy plan, the energy-aware navigation module 332 continues executing the existing energy plan. In these embodiments, if the new user wants to create a new energy plan, the new user must instruct the energy-aware navigation module 332 to do so.

[00135] In some embodiments, if the energy plan does not exist (404, no), the energy-aware navigation module 332 determines (408) whether one or more destinations have been specified by the user of the electric vehicle. If the user has specified one or more destinations (410, yes), the energy-aware navigation module 332 generates (412) an energy plan using the destinations. Note that step 412 is described in more detail with respect to Figure 5.

[00136] In some embodiments, if the user has not specified one or more destinations (410, no), the energy-aware navigation module 332 displays (414) likely destinations for the user. In some embodiments, the energy-aware navigation module 332 displays the likely destinations on a map displayed in a user interface of the electric vehicle. In some embodiments, the energy-aware navigation module 332 displays the likely destinations as a list in the user interface of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the likely destinations based on the past driving history (*e.g.*, nearby destinations for the user), nearby points of interest, and the like. In some embodiments, the energy-aware navigation module 332 displays the likely destinations on a map in ranked order. For example, the likely destinations may be displayed in rank order on

a list displayed in the user interface of the electric vehicle 102. On the other hand, the likely destinations may be displayed on the map, visual indicators (*e.g.*, colors, numbers, icons of varying sizes, *etc.*) may be displayed with the likely destinations to indicate the rank order of the likely destinations. In some embodiments, the rank order of the likely destinations are determined based on a distance from the current location of the electric vehicle, the number of times the user visited respective destinations, the amount of time the user spent at the respective destinations, user-specified rankings of destinations, or a combination thereof. For example, a user's home and work addresses are typically ranked high on the list of likely destinations. In these embodiments, the information is obtained from the user profile 352.

[00137] In some embodiments, in addition to determining likely destinations based on the user's profile, the energy-aware navigation module 332 uses aggregate data from a plurality of users. For example, the aggregate data may include the number of times the plurality of users visited respective destinations, the amount of time the plurality of users spent at the respective destinations, user rankings of the respective destinations, or a combination thereof.

[00138] The user of the electric vehicle may (but is not required to) select one or more of the likely destinations. The energy-aware navigation module 332 then determines (416) whether the user selected one or more of the likely destinations. If the user selected one or more of the likely destinations (418, yes), the energy-aware navigation module 332 generates (412) an energy plan using the likely destinations. If the user did not select one or more of the likely destinations (418, no), the energy-aware navigation module 332 monitors (420) energy usage based on a reference point. In some embodiments, the reference point is the most likely destination from the ranked list of destinations. Note that step 420 is described in more detail with respect to Figure 8.

[00139] Figure 5 is a flow diagram expanding on step 412 of Figure 4, according to some embodiments. The energy-aware navigation module 332 receives (502) one or more waypoints or destinations. In some embodiments, the energy-aware navigation module 332 receives the plurality of destinations from the user of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the plurality of destinations based on the profile 352 of the user. For example, the energy-aware navigation

module 332 may use historical information stored in the profile 352, the date, the day of the week, the time of day, or a subset thereof to determine a likely destination of the user.

[00140] In some embodiments, prior to operating the electric vehicle 102, the electric vehicle control system 107 identifies the user. For example, the electric vehicle control system 107 may identify the user by a unique identifier (e.g., a personal identification number, a user name and password, an identifier included in a key for the electric vehicle 102, an identifier included in a radio frequency identification card, an identifier included in a smart card, *etc.*).

[00141] The energy-aware navigation module 332 determines (504) a current location of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the current location based on position data received from the positioning module 322. The energy-aware navigation module 332 determines (506) current charge levels for the battery packs of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the current charge levels for the battery packs of the electric vehicle based on battery status data received form the BMS module 320.

[00142] In some embodiments, the energy-aware navigation module 332 obtains (508) the profile 352 of the user of the electric vehicle. In some embodiments, the energy-aware navigation module 332 obtains the profile 352 of the user from the control center 130. In some embodiments, the energy-aware navigation module 332 obtains the profile 352 from the user account module 346 of the electric vehicle control system 107. In these embodiments, the profile 352 of the user was previously obtained from the control center.

[00143] In some embodiments, the energy-aware navigation module 332 obtains (510) road conditions. In some embodiments, the energy-aware navigation module 332 obtains the road conditions from the control center. In some embodiments, the energy-aware navigation module 332 obtains the road conditions from a third party provider. In some embodiments, the road conditions include speed limits of roads, the current and future weather forecasts, terrain information (*e.g.*, grade, road type, *etc.*), and current and historical traffic conditions on the road.

[00144] In some embodiments, the energy-aware navigation module 332 obtains (512) a battery history for the one or more battery packs of the electric vehicle. In some

embodiments, the energy-aware navigation module 332 obtains the battery history from the battery status database 356. In some embodiments, the energy-aware navigation module 332 obtains the battery history from the control center.

[00145] Note that steps 504-512 may be performed in any order.

[00146] The energy-aware navigation module 332 then determines (514) the theoretical maximum range of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the theoretical maximum range of the electric vehicle based at least in part on the battery status data (*e.g.*, charge levels, *etc.*) received from the BMS module 320, the battery history (*e.g.*, the number of charge/discharge cycles of the battery packs, the age of the battery packs, *etc.*), position data received from the positioning module 322, the profile 352, properties of the electric motors (*e.g.*, power consumption, *etc.*), the road conditions (*e.g.*, types of terrain on which the roads are situated, weather, traffic, speed limits, *etc.*), a specified speed of the electric vehicle (*e.g.*, speeds no greater than the speed limit of respective roads, an average speed, *etc.*), the time of day, the day of the week, or a subset thereof. In some embodiments, the theoretical maximum range of the electric vehicle includes a margin of safety (*e.g.*, a 10% margin). This margin of safety is used to account for unpredictable situations that may arise during the operation of the electric vehicle (*e.g.*, traffic jams, failure of battery packs, *etc.*). In some embodiments, the margin of safety is determined dynamically based on the charge levels of the battery packs and the distance to the closest battery service station.

[00147] In some embodiments, the energy-aware navigation module 332 displays, in the user interface of the electric vehicle, the theoretical maximum range of the electric vehicle on a map including the current location of the electric vehicle. Figure 7A illustrates an exemplary user interface of the electric vehicle 102 displaying a map 701 including a current location of the electric vehicle 102 and a destination 706. A visual indicator (*e.g.*, shading, colors, *etc.*) is used to indicate that destinations outside of a theoretical maximum range 704 are not reachable. Destinations within the theoretical maximum range 704 are reachable on the current charge levels of the battery packs.

[00148] Returning to Figure 5, the energy-aware navigation module 332 then selects (516) an unprocessed destination from the plurality of destinations and determines (518)

whether the destination is reachable from the current location based on the theoretical maximum range. Note that the energy-aware navigation module 332 uses road data (*e.g.*, from the geographic location database 358) to determine whether the destination is reachable from the current location (*i.e.*, whether the charge levels of the battery packs are sufficient to get the electric vehicle 102 to the destination). Thus, the determination is made based on an actual route and not based on whether the destination is within a single fixed radius of the theoretical maximum range of the current location (*e.g.*, a circle). In some embodiments, the energy-aware navigation module 332 determines whether the destination is reachable from the current location by: calculating a route from the current location to the destination, calculate the driving distance of the route, and comparing the driving distance to the theoretical maximum range to determine whether the destination is reachable from the current location.

[00149] In some cases, the destination is reachable (*e.g.*, in Figure 7A, the destination 706 is within the theoretical maximum range 704). If the destination is reachable (520, yes), the energy-aware navigation module 332 generates (522) a route (*e.g.*, route 708 in Figure 7A) from the current location to the destination. The energy-aware navigation module 332 then adds (524) the route to the energy plan and sets (526) the destination as the current location. In some embodiments, after setting the destination as the current location, the energy-aware navigation module 332 predicts the amount of energy required for the electric vehicle to reach the destination and calculates predicted charge levels of the battery packs of the electric vehicle at the destination (*e.g.*, after the electric vehicle has reached the destination). By setting the destination as the current location, the energy-aware navigation module 332 can compute whether the electric vehicle can reach the next destination (if any).

[00150] The energy-aware navigation module 332 then marks (528) the destination as processed.

[00151] In some cases, the destination is not reachable unless the battery pack is first serviced (*e.g.*, in Figure 7B, destination 711 is outside of the theoretical maximum range 704). If the destination is not reachable (520, no), the energy-aware navigation module 332 generates (530) an energy plan from the current location to the destination that includes stops at suitable battery service stations. This step is described in more detail below

with respect to Figure 6 and Figures 7B-7H. After generating the energy plan, the energy-aware navigation module 332 marks (528) the destination as processed.

[00152] After marking the destination as processed, the energy-aware navigation module 332 determines (532) whether there are more unprocessed destinations. If there are more unprocessed destinations (534, yes), the energy-aware navigation module 332 returns to step 516. If there are no more unprocessed destinations (534, no), the energy-aware navigation module 332 proceeds to step 406 in Figure 4.

[00153] In some embodiments, if the user of the electric vehicle cancels the energy plan, the energy-aware navigation module 332 performs the operations in Figure 8.

[00154] Figure 6 is a flow diagram expanding on step 530 of Figure 5, according to some embodiments. The energy-aware navigation module 332 determines (602) suitable battery service stations within the theoretical maximum range of the current location. A suitable battery service station is a battery service station that is within the theoretical maximum range of the current location and that is able to service the battery packs of the electric vehicle (*e.g.*, has available battery exchange bays for exchanging battery packs, has available charge stations for charging battery packs, has the type of battery packs that are compatible with the electric vehicle, the compatible battery packs are charged, *etc.*). In some embodiments, the energy-aware navigation module 332 queries the battery service station database 364 to determine a set of battery service stations within the theoretical maximum range of the current location. In some embodiments, the energy-aware navigation module 332 receives updated information about the status of battery service stations from the control center (*e.g.*, the control center 130 in Figure 1). The energy-aware navigation module 332 may store this information in the battery service station database 364. In these embodiments, the energy-aware navigation module 332 only includes battery service stations that have space and time available to service the battery packs of the electric vehicle. Note that the energy-aware navigation module 332 uses road data (*e.g.*, from the geographic location database 358) to determine the set of battery service stations within the theoretical maximum range of the current location. For example, the energy-aware navigation module 332 may first determine a set of routes to destinations that may be reached via roads from the current location of the electric vehicle. The energy-aware navigation module 332 may then determine a set of battery service stations based on these determined routes and based on data

stored in the battery service station database 364. Thus, the set of battery service stations is not the set of battery service stations that are within radius of the theoretical maximum range of the current location (*e.g.*, a circle). In some embodiments, the energy-aware navigation module 332 first determines a route from the current location to the destination. The energy-aware navigation module 332 then determines a set of battery service stations within a specified distance of the determined route (*e.g.*, within five miles of the determined route). In some embodiments, a route is determined based on aggregated road segments. In some embodiments, an aggregated road segment includes a plurality of road segments for which road conditions (*e.g.*, traffic, speed limit, terrain type, elevation, *etc.*) of the individual segments in the plurality of segments are averaged. In doing so, approximate routes may be quickly calculated and updated in real-time.

[00155] In some embodiments, the energy-aware navigation module 332 displays the suitable battery service stations in the user interface of the electric vehicle. For example, referring to Figure 7B, the suitable battery service stations include the battery service stations within the theoretical maximum range 704 (*e.g.*, the un-shaded areas of the map 701). In some embodiments, the energy-aware navigation module 332 uses a visual indicator to indicate the suitable battery service stations that are along a route to the destination. For example, the battery service stations that are along a route to the destination may be highlighted.

[00156] The energy-aware navigation module 332 then selects (604) a suitable battery service station (that is within the theoretical maximum range of the current location and on a route to the destination. In some embodiments, the energy-aware navigation module 332 selects the battery service station based on the profile 352 (*e.g.*, including user preferences, driving history of the user, previous battery service stations used by the user, *etc.*) and/or a battery service station specified by the user. In some embodiments, the energy-aware navigation module 332 allows the user to select a suitable battery service station.

[00157] In some embodiments, the energy-aware navigation module 332 verifies that the selected battery service station can service the battery of the electric vehicle. For example, if the battery service station is a battery exchange station, the energy-aware navigation module 332 verifies that the battery exchange station has battery packs that are compatible with the electric vehicle and has an available battery exchange bay for

exchanging the battery packs of the electric vehicle. Similarly, if the battery service station is a charge station, the energy-aware navigation module 332 verifies that the charge station is available to charge the battery packs of the electric vehicle.

[00158] In some embodiments, the energy-aware navigation module 332 then schedules (606) time for the electric vehicle to be serviced at the selected battery service station. In some embodiments, the energy-aware navigation module 332 schedules time at the selected battery service station based on an estimated time of arrival of the electric vehicle at the selected battery service station. In some embodiments, the energy-aware navigation module 332 also reserves a battery and a battery exchange platform for the electric vehicle. In some embodiments, the energy-aware navigation module 332 uses the one or more communication interfaces 304 to communicate with the selected battery service station to reserve time at the selected battery service station. In some embodiments, the energy-aware navigation module 332 uses the one or more communication interfaces 304 to communicate with the control center to reserve time at the selected battery service station. In these embodiments, the control center then transmits the reservation to the selected battery service station.

[00159] The energy-aware navigation module 332 adds (608) the selected battery service station as a waypoint in a list of waypoints. The list of waypoints may then be used by the energy-aware navigation module 332 to provide guidance (*e.g.*, turn-by-turn directions, *etc.*) for the route. Note that a waypoint may also include a home of the user, a workplace of the user, a location where the electric vehicle is charged, a user-specified destination, a destination determined based on a user profile, and a destination determined based on aggregate user profile data.

[00160] The energy-aware navigation module 332 then determines (610) the theoretical maximum range of the electric vehicle after the battery packs are serviced. As described above, the energy-aware navigation module 332 may determine the theoretical maximum range of the electric vehicle based at least in part on the battery status after exchanging or recharging the battery packs, the battery history, position data received from the positioning module 322, the profile 352, properties of the electric motors, the road conditions, a specified speed of the electric vehicle, the time of day, the day of the week, or a subset thereof. Again, the theoretical maximum range of the electric vehicle may include a

margin of safety (*e.g.*, a 20% margin). This margin of safety is used to account for unpredictable situations that may arise during the operation of the electric vehicle (*e.g.*, traffic jams, failure of battery packs, *etc.*). The battery service may include a battery charging service at a charging station and/or a battery exchange service at a battery exchange station.

[00161] The energy-aware navigation module 332 determines (612) whether the destination is reachable after the battery packs are serviced. The energy-aware navigation module 332 may make this determination by first determining a route from the selected battery service station to the destination, and then determining whether the length of the route is within the theoretical maximum range.

[00162] If the destination is not reachable after the battery packs are serviced (614, no), the energy-aware navigation module 332 determines (616) suitable battery service stations within the theoretical maximum range of the selected battery service station (*e.g.*, as described above).

[00163] The energy-aware navigation module 332 then selects (618) a new suitable battery service station that is within the theoretical maximum range of the previously selected battery service station and on a route to the destination. As discussed above, the energy-aware navigation module 332 may select the new suitable battery service station based on the profile 352 (*e.g.*, including user preferences, driving history of the user, previous battery service stations used by the user, *etc.*) and/or a battery service station specified by the user. In some embodiments, the energy-aware navigation module 332 allows the user to select a suitable battery service station.

[00164] The energy-aware navigation module 332 then returns to step 606.

[00165] If the destination is reachable after the battery packs are serviced (614, yes), the energy-aware navigation module 332 determines (620) a route from the current location to a first battery service station in the list of waypoints.

[00166] The energy-aware navigation module 332 then adds (622) the route to the energy plan. The energy-aware navigation module 332 determines (624) whether there are more battery service stations in the list of waypoints. If there are more battery service stations in the list of waypoints (626, yes), the energy-aware navigation module 332

determines (628) a route from the previous battery service station to a next battery service station in the list of waypoints. The energy-aware navigation module 332 then returns to step 622. If there are no more battery service stations in the list of waypoints (626, no), the energy-aware navigation module 332 determines (630) a route from the last battery service station to the destination and adds (632) the route to the energy plan. The energy-aware navigation module 332 then proceeds to step 528 in Figure 5.

[00167] Several examples of the process described in Figure 6 are described with reference to Figures 7B-7H. Figures 7B-7C illustrate a case where the user of the electric vehicle 102 has specified a destination 711 that is outside of the theoretical maximum range 704 of the electric vehicle. In this case, the energy-aware navigation module 332 selects and schedules time at a battery exchange station 712 at which the battery packs of the electric vehicle 102 can be exchanged for charged battery packs. The energy-aware navigation module 332 adds the battery exchange station 712 as a waypoint 713 in the list of waypoints. The energy-aware navigation module 332 then determines the theoretical maximum range of the electric vehicle 102 after the battery packs are exchanged and determines whether the electric vehicle 102 can reach the destination 711. As illustrated in Figure 7C, the destination 711 is now within theoretical maximum range (*i.e.*, the theoretical maximum range includes all destinations displayed in the map 701). Thus, the energy-aware navigation module 332 determines that the destination 711 is reachable from the battery exchange station 712. The energy-aware navigation module 332 then iterates through the list of waypoints to generate routes 714 and 721.

[00168] In Figure 7D-7H, the user of the electric vehicle 102 has specified a destination 732 (*e.g.*, Sacramento, CA) that requires multiple stops at battery exchange stations to reach the destination 732. A map 731 illustrated in Figures 7D-7H include both the current location of the electric vehicle 702 and the destination 732. As illustrated in Figure 7E, the theoretical maximum range of the electric vehicle 102 is bounded by the shaded areas of the map 731. The energy-aware navigation module 332 determines that battery exchange stations 741-1 and 744 are reachable from the current location of the electric vehicle 102. The energy-aware navigation module 332 selects and schedules time at battery exchange station 741-1 (*e.g.*, based on the user profile or via user input, *etc.*). The energy-aware navigation module 332 then adds the battery exchange station 741-1 as a waypoint 742-1 in a list of waypoints.

[00169] As illustrated in Figure 7F, the energy-aware navigation module 332 then determines the theoretical maximum range of the electric vehicle 102 after the battery packs are exchanged and determines whether the electric vehicle 102 can reach the destination 732 from the battery exchange station 741-1. The destination 732 is still unreachable so the energy-aware navigation module 332 selects and schedules time at a battery exchange station 741-2, which is within the theoretical maximum range of the battery exchange station 741-1. The energy-aware navigation module 332 then adds the battery exchange station 741-2 as a waypoint 742-2 in the list of waypoints.

[00170] As illustrated in Figure 7G, the energy-aware navigation module 332 then determines the theoretical maximum range of the electric vehicle 102 after the battery packs are exchange and determines whether the electric vehicle 102 can reach the destination 732 from the battery exchange station 741-2. The destination 732 is now reachable, so the energy-aware navigation module 332 determines a route 743-1 from the current location of the electric vehicle 102 to the battery exchange station 741-1, a route 743-2 from the battery exchange station 741-1 to the battery exchange station 741-2, and a route 743-3 from the battery exchange station 741-2 to the destination 732. The energy-aware navigation module 332 then adds the routes to the energy plan.

[00171] Figure 7H illustrates the routes from the current location of the electric vehicle to the destination 732. Figure 7H also illustrates destinations off of the routes that are also reachable. If the user decides to drive to reachable destinations off of the planned route, the energy-aware navigation module 332 monitors and determines whether the energy plan is still executable. If the energy plan is no longer executable, the energy-aware navigation module 332 repeats the process described in Figure 6.

[00172] Note that in Figures 7A-7H, the energy-aware navigation module 332 selected battery exchange stations. However, the energy-aware navigation module 332 may select charge stations, battery exchange stations, and a combination thereof to generate the energy plan. In some embodiments, the energy-aware navigation module 332 asks the user to select battery service stations.

[00173] In some embodiments, the energy-aware navigation module 332 periodically updates the map (*e.g.*, the map 701, the map 731, *etc.*) displayed in the user interface of the

electric vehicle based on the current location of the electric vehicle, the charge levels of the battery packs of the electric vehicle, the set of suitable battery service stations (*e.g.*, based on the charge levels of the battery packs and updated status of the battery service stations, *etc.*).

[00174] Figure 8 is a flow diagram expanding on step 420 of Figure 4, according to some embodiments. The energy-aware navigation module 332 determines (802) a current location of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the current location based on position data received from the positioning module 322. The energy-aware navigation module 332 determines (804) current charge levels for the battery packs of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines charge levels for the battery packs of the electric vehicle based on battery status data received form the BMS module 320.

[00175] In some embodiments, the energy-aware navigation module 332 obtains (806) the profile 352 of the user of the electric vehicle, as described above (*e.g.*, step 508 in Figure 5).

[00176] In some embodiments, the energy-aware navigation module 332 obtains (808) road conditions, as described above (*e.g.*, step 510 in Figure 5).

[00177] In some embodiments, the energy-aware navigation module 332 obtains (810) battery history for the one or more battery packs of the electric vehicle, as described above (*e.g.*, step 512 in Figure 5).

[00178] Note that steps 802-810 may be performed in any order.

[00179] The energy-aware navigation module 332 then determines (812) whether the current location is within a specified distance of a reference point (*e.g.*, within an area bounded by a point-of-no-return, as described below). In some embodiments, the reference point is a point at which the electric vehicle spends the most time charging (*e.g.*, a home or an office of the user, *etc.*). In some embodiments, the specified distance is a specified percentage (*e.g.*, 50%) of the theoretical maximum range of the electric vehicle based on the determined charge levels of the one or more battery packs.

[00180] If the electric vehicle is within the specified distance of the reference point (814, yes), the energy-aware navigation module 332 waits (816) for a specified time period and then returns to step 802.

[00181] Attention is now directed to Figure 9, which is an exemplary user interface 900 of the electric vehicle 102 displaying a map 901 and reachable destinations for the electric vehicle 102, according to some embodiments. The current location of the electric vehicle 102 and the reference point 904 is displayed on the map 901. In this case, the reference point 904 is within theoretical maximum range 906. The energy-aware navigation module 332 also calculates a point-of-no-return 908 that indicates the farthest destination that the electric vehicle can travel to and still be able to return to the reference point 904. If the electric vehicle 102 travels past the point-of-no-return 908, the battery packs of the electric vehicle must be serviced (*e.g.*, exchanged or recharged).

[00182] Returning to Figure 8, if the electric vehicle is not within the specified distance of the reference point (814, no), the energy-aware navigation module 332 determines (818) the theoretical maximum range of the electric vehicle (*e.g.*, as described above with respect to step 514 of Figure 5).

[00183] The energy-aware navigation module 332 determines (820) a set of suitable battery service stations (*e.g.*, battery exchange stations 910 and charge stations 912 in Figure 9) within the theoretical maximum range of the current location of the electric vehicle (*e.g.*, as described above).

[00184] The energy-aware navigation module 332 then generates (822) an alert. The alert may be an audio alert (*e.g.*, a sound, a voice, *etc.*) or a visual alert (*e.g.*, text, *etc.*). The alert may be serviced by the user interface 305 (*e.g.*, display, speakers, *etc.*).

[00185] The energy-aware navigation module 332 prompts (824) the user via the user interface 305 to select a battery service station. The prompt may be an audio prompt or a visual prompt via a user interface (*e.g.*, the user interface 210 in Figure 2, the user interface 305 in Figure 3, *etc.*). The energy-aware navigation module 332 then determines (826) whether the user selected a battery service station.

[00186] If the user selected a battery service station (828, yes), the energy-aware navigation module 332 schedules (836) time at the selected battery service station (*e.g.*, as described above with respect to step 606 of Figure 6), generates (838) a route from the current location of the electric vehicle to the selected battery service station, and adds (840) the route to the energy plan. The energy-aware navigation module 332 then proceeds to step 406 of Figure 4.

[00187] If the user did not select a battery service station (828, no), the energy-aware navigation module 332 determines (830) whether the user has ignored prompts to select a battery service station more than a specified number of times (*e.g.*, after 3 times).

[00188] If the user has ignored prompts to select a battery service station more than the specified number of times (832, yes), the energy-aware navigation module 332 selects (834) a suitable battery service station and proceeds to step 836. The selection of the battery service station may be based on the profile 352 and/or aggregate user profile data obtained from group of users. Thus, after the user has ignored the prompts for the specified number of times, the energy-aware navigation module 332 selects a battery service station for the user and provides navigation services to the selected battery service station. In some embodiments, the energy-aware navigation module 332 provides guidance using the energy plan regardless of whether the user has specified a silent navigation mode (as described with respect to Figure 11 below).

[00189] If the user has ignored prompts to select a battery service station less than the specified number of time (832, no), the energy-aware navigation module 332 proceeds to step 816.

[00190] Figure 10 is a flow diagram expanding on step 406 in Figure 4, according to some embodiments. The energy-aware navigation module 332 selects (1002) a waypoint in the energy plan. When the energy-aware navigation module 332 starts executing the energy plan, the energy-aware navigation module 332 selects the first waypoint on the energy plan. During subsequent iterations, the energy-aware navigation module 332 selects the next waypoint on the energy plan.

[00191] The energy-aware navigation module 332 provides (1004) guidance to the selected waypoint using the route in the energy plan. In some embodiments, if the electric

vehicle goes off of the route, the energy-aware navigation module 332 generates a new route based on the current location of the electric vehicle and the selected waypoint, and provides guidance based on the new route. In some embodiments, the energy-aware navigation module 332 provides audio guidance (*e.g.*, voice, *etc.*). In some embodiments, the energy-aware navigation module 332 provides visual guidance (*e.g.*, map, text, *etc.*). In some embodiments, the energy-aware navigation module 332 provides both audio and visual guidance. The energy-aware navigation module 332 then optionally waits (1006) for a specified time period.

[00192] The energy-aware navigation module 332 then determines (1008) whether the selected waypoint was reached. If the selected waypoint was not reached (1010, no), the energy-aware navigation module 332 determines (1012) the current location of the electric vehicle, as described above. The energy-aware navigation module 332 determines (1014) charge levels for the battery packs of the electric vehicle, as described above.

[00193] In some embodiments, the energy-aware navigation module 332 obtains (1016) the profile 352 of the user of the electric vehicle, as described above (*e.g.*, step 508 in Figure 5).

[00194] In some embodiments, the energy-aware navigation module 332 obtains (1018) road conditions, as described above (*e.g.*, step 510 in Figure 5).

[00195] In some embodiments, the energy-aware navigation module 332 obtains (1020) battery history for the one or more battery packs of the electric vehicle, as described above (*e.g.*, step 512 in Figure 5).

[00196] Note that steps 1012-1020 may be performed in any order.

[00197] The energy-aware navigation module 332 then determines (1022) the theoretical maximum range of the electric vehicle, as described above (*e.g.*, step 514 in Figure 5).

[00198] The energy-aware navigation module 332 then determines (1024) whether the selected waypoint is reachable. Note that a selected waypoint may no longer be reachable because of changed conditions (*e.g.*, traffic, weather, terrain, battery pack failures, vehicle speed, *etc.*).

[00199] If the selected waypoint is reachable (1026, yes), the energy-aware navigation module 332 returns to step 1004. If the selected waypoint is not reachable (1026, no), the energy-aware navigation module 332 notifies (1028) the user that the waypoint is no longer reachable, resets (1030) the energy plan, and returns to step 402 in Figure 4 to create a new energy plan.

[00200] Note that the energy-aware navigation module 332 may first determine whether the waypoint is reachable before determining whether the waypoint was reached.

[00201] If the selected waypoint was reached (1010, yes), the energy-aware navigation module 332 determines (1032) whether the selected waypoint is a battery service station. If the selected waypoint is a battery service station (1034, yes), the energy-aware navigation module 332 determines (1036) whether the battery packs of the electric vehicle were serviced at the battery service station. If the battery packs of the electric vehicle were serviced at the battery service station (1038, yes), the energy-aware navigation module 332 records (1040) information about service performed on the battery packs by the battery service station. For example, the energy-aware navigation module 332 may store the information about the service performed on the battery packs in the battery status database 356. After step 1040 or after determining that the battery packs were not serviced at the battery service station (1038, no), or after determining that the selected waypoint is not a battery service station (1034, no), the energy-aware navigation module 332 determines (1042) whether there are any more waypoints.

[00202] If there are more waypoints in the energy plan (1044, yes), the energy-aware navigation module 332 returns to step 1002. If there are no more waypoints in the energy plan (*e.g.*, the final destination is reached) (1044, no), the energy-aware navigation module 332 performs (1046) specified actions. For example, the energy-aware navigation module 332 may record the route taken and the stops made along the route to the profile 352 and/or the geographic location database 358. Similarly, the energy-aware navigation module 332 may transmit data about the route and/or destination the value-added services module 344, which in turn provides value-added services (*e.g.*, coupons, *etc.*). In some embodiments, if the destination is associated with an offer provided by the value-added services module 344 and selected by the user of the electric vehicle (*e.g.*, see Figure 22 below), the energy-aware navigation module 332 notifies the value-added services

module 344 that the destination was reached so that the value-added services module 344 can provide tracking information to the control center. In doing so, the service provide may receive advertisement revenue for the user arriving at the planned destination associated with the selected offer.

[00203] Users do not always use navigation services while operating vehicles. For example, the user may want to travel to multiple destinations, but only needs turn-by-turn guidance for certain portions of the trip. Thus, when the user is in a familiar area, the user may choose not to use the navigation system of the vehicle. However, when the user is in an unfamiliar area, the user may choose to use the navigation system of the vehicle. Thus, some embodiments provide at least two modes of energy management. In a first mode, the electric vehicle control system (*e.g.*, the electric vehicle control system 107 in Figure 3) provides visual (*e.g.*, a map, text, *etc.*) and/or audio (*e.g.*, voice, *etc.*) turn-by-turn guidance based on a destination received from a user of the electric vehicle and/or a profile of the user of the electric vehicle. In a second mode, the electric vehicle control system executes the energy plan, but does not provide turn-by-turn guidance. In doing so, the energy-aware navigation module 332 can still monitor the progress of the electric vehicle 102 in reaching the waypoints of the energy plan and re-compute the energy plan, if necessary, without providing audio and/or visual turn-by-turn guidance. In some embodiments, the silent navigation feature is a preference set in the profile 352. In some embodiments, the user toggles the silent navigation feature on or off during execution of the energy plan.

[00204] In embodiments where the silent navigation feature is available, step 1004 includes the operations illustrated in Figure 11. As illustrated in Figure 11, the energy-aware navigation module 332 determines (1102) whether silent navigation is enabled. If silent navigation is not enabled (1104, no), the energy-aware navigation module 332 provides turn-by-turn guidance during execution of the energy plan. If silent navigation is enabled (1104, yes), the energy-aware navigation module 332 disables turn-by-turn guidance during execution of the energy plan. After steps 1106 and 1108, the energy-aware navigation module 332 proceeds to step 1006.

[00205] Even though the energy-aware navigation module 332 and/or the energy management module 340 may provide energy management services, the electric vehicle may still be unable to reach a destination. For example, battery service stations may become

non-operational and no other battery service stations may be within range of the electric vehicle. Similarly, the battery packs of the electric vehicle may fail unexpectedly. Thus, in some embodiments, the energy-aware navigation module 332 determines whether the electric vehicle is out-of-range of a battery service station and makes a request for a mobile battery service station to service the batteries of the electric vehicle. These embodiments are discussed with reference to Figure 12.

[00206] Figure 12 is a flow diagram of a method 1200 for determining whether an electric vehicle is out-of-range of a battery service station, according to some embodiments. In some embodiments, the energy-aware navigation module 332 performs the following operations. The energy-aware navigation module 332 determines (1202) the current location of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines the current location based on position data received from the positioning module 322. The energy-aware navigation module 332 determines (1204) charge levels for the battery packs of the electric vehicle. In some embodiments, the energy-aware navigation module 332 determines charge levels for the battery packs of the electric vehicle based on battery status data received from the BMS module 320.

[00207] In some embodiments, the energy-aware navigation module 332 obtains (1206) the profile 352 of the user of the electric vehicle, as described above (*e.g.*, step 508 in Figure 5).

[00208] In some embodiments, the energy-aware navigation module 332 obtains (1208) road conditions, as described above (*e.g.*, step 510 in Figure 5).

[00209] In some embodiments, the energy-aware navigation module 332 obtains (1210) battery history for the one or more battery packs of the electric vehicle, as described above (*e.g.*, step 512 in Figure 5).

[00210] Note that steps 1202-1210 may be performed in any order.

[00211] The energy-aware navigation module 332 determines (1212) the theoretical maximum range of the electric vehicle (*e.g.*, as described above with respect to step 514 in Figure 5).

[00212] The energy-aware navigation module 332 then determines (1214) whether at least one battery service station or a reference point is within the theoretical maximum range of the current location. In some embodiments, the energy-aware navigation module 332 queries the battery service station database 364 to determine a set of battery service stations within the theoretical maximum range of the current location (*e.g.*, as described above).

[00213] In some embodiments, the energy-aware navigation module 332 determines a set of battery service stations within the theoretical maximum range of the current location of the electric vehicle. As described above, the set of battery service stations may only include battery service stations that are within the theoretical maximum range of the current location of the vehicle using roads. Furthermore, the battery stations within the set of battery service stations may only include battery service stations that are available to service the battery packs of the electric vehicle.

[00214] If there is at least one battery service station within the theoretical maximum range of the current location of the electric vehicle (1216, yes), the energy-aware navigation module 332 waits (1218) for a specified amount of time and proceeds to step 1202. If there is not at least one battery service station within the theoretical maximum range of the current location of the electric vehicle (1216, no), the energy-aware navigation module 332 generates (1220) a warning. The warning may be an audio warning and/or a visual warning that is serviced by a user interface (*e.g.*, the user interface 210 in Figure 2, the user interface 305 in Figure 3, *etc.*).

[00215] In some embodiments, the energy-aware navigation module 332 generates (1222) a request for a mobile battery service station to service the battery packs of the electric vehicle. For example, the mobile battery service station may carry charged battery packs to the electric vehicle so that the charged battery packs may be exchanged with the spent battery packs of the electric vehicle.

[00216] In some embodiments, the energy-aware navigation module 332 monitors routes traveled by the electric vehicle. In doing so, the energy-aware navigation module 332 may obtain data that may be used to generate the profile 352. These embodiments are discussed with reference to Figure 13, which is a flow diagram of a method 1300 for monitoring routes traveled by an electric vehicle, according to some embodiments. The

energy-aware navigation module 332 monitors (1302) the route taken between two points of interest (*e.g.*, a home, a business, a landmark, a recreation area, a government building, *etc.*). For example, the energy-aware navigation module 332 may monitor position data received from the positioning module 322.

[00217] The energy-aware navigation module 332 determines (1304) the travel time between two points of interest and records (1306) the route and the travel time. For example, the energy-aware navigation module 332 may record the route and the travel time to the profile 352.

[00218] In some embodiments, the energy-aware navigation module 332 transmits (1308) the route and the travel time to a server (*e.g.*, the control center 130, *etc.*). The server may then aggregate data about the user to build a profile of the user. Similarly, the server may aggregate the data about the user with data from other users to compile statistics in the aggregate about the users of electric vehicles. The route and travel time may also be used to determine current traffic conditions.

[00219] In some embodiments, the energy-aware navigation module 332 periodically transmits the current location of the electric vehicle and the charge levels of the battery packs of the electric vehicle to a control center (*e.g.*, the control center 130 in Figure 1). Accordingly, the control center may then monitor the present charge levels and locations of electric vehicles in order to plan overall power grid management. For example, the control center may adjust battery service plans (*e.g.*, by reducing the rate of recharging the battery packs, rescheduling electric vehicles to other battery service stations to balance the power grid, *etc.*) so that the power grid is not overburdened with battery service requests. These embodiments are discussed with respect to Figure 14.

[00220] Figure 14 is a flow diagram of a method 1400 for monitoring charge levels of battery packs of an electric vehicle, according to some embodiments. The energy-aware navigation module 332 determines (1402) current charge levels of the battery packs of the electric vehicle. For example, the energy-aware navigation module 332 may determine the charge levels of the battery packs based on battery status data received from the BMS module 320.

[00221] The energy-aware navigation module 332 determines (1404) a current location of the electric vehicle. For example, the energy-aware navigation module 332 may determine the current location of the electric vehicle from position data received from the positioning module 322. Note that steps 1402-1404 may be performed in any order.

[00222] The energy-aware navigation module 332 then transmits (1406) the current charge levels of the battery packs and the current location to the control center (e.g., the control center 130 in Figure 1. In some embodiments, to protect the privacy of users, the current charge levels of the battery packs and/or the current location of the electric vehicle is sent to the control center without identifiers (*e.g.*, a vehicle identifier, a user identifier, a battery identifier, *etc.*). The control center may then track the current positions and current charge levels of the battery packs of a plurality of electric vehicles. The control center may then use this information to adjust battery service plans so that the power grid is not overburdened with battery service requests.

[00223] The energy-aware navigation module 332 then waits (1408) for a specified amount of time and proceeds to step 1402.

Servicing Battery Packs

[00224] As discussed above, the battery packs of the electric vehicle may be serviced by a charge station and/or a battery exchange station. The battery service operations are discussed below with respect to Figures 15-21.

[00225] Figure 15 is a flow diagram of a method 1500 for servicing battery packs of an electric vehicle, according to some embodiments. As illustrated in Figure 15, at least a battery service module 1502 of an electric vehicle control system for the electric vehicle (*e.g.*, the battery service module 330 in Figure 3), a control center 1504 (*e.g.*, the control center 130 in Figure 1), and a battery service station 1506 (*e.g.*, the battery service station 134 in Figure 1) perform operations during the servicing of the battery packs of the electric vehicle.

[00226] When the electric vehicle arrives at the battery service station 1506, the battery service module 1502 sends (1508) a request to service the battery packs of the electric vehicle to the control center 1504 (*e.g.*, the control center 130). In some embodiments, the request includes identity information including battery identifiers for the battery packs, a user

identifier, a vehicle identifier, charge levels of the battery packs, types of the battery packs, *etc.* The battery service module 1502 may communicate with the control center 1504 via a wired connection (*e.g.*, an Ethernet connection at the battery service station 1506) or a wireless connection (*e.g.*, Wi-Fi, cellular, Bluetooth, *etc.*). The battery service module 1502 may transmit the request to a communication module of the electric vehicle (*e.g.*, the communication module 106 in Figure 1, the communication module 106 in Figure 2, *etc.*), which in turn transmits the request to the control center 1504. In this case, the battery service module 1502 may use the one or more communication interfaces of the electric vehicle control system (e.g., the one or more communication interfaces 304) to interface with the communication module of the electric vehicle. Alternatively, the battery service module 1502 may transmit the request to the control center 1504 via the one or more communication interfaces of the electric vehicle control system (e.g., the one or more communication interfaces 304).

[00227] The control center 1504 receives (1510) the request to service the battery packs and verifies (1512) the account status for the user. For example, the control center 1504 may verify that the account for the user is current and active (*e.g.*, the user has paid a periodic subscription fee, the user has paid off non-recurring fees, *etc.*). If the account status is not verified (1514, no), the control center 1504 prompts (1516) the user to update attributes of the account (*e.g.*, payment information, subscription type, *etc.*) or to create a new account if the user does not have an existing account. The control center 1504 then returns to step 1512.

[00228] If the account status is verified (1514, yes), the control center 1504 determines (1518) a service plan for the battery packs. In some embodiments, the control center 1504 determines the service plan based at least in part on the charge levels of the battery packs of the electric vehicle, the battery pack types, the type and/or status of account of the user, the present status of the electric power grid, the charge levels of the battery packs of other electric vehicle, *etc.* The service plan may include a charge plan for recharging the battery packs of the electric vehicle, a battery exchange plan for exchanging the batteries of the electric vehicle, and/or a combination of a charge plan and a battery exchange plan. In some embodiments, the service plan includes a set of instructions that are executable by the battery service station and/or the electric vehicle (*e.g.*, the electric vehicle control system 107 in Figure 3). In some embodiments, the service plan includes a set of parameters that provide

information about the services to be performed on the battery packs of the electric vehicle. These parameters may then be interpreted by the battery service station and/or the electric vehicle (*e.g.*, the electric vehicle control system 107 in Figure 3) during the battery pack service process.

[00229] In some embodiments, the control center 1504 sends (1520) the service plan to the battery service station 1506. The battery service station 1506 receives (1522) the service plan. In some embodiments, the battery service station 1506 receives the service plan from the battery service module 1502 of the electric vehicle control system. The battery service station 1506 then monitors and manages (1524) the battery service.

[00230] In some embodiments, the control center 1504 sends (1526) the service plan to the battery service module 1502. The battery service module 1502 receives (1528) the service plan. The battery service module 1502 then monitors and manages (1530) the battery service. For example, the battery service module 1502 may monitor battery status data received from a BMS module of the electric vehicle control system (*e.g.*, the BMS module 320 in Figure 3). Similarly, the battery service module 1502 may issue commands to a battery pack lock module of the electric vehicle (*e.g.*, the battery pack lock module 202 in Figure 2) to engage/disengage locks during a battery exchange operation. In some embodiments, the battery service module 1502 receives the service plan from the battery service station 1506.

[00231] Steps 1530 and 1524 are described in more detail with respect to Figure 16-17 below.

[00232] Figure 16 is a flow diagram of a method 1600 for servicing battery packs of an electric vehicle at a battery exchange station 1604, according to some embodiments. As illustrated in Figure 16, at least a battery service module 1602 of an electric vehicle (*e.g.*, the battery service module 330 in Figure 3) and the battery exchange station 1604 perform operations during the servicing of the battery of the electric vehicle.

[00233] When the electric vehicle is substantially aligned with a battery exchange platform of the battery exchange station 1604, the battery exchange station 1604 raises (1606) the battery exchange platform to support the battery packs of the electric vehicle. In some embodiments, the battery exchange station 1604 determines that the battery packs of the

electric vehicle are supported by the battery exchange platform (*e.g.*, using pressure sensors) and transmits a signal to the electric vehicle indicating that the battery packs are supported by the platform.

[00234] In some embodiments, the battery exchange station 1604 inserts (1616) a key into a locking mechanism for battery packs of the electric vehicle to disengage battery locks (*e.g.*, the one or more battery pack locks 204 in Figure 2) for the battery packs of the electric vehicle. In some embodiments, the electric vehicle includes two sets of battery pack locks. One set of battery pack locks may be locked/unlocked using the key of the battery exchange platform. Another set of battery pack locks may be (electronically) locked/unlocked by the battery service module 1602. The benefit of having two sets of locks is that if one set of locks inadvertently unlocks itself (*e.g.*, an error in the battery service module 1602, *etc.*), the other set of locks prevents the battery packs from being decoupled from the electric vehicle.

[00235] The battery service module 1602 determines (1608) whether the battery packs of the electric vehicle are supported by the battery exchange platform of the battery exchange station 1604. The battery service module 1602 may make this determination based on sensor signals received from a sensor module of the electric vehicle (*e.g.*, the sensor module 212) and/or signals sent from the battery exchange station 1604. For example, the sensor module may receive sensor signals from pressure sensors on the electric vehicle that indicate that the battery packs are supported by the platform of the battery exchange station 1604.

[00236] If the battery packs are not supported by the battery exchange platform (1610, no), the battery service module 330 waits (1612) for a specified amount of time and returns to step 1608. Alternatively, the battery service module 330 may notify an attendant of the battery exchange station 1604 that the battery exchange platform is not supporting the battery packs. The battery service module 330 may notify the attendant via a communication interface of the electric vehicle control system (*e.g.*, the communication interfaces 304 in Figure 3). Alternatively, the battery service module 330 may notify the attendant via the communication module of the electric vehicle (*e.g.*, the communication module 106 in Figure 2). The notification may be sent via a wired or wireless connection. The attendant may then manually raise the battery exchange platform.

[00237] If the battery packs are supported by the battery exchange platform (1610, yes), the battery service module 1602 disengages (1614) the battery pack locks. For example, the battery service module 1602 may instruct a battery pack lock module of the electric vehicle (*e.g.*, the battery pack lock module 202 in Figure 2) to disengage the battery pack locks (*e.g.*, the one or more battery pack locks 204 in Figure 2) that prevent hooks that couple the battery packs to the chassis of the electric vehicle from being disengaged.

[00238] The battery service module 1602 determines (1618) whether the battery pack locks are disengaged. The battery service module 1602 may make this determination based on sensor signals received from the sensor module of the electric vehicle (*e.g.*, the sensor module 212). For example, the sensor module may receive sensor signals from pressure sensors on the electric vehicle that indicate that the battery pack locks have been disengaged.

[00239] If the battery pack locks are not disengaged (1620, no), the battery service module 1602 waits (1622) for a specified amount of time and returns to step 1618. Alternatively, the battery service module 1602 may notify an attendant that the battery pack locks are not disengaged (*e.g.*, as described above). The attendant may then manually disengage the battery pack locks.

[00240] If the battery pack locks are disengaged (1620, yes), the battery service module 1602 decouples (1624) the battery packs from battery bays of the electric vehicle. For example, the battery service module 1602 may disengage mechanical hooks that couple the battery packs to the battery bays. In some embodiments, the battery service module 1602 notifies the battery exchange station 1604 that the battery packs have been decoupled. In some embodiments, the battery exchange station 1604 detects that the battery packs have been decoupled using sensors located on the battery exchange platform (*e.g.*, pressure sensors that detect the weight of the battery packs on the battery exchange platform, *etc.*). The battery service module 1602 then waits (1626) for a specified amount of time (*e.g.*, waits for the battery exchange station 1604 to exchange the battery packs).

[00241] After the battery packs have been decoupled from the battery bay, the battery exchange station 1604 removes (1628) the battery packs from the battery bay of the electric vehicle. The battery exchange station 1604 then transports (1630) the spent (or partially spent) battery packs to a storage facility (*e.g.*, at the battery exchange station 1604). The

battery exchange station 1604 retrieves (1632) fresh battery packs from the storage facility. The battery exchange platform of the battery exchange station 1604 then inserts (1634) the battery packs into the battery bays of the electric vehicle. In some embodiments, the battery exchange station 1604 sends signals to the battery service module 1602 indicating that the battery packs are ready to be coupled to the battery bays of the electric vehicle.

[00242] The battery service module 1602 determines (1636) whether the battery packs are ready to be coupled to the battery bay of the electric vehicle. In some embodiments, the battery service module 1602 makes this determination based on sensor signals received from the sensor module 212. For example, pressure sensors in the battery bays of the electric vehicle may indicate that the battery packs have been inserted into the battery bays of the electric vehicle. In some embodiments, the battery service module 1602 receives signals from the battery exchange station 1604 indicating that the battery packs are ready to be coupled to the battery bays of the electric vehicle.

[00243] If the battery packs are not ready to be coupled to the battery bay (1638, no), the battery service module 1602 waits (1626) for a specified amount of time and returns to step 1626. Alternatively, the battery service module 1602 may notify the attendant that the battery packs are not ready to be coupled to the battery bays (*e.g.*, after waiting a specified time period). The attendant may then perform remedial actions (*e.g.*, manually retrieving the battery packs, manually raising the battery exchange platform, *etc.*).

[00244] If the battery packs are ready to be coupled to the battery bay (1638, yes), the battery service module 1602 couples (1640) the battery packs to the battery bays of the electric vehicle. For example, the battery service module 1602 may engage mechanical hooks that couple the battery packs to the chassis of the battery bay.

[00245] The battery service module 1602 determines (1642) whether the battery packs are coupled to the battery bay of the electric vehicle. For example, the battery service module 1602 may make this determination based on sensor signals received from the sensor module.

[00246] If the battery packs are not coupled to the battery bay (1644, no), the battery service module 1602 waits (1646) for a specified amount of time and returns to step 1642. Alternatively, the battery service module 1602 may notify the attendant that the battery packs

are not coupled to the battery bay. The attendant may then manually couple the battery packs to the battery bay.

[00247] If the battery packs are coupled to the battery bay (1644, yes), the battery service module 1602 engages (1650) the battery pack locks (*e.g.*, the one or more battery pack locks 204). For example, the battery service module 1602 may instruct the battery pack lock module of the electric vehicle (*e.g.*, the battery pack lock module 202 in Figure 2) to engage the battery pack locks (*e.g.*, the one or more battery pack locks 204 in Figure 2) to prevent hooks that couple the battery packs to the chassis of the electric vehicle from being disengaged. In some embodiments, the battery exchange platform of the battery exchange station 1604 engages (1648) battery pack locks and removes the key.

[00248] The battery service module 1602 determines (1652) whether the battery pack locks are engaged. The battery service module 1602 may make this determination based on sensor signals received from the sensor module of the electric vehicle (*e.g.*, the sensor module 212). For example, the sensor module may receive sensor signals from pressure sensors on the electric vehicle that indicate that the battery pack locks have been engaged.

[00249] If the battery pack locks have not been engaged (1654, no), the battery service module 1602 waits (1656) for a specified amount of time and returns to step 1652. Alternatively, the battery service module 1602 may notify the attendant that the battery pack locks are not engaged. The attendant may then manually engage the battery pack locks.

[00250] If the battery pack locks have been engaged (1654, yes), the battery service module 1602 performs (1660) specified actions to complete the battery exchange process. For example, the battery service module 1602 may register the new battery packs with the electric vehicle control system 107. Similarly, the battery service module 1602 may register the new battery packs with the control center (*e.g.*, the control center 160 in Figure 1).

[00251] The battery exchange station 1604 may then lower (1658) the battery exchange platform.

[00252] Figure 17 is a flow diagram of a method 1700 for servicing battery packs of an electric vehicle at a charge station 1704, according to some embodiments. As illustrated in Figure 17, at least a battery service module 1702 of an electric vehicle (*e.g.*, the battery

service module 330 in Figure 3) and the charge station 1704 perform operations during the servicing of the battery packs of the electric vehicle.

[00253] In some embodiments, the user of the electric vehicle manually couples (mechanically and electrically) the electric vehicle to the charge station 1704 using a charge cord. In some embodiments, the charge station 1704 automatically couples (mechanically and electrically) a charge cord to the electric vehicle. In some embodiments, the electric vehicle and the charge station 1704 are electrically coupled via induction when the electric vehicle is within a specified range of the charge station 1704.

[00254] The charge station 1704 determines (1722) whether the charge station is electrically coupled to the electric vehicle. In some embodiments, the charge station 1704 makes this determination based on sensor signals received from sensors on the charge cord. In some embodiments, the charge station 1704 makes this determination based on a signal sent between the electric vehicle and the charge station 1704 via the charge cord. In some embodiments, the charge station 1704 makes this determination based on a handshake operation between the charge station 1704 and the electric vehicle. For example, if induction charging is used, the electric vehicle may send a signal to the charge station 1704 (*e.g.*, via a wireless connection) indicating that the electric vehicle has detected the presence of the charge station 1704. The charge station 1704 may then acknowledge the detection.

[00255] If the charge station 1704 is not electrically coupled to the electric vehicle (1724, no), the charge station 1704 waits (1726) for a specified amount of time and returns to step 1720. If the charge station 1704 is electrically coupled to the electric vehicle (1724, yes), the charge station arms (1728) itself. In doing so, the charge station may enable current flow between the charge station 1704 and the electric vehicle. The charge station 1704 then provides (1730) energy to charge the battery packs of the electric vehicle based on a service plan (*e.g.*, a service plan provided by the control center 130, *etc.*).

[00256] At the electric vehicle, the battery service module 1702 determines (1706) a charge level of the battery packs of the electric vehicle. The battery service module 1702 may make this determination based on battery status data received from a BMS module (*e.g.*, the BMS module 320 in Figure 3). The battery service module 1702 then transmits (1710) the charge levels to the charge station 1704 (*e.g.*, via a wireless connection).

[00257] In some embodiments, the battery service module 1702 notifies (1710) the user of the electric vehicle of the charge levels of the battery packs. For example, the battery service module 1702 may transmit the charge levels of the battery packs to a mobile phone of the user.

[00258] The battery service module 1702 determines (1712) whether the charge is complete. If the charge is not complete (1714, no), the battery service module 1702 waits (1716) for a specified amount of time and returns to step 1706. In some embodiments, if the charge is complete, the battery service module 1702 receives (1718) a report of the energy used to charge the battery packs. In some embodiments, the battery service module 1702 receives the report from the charge station 1704. In some embodiments, the battery service module 1702 receives the report from the control center. In these embodiments, the battery service module 1702 transmits (1720) the report to the control center.

[00259] After the battery service module 1702 transmits the charge levels to the charge station 1704, the charge station 1704 receives (1732) the charge levels of the battery packs and determines (1734) whether the charge process is complete. For example, the charge station 1704 may make this determination based at least in part on the charge levels of the battery packs received from the battery service module 1702 and the service plan.

[00260] If the charge process is not complete (1736, no), the charge station 1704 determines (1738) whether the charge station is electrically coupled to the electric vehicle. Note that the charge station may no longer be electrically coupled to the electric vehicle because the user disconnected the plug. If the charge station is electrically coupled to the electric vehicle (1740, yes), the charge station 1704 returns to step 1730.

[00261] If the charge process is complete (1736, yes) or if the charge station 1704 is not electrically coupled to the electric vehicle (1740, no), the charge station 1704 disarms (1742) the charge station. For example, the charge station 1704 may disable the current flow from the charge station 1704 to the electric vehicle. The charge station 1704 then determines (1744) the amount of energy used during the charging process. In some embodiments, the charge station 1704 transmits (1746) the energy used to the control center (*e.g.*, via a wired or wireless connection). In some embodiments, the charge station 1704 transmits a report of the amount of energy used during the charging process to the battery service module 1702.

[00262] Figures 18-21 illustrate exemplary charging scenarios.

[00263] Figure 18 is a block diagram 1800 illustrating data and energy flows for an electric vehicle 1802 being charged at public charge stations 1806, according to some embodiments. In Figure 18, the electric vehicle 1802 is an electric vehicle that does not include an electric vehicle control system as described herein. Thus, the electric vehicle 1802 may be referred to as a "guest vehicle."

[00264] In some embodiments, the charge stations 1806 are coupled to a switchboard 1808. The switchboard 1808 provides energy to the charge stations 1806. The switchboard 1808 also communicates with the charge stations 1806 via a data network (*e.g.*, a wired network, a wireless network, *etc.*). For example, the charge stations 1806 may provide status information (*e.g.*, the amount of energy being used by the charge station, the type of vehicle coupled to the charge station, *etc.*) of the charge stations 1806 to the switchboard 1808.

[00265] In some embodiments, the switchboard 1808 is coupled to a power network 1840 that provides energy from power generators 1842. In some embodiments, the power generators 1842 include fossil fuel power generators, hydroelectric power generators, wind power generators, solar power generators, *etc.* In some embodiments, the switchboard 1808 is coupled to a data network 1820. The data network 1820 may be coupled to a control center 1850 (*e.g.*, the control center 130 in Figure 1) and the power generators 1842. In some embodiments, the power generators 1842 provide data to the control center 1850 via the data network 1820 that indicates the present power-generation capacity, the present power draw on the power grid, *etc.* In some embodiments, the control center 1850 regulates the energy usage of the battery service stations (e.g., the charge stations 1806) so that the energy usage does not exceed the power-generation capacity. In some embodiments, the control center 1850 modifies the service plans for electric vehicles in accordance with the data received from the power generators 1842.

[00266] In some embodiments, when the electric vehicle 1802 arrives at a charge station 1806-1, the user of the electric vehicle 1802 uses an identity card 1804 to request energy from the charge station 1806-1. In some embodiments, the energy request includes an identifier for the user (*e.g.*, an account), the type of battery packs of the electric vehicle 1802, and an amount of energy desired. The charge station 1806-1 transmits the energy request to the control center 1850 via the data network 1820. The control center 1850 then generates a service plan based on the energy request and the present status of the power network 1840

and transmits the service plan to the charge station 1806-1. The charge station 1806-1 then manages the charging of the battery packs of the electric vehicle 1802 based on the service plan.

[00267] In some embodiments, the electric vehicle 1802 communicates with the charge station 1806-1 via a charge cord. For example, the communication may use the SAE J1772 communication protocol. The electric vehicle 1802 may transmit charge levels of the battery packs of the electric vehicle 1802 to the charge station 1806-1 so that the charge station 1806-1 may manage the charging process.

[00268] In some embodiments, the electric vehicle 1802 communicates with the charge station 1806-1 via a local wireless network (*e.g.*, a Bluetooth network, a Wi-Fi network, *etc.*).

[00269] Figure 19 is a block diagram 1900 illustrating data and energy flows for an electric vehicle 1902 being charged at public charge stations 1906, according to some embodiments. In Figure 19, the electric vehicle 1902 is an electric vehicle that includes an electric vehicle control system as described herein.

[00270] In some embodiments, the charge stations 1906 are coupled to a switchboard 1908. The switchboard 1908 may provide energy to the charge stations 1906. In some embodiments, the switchboard 1908 communicates with the charge stations 1906 via a data network (*e.g.*, a wired network, a wireless network, *etc.*). For example, the charge stations 1906 may provide status information (*e.g.*, the amount of energy being used by the charge station, the type of vehicle coupled to the charge station, *etc.*) of the charge stations 1906 to the switchboard 1908.

[00271] In some embodiments, the switchboard 1908 is coupled to a power network 1940 that provides energy from power generators 1942. In some embodiments, the power generators 1942 may include fossil fuel power generators, hydroelectric power generators, wind power generators, solar power generators, *etc.* In some embodiments, the switchboard 1908 is coupled to a data network 1920. The data network 1920 may be coupled to a control center 1950 (*e.g.*, the control center 130 in Figure 1) and the power generators 1942. In some embodiments, the power generators 1942 provide data to the control center 1950 via the data network 1920 that indicates the present power-generation capacity, the present power draw on the power grid, *etc.* In some embodiments, the control center 1950 regulates the energy usage of the battery service stations (e.g., the charge

stations 1906) so that the energy usage does not exceed the power-generation capacity. In some embodiments, the control center 1950 modifies the service plans for electric vehicles in accordance with the data received from the power generators 1942.

[00272] In some embodiments, when the electric vehicle 1902 arrives at a charge station 1906-1, the user of the electric vehicle 1902 uses an identity card 1904 to request energy from the charge station 1906-1. In some embodiments, the energy request includes an identifier for the user (*e.g.*, an account), the type of battery packs of the electric vehicle 1902, and an amount of energy desired. The charge station 1906-1 transmits the energy request to the control center 1950 via the data network 1920. The control center 1950 then generates a service plan based on the energy request and the present status of the power network 1940 and transmits the service plan to the charge station 1906-1. The charge station 1906-1 then manages the charging of the battery packs of the electric vehicle 1902 based on the service plan.

[00273] Alternatively, the electric vehicle control system (*e.g.*, the electric vehicle control system 107) may generate an energy request. The electric vehicle control system may transmit the energy request to the charge station 1906-1, which in turn transmits the energy request to the control center 1950 via the data network 1920. Alternatively, the electric vehicle control system may transmit the energy request to the control center 1950 via the data network 1920. The control center 1950 then generates a service plan based on the energy request and the present status of the power network 1940 and transmits the service plan to the electric vehicle control system. The electric vehicle control system may then transmit the service plan to the charge station 1906-1. The charge station 1906-1 then manages the charging of the battery packs of the electric vehicle 1902 based on the service plan.

[00274] In some embodiments, the electric vehicle 1902 communicates with the charge station 1906-1 via a charge cord. For example, the communication may use the SAE J1772 communication protocol. The electric vehicle 1902 may transmit charge levels of the battery packs of the electric vehicle 1902 to the charge station 1906-1 so that the charge station 1906-1 may manage the charging process.

[00275] In some embodiments, the electric vehicle 1902 communicates with the charge station 1906-1 via a local wireless network (*e.g.*, a Bluetooth network, a Wi-Fi network, *etc.*).

[00276] In some embodiments, the electric vehicle control system monitors the charge process and transmits the present charge levels to a mobile device 1910 of the user via the data network 1920.

[00277] Figure 20 is a block diagram 2000 illustrating data and energy flows for an electric vehicle 2002 being charged at a home charge station 2006, according to some embodiments. In Figure 20, the electric vehicle 2002 is an electric vehicle that includes an electric vehicle control system as described herein.

[00278] In some embodiments, the home charge station 2006 is coupled to a home switchboard 2008. The home switchboard 2008 provides energy to the home charge station 2006.

[00279] In some embodiments, the home switchboard 2008 is coupled to a power network 2040 that provides energy from power generators 2042. In some embodiments, the power generators 2042 may include fossil fuel power generators, hydroelectric power generators, wind power generators, solar power generators, *etc.*

[00280] In some embodiments, the electric vehicle 2002 is coupled to a data 2020 (*e.g.*, a wired connection, a wireless connection, *etc.*). In some embodiments, the data network 2020 is coupled to a control center 2050 (*e.g.*, the control center 130 in Figure 1) and the power generators 2042. The power generators 2042 may provide data to the control center 2050 via the data network 2020 that indicates the present power-generation capacity, the present power draw on the power grid, *etc.* In some embodiments, the control center 2050 regulates the energy usage of the battery service stations (e.g., the home charge station 2006) so that the energy usage does not exceed the power-generation capacity. In some embodiments, the control center 2050 modifies the service plans for electric vehicles in accordance with the data received from the power generators 2042.

[00281] In some embodiments, when the electric vehicle 2002 arrives at the home charge station 2006, the electric vehicle control system generates an energy request. The electric vehicle control system (*e.g.*, the electric vehicle control system 107 in Figure 3) transmits the energy request to the control center 2050 via the network 2020. The control center 2050 then generates a service plan based on the energy request and the present status of the power network 2040 and transmits the service plan to the electric vehicle control system. The electric vehicle control system then transmits the service plan to the home

charge station 2006. The home charge station 2006 then manages the charging of the battery packs of the electric vehicle 2002 based on the service plan.

[00282] In some embodiments, the electric vehicle 2002 communicates with the home charge station 2006 via a charge cord. For example, the communication may use the SAE J1772 communication protocol. The electric vehicle 2002 may transmit charge levels of the battery packs of the electric vehicle 2002 to the home charge station 2006 so that the home charge station 2006 may manage the charging process.

[00283] In some embodiments, the electric vehicle 2002 communicates with the home charge station 2006 via a local wireless network (*e.g.*, a Bluetooth network, a Wi-Fi network, *etc.*).

[00284] In some embodiments, the electric vehicle control system monitors the charge process and transmits the present charge levels to a mobile device 2010 of the user via the network 2020.

[00285] After the charging process is complete, the home charge station 2006 transmits a report of the energy used to the electric vehicle control system. The electric vehicle control system then transmits the report to the control center 2050.

[00286] Figure 21 is a block diagram 2100 illustrating data and energy flows for an electric vehicle 2102 being charged at a home charge station 2106, according to some embodiments. In Figure 21, the electric vehicle 2102 is an electric vehicle that includes an electric vehicle control system as described herein.

[00287] In some embodiments, the home charge station 2106 is coupled to a home meter 2108. The home meter 2108 provides energy to the home charge station 2106. The home meter 2108 also communicates with the home charge station 2106 via a local data network (*e.g.*, a wired network, a wireless network, *etc.*). For example, the home charge station 2106 may provide status information (*e.g.*, the amount of energy being used by the charge station, the type of vehicle coupled to the charge station, *etc.*) of the home charge station 2106 to the home meter 2108.

[00288] In some embodiments, the home meter 2108 is coupled to a transformer 2112 that receives energy from a power network 2140. The power network 2140 receives energy from power generators 2142. In some embodiments, the power generators 2142 may include fossil fuel power generators, hydroelectric power generators, wind power generators, solar

power generators, *etc.* The home meter 2108 may communicate with the transformer 2112 via a data network.

[00289] In some embodiments, the electric vehicle 2102 is coupled to a data network 2120 (*e.g.*, a wired connection, a wireless connection, *etc.*). In some embodiments, the data network 2120 is coupled to a control center 2150 (*e.g.*, the control center 130 in Figure 1) and the power generators 2142. The power generators 2142 provide data to the control center 2150 via the data network 2120 that indicates the present power-generation capacity, the present power draw on the power grid, *etc.* In some embodiments, the control center 2150 regulates the energy usage of the battery service stations (e.g., the home charge station 2106) so that the energy usage does not exceed the power-generation capacity. In some embodiments, the control center 2150 modifies the service plans for electric vehicles in accordance with the data received from the power generators 2142.

[00290] In some embodiments, when the electric vehicle 2102 arrives at the home charge station 2106, the electric vehicle control system generates an energy request. The electric vehicle control system transmits the energy request to the control center 2150 via the network 2120. In some embodiments, the control center 2150 generates a service plan based on the energy request and the present status of the power network 2140, and transmits the service plan to a utility grid management system 2130. The utility grid management system 2130 then transmits the service plan to the home meter 2108, which in turn transmits the service plan to the home charge station 2106. The home charge station 2106 then manages the charging of the battery packs of the electric vehicle 2102 based on the service plan.

[00291] In some embodiments, the electric vehicle 2102 communicates with the home charge station 2106 via a charge cord. For example, the communication may use the SAE J1772 communication protocol. The electric vehicle 2102 may transmit charge levels of the battery packs of the electric vehicle 2102 to the home charge station 2106 so that the home charge station 2106 may manage the charging process.

[00292] In some embodiments, the electric vehicle 2102 communicates with the home charge station 2106 via a local wireless network (*e.g.*, a Bluetooth network, a Wi-Fi network, *etc.*).

[00293] In some embodiments, the electric vehicle control system monitors the charge process and transmits the present charge levels to a mobile device 2110 of the user.

[00294] After the charging process is complete, the home charge station 2106 transmits a report of the energy used to the electric vehicle control system. The electric vehicle control system then transmits the report to the control center 2150.

Providing Value-Added Services

[00295] Aside from providing energy management services, the electric vehicle control system 107 may also provide value-added services via the value-added services module 344. The value-added services are described in more detail with respect to Figure 22, which is a flow diagram of a method 2200 for providing value-added services to an electric vehicle, according to some embodiments. The value-added services module 344 receives (2202) the search query. The search query may include a search for a point of interest (*e.g.*, a coffee shop within a specified distance of the current location of the electric vehicle), a search for an address, a search for a product, and/or a search for a service.

[00296] The value-added services module 344 retrieves (2204) search results based on the search query and presents (2206) the search results to the user of the electric vehicle. In some embodiments, the value-added services module 344 presents the search results in the user interface 305 of the electric vehicle control system 107. In some embodiments, the value-added services module 344 presents the search results in a user interface of a positioning system (*e.g.*, the positioning system 105 in Figure 2). In some embodiments, the value-added services module 344 presents the search results in the user interface 210. The value-added services module 344 may present a visual representation of the results (*e.g.*, text, map, *etc.*), an audio representation of the results (*e.g.*, voice, *etc.*), or a combination thereof.

[00297] The user of the electric vehicle may then select one of the search results. The value-added services module 344 receives (2208) a selected search result. The selected search result may be the destination. The value-added services module 344 then determines (2210) offers within a specified distance of the selected search result. For example, the offers may include coupons, sales, promotional discounts, *etc.*

[00298] The value-added services module 344 then presents (2212) the offers to the user. Again, the value-added services module 344 may present a visual representation of the

offers (*e.g.*, text, map, *etc.*), an audio representation of the offers (*e.g.*, voice, *etc.*), or a combination thereof.

[00299] In some embodiments, the value-added services module 344 sends (2214) tracking information about the offers presented to the user to a control center (*e.g.*, the control center 130 in Figure 1). In doing so, a service provider may receive advertisement revenue for displaying the offers. In some embodiments, the service provider is the same entity as the entity that operates the control center.

[00300] The value-added services module 344 determines (2216) whether the user selected an offer. If the user selected an offer (2218, yes), the value-added services module 344 receives (2220) the selected offer. In some embodiments, the value-added services module 344 sends (2222) tracking information about the offer selected to the control center. In doing so, the service provider may receive advertisement revenue for generating a "clickthrough." The energy-aware navigation module 332 sets (2224) the selected search result as the destination and proceeds to step 402 in Figure 4. The selected offer may be associated with a destination. In this case, the destination associated with the selected offer is used. If a destination is not associated with the offer, the destination associated with the selected search result may be used. In some embodiments, the energy-aware navigation module 332 generates an energy plan to a charge station that is closest (and that is available) to a location associated with the selected offer. For example, if the selected offer was for a discount on coffee at a coffee shop, the energy-aware navigation module 332 may generate an energy plan to a charge station that is located in a parking lot that is near the coffee shop.

[00301] If an offer is not selected (2218, no), the energy-aware navigation module 332 sets (2224) the selected search result as the destination (*e.g.*, the destination associated with the selected search result) and proceeds to step 402 in Figure 4.

[00302] In some embodiments, when the user arrives at the destination associated with the offer, the energy-aware navigation module 332 sends tracking information to the control center that indicates that the user arrived at the destination. In doing so, the service provider may receive advertisement revenue for the user arriving at the destination. In some embodiments, the service provider receives advertisement revenue when the user makes a purchase at a business associated with the offer.

[00303] The methods described herein may be governed by instructions that are stored in a computer readable storage medium and that are executed by one or more processors of one or more computer systems. Each of the operations shown in Figures 4-6, 8, and 10-22 may correspond to instructions stored in a computer memory or computer readable storage medium. The computer readable storage medium may include a magnetic or optical disk storage device, solid state storage devices such as Flash memory, or other non-volatile memory device or devices. The computer readable instructions stored on the computer readable storage medium are in source code, assembly language code, object code, or other instruction format that is interpreted by one or more processors.

[00304] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A computer-implemented method for managing energy usage of an at least partially electric vehicle, comprising:

at a computer system of the at least partially electric vehicle, the computer system including one or more processors, and memory storing one or more programs, and a display device, the one or more processors executing the one or more programs to perform the operations of:

receiving a charge level of at least one battery of the at least partially electric vehicle;

receiving a current location of the at least partially electric vehicle;

determining a theoretical maximum range of the at least partially electric vehicle based on the current location of the at least partially electric vehicle and the charge level of the at least one battery of the at least partially electric vehicle;

displaying on the display device a geographic map including the current location of the at least partially electric vehicle; and

displaying a first boundary on the geographic map indicating the maximum theoretical range of the at least partially electric vehicle.

2. The method of claim 1, further comprising displaying one or more visual indicators on the geographic map to indicate that locations outside of the first boundary are unreachable by the at least partially electric vehicle based at least in part on the current location and the theoretical maximum range of the at least partially electric vehicle.

3. The method of claim 1, further comprising:

determining a second boundary that is a predetermined distance from a reference point, wherein the predetermined distance is the farthest destination that the at least partially electric vehicle can travel to and still be able to return to the reference point; and

displaying the second boundary on the geographic map.

4. The method of claim 3, wherein the reference point is the point at which the at least partially electric vehicle spends the most time charging the at least one battery of the at least partially electric vehicle.

5. The method of claim 4, wherein the reference point is selected from the group consisting of a home of a user of the at least partially electric vehicle and an office of a user of the at least partially electric vehicle.

6. The method of claim 1, further comprising generating an energy plan for the at least partially electric vehicle.

7. The method of claim 6, wherein the energy plan includes:

one or more routes;

a destination; and

one or more battery service stations at which the at least one battery may be serviced.

8. The method of claim 6, wherein generating the energy plan for the at least partially electric vehicle includes:

determining whether the at least partially electric vehicle can reach a predefined location based on the theoretical maximum range;

in response to determining that the at least partially electric vehicle cannot reach the predefined location,

determining a battery service station within the theoretical maximum range of the current location of the at least partially electric vehicle at which the at least one battery of the at least partially electric vehicle may be serviced; and

adding the battery service station to the energy plan.

9. The method of claim 8, wherein after adding a battery service station to the energy plan, the method further comprises scheduling time at the battery service station to service the at least one battery of the at least partially electric vehicle.

10. The method of claim 9, wherein scheduling time at the battery service station to service the at least one battery of the at least partially electric vehicle includes scheduling time at the battery service station to service the at least one battery of the at least partially electric vehicle based on an estimated time that the at least partially electric vehicle will arrive at the battery service station.

11. The method of claim 8, wherein the predefined location is selected from the group consisting of:

a home of the user;

a workplace of the user; and

a location where the at least partially electric vehicle is charged.

12. The method of claim 11, further comprising in response to determining that the at least partially electric vehicle can reach the predefined location, repeating the operations of claim 1.

13. The method of claim 11, further comprising:

generating a route from the current location of the at least partially electric vehicle to the battery service station; and

adding the route to the energy plan.

14. The method of claim 8, wherein the battery service station is selected from the group consisting of:

charge stations that recharge the one or more battery packs of the vehicle;

battery exchange stations that replace a spent battery of the vehicle with a charged battery; and

any combination of the aforementioned battery service stations.

15. The method of claim 8, wherein the predefined location is selected from the group consisting of:

a user-specified destination;

a battery service station;

a destination determined based on a user profile; and

a destination determined based on aggregate user profile data.

16. The method of claim 15, further comprising:

determining the theoretical maximum range of the at least partially electric vehicle after the at least one battery is serviced at the battery service station;

determining whether the at least partially electric vehicle can reach the predefined location based on the theoretical maximum range;

in response to determining that the at least partially electric vehicle cannot reach the predefined location,

determining a next battery service station within the theoretical maximum range of a previous battery service station in the energy plan and on a route to the predefined location;

adding the next battery service station to the energy plan; and

repeating the operations of claim 16 until the predefined location is reachable.

17. The method of claim 16, further comprising:

generating a route from the current location of the at least partially electric vehicle to the destination, wherein the route includes stops at the battery service stations in the energy plan; and

adding the route to the energy plan.

18. The method of claim 15, further comprising in response to determining that the at least partially electric vehicle can reach the destination,

generating a route from the current location of the at least partially electric vehicle to the destination; and

adding the route to the energy plan.

19. The method of claim 1, wherein the theoretical maximum range is based at least in part on:

the charge level of the at least one battery of the at least partially electric vehicle;

the current location of the at least partially electric vehicle;

a profile of the user;

properties of at least one electric motor of the at least partially electric vehicle;

types of terrain on which roads are situated;

a speed of the at least partially electric vehicle; and

any combination of the aforementioned elements.

20. The method of claim 1, wherein the theoretical maximum range is adjusted to provide a margin of safety.

21. The method of claim 1, further comprising:

determining whether a silent navigation mode is enabled; and

in response to determining that the silent navigation mode is not enabled, providing guidance based on the energy plan.

22. The method of claim 21, further comprising in response to determining that the silent navigation mode is enabled, disabling guidance based on the energy plan.

23. The method of claim 21, wherein the guidance includes turn-by-turn guidance.

24. The method of claim 21, wherein the guidance is selected from the group consisting of:

visual guidance;

audio guidance; and

any combination of the aforementioned guidance.

25. The method of claim 1, wherein receiving the current location of the at least partially electric vehicle includes receiving the current location of the at least partially electric vehicle from a global satellite navigation system.

26. The method of claim 1, further comprising:

receiving an energy plan for the at least partially electric vehicle;

providing guidance based on the energy plan; and

periodically determining whether the energy plan is still valid.

27. The method of claim 1, further comprising:

at a computer system remote from the at least partially electric vehicle, the computer system including one or more processors and memory storing one or more programs, the one or more processors executing the one or more programs to perform the operations of:

receiving a request to service the at least one battery of the at least partially electric vehicle; and

in response to the request, generating a service plan to service the at least one battery of the at least partially electric vehicle.

28. The method of claim 1, further comprising:

transmitting to a server a request to service the at least one battery of the at least partially electric vehicle;

in response to the request, receiving from the server a service plan; and

managing the service plan.

29. The method of claim 28, wherein the service plan indicates that the at least one battery of the at least partially electric vehicle is to be exchanged for at least one charged battery, and wherein the method further comprises facilitating the exchanging of the at least one battery for the at least one charged battery.

30. A system for managing energy usage of an at least partially at least partially electric vehicle, comprising:

one or more processors;

memory; and

one or more programs stored in the memory, the one or more programs comprising instructions to:

receive a charge level of at least one battery of the at least partially at least partially electric vehicle;

receive a current location of the at least partially at least partially electric vehicle; and

determine a theoretical maximum range of the at least partially at least partially electric vehicle based on the current location of the at least partially at least partially electric vehicle and the charge level of the at least one battery of the at least partially at least partially electric vehicle.

31. A computer readable storage medium storing one or more programs configured for execution by a computer, the one or more programs comprising instructions to:

receive a charge level of at least one battery of the at least partially electric vehicle;

receive a current location of the at least partially electric vehicle; and

determine a theoretical maximum range of the at least partially electric vehicle based on the current location of the at least partially electric vehicle and the charge level of the at least one battery of the at least partially electric vehicle.

32. A computer-implemented method for providing value-added services to an electric vehicle, comprising:

at a computer system of an electric vehicle, the computer system including one or more processors and memory storing one or more programs, the one or more processors executing the one or more programs to perform the operations of:

receiving a selected search result from a user of the electric vehicle;

determining offers with a specified distance of the selection; and

presenting the offers to the user in a user interface of the electric vehicle.

33. The method of claim 32, wherein a search query is selected from the group consisting of:

a point of interest;

an address;

a product;

a service; and

any combination of the aforementioned search queries.

34. The method of claim 32, wherein an offer is selected from the group consisting of:

a coupon;

a sale price;

promotional discount; and

any combination of the aforementioned offers.

35. The method of claim 32, wherein prior to receiving the selected search result from the user, the method further comprises:

receiving a search query from a user of the electric vehicle;

retrieving search results based on the search query; and

presenting the search results to the user in the user interface of the electric vehicle.

36. The method of claim 32, wherein after presenting the offers, the method further comprises sending tracking information to a server.

37. The method of claim 32, further comprising:

receiving a selected offer from the user of the electric vehicle;

generating an energy plan for the electric vehicle; and

providing guidance based on the energy plan.

38. The method of claim 37, wherein the guidance includes turn-by-turn guidance.

39. The method of claim 37, wherein the guidance is selected from the group consisting of:

visual guidance;

audio guidance; and

any combination of the aforementioned guidance.

40. The method of claim 37, wherein after receiving the selected offer from the user, the method further comprises sending tracking information to the server.

41. The method of claim 32, further comprising:

determining that the electric vehicle has reached a destination associated with the selected offer; and

sending tracking information to the server.

42. A system for providing value-added services to an electric vehicle, comprising:

one or more processors;

memory; and

one or more programs stored in the memory, the one or more programs comprising instructions to:

receive a selected search result from a user of the electric vehicle;

determine offers with a specified distance of the selection; and

present the offers to the user in a user interface of the electric vehicle.

43. A computer readable storage medium storing one or more programs configured for execution by a computer, the one or more programs comprising instructions to:

receive a selected search result from a user of the electric vehicle;

determine offers with a specified distance of the selection; and

present the offers to the user in a user interface of the electric vehicle.

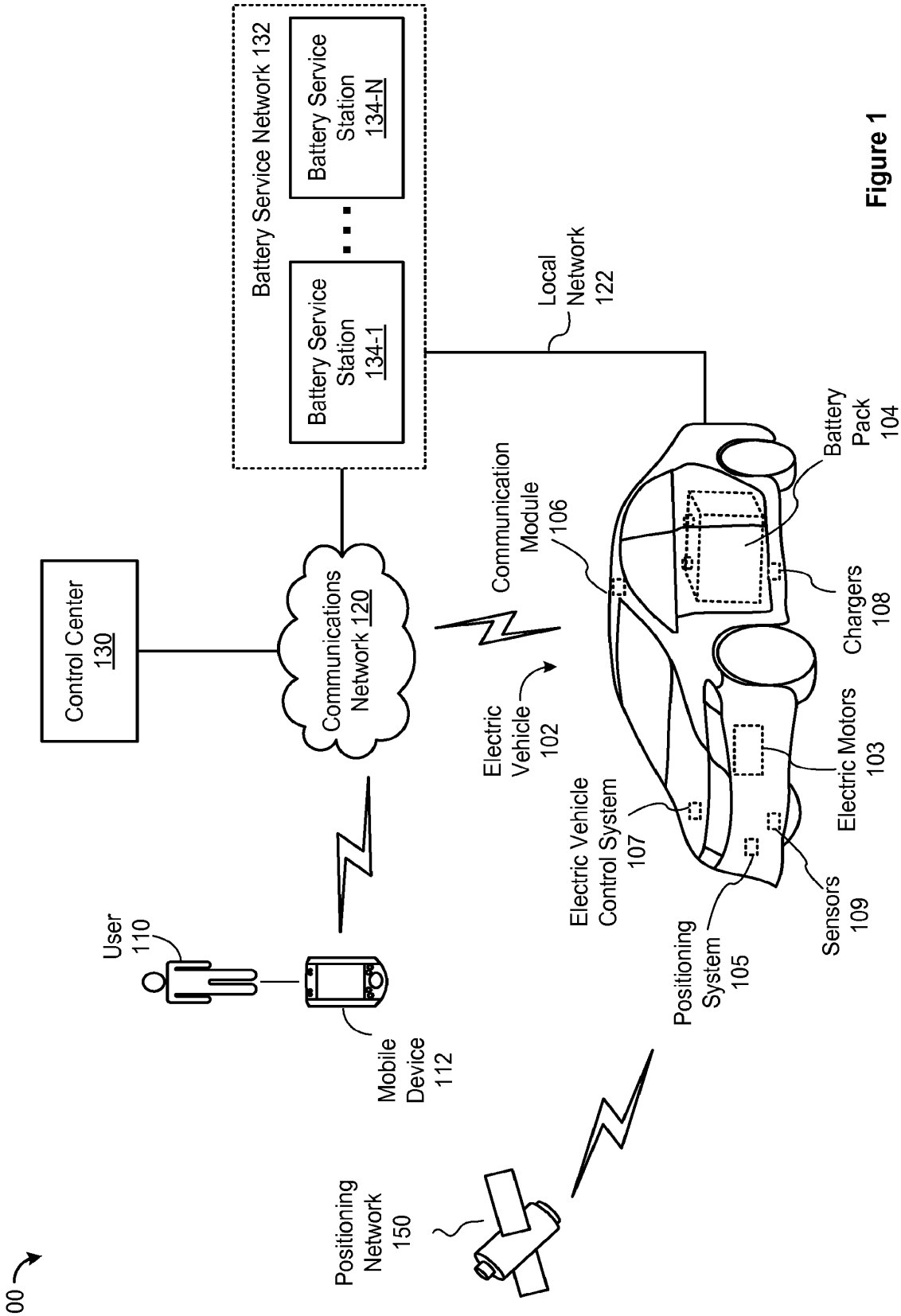

100
Positioning Network 150
Mobile Device 112
User 110
Control Center 130
Communications Network 120
Battery Service Network 132
Battery Service Station 134-1
Battery Service Station 134-N
Local Network 122
Communication Module 106
Electric Vehicle 102
Electric Vehicle Control System 107
Positioning System 105
Sensors 109
Electric Motors 103
Chargers 108
Battery Pack 104

Figure 1

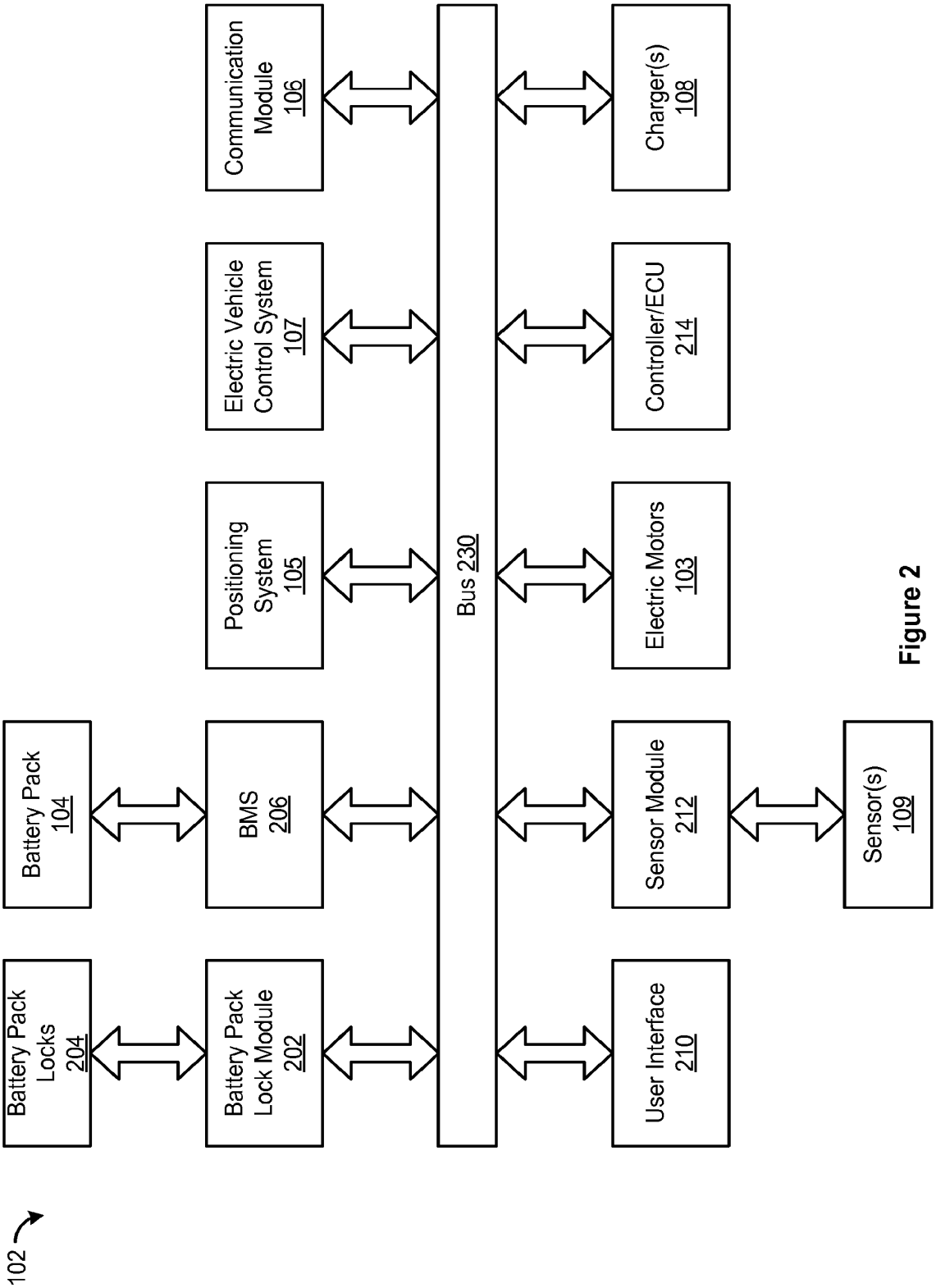

102
Battery Pack Locks 204
Battery Pack Lock Module 202
Battery Pack 104
BMS 206
Positioning System 105
Electric Vehicle Control System 107
Communication Module 106
Bus 230
User Interface 210
Sensor Module 212
Electric Motors 103
Controller/ECU 214
Charger(s) 108
Sensor(s) 109

Figure 2

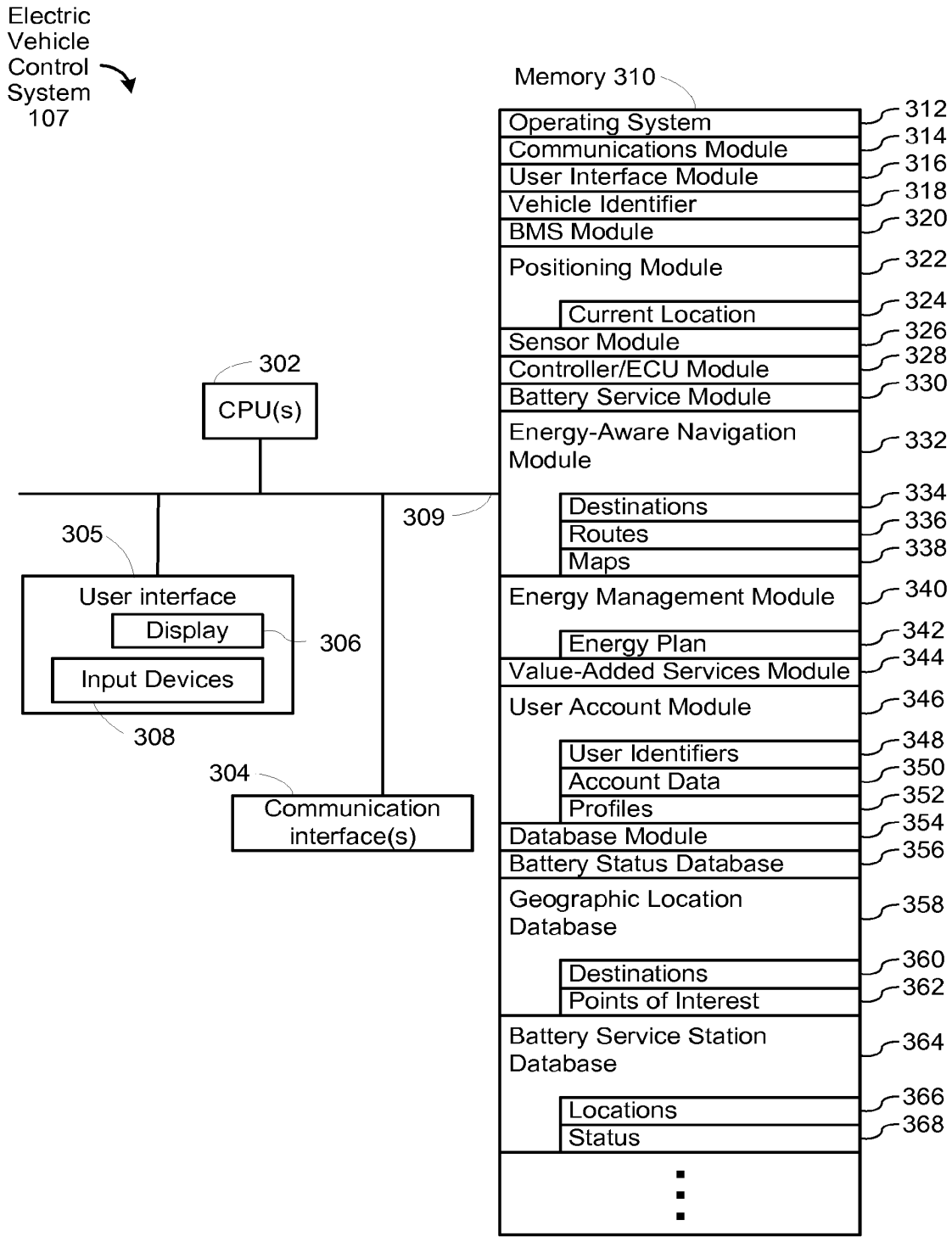

Electric Vehicle Control System 107
Memory 310
Operating System
Communications Module
User Interface Module
Vehicle Identifier
BMS Module
Positioning Module
Current Location
Sensor Module
Controller/ECU Module
Battery Service Module
Energy-Aware Navigation Module
Destinations
Routes
Maps
Energy Management Module
Energy Plan
Value-Added Services Module
User Account Module
User Identifiers
Account Data
Profiles
Database Module
Battery Status Database
Geographic Location Database
Destinations
Points of Interest
Battery Service Station Database
Locations
Status
312
314
316
318
320
322
324
326
328
330
332
334
336
338
340
342
344
346
348
350
352
354
356
358
360
362
364
366
368
302
CPU(s)
309
305
User interface
Display
306
Input Devices
308
304
Communication interface(s)

Figure 3

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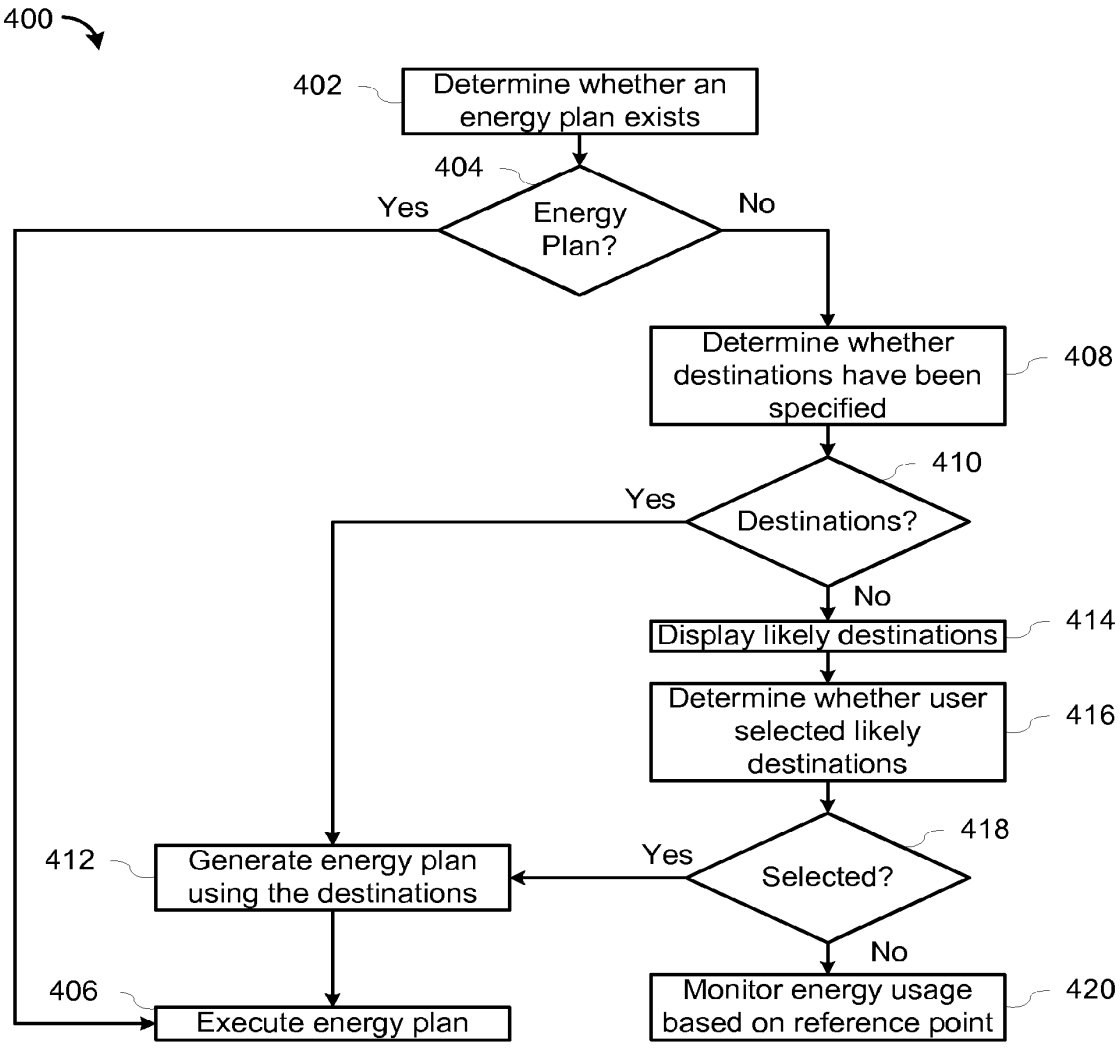

400
402
Determine whether an energy plan exists
404
Energy Plan?
Yes
No
Determine whether destinations have been specified
408
410
Destinations?
Yes
No
Display likely destinations
414
Determine whether user selected likely destinations
416
418
Selected?
Yes
No
412
Generate energy plan using the destinations
406
Execute energy plan
Monitor energy usage based on reference point
420

Figure 4

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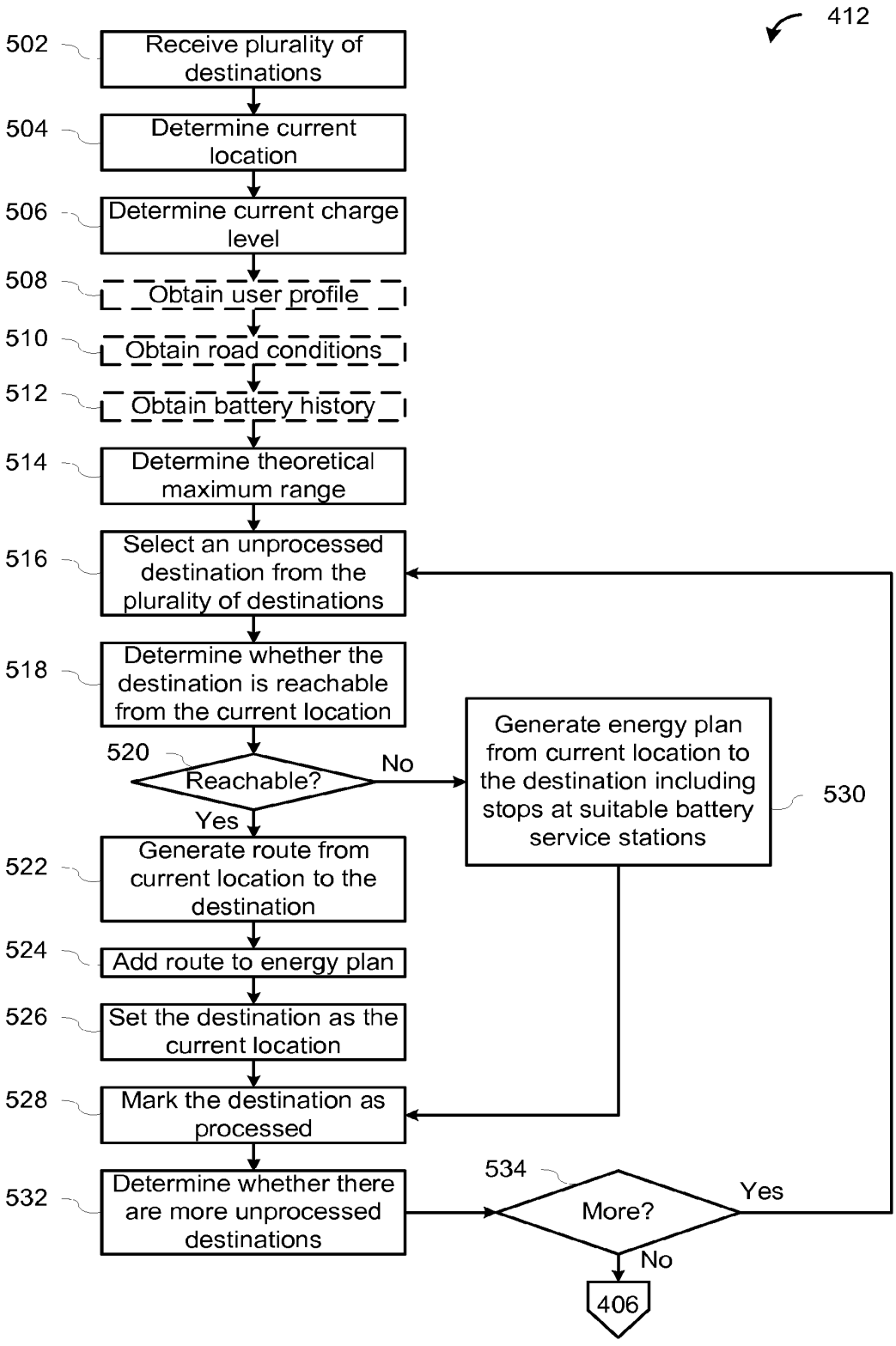

412
502
Receive plurality of destinations
504
Determine current location
506
Determine current charge level
508
Obtain user profile
510
Obtain road conditions
512
Obtain battery history
514
Determine theoretical maximum range
516
Select an unprocessed destination from the plurality of destinations
518
Determine whether the destination is reachable from the current location
520
Reachable?
No
Yes
530
Generate energy plan from current location to the destination including stops at suitable battery service stations
522
Generate route from current location to the destination
524
Add route to energy plan
526
Set the destination as the current location
528
Mark the destination as processed
532
Determine whether there are more unprocessed destinations
534
More?
Yes
No
406

Figure 5

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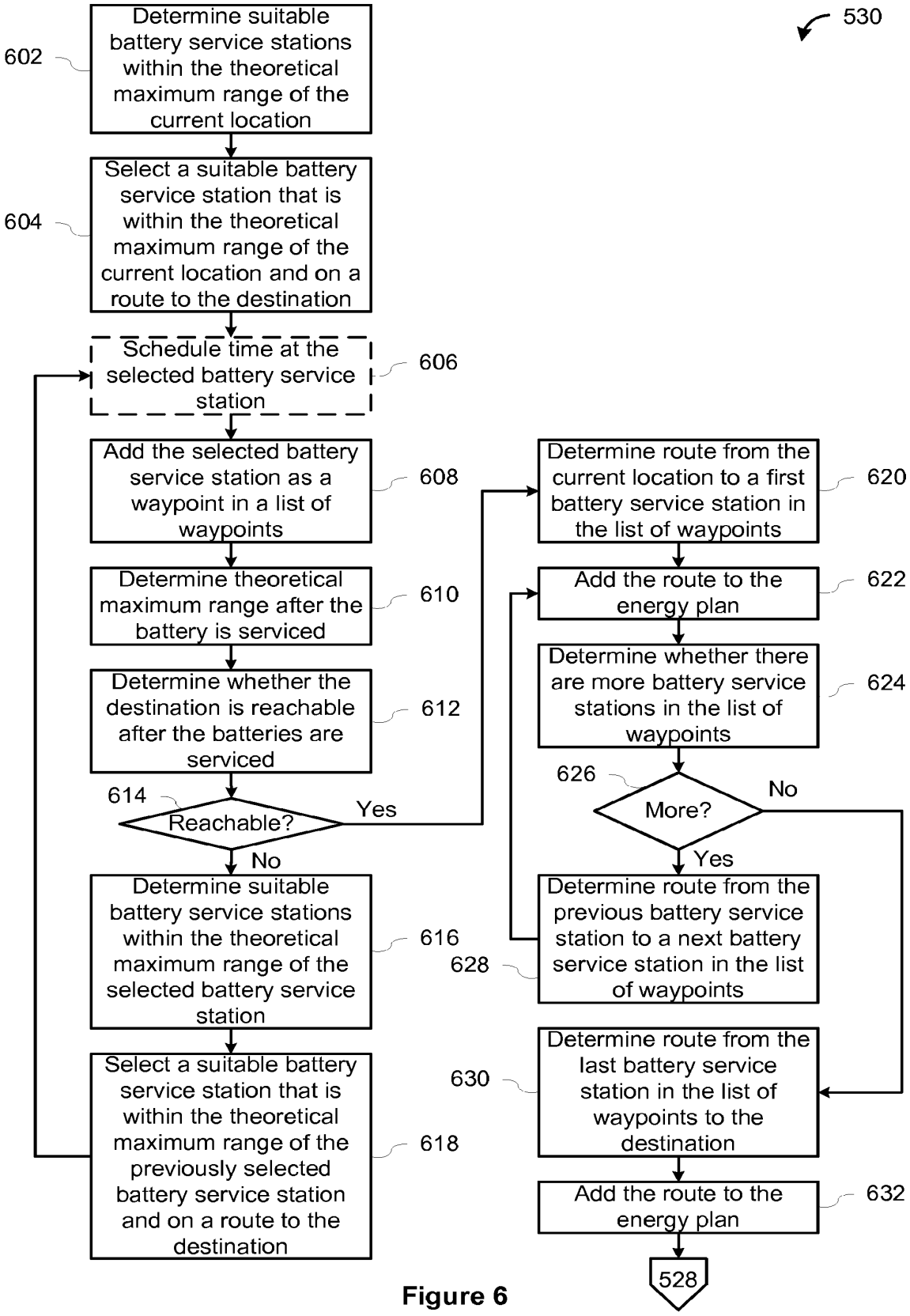

530
602
Determine suitable battery service stations within the theoretical maximum range of the current location
604
Select a suitable battery service station that is within the theoretical maximum range of the current location and on a route to the destination
Schedule time at the selected battery service station
606
Add the selected battery service station as a waypoint in a list of waypoints
608
Determine theoretical maximum range after the battery is serviced
610
Determine whether the destination is reachable after the batteries are serviced
612
614
Reachable?
Yes
No
Determine suitable battery service stations within the theoretical maximum range of the selected battery service station
616
Select a suitable battery service station that is within the theoretical maximum range of the previously selected battery service station and on a route to the destination
618
Determine route from the current location to a first battery service station in the list of waypoints
620
Add the route to the energy plan
622
Determine whether there are more battery service stations in the list of waypoints
624
626
More?
No
Yes
Determine route from the previous battery service station to a next battery service station in the list of waypoints
628
Determine route from the last battery service station in the list of waypoints to the destination
630
Add the route to the energy plan
632
528

Figure 6

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Figure 7A

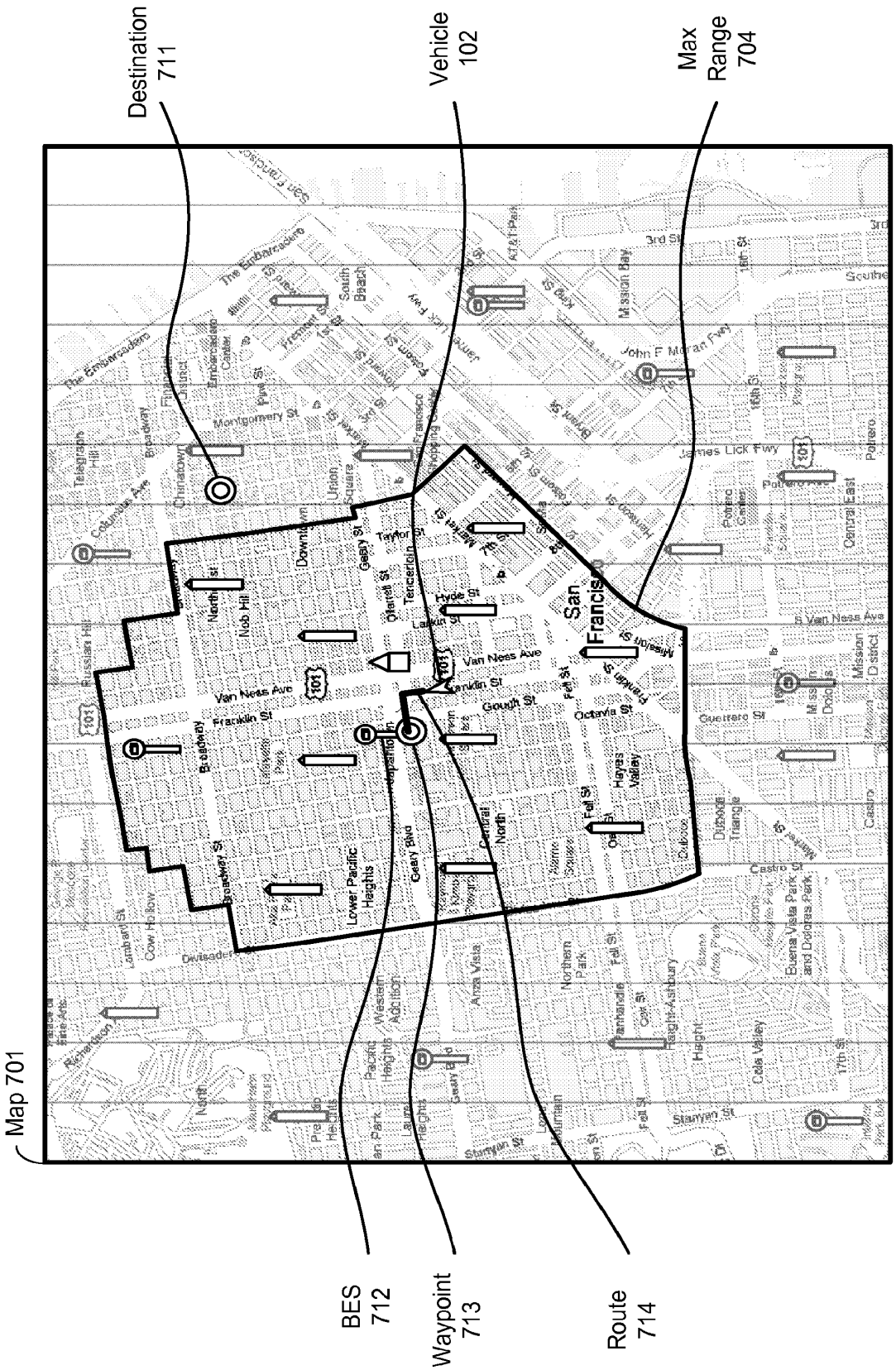

Destination
711
Vehicle
102
Max
Range
704
Map 701
BES
712
Waypoint
713
Route
714

Figure 7B

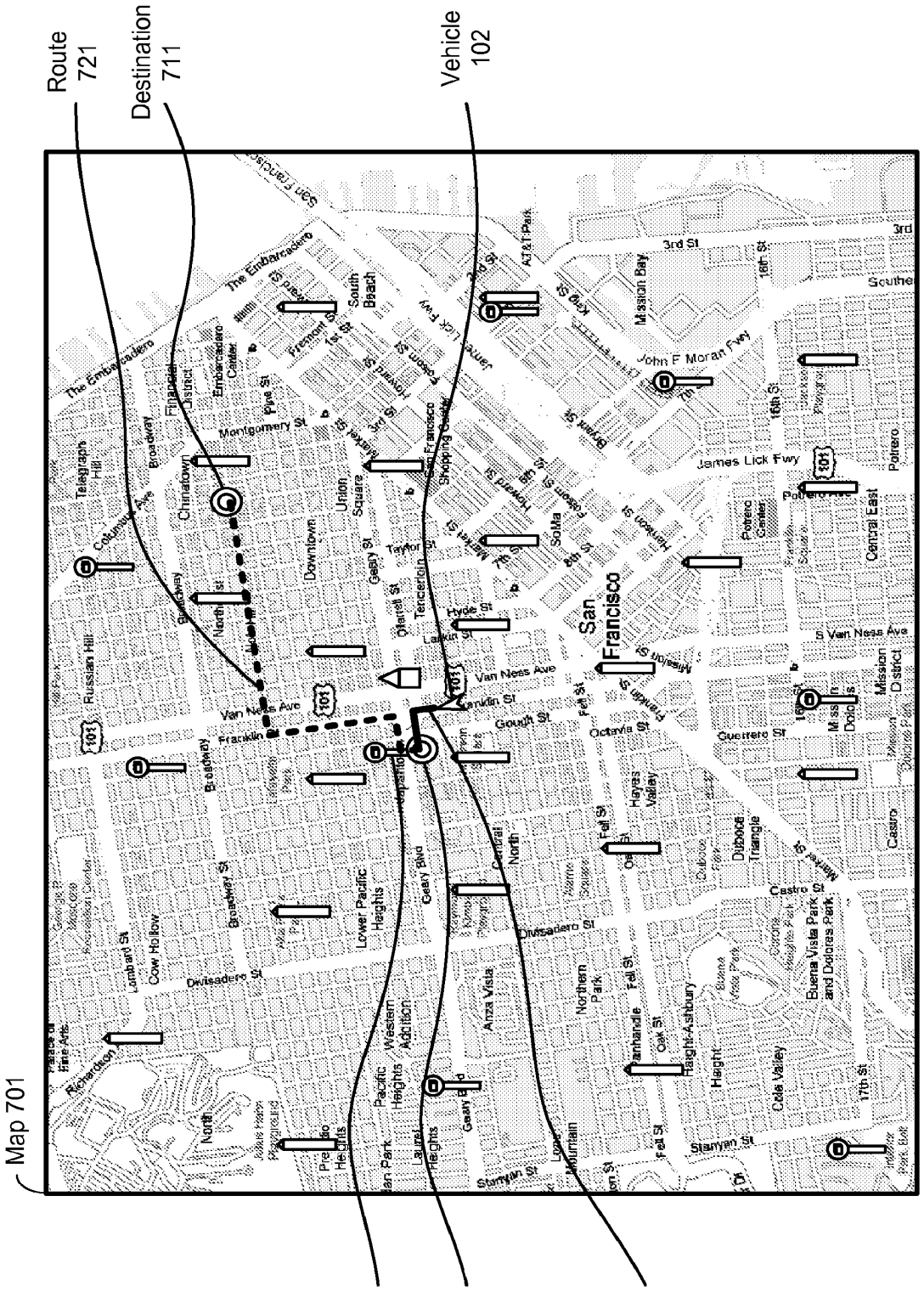

Route 721
Destination 711
Vehicle 102
Map 701
BES 712
Waypoint 713
Route 714
San Francisco
Van Ness Ave
Franklin St
Gough St
Octavia St
Fell St
Oak St
Haight-Ashbury
Haight
Castro St
Guerrero St
Mission District
Dolores Park
Buena Vista Park
Duboce Triangle
Hayes Valley
Civic Center
Tenderloin
SoMa
Union Square
Downtown
Chinatown
Financial District
Telegraph Hill
Russian Hill
Lombard St
Cow Hollow
Pacific Heights
Lower Pacific Heights
Western Addition
Alamo Square
Haight Ashbury
Cole Valley
Noe Valley
Potrero Hill
Mission Bay
South Beach
Embarcadero Center
Ferry Building
Pier 39
Fisherman's Wharf
Ghirardelli Square
Palace of Fine Arts
Richardson Bay
Golden Gate Park
Presidio Heights
Laurel Heights
Anza Vista
Northern Panhandle
Central North
Central East
Potrero
Mission Bay
John F Moran Fwy
James Lick Fwy
Bryant St
Howard St
Folsom St
Harrison St
Mission St
Market St
Geary Blvd
Divisadero St
Stanyan St
17th St
16th St
3rd St
4th St
5th St
6th St
7th St
8th St
9th St
10th St
Broadway
Columbus Ave
The Embarcadero
Montgomery St
Kearny St
Taylor St
Jones St
Hyde St
Larkin St
Polk St
Van Ness Ave
Franklin St
Gough St
Octavia St
Laguna St
Buchanan St
Webster St
Fillmore St
Steiner St
Pierce St
Scott St
Baker St
Lyon St
Presidio Ave
Arguello Blvd
Funston Ave
19th Ave
101
80

Figure 7C

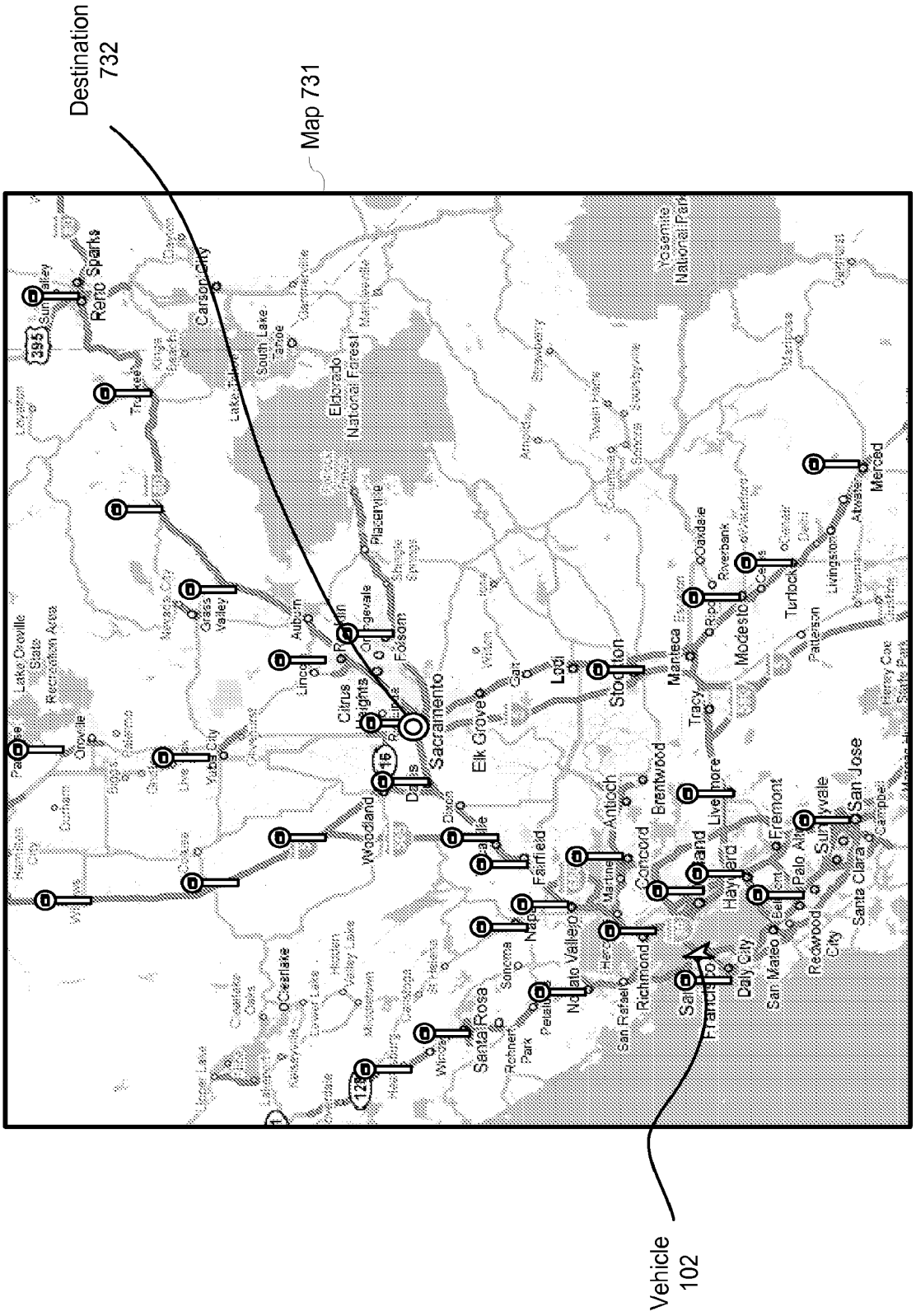

Destination
732
Map 731
Vehicle
102
Sacramento
Elk Grove
Stockton
Modesto
Merced
San Jose
Oakland
San Francisco
Santa Rosa
Napa
Fairfield
Vallejo
Concord
Antioch
Tracy
Livermore
Fremont
Eldorado
National Forest
Yosemite
National Park
Reno
Sparks
Carson City
South Lake
Tahoe
Placerville
Folsom
Roseville
Auburn
Woodland
Davis
Lodi
Manteca
Turlock
Oakdale
Riverbank
Patterson
Livingston
Atwater
Dixon
Vacaville
Benicia
Martinez
Pittsburg
Brentwood
Hayward
Daly City
San Mateo
Redwood
City
Palo Alto
Sunnyvale
Santa Clara
Campbell
Richmond
San Rafael
Petaluma
Sonoma
Healdsburg
Windsor
Clearlake
Lakeport
Ukiah
Willits
Chico
Oroville
Yuba City
Marysville
Grass
Valley
Nevada City
Lake Oroville
State
Recreation Area
Palermo
Live
Oak
Gridley
Colusa
Williams
Orland
Corning
Red Bluff
Hamilton
City
Durham
Citrus
Heights
Orangevale
Rio
Linda
Lincoln
Loomis
Rocklin
Roseville
Foresthill
Shingle
Springs
Amador
City
Sutter
Creek
Jackson
Ione
Valley
Springs
Copperopolis
Angels
Camp
Murphys
Avery
Arnold
Mokelumne
Hill
Mariposa
Groveland
Sonora
Twain
Harte
Bridgeport
Lee
Vining
Mammoth
Lakes
June
Lake
Lakeport
Middletown
Hidden
Valley
Lake
Kelseyville
Clearlake
Oaks
Clearlake
Upper
Lake
Calistoga
St Helena
Yountville
Napa
Petaluma
Rohnert
Park
Santa Rosa
Windsor
Healdsburg
Cloverdale
Geyserville
Guerneville
Occidental
Bodega
Bay
Tomales
Point
Reyes
Station
Inverness
Olema
Bolinas
Stinson
Beach
Muir
Woods
Mill
Valley
Sausalito
Tiburon
Belvedere
Corte
Madera
Larkspur
Novato
Petaluma
Sebastopol
Forestville
Guerneville
Monte
Rio
Jenner
Fort
Ross
Gualala
Point
Arena
Mendocino
Fort
Bragg
Willits
Laytonville
Leggett
Garberville
Redway
Miranda
Scotia
Rio
Dell
Fortuna
Ferndale
Eureka
Arcata
Trinidad
Crescent
City
Klamath
Orick
Weott
Myers
Flat
Shelter
Cove
Whitethorn
Briceland
Honeydew
Petrolia
Ferndale
Loleta
Fortuna
Rio
Dell
Scotia
Redway
Garberville
Leggett
Laytonville
Willits
Ukiah
Hopland
Cloverdale
Healdsburg
Windsor
Santa Rosa
Rohnert
Park
Petaluma
Novato
Sausalito
Tiburon
Belvedere
Corte
Madera
Larkspur
San Rafael
Richmond
Hercules
Martinez
Pittsburg
Antioch
Brentwood
Oakley
Concord
Pleasant
Hill
Walnut
Creek
Danville
San
Ramon
Dublin
Pleasanton
Livermore
Tracy
Lathrop
Manteca
Ripon
Escalon
Oakdale
Riverbank
Modesto
Turlock
Ceres
Patterson
Newman
Gustine
Los
Banos
Dos
Palos
Chowchilla
Madera
Merced
Atwater
Livingston
Winton
Hilmar
Delhi
Planada
Le
Grand
Athlone
Mariposa
Coulterville
Groveland
Big
Oak
Flat
Yosemite
National Park
Oakhurst
Fish
Camp
Wawona
Yosemite
Valley
Lee
Vining
Mammoth
Lakes
June
Lake
Bridgeport
Topaz
Coleville
Walker
Minden
Gardnerville
Carson
City
Reno
Sparks
Verdi
Truckee
Kings
Beach
Tahoe
City
Meeks
Bay
South
Lake
Tahoe
Stateline
Zephyr
Cove
Glenbrook
Incline
Village
Crystal
Bay
Alpine
Meadows
Homewood
Tahoma
Emerald
Bay
Meyers
Christmas
Valley
Cedarpines
Park
Fawnskin
Big
Bear
City
Big
Bear
Lake
Sugarloaf
Crestline
Lake
Arrowhead
Running
Springs
Arrowbear
Lake
Forest
Falls
Mentone
Redlands
Yucaipa
Calimesa
Beaumont
Banning
Cabazon
Whitewater
Palm
Springs
Cathedral
City
Rancho
Mirage
Palm
Desert
Indian
Wells
La
Quinta
Indio
Coachella
Thermal
Mecca
Oasis
North
Shore
Salton
City
Desert
Hot
Springs
Morongo
Valley
Joshua
Tree
Yucca
Valley
Twentynine
Palms
Landers
Yucca
Valley
Barstow
Victorville
Hesperia
Apple
Valley
Adelanto
Lucerne
Valley
Helendale
Silver
Lakes
Oro
Grande
Phelan
Pinon
Hills
Wrightwood
Lake
Arrowhead
Crestline
Running
Springs
Arrowbear
Lake
Forest
Falls
Mentone
Redlands
Yucaipa
Calimesa
Beaumont
Banning
Cabazon
Whitewater
Palm
Springs
Cathedral
City
Rancho
Mirage
Palm
Desert
Indian
Wells
La
Quinta
Indio
Coachella
Thermal
Mecca
Oasis
North
Shore
Salton
City
Desert
Hot
Springs
Morongo
Valley
Joshua
Tree
Yucca
Valley
Twentynine
Palms
Landers
Yucca
Valley
Barstow
Victorville
Hesperia
Apple
Valley
Adelanto
Lucerne
Valley
Helendale
Silver
Lakes
Oro
Grande
Phelan
Pinon
Hills
Wrightwood
Lake
Arrowhead
Crestline
Running
Springs
Arrowbear
Lake
Forest
Falls
Mentone
Redlands
Yucaipa
Calimesa
Beaumont
Banning
Cabazon
Whitewater
Palm
Springs
Cathedral
City
Rancho
Mirage
Palm
Desert
Indian
Wells
La
Quinta
Indio
Coachella
Thermal
Mecca
Oasis
North
Shore
Salton
City
Desert
Hot
Springs
Morongo
Valley
Joshua
Tree
Yucca
Valley
Twentynine
Palms
Landers
Yucca
Valley
Barstow
Victorville
Hesperia
Apple
Valley
Adelanto
Lucerne
Valley
Helendale
Silver
Lakes
Oro
Grande
Phelan
Pinon
Hills
Wrightwood

Figure 7D

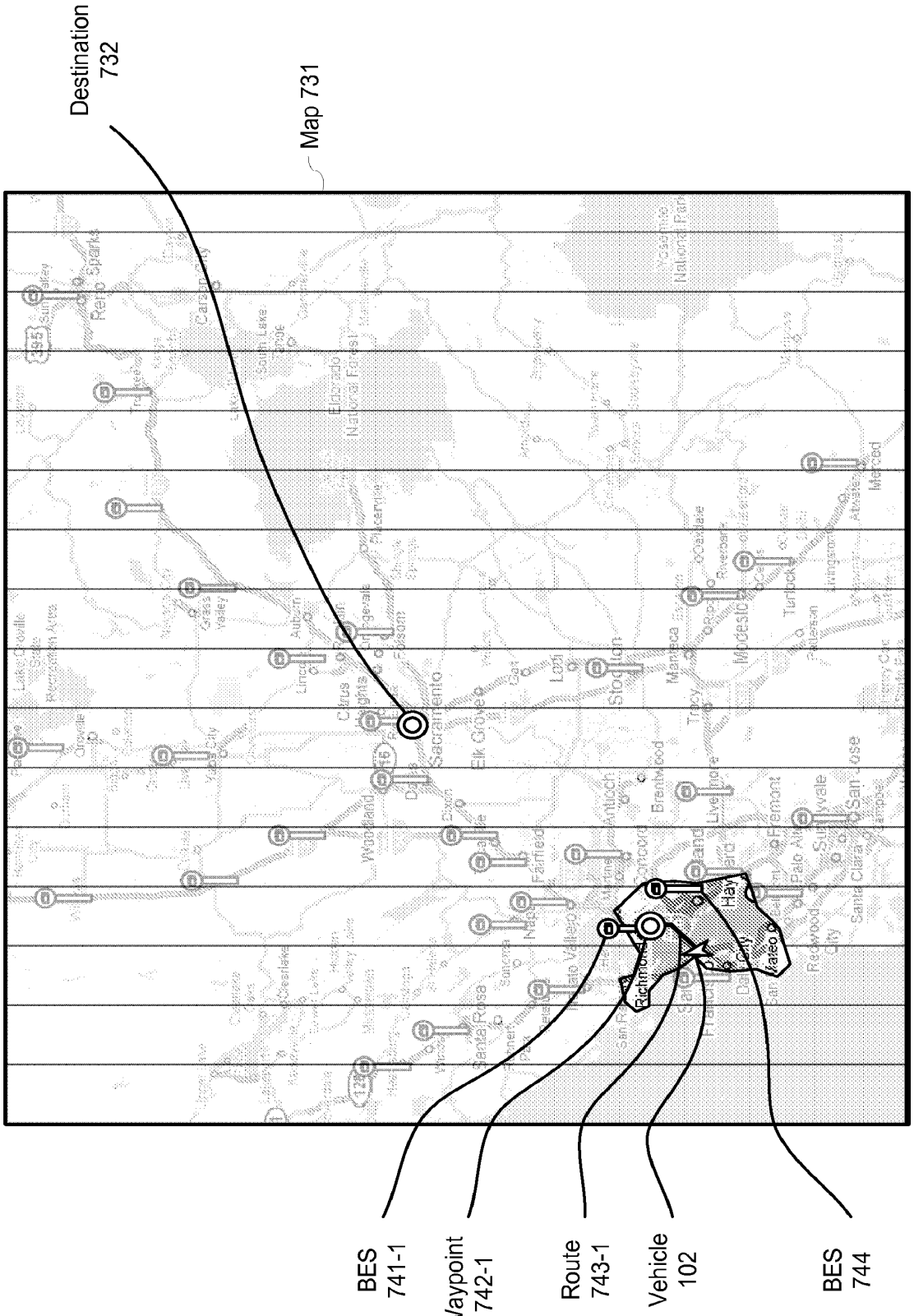

Destination
732
Map 731
BES
741-1
Waypoint
742-1
Route
743-1
Vehicle
102
BES
744

Figure 7E

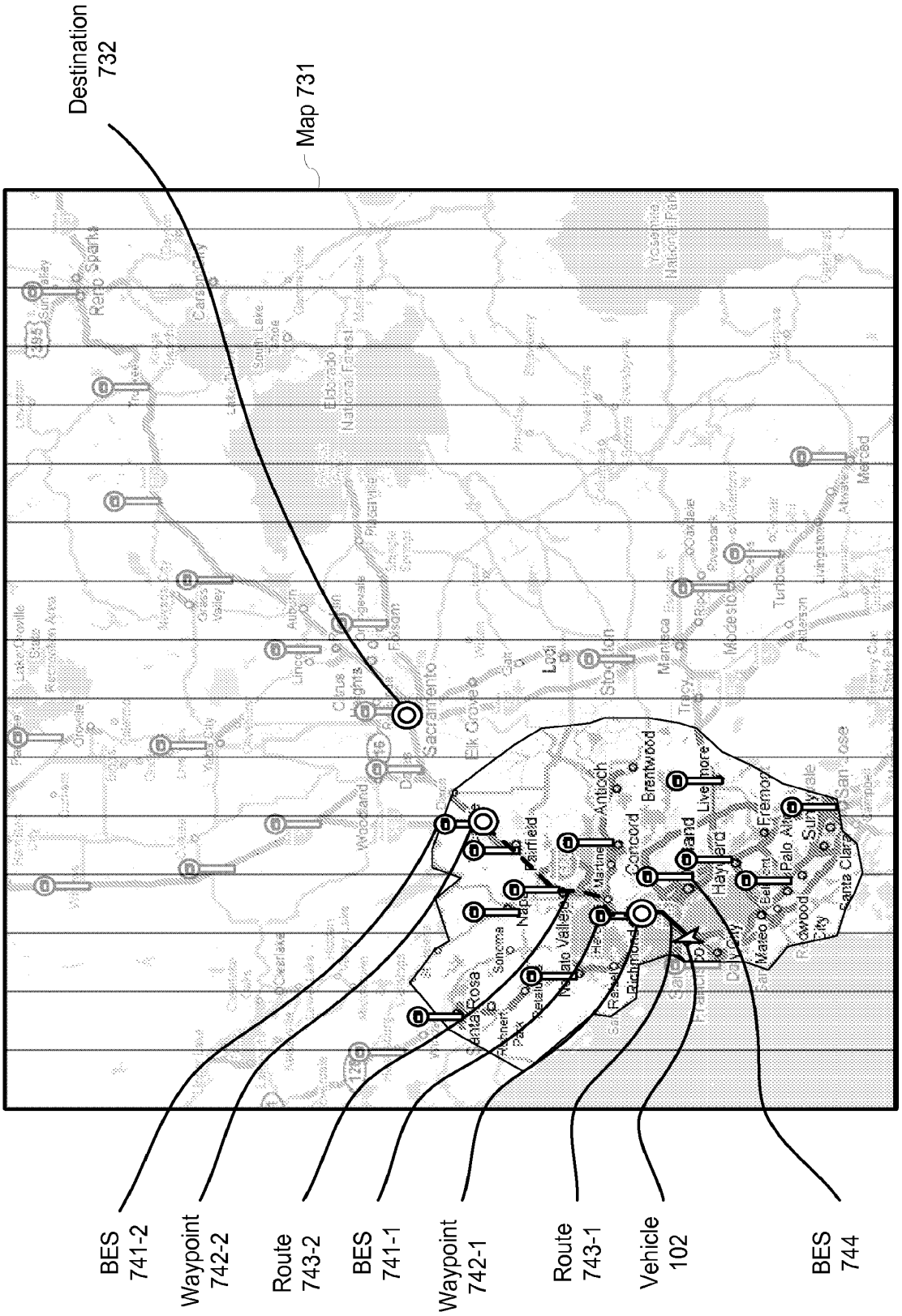

Destination
732
Map 731
BES
741-2
Waypoint
742-2
Route
743-2
BES
741-1
Waypoint
742-1
Route
743-1
Vehicle
102
BES
744

Figure 7F

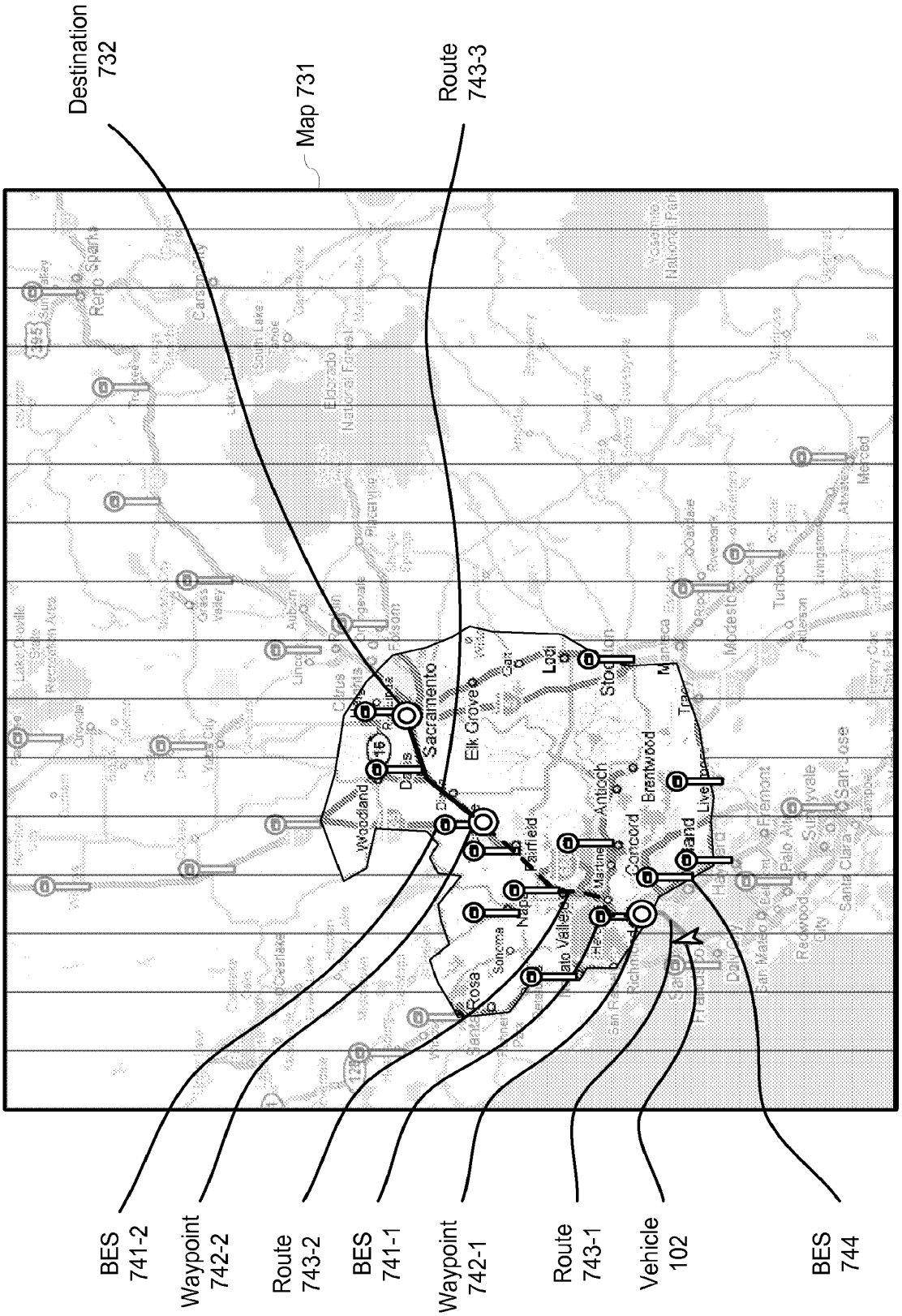

Destination 732
Map 731
Route 743-3
BES 741-2
Waypoint 742-2
Route 743-2
BES 741-1
Waypoint 742-1
Route 743-1
Vehicle 102
BES 744
Sacramento
Elk Grove
Lodi
Woodland
Davis
Fairfield
Napa
Vallejo
Concord
Antioch
Brentwood
Oakland
Livermore
Modesto
Tracy
Merced
San Jose
Santa Rosa
Sonoma

Figure 7G

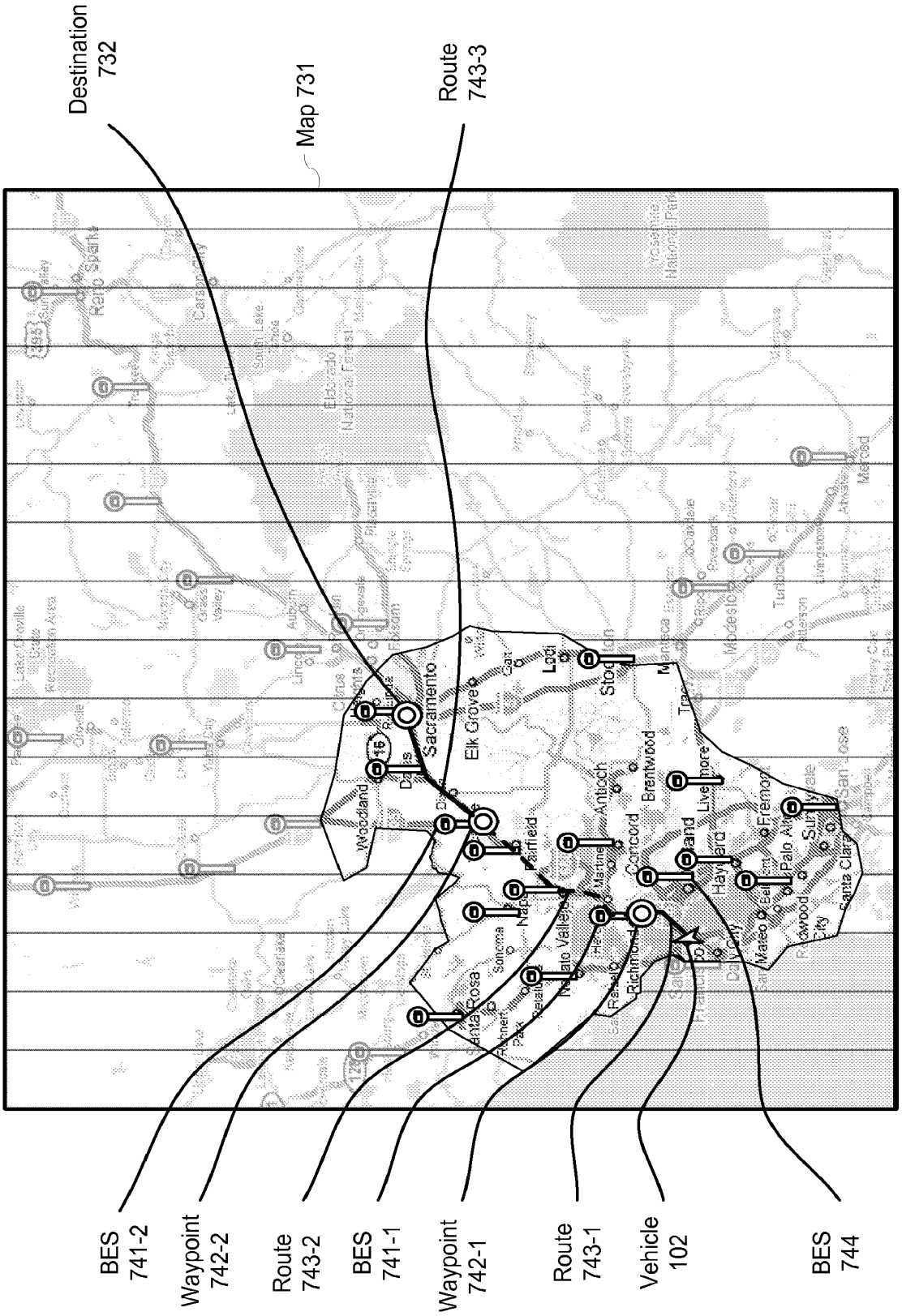

Destination 732
Map 731
Route 743-3
BES 741-2
Waypoint 742-2
Route 743-2
BES 741-1
Waypoint 742-1
Route 743-1
Vehicle 102
BES 744
Sacramento
Elk Grove
Lodi
Woodland
Davis
Fairfield
Antioch
Brentwood
Concord
Oakland
Livermore
Fremont
Hayward
Richmond
Napa
Santa Rosa
Vallejo
Modesto
Merced

Figure 7H

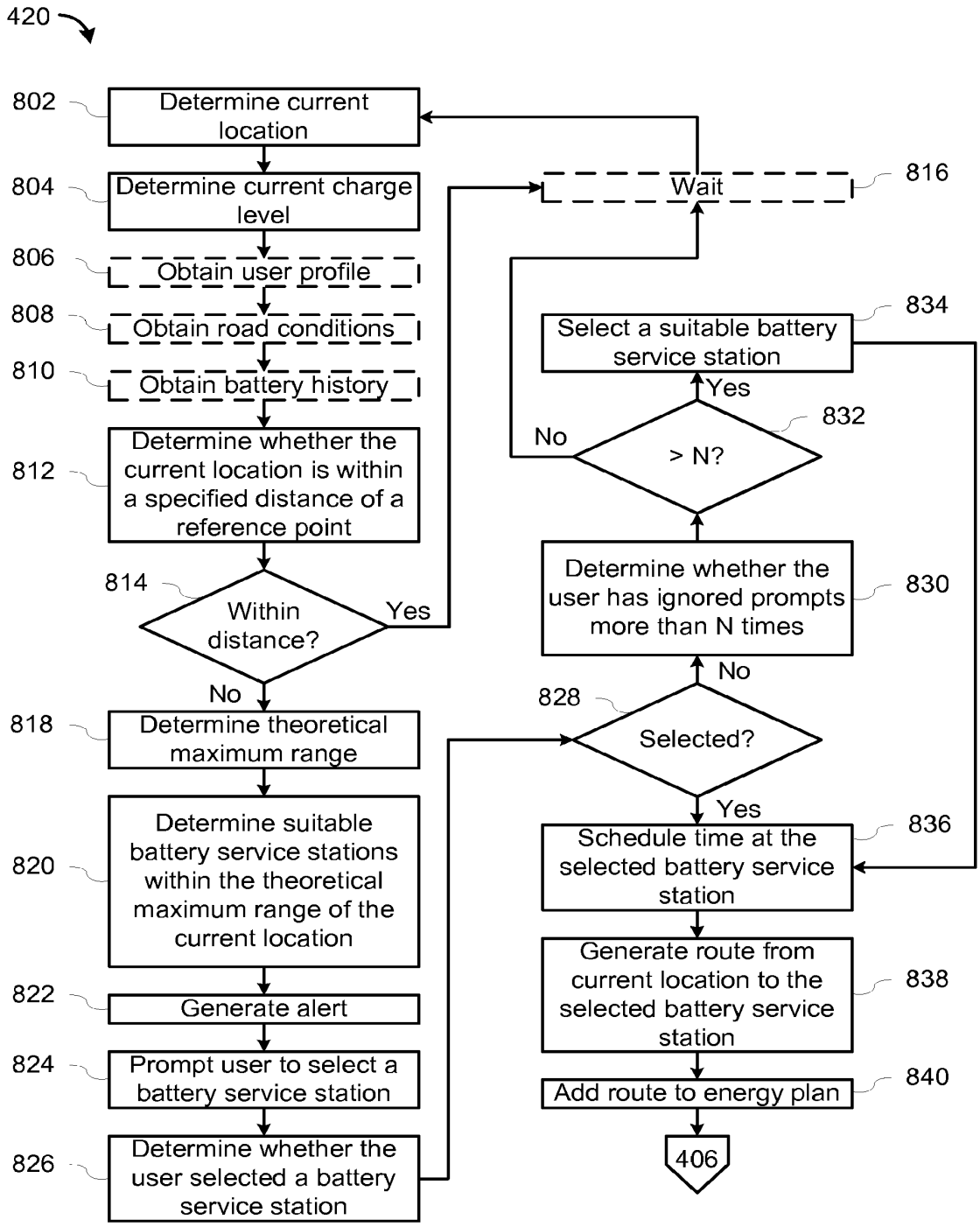

420
802
Determine current location
804
Determine current charge level
806
Obtain user profile
808
Obtain road conditions
810
Obtain battery history
812
Determine whether the current location is within a specified distance of a reference point
814
Within distance?
Yes
No
818
Determine theoretical maximum range
820
Determine suitable battery service stations within the theoretical maximum range of the current location
822
Generate alert
824
Prompt user to select a battery service station
826
Determine whether the user selected a battery service station
816
Wait
834
Select a suitable battery service station
832
> N?
Yes
No
830
Determine whether the user has ignored prompts more than N times
828
Selected?
No
Yes
836
Schedule time at the selected battery service station
838
Generate route from current location to the selected battery service station
840
Add route to energy plan
406

Figure 8

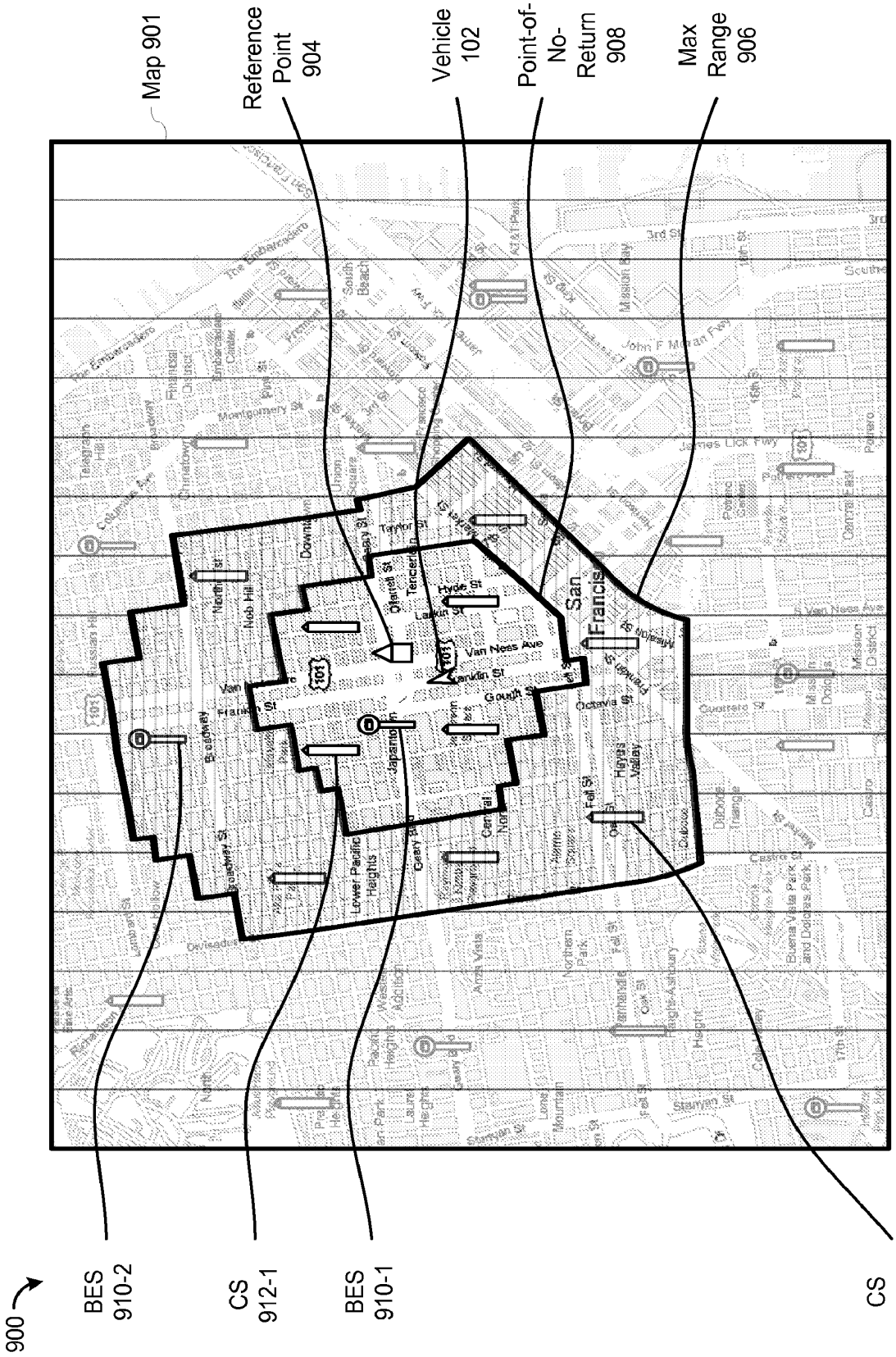

Map 901
Reference Point 904
Vehicle 102
Point-of-No-Return 908
Max Range 906
900
BES 910-2
CS 912-1
BES 910-1
CS 912-2

Figure 9

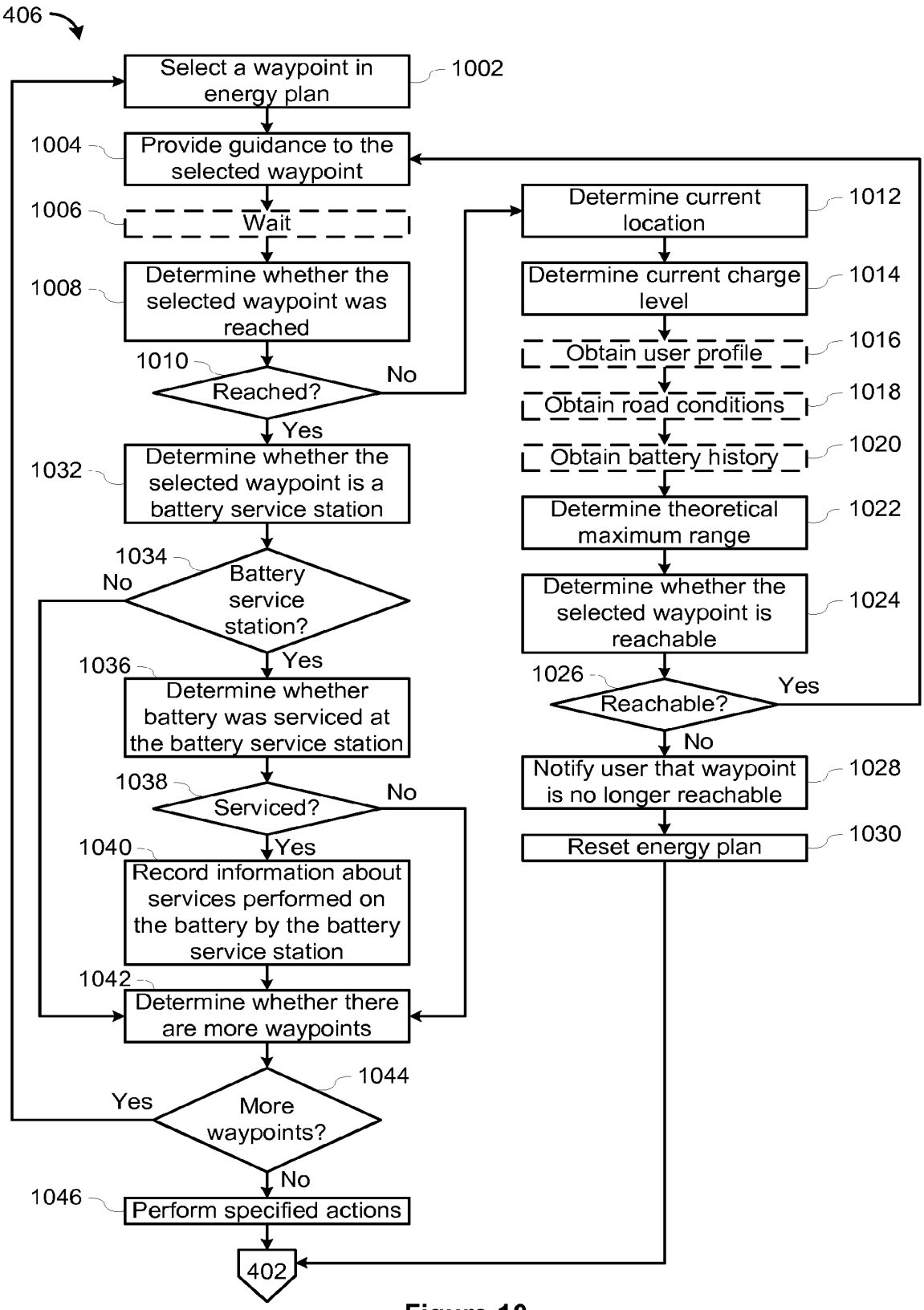


Figure 10

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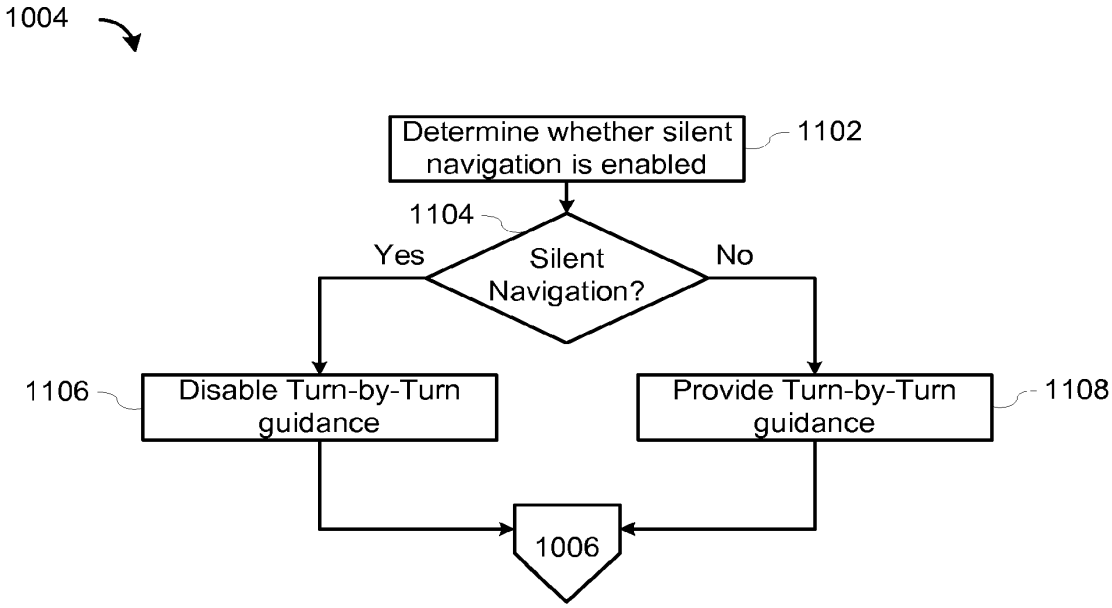

1004
Determine whether silent navigation is enabled
1102
1104
Silent Navigation?
Yes
No
1106
Disable Turn-by-Turn guidance
Provide Turn-by-Turn guidance
1108
1006

Figure 11

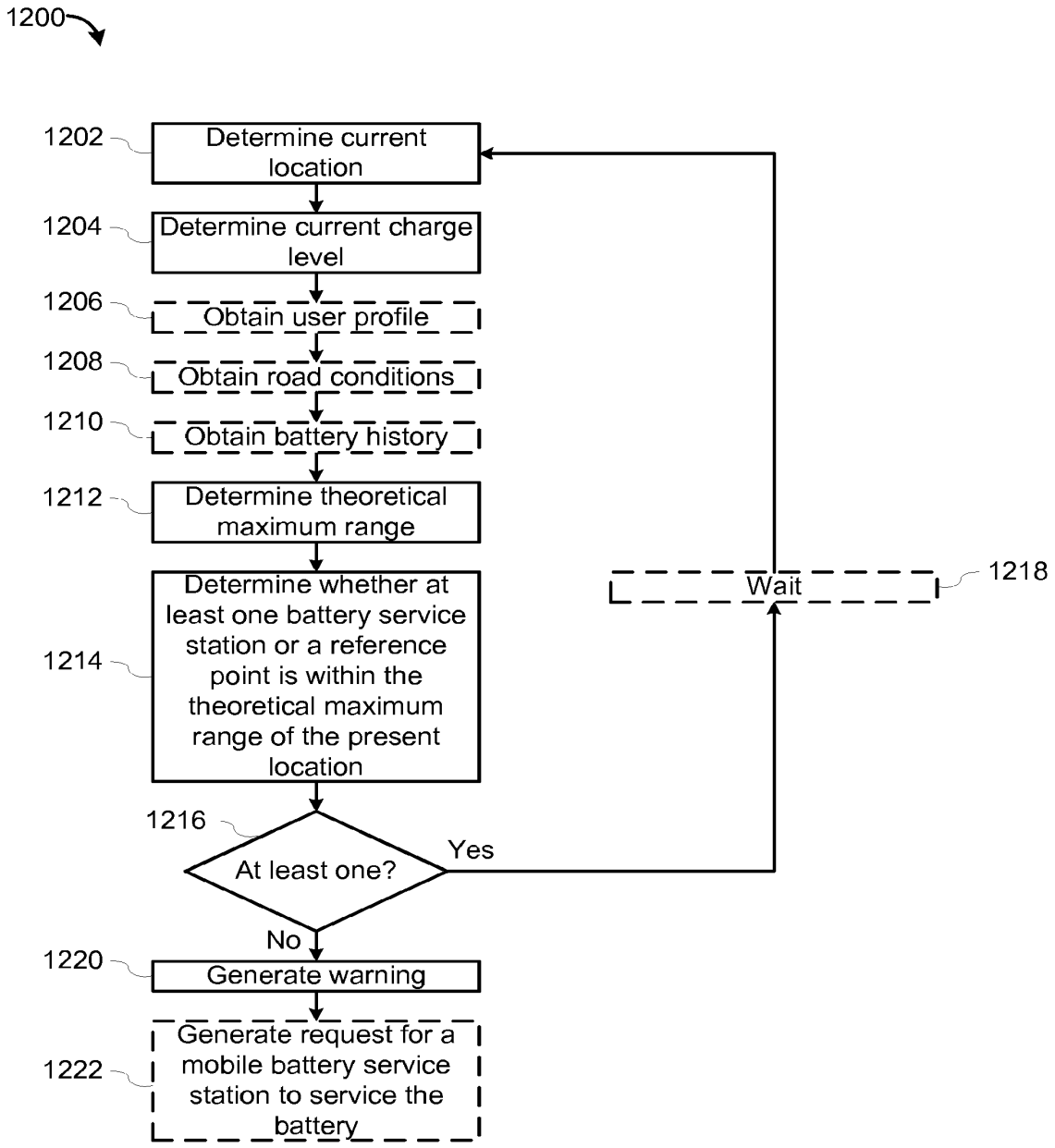

1200
1202
Determine current location
1204
Determine current charge level
1206
Obtain user profile
1208
Obtain road conditions
1210
Obtain battery history
1212
Determine theoretical maximum range
1214
Determine whether at least one battery service station or a reference point is within the theoretical maximum range of the present location
1216
At least one?
Yes
No
1218
Wait
1220
Generate warning
1222
Generate request for a mobile battery service station to service the battery

Figure 12

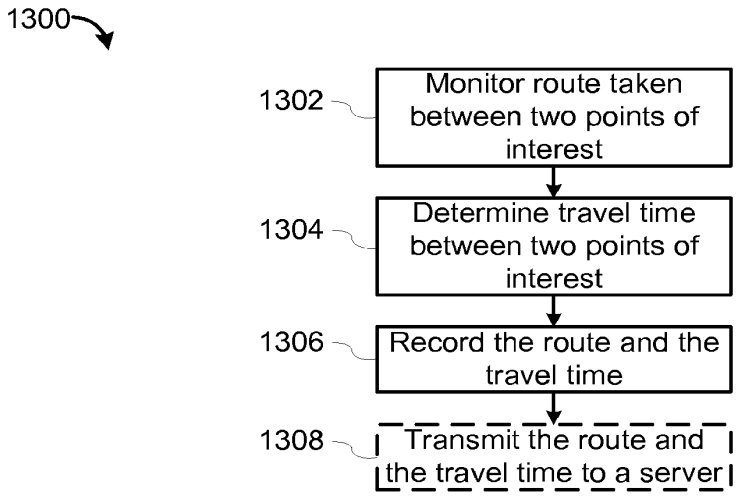


Figure 13

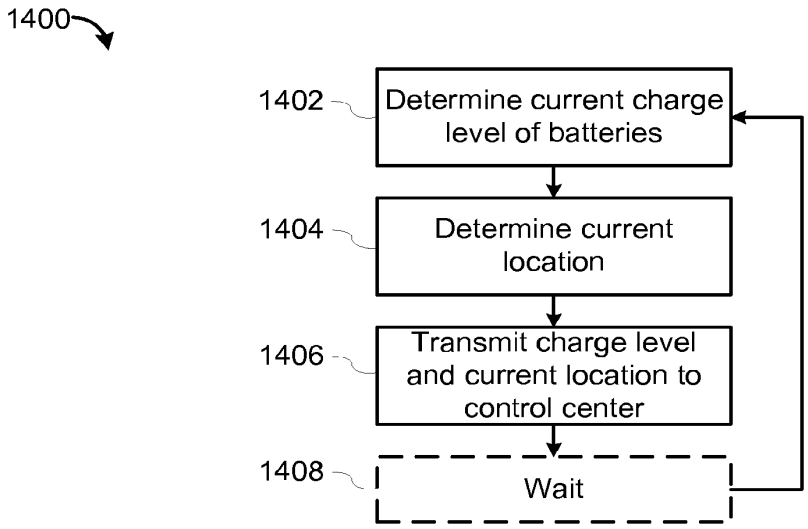


Figure 14

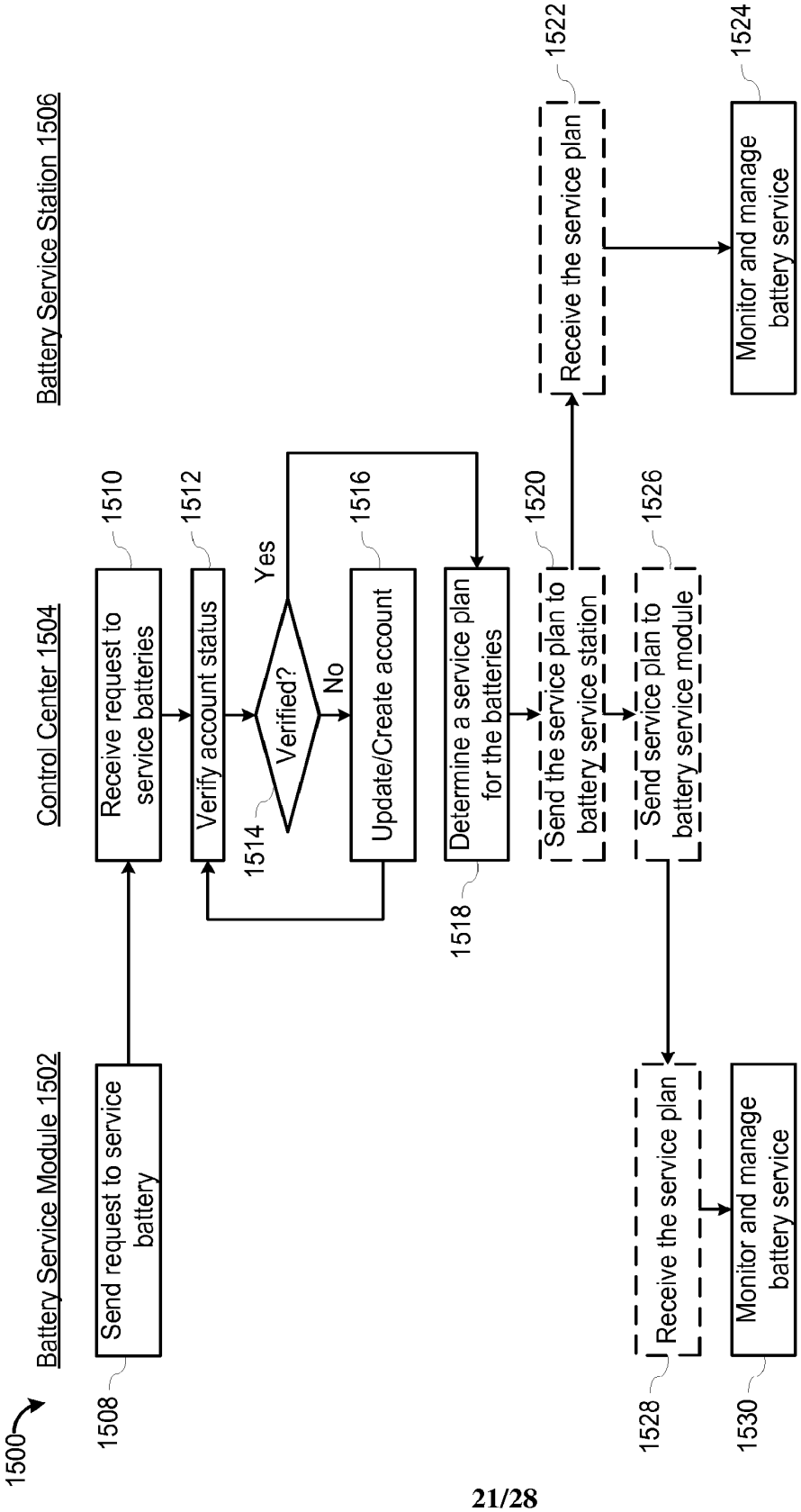

1500
Battery Service Module 1502
Control Center 1504
Battery Service Station 1506
Send request to service battery
1508
Receive request to service batteries
1510
Verify account status
1512
Verified?
1514
Yes
No
Update/Create account
1516
Determine a service plan for the batteries
1518
Send the service plan to battery service station
1520
Receive the service plan
1522
Monitor and manage battery service
1524
Send service plan to battery service module
1526
Receive the service plan
1528
Monitor and manage battery service
1530

Figure 15

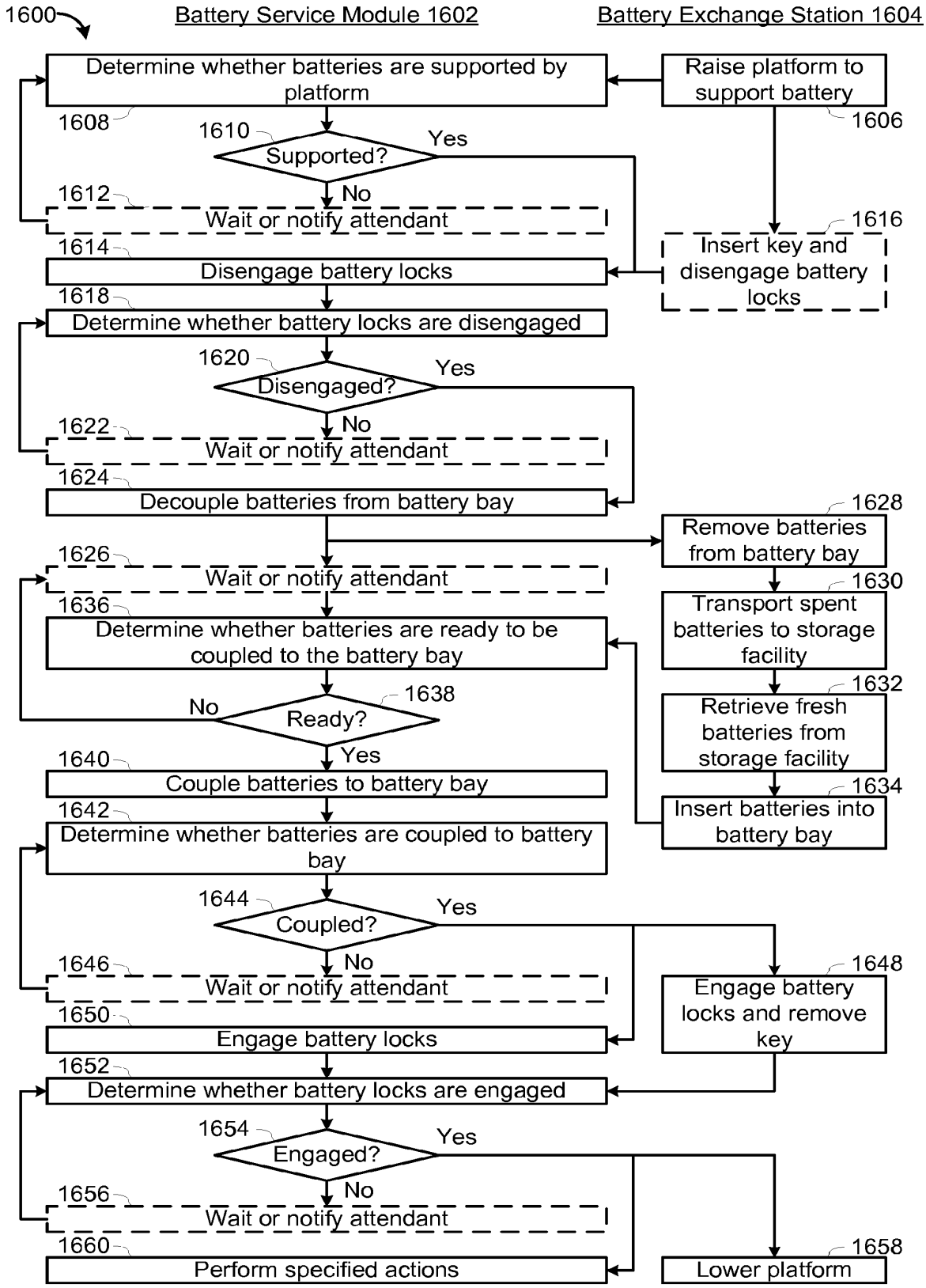

1600
Battery Service Module 1602
Battery Exchange Station 1604
Determine whether batteries are supported by platform
1608
1610
Supported?
Yes
No
1612
Wait or notify attendant
1614
Disengage battery locks
1618
Determine whether battery locks are disengaged
1620
Disengaged?
Yes
No
1622
Wait or notify attendant
1624
Decouple batteries from battery bay
1626
Wait or notify attendant
1636
Determine whether batteries are ready to be coupled to the battery bay
1638
No
Ready?
Yes
1640
Couple batteries to battery bay
1642
Determine whether batteries are coupled to battery bay
1644
Coupled?
Yes
No
1646
Wait or notify attendant
1650
Engage battery locks
1652
Determine whether battery locks are engaged
1654
Engaged?
Yes
No
1656
Wait or notify attendant
1660
Perform specified actions
Raise platform to support battery
1606
1616
Insert key and disengage battery locks
1628
Remove batteries from battery bay
1630
Transport spent batteries to storage facility
1632
Retrieve fresh batteries from storage facility
1634
Insert batteries into battery bay
1648
Engage battery locks and remove key
1658
Lower platform

Figure 16

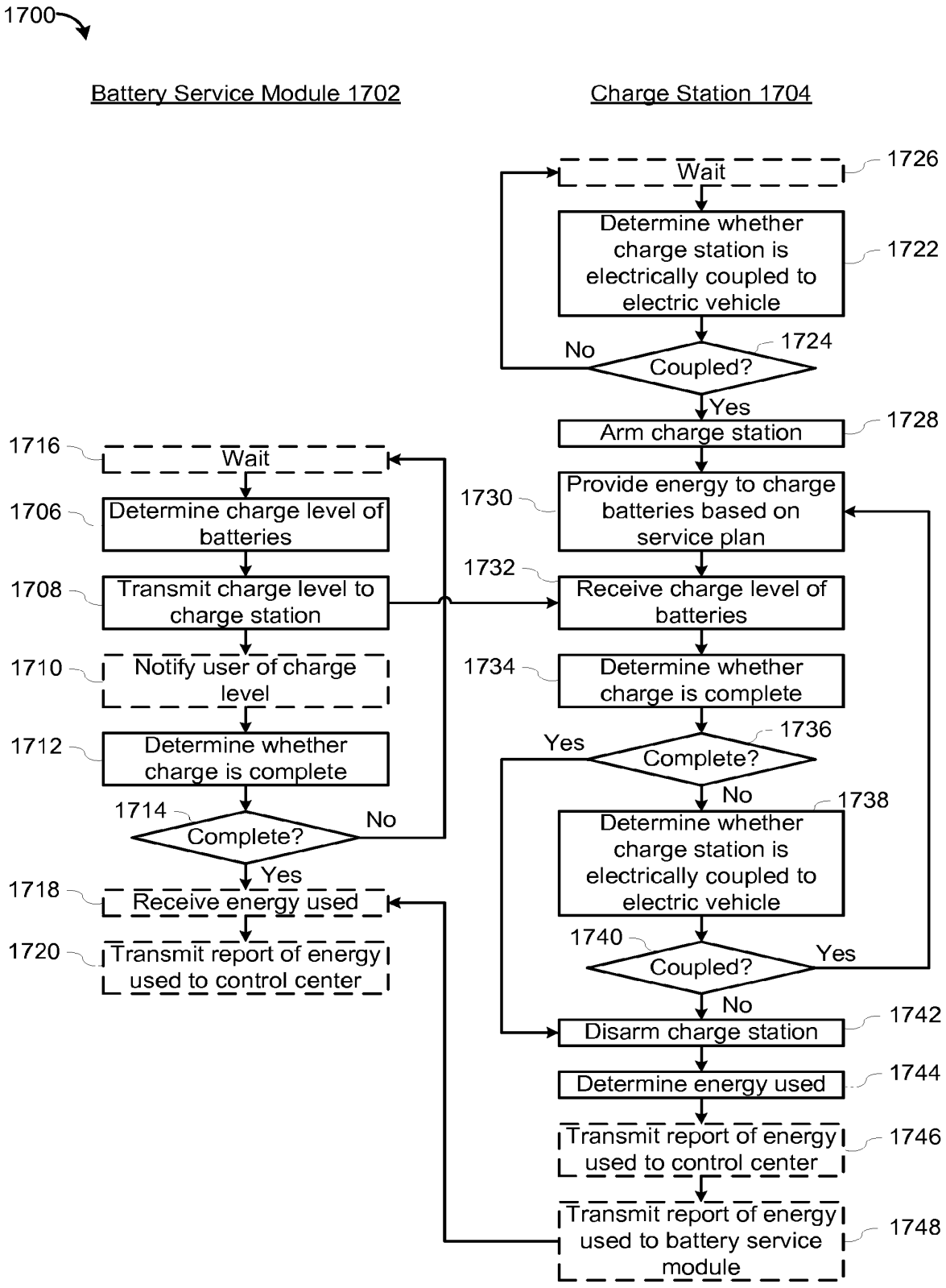

1700
Battery Service Module 1702
Charge Station 1704
Wait
1726
Determine whether charge station is electrically coupled to electric vehicle
1722
No
Coupled?
1724
Yes
Arm charge station
1728
1716
Wait
1706
Determine charge level of batteries
1730
Provide energy to charge batteries based on service plan
1708
Transmit charge level to charge station
1732
Receive charge level of batteries
1710
Notify user of charge level
1734
Determine whether charge is complete
1712
Determine whether charge is complete
Yes
Complete?
1736
1714
No
Complete?
No
1738
Determine whether charge station is electrically coupled to electric vehicle
Yes
1718
Receive energy used
1740
Coupled?
Yes
1720
Transmit report of energy used to control center
No
Disarm charge station
1742
Determine energy used
1744
Transmit report of energy used to control center
1746
Transmit report of energy used to battery service module
1748

Figure 17

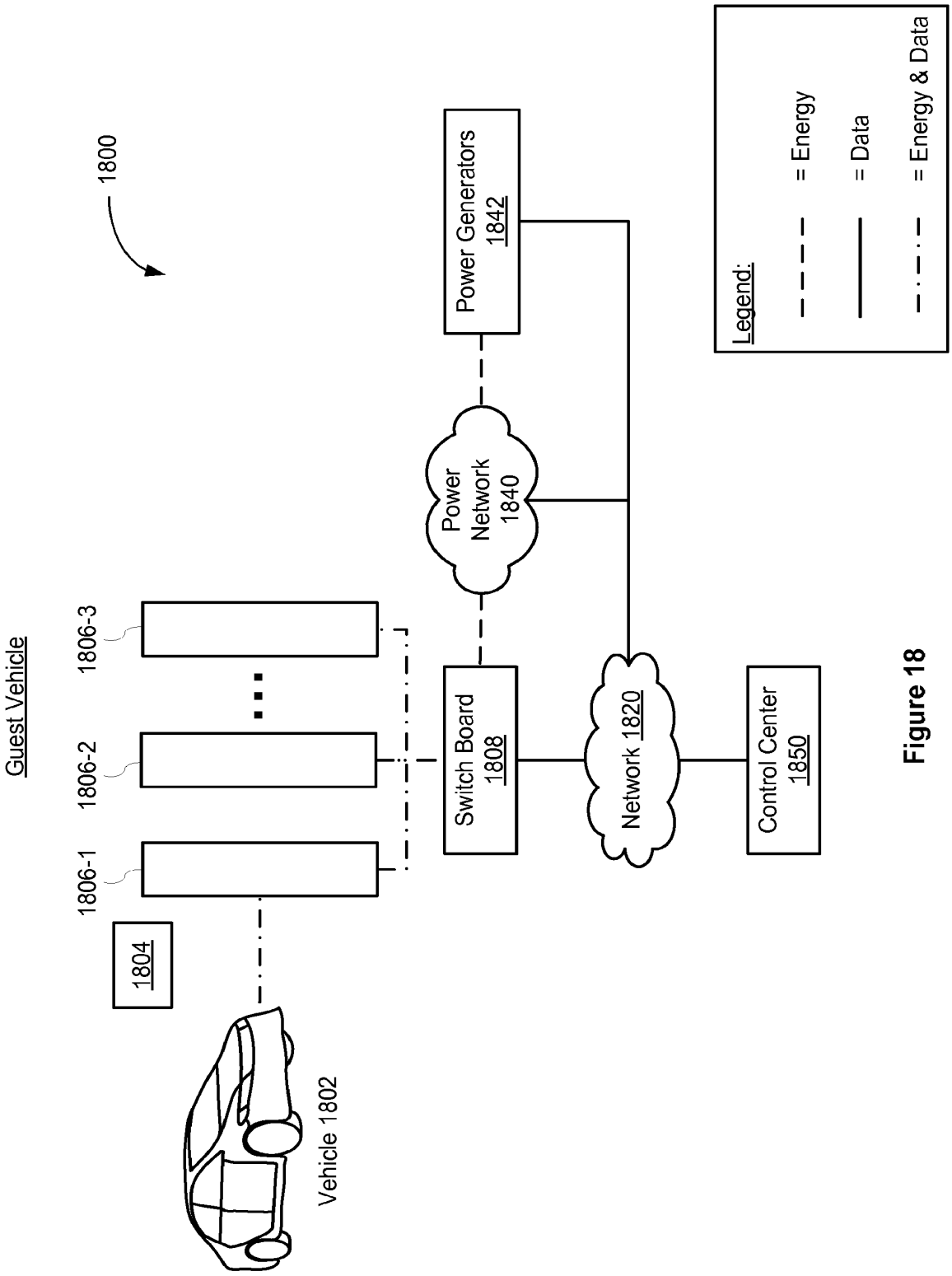

1800
Power Generators 1842
Legend:
= Energy
= Data
= Energy & Data
Power Network 1840
Guest Vehicle
1806-3
1806-2
1806-1
Switch Board 1808
Network 1820
Control Center 1850
1804
Vehicle 1802

Figure 18

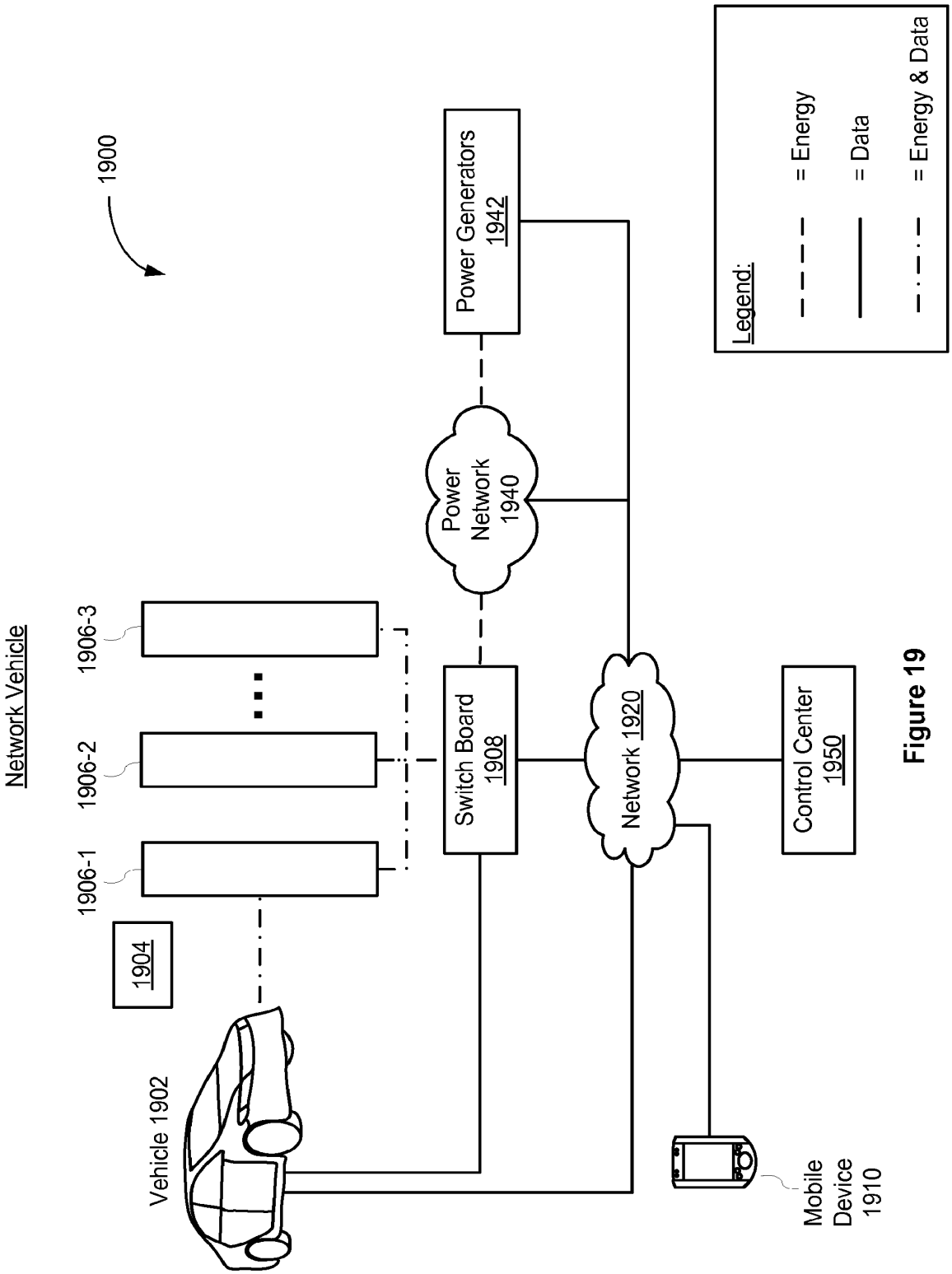

1900
Power Generators 1942
Legend:
= Energy
= Data
= Energy & Data
Power Network 1940
Network Vehicle
1906-3
1906-2
1906-1
1904
Switch Board 1908
Network 1920
Control Center 1950
Vehicle 1902
Mobile Device 1910

Figure 19

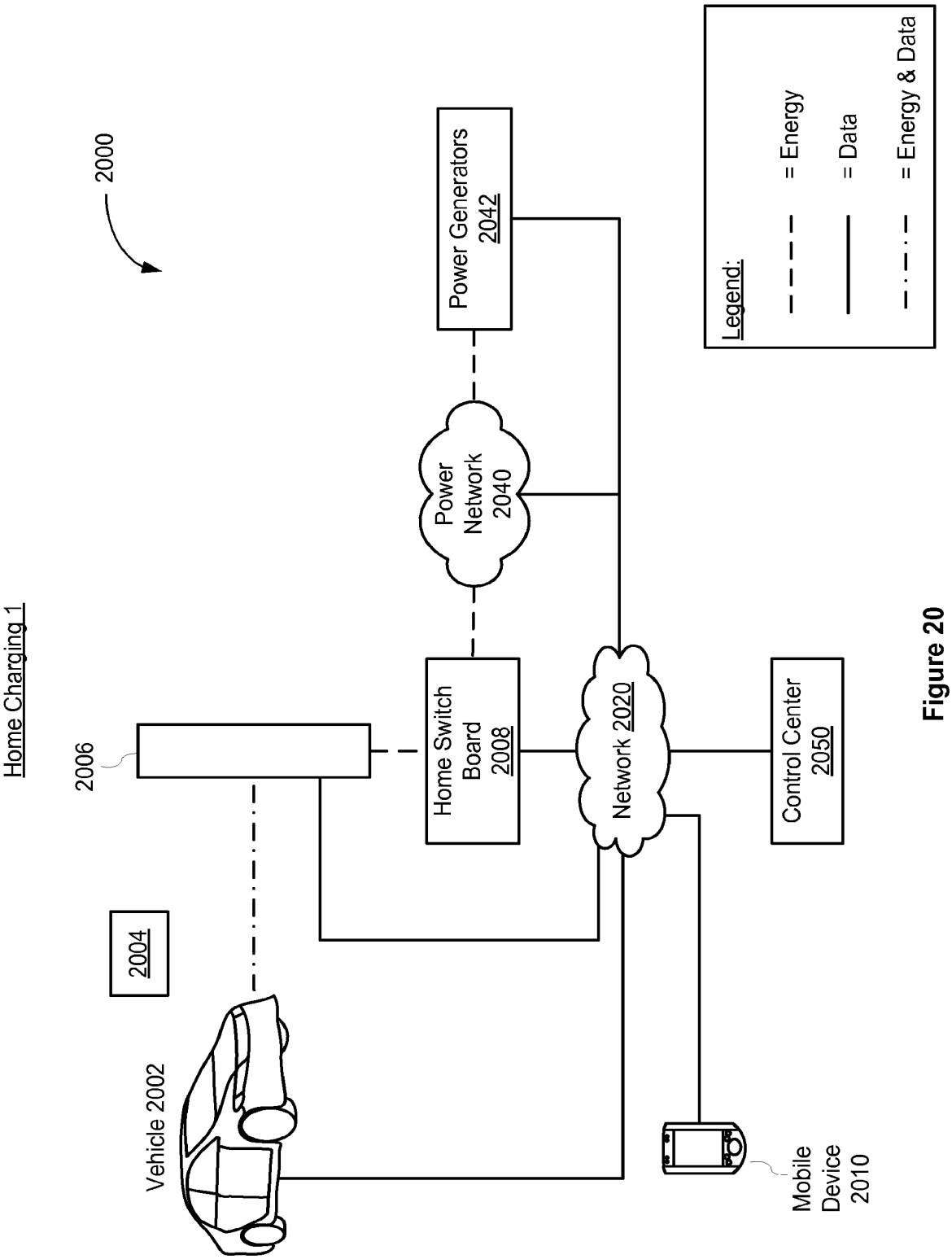

2000
Power Generators 2042
Legend:
= Energy
= Data
= Energy & Data
Power Network 2040
Home Charging 1
2006
Home Switch Board 2008
Network 2020
Control Center 2050
2004
Vehicle 2002
Mobile Device 2010

Figure 20

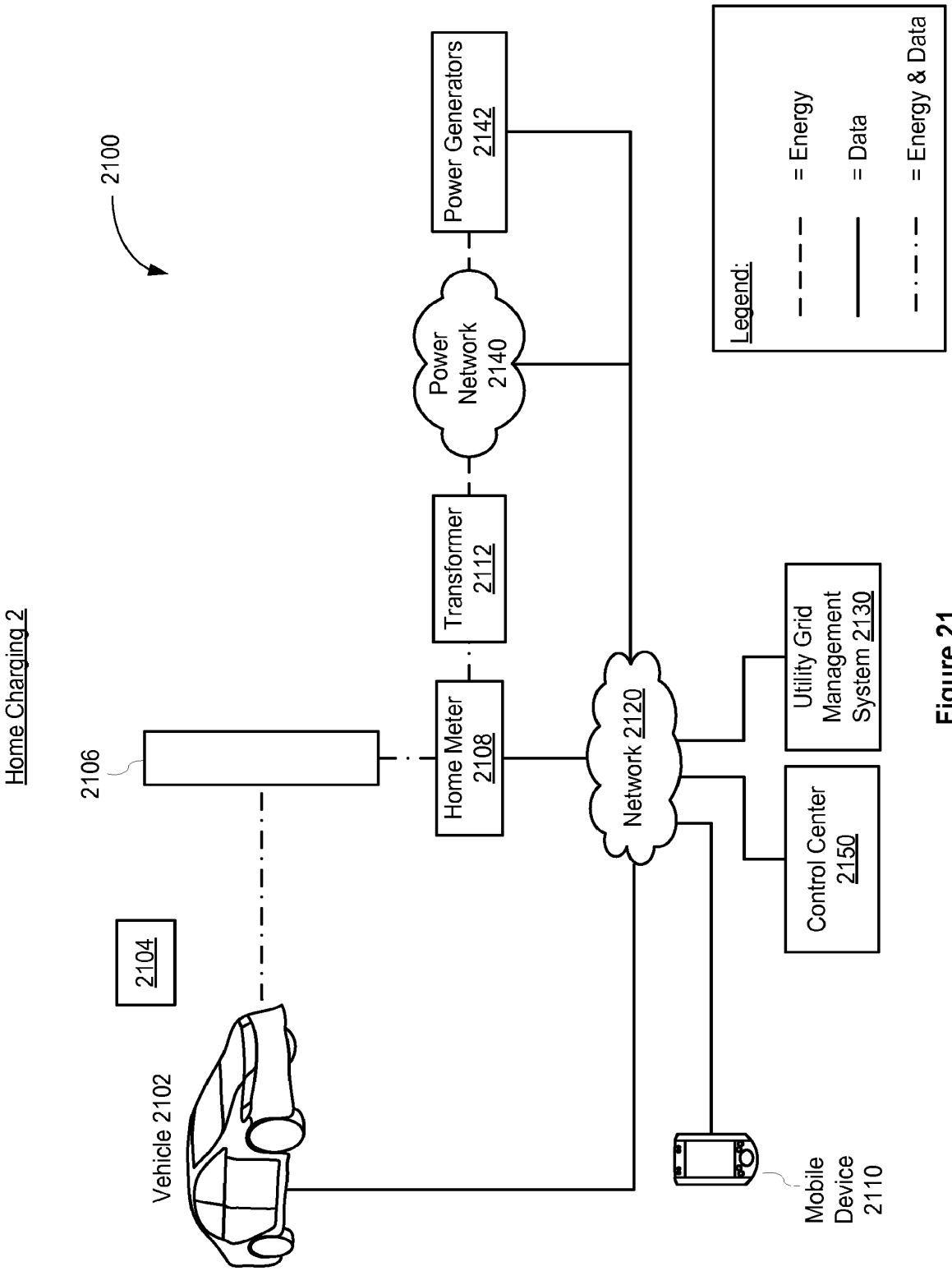

2100
Power Generators 2142
Power Network 2140
Transformer 2112
Home Meter 2108
Network 2120
Utility Grid Management System 2130
Control Center 2150
Home Charging 2
2106
2104
Vehicle 2102
Mobile Device 2110
Legend:
= Energy
= Data
= Energy & Data

Figure 21

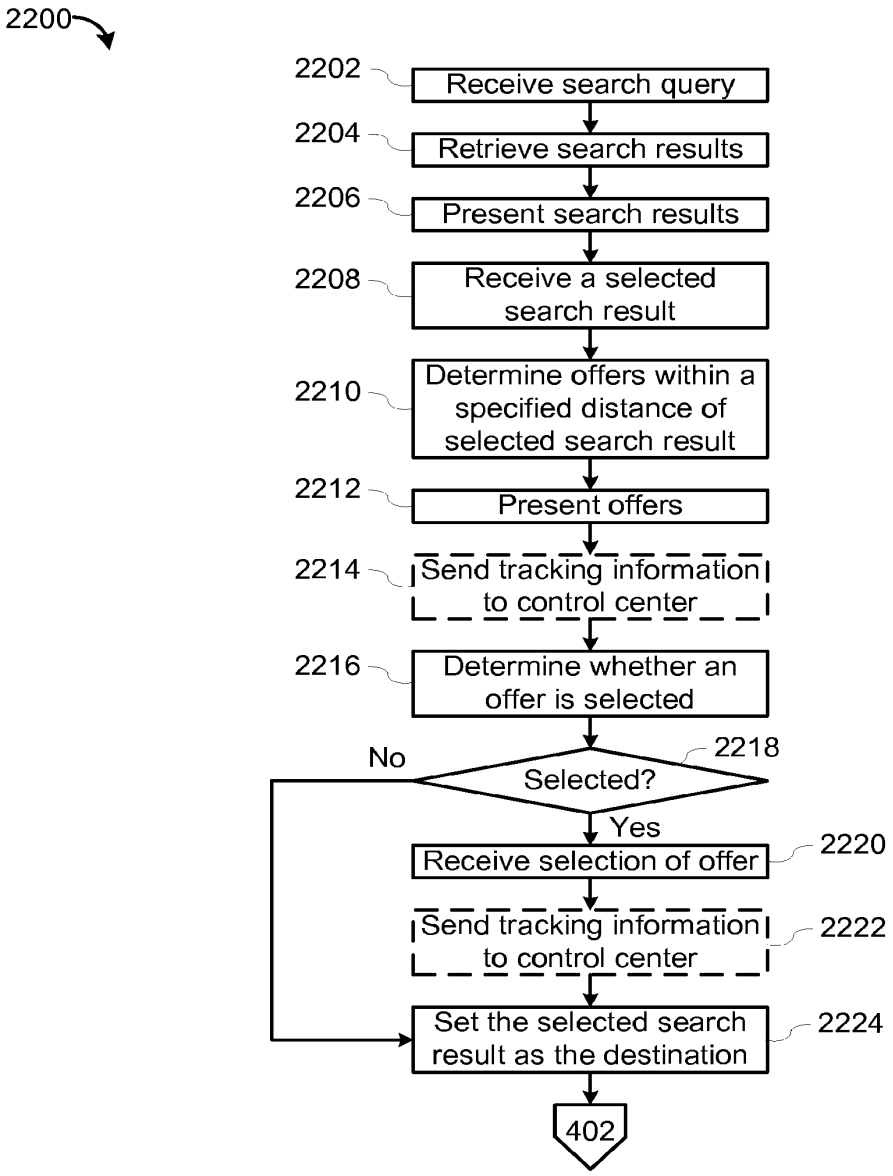


Figure 22

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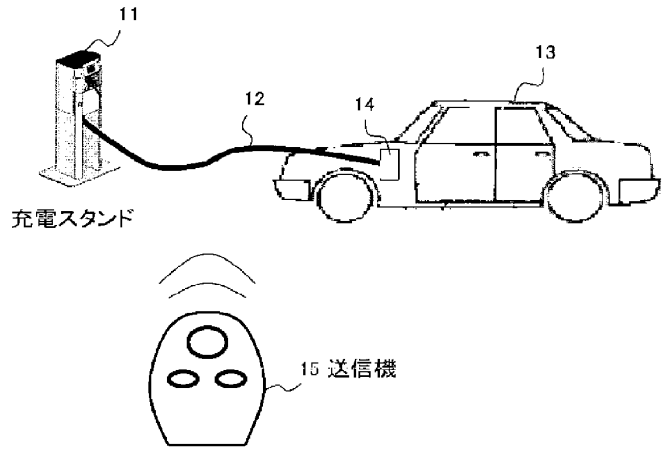
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[続葉有]

(54) **Title**: CHARGING DEVICE

(54) 発明の名称 : 充電装置

[図1]



11 CHARGING STAND
15 TRANSMITTER

(57) **Abstract**: Provided is a charging device for a vehicle, wherein easy authentication for the charging device is enabled. A transmitter has a function to transmit radio signals and can transmit with the radio signal an authentication code for locking or unlocking the doors of a vehicle, by manipulating a button on the face of the transmitter body. An authentication code is transmitted from the transmitter to a charging stand and registered, in advance. Thereafter, when using the charging stand, authentication can be performed by transmitting the authentication code from the transmitter by radio transmission.

(57) 要約: 車両用の充電装置に対する認証を簡易に行えるようにすることを目的とする。送信機は無線信号の送信機能を有し、本体表面のボタンを操作することで、車両のドアを施錠又は解錠するための認証コードを無線信号により車両に送信することができる。送信機から予め認証コードを充電スタンドに送信して登録しておく。そして、充電スタンドを使用するときに、送信機から認証コードを無線送信することで認証を行うことができる。

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添付公開書類:

— 国際調査報告（条約第 21 条(3)）

明　細　書

発明の名称 ： 充電装置

技術分野

[0001] 本発明は、車両用の充電装置に関する。

背景技術

[0002] 環境問題を考慮して電気自動車・プラグインハイブリッド自動車などが普及してきている。電気自動車が普及するためには、車両に搭載されているバッテリを充電するための充電設備が必要となる。

[0003] 個人の住宅などで使用する充電装置は外部の人が利用する可能性がないので、車両の認証を行う必要はない。しかしながら、不特定多数の人が利用する充電装置では、使用権限のある車両のみが充電を行えるようにするために認証が必要となる。例えば、会社で所有する車両の充電に使用される充電装置などでは、許可された車両以外の車両が充電できないように充電装置が認証機能を持つ必要がある。

[0004] 特許文献１には、車両側にＥＴＣカードの使用者特定情報を無線信号として送信する送信部を有し、充電装置側にその無線信号を受信して使用者を特定することが記載されている。

[0005] 特許文献２には、充電スタンドが、電動車両の識別情報記録担体に記録されている車両の識別情報を取得する情報取得手段を有し、取得した識別情報を予め登録されている登録情報と照合して充電スタンドの利用の認証を行うことが記載されている。

[0006] 上記の認証方法は、ＥＴＣカード、あるいは識別情報を記録した専用の担体を必要としている。

先行技術文献

特許文献

[0007] 特許文献1：特開２００７－２２８６９５号公報

特許文献2：特開２００８－６５６３５号公報

発明の開示

発明が解決しようとする課題

[0008] 本発明の課題は、車両用の充電装置に対する認証を専用の担体を必要とせず簡易に行えるようにする。

課題を解決するための手段

[0009] 本発明の車両用の充電装置は、車両のドアを施錠又は解錠するための無線信号の送信機能を有する無線通信装置から送信される無線信号を受信する受信手段と、前記受信手段で受信された無線信号に含まれる認証コードと、記憶手段に予め登録されている認証コードを照合して両者が一致するか否かを判定する判定手段と、前記判定手段により前記認証コードが不一致と判定されたときには、外部の車両への電力の供給を停止し、前記認証コードが一致すると判定されたときには、外部の車両へ電力を供給する電力供給手段とを備える。

[0010] この充電装置によれば、車両のドアを施錠又は解錠する無線信号を送信する無線通信装置を用いて、充電装置を利用するための認証を簡易に行うことができる。

[0011] 上記の充電装置において、認証ために前記無線通信装置から前記充電装置に送信される前記認証コードは、前記車両のドアを施錠又は解錠するためのコードである。

[0012] このように構成することで、車両のドアを施錠又は解錠するためのコードを認証コードとして充電装置に送信することで、充電装置を利用するための認証を行うことができる。

発明の効果

[0013] 本発明によれば、車両用の充電装置を利用するための認証を専用の担体を必要とせず簡易に行うことができる。

図面の簡単な説明

[0014] [図1]実施の形態の充電システムの構成を示す図である。

[図2]充電スタンドと送信機の構成を示す図である。

[図3]認証コードの登録処理のフローチャートである。

[図4]認証コードの照合処理のフローチャートである。

発明を実施するための形態

[0015] 以下、実施の形態について図面を参照して説明する。図１は、実施の形態の電気自動車（又はプラグインハイブリッド自動車など）の充電システムの構成を示す図である。

[0016] 充電スタンド（充電装置）１１は、交流電源に接続されており、充電ケーブル１２を介して車両１３のバッテリを充電するための電力を供給する。車両１３の側面には充電ケーブル１２の先端のプラグを挿入する挿入口１４が設けられている。

[0017] 送信機（無線キーなど）１５は無線信号の送信機能を有し、本体表面のボタンを操作することで、車両１３のドアを施錠又は解錠するため、あるいはトランクを開けるための認証コードを無線信号として送信することができる。

[0018] 車両１３は無線受信機を有しており、送信機１５から送信される無線信号を受信し、受信した認証コードを予め設定されている認証コードと照合して一致するか否かを判定する。認証コードが一致した場合には、ドアを施錠又は解錠する。

[0019] この実施の形態では、送信機１５から予め認証コードを充電スタンド１１に送信して登録しておく。そして、送信機１５から充電スタンド１１に認証コードを無線送信することで簡易に認証を行うことができる。

[0020] 図２（Ａ）は充電スタンド１１の構成を示す図であり、図２（Ｂ）は送信機１５の構成を示す図である。

[0021] 図２（Ａ）において、アンテナ２１で受信された無線信号は、受信回路２２で復調され制御回路２３に出力される。メモリ２４には、登録された１又は複数の車両１３の認証コードが記憶されている。認証コードは、例えば、車両１３のドアを解錠又は施錠するために送信機１５から送信されるコード

である。

[0022] 制御回路（例えば，ＣＰＵ）２３は、受信回路２２から出力される信号をデジタルデータに変換し、変換したデジタルデータとメモリ２４に記憶されている認証コードを比較する。一致する認証コードが登録されている場合には、電力供給回路２５をオフ状態からオン状態に切り換え、交流電圧を車両１３に供給する。電力供給回路２５は、例えば、スイッチで実現できる。なお、受信回路２２がＡ／Ｄ変換器を有し、アナログ信号をデジタルデータに変換して制御回路２３に出力しても良い。

[0023] 内部電源回路２６は、交流電圧２７を所望の直流電圧に変換して回路各部に供給する。

[0024] 図２（Ｂ）に示す送信機１５は、３個のスイッチＳＷ１～ＳＷ３、制御回路３１、送信回路３２、アンテナ３３、メモリ３４、電池３５を有する。

[0025] スイッチＳＷ１～ＳＷ３は、一端が電池３５の電源端子（又は接地）に接続され、他端が制御回路３１の入力端子に接続されている。スイッチＳＷ１～ＳＷ３は、例えば、車両１３のドアを解錠するためのコード、施錠するためのコード、トランクを開けるためのコード等を無線送信するためのスイッチである。メモリ３４には、スイッチＳＷ１～ＳＷ３に対応する認証コードが記憶されている。

[0026] 制御回路３１は、スイッチＳＷ１～ＳＷ３の内の何れのスイッチが操作されたかを判定し、操作されたスイッチＳＷ１～ＳＷ３に対応する認証コードをメモリ３４から読み出し、読み出した認証コードを送信回路３２に出力する。

[0027] 送信回路３２は、認証コードで搬送波を変調しこれを増幅して、無線信号としてアンテナ３３から外部に送信する。電池３５は、送信機１５の回路各部に供給する電圧を出力する。

[0028] 次に、充電スタンド１１に車両１３の認証コードを登録するときの処理を図３のフローチャートを参照して説明する。

[0029] 充電スタンド１１の制御回路２３は、登録ボタンが押下されたか否かを判

定する（Ｓ１１）。登録ボタンが押下されたのを検出するまでステップＳ１１の処理を繰り返す。

[0030] 利用者は、登録ボタンを操作した後、送信機１５のボタンを操作して登録する認証コードを無線送信する（Ｓ１２）。

[0031] 充電スタンド１１の制御回路２３は、認証コードを受信したか否かを判定する（Ｓ１３）。認証コードを受信するまでステップＳ１３の処理を繰り返す。

[0032] 認証コードを受信した場合には（Ｓ１３、受信）、ステップＳ１４に進み、受信した認証コードを充電が許可された車両１３の認証コードとして登録する。

[0033] 上記の処理を車両１３の利用者がそれぞれ行うことで、各車両１３の認証コードを充電スタンド１１に登録することができる。

[0034] 次に、認証コードの登録を行った後の認証コードの照合処理について、図４のフローチャートを参照して説明する。

[0035] 充電スタンド１１の制御回路２３は、送信機１５から認証コードを受信したか否かを判定する（Ｓ２１）。認証コードを受信するまでステップＳ２１の処理を繰り返す。

[0036] 認証コードを受信した場合には（Ｓ２１、受信）、ステップＳ２２に進み、受信した認証コードと、メモリ２４に記憶されている認証コードを順に照合する。

[0037] 次に、照合結果が合致したか否かを判定する（Ｓ２３）。ステップＳ２３の処理では、受信した認証コードと一致する認証コードがメモリ２４に登録されているか否かを判断する。

[0038] 照合結果が合致しない場合、つまり一致する認証コードがメモリ２４に登録されていない場合には（Ｓ２３、否）、ステップＳ２４に進み、認証エラーであることを通知する。

[0039] 他方、照合結果が合致した場合、つまり送信機１５から送信された認証コードと一致する認証コードがメモリ２４に登録されている場合には、その車

両は充電が許可された車両であるので、ステップＳ２５に進み、交流電力の供給を開始する。ステップＳ２５の処理では、制御回路２３が電力供給回路２５をオン状態に切り換え、交流電力が車両１３に供給されるようにする。

[0040] 上述した実施の形態によれば、車両１３のドアの解錠又は施錠を行う際に使用する送信機１５を用いて充電スタンド１１との間で簡易に認証を行うことができる。すなわち、特別な認証手段を使用せずに、車両１３のドアを解錠するための送信機１５を利用して認証を行うことができる。

[0041] 上述した実施の形態では、送信機１５のボタンを操作して認証コードを送信しているが、ボタンを操作しなくとも認証コードが送信されるようにしても良い。例えば、利用者が充電スタンド１１に近づき、充電スタンド１１と送信機１５との間で無線通信が可能となったとき、送信機１５から自動的に認証コードが送信されるようにしても良い。この場合、認証時にボタンを操作する必要が無くなるので、利用者は認証のための特別な操作を行わずに充電を行うことができる。

請求の範囲

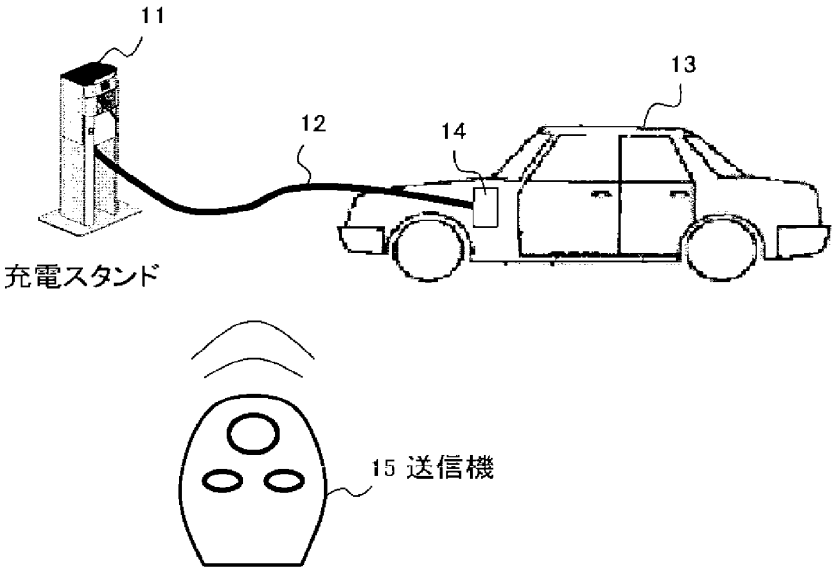
[請求項1] 車両のドアを施錠又は解錠するための無線信号の送信機能を有する無線通信装置から送信される前記無線信号を受信する受信手段と、

前記受信手段で受信された前記無線信号に含まれる認証コードと、記憶手段に予め登録されている認証コードを照合して両者が一致するか否かを判定する判定手段と、

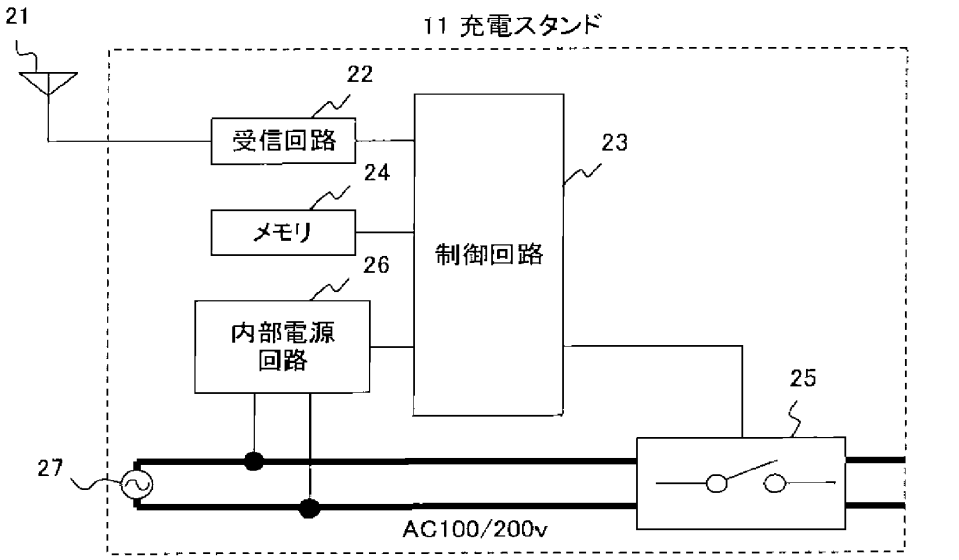
前記判定手段により前記認証コードが不一致と判定されたときには、外部の車両への電力の供給を停止し、前記認証コードが一致すると判定されたときには、外部の車両へ電力を供給する電力供給手段と、を備える車両用の充電装置。

[請求項2] 認証ために前記無線通信装置から前記車両用の充電装置に送信される前記認証コードは、前記車両のドアを施錠又は解錠するためのコードである請求項1記載の車両用の充電装置。

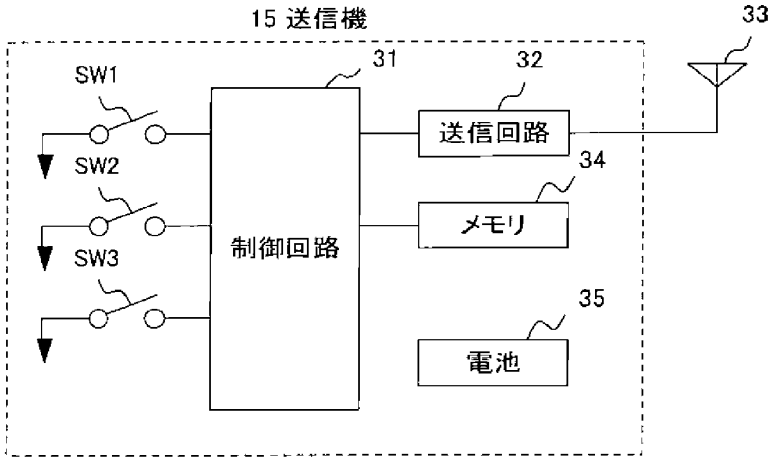
[図1]



[図2]

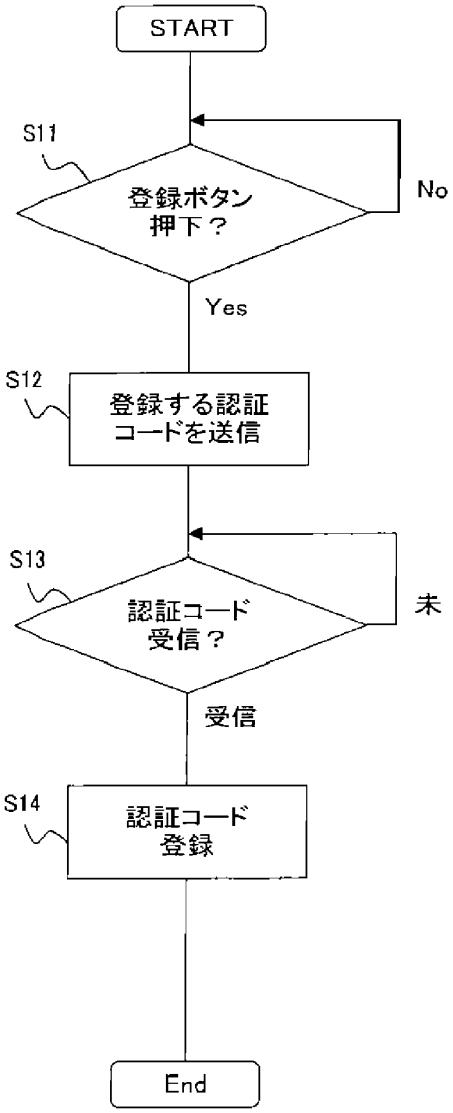

21
11 充電スタンド
22
受信回路
23
24
メモリ
制御回路
26
内部電源
回路
25
27
AC100/200v

(A)

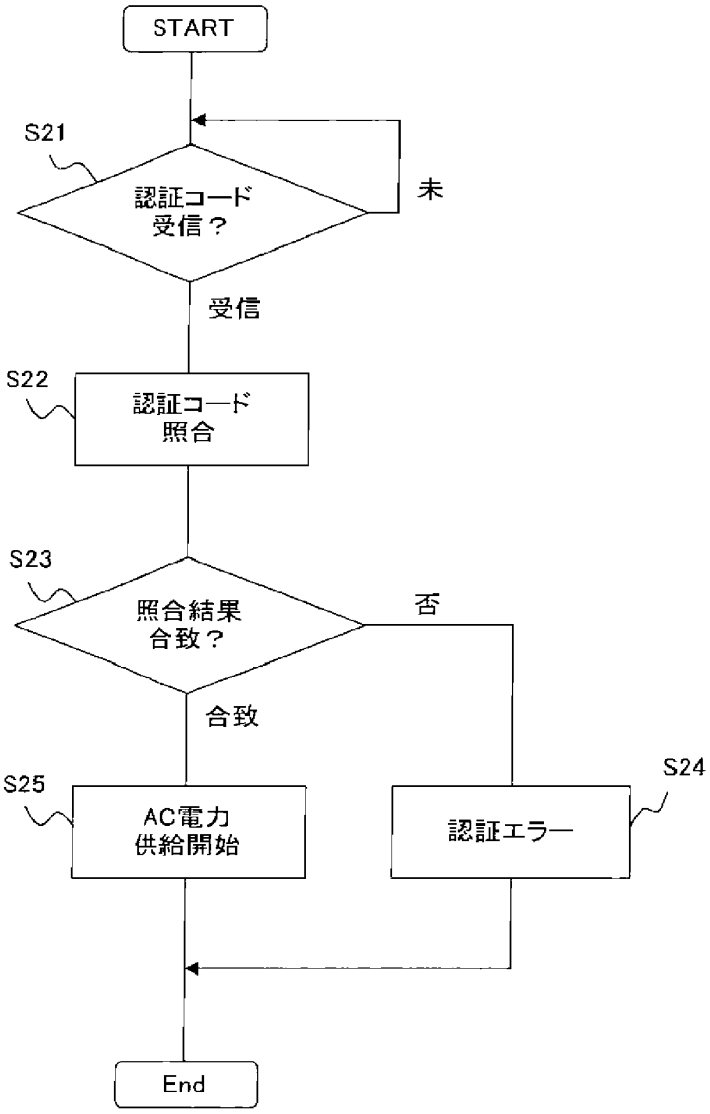

15 送信機
33
SW1
31
32
送信回路
SW2
34
メモリ
制御回路
SW3
35
電池

(B)

[図3]


START
S11
登録ボタン
押下？
No
Yes
S12
登録する認証
コードを送信
S13
認証コード
受信？
未
受信
S14
認証コード
登録
End

[図4]


START
S21
認証コード
受信？
未
受信
S22
認証コード
照合
S23
照合結果
合致？
否
合致
S25
AC電力
供給開始
S24
認証エラー
End

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/057686

A. CLASSIFICATION OF SUBJECT MATTER
H02J7/00(2006.01)i, *B60L11/18*(2006.01)i, *B60R25/00*(2006.01)i, *H01M10/44*(2006.01)i, *H02J7/02*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02J7/00, B60L11/18, B60R25/00, H01M10/44, H02J7/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2007-252016 A (Toyota Motor Corp.), 27 September 2007 (27.09.2007), claim 6; paragraphs [0068], [0069]; fig. 4 & US 2009/0043450 A1 & EP 1995109 A1 & WO 2007/105579 A1 & KR 10-2008-0102290 A & CN 101400542 A	1,2
A	JP 2009-100608 A (Nippon Yusoki Co., Ltd.), 07 May 2009 (07.05.2009), claim 1 (Family: none)	1,2

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

☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 July, 2010 (22.07.10)	03 August, 2010 (03.08.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

国際調査報告	国際出願番号　ＰＣＴ／ＪＰ２０１０／０５７６８６

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H02J7/00(2006.01)i, B60L11/18(2006.01)i, B60R25/00(2006.01)i, H01M10/44(2006.01)i, H02J7/02(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H02J7/00, B60L11/18, B60R25/00, H01M10/44, H02J7/02

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１０年
日本国実用新案登録公報	１９９６－２０１０年
日本国登録実用新案公報	１９９４－２０１０年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
X	JP 2007-252016 A（トヨタ自動車株式会社）2007.09.27,　【請求項６】【００６８】【００６９】【図４】& US 2009/0043450 A1 & EP 1995109 A1 & WO 2007/105579 A1 & KR 10-2008-0102290 A & CN 101400542 A	1,2
A	JP 2009-100608 A（日本輸送機株式会社）2009.05.07,　【請求項１】（ファミリーなし）	1,2

☐　Ｃ欄の続きにも文献が列挙されている。　　☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
２２．０７．２０１０	０３．０８．２０１０

国際調査機関の名称及びあて先	特許庁審査官（権限のある職員）	５Ｔ	３９８６
日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	石川　晃 電話番号　０３－３５８１－１１０１　内線　３５６８		

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２００９年７月）

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(74) Agent: **REINHOLD COHN & PARTNERS**; P.O.B. 13239, Tel Aviv 61131 (IL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: MULTI-MOTOR LATCH ASSEMBLY

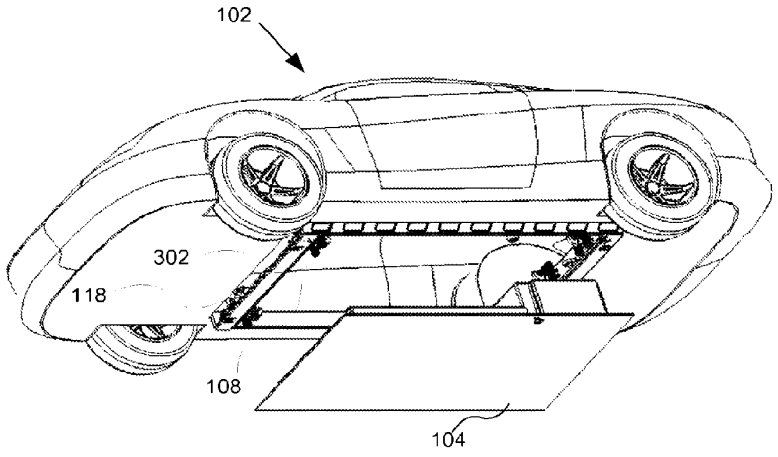


FIG. 3B

(57) Abstract: A method for securing and releasing a battery pack (104) from a battery bay (108) of an at least partially electric vehicle (102) is disclosed. The battery bay (108) includes multiple latching units each separately controllable and have a latch configured to couple to the battery pack (104). The method includes actuating each of the latching units to rotate its respective latch to engage or disengage with the battery pack (104). The method includes measuring a position of each respective latch of the latching units; and individually controlling each of the latching units based on the position of its respective latch to synchronize the positions of all latches.

WO 2012/160407 A1

Multi-Motor Latch Assembly

TECHNICAL FIELD

[0001] The disclosed embodiments relate generally to electric vehicles with removable battery packs. In particular, the disclosed embodiments relate to an electric vehicle battery pack and battery bay, and related mechanisms for insertion, removal, and locking of the battery pack in the battery bay of the electric vehicle.

BACKGROUND

[0002] The vehicle (*e.g.*, cars, trucks, planes, boats, motorcycles, autonomous vehicles, robots, forklift trucks *etc.*) is an integral part of the modern economy. Unfortunately, fossil fuels, like oil which is typically used to power such vehicles, have numerous drawbacks including: a dependence on limited foreign sources of fossil fuels; these foreign sources are often in volatile geographic locations; and such fuels produce pollution and climate change. One way to address these problems is to increase the fuel economy of these vehicles. Recently, gasoline-electric hybrid vehicles have been introduced, which consume substantially less fuel than their traditional internal combustion counterparts, *i.e.*, they have better fuel economy. However, gasoline-electric hybrid vehicles do not eliminate the need for fossil fuels, as they still require an internal combustion engine in addition to the electric motor.

[0003] Another way to address this problem is to use renewable resource fuels such as bio-fuels. Bio-fuels, however, are currently expensive and years away from widespread commercial use.

[0004] Yet another way to address these problems is to use clean technologies, such as electric motors powered by fuel cells or batteries. However, many of these clean technologies are not yet practical. For example, fuel cell vehicles are still under development and are expensive. Batteries are costly and may add as much as 40% to the cost of a vehicle. Similarly, rechargeable battery technology has not advanced to the point where mass-produced and cost effective batteries can power electric vehicles for long distances. Present battery technology does not provide an energy density comparable to gasoline. Therefore, even on a typical fully charged electric vehicle battery, the electric vehicle may only be able

to travel about 40 miles before needing to be recharged, *i.e.*, for a given vehicle storage, the electric vehicles travel range is limited. Furthermore, batteries can take many hours to recharge. For example, batteries may need to be recharged overnight. As the charging time of a typical electric vehicle battery can last numerous hours and recharging may not be an option on a long journey, a viable "quick refuel" system and method for battery powered electric vehicles would be highly desirable.

SUMMARY

[0005] In order to overcome the above described drawbacks, a network of charge spots and battery exchange stations are deployed to provide the EV (electric vehicle) user with the ability to keep his or her vehicle charged and available for use at all times. Some embodiments provide a system and method to quickly exchange, a spent depleted (or substantially discharged) battery pack for a fully charged (or substantially fully charged) battery pack at a battery exchange station. The quick exchange is performed in a period of time significantly less than that required to recharge a battery. Thus, the long battery recharge time may no longer be relevant to a user of an electric vehicle who is traveling beyond the range of the battery.

[0006] Furthermore, the cost of the electric vehicle can be substantially reduced because the battery of the electric vehicle can be separated from the initial cost of the vehicle. For example, the battery can be owned by a party other than the user of the vehicle, such as a financial institution or a service provider. These concepts are explained in more detail in U.S. Patent Application No. 12/234,591, filed September 19, 2008, entitled Electronic Vehicle Network, incorporated herein by reference. Thus, the batteries may be treated as components of the electric recharge grid (ERG) infrastructure to be monetized over a long period of time, and not a part of the vehicle purchased by the consumer.

[0007] The following provides a detailed description of a system and method for swapping-out or replacing battery packs in electric vehicles. Some embodiments provide a description of the quick exchangeable battery packs attached to the vehicle.

[0008] Some embodiments provide a battery bay configured to be disposed at an underside of an at least partially electric vehicle. The battery bay includes a frame that defines a cavity configured to at least partially receive a battery pack therein. In some

embodiments, the frame of the battery bay forms part of the structure of the vehicle body and is not a separate component. The battery bay also includes at least one latch mechanism rotatably pivoted about an axis substantially parallel with a plane formed by an underside of the vehicle (and/or the surface on which the vehicle is configured to travel, *e.g.*, the road). The latch mechanism is configured to retain the battery pack at least partially within the cavity. In some embodiments, an additional latch is rotatably pivoted about an additional axis substantially parallel to and distinct from the first axis. In some embodiments, the axis and the additional axis are substantially perpendicular to a length of the vehicle.

[0009] In some embodiments, a transmission assembly is mechanically coupled to the latch and the additional latch, the transmission assembly is configured to simultaneously rotate the latch and the additional latch in rotational directions opposite to one another. In some embodiments, an electric motor is mechanically coupled to the frame for driving the transmission assembly. In some embodiments, the transmission assembly is configured to be driven by a rotation mechanism external to the vehicle.

[0010] Some embodiments provide a method of removing a battery pack from an underside of an at least partially electric vehicle. The method includes rotating a latch mechanism mechanically coupled to a vehicle so as to disengage contact between the latch and a battery pack disposed at an underside of at least partially electric vehicle. The battery pack is then translated away from the underside of the vehicle. In some embodiments, the method of removal involves, prior to the rotating, mechanically disengaging a first lock mechanism. In some embodiments, the method of removal involves, prior to the rotating, electronically disengaging a second lock mechanism. In some embodiments, the method of removal involves occurs in less than one minute.

[0011] Some embodiments provide another method of coupling a battery pack to an electric vehicle. The method of coupling includes substantially simultaneously engaging a first latch located at a front end of the underside of the electric vehicle with a first striker located at a front end of a battery pack and a second latch located at a back end of the underside of the electric vehicle with a second striker located at a back end of a battery pack. Then, the battery pack is substantially simultaneously locked into the electric vehicle by rotating the first and second latches into their respective physical lock positions. In some embodiments, the method of coupling further comprises substantially simultaneously

vertically lifting the battery pack into the electric vehicle by rotating the first and second latches in opposite directions, which engages with and raises the battery pack.

[0012] Some embodiments provide a battery system that includes a battery bay for receiving a battery pack. The battery bay is located at an underside of the electric vehicle. The battery bay includes a first latch configured to mechanically couple a front end of the battery pack to a front end of the underside of the electric vehicle, and a second latch configured to mechanically couple a back end of the battery pack to a back end of the underside of the electric vehicle. The first latch and the second latch mechanically couple the battery pack to the underside of the electric vehicle by engaging, vertically lifting, and locking the front and back ends of the battery pack to the electric vehicle substantially simultaneously.

[0013] Some embodiments provide a battery system that includes a battery pack configured to be mechanically coupled to an underside of an electric vehicle, a first latch configured to mechanically couple a proximate end of the battery pack to a proximate end of the underside of the electric vehicle, and a second latch configured to mechanically couple a distal end of the battery pack to a distal end of the underside of the electric vehicle. The first latch and the second latch mechanically couple the battery pack to the underside of the electric vehicle substantially simultaneously.

[0014] In some embodiments, the battery bay includes a latch that is attached to the frame at a first side of the cavity. The battery bay also includes at least one additional latch attached to the frame at a second side of the cavity opposite the first side of the cavity. The additional latch is rotatably pivoted about another axis substantially parallel with the plane formed by the underside of the vehicle. The additional latch is configured to retain the battery pack at least partially within the cavity.

[0015] In some embodiments, the battery bay's latch has a proximate end which rotates about the axis and a distal end remote from the proximate end that is configured to engage a bar shaped striker on the battery pack. In some embodiments, the distal end of the latch has a hook shape.

[0016] In some embodiments, the frame is formed integrally with a frame of the vehicle. In some embodiments, the frame is a separate unit configured to attach to the at least partially electric vehicle. In some embodiments, the frame is located between a front axle and a rear axle of the partially electric vehicle. In some embodiments, the frame defines a

substantially rectangular shaped opening, having two long sides and two short sides. In some embodiments, the frame defines an opening having five, six, or more sides defining any shape configured to receive a corresponding battery pack. In some embodiments, the long sides extend along axes substantially parallel (or near parallel) with an axis extending from the front to the back of the vehicle. In some embodiments, the frame defines a substantially cuboid shaped cavity for at least partially receiving the battery pack therein.

[0017] In some embodiments, the battery bay has one or more vibration dampers that are disposed between the frame and the at least partially electric vehicle.

[0018] In some embodiments, the latch and the additional latch substantially simultaneously rotate in opposite directions about their respective axes. In some embodiments, the battery pack is engaged and locked into the at least partially electric vehicle when the latches substantially simultaneously rotate towards one another. In some embodiments, the battery pack is disengaged and unlocked from the at least partially electric vehicle when the latches substantially simultaneously rotate away from one another.

[0019] In some embodiments, the latch and the additional latch are configured to mechanically decouple the battery pack from the underside of the at least partially electric vehicle substantially simultaneously.

[0020] In some embodiments, the latch (or latch mechanism) is part of a four bar linkage mechanism. In some embodiments, the four bar linkage mechanism includes: a latch housing, a input link including a first pivot point and a second pivot point, wherein the first pivot point is pivotably coupled to a proximate end of the latch housing; a latch including a third pivot point and a fourth pivot point; and a coupler link rod including a first rod end and a second rod end. The fourth pivot point is pivotably coupled to a distal end of the latch housing. The first rod end is pivotably coupled to the second pivot point of the input link. The second rod end is also pivotably coupled to the third pivot point of the latch.

[0021] In some embodiments, the coupler link rod includes an adjustment bolt configured to adjust a length of the coupler link rod. In some embodiments, when the input link is in a first position, the latch is configured to mechanically decouple from a striker of the battery pack. In some embodiments, when the input link is in a second position, the latch is in an engaged position configured to mechanically couple to a striker of the battery pack and the input link, the coupler link rod, and the hook are in a geometric lock configuration.

In some embodiments, the latch is configured to raise the battery pack along an axis substantially perpendicular to the plane formed by the underside of the vehicle.

[0022] In some embodiments, the battery bay further comprises a battery pack, which comprises: at least one rechargeable battery cell that stores electrical energy, and a housing at least partially enclosing the at least one rechargeable battery cell. The housing further comprises at least one striker having a bar shape, that is configured to engage with the latch.

[0023] In some embodiments, the housing of the battery pack has a height substantially less than its length, wherein a portion of the housing includes a heat exchange mechanism that has at least a portion thereof exposed to ambient air at the underside of the vehicle when the battery pack is attached to the vehicle. In some embodiments, the battery pack, when attached to the vehicle, at least partially protrudes below the plane of the underside of the electric vehicle. In some embodiments, a portion of the housing includes a heat exchange mechanism that has at least a portion thereof exposed to ambient air at the underside of the vehicle, when the battery pack is attached to the vehicle. In some embodiments, the heat exchange mechanism is selected from at least one of: a heat sink; a heat exchanger; a cold plate; and a combination of the aforementioned mechanisms. In some embodiments, the heat exchange mechanism is a cooling mechanism that includes a duct running through the housing. In some embodiments, the cooling duct includes a plurality of fins. In some embodiments, the cooling duct includes a scooped inlet. In some embodiments, the scooped inlet contains a filter to prevent debris from entering the cooling duct.

[0024] In some embodiments, the battery bay further includes a battery pack. The battery pack includes a housing configured to substantially fill a cavity in a battery bay of the vehicle. The housing includes: a first side wall; a second side wall opposing the first side wall; at least one first striker disposed at the first side wall having a bar shape wherein the central axis of the first striker is parallel to the first side wall; at least one second striker disposed at the second side wall having a bar shape wherein the central axis of the second striker is parallel to the second side wall; and at least one battery cell that stores electrical energy. The battery cell is at least partially enclosed within the housing. In some embodiments the bar shaped strikers have some anti-friction attachments such as roller bearings or low friction surface treatments.

[0025] In some embodiments, the frame of the battery bay further includes at least one alignment socket configured to mate with at least one alignment pin on the battery pack. The alignment socket and the alignment pin may be used as a reference point during assembly.

[0026] In some embodiments, the frame of the battery bay further includes at least one compression spring coupled to the battery bay, wherein the at least one compression spring is configured to generate a force between the battery bay and the battery pack when the battery pack is held at least partially within the cavity. This spring or any other elastic member is used to preload the battery pack to the vehicle body in order to prevent the relative motion between the vehicle body and the battery pack during vehicle operation.

[0027] In some embodiments, the transmission assembly further includes: a plurality of latches mechanically coupled to a first torque bar. The first torque bar is configured to actuate the latches. Additional latches are mechanically coupled to a second torque bar. The second torque bar is configured to actuate the additional latches. Furthermore, the first torque bar and the second torque bar are configured to substantially simultaneously rotate in opposite directions. In some embodiments, the first torque bar is located at a side of the battery bay nearest to a front end of the vehicle. The second torque bar is located at a side of the battery bay nearest to a back end of the vehicle.

[0028] In some embodiments, the transmission assembly further includes a first gear shaft coupled to a first torque bar via a first worm gear set, and a second gear shaft coupled to a second torque bar via a second worm gear set. The first gear shaft and the second gear shaft substantially simultaneously rotate in opposite directions causing the first torque bar and the second torque bar to substantially simultaneously rotate in opposite directions via the first worm gear set and second worm gear set. In some embodiments, the first gear shaft comprises two shafts joined by a universal joint. In some embodiments the design may include left and right worm gear set, a design which does not require the gear shafts to rotate in opposite directions.

[0029] In some embodiments, the transmission assembly further includes a miter gear set coupled to the first gear shaft and a second gear shaft. The miter gear set is configured to synchronously rotate the first and second gear shafts in opposite directions.

[0030] In some embodiments, the transmission assembly further includes a drive motor coupled to the miter gear set via a gear ratio set. The drive motor is configured to

rotate the first and second gear shafts in opposite directions via the gear ratio set and the miter gear set.

[0031] In some embodiments, the transmission assembly further includes a drive socket located at an underside of the electric vehicle. The socket is coupled to the central gear of the miter gear set. Rotation of the socket actuates the miter gear set. In some embodiments, the drive socket has a non-standard shape for receiving a socket wrench having a head corresponding to the non-standard shape.

[0032] In some embodiments, the transmission assembly further includes a miter gear lock configured to prevent the miter gear set from rotating. In some embodiments, the miter gear lock is configured to be released with a key. In some embodiments, the key physically unlocks the miter gear lock. In some embodiments, miter gear lock is spring loaded.

[0033] In some embodiments, the battery bay further includes one or more latch locks, which when engaged, are configured to prevent the at least one latch from rotating. In some embodiments, the latch lock further includes a lock synchronization bar coupled to the one or more latch locks and a lock actuator coupled to the lock synchronization bar. The lock synchronization bar is configured to actuate the one or more latch locks. The lock actuator is configured to actuate the lock synchronization bar. In some embodiments, the one or more latch locks are lock bolts. In some embodiments, the lock actuator is coupled to an electric motor configured to actuate the lock synchronization bar via the lock actuator. In some embodiments, the lock synchronization bar is configured to rotate the one or more latch locks in a first direction so that the one or more latch locks become engaged, and wherein the lock synchronization bar is configured to rotate the one or more latch locks in a second direction so that the one or more latch locks become disengaged.

[0034] In some embodiments, the battery bay further comprises one or more latch locks, which when engaged, are configured to prevent the at least one latch from rotating. The one or more latch locks are configured to disengage only when the miter gear lock has been released.

[0035] In some embodiments, the battery bay further comprises a latch position indicator configured to determine an engaged position and a disengaged position of the latch.

[0036] In accordance with some embodiments, a method is disclosed for securing and releasing a battery pack from a battery bay of an at least partially electric vehicle. The

battery bay includes multiple latching units each separately controllable and has a latch configured to couple to the battery pack. In use, each of the latching units is activated to rotate its respective latch to engage or disengage with the battery pack. A position of each respective latch of the latching units is measured, and each of the latching units is individually controlled based on the position of its respective latch to synchronize the positions of all latches.

[0037] In accordance with some embodiments, a system is disclosed for supporting a battery pack that includes multiple latching units each separately controllable and having a latch configured to couple to the battery pack. A respective latch of each latching unit is configured to rotate so as to engage or disengage with the battery pack; and each latching unit is configured for actuation based on a position of its respective latch to synchronize the positions of all latches.

[0038] In accordance with some embodiments, the latching unit supports the battery pack. The latching unit includes: a motor having a rotatable shaft; a worm gear coupled to the rotatable shaft; a gear coupled with the worm gear, wherein the gear is a partial gear; a push rod coupled with the gear at a first end of the push rod; and a bell crank including two arms. A joint of the two arms is coupled with the push rod at a second end of the push rod, where a first arm of the two arms is rotatably pivoted, and a second arm of the two arms is shaped as a hook to engage a striker of the battery pack. The latching unit also includes: a rotation sensor configured to detect a position of the motor; one or more bolts each configured to stop the rotation of the gear at a respective limit position; one or more limit switches each configured to detect a position of the gear at one of the respective limit positions; and a plunger configured to preload the battery pack by applying apply downward force on the battery pack when the battery pack is fully engaged.

[0039] In accordance with some embodiments, an apparatus is disclosed for supporting a battery pack. The apparatus includes: a worm gear coupled with a motor; a gear coupled with the worm gear, wherein the gear is a partial gear; a push rod coupled with the gear; and a latch including two arms, where a joint of the two arms is coupled with the push rod. A first arm of the two arms is rotatably pivoted, and a second arm of the two arms is shaped as a hook to engage a striker of the battery pack.

[0040] Thus, electric vehicles are provided with faster, more efficient, and more reliable methods and systems for exchanging battery packs, thereby allowing drivers of such vehicles to avoid unnecessary waits associated with battery recharges.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] Figure 1 illustrates an electric vehicle network.

[0042] Figures 2A-2B are views of the electric vehicle of Figure 1. Figure 2A is a bottom view of the electric vehicle and Figure 2B is a side view of the electric vehicle.

[0043] Figures 3A and 3B are underside perspective views of the electric vehicle and battery pack of Figure 1.

[0044] Figure 4 is a perspective view of one embodiment of the battery pack of Figures 1-3.

[0045] Figure 5 is a perspective view of one embodiment of the battery pack of Figures 1-3 showing various chemical modules or cells.

[0046] Figure 6 is a perspective view of one embodiment of a battery pack with a first cooling system.

[0047] Figure 7 is a bottom perspective view of another embodiment of a battery pack with a second cooling system.

[0048] Figure 8 is a perspective view of another embodiment of a battery pack.

[0049] Figure 9 is a perspective view of an electrical connection system.

[0050] Figure 10 is a perspective view of an embodiment of a battery pack connected to a battery bay and the battery bay's transmission assembly.

[0051] Figure 11 is a perspective view of another embodiment of a battery bay.

[0052] Figure 12 is a close-up oblique view of an embodiment of the worm gear set of Figure 11.

[0053] Figure 13 is a close-up perspective view of an embodiment of a first gear set mechanism of Figure 11.

[0054] Figure 14 is a close-up perspective view of the underside of the battery and bay including a close-up view of an embodiment of a drive socket.

[0055] Figure 15 is a perspective view of one embodiment of a gear lock.

[0056] Figure 16 is a perspective view of another embodiment of a gear lock.

[0057] Figure 17 is a close-up perspective view of a key inserted into a key hole and releasing the gear lock of Figure 16.

[0058] Figure 18 is a close-up perspective view of an embodiment a battery bay with several alignment sockets configured to mate with alignment pins on the battery pack.

[0059] Figures 19A-19C are side views of a latch mechanism at various positions.

[0060] Figure 20 is a close-up perspective view of the latch lock mechanism of the battery bay.

[0061] Figure 21 is a flow diagram of a process for releasing a battery pack from a battery bay.

[0062] Figure 22 is a flow diagram of a process for engaging a battery pack to a battery bay.

[0063] Figures 23A and 23B are perspective and close-up perspective views respectively of another embodiment of a transmission assembly of a battery bay.

[0064] Figure 24 is a perspective view of an individual latching unit in accordance with some embodiments.

[0065] Figures 25A and 25B are close-up side views of internal components in an individual latching unit in accordance with some embodiments.

[0066] Figure 26 is a perspective view of a battery pack secured with multiple latching units in accordance with some embodiments.

[0067] Figure 27 is a block diagram illustrating a system for controlling multiple latching units in accordance with some embodiments.

[0068] Figure 28 is a flow diagram illustrating a method for controlling latching units in accordance with some embodiments.

[0069] Figure 29 is a flow diagram illustrating a method for controlling latching units in accordance with some embodiments.

[0070] Figures 30A and 30B are close-up views of selected internal components in an individual latching unit in accordance with some embodiments.

[0071] Like reference numerals refer to corresponding parts throughout the drawings.

DESCRIPTION OF EMBODIMENTS

[0072] Figure 1 illustrates an electric vehicle network 100, according to some embodiments. The electric vehicle network 100 includes a vehicle 102 and a battery pack 104 configured to be removably mounted to the vehicle 102. In some embodiments, the battery pack 104 includes any device capable of storing electric energy such as batteries (*e.g.*, lithium ion batteries, lead-acid batteries, nickel-metal hydride batteries, *etc.*), capacitors, reaction cells (*e.g.*, Zn-air cell), *etc.* In some embodiments, the battery pack 104 comprises a plurality of individual batteries or battery cells/chemical modules. In some embodiments, the battery pack 104 also comprises cooling mechanisms, as well as mechanical and electrical connectors for connecting to the vehicle 102 or to the various elements of the battery exchange station 134. These mechanical and electrical connectors will be described in further detail below.

[0073] In some embodiments, the vehicle 102 includes an electric motor 103 that drives one or more wheels of the vehicle. In these embodiments, the electric motor 103 receives energy from the battery pack 104 (shown separate from the vehicle for the ease of explanation). The battery pack 104 of the vehicle 102 may be charged at a home 130 of a user 110 or at one or more charge stations 132. For example, a charge station 132 may be located in a shopping center parking lot. Furthermore, in some embodiments, the battery pack 104 of the vehicle 102 can be exchanged for a charged battery pack at one or more battery exchange stations 134. Thus, if a user is traveling a distance beyond the range of a

single charge of the battery of the vehicle, the spent (or partially spent) battery can be exchanged for a charged battery so that the user can continue with his/her travels without waiting for the battery to be recharged. The battery exchange stations 134 are service stations where a user can exchange spent (or partially spent) battery packs 104 of the vehicle 102 for charged battery packs 104. The charge stations 132 provide energy to charge the battery pack 104 while it is coupled to the vehicle 102. These components of the network 100 are connected to related power and data networks, as explained in more detail in U.S. Patent Application No. 12/234,591, filed September 19, 2008, entitled Electronic Vehicle Network, the disclosure of which is incorporated herein by reference.

[0074] Figures 2A-2B are side and bottom views of an at least partially electric vehicle 102. The vehicle 102 includes a removable battery pack 104 (sometimes herein referred to just as a battery) attached to the vehicle 102 at its underside. In some embodiments, the battery pack 104 is substantially flat and runs along at least a portion of the length of the vehicle 102; *i.e.*, along the longitudinal X-axis of the vehicle. In some embodiments, the battery 104 may protrude below the plane 204 of the underside of the vehicle 102, *i.e.*, protruding in the negative Y-axis direction. Protruding from the underside of the vehicle is helpful for air cooling the battery pack 104, as the protruding battery pack is exposed to ambient air flow. In embodiments with air scoops, discussed below in relation to Figure 6, at least the air scoop intake will be exposed to ambient air at the underside of the vehicle 102 to receive air flow when the vehicle 102 is moving forward. In some embodiments where the battery pack is retrofitted to a vehicle, *i.e.*, after-market, the battery pack may protrude from the bottom of the vehicle.

[0075] When the battery 104, or portions thereof, protrude from below the plane of the underside 204 of the vehicle 102, it may, however, be unsightly. Therefore, in some embodiments, cosmetic fairings 202 are attached to the vehicle to hide the battery pack 104. In some embodiments, the cosmetic fairings 202 also produce a smooth outline and reduce drag. These cosmetic fairings 202 may be mounted on any or all of the front, sides, and rear of the vehicle.

[0076] Figures 3A and 3B are underside perspective views of the electric vehicle 102 and battery pack 104 of Figure 1. Figure 3A shows the battery pack 104 mounted in a battery bay 108. Figure 3B shows the battery pack 104 removed from the battery bay 108. The battery bay 108 includes a frame 118 that defines the outline of a cavity 302 disposed at the

underside of the vehicle 102. The cavity 302 is configured to at least partially receive the battery pack 104 therein. In some embodiments, the bay frame 118 has a substantially rectangular shape, for at least partially receiving a substantially cuboid or rectangular parallelepiped battery pack 104 therein. In some embodiments, the frame 118 has two long sides along at least part of the length of the vehicle 102 (parallel to the X-axis) and two shorter sides along at least part of the width of the vehicle (parallel to the Z-axis) as shown. In some embodiments, the long sides of the frame 118 extend along axes substantially parallel with an axis extending from the front to the back of the vehicle 102 (parallel to the X-axis). In some embodiments, the battery bay 108 is located under the vehicle floor boards, between the rear and front axles of the vehicle 102.

[0077] In some embodiments, the cavity 302 into which the battery bay 108 is inserted uses existing volumes which are normally occupied by the fuel tank and muffler in a traditional gasoline or hybrid vehicle. In such a manner, the storage and/or passenger volume is not substantially impacted by the addition of the battery pack 104. In some embodiments, the vehicle body floor structure is shaped as a basin to accommodate the battery pack. The location of the battery bay 108 at or near the bottom of the vehicle lowers the vehicle's center of mass or gravity, when the battery pack 104 is coupled to the vehicle, which improves the cornering, road-holding, and performance of the vehicle. In some embodiments, the battery bay 108 is located within zones of the vehicle that are designed to not buckle during front or rear collisions to protect the battery pack 104.

[0078] In some embodiments, the battery bay 108 is a self-contained unit. In some embodiments, the battery bay structural connections to the vehicle frame (or unibody) are made through flexible vibration dampers (not shown). This allows the battery bay 108 to not interfere with the natural bending and torsion deflection of the vehicle frame. In some embodiments, the connections to the vehicle frame are made using removable fasteners such as bolts. In other embodiments the battery bay 104 is substantially permanently mounted to the vehicle by welding or other means.

[0079] The battery bay 108 is designed to withstand the load factors required by an original equipment manufacturer, national safety standards, or international safety standards. In some embodiments, the battery bay 108 is designed to withstand the following load factors:

- Normal Operating Conditions: +/- 1.5 F_x and F_z, and +/- 4 F_y, which may be substantially continuously oscillating at 1 – 100 IIz, where F_x, F_y, and F_z are the forces in the X, Y, and Z directions respectively. In some embodiments, at this condition substantially no plastic deformation of the battery bay 108 will occur.
- Exceptional Operating Conditions: +/- 12 F_x and F_z, and +/- 8 F_y, which are not substantially continuously oscillating. In some embodiments, at these conditions substantially no plastic deformation of the battery bay 108 will occur.
- Crash Conditions: +/- 30 in F_x and F_z, and +/- 20 F_y.

[0080] In some embodiments, during Normal and Exceptional Operating Conditions, the battery pack 104 does not substantially rock, rattle, or otherwise move.

[0081] In some embodiments, the mechanical connection between the battery bay 108 and the vehicle frame is provided during the assembly of the vehicle 102. In other words, the battery bay 108 is a separate unit configured to attach to the at least partially electric vehicle 102. In some embodiments, the separate unit style battery bay 108 is retrofitted to a hybrid or internal combustion engine vehicle either before or after market. In other embodiments, the design of the battery bay 108 is formed integrally with a frame of the vehicle 102.

[0082] Figure 4 is a perspective view of an embodiment of the battery pack 104. In some embodiments, the battery pack 104 has a height (h or H) substantially less than its length (L). In some embodiments, the battery 104 has a first portion 401 being substantially long and flat and a second portion 402 being shorter and thicker than the first portion, *i.e.*, the first portion 401 has a height (h) significantly less than the height (H) of the second portion 402. In some embodiments, the second portion 402 has a greater height (H) as it is configured to fit under or behind the rear passenger seats or in a portion of the trunk, and as such does not significantly impact the passenger space inside the electric vehicle. In some embodiments, the volume of the battery pack 104 is 200 to 300 liters. In some embodiments, the weight of the battery pack 104 is 200-300 kg.

[0083] In some embodiments, the battery pack 104 is an at least partially sealed enclosure which is built to substantially enclose and absorb an explosion of battery cells/chemical modules (502, Fig 5) within the battery pack. The sealed enclosure of the battery pack 104 is made of materials that are able to substantially withstand damage caused by dust, dirt, mud, water, ice, and the impact of small rigid objects. Suitable materials

include some plastics, carbon fibers, metals, or polymers, etc. In some embodiments, an external cover on the battery pack 104 protects and insulates the internal components of the battery from harsh environmental conditions and penetration of moisture or fuel vapors.

[0084] In some embodiments, a battery management system (BMS) 406 in the battery pack 104 manages the charging and the discharging cycles of the battery pack. The BMS 406 communicates with the vehicle onboard computer to report on the battery's state of charge and to alert of any hazardous operating conditions. In some embodiments, during charging, the BMS 406 communicates with the battery charge station 132. In some embodiments, the BMS 406 can communicate with the vehicle onboard computer via a 9-pin connector. The number of pins in the connector varies depending on the connector design. In some embodiments, the BMS 406 is able to arm and disarm the electric power connector between the battery pack 104 and the vehicle 102 by cutting the current to the connector using a switching device located in the battery pack 104. In some embodiments, the BMS 406 handles substantially all aspects of battery safety issues during charging, operation and storage.

[0085] Figure 5 is a perspective view of the battery pack 104 with the battery pack chemical modules 502 that receive, store, and discharge electric energy. The modules 502 are housed within a battery pack housing 504. These chemical modules 502 are sometimes referred to herein as rechargeable battery cells 502. In some embodiments, a plurality of chemical modules 502 are disposed within the battery pack 104. In other embodiments, at least one chemical module 502 is used. In most embodiments, each chemical module 502 is rechargeable but there may be instances where a one time use emergency battery could be used. The chemical modules 502 are re-charged as a group at either a charge station 132 or at a charging portion of a battery exchange station 134, based on parameters set and controlled by the BMS.

[0086] Figure 6 is a perspective view of an embodiment wherein the battery pack 104 includes a cooling system which dissipates heat from the battery pack 104. In some embodiments, a portion of the battery pack's housing 504 includes a heat exchange mechanism with at least a portion thereof exposed to ambient air at the underside of the vehicle 102 when the battery pack 104 is attached to the vehicle. In some embodiments, the heat is conducted from the modules 502 to a heat exchanger or heat sink at the bottom section of the battery pack. In some embodiments, the cooling system includes openings 404 in the

external cover, which fluidly communicate with one or more cooling ducts 602 that direct ram air flow past the battery to further dissipate heat generated by the battery. In some embodiments, the cooling ducts 602 run the entire length of the battery pack 104 while in other embodiments the ducts take any appropriate path to best cool the modules 502. In some embodiments, the cooling ducts 602 direct air through heat exchangers which dissipate heat from the battery pack modules. In some embodiments, the cooling ducts 602 also include cooling fins 604 therein. In some embodiments, air cooling is accomplished by electric fans. In some embodiments, the inlet 404 comprises a scoop 606 for directing ram air through the ducts 602 while the vehicle is in motion. In some embodiments, the scoop 606 contains a mesh cover 608 for preventing debris from entering the cooling ducts 602.

[0087] Figure 7 is a perspective view of the battery pack 104 and battery bay frame as viewed from the underside of the battery pack. In some embodiments, the battery pack 104 includes another cooling system made up of dimples or cavities 702. The dimples/cavities 702 are located in the bottom surface of the battery pack 104, which runs along the bottom of the vehicle, to be exposed to air passing over them when the vehicle 102 is in motion. Even when the vehicle is stopped, heat generated by the battery is dissipated due to its large surface area and shaded location on the underside of the vehicle. The dimples/cavities 702 increase the overall surface area of the bottom of the battery pack, which further helps to cool the modules 502. In some embodiments, the increased surface area is sufficient for cooling, and ducts and/or heat exchangers are not necessary. In some embodiments, this increased surface area is used in conjunction with one or more of the previously described cooling mechanisms (such as the cooling ducts with fins described in Figure 6, or the heat sink and heat exchanger also described above.)

[0088] In some embodiments, battery pack cooling systems, such as those described above in relation to Figures 6 and 7, are capable of dissipating a majority of the heat generated during full power operation and/or during the charging process. In some embodiments, the cooling systems are capable of dissipating 3 KW of heat. The exact amount of heat emitted from the battery varies from one design to another. In some embodiments, the heat from the cooling systems described above is substantially emitted to the environment rather than to other parts of the vehicle 102.

[0089] Figure 7 also shows an embodiment with a plurality of pilot holes 704 on the underside of the battery pack 104. These pilot holes 704 mate with locating pins on an

exchange device platform discussed in application No. 61/166,239 (filed April 2, 2009, entitled Battery Exchange Station and incorporated herein) to help properly align the exchange device platform with the battery pack 104. In some embodiments, one pilot hole is present. In other embodiments, two or more pilot holes are present. The embodiment of Figure 7 shows pilot holes on either side of every striker on the battery. In some embodiments, the pilot holes 704 exist in the frame of the battery bay rather than the battery, and function substantially the same, *i.e.*, to facilitate proper alignment of the exchange platform during a battery exchange operation.

[0090] Figure 8 is a perspective view of another embodiment a battery pack 806. The battery pack 806 has a first portion 401 being substantially long and flat; a second portion 402 being shorter and thicker than the first portion; and a third portion 403 of the battery pack 104 being long and thin and running substantially the length of the first portion 401 with a height larger than the first portion 401 but smaller than or equal to the height of the second portion 402. The third portion 403 of the battery 104 protrudes in the Y-direction from the first portion 401 along a central axis in the X-direction formed between the driver and passenger seats, as shown. Still other embodiments (not shown) have a substantially cuboid shape, without two differently shaped portions. Other embodiments may have more complex shapes. For example, some embodiments are taller than they are wide. Embodiments of this general shape are sometimes located behind a passenger space, rather than underneath it.

[0091] In some embodiments, the battery pack 104 includes one or more pins 802 to align the battery 104 with the battery bay 108 of the vehicle 102. The pins 802 may also be used to prevent the battery pack from being inserted in the battery bay 108 in the wrong direction. For example, the pins at the battery and corresponding openings in the battery bay may be keyed to one another.

[0092] In some embodiments, the battery pack housing 504 further comprises bar shaped strikers 1924, which are firmly attached to the battery pack housing and configured to carry the entire weight of the battery pack 104, *i.e.*, the battery pack can be suspended from the strikers 1924 when they are engaged with latches 1920 (Figure 19A) on the battery bay 108. All versions of the battery pack 104 also contain an electrical connector 804 (discussed below in relation to Figure 9), for quickly and safely connecting and disconnecting the battery pack 104 to and from the vehicle 102. In some embodiments the electrical connector

804 is located on the third portion 403 of the battery 104, but in other embodiments, it may be located anywhere on the pack.

[0093] Figure 9 is a detailed perspective view of the electrical connection system 900. This figure shows both the battery electrical connector 804 as well as the corresponding battery bay electrical connector 902 which mate together to form the electrical connection system 900. The battery electrical connector 804 is attached to the battery pack 104 by means of a base unit 916. Similar attachment mechanisms are used to attach the battery bay electrical connector 902 to the frame 118 of the battery bay 108 or to the electric vehicle 102 directly. In some embodiments, the electrical interface between the battery bay 108 and the battery pack 104 (*i.e.* the connection between the bay electrical connector 902 and the battery pack electrical connector 804) allows for quick connect/disconnection between the pack and the bay or vehicle.

[0094] Both connectors also include electric shields 904 to shield the electro-magnetic forces of the connections from interfering with the chemical modules/ battery cells 502. The electric shield may be grounded. In some embodiments, the electric shield 904 also comprises an O-ring 913 to prevent moisture and debris from fouling the electrical connectors and causing electrical shorts and/or fires. The alignment between the bay electrical connector 902 and the battery pack electrical connector 804 is facilitated by one or more tapered alignment pins 912 and corresponding alignment receptacles or sockets 914. In some embodiments, the alignment pins 912 are on the battery pack electrical connector 804 while the alignment sockets/receptacles 914 are on the bay electrical connector 902. In other embodiments, the arrangement is transposed. In some embodiments, the pins 912 are keyed to one another to prevent inappropriate mating of the electrical connectors.

[0095] In some embodiments, the electric connections between the battery bay 108 and the battery pack 104 have two separate groups of connectors. The first group of connectors is for power (approximately 400VDC, 200 Amp) to and from the battery pack 104. The second group of connectors 910 is for data communications (5-12V, low current.) In some embodiments, the connector has 9 pins. In other embodiments the connector will have more or fewer pins than 9.

[0096] In some embodiments, the first group of connectors includes a first pair of connectors 906 for power to the battery pack 104 from a charging mechanism. In some embodiments, the charging mechanism is a stand alone charging station 132 that connects to

the vehicle 102 and charges the battery pack 104 while it is still coupled to the vehicle (as shown in Figure 1). In some embodiments, the charging mechanism is incorporated into a portion of the battery exchange station (134, Fig 1), where the depleted/discharged battery pack 104 that has been removed from a vehicle 102 is charged again before being inserted into a vehicle. In some embodiments, the first group of connectors also includes a second pair of connectors 908 to provide power from the battery pack 104 to the electric motor 103.

[0097] In some embodiments, the battery electrical connector 804 as well as the corresponding battery bay electrical connector 902 mate together as a result of the translation of the battery pack 104 into the battery bay 108. Both the battery electrical connector 804 as well as the corresponding battery bay electrical connector 902 have some flotation, *i.e.*, they can travel a few millimeters to the left and right. The male connector (battery bay electrical connector 902 in this embodiment) has alignment pins 912 which penetrate into sockets 914 in the female connector (the battery electrical connector 804 in this embodiment). The connection between the pins 912 and the sockets 914 and this aligns the two parts of the electrical connection system 900 during the translation of the battery pack 104 to its final position in the battery bay 108. The flotation of the two parts of the electrical connection system 900 allows some misalignments (due to production and assembly tolerances) of the two connector parts.

[0098] In some embodiments, the electrical connectors 906, 908, and 910 in the electrical connection system 900 align and connect themselves automatically only after the mechanical connections (*i.e.*, the locking of the battery pack 104 into the battery bay 108 by means of the latch mechanisms 1016, 1018 in the transmission assembly 1000, described in Figures 10 and 19) have been established.

[0099] Figure 10 is a perspective top side view of one embodiment of the battery pack 104 connected to the battery bay 108. In this embodiment the battery pack 104 and battery bay 108 are substantially cuboid/rectangular parallelepiped in shape. This embodiment includes a battery electrical connector 1022 being on one side of the first portion 401.

[00100] In some embodiments, the battery bay 108 includes a battery bay transmission assembly 1000. The transmission assembly 1000 is a grouping of gears, rotating shafts, and associated parts that transmit power from a drive motor 1310 or alternatively from an external/manual rotation source (such as the wrench received within a drive socket 1308

shown in Figure 13). The latch mechanisms 1016, 1018 as will be explained in detail below with regard to Figure 19.

[00101] In some embodiments, the transmission assembly 1000 includes a first gear set 1002 (such as a miter gear set) which drives a first gear shaft 1004 and a second gear shaft 1006 in opposite directions. The rotational force about the Y-axis by the drive motor 1310 or manual rotation is translated by the first gear set 1002 into equal and opposite rotational forces of the gear shafts 1004, 1006 about the X-axis. The first gear shaft 1004 is attached to a second gear set 1008 (such as a first worm gear set). The second gear shaft 1006 is attached to a third gear set 1010 (such as a second worm gear set). The second and third gear sets 1008, 1010, which are discussed in more detail below with respect to Figure 12, connect each gear shaft 1004, 1006 to respective torque bars 1012, 1014 which permits the power flow to turn a corner around the battery bay. In other words, the rotational force of the gear shaft 1004 about the X-axis is translated by the gear set 1008 into a rotational force of torque bar 1012 about the Z_1-axis, while at the same time the rotational force of gear shaft 1006 about the X-axis (in an equal and opposite direction to that of gear shaft 1004) is translated by gear set 1010 into a rotational force of torque bar 1014 about the Z_2-axis (in an equal an opposite direction to the rotation of torque bar 1012.) By this means, the transmission assembly 1000 drives the torque bars 1012, 1014 to substantially simultaneously rotate in equal but opposite directions.

[00102] In some embodiments, the torque bars 1012, 1014 and gear shafts 1004, 1006 are at right angles to one another respectively. In some embodiments, the torque bars 1012, 1014 and gear shafts 1004, 1006 form an obtuse angle with each other, and in further embodiments they form an acute angle with one another. In this embodiment second gear set 1008 connects the first gear shaft 1004 to the first torque bar 1012, and the third gear set 1010 connects the second gear shaft 1006 to the second torque bar 1014. As such, in some embodiments, the first gear shaft 1004 and the second gear shaft 1006 substantially simultaneously rotate in opposite directions causing the first torque bar 1012 and the second torque bar 1014 to substantially simultaneously rotate in opposite directions via the second gear set 1008 and third gear set 1010.

[00103] The embodiment shown in Figure 10 shows two latch mechanisms 1016, 1018 attached to each torque bar 1012, 1014. These latches 1016, 1018 hold the battery pack 104 at least partially inside the battery bay 108 during normal operation of the vehicle.

[00104] Some embodiments include one or more first latches 1016 coupled to the first torque bar 1012 and one or more second/additional latches 1018 coupled to the second torque bar 1014. The first torque bar 1012 is configured to actuate the first latch mechanism(s) 1016, whereas the second torque bar 1014 is configured to actuate the second latch mechanism(s) 1018. When more than one of the first latches 1016 or second latches 1018 are attached to each torque bar 1012, 1014 the torque bar ensures that the plurality of latches actuated and thus rotating substantially simultaneously with each other.

[00105] At least one latch lock mechanism 1020 prevents the latches 1016, 1018 from releasing the battery 104 from the battery bay 108 until the lock is disengaged as described in more detail in relation to Figure 20. In some embodiments, only one latch lock mechanism 1020 is used, while in other embodiments at least one latch lock mechanism 1020 is attached to each torque bar 1012, 1014. In some embodiments, the latch lock 1020 is electronically activated, while in other embodiments it is mechanically activated.

[00106] In some embodiments, the first torque bar 1012 is located at a side of the battery bay 108 nearest to the front end of the vehicle 102, and the second torque bar 1014 is located at a side of the battery bay 108 nearest to the rear of the vehicle, or the arrangement may be transposed. The gear sets and mechanisms of the transmission assembly may be located anywhere so long as the torque bars 1012, 1014 are driven in opposite directions simultaneously at the same angular velocity to actuate the latch mechanisms 1016, 1018.

[00107] Figure 11 is a perspective view of another embodiment of a battery bay 108. This embodiment also includes a first gear set 1002 (such as miter gear set) that drives a first gear shaft 1004 and a second gear shaft 1006 in opposite directions. In this embodiment, however, the battery bay's frame is not rectangular in shape. Instead, along one side of the battery bay 108, the second gear shaft 1006 is made up of three portions, a first gear shaft link 1102 connected by a first universal joint 1104 to a second gear shaft link 1106, and a third gear shaft link 1108 connected by a second universal joint 1110 to a third gear shaft link 1112. In this manner the first gear shaft 1006 is bent to accommodate for other components of the electric vehicle 102. As such, the battery bay 108 cavity has a smaller volume than it would have were the first gear shaft 1006 a single straight component extending from the first gear set 1002.

[00108] Figure 11 also shows a lock synchronization bar 1112 in the transmission assembly 1000 which is located near each torque bar 1012 (Figure 10), 1014. Each lock

synchronization bar 1112 is attached to a latch lock mechanism 1020 to keep its respective latch mechanisms 1016, 1018 from releasing, as will be explained in detail below with respect to Figure 20. Figure 11 also shows springs 1806 in the latch mechanisms 1016, 1018 which are located on either side of the latch 1920 as explained in more detail in Figure 18.

[00109] It should be noted that while various forms of shafts and gear sets have been described above, in other embodiments the driving torque can be transmitted to the latches by using other types of drive components such as belts, pulleys, sprockets drive chains.

[00110] Figure 12 shows one embodiment of the second and third gear sets 1008, 1010. In some embodiments the gear sets 1008, 1010 are each made up of a helical gear 1202 and a spur gear 1204. In some embodiments, the helical gear 1202 is a worm gear. In operation, the rotation of the helical gear 1202, which is connected to the gear shafts 1004, 1006, rotates the corresponding torque bar 1012, 1014 by means of interlocking teeth on the helical gears 1210 and spur gear 1204. The precise number and configuration of teeth on the helical gear 1210 and the spur gear 1204 varies depending on the particular electric vehicle 102. For example, in some embodiments the helical gear 1202 is significantly longer and has more threading, while in some embodiments, the spur gear 1204 gear has more teeth, or forms a complete circle. In other embodiments the diameter of the helical gear 1202 is larger than the proportions shown in Figure 12. In normal operation, the helical gear 1202 turns the spur gear 1204 in one direction to engage the latch mechanisms 1016, 1018 by which the battery 104 is lifted and locked into the battery bay 108, and the helical gear 1202 turns the spur gear 1204 in the opposite direction to disengage the latch mechanisms 1016, 1018 and allow the battery 104 to be removed from the battery bay 108.

[00111] Figure 13 shows a detailed view of one embodiment of the first gear set 1002. In some embodiments, the first gear set 1002 is a miter gear set. In some embodiments, the miter gear set 1002 comprises three helical bevel gears; including a central gear 1302 coupled to a first outer gear 1304 and a second outer gear 1306. As the central gear 1302 rotates it drives the first outer gear 1304 in a first rotational direction and the second outer gear 1306 in a second rotational direction opposite of the first rotational direction. The first outer gear 1304 drives the first gear shaft 1004, while the second outer gear 1306 drives the second gear shaft 1006. As such, the rotation of the central gear 1302 drives the first gear shaft 1004 in a first rotational direction by means of the first outer gear 1304 while simultaneously/synchronously driving the second gear shaft 1006 in a second

rotational direction by means of the second outer gear 1306. In some embodiments, the first gear set 1002, specifically the central gear 1302 is driven by the rotation of a drive socket 1308 located at the underside of the electric vehicle 102. To turn the gear 1308, the shaft is mechanically rotated, such as by an Allen or socket wrench 1314 configured to mate with the drive socket 1308. In some embodiments, the female drive socket 1308 has an unusual or non-standard shape such that it can only receive a particular shaped Allen or socket wrench 1314 made to mate with the non-standard shaped drive socket 1308.

[00112] In some embodiments, the transmission assembly 1000 is driven by an electric drive motor 1310 through the drive motor gear ratio set 1312. The gear ratio set 1312 drives the first gear set 1302, which drives the first gear shaft 1004 and the second gear shaft 1006 simultaneously in opposite directions to eventually simultaneously actuate the latch mechanisms 1016 , 1018 as described above with relation to Figure 10. In some embodiments, the drive motor 1310 is used in most circumstances to rotate the shafts 1004, 1006, while the drive socket 1308 is only used for manual override situations. In some embodiments, the drive socket 1308 is the preferred means for driving the first gear set 1002.

[00113] As shown in Figures 23A and 23B, in some embodiments, the transmission assembly 1000 encompasses a second gear set 1008 which is a right worm gear set and third gear set 1010 which is a left worm gear set. When right gear set 1008 and the left worm gear set 1010 are used in the transmission assembly 1000, the first gear shaft 1004 and the second gear shaft 1006 need not be driven to rotate in opposite directions about the X-axis. Instead, the torque bar 1012 is driven about the Z_1-axis and torque bar 1014 is driven about the Z_2-axis (in an equal an opposite direction to the rotation of torque bar 1012) by means of the opposite threading on the right and left worm gears (1008, 1010). In other words, the pitch of the threading on the right worm gear 1008 is opposite to the pitch of the threading on the left worm gear 1010. As such, the first gear set 1002 need not be a miter gear set as shown in Fig. 13, but is instead a simpler gear set shown in Figure 23B. In other words, because the right and left worm gears 1008, 1010 translate the motion of the first gear set 1008 in directions opposite from one another due to their opposing thread pitch, the shafts 1004, 1006 can rotate the same direction, and a complex miter gear set is not needed at the point of actuation of the shafts 1004, 1006.

[00114] Figure 14 shows a bottom perspective view of another embodiment of the drive socket 1308 as viewed from the underside of the at least partially electric vehicle 102.

In some embodiments, the drive socket 1308 is accessible through a hole in the battery pack housing 1400. In other embodiments, the drive socket 1308 is accessible at the side of the cavity 302 in the battery bay 108. In some embodiments, the first gear set 1002 is driven by the socket wrench 1314 only after a key 1602 has been inserted into a key hole 1402 and unlocks the first gear set 1002 as described in Figure 17. Like the drive socket 1308, in this embodiment, the key hole 1402 is also located at the underside of the electric vehicle 102 and requires a hole in the battery housing 1400. In other embodiments, the key hole 1402 is in the battery bay 108.

[00115] Figure 15 is a perspective view of one embodiment of a first gear lock 1502 (which in some embodiments is the miter gear lock). In this embodiment, when a key is inserted into the key hole 1402, as depicted by the arrow in the figure, the first gear lock 1502 rotates upward and disengages from a small gear on the shaft 1004 and thus is unlocked. Then, the first gear set 1002 can then perform its function of rotating the central gear 1302, which drives the first gear shaft 1004 in a first rotational direction by means of the first outer gear 1304 while simultaneously driving the second gear shaft 1006 in a second rotational direction (opposite the first rotational direction) by means of the second outer gear 1306. When the key is removed the first gear lock 1502 rotates downward and engages the small gear on the shaft 1004 and thus locks it. In the embodiment shown in Figure 15, the electric drive motor 1310 of the transmission assembly 1000 is located above the first gear set 1002, and as such does not require a drive motor gear set 1312 as described in Figure 13.

[00116] Figure 16 is a perspective view of a second embodiment of the gear lock 1600. In this figure the key 1602 is shown outside of the key hole 1402. In some embodiments, the key hole 1402 is located close to the drive socket 1308. In some embodiments, the key 1602 has a specific and unconventional shape for mechanically releasing the second embodiment of the gear lock 1600, explained in more detail below, while avoiding other components of the first gear set 1002.

[00117] Figure 17 is a detailed view of the key 1602 inserted into the key hole 1402 and releasing the first gear lock 1502. In Figure 17, the first gear lock 1502 is positioned in-between the motor 1310 and the gear set 1312. In some embodiments, the key 1602 unlocks the first gear lock 1502 by pushing a locking latch 1702 with a locking tooth 1704 away from a locking gear 1706. In some embodiments, the locking latch 1702 is designed to be biased into its locked position, *i.e.*, mated with the locking gear 106, as soon as the key 1602 is

removed. In some embodiments, a spring 1708 is attached to the locking latch 1702 to provide the biasing force, while in other embodiments gravity or other mechanisms for biasing the locking latch 1702 may be used. In some embodiments, the key 1062 remains in the inserted position throughout the battery exchange process. In other embodiments the key 1602 is only required to originally unlock the first gear lock 1502, but is not required to remain in place throughout the battery exchange process.

[00118] In all of the embodiments of the key 1602 and first gear lock 1502, like those shown in Figures 15 – 17, the first gear set 1002 is kept from rotating until the key 1602 unlocks the gear lock 1502. As such, the shafts 1004, 1006, torque bars 1012, 1014, and their corresponding latch mechanisms 1016, 1018 will not turn unless the gear lock 1502 has been unlocked. Furthermore, in some embodiments, a latch lock mechanism 1020 (described in relation to Figure 20) must also be unlocked before the process to actuate the latch mechanisms 1016, 1018 can begin. In some embodiments, the latch lock mechanism and the gear lock 1502 are independent of one another, and are individually/independently released before the transmission assembly 1000 can be actuated. In some embodiments, the latch lock mechanism 1020 is electrically actuated, and the gear lock 1502 is mechanically activated or vice versa. Activating the two different locks by two separate mechanisms (mechanical and electrical) prevents unauthorized or inadvertent removal of the battery pack 104 from the vehicle 102. Furthermore, in some embodiments, all of the locks are equipped with indicators which indicate possible failure before, during, or after the battery exchange process.

[00119] An actuator located on board the vehicle 102 actuates one or both of the above described locks. In some embodiments, the actuator is operated by a single 5V 15 mA digital signal, which is sent from an onboard computer system on the vehicle. In some embodiments, the actuator is protected against excessive power flow by indicators. In some embodiments, other types of mechanical or electro-mechanical actuators may be used to remove the safety locks.

[00120] Figure 18 shows a battery bay 108 with several alignment sockets/holes 1802 configured to receive tapered alignment pins 802 disposed on the battery 104. This figure shows an embodiment with two alignment sockets 1802 and alignment pins 802, but in some embodiments, only one alignment socket 1802 and pin 802 are used. In some embodiments, the aligned pins 802 and the alignment holes have keyed shapes different from

one another to prevent backwards or incorrect alignment of the battery pack 104 with the battery bay 108. In some embodiments, at least one compression spring 1806 is mounted to the battery bay 108. The compression springs 1806 are configured to generate a force between the frame 118 battery bay 108 and the battery pack 104 when the battery pack 104 is held and locked at least partially within the cavity 302 of the battery bay 108. Thus, the springs 1806 absorb vertical motion (Y-axis motion) of the battery pack 104 and bay 108 during driving or other operations. Also, the compression springs 1806 help maintain the latches 1920 in contact with the strikers 1924 on the battery locked position, and also help expel the battery 104 from the battery bay 108 when the locks are unlocked. Figure 18 shows compression springs 1806 on either side of each latch 1920. Matching compression springs 1806 on either side of the latches balance each other such that the resulting force on the battery is substantially in a vertical (Y-axis) direction only. Other embodiments use greater or fewer compression springs 1806. In some embodiments, other types of flexible mechanical parts are used to preload the latches. For example, rubber seals are used instead of the springs 1806.

[00121] Figure 18 shows an embodiment having three strikers 1924. The strikers in Figure 18 are not bar shaped, as they are shown in other figures, but instead are rounded cut away portions in the frame 118 of the battery pack 104 itself. Other embodiments employ non-bar shaped strikers as well. In some embodiments, the strikers have different forms. In some embodiments, the strikers contain low friction solutions. Examples of low friction solutions include but are not limited to roller bearings or low friction coatings, as shown in Figure 19A, element 1930.

[00122] Figure 19A shows one embodiment of a latch mechanism 1016, 1018 used by the battery bay transmission assembly 1000. In this embodiment, the latch mechanism 1016, 1018 is a four bar linkage mechanism. The latch mechanism 1016, 1018 comprises a latch housing 1902 which is rigidly attached to the frame of the battery bay. It also comprises a cam shaped input link 1904 rigidly coupled to a respective torque bar at first a pivot point 1906 such that the input link 1904 rotates/pivots together with a torque bar 1012, 1014 around the first pivot point 1906 with respect to the stationary latch housing 1902. The end of the input link 1904 remote from the torque bar is rotatably coupled at second pivot point 1908 to a first rod end 1912 of a coupler link rod 1910. The coupler link rod 1910 has a second rod end 1914 remote from the first rod end 1912 that is pivotably coupled to a latch

1920 at a third pivot point 1918. In some embodiments, the coupler link rod 1910 is a turnbuckle which includes an adjustment bolt 1916 configured to adjust the length of the coupler link rod 1910. The latch 1920 has a fourth pivot point 1922 pivotably connected to another portion of the latch housing 1902. The latch 1920 pivots about an axis, running through the center of the fourth pivot point 1922. In some embodiments, the axis about which the latch pivots at the fourth pivot point 1922 is parallel but distinct from to the axis about which the torque bar 1012, 1014 rotates at the first pivot point 1906. The latch is substantially "V" or hook shaped with the third pivot point 1918 at the apex of the "V." The fourth pivot point 1922 is at an end of the "V" remote from the apex (this end shall be called herein the latch's proximate end 1926). The other end of the "V," is also remote from the apex of the "V" (this other end shall be called the latch's distal end 1928). The distal end 1928 of the latch is configured to engage the bar shaped striker 1924 on the battery pack 104. In some embodiments, the distal end 1928 of the latch 1920 has a hook shape, as shown in Figure 19A, which is configured to cradle the striker 1924 when engaged with the striker (as shown in Figure 19C). The hook shaped distal end 1928 is also useful in engaging and lifting the battery pack 104, at least partially, into the cavity of the battery bay 108 (Figure 3) when engaging/receiving the battery. The striker 1924 may have a low friction element such as a roller bearings or low friction coating 1930.

[00123] As shown in Figure 19A, when the input link 1904 is in a released position, the latch 1920 is configured to mechanically disengage from a corresponding striker 1924 on the battery pack 104. In other words, when the input link 1904 is in a released position, the latch 1920 does not contact the striker 1924. The input link 1904 is driven/rotated, by means of the torque bar 1012, 1014 connected to it.

[00124] Figure 19B shows an intermediate position where the input link 1904 has rotated such that the latch 1920 begins to engage the striker 1924 on the battery pack 104 and begins lifting the battery pack 104, at least slightly into the cavity of the battery bay 108 (Figure 3).

[00125] As shown in Figure 19C, when the input link 1904 is in a fully engaged position, striker 1924 is cradled in the hook shaped distal end 1928 of the latch 1920, and the input link 1904 and coupler link rod 1910 are in a geometric lock configuration. The geometric lock is the position in which the input link 1904 and the coupler link rod 1910 are in vertical alignment with one another with the coupler link rod 1901 in its fully extended

position. In other words, the input link 1904, coupler link rod 1901, and first 1906, second 1908, and third 1918 pivot points are all substantially along the same axis. As such, any movement of the battery pack 104 is converted into compression or tensile forces along the single axis to the stationary latch housing 1902 without rotating any of the pivot points. Because the input link 1904 and coupler link rod 1910 are in a geometric lock they prevent the battery 104 from being released from the battery bay 108, such as while the vehicle 102 is driving. Furthermore, in the geometric lock position, only minimal loads are transferred from the battery pack 104 to the drive components of the vehicle 102.

[00126] In some embodiments, (a) releasing and (b) engaging are done as follows. The (a) releasing a battery pack 104 from the battery bay 108 is performed by means of the transmission assembly 1000 by rotating the latch(s) 1920 on the battery bay 108 to disengage the striker(s) 1924 on the battery pack 104, and (b) engaging a new battery pack 104 in the battery bay 108 is done by means of the transmission assembly 1000 rotating the latch(s) 1920 on the battery bay 108 to engage, lift, and lock the striker(s) 1924 on the battery pack 104. In some embodiments, the (a) releasing occurs in less than one minute. In some embodiments, the (b) engaging happened in less than one minute. In some embodiments, both the (a) releasing of the first battery pack 104 from the battery bay 108 and the (b) engaging of a second battery pack 104 in the battery bay 108 occur in less than one minute.

[00127] In some embodiments, a latch position indicator is utilized to measure whether the latch 1920 is in an engaged or disengaged position. In some embodiments, the latch position indicator communicates the position of the latch 1920 to a computer system in the electric vehicle 102. In some embodiments, other indicators are used throughout the battery pack 104 and battery bay 108 to verify the workings of any or all of the following elements: the first gear lock 1502, the latch lock mechanism 1020, the latch mechanism 1016, 1018, the miter gear set 1002, the torque bars 1010, 1012, the gear shafts 1004, 1006, the electrical connector 804, and the position of the battery pack 104 inside the battery bay 108. In some embodiments, the indicators include switches, Hall sensors, and/or micro-switches. In some embodiments, the alignment devices (such as alignment pins 802 and latch mechanisms 1016, 1018) and position indicators allow the battery pack 104 to be precisely monitored and positioned inside the battery bay 108 in six different degrees of freedom (3 degrees of translation and 3 degrees of rotation.)

[00128] In some embodiments, the battery bay have some or all of the following internal electric indications: **a)** proper/improper connection of the electrical connectors between the battery bay and the battery pack; **b)** open/close indication on each of the individual latches which fasten the battery pack to the battery bay; **c)** open/close indication on each of the safety lock devices; **d)** existence/non existence of the unique key like device which is mentioned in section 14; **e)** in-position/out-of-position of battery pack inside the battery bay in at least three different locations around the battery pack; **f)** excessive/in-excessive temperature measurement in two different locations within the battery bay. (Excessive temperature may be a temperature above 90° C); and **g)** excessive/in-excessive power limits in the quick release actuator.

[00129] Figure 20 is a detailed view of the latch lock mechanism 1020. When the latch mechanism 1016, 1018 is in its lock configuration, with the latch 1920 engaging the striker 1924, the latch lock mechanism 1020 will also be engaged. The latch lock mechanism 1020 is configured to prevent the latch mechanism 1016, 1018 from rotating when engaged. In some embodiments, the latch lock mechanism 1020 comprises a toothed cantilevered lock arm (2002) (also called a lock bolt) configured to engage a corresponding tooth 2010 on the latch 1920. As such, the toothed cantilevered lock arm 2002 is configured to prevent the latch 1920 from rotating when engaged. The toothed cantilevered lock arm 2002 is coupled to a lock synchronization bar 2004, which is configured to disengage the toothed cantilevered lock arm 2002 when rotated. The lock synchronization bar 2004 is also coupled to a lock actuator 2006, which is configured to rotate the synchronization bar 2004. In some embodiments, the lock actuator 2006 includes an electric motor 2008 that rotates the lock synchronization bar 2004 via a gear set or any other suitable mechanism. In some embodiments, the electric motor 2008 is activated by an electric lock or unlock signal. In other embodiments, latch lock mechanism is mechanically activated. In some embodiments, both electrical and mechanical activation is provided, the mechanical activation being useful if any electronic malfunctions occur. In some embodiments, the latch lock mechanism 1020 is configured to disengage only after the gear lock 1502 (shown in Figure 15) has been released.

[00130] The lock synchronization bar 2004 is configured to rotate one or more latch locks 2002 in a first direction so that the one or more latch locks 1920 engage with the latch 1920. The lock synchronization bar 2004 is also configured to rotate the one or more latch

locks 2002 in a second, opposite, direction to disengage the latch locks 2002 from the latch 1920. As such, after the latch locks have been rotated in a second direction, to unlock the latch 1920, the latch is allowed to disengage the striker 1924 by means of the torque bar 1012, 1014 rotation through the four bar linkage latch mechanism 1016, 1018 described above.

[00131] By means of the mechanisms described above, the miter gear set 1002, driven by the electric drive motor 1310, causes the latches 1016, 1018 to rotate opposite one another. When the latches 1016, 1018 on either side of the battery bay 108 rotate away from each other, they release the corresponding strikers 1924 on the battery 104.

[00132] Figure 21 is a flow diagram of a process for releasing a battery pack from a battery bay. In some embodiments, the release process happens as follows. A first latch mechanism, the miter gear lock 1502, is which physically released (2102). In some embodiments, the physical release happens by means of a key 1602 inserted into the key hole 1402 (2104). A second latch mechanism, the latch lock mechanism 1020, releases the one or more latches 1016, 1018 (2106). In some embodiments, the latch lock unlocks when an electric motor 2008, activated by an electronic unlock signal, actuates the lock actuator 2006 which rotates the latch lock 2002 and disengage its tooth from the tooth of the latch 1920 by rotating the lock synchronization bar 2004 (2108). Once both the miter gear lock and the latch lock have been released, the battery 104 is released from the battery bay 108 as follows. The drive motor 1310 actuates a transmission assembly (2110). In some embodiments, the transmission assembly is actuated as follows, the drive motor 1310 rotates the miter gear set, which rotates the gear shafts, which rotate the worm gears, which rotate the torque bars (2112). Specifically, the drive motor rotates the central gear 1302 of the miter gear set 1002 by means of a gear ratio set 1312. As the central gear 1302 rotates it drives the first outer gear 1304 in a first rotational direction and the second outer gear 1306 in a second rotational direction opposite of the first rotational direction. The first outer gear 1304 drives the first gear shaft 1004 in a first rotational direction, while the second outer gear 1306 drives the second gear shaft 1006 in a second rotational direction. The first gear shaft 1004 rotates the first torque bar 1012 by means of the first worm gear set 1008. The second gear shaft 1006 rotates the second torque bar 1014 in a direction opposite that of the first torque bar 1012 by means of the second worm gear set 1010. The rotation of the first torque bar 1012 then causes at least one latch 1920 to rotate and disengage a striker 1924 on the battery 104

(2114). Specifically, the first torque bar 1012, being coupled to the input link 1904, rotates the input link 1904, which actuates the coupler link rod 1910 such that the latch 1920 disengages the striker 1924. In some embodiments, substantially simultaneously, the rotation of the second torque bar 1014 causes the latch mechanism 1018 coupled to the second torque bar 1014 to rotate in a direction opposite that of the latch mechanism 1016 coupled to the first torque bar 1012. As such, latches on either side of the battery bay 108 rotate away from one another to release their respective strikers 1924. (2116) Then the battery pack is translated vertically downward away from the underside of the vehicle. In some embodiments, the battery pack is translated by means of first being lowered onto a platform under the battery and then being further lowered by means of the platform lowering.

[00133] Figure 22 is a flow diagram of a process for engaging a battery pack to a battery bay. To engage a battery 104 at least partially within the battery bay 108 involves substantially the same process described above only in reverse. Specifically, the drive motor 1310 actuates a transmission assembly (2202). In some embodiments, the transmission assembly is actuated as follows, the drive motor 1310 rotates the miter gear set, which rotates the gear shafts, which rotate the worm gears, which rotate the torque bars (2204). Specifically, the drive motor 1310 rotates the central gear 1302 of the miter gear set 1002 in the opposite direction as that used for disengaging a battery 104 by means of a gear ratio set 1312. As the central gear 1302 rotates, it drives the first outer gear 1304 one rotational direction and the second outer gear 1306 in the opposite direction. The first outer gear 1304 drives the first gear shaft 1004 in one direction, while the second outer gear 1306 drives the second gear shaft 1006 in the opposite direction. The first gear shaft 1004 rotates the first torque bar 1012 by means of the first worm gear set 1008. The second gear shaft 1006 rotates the second torque bar 1014 in a direction opposite that of the first torque bar 1012 by means of the second worm gear set 1010. The rotation of the first torque bar 1012 then causes at least one first latch 1920 to rotate and engage a striker 1924 on the battery 104 (2206). Specifically, the first torque bar 1012, being coupled to the input link 1904, rotates the input link 1904, which actuates the coupler link rod 1910 such that the latch 1920 engages the striker 1924. In some embodiments, the first latch is located at the front end of the underside of the vehicle. In some embodiments, substantially simultaneously a second latch located at the back end of the electronic vehicle is also rotated in the same manner (2208).

[00134] Once the strikers are engage, they then vertically lift the battery at least partially into the battery bay of the electronic vehicle (2210). The lifting happens as follows, substantially simultaneously, the rotation of the second torque bar 1014 causes the latch mechanism 1018 coupled to the second torque bar 1014 to rotate in a direction opposite that of the latch mechanism 1016 coupled to the first torque bar 1012. As such, latches on either side of the battery bay 108 rotate towards one another to engage their respective strikers 1924 substantially simultaneously and lift them. Then the battery is secured into the battery bay 108 (2212). Specifically, the latches 1920 hook onto the strikers 1924 and lift the battery until the latches are in their geometric lock (dead center) positions. Once the battery 104 is engaged, the first lock mechanism is engaged. (2214) Specifically, once the four bar mechanism of the latches 1016, 1018 are in their geometric lock positions, the key 1602 is removed from the key hole 1401 and the locking latch 1702 with a locking tooth 1704 engages with the locking gear 1706 (2216). Also, the second lock mechanism is electrically engaged (2218). Specifically, the an electric motor 2008, activated by an electronic unlock signal, actuates the lock actuator 2006 which rotates the latch lock 2002 and engages its tooth with the tooth of the latch 1920 by rotating the lock synchronization bar 2004 (2220).

[00135] In some embodiments, the battery bay 108 is configured to be disposed at the underside of the at least partially electric vehicle 102 such that the releasing and engaging mechanisms described can release an at least partially spent battery 104 and have it replaced by an at least partially charged battery 104 underneath the vehicle 102.

[00136] As described above, in reference to Figures 21 and 22, in some embodiments, the first latch mechanism 1016 and the second latch mechanism 1018 substantially simultaneously rotate in opposite directions about their respective axes. In some embodiments, the at least two latches rotate towards one another to engage, lift, and lock the battery 104 at least partially within the cavity of the battery bay 108. In some embodiments, the at least two latches then rotate away from each other to disengage the battery 104. Similarly, the battery pack 104 is disengaged and unlocked from the at least partially electric vehicle 102 when the latches 1920 of the first latch mechanism 1016 and the second latch mechanism 1018 substantially simultaneously rotate away from one another.

[00137] In some embodiments, it may not be feasible to implement the transmission assembly 1000 (Figure 10) into an automobile due to weight or space constraints. In such

cases, it is necessary to coordinate the operations of multiple individual latches by electronic means.

[00138] Figure 24 is a perspective view of an individual latching unit 2400 in accordance with some embodiments. In some embodiments, multiple latching units 2400 are included in an automobile in order to secure or release a battery pack. The latching unit 2400 includes a housing 2410 and a latch 2420. The housing 2410 encloses additional components that are described in detail with reference to Figures 25A and 25B. The latching unit 2400 may be secured to the automobile by using one or more fasteners (e.g., bolts 2412-1 through 2412-5). The bolts 2412-1 through 2412-5 provide support to reduce or prevent movement of the latching unit with respect to the automobile. The latch 2420 typically rotates about a pivot point to engage or release a striker 2430 of a battery pack. It should be appreciated that a portion of the striker 2430 is included in Figure 24 for illustration purposes only, and the striker 2430 is not part of the latching unit 2400.

[00139] Figures 25A and 25B are close-up side views of internal components in an individual latching unit 2400 in latched and unlatched positions respectively, in accordance with some embodiments. The latching unit 2400 includes a motor 2510 configured to rotate a shaft 2512. The motor 2510 is typically an electric motor. For example, the motor 2510 may include a direct current (DC) motor, an alternating current (AC) motor, a universal motor, a stepper motor, etc. In some embodiments, the motor 2510 may include a plurality of motors configured to operate in conjunction. In other embodiments, the motor 2510 in each latching unit 2510 includes a single motor (as illustrated). In some embodiments, one or more motors reside outside the automobile (e.g., within a battery exchange station). As used herein, the term "a position of the motor" refers to an angular position of the motor (e.g., the angle of rotation by the motor). The position of the motor may be represented in degrees, or by a number of rotations and/or a fraction thereof. Because the motor 2510 is coupled to the shaft 2512, the position of the motor also corresponds to the angle of rotation by the shaft 2512. In some embodiments, the motor 2510 or the shaft 2512 is coupled to a rotation sensor 2530 that detects the position of the motor 2510 (directly or indirectly). In some embodiments, the rotation sensor 2530 detects the rotation of the shaft 2512 or any other rotating part of the motor 2510. In some embodiments, the rotation sensor 2530 counts the rotation or any fraction thereof. In some embodiments, the rotation sensor 2530 counts pulses resulting from the rotation of the shaft 2512 or any other rotating part of the motor 2510. Therefore, the

position and/or speed of the latch movement may be monitored and controlled. In some embodiments, the rotation sensor 2530 comprises one or more encoders.

[00140] The shaft 2512 is coupled to a worm gear 2514 (also called a worm or worm screw), and the worm gear 2514 is coupled with a gear 2516. In Figures 25A and 25B, the gear 2516 is a portion of a spur gear (i.e., a partial gear). The partial gear as opposed to a full spur gear is used in order to reduce the size and weight of the latching unit 2400. Alternatively, the gear 2516 may include a portion of any other gear that is configured to mesh with the worm gear 2514. The combination of the worm gear 2514 and the gear 2516 couples two different axes of rotation (e.g., the axis of rotation for the worm gear 2514 is not parallel to the axis of rotation for the gear 2516). In addition, the combination of the worm gear 2514 and the gear 2516 has a high gear reduction ratio, which increases the torque of the gear 2516. As a result, a compact motor 2510 with a relatively low torque can be used in the latching unit 2400. An additional benefit of the high gear reduction ratio is that a high torque is required to reverse the operation of the worm-gear combination, which reduces the chance that the latch 2420 of the latching unit 2400 rotates backward under the weight of the battery pack. The gear reduction ratio of the worm-gear combination may be selected based on one or more of: the torque and rotational speed of the motor 2510, the desired speed of the latch, the weight of the battery pack, the number of latching units included in the battery bay, the size of the latching unit, and the size and shape of the latch. In some embodiments, multiple gears can be used in combination with the worm gear in order to further increase torque. In some embodiments, a screw and nut arrangement can be used instead or in combination with the worm gear in order to increase torque (e.g., see Figures 30A and 30B).

[00141] The gear 2516 is coupled to the housing 2410 (Figure 24) of the latching unit 2400 at a pivot point 2518, and the gear 2516 is configured to pivot about the pivot point 2518. The gear 2516 is also coupled with a first end 2521 of the push rod 2520. A second, opposite, end 2523 of the push rod 2520 is coupled with the latch 2420 at a connection point 2522. The latch 2420 is configured to pivot about the connection point 2522 with respect to the push rod 2520 (i.e., the push rod 2520 is rotatably coupled to the latch 2420 about the connection point 2522).

[00142] In some embodiments, the latch 2420 includes a bell crank with two arms: a first arm 2524 and a second arm 2526. The first arm 2524 is secured to the housing of the latching unit 2400 at a pivot point 2528. The latch 2420 is configured to pivot about the

pivot point 2528, which is coupled to the housing 2410 (Figure 24). The second arm 2526 is shaped as a hook or latch to engage a striker 2430 of the battery pack. As illustrated, the second arm 2526 includes a curved surface configured to cradle the striker 2430 when engaged and allows the striker 2430 to gradually slip off the latch 2420 when released. The curve is also useful in engaging and lifting the battery pack, at least partially, into the cavity of the battery bay when engaging/receiving the battery. The latch 2420 may have a low friction element such as a roller 2536 or low friction coating for engaging and releasing the battery pack. In some embodiments, the latch 2420 includes the latch 1920 described above with reference to Figures 19A-19C.

[00143] In some embodiments, the battery pack includes one or more bar shaped strikers 2430, which are securely attached to the battery pack housing and configured to carry the entire weight of the battery pack 104, *i.e.*, the battery pack can be suspended from the strikers 2430 when they are engaged with the latches 2420 on the battery bay. It should be appreciated that the striker 2430 is included in Figures 25A-25B for illustration purposes only, and the striker 2430 is not part of the latching unit 2400.

[00144] Figure 25A shows the internal components of the latching unit 2400 when the latching unit is in an engaged position. In the engaged position, the latch 2420 is in contact with the striker 2430 and the striker 2430 is securely cradled in the latch 2420.

[00145] In some embodiments, the size, shape, and position (relative to the position of the gear 2516 and the push rod 2520) of the latch 2420 are predetermined such that the latch 2420, the push rod 2520, and the gear 2516 are configured to form a geometric lock, which adds significant advantage when the battery pack is secured in place. When the geometric lock is formed, the weight of the battery pack is converted at least partially into a compression force along the push rod 2520. Because the pivot point 2518 of the gear 2516 is positioned along the extension of the push rod 2520 when the geometric lock is formed, the compression force along the push rod 2520 does not rotate the gear 2516, thereby helps prevent the accidental release of the battery pack. Therefore, in the geometric lock position, only minimal loads, if any, are transferred from the battery pack to the drive components of the motor 2510.

[00146] The use of the geometric lock and the worm-gear combination prevents unintentional release of the battery pack, and therefore significantly improves the safety of the battery bay.

[00147] In some embodiments, the latching unit also includes one or more stop bolts 2532 to stop the rotation of the gear 2516 at respective limit positions. In some embodiments, one or more limit switches are used to detect the position of the gear 2516 at one of the limit positions. For example, the one or more limit switches are utilized to measure whether the latch 2420 is in an engaged or disengaged position. In some embodiments, the one or more limit switches communicate the position of the latch 2420 to a computer system in a battery bay system, which is discussed in more detail with reference to Figure 27. In some embodiments, other indicators are used throughout the battery pack and battery bay to verify the workings of any or all of the latching units 2400. In some embodiments, the limit switches include mechanical switches, Hall sensors, and/or micro-switches.

[00148] In some embodiments, the readings from the limit switches are used to determine the range of motion for each motor. In some embodiments, the readings from the limit switches are used to prevent damage to the internal components from driving the internal components beyond the limit positions.

[00149] Figure 25B shows the internal components of the latching unit 2400 when the latching unit 2400 is in a released position. In the released position, the latch 2420 is rotated so that the striker 2430 is free to move down to release/remove the battery pack from the vehicle.

[00150] The latching unit 2400 transitions from the engaged position (Figure 25A) to the released position (Figure 25B) by actuating the motor 2510 in a first direction, which rotates the shaft 2512, which in turn rotates the worm gear 2514. The worm gear 2514 rotates the gear 2516 about the pivot point 2518, which moves the push rod 2520, which in turn rotates the bell crank about the pivot point 2528, thereby releasing the latch 2420 from the striker 2430. The latching unit 2400 transitions from the released position (Figure 25B) to the engaged position (Figure 25A) by actuating the motor 2510 in a second direction opposite to the first direction, which in turn moves the internal components in respective opposite directions.

[00151] In some embodiments, the latching unit 2400 includes one or more plungers 2534 configured to apply downward force on the battery pack when the battery pack is fully engaged. This preloading feature maintains compressive force on the battery pack and compensates for material creep, thermal expansion/contraction of elements, and any other

free movement of the battery pack. Thus, the preloading reduces the vibration and/or motion of the battery pack relative to the latching unit 2400.

[00152] Figures 30A and 30B are close-up views of selected internal components in an individual latching unit in accordance with some embodiments. In Figure 30A, a motor 3002 is coupled with a worm gear 3004. The worm gear 3004 and a gear 3006 form a gear assembly. The gear 3006 is coupled with a lead screw 3008. In some embodiments, the lead screw 3008 has trapezoidal threads or Acme threads. A nut 3010 rigidly mounted at the end of a hollow push rod 3012 is rotatably coupled with the lead screw 3008. The push rod 3012 is coupled with a latch 3014.

[00153] Figure 30B illustrates the rotatable coupling of the lead screw 3008 and the nut 3010. A rotation of the worm gear 3004 rotates the gear 3006, which in turn rotates the lead screw 3008. The rotation of the lead screw 3008 translates the nut 3010 along the lead screw 3008, which in turn moves the push rod 3012 and the latch 3014. The use of the lead screw 3008 and the nut 3010 further increases torque and therefore the latching unit can handle heavier load without increasing the size of the motor. In some embodiments, the lead screw 3008 is configured to self-lock, which prevents the latch 3014 from opening under the weight of the battery pack when the motor 3002 is not energized (i.e., the motor 3002 does not provide any torque to prevent the latch 3014 from opening).

[00154] In some embodiments, the motor 3002 is directly coupled to the lead screw, thereby eliminating the use of the worm gear 3004 and the gear 3006.

[00155] Figure 26 is a perspective view of a battery pack secured with multiple latching units in accordance with some embodiments. In Figure 26, a battery pack 2602 is secured with multiple latching units 2604-1 through 2604-4. Each latching unit 2604 is secured to an automobile (in particular to a battery bay of the automobile). In some embodiments, the battery pack is secured with at least two latching units (e.g., two, three, four, or more latching units may be used in different embodiments). However, the number of latching units 2604 can be determined at least based on the weight of the battery pack, the size and shape of the battery pack, the torque of a motor in each latching unit, and the gear reduction ratio for each latching unit.

[00156] As shown in Figure 26, the plurality of latching units 2604 is mechanically configured for independent operation. In other words, multiple latching units 2604 shown in

Figure 26 are not interconnected mechanically (except for the fact that they are all secured to the battery bay of the automobile) as compared to the latch mechanism shown in Figure 10. Therefore, each latching unit 2604 shown in Figure 26 is separately controllable.

[00157] Each latching unit 2604 has a latch configured to engage with the battery pack (in particular with a respective striker of the battery pack). Each latching unit 2604 is rigidly attached to the frame of the battery bay. A respective latch of each latching unit 2604 is typically configured to rotate so as to engage or disengage with the battery pack. Each latching unit 2604 (e.g., 2604-1) is configured to synchronize the position of its latch with the positions of the latches in other latching units 2604 (e.g., 2604-2 through 2604-4) so as to prevent tipping of the battery pack during loading or unloading. In other words, the latching units enable vertical lifting of the battery pack. The alignment between the battery pack and the automobile is maintained during the vertical lifting.

[00158] Figure 27 is a block diagram illustrating a battery bay system 2700 for controlling multiple latching units in accordance with some embodiments. The battery bay system 2700 typically includes one or more processors (e.g., CPUs) 2702, memory 2704, one or more network or other communications interfaces 2706, and one or more communication buses 2714 for interconnecting these components. In some embodiments, communication buses 2714 include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. In some other embodiments, the battery bay system 2700 includes a user interface (not shown) (e.g., a user interface having a touch-sensitive display and/or a voice recognition system) for displaying the status of the battery bay system.

[00159] The communication interface(s) 2706 includes a sensor interface 2710 and a motor driver 2712. The motor driver 2712 is connected to motors (e.g., 2770-1 through 2770-x) each included in a respective latching unit. The motor driver 2712 typically provides respective inputs to respective motors to actuate the respective motors. Depending on the type of the motors (e.g., stepper motors v. direct current motors), a respective input generated by the motor driver 2712 may be of a particular current or voltage, or a current or voltage of a particular waveform. The sensor interface 2710 is connected to, and receives signals from, sensor sets (e.g., 2772-1 through 2772-x) each coupled with a respective latching unit. In some embodiments, a respective sensor set 2772 includes one or more of: an encoder 2774 (as an exemplary rotation sensor) and a limit switch 2776. In some embodiments, the sensor

interface 2710 also processes the signals received from the sensor sets 2772 (e.g., filters, amplifies, converts analog signals to digital signals, etc.). In some embodiments, the sensor interface 2710 is connected to one or more battery sensors 2774, which detects the presence or absence of the battery, the voltage and/or current of the battery, and/or the temperature of the battery.

[00160] The communication interface(s) 2706 optionally includes a network communication interface 2708 for communication with other computers based on one or more communications networks, such as the Internet, wireless networks, other wide area networks, local area networks, metropolitan area networks, and so on.

[00161] Memory 2704 of the battery bay system 2700 includes high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and may include non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory 2704 may optionally include one or more storage devices remotely located from the CPU(s) 2702. Memory 2704, or alternately the non-volatile memory device(s) within memory 2704, comprises a non-transitory computer readable storage medium for storing information. In some embodiments, memory 2704 or the computer readable storage medium of memory 2704 stores the following programs, modules and data structures, or a subset thereof:

- Operating System 2716 that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- Communication Module (or instructions) 2718 that is used for connecting the battery bay system 2700 to other computers (e.g., other processors of the automobile or other servers at a charging station, exchange station, or control center) via one or more communications interfaces 2706 (e.g., based on a direct connection or based on one or more communications networks, using the network communication interface 2708);
- Sensor Reader Module 2720 that receives signals from the sensor interface 2710;
- Motor Driver Module 2722 that controls motor driver 2712 for actuating motors (e.g., 2770-1 through 2770-x);
- Application(s) 2724 that includes a latch control application 2726 for controlling multiple latching units; and/or

- Other Modules 2728, which may be included to improve the operation of the battery bay system 2700 (e.g., modules for self-test of the battery bay system 2700, and safety modules that interrupt the operations of the latch control application 2726 when one or more predefined conditions are identified).

[00162] Notwithstanding the discrete blocks in Figure 27, these figures are intended to be a functional description of some embodiments rather than a structural description of functional elements in the embodiments. One of ordinary skill in the art will recognize that an actual implementation might have the functional elements grouped or split among various components. In practice, and as recognized by those of ordinary skill in the art, items shown separately could be combined and some items could be separated. For example, in some embodiments, the sensor reader module 2720 and the motor driver module 2722 are part of a same module. In other embodiments, the communication module 2718 is part of the operating system 2716. In some embodiments, the operating system 2716 and the latch control application 2726 are integrated. In some embodiments, memory 2704 may store a subset of the modules identified above. Furthermore, memory 2704 may store additional modules and data structures not described above.

[00163] In some embodiments, the battery bay system 2700 is implemented in the electric vehicle (e.g., vehicle 102, Figure 1). In other embodiments, the battery bay system 2700 is implemented in a battery exchange station (e.g., battery exchange station 134, Figure 1). Alternatively, battery bay system 2700 may be implemented as a distributed system. For example, one or more functional elements may be implemented in the electric vehicle and other functional elements may be implemented in the battery exchange station.

[00164] Figure 28 is a flow diagram illustrating a method 2800 for controlling latching units in accordance with some embodiments. The method 2800 is used for securing and releasing a battery pack from a battery bay of an at least partially electric vehicle. The method 2800 is performed at a battery bay system (e.g., battery bay system 2700, Figure 27) that includes multiple latching units each separately controllable and having a latch configured to couple to the battery pack (e.g., the latching unit 2400, Figure 24).

[00165] The battery bay system actuates (2802) each of the latching units to rotate its respective latch to engage or disengage with the battery pack. For example, the battery bay actuates each latching unit to rotate its latch from the engaged position (Figure 25A) to the

disengaged position (Figure 25B) or from the disengaged position (Figure 25B) to the engaged position (Figure 25A).

[00166] The battery bay system measures (2804) a position of each respective latch of the latching units. For example, the battery bay system may measure the angle of rotation for each motor 2510 (Figure 25A) in a respective latching unit using a respective rotation sensor 2530 (Figure 25A), and determines the position of each latch 2420. In some cases, a lookup table that correlates the angular position of the motor to a position of the latch may be used. In some cases, the angular position of the motor may be directly used as representing the position of a respective latch.

[00167] In some embodiments, the measuring includes (2806) determining the speed of each respective latch of the latching units. For example, the battery bay system may determine the speed of each latch based on the change in the angular position of a respective motor over time.

[00168] The battery bay system individually controls (2808) each of the latching units based on the position of its respective latch to synchronize the positions of all latches. In some embodiments, the battery bay system compares the positions of all latches, and if the difference between the highest position (e.g., a highest value among values corresponding to the positions of latches) and the lowest position (e.g., a lowest value among values corresponding to the positions of latches) exceeds a predefined threshold, the battery bay system adjusts the position and/or speed of at least one of the latches. For example, when the battery bay system determines that the difference between the highest position and the lowest position exceeds the predefined threshold while the battery bay system is securing a battery pack by moving all latches from disengaged positions to engaged positions (e.g., raising the latches), the battery bay system may stop the movement of the latch that has the highest position until the difference between the highest position and the lowest positions falls below the predefined threshold. In other words, the battery bay system allows the latch with the lowest position to catch up with the latch with the highest position. In another example, instead of stopping the latch with the highest position, the battery bay system may slow down the movement of the latch with the highest position while maintaining the speed of the rest of the latches. Alternatively, the battery bay system may increase the speed of the latch with the lowest position, if feasible, while maintaining the speed of the rest of the latches. In yet another example, the battery bay system may increase the speed of the latch with the lowest

position and decrease the speed of the latch with the highest position while maintaining the speed of the rest of the latches.

[00169] In some embodiments, the battery bay system individually controls (2810) each of the latching units to synchronize the speed of all latches.

[00170] In some embodiments, actuating each of the latching units includes (2812) providing a respective input to a respective latching unit of the latching units, and individually controlling each of the latching units includes adjusting the respective input to the respective latching unit. In some embodiments, the respective motor 2510 (Figure 25A) in the respective latching unit includes a direct current (DC) motor, and the battery bay system adjusts the voltage and/or current provided to the DC motor.

[00171] In some embodiments, the respective input includes (2814) a pattern of voltage or current. In some embodiments, a respective motor 2510 in a respective latching unit includes a stepper motor that requires current of one or more waveforms (e.g., four phases of step waveforms or sinusoidal waveforms), and the battery bay system adjusts the one or more waveforms to adjust the position and/or speed of the stepper motor such that the position and/or speed of the latch in the respective latching unit is adjusted (e.g., the one or more waveforms may be stretched in time to slow down the stepper motor).

[00172] In some embodiments, the position of each respective latch includes (2816) an angular position of each respective latch. In some embodiments, the angular position of each respective latch includes the angular position of a corresponding motor. In other words, the angular position of a driving motor may be used to represent the angular position of the respective latch.

[00173] In some embodiments, the position of each respective latch is determined (2818) by a respective limit switch. For example, the position of each respective latch is determined when the respective limit switch is activated. In some embodiments, the respective limit switch includes a mechanical or electrical switch that is activated when at least one component of the latching unit is at a limit position. For example, the gear 2516 (Figure 25A) and the respective limit switch may be positioned such that the gear 2516 presses and therefore activates the respective limit switch when the latch is in a fully engaged or fully disengaged position. In some embodiments, the respective limit switch is positioned such that the respective latch presses and therefore activates the respective limit switch when the latch is in a fully engaged or fully disengaged position. In some embodiments, the

respective latching unit includes two respective limit switches, a first limit switch configured to be activated when the latch is in a fully engaged position and a second limit switch configured to be activated when the latch is in a fully disengaged position. In some embodiments, the respective limit switch includes a current limit switch. Typically, the current limit switch does not include a physical switch for monitoring the position of a respective latch. Instead, the position of the respective latch is determined to be at a limit position by monitoring an electrical input to the respective latching unit (e.g., using a current sensor). For example, when a motor current for the respective latching unit reaches a predefined threshold, the respective latching unit is determined to be at a limit position. When at least one of the latches reach the limit position (e.g., the position that activates a respective limit switch), the battery bay system stops one or more motors of the one or more latching units that include latches that have reached one or more respective limit positions (e.g., by stopping the driving inputs or providing inputs only sufficient to maintain their positions) while actuating the rest of the motors until all latches reach respective limit positions.

[00174] Although the method 2800 is illustrated as a linear flow of operations in Figure 28, in some embodiments, the method 2800 is performed as part of a feedback loop. Figure 29 is a flow diagram illustrating a method 2900 for controlling latching units in accordance with some embodiments. As illustrated, the method 2900 involves a feedback loop, and some of the operations shown in Figure 29 correspond to operations shown in Figure 28. Therefore, some of the details described above with respect to Figure 28 apply to operations described in Figure 29. For brevity, these are not repeated.

[00175] The battery bay system measures (2904) a position of each respective latch 2420 of the latching units 2400. The battery bay system determines (2906) whether all the latches 2420 are in final positions. If they are (i.e., yes), the method 2900 is terminated. If not all the latches 2420 are in final positions (i.e., no), the battery bay system determines (2908) whether all the latches 2420 are in sync. If all the latches 2420 are in sync (i.e., yes), the battery bay system further actuates (2910) all motors 2510 of the latching units 2400. If not all the latches 2420 are in sync (i.e., no), the battery bay system adjusts (2912) the position of the one or more out-of-sync motors 2510. Thereafter, the battery bay system repeats at least a subset of the above-described operations (e.g., operations 2904 through 2912) until all the latches 2420 are in final positions.

[00176] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A method for securing and releasing a battery pack from a battery bay of an at least partially electric vehicle, the battery bay including multiple latching units each separately controllable and having a latch configured to couple to the battery pack, the method comprising:

actuating each of the latching units to rotate its respective latch to engage or disengage with the battery pack;

measuring a position of each respective latch of the latching units; and

individually controlling each of the latching units based on the position of its respective latch to synchronize the positions of all latches.

2. The method of claim 1, including individually controlling each of the latching units to synchronize the speed of all latches.

3. The method of claim 1, wherein:

actuating each of the latching units includes providing a respective input to a respective latching unit of the latching units; and

individually controlling each of the latching units includes adjusting the respective input to the respective latching unit.

4. The method of claim 3, wherein the respective input includes a pattern of voltage or current.

5. The method of claim 1, wherein the position of each respective latch includes an angular position of each respective latch.

6. The method of claim 1, wherein the position of each respective latch is determined by a respective limit switch.

7. The method of claim 1, wherein the measuring further comprises determining the speed of each respective latch of the latching units.

8. A system for supporting a battery pack, comprising:

multiple latching units each separately controllable and having a latch configured to couple to the battery pack, wherein:

a respective latch of each latching unit is configured to rotate so as to engage or disengage with the battery pack; and

each latching unit is configured for actuation based on a position of its respective latch to synchronize the positions of all latches.

9. The system of claim 8, wherein the plurality of latching units is mechanically configured for independent operation.

10. The system of claim 8, further comprising:

one or more processors; and

memory storing one or more programs for execution by the one or more processors, the one or more programs including instructions for individually controlling each of the latching units to synchronize the speed of all latches.

11. The system of claim 10, wherein the one or more programs include instructions for:

actuating each of the latching units by providing a respective input to a respective latching unit of the latching units; and

individually controlling each of the latching units by adjusting the respective input to the respective latching unit.

12. The system of claim 11, wherein the respective input includes a pattern of voltage or current.

13. The system of claim 10, wherein the one or more programs include instructions for determining the speed of each respective latch of the latching units.

14. The system of claim 8, wherein the position of each respective latch includes an angular position of each respective latch.

15. The system of claim 8, wherein the position of each respective latch is determined by a respective limit switch.

16. A latching unit for supporting a battery pack, the latching unit comprising:

a motor having a rotatable shaft;

a worm gear coupled to the rotatable shaft;

a gear coupled with the worm gear, wherein the gear is a partial gear;

a push rod coupled with the gear at a first end of the push rod;

a latch including two arms, wherein a joint of the two arms is coupled with the push rod at a second end of the push rod, a first arm of the two arms is rotatably pivoted, and a second arm of the two arms is shaped as a hook to engage a striker of the battery pack;

a rotation sensor configured to detect a position of the motor;

one or more bolts each configured to stop the rotation of the gear at a respective limit position;

one or more limit switches each configured to detect a position of the gear at one of the respective limit positions; and

a plunger configured to preload the battery pack by applying downward force on the battery pack when the battery pack is fully engaged.

17. The latching unit of claim 16, wherein the rotation sensor comprises one or more rotary encoders.

18. The latching unit of claim 16, wherein the one or more limit switches include one or more current limit switches.

19. The latching unit of claim 16, wherein the gear, the push rod, and the latch are configured to move between a released position and a fully engaged position.

20. The latching unit of claim 19, wherein the gear and the push rod are positioned and sized such that a pivot of the gear lines up with the push rod when the latching unit is in the fully engaged position.

21. The latching unit of claim 19, wherein the gear, the push rod, and the latch are configured to form a geometric lock when the latching unit is in a fully engaged position.

22. The latching unit of claim 16, wherein the two arms are substantially perpendicular to each other.

23. An apparatus for supporting a battery pack, the apparatus comprising:

a worm gear coupled with a motor;

a gear coupled with the worm gear, wherein the gear is a partial gear;

a push rod coupled with the gear; and

a latch including two arms, wherein a joint of the two arms is coupled with the push rod, a first arm of the two arms is rotatably pivoted, and a second arm of the two arms is shaped as a hook to engage a striker of the battery pack.

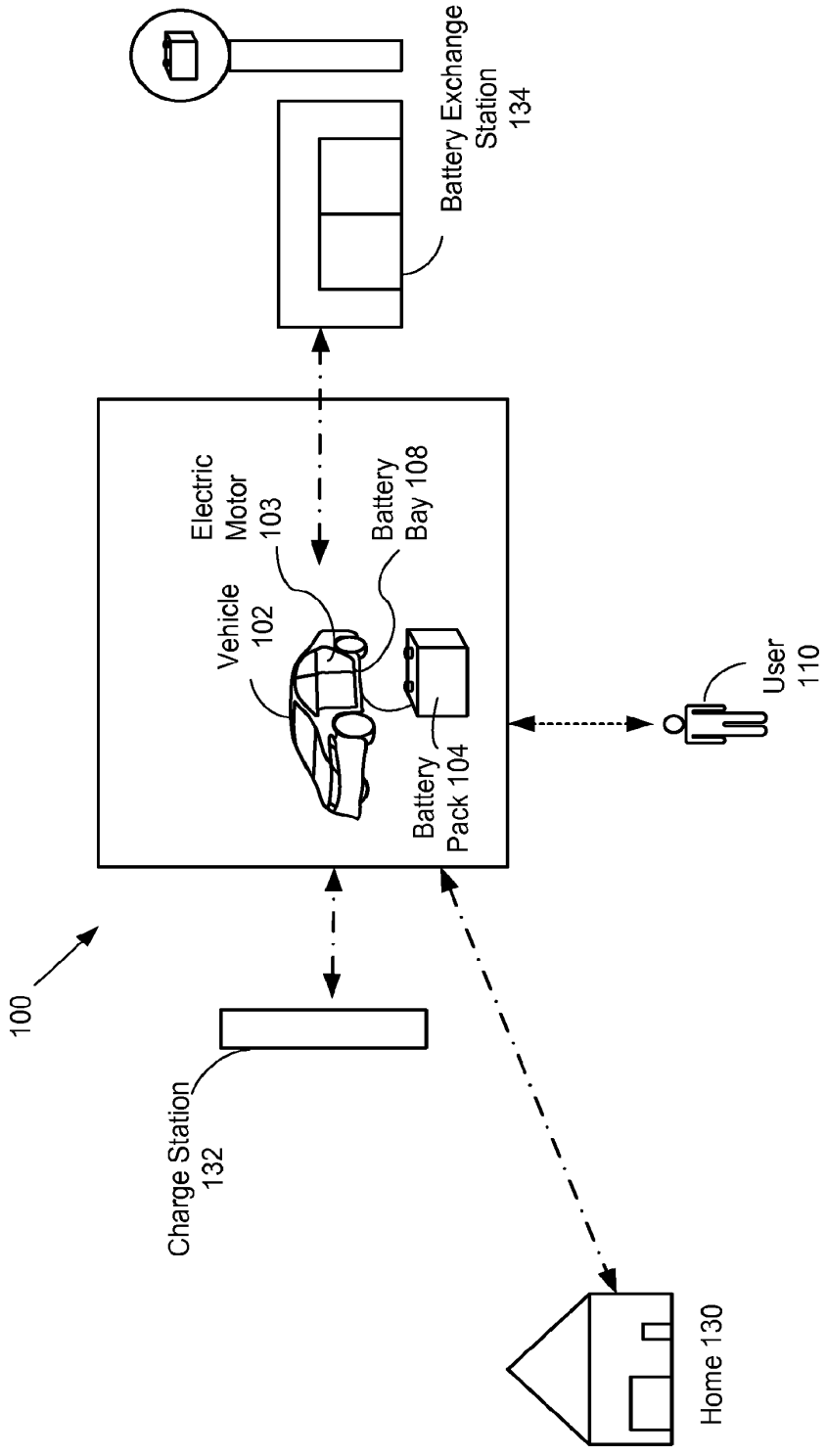

Battery Exchange Station 134
Electric Motor 103
Battery Bay 108
Vehicle 102
Battery Pack 104
User 110
100
Charge Station 132
Home 130

FIG. 1

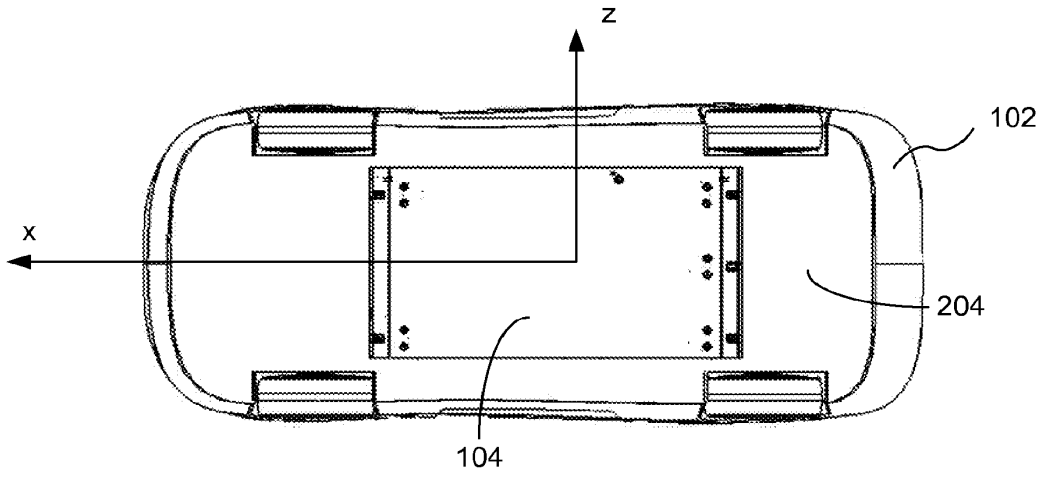


FIG. 2A

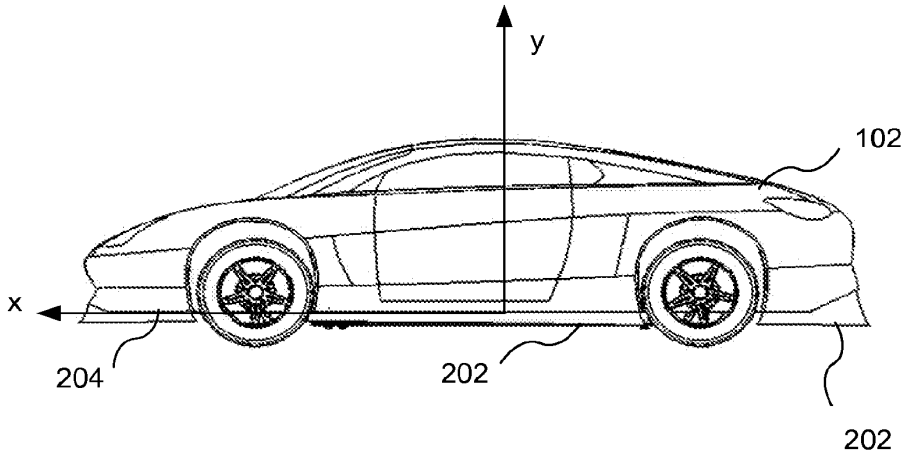


FIG. 2B

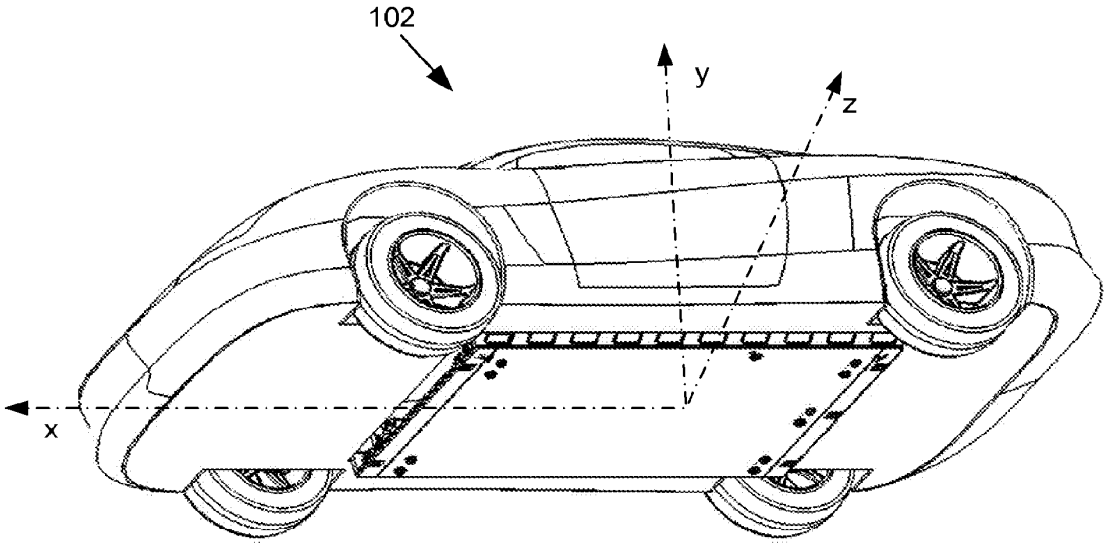


FIG. 3A

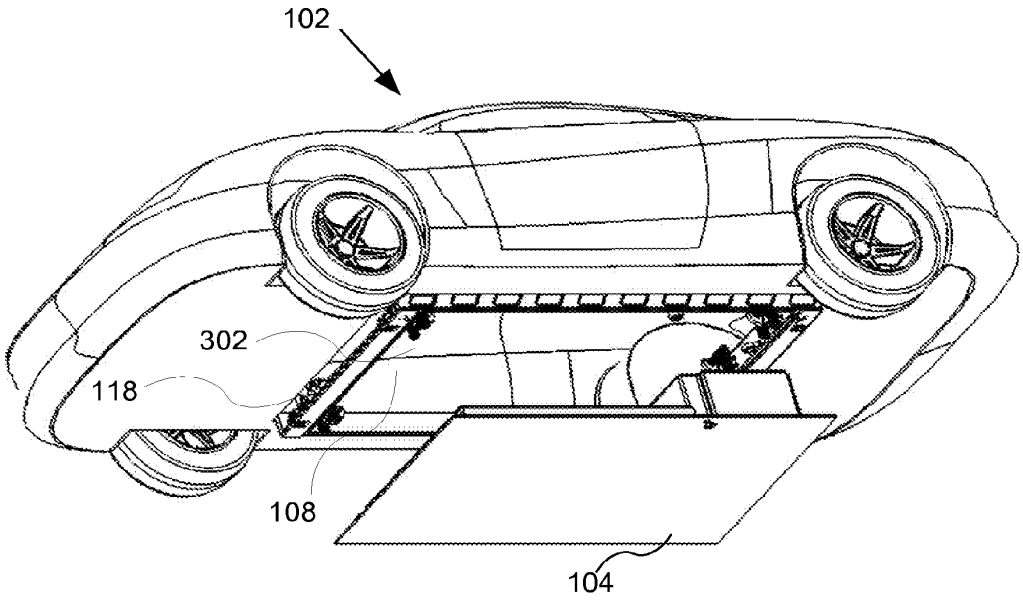


FIG. 3B

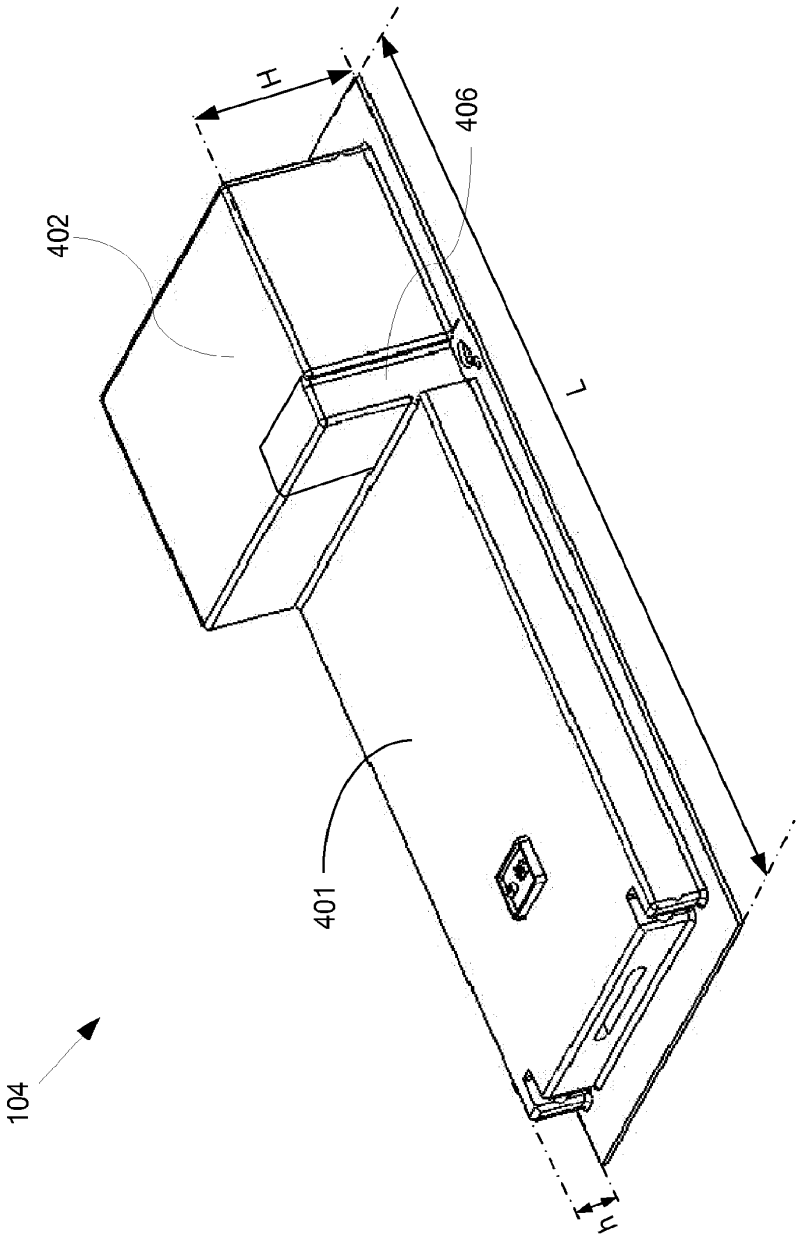


FIG. 4

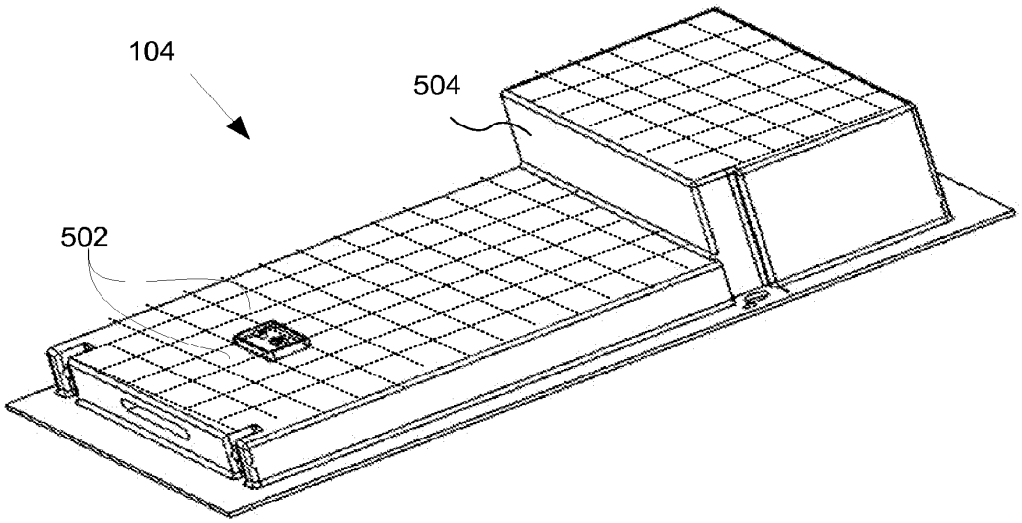


FIG. 5

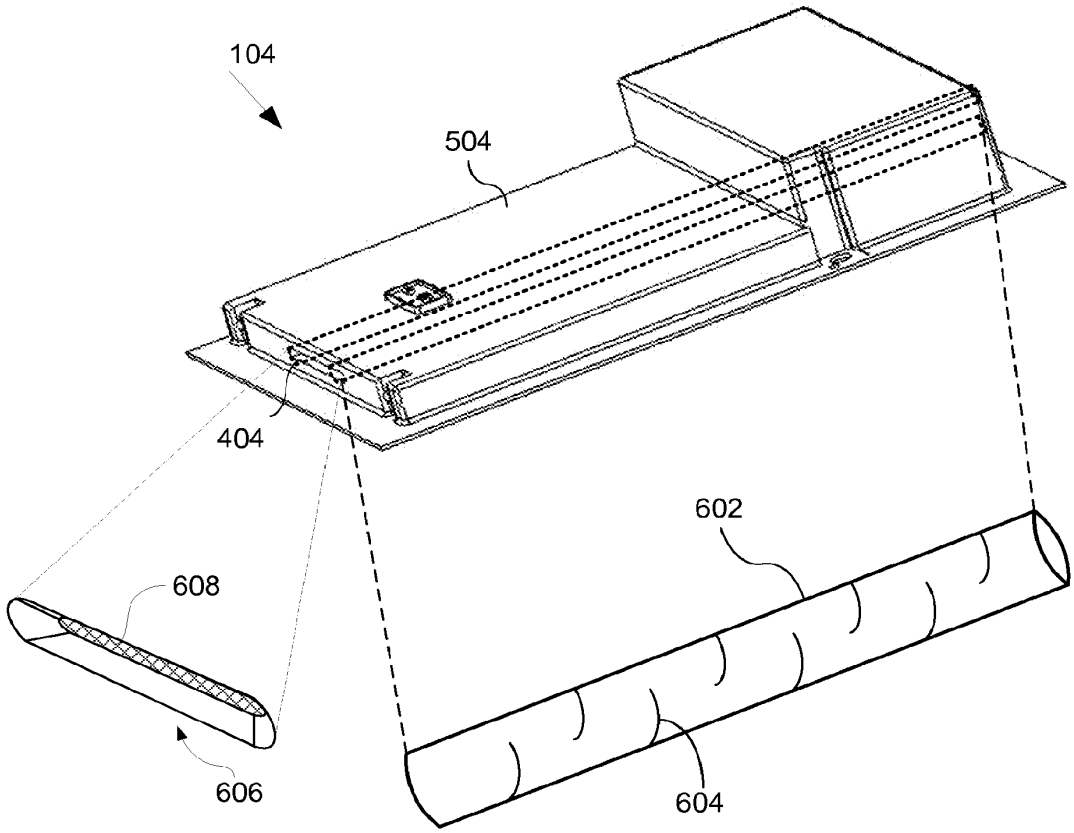


FIG. 6

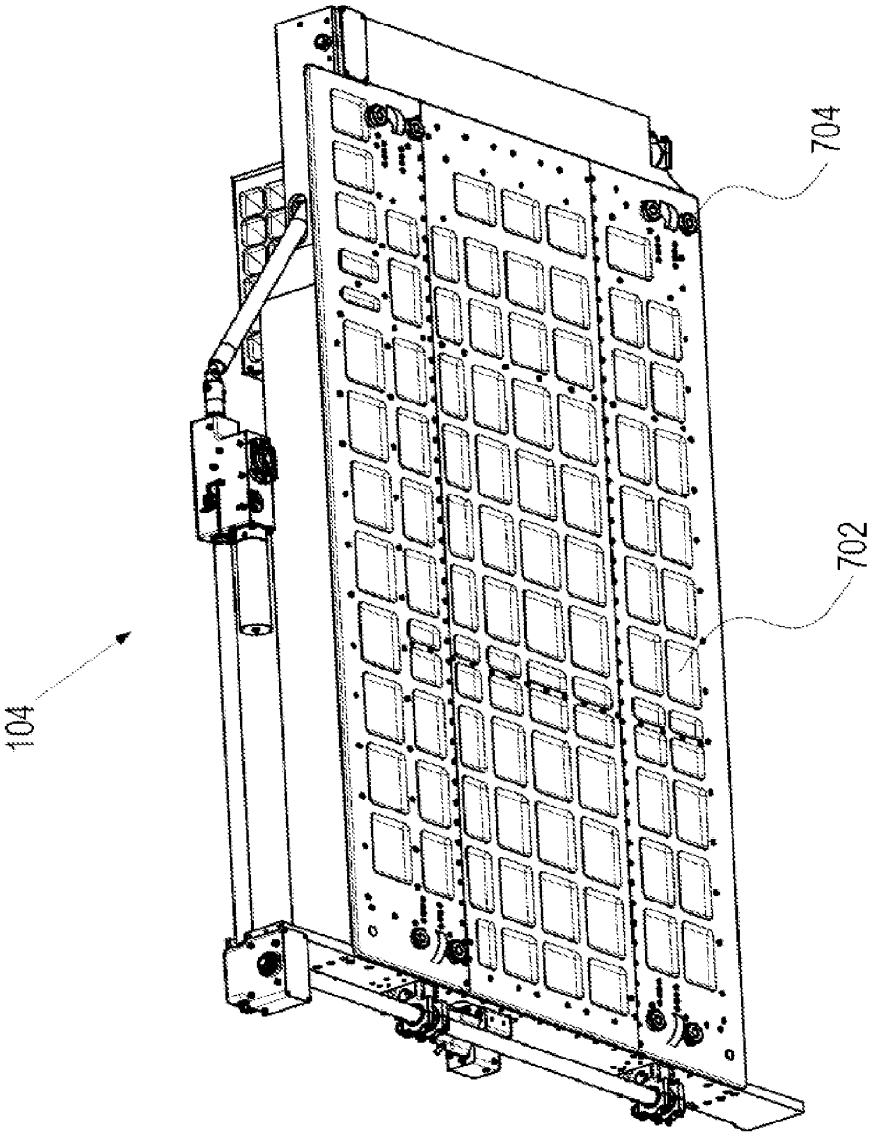


FIG. 7

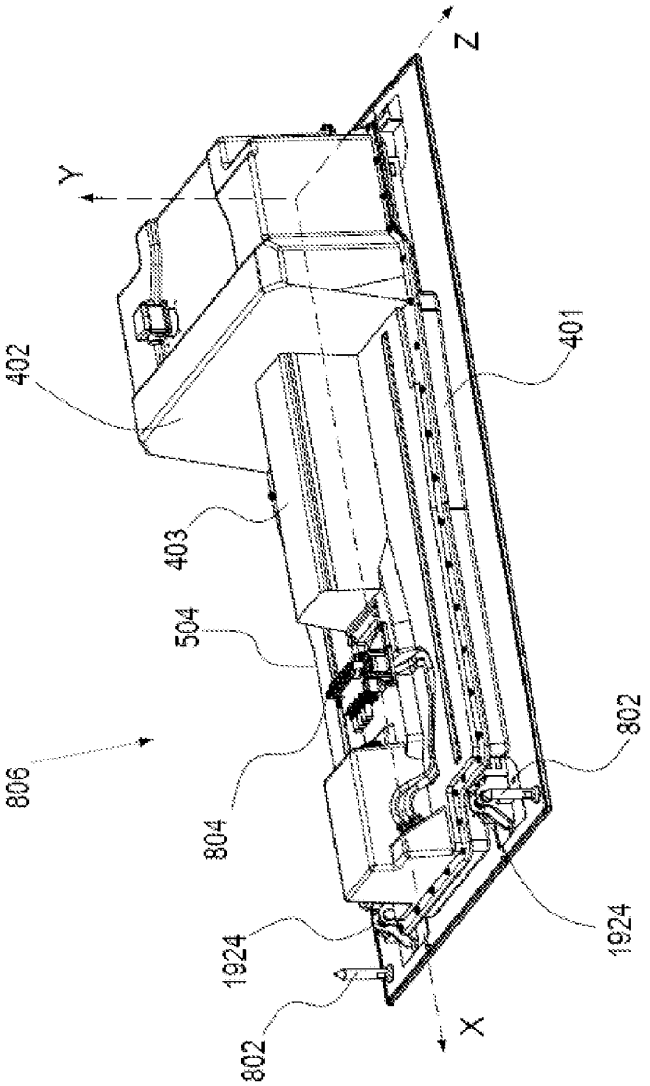


FIG. 8

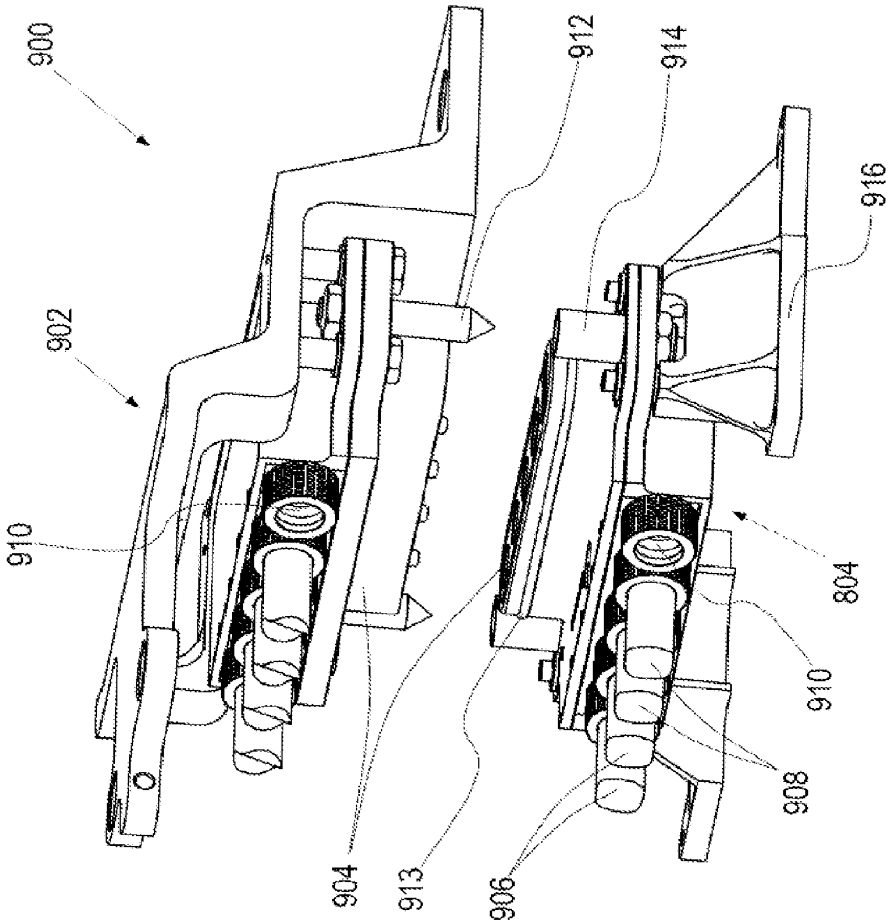


FIG. 9

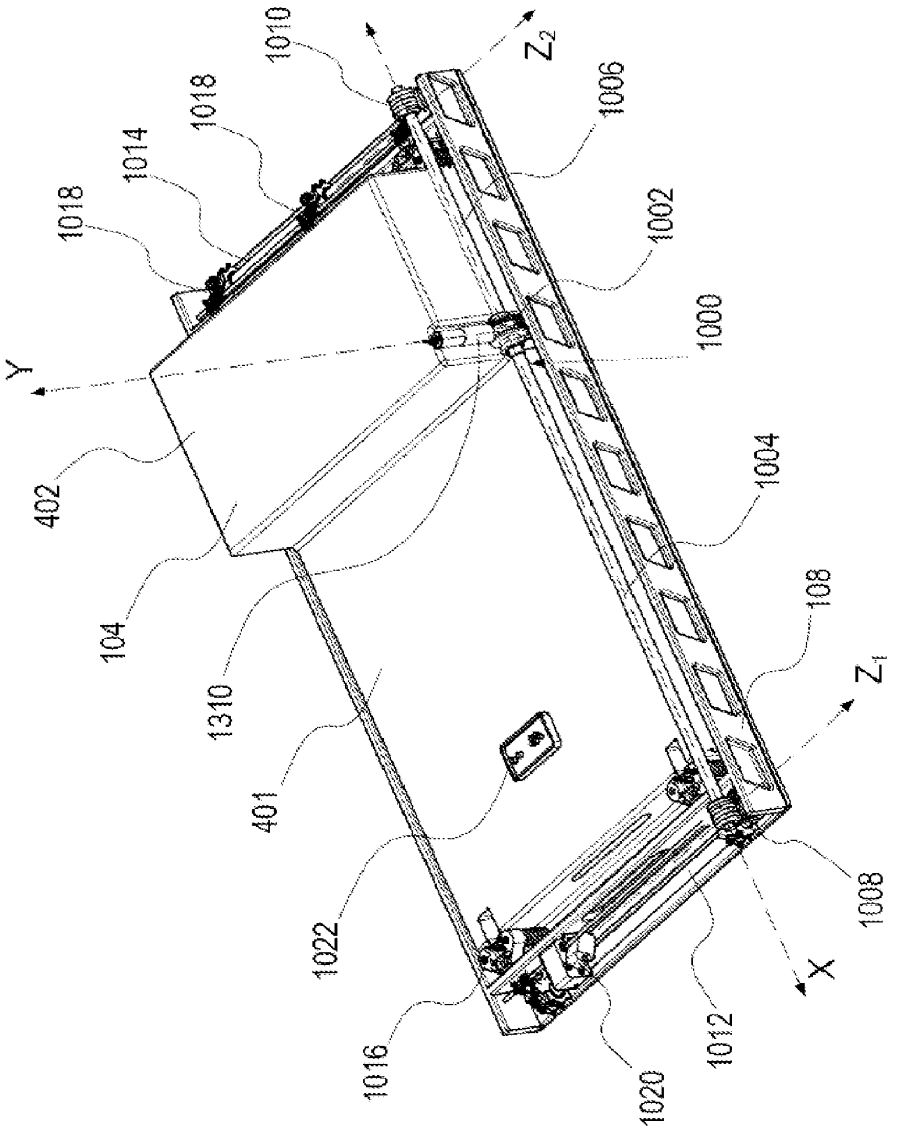

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Z_2
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1012
1020

FIG. 10

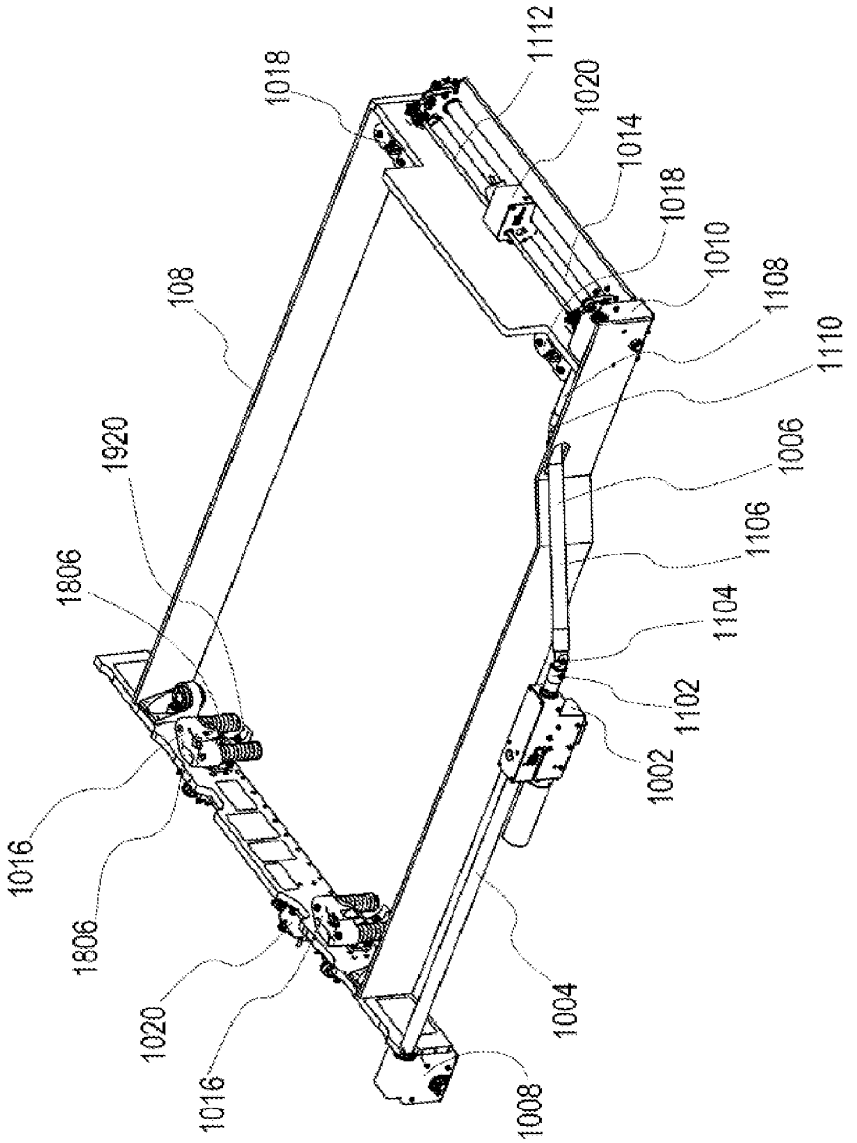

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FIG. 11

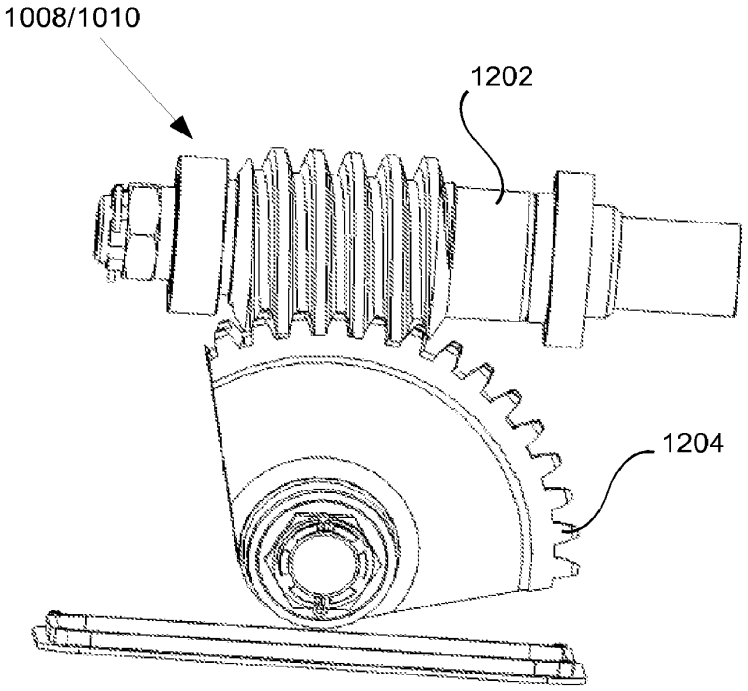


FIG. 12

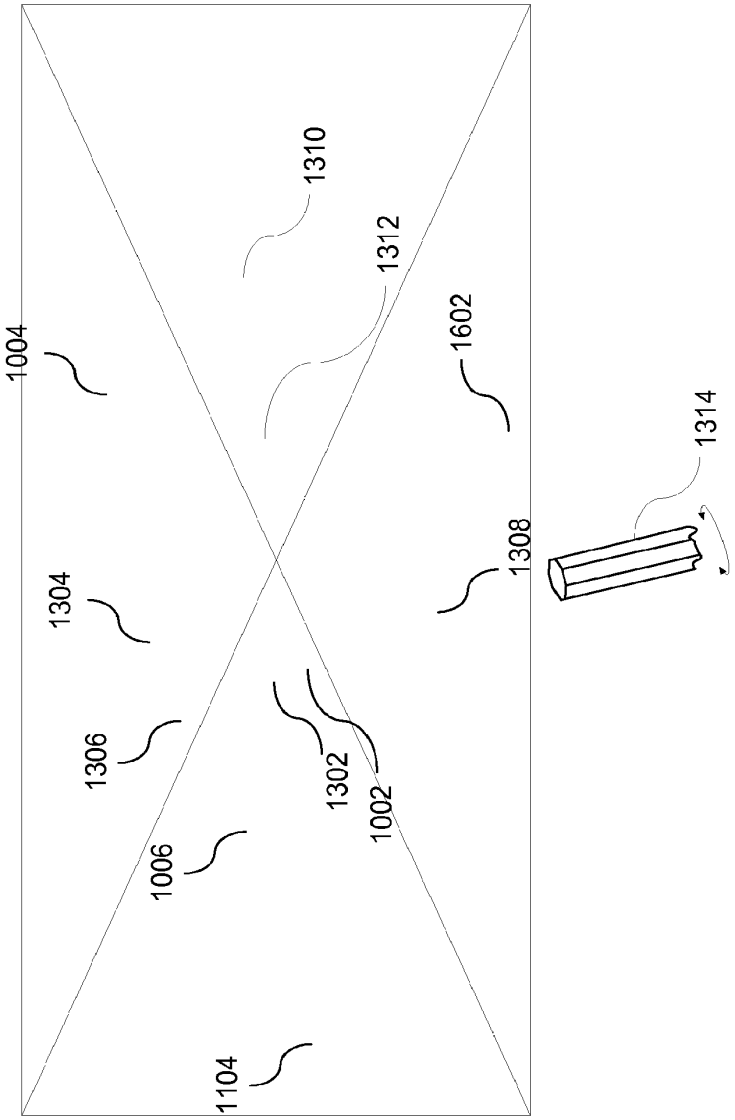


FIG. 13

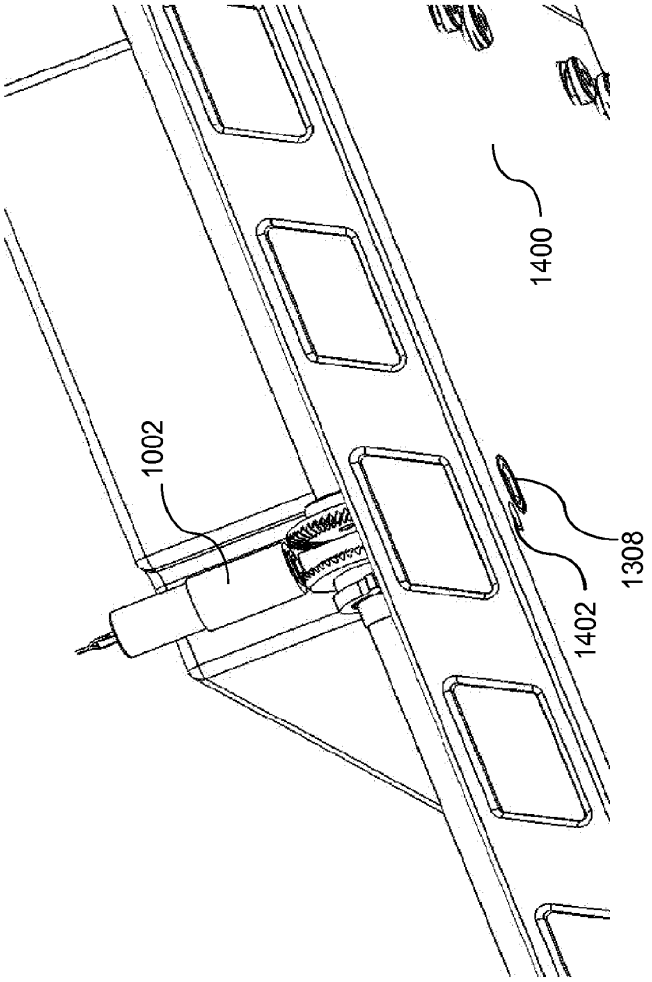


FIG. 14

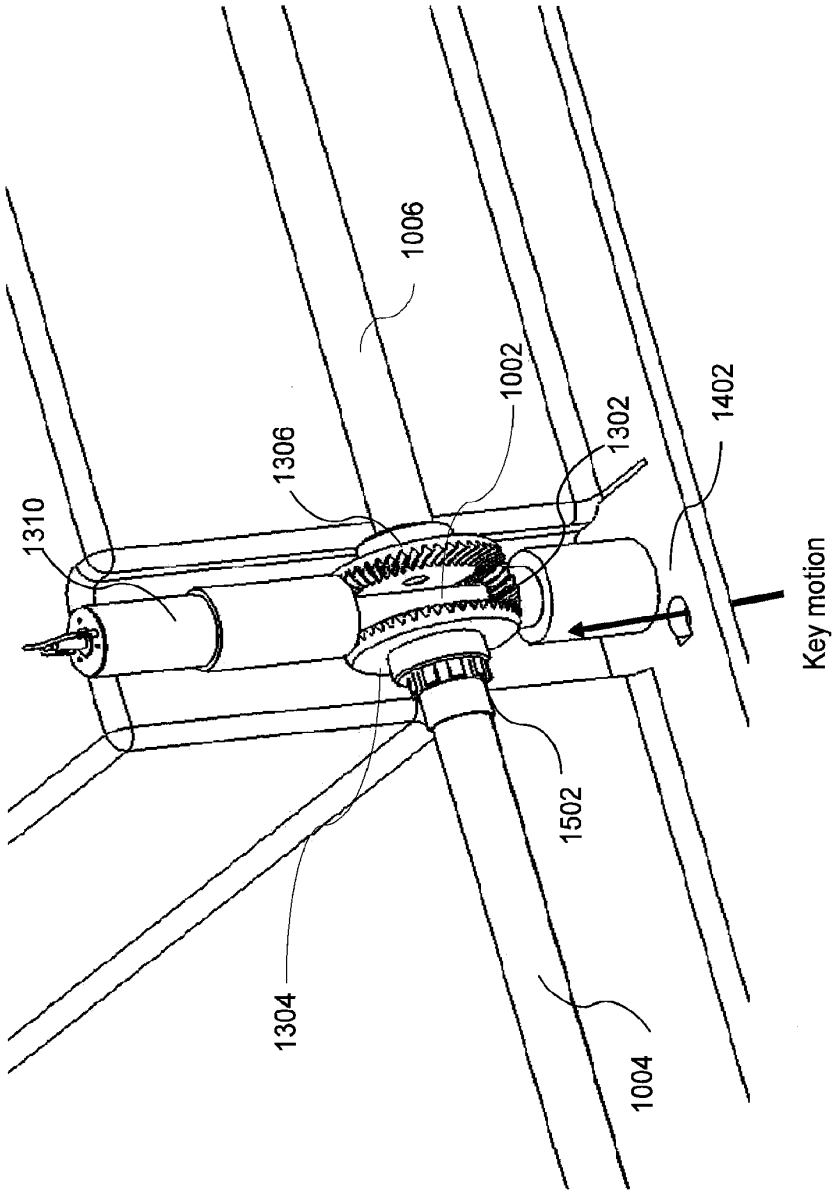


FIG. 15

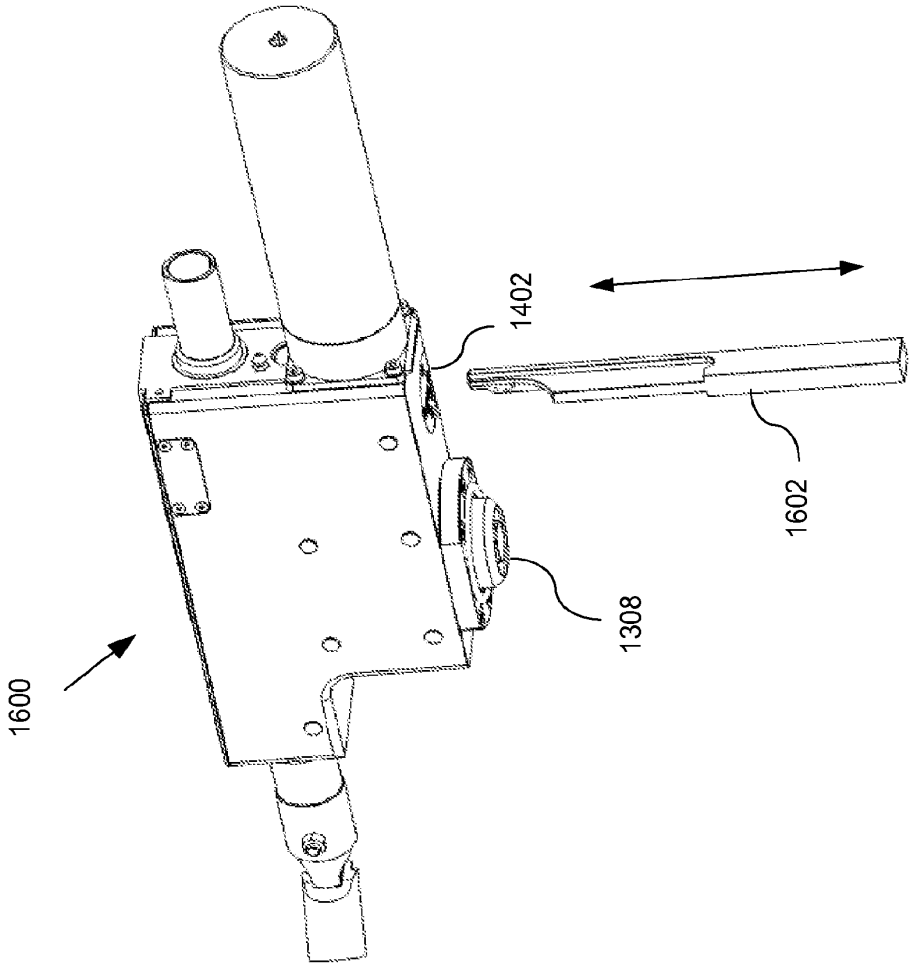


FIG. 16

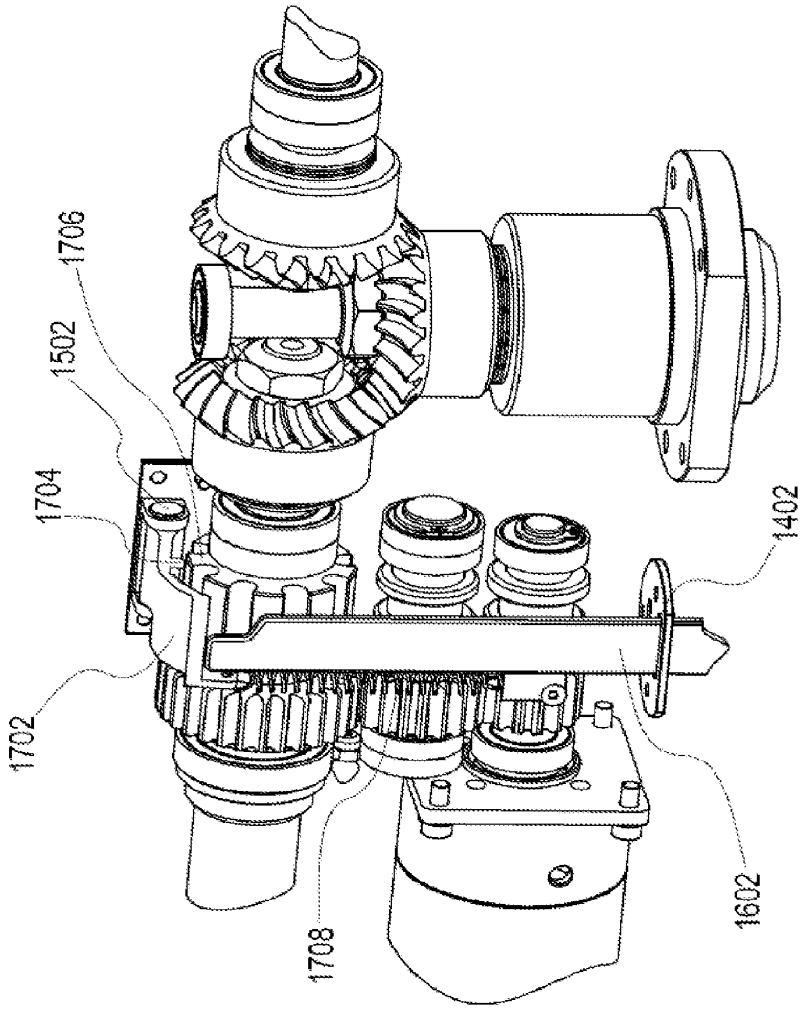


FIG. 17

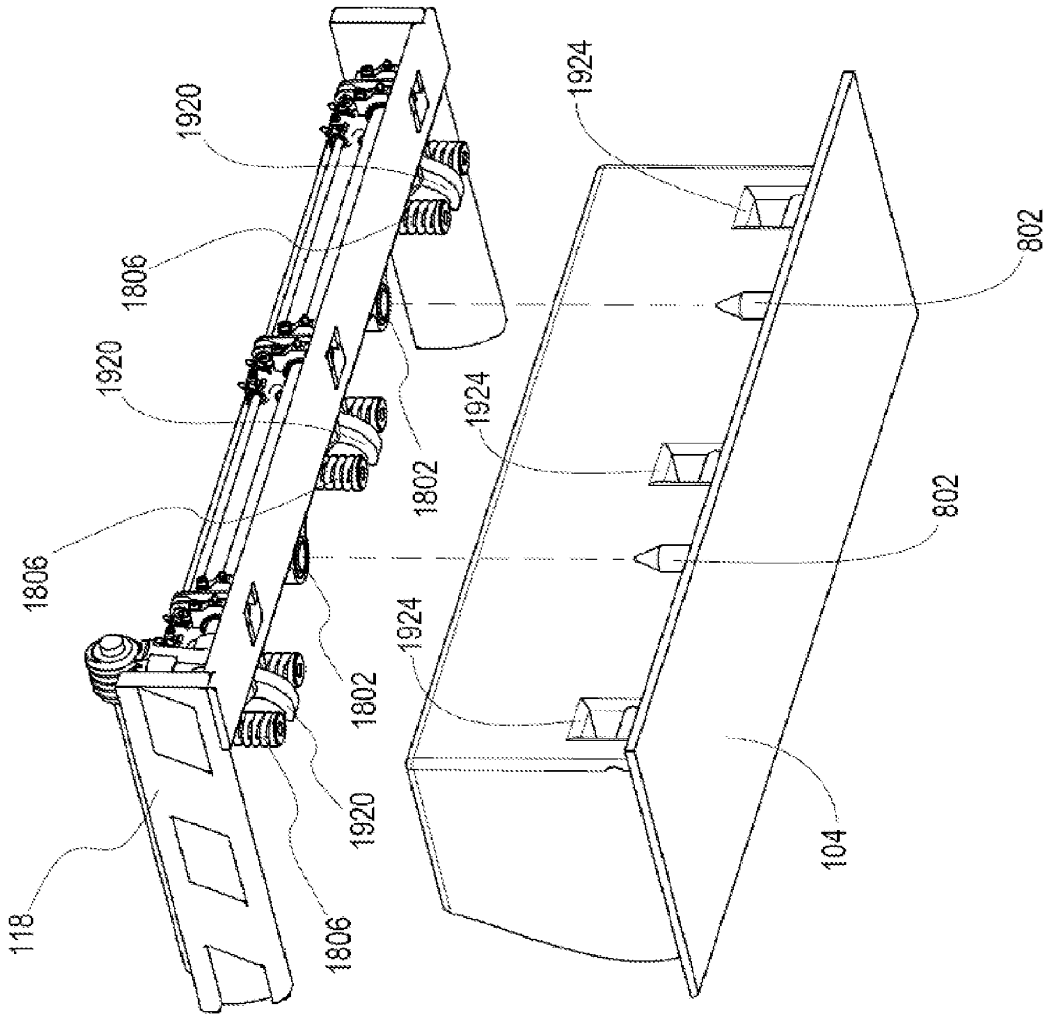

1920
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1806
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118
1806
1802
1802
1924
1924
1924
802
802
104

FIG. 18

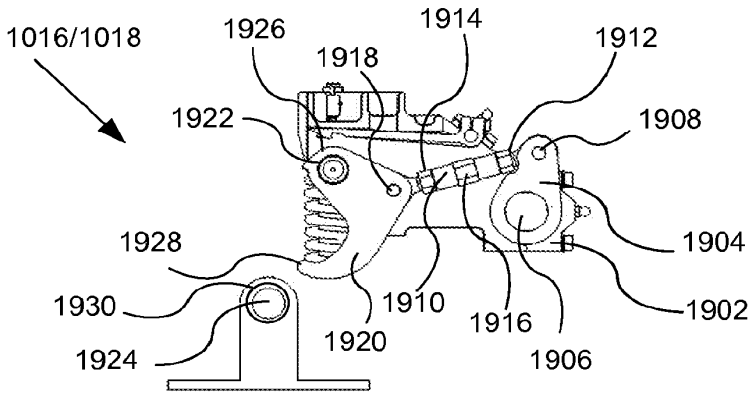


FIG. 19A

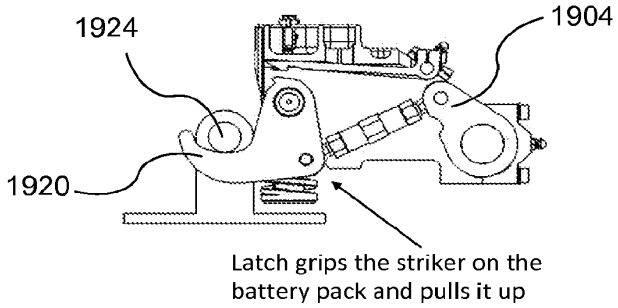


FIG. 19B

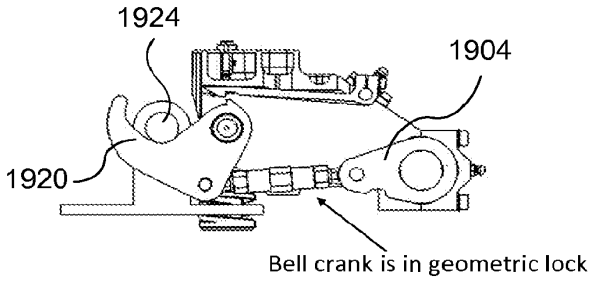


FIG. 19C

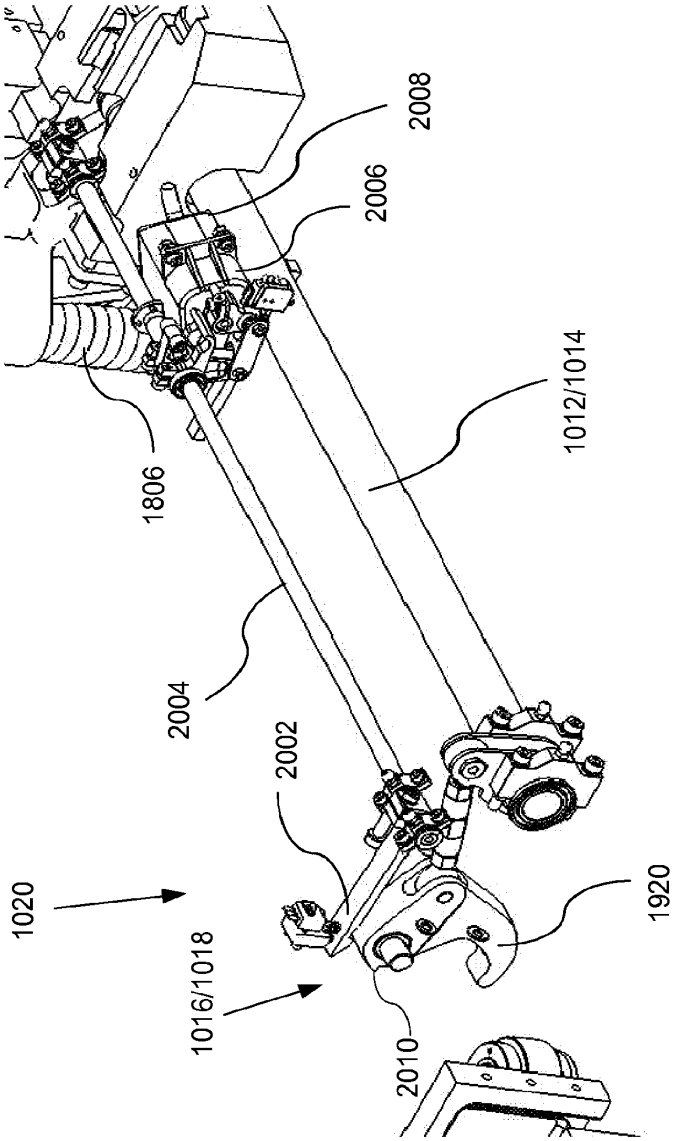


FIG. 20

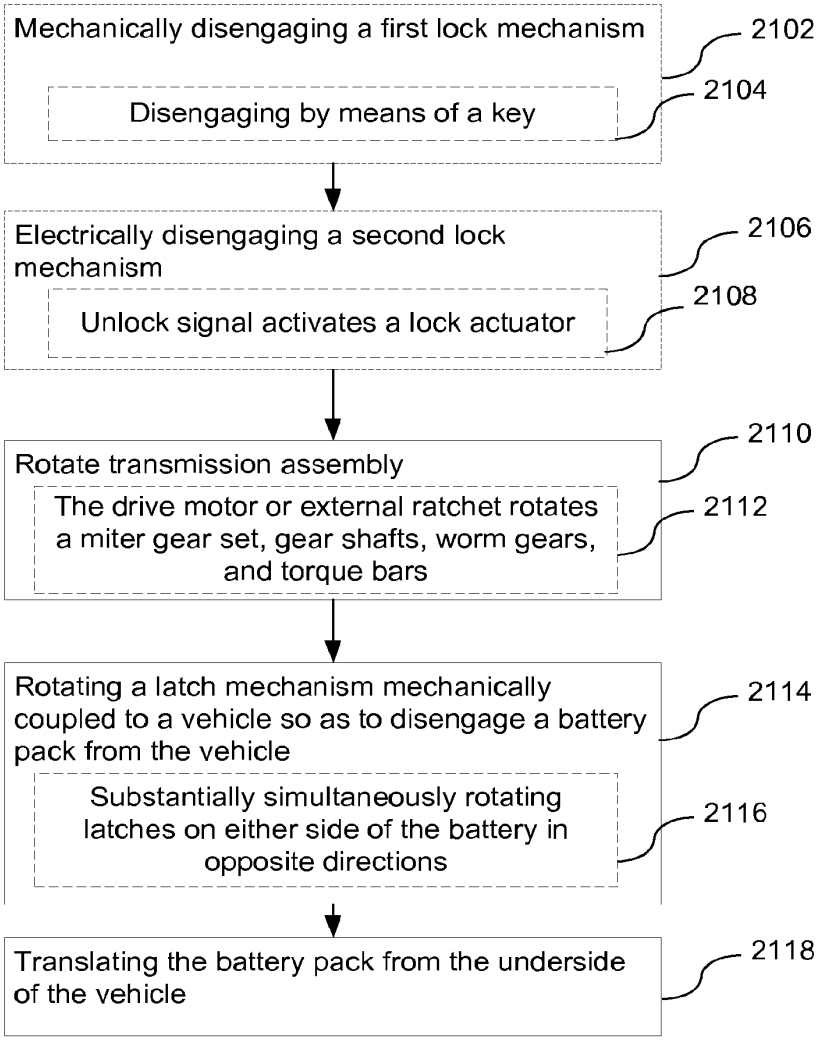

Mechanically disengaging a first lock mechanism
2102
Disengaging by means of a key
2104
Electrically disengaging a second lock mechanism
2106
Unlock signal activates a lock actuator
2108
Rotate transmission assembly
2110
The drive motor or external ratchet rotates a miter gear set, gear shafts, worm gears, and torque bars
2112
Rotating a latch mechanism mechanically coupled to a vehicle so as to disengage a battery pack from the vehicle
2114
Substantially simultaneously rotating latches on either side of the battery in opposite directions
2116
Translating the battery pack from the underside of the vehicle
2118

FIG. 21

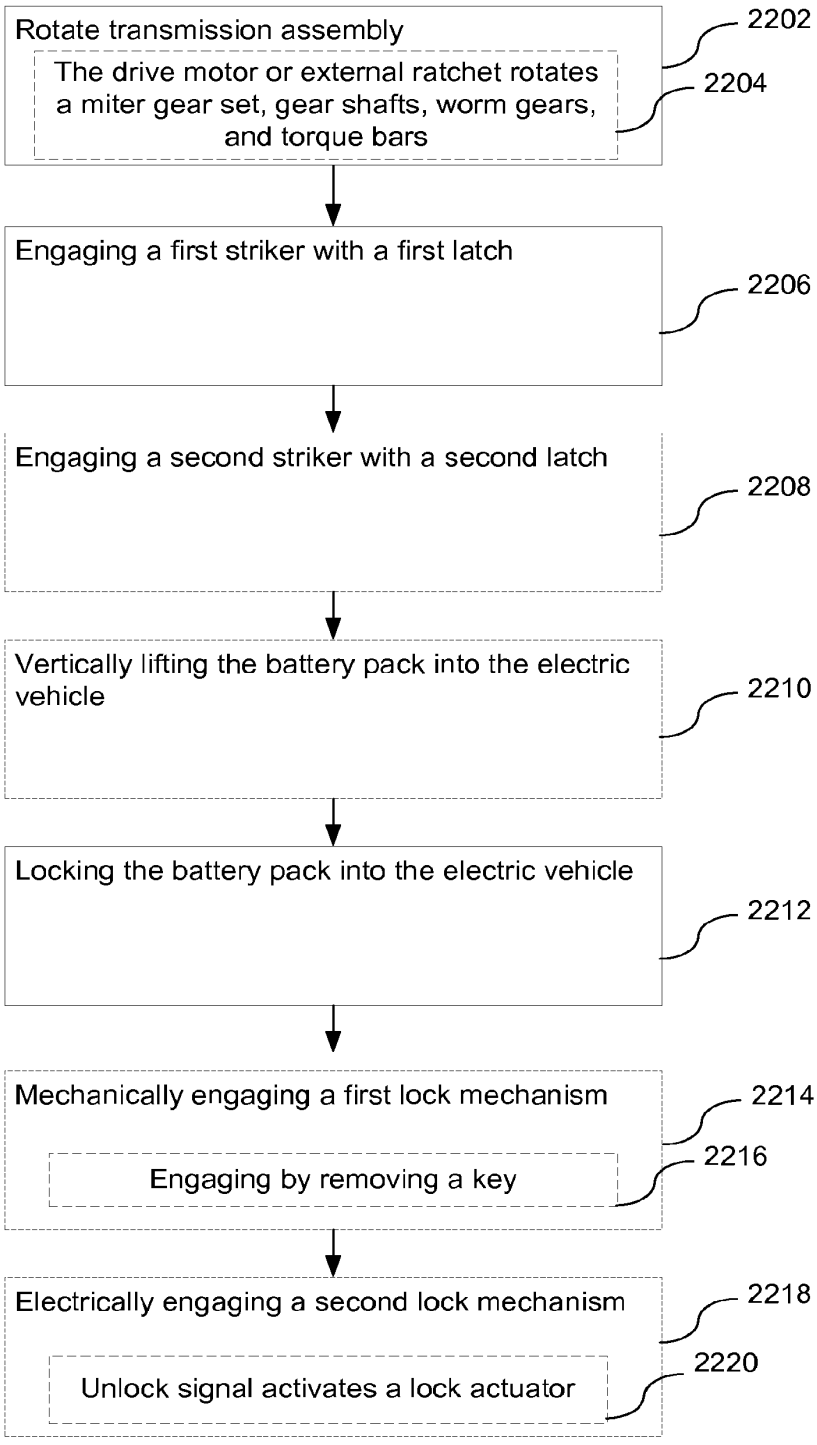

Rotate transmission assembly
The drive motor or external ratchet rotates a miter gear set, gear shafts, worm gears, and torque bars
2202
2204
Engaging a first striker with a first latch
2206
Engaging a second striker with a second latch
2208
Vertically lifting the battery pack into the electric vehicle
2210
Locking the battery pack into the electric vehicle
2212
Mechanically engaging a first lock mechanism
Engaging by removing a key
2214
2216
Electrically engaging a second lock mechanism
Unlock signal activates a lock actuator
2218
2220

FIG. 22

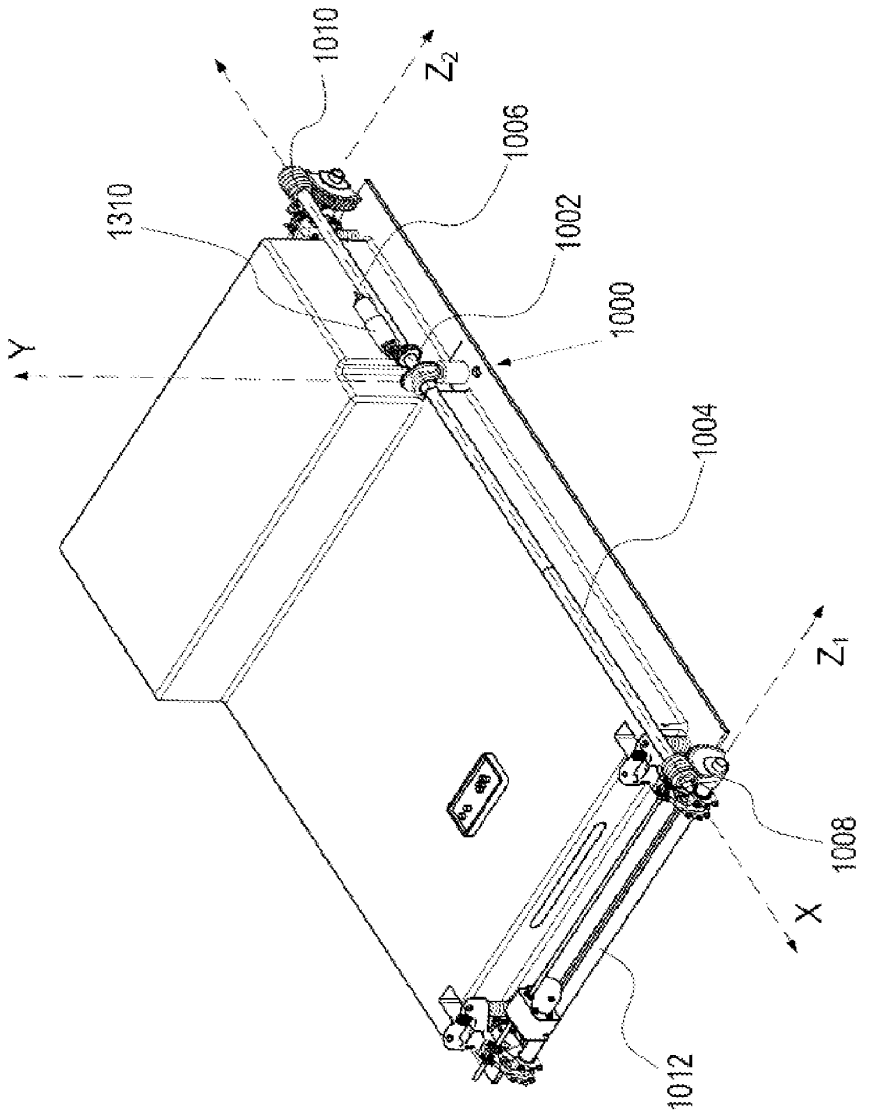


FIG. 23A

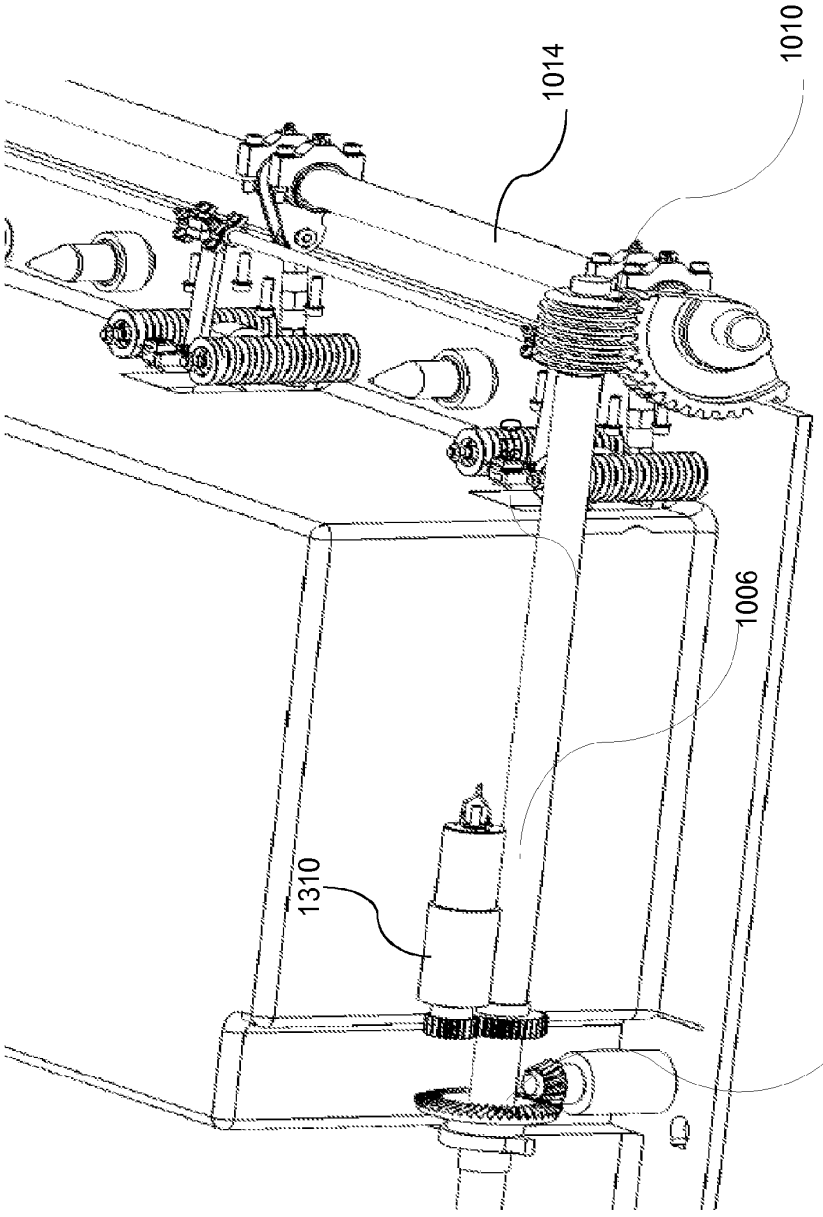


FIG. 23B

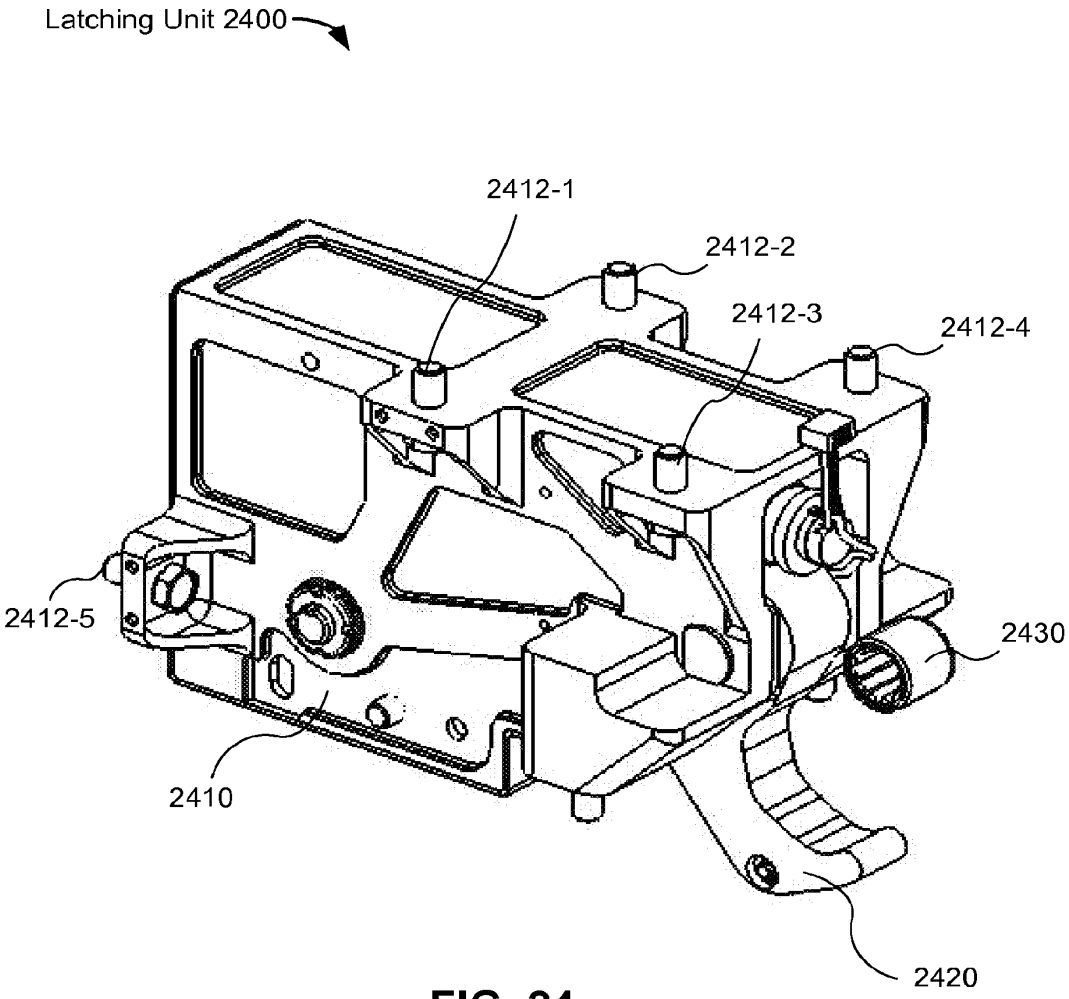

Latching Unit 2400
2412-1
2412-2
2412-3
2412-4
2412-5
2430
2410
2420

FIG. 24

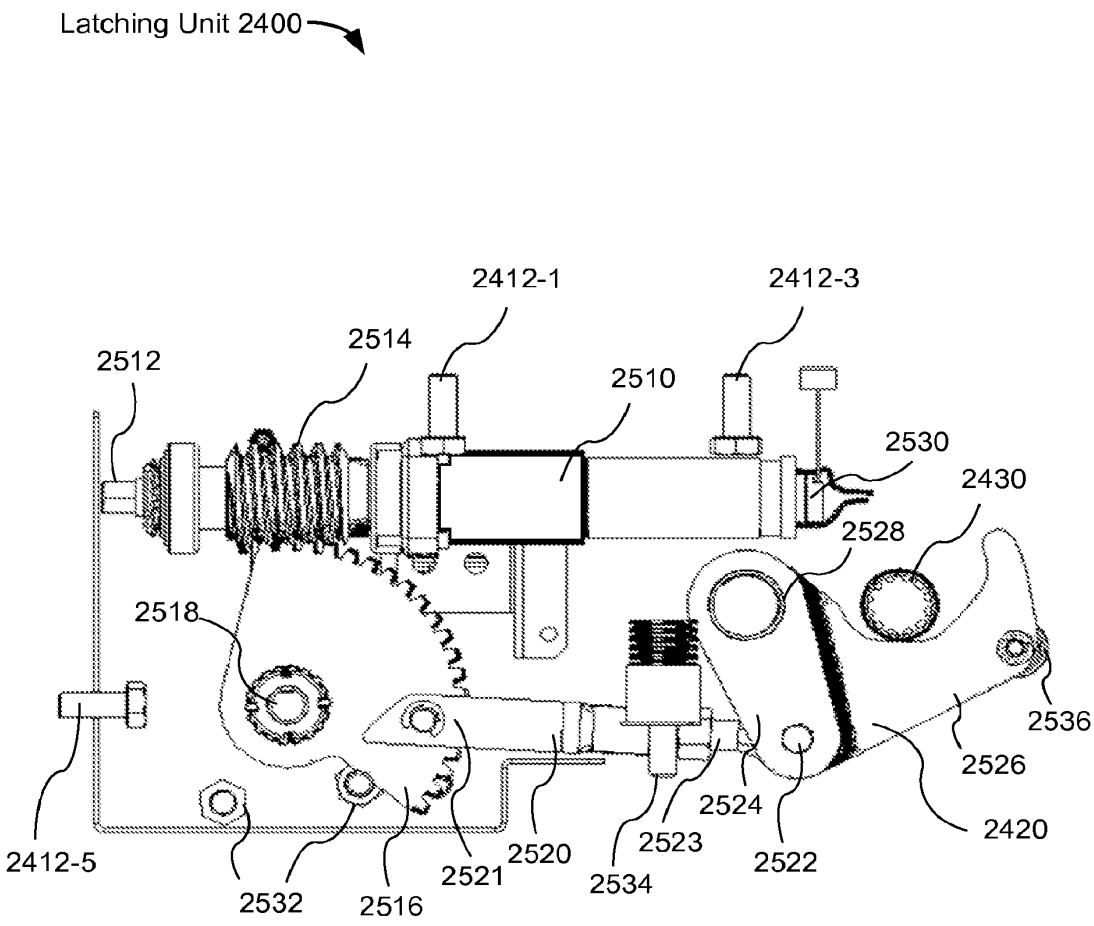

Latching Unit 2400
2412-1
2412-3
2514
2512
2510
2530
2430
2528
2518
2536
2526
2524
2420
2523
2522
2520
2534
2521
2516
2532
2412-5

FIG. 25A

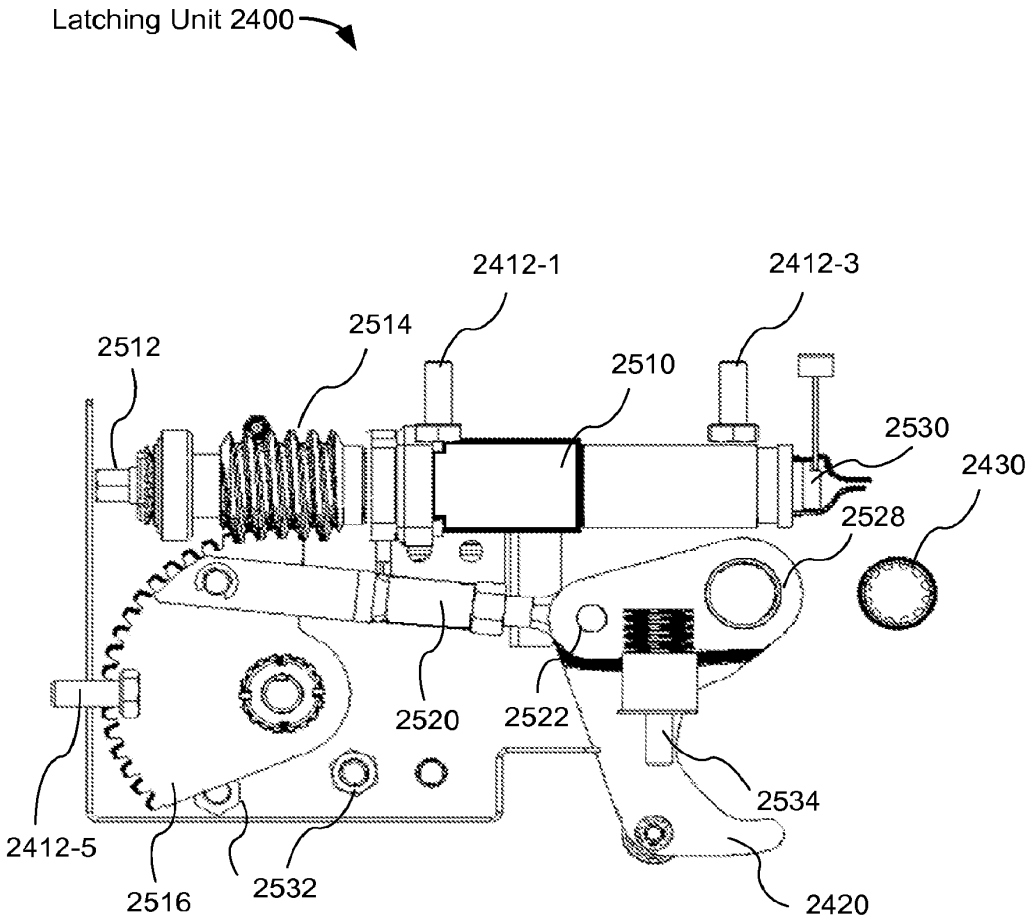

Latching Unit 2400
2412-1
2412-3
2514
2512
2510
2530
2430
2528
2520
2522
2534
2412-5
2516
2532
2420

FIG. 25B

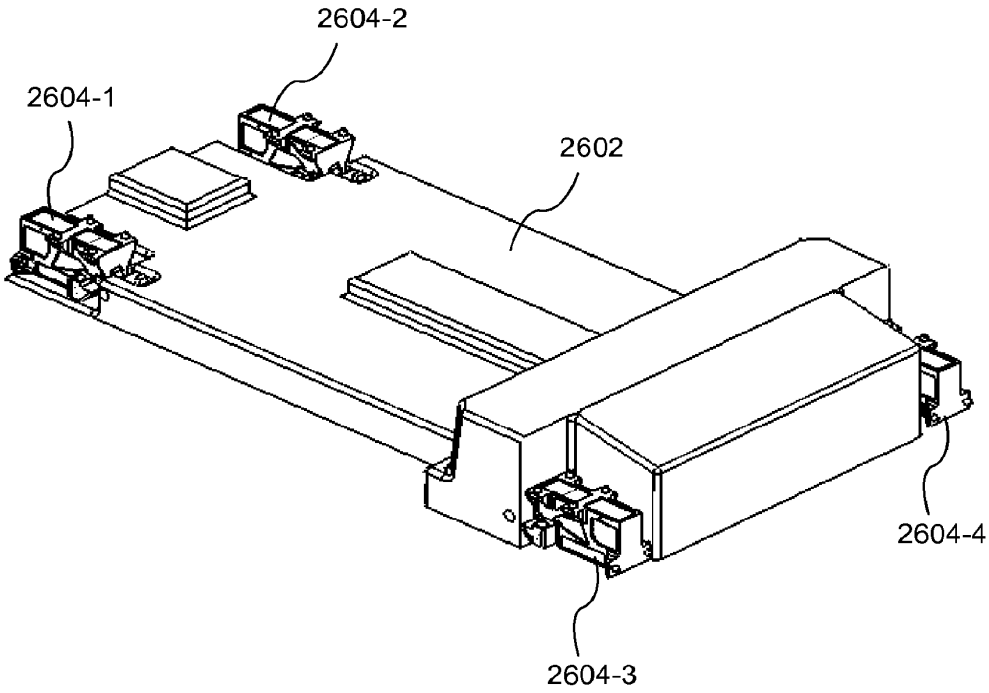


FIG. 26

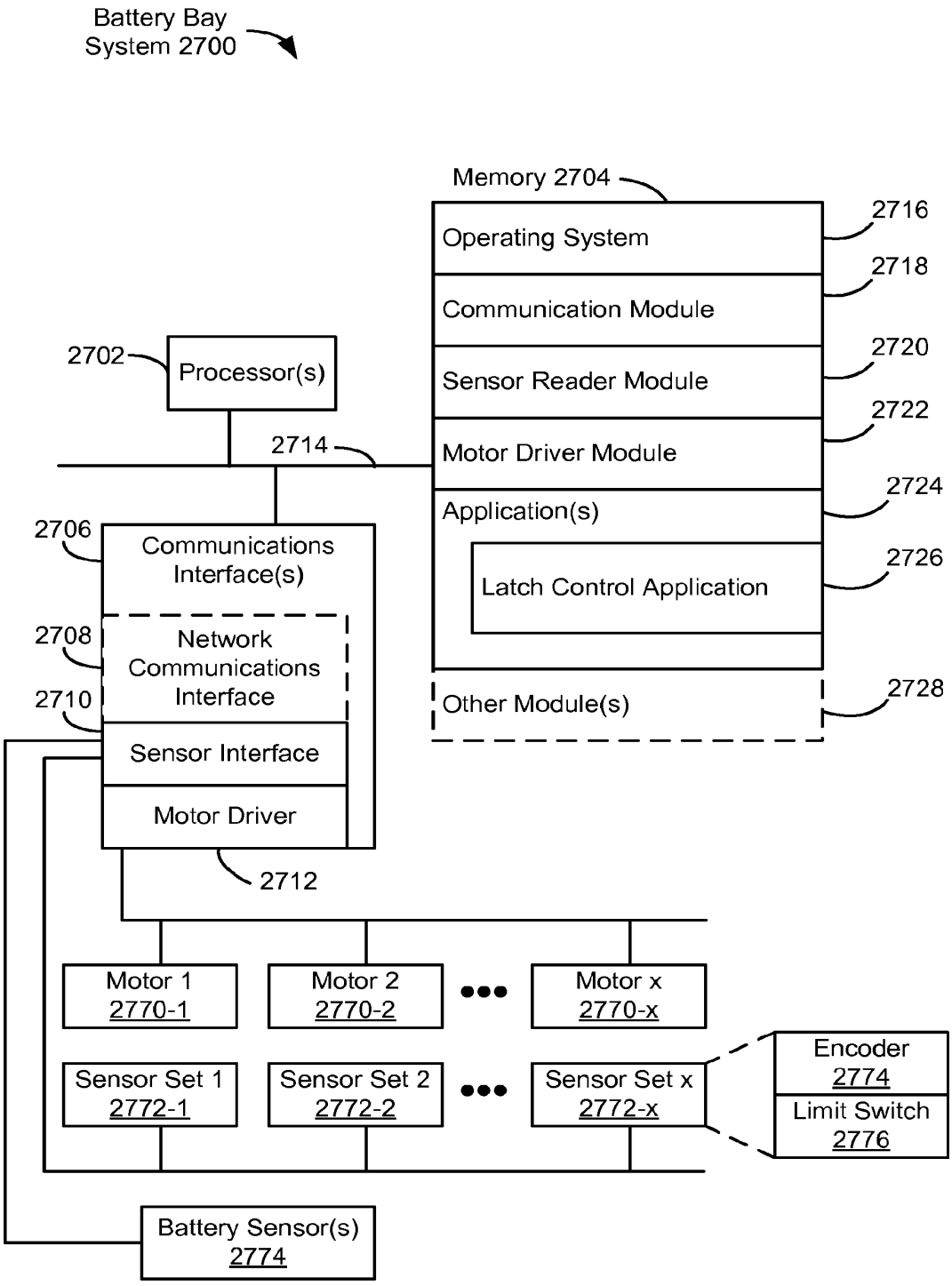

Battery Bay System 2700
Memory 2704
Operating System
2716
Communication Module
2718
Sensor Reader Module
2720
Motor Driver Module
2722
Application(s)
2724
Latch Control Application
2726
Other Module(s)
2728
2702
Processor(s)
2714
2706
Communications Interface(s)
2708
Network Communications Interface
2710
Sensor Interface
Motor Driver
2712
Motor 1 2770-1
Motor 2 2770-2
Motor x 2770-x
Sensor Set 1 2772-1
Sensor Set 2 2772-2
Sensor Set x 2772-x
Encoder 2774
Limit Switch 2776
Battery Sensor(s) 2774

Figure 27

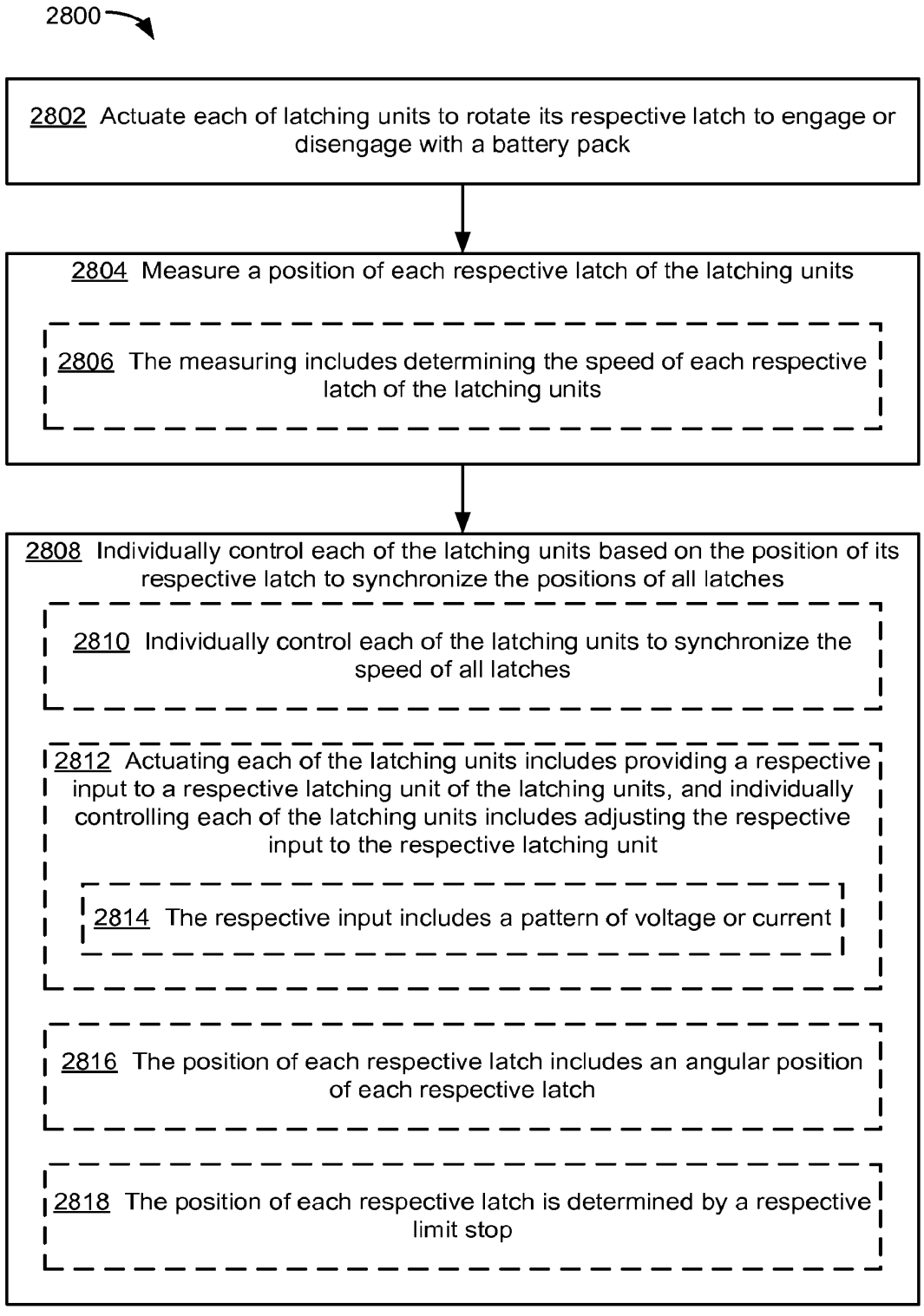

2800
2802 Actuate each of latching units to rotate its respective latch to engage or disengage with a battery pack
2804 Measure a position of each respective latch of the latching units
2806 The measuring includes determining the speed of each respective latch of the latching units
2808 Individually control each of the latching units based on the position of its respective latch to synchronize the positions of all latches
2810 Individually control each of the latching units to synchronize the speed of all latches
2812 Actuating each of the latching units includes providing a respective input to a respective latching unit of the latching units, and individually controlling each of the latching units includes adjusting the respective input to the respective latching unit
2814 The respective input includes a pattern of voltage or current
2816 The position of each respective latch includes an angular position of each respective latch
2818 The position of each respective latch is determined by a respective limit stop

Figure 28

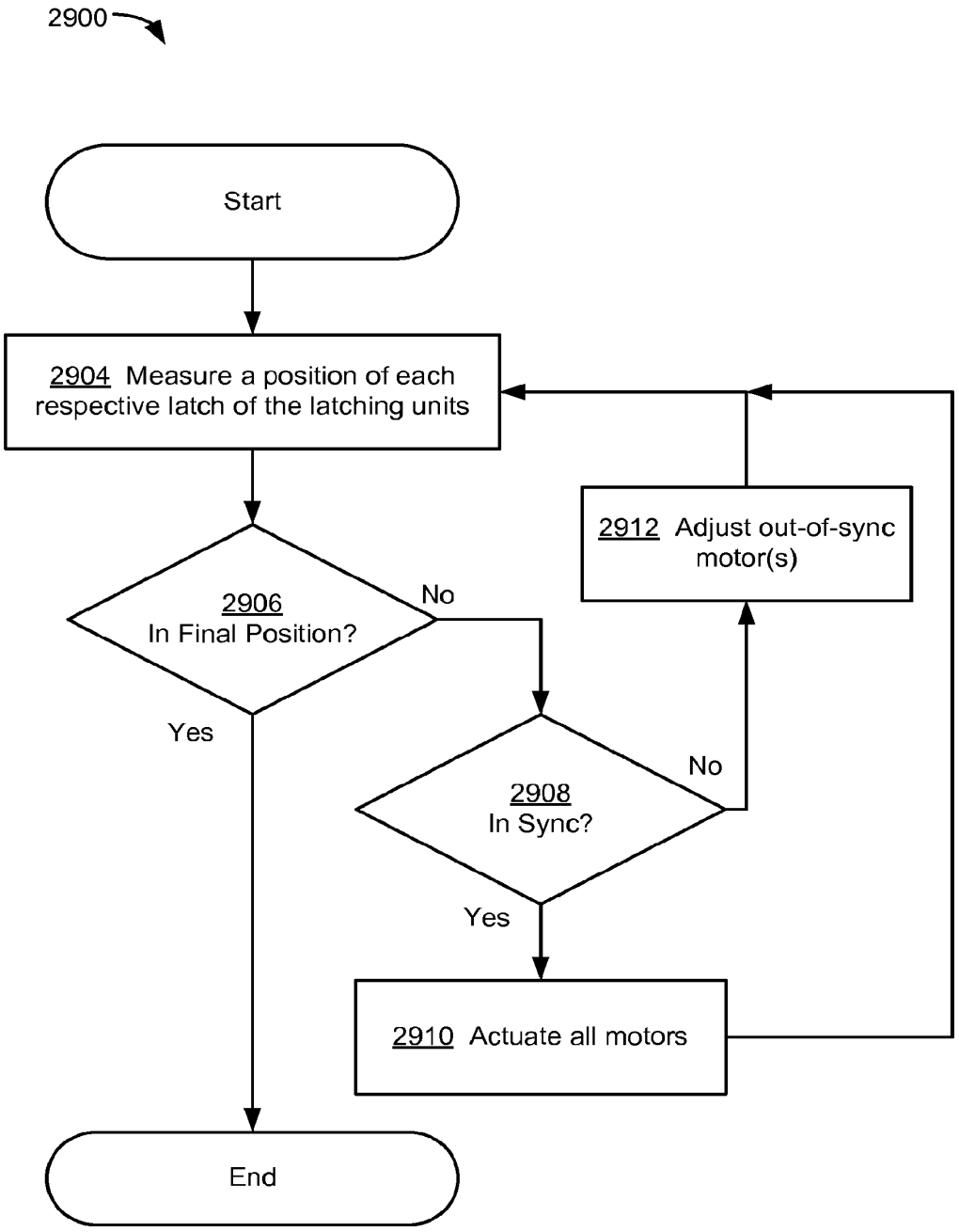

2900
Start
2904 Measure a position of each respective latch of the latching units
2906 In Final Position?
No
Yes
2912 Adjust out-of-sync motor(s)
2908 In Sync?
No
Yes
2910 Actuate all motors
End

Figure 29

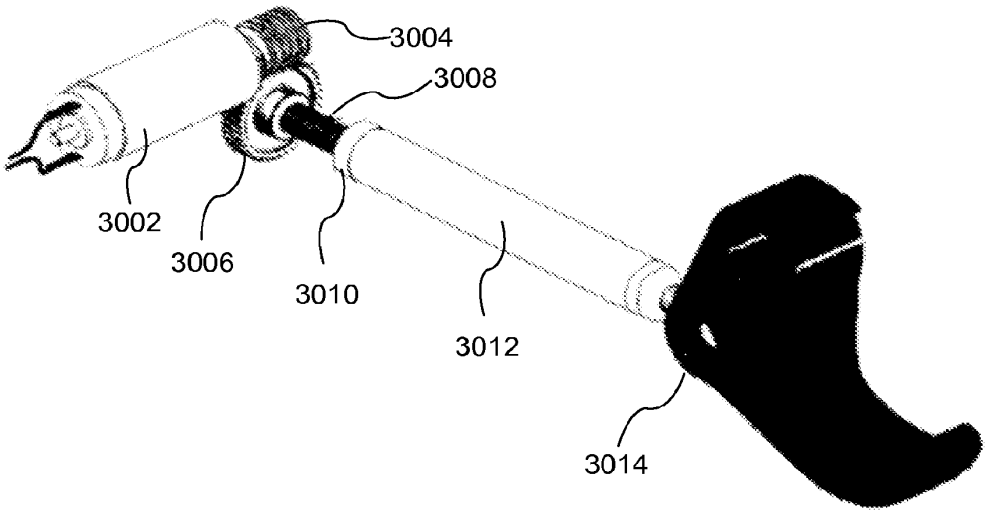


Figure 30A

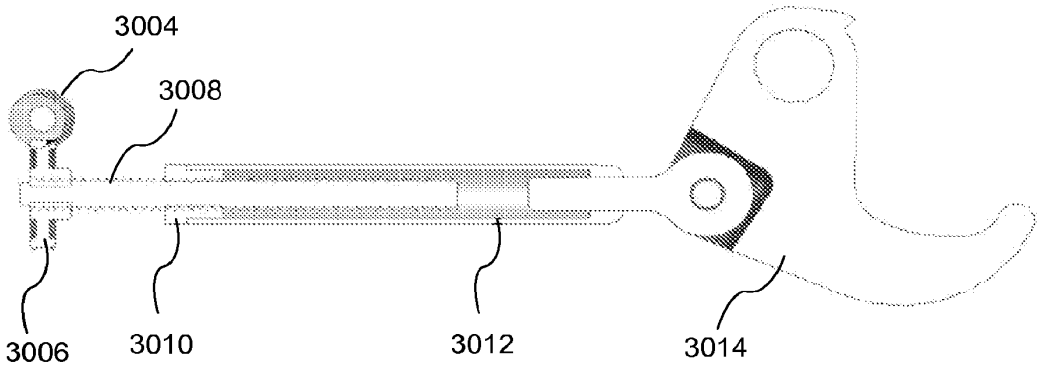


Figure 30B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/001486

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60L11/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60L B60S

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/071979 A1 (HEICHAL YOAV [IL] ET AL) 25 March 2010 (2010-03-25) abstract paragraph [0098] - paragraph [0101] paragraph [0121] - paragraph [0124] claim 7 figures 1-23	1-23
X	US 2010/112843 A1 (HEICHAL YOAV [IL] ET AL) 6 May 2010 (2010-05-06) abstract paragraph [0036] - paragraph [0039] paragraph [0123] - paragraph [0125] paragraph [0146] - paragraph [0153] figures 1-23	1-23

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2012	19/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Törgyekes, Szabolcs

1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/001486

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 934 927 A1 (RENAULT SAS) 12 February 2010 (2010-02-12) abstract page 3, line 4 - page 3, line 18 page 5, line 1 - page 6, line 10 claims 1,6,7,10 figures 1-5 -----	1-15

1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2011/001486

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		AU 2009293024 A1	25-03-2010
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		EP 2231447 A1	29-09-2010
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		ES 2377804 T3	02-04-2012
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		US 2011139527 A1	16-06-2011
		WO 2010015777 A1	11-02-2010

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
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WIPO | PCT

(10) International Publication Number
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(51) International Patent Classification: Not classified

(21) International Application Number:
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(22) International Filing Date:
27 March 2012 (27.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/IB2011/001486 20 May 2011 (20.05.2011) IB

(71) Applicant *(for all designated States except US)*: **BETTER PLACE GMBH** [CH/CH]; Industriestrasse 13C c/o Hodel Advokatur, + Notariat, 6304 Zug (CH).

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(54) **Title**: LATCHING MECHANISM FOR A VEHICLE'S BATTERY PACK

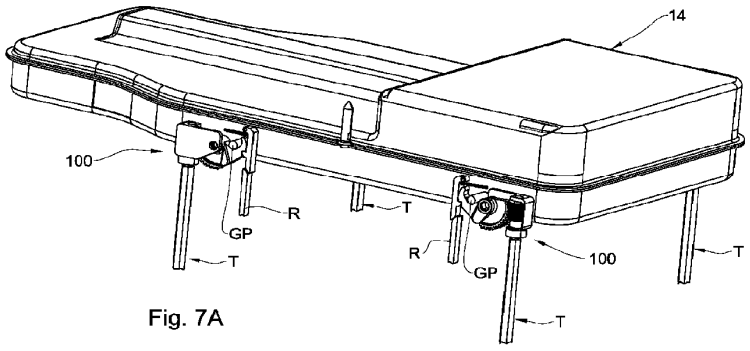


Fig. 7A

(57) **Abstract**: An attachment arrangement for attaching a battery pack to a battery bay of a vehicle. The arrangement comprises an array of latch units associated with either of the battery pack and battery bay. The latch units are configured for engagement with a corresponding array of grip portions associated with the other of the battery pack and battery bay. Two or more of the latch units are configured for being individually and mechanically switchable between an engaged and disengaged states by a designated tool external to both the battery pack and the vehicle.

LATCHING MECHANISM FOR A VEHICLE'S BATTERY PACK

TECHNOLOGICAL FIELD

The disclosure herein concerns electric vehicles with Switchable battery packs. In particular, the disclosed subject matter concerns a mechanism for attaching and detaching the battery pack to and from the vehicle's battery bay.

BACKGROUND

An electric vehicle with a battery that can be quickly switched is disclosed in WO 2009/039454, assigned to the assignee of this application. Disclosed there is also a battery switch station (BSS) where a spent or partially spent battery may be quickly exchanged with a fresh one.

WO 2010/033881 and WO 2010/033883, also assigned to the assignee of this application, disclose an electric vehicle where the battery is held within a battery bay located at the underbody of the vehicle. Disclosed there also is a battery switch station permitting switch of such a battery. Where the battery is held in a battery bay situated at the vehicle underbody, the insertion of the battery and its removal is done vertically, i.e., into and out of the battery bay at the bottom of the vehicle. There are typically a plurality of latches which are linked to one another and operate together for locking and unlocking the battery pack to secure it in position or permit its replacement.

GENERAL DESCRIPTION

In accordance with the subject matter of the present application, it has been realized that one of the major concerns for switchable batteries stored in a battery bay at the vehicle underbody is safety. A battery latching and release mechanism needs to provide for quick unlatching, on the one hand, and safety from accidental release (e.g. upon impact, in an accident, etc.), on the other hand.

It has been realized, in accordance with the subject matter of the present application, that these challenges can be met by a latching mechanism comprising a plurality of latching members that are configured to be mechanically and separately actuated by an external tool, the latching members accordingly having an external port for engagement with such a tool. The latching and unlatching according to one example is through rotational actuation.

The battery pack typically includes or is held on a substantially flat plate, which, once in position in the battery bay, forms part of the vehicle sill. There is a predetermined number of latching arrangements (typically, although not exclusively, four), for example, one at each corner of a substantially rectangular or trapezoid plate. Such latches may cooperate with a specific tool system designed to engage with and operate all latches simultaneously. Such a tool is disclosed in a co-pending application to the applicant, titled: Battery Switch Module.

The disclosed subject matter of the present application brings forth an arrangement for the secure attachment and detachment of a battery to and from a vehicle, the arrangement comprising a system of latches, each being configured for individual mechanical actuation by a designated tool external to both the battery and the vehicle.

Thus, according to one aspect of the disclosed subject matter of the present application there is provided an attachment arrangement for attaching a battery pack to a battery bay of a vehicle, said arrangement comprising an array of latch units associated with either of said battery pack and battery bay and configured for engagement with a corresponding array of grip portions associated with the other of the battery pack and battery bay, two or more of said latch units being configured for being individually and mechanically switchable between an engaged and disengaged states by a designated tool external to both the battery pack and the vehicle.

Each of the latch units can assume a first, engaged position in which it is configured for being mechanically engaged with its corresponding grip portion, and a second, disengaged position, in which it configured for being disengaged from its corresponding grip portion. In the disengaged position, the latch unit is configured for being so disengaged as to allow the battery pack to be removed from the battery bay. In addition, each of the latch units is configured for assuming a plurality of intermediary positions between the engaged position and the disengaged position.

Since each latch unit is independent and is configured for being individually operated, it is appreciated that the latch array can assume various positions in which some of the latch units are in their engaged position while the remainder of the latch units are at their disengaged position, or at any other intermediary position.

Specifically, when all the latch units of the array are in their respective first, engaged position, the latch array is considered to be in a *'secured'* state, in which the battery is firmly secured within the battery bay of the vehicle. Similarly, when all the latch units of the latch array are in their respective second, disengaged position, the latch array is considered to be in a *'switch'* state, in which the battery is disengaged from the bay, allowing its removal/extraction from the battery bay and corresponding replacement/exchange thereof.

It is also noted that using a mechanically operated array of individually operated latches provides, *inter alia*, the following advantages:

- the mechanical nature of the latches prevents spontaneous unlatching (and subsequently disengagement of the battery from the battery bay) at an undesired location and/or time, e.g. while driving or in the event of an accident. In particular, compared to electric-based latch operating mechanisms, the present arrangement excludes the possibility, for example, of a short-circuit in the electric system erroneously actuating the latch mechanism;
- individual operation of the latches yields that any single latch is unaffected by a possible malfunction in another latch. This arrangement allows more convenient control, maintenance and repair of the latch array.
- when using such a latch arrangement, alignment between the battery pack, which is installed to the car and the car body, is easily achieved since the latch hook picks the battery from the BSS reference system and translate it to the vehicle reference system. By this, a quick and reliable battery switch is achieved.

According to a specific example, the battery bay of the vehicle can be provided with the array of latch units while the battery is provided with the array of grip portions. It is appreciated that the latch array, comprising a plurality of moving mechanical components, is of a more complicated design than that of the grip portions. Thus, in the context of the disclosed subject matter, in which the battery is the component being

periodically replaced (i.e. periodically being installed onto and removed from the battery bay of the vehicle), the above arrangement also provides the advantage of a considerably simpler and lighter design of the battery.

The attachment arrangement can also comprise a control system configured for monitoring operation of the latch units and providing the user/operator with an indication regarding the position of each latch unit as well as an indication regarding possible malfunction of any of the latch units.

The latches may, by an embodiment, be linked to an electrical or computerized state-monitoring system for monitoring whether the latch array is in a secured state prior to leaving a battery replace station or in an exchange state prior to batter exchange. Such indication may be visually displayed to the driver and/or to an operator at a battery switch station and/or may be linked (typically wirelessly) to a robotic battery switch tool in such a station, etc.

The monitoring system can be assisted by a synchronization arrangement configured for assuring that during operation, when the latches are operated by the external tool, all latch units are at the same respective position (i.e. all engaged or all disengaged). In particular, the arrangement can be such that given an initial position of the latches (not necessarily all in the same position), the synchronization arrangement allows controlling operation of each of the latch units so as to bring them into the same position.

The synchronization arrangement can either be a mechanical arrangement associated with each of the latch units, or, alternatively, an electronic arrangement controlling the operation of the external designated tool.

In particular, the arrangement can be such that when a latch comes in contact with its corresponding grip portion, indication is provided to the controller that the latch unit is in its closed position. For example, contact between the latch and grip portion can facilitate the closing of an electric circuit providing the desired indication. For this purpose, a latch portion of each unit can be provided with a latch contact surface and each grip portion can be provided with a corresponding grip contact surface, wherein contact between the surfaces entails closing the electric circuit.

It is appreciated that the above arrangement is capable for indicating a closed/non-closed position of the latch unit, the term 'non-closed' referring to any intermediary position of the latch in which it is out of contact with the grip portion.

In order to provide the operator/driver of the vehicle an indication that the latch unit is in its fully open position, the controller can also be configured for monitoring operation of the tool. It is noted that since the operation of the latch is mechanical, monitoring of the number of revolutions performed by the external tool provides a clear indication as to the displacement of the latch.

With reference to the above, the controller and synchronization arrangement can be configured for assuring that all latch units are in the same position during latching and unlatching. It is appreciated that at least one of the advantages provided by the above is that the weight of the battery pack being supported by the latch array is evenly distributed between the latch units.

Each latch unit can comprise a latch and a drive assembly configured for operating the latch for displacing it between its respective first, engaged position and second, disengaged position. Specifically, the drive assembly of the latch unit is configured for translating the displacement/rotation provided by the external designated tool into the appropriate (linear/rotational) movement of the latch.

Each latch unit can further comprise an operation port associated with the drive assembly and configured for mechanical articulation thereto of the external tool to allow operation of the drive assembly. The articulation is such that displacement and/or rotation of the external tool mechanically entails a corresponding displacement and/or rotation of the drive assembly, which is then translated to the latch.

The external tool can be responsible for latch activation synchronization in order to reduce the functions the vehicle has to do, and by that to reduce vehicle cost. By using external actuation of the latches, the actuation device is no longer in the car, thus reducing the car cost but maintaining the same functionality.

According to a specific design, the arrangement is such that while displacement and/or rotation of the drive assembly entails a corresponding displacement and/or rotation of the latch, the opposite is prevented, i.e. displacement and/or rotation of the latch does not entail displacement and/or rotation of the drive assembly. In particular, such an arrangement may also allow the latches to withstand various forces applied thereto during driving.

According to one example, the above arrangement can be achieved via the mechanical engagement between the latch and the drive assembly, e.g. a worm gear mechanism. Alternatively, according to another example, the latch can be articulated to

the drive assembly so that in said first, engaged position, the latch and drive assembly are geometrically locked.

With respect to the latter example, the external designated tool can be configured for first releasing the geometric lock and only thereafter to displace the latch into its second, disengaged position.

Each latch can be formed with an engagement portion configured for engagement with the corresponding grip portion, and an articulation portion configured for association with the drive assembly.

According to one example, the latch can have a pivot point so that the engagement portion thereof is configured for performing a rotary motion about a pivot axis in its transition between the first, engaged position and the second, disengaged position. Alternatively, the latch can be configured for performing linear displacement during said transition.

According to the first of the above examples, the engagement portion of the latch can be formed with a cradle configured for accommodating a corresponding cam of the grip portion, thereby supporting at least a portion of the weight of the battery pack. In particular, the latch can be designed such that the cradle is located adjacent the pivot point, thereby reducing the torque applied to the latch about the pivot point by the weight of the battery pack.

In accordance with the disclosed subject matter, the operation port of the latch unit can be configured for revolution/rotation about an axis thereof, and being associated with the drive assembly such that the rotational movement thereof is translated into linear/rotational movement of the latch. Specifically, the operation port can be directly associated with a rotary element of the drive assembly, whereby rotation of the designated tool (when properly associated with the operational port) entails rotation of the rotary element.

The drive assembly can assume various designs configured for translating the rotational motion to the latch, for example, a bevel gear, a worm gear a screw and cam follower, a bell crank etc.

According to some examples, the latch can be directly driven by the rotary element, i.e. the articulation portion of the latch constitutes a part of the drive assembly. According to other examples, the drive assembly can include additional transition

components articulated to both the latch with the rotary element to provide mechanical connection therebetween.

The grip portion can be in the form of cams projecting from the battery pack/battery bay, or, alternatively, in the form of recesses formed in the pack/bay itself. It is appreciated, however, that a different design of the cams/recesses can be required depending on the design of the latch, e.g. for a latch configured for linear displacement the recess can be straight (similar to a strike plate of a lock mechanism), while for a latch configured for rotational movement, the recess can be curved.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1A is a schematic view of an electric vehicle network comprising an electric vehicle and a replaceable battery pack;

Fig. 1B is a schematic isometric bottom view of the vehicle shown in Fig. 1A with the battery pack secured to the vehicle;

Fig. 1C is a schematic isometric exploded bottom view of the vehicle shown in Fig. 1B;

Fig. 2A is a schematic isometric view of one example of a latch unit of the attachment arrangement used in the vehicle shown in Figs. 1A to 1C, shown in attachment to a battery pack of the vehicle, with the latch at its closed position;

Fig. 2B is a schematic isometric view of the latch unit shown in Fig. 2A, with the battery pack removed;

Fig. 2C is a schematic isometric view of the latch unit shown in Fig. 2B, with a housing thereof being removed;

Fig. 2D is a schematic front view of the latch unit shown in Fig. 2C;

Fig. 2E is a schematic front view of the latch unit shown in Figs. 2A to 2D, with the latch at an intermediary position;

Fig. 2F is a schematic front view of the latch unit shown in Figs. 2A to 2E, with the latch at its open position;

Fig. 3A is a schematic isometric view of another example of a latch unit of the attachment arrangement shown in Figs. 1A to 1C, with the latch at a closed position thereof;

Fig. 3B is a schematic isometric view of the latch unit shown in Fig. 3A, with a housing thereof being removed;

Fig. 3C is a schematic front view of the latch unit shown in Fig. 3B;

Fig. 3D is a schematic front view of the latch unit shown in Figs. 3A to 3C, with the latch at an intermediary position;

Fig. 3E is a schematic front view of the latch unit shown in Figs. 3A to 3D, with the latch at its open position;

Fig. 4A is a schematic isometric view of still another example of a latch unit of the attachment arrangement shown in Figs. 1A to 1C, with the latch at a closed position thereof;

Fig. 4B is a schematic isometric view of the latch unit shown in Fig. 4A, with a housing thereof being removed;

Fig. 4C is a schematic front view of the latch unit shown in Fig. 4B, with the latch at its closed position;

Fig. 4D is a schematic front view of the latch unit shown in Figs. 4A to 4C, with the latch at an intermediary position;

Fig. 4E is a schematic front view of the latch unit shown in Figs. 4A to 4D, with the latch at its open position;

Fig. 5A is a schematic isometric view of yet another example of a latch unit of the attachment arrangement shown in Figs. 1A to 1C, with the latch at a closed position thereof;

Fig. 5B is a schematic isometric view of the latch unit shown in Fig. 5A, with a housing thereof being removed;

Fig. 5C is a schematic front view of the latch unit shown in Fig. 5B;

Fig. 5D is a schematic front view of the latch unit shown in Figs. 5A to 5C, with the latch at an intermediary position;

Fig. 5E is a schematic front view of the latch unit shown in Figs. 5A to 5D, with the latch at its open position;

Fig. 6A is a schematic isometric view of yet another example of a latch unit of the attachment arrangement shown in Figs. 1A to 1C, with the latch at a closed position thereof;

Fig. 6B is a schematic isometric view of the latch unit shown in Fig. 6A, with a housing thereof being removed;

Fig. 6C is a schematic front view of the latch unit shown in Fig. 6B;

Fig. 6D is a schematic front view of the latch unit shown in Figs. 6A to 6C, with the latch at an intermediary position;

Fig. 6E is a schematic front view of the latch unit shown in Figs. 6A to 6D, with the latch at its open position;

Fig. 7A is a schematic bottom isometric view of the battery pack show in Fig. 1C with the latches being in a secured state; and

Fig. 7B is a schematic bottom isometric view of the battery pack show in Fig. 1C with the latches being in a switch state.

DETAILED DESCRIPTION OF EMBODIMENTS

Attention is first drawn to Figs. 1A to 1C, illustrating an electric vehicle network **10** including an electric vehicle **12** comprising a battery pack **14** configured to be removably mounted to the vehicle **12**. In some embodiments, the battery pack **14** includes any device capable of storing electric energy such as batteries (*e.g.*, lithium ion batteries, lead-acid batteries, nickel-metal hydride batteries, *etc.*), capacitors, reaction cells (*e.g.*, Zn-air cell), *etc.* In other embodiments, the battery pack **14** comprises a plurality of individual batteries or battery cells/chemical modules. In still other embodiments, the battery pack **14** also comprises cooling mechanisms, as well as mechanical and electrical connectors for connecting to the vehicle **12** or to the various elements of the battery exchange station (not shown).

The vehicle **12** includes an electric motor **13** that drives one or more wheels of the vehicle. The electric motor **13** receives energy from the battery pack **14** (shown separate from the vehicle for the ease of explanation). The battery pack **14** of the vehicle **12** may be charged at a home of a user or at one or more charge stations **15**. For example, a charge station **15** may be located in a shopping center parking lot. Furthermore, the battery pack **14** of the vehicle **12** can be exchanged for a charged

battery pack at one or more battery exchange stations **17**. Thus, if a user is traveling a distance beyond the range of a single charge of the battery of the vehicle **12**, the spent (or partially spent) battery can be exchanged for a charged battery so that the user can continue with his/her travels without waiting for the battery to be recharged.

The battery switch stations **17** are service stations where a user can switch discharged (or partially discharged) battery packs **14** of the vehicle **12** for charged or partially charged battery packs **14**. The charge spots provide energy to charge the battery pack **14** while it is coupled to the vehicle **12**. These components of the network **10** are connected to related power and data networks, as explained in more detail in U.S. Patent Application No. 12/234,591, filed September 19, 2008, entitled Electronic Vehicle Network, the disclosure of which is incorporated herein by reference.

Figs. 1B and 1C are bottom views of an at least partially electric vehicle **12**. The vehicle **12** includes a switchable battery pack **14** (sometimes herein referred to just as a battery), shown attached to the vehicle **12** at its underside in Fig. 1B and detached therefrom in Fig. 1C. The battery pack **14** is substantially flat and runs along at least a portion of the length of the vehicle **12**, *i.e.*, along the longitudinal X-axis of the vehicle. In some embodiments, the battery **14** may protrude below the plane of the underside of the vehicle **12**, *i.e.*, protruding in the negative Y-axis direction. Protruding from the underside of the vehicle is helpful for air cooling the battery pack **14**, as the protruding battery pack is exposed to ambient air flow. In some embodiments where the battery pack is retrofitted to a vehicle, *i.e.*, after-market, the battery pack may protrude from the bottom of the vehicle.

The battery bay **18** of the vehicle is a structural cavity in the underbody of the car that defines the outline of a cavity **16** disposed at the underside of the vehicle **12**. The cavity **16** is configured to at least partially receive the battery pack **14** therein. In some embodiments, the bay frame has a substantially rectangular shape, for at least partially receiving a substantially cuboid or rectangular parallelepiped battery pack **14** therein (battery pack can be in any shape or form). In some embodiments, the battery bay has two long structural elements along at least part of the length of the vehicle **12** (parallel to the X-axis) and two shorter sides along at least part of the width of the vehicle (parallel to the Z-axis) as shown. The long sides of the battery bay can extend along axes substantially parallel with an axis extending from the front to the back of the

vehicle **12** (parallel to the X-axis). The battery bay **18** is located under the vehicle floor boards, between the rear and front axles of the vehicle **12**.

In general, the battery pack **14** can be secured within the cavity/battery bay **16** using a system of latches configured for engagement with corresponding projections on the battery pack **14**. In particular, the battery bay **16** can comprise an array of latch units (**100, 200, 300, 400** and **500** shown in Figs. 2A to 6C) associated with either of said battery pack **14** and battery bay **16** and configured for engagement with a corresponding array of grip portions **GP** associated with the other of the battery pack **14** and battery bay **16**, each of a majority of said latch units **100** through **500** being configured for being individually and mechanically operated by a designated tool T external to both the battery pack **14** and the vehicle **12**.

With particular reference to Figs. 2A to 2F, one latch unit **100** is shown in engagement with its corresponding grip portion **GP** of the battery pack **14**. The latch unit **100** comprises a housing **110** configured for being anchored to a battery bay **16** of the vehicle **12** (both shown in Figs. 1A to 1C), an actuation mechanism **120,** and an integrated rotary element and latch **130** associated with the actuation mechanism **120** to be actuated thereby. The latch unit **100** further is connected to the vehicle structural elements **140**, and a securing mechanism **150** configured for preventing spontaneous displacement, rotation and/or translation of the latch **130**.

With particular reference now being drawn to Figs. 2C and 2D, the actuation mechanism **120** comprises an engagement port in the form of a socket **122** configured for receiving therein a corresponding tip **99** of an external tool **T** (a ball head drive shaft in the present examples), and a worm gear **126** fixedly attached to the socket **122** via a base portion **124**, and configured for engagement with the integrated rotary element and latch **130**. The arrangement is such that the worm gear **126** is configured for revolving together with the socket **122**.

The integrated rotary element and latch **130** comprises a body **132** in the form of a portion of a circular gear, and is formed, at the circular periphery thereof with a plurality of gear teeth **133** configured for mesh engagement with the worm gear **126** of the actuation mechanism **120**, in order to be driven thereby.

The integrated rotary element and latch **130** is formed, at a side opposite said gear teeth **133** with a latch portion **136** having a latch hook **137** and a latch cradle **138** configured for receiving and supporting a corresponding grip portion GP of the battery pack **14**. The latch portion **136** is further formed with a locking recess **139** configured for engagement with the securing mechanism **150**.

The integrated rotary element and latch **130** is anchored to the support frame **140** via a pivot portion **134** thereof, allowing it to freely perform rotary motion about an auxiliary axis X_2 upon proper actuation by the actuation mechanism **120.**

The securing mechanism **150** comprises a shaft **152** anchored to the support frame **140** via a pivot point **153** at a top end **158** thereof. The shaft comprises a locking projection **154** extending from the middle of the shaft **152** in a direction transverse to a longitudinal direction of the shaft, and a bottom surface **156** extending at an angle to the longitudinal direction of the shaft **152**. The shaft **152** is anchored via the pivot point **153**, so as to allow the shaft **152** to perform a rotary motion about the pivot axis X_P upon proper actuation.

The securing mechanism **150** further comprises a biasing spring **159** having a first end associated with the top end **158** of the shaft **152**, attached to the top end **158** slightly below the pivot point **153**, and a second end associated with the support frame **140**. The arrangement is such that the biasing spring **159** constantly urges the shaft **152** in a CCW direction about the pivot point **153** (axis X_P).

In operation, the tool **T** is configured for engagement with the latch unit **100** via the socket **122** for latching/unlatching of the latch **136**. Specifically, the socket **122** is of a hexagonal form and the tip **99** is of corresponding shape and size, whereby, after being received within the socket **122,** rotation of the tool **T** about its central axis $\mathbf{X_1}$ entails rotation of the socket **122** about the same axis. Consequently, rotation of the socket **122** entails rotation of the worm gear **126,** thereby allowing actuation of the integrated rotary element and latch **130.**

Thereupon, with the teeth **133** of the rotary element being meshed with the worm gear **126,** rotary motion of the latter about axis $\mathbf{X_1}$ entails rotary motion of the former about the auxiliary axis $\mathbf{X_2}$. As the latch portion **136** is integrally formed with

the body **132** of the rotary element, the above rotary motion entails latching/unlatching of the latch **136** portion.

The association between the worm gear **126** and the integrated rotary element and latch **130** is such that while rotary motion of the former entails rotary motion of the latter, rotary motion of the latter cannot initiate rotary motion of the former as know from worm gear mechanisms *per se*.

It is thus appreciated that the above arrangement provides for securing the latch unit **100** from accidental or spontaneous unlatching. In particular, since the latch unit **100** is actuated by an external tool **T**, it is also ensured that spontaneous revolution of the worm gear **126** (and subsequent unlatching), when the external tool **T** is not engages therewith (e.g. while driving) is also prevented.

In the position shown in Figs. 2C and 2D, the latch unit **100** is shown in a latched position (e.g. closed position). It is observed that the locking projection **154** is received within the locking recess **139** of the latch **136,** so that a top surface **155** of the locking projection **154** is mated with a bottom surface of the locking recess **139.** Under this configuration, the integrated rotary element and latch **130** is restricted from performing rotational movement in a CCW direction about the auxiliary axis X_2.

With particular reference to Figs. 2E and 2F, in order to perform unlatching of the latch unit **100,** it is first required to retract the locking projection **154** from the locking recess **139**. For this purpose, the external tool **T** can be provided with an auxiliary release tool **R**, configured for engagement with the shaft **152**. The release tool **R** is formed with a slanted surface configured to be mated with the bottom surface **156** of the securing mechanism **150**, when engaged therewith.

In operation, once the slanted surface of the release tool **R** is properly engaged with the slanted surface **156** as shown in Fig. 2E, upward displacement of the release tool **R** applies pressure on the shaft **152**, entailing CW rotary motion thereof, thereby releasing the locking projection **154** from the recess **139,** to the position shown in Fig. 2F. It is appreciated that the pressure exerted on the shaft **152** to perform the CW rotation operates against the biasing force applied to the shaft by the biasing spring **159** in the CCW direction.

With respect to the above, although the arrangement is such that the integrated rotary element and latch **130** cannot perform rotary motion without external actuation (even without the presence of a securing mechanism), the securing mechanism **150** provides another level of security, ensuring that the battery pack **14** is properly secured within the battery bay **16**.

During latching, i.e. displacement of the latch unit from the position shown in Fig. 2F to that shown in Fig. 2C, the tip **137** of the integrated rotary element and latch **130** comes in contact with the slanted surface **156** of the securing mechanism **150** in order to push the shaft **152** to allow the latch into its closed position. In this sense, during latching, the tip **137** performs an operation similar to that of the auxiliary tool **R**.

In addition, in most examples of the electric vehicle **12**, the battery bay **16** is located at the bottom end of the vehicle **12**, wherein mounting the battery **14** into the bay is performed by lifting the battery **14** upwards towards the bay **16** using a designated lifting platform (not shown). When using the latch unit **100,** as well as all other latch units **200** to **500,** the arrangement is such that during mounting, the lifting platform is only required to lift the battery **12** until it reaches the position shown in Fig. 2E. Thereafter, the latching also facilitates lifting of the battery **14** to its final position within the bay **16**.

Reference is now made to Figs. 7A and 7B, in which the battery pack 14 and latches **100** are shown in respective '*secured*' and '*switch*' states. With particular reference to Fig. 7A, it is observed that all the latch units **100** are at their closed position, i.e. the lath arrangement is in the secured state, thereby fully securing the battery pack **14** to the vehicle (shown in Figs. 1B and 1C). In this position, each of the gripping portions **GP** (represented by pins in the present example) is secured by a respective latch **100** and the battery pack 14 is prevented from downward displacement.

To the contrary, in Fig. 7B, all the latch units **100** are at their respective open position, and the latch arrangement is thus disengaged from the battery pack allowing switching thereof. It is observed that the latches **100**, in their open position, do not obstruct the gripping portions **GP** thereby allowing the battery pack **14** to displace downwards during exchange/replacement.

Attention in now drawn to Figs. 3A to 3E, in which another example of a latch unit is shown, generally being designated as **200**. The latch unit **200** comprises a housing **210,** and an actuation mechanism **220,** a rotary element **230,** a transition member **240** and a latch **260** which are all mechanically associated with one another to form a drive chain.

The actuation mechanism is similar to actuation mechanism **120** previously described, and comprises a socket **222** and a worm gear **226,** the actuation mechanism being designed such that upon being received within the socket **222,** rotation of a tool **T** entails rotation of the worm gear **226** about the central axis $\mathbf{X_1}$ thereof.

The rotary element **230** comprises a circular body portion **232** formed with gear teeth **233,** and is anchored to the housing **210** via a pivot portion **234** thereof, allowing it to freely perform rotary motion about an auxiliary axis $\mathbf{X_2}$ upon proper actuation by the actuation mechanism **220.**

However, as opposed to the rotary element and latch **130** previously described, the rotary element **230** is not integrally formed with the latch **260**. Instead, the rotary element **230** comprises a two extensions **236** forming a fork, having ends located at the periphery of the body **232,** the ends **237** being configured for articulation to the transition element **240.**

The association between the latch **260** and the rotary element **230** is provided by the transition element **240,** which similarly comprises two fork extensions **242,** each being hingedly articulated to an extension **236** of the actuation mechanism at an end point **244** thereof. The transition element **240** is articulated to the latch **260** at an end opposite the fork extensions **242** via a hinge point **263** of the latch **260.**

The latch **260** itself is of similar construction to the latch portion **136** of the rotary element and latch **130** previously described, and is formed with a latch hook **267** and a latch cradle **268.** The latch **260** is anchored to the housing **210** via a pivot portion **264,** configured for allowing the latch **260** to perform a rotary motion about an axis X_3 thereof.

The latch **260** also comprises a locking clasp **269** configured for engagement with a securing mechanism **250** (not shown), and fulfills a similar function to the locking recess **139** previously described with respect to latch **100.**

In operation, rotation of the tool T about the axis X_1 (when received within the socket **222**) entails rotation of the worm gear **226** about the same axis. In turn, rotation of the worm gear **226** entails rotation of the rotary element **230** about its axis X_2.

Being fixed to the rotary element **230,** the extensions **236** are configured to revolve together with the rotary element **230.** Rotary motion of the extensions **236** is translated into displacement of the transition element **240** due to the hinged articulation between the two.

In particular, in the position shown in Fig. 3B, the extensions **242** are oriented so as to extend perpendicular to axis X_1, whereby an end point **237** thereof is at its most proximal position with respect to the latch **260.** From this position, rotation of the rotary element **230** in a CW direction will entail rotation of the extensions **236** so that the ends **237** thereof are at a distal position with respect to the latch **260** (i.e. at a distance from the latch **260** which is greater than the distance at the most proximal position).

Due to the hinged articulation between the fork like extensions **242** of the transition element **240** and the ends **237,** rotation of the extensions **236** entails pulling back on the transition element, urging the latch **260** to perform a rotary motion about its axis X_3, i.e. unlatching.

With respect to the above, in the current example of the latch unit **200,** the rotary element **230,** and specifically the location of the ends **237** on its periphery, allow the rotary element **230** to function as an eccentric or bell crank, configured for moving the transition element **240** back and forth.

When unlatching of the latch **260** is desired, rotation of the rotary element **230** will entail a corresponding return of the ends **237** of the extensions **236** to their proximal position, and a subsequent displacement of the transition element **240** and latching of the latch **260.**

Turning now to Figs. 4A to 4E, another example of a latch unit is shown, being generally designated as **300**. The latch unit **300** comprises a housing **310,** and an actuation mechanism **320,** a rotary element **330,** a transition member **340** and a latch **360** which are all mechanically associated with one another to form a drive chain.

In principle, the latch unit **300** is of similar construction to that of latch unit **200** previously described, with the main difference lying in the fact that the rotary element

330 is associated to the actuation mechanism **320** via a cam arrangement rather than meshing of gear teeth.

Specifically, the actuation mechanism **320** comprises a socket **322,** a sliding nut **324** mounted onto a threaded shaft **326** (also referred herein as lead screw) being revolvingly retained with a corresponding threaded hole of the housing **310**, and a cam member **328** hingedly articulated to the base portion **324.**

The rotary element **330** is in the form of a cam plate **332** and is formed with three openings:

- a pivot hole **334** configured for pivotal anchoring of the rotary element **330** to the housing **310,** in a manner allowing it to perform rotary motion about its axis X_2**;**
- an articulation hole **336** configured for hinged articulation to the transition element **340;** and
- a longitudinal cam slot **338** configured for receiving therein the cam member **328** in a freely sliding manner.

The transition element **340** is in the form of a push rod **342** being hingedly articulated at one end **344** thereof to the cam plate **332** and at the other end **346** thereof to the latch **360.**

The latch **360** is of similar construction to the previously described latches **260** and **136,** and comprises a latch hook **367** and a latch cradle **368.** The latch **360** is anchored to the housing **310** via a pivot portion **364,** configured for allowing the latch **360** to perform a rotary motion about an axis X_3 thereof.

In operation, revolution of the tool **T** about the central axis X_1 (when the tip **99** is received within the socket **322**) entails rotation of the lead screw **326** about the same axis. Since the lead screw **326** is only allowed to revolve within the threaded bore of the housing (not shown), i.e. it is not allowed to linearly displace along axis $\mathbf{X_1}$, rotation thereof entails linear displacement of the sliding nut **324** along the axis X_1**,** up or down depending on the direction of rotation.

Being attached to the base portion **324,** the cam member **328** performs linear displacement along the axis direction together with the threaded shaft **326,** and, being

received within the longitudinal cam slot **338,** entails rotary motion of the cam plate **332** about the auxiliary axis X_2.

As in the previously described example of rotary element **230,** the rotary element **330** functions as an eccentric or bell crank, whereby rotary motion thereof entails pulling/pushing of the transition element **340,** via the hinge articulation at **336**, causing its displacement.

Consequently, displacement of the transition element **340** entails rotary motion of the latch **360** about the pivot point **364** thereof, thereby allowing latching and unlatching of the latch **360.**

Attention is now drawn to Figs. 5A to 5E, in which yet another example of a latch unit is shown, being generally designated as **400**. The latch unit comprises a housing **410,** an actuation mechanism **420,** an integrated rotary element and latch **430,** a support frame **440** and a securing mechanism **450.**

In principle, the latch unit **400** is of similar construction to that of latch unit **100** previously described, i.e. a latch unit with an integrated rotary element and latch, with the main difference lying in the fact that the rotary element **430** is associated to the actuation mechanism **420** via a cam arrangement rather than meshing of gear teeth.

In particular, the actuation mechanism **420** comprises, similarly to the actuation mechanism **320** previously described, a socket **422,** a sliding nut **424,** a threaded shaft **426** (also referred herein as a lead screw) and a cam roller **428** fixed to the base portion **424**.

The integrated rotary element and latch **430** comprises a body **432** and is pivotally anchored to the support frame **440** via a pivot portion **434** thereof, allowing it to freely perform rotary motion about an auxiliary axis X_2 upon proper actuation by the actuation mechanism **420.**

The integrated rotary element and latch **430** comprises a cam arm **433** formed with a longitudinal cam slot 433_S, configured for slidingly receive therein the cam roller **428** of the actuation mechanism **420.**

The integrated rotary element and latch **430** is also formed, at a side opposite said cam arm **433,** with a latch portion **436** having a latch hook **437** and a latch cradle

438 configured for receiving and supporting a corresponding grip portion GP of the battery pack **14**. The latch portion **436** is further formed with a locking recess **439** configured for engagement with the securing mechanism **450.**

In operation, revolution of the tool **T** about the central axis $\mathbf{X_1}$ (when the tip **99** is received within the socket **422**) entails rotation of the threaded shaft **426** about the same axis. Since the lead screw **426** is only allowed to revolve within the threaded bore of the housing (not shown), i.e. it is not allowed to linearly displace along axis $\mathbf{X_1}$, rotation thereof entails linear displacement of the sliding nut **424** along the axis X_1, up or down depending on the direction of rotation.

Being attached to the sliding nut **424,** the cam roller **428** performs linear displacement along the axis direction together with the threaded shaft **426,** and, being slidingly received within the longitudinal cam slot $\mathbf{433_S}$, entails rotary motion of the integrated rotary element and latch **430** about the auxiliary axis X_2**.** As the integrated rotary element and latch **430** constitute a single body, rotary motion thereof directly entails latching/unlatching of the latch **436.**

Finally, referring now to Figs. 6A to 6E, yet another example of a latch unit is shown, generally being designated as **500.** The latch unit comprises a housing **510,** an actuation mechanism **520,** a rotary element **530,** a transition element **540** and a latch **560.**

The actuation mechanism **520** comprises a socket **522,** a central shaft **524** and a first bevel gear **526** configured for being meshed with a corresponding bevel gear **534** of the rotary element **530.**

The rotary element **530** is in the form of a threaded rod **532** configured for being threadingly received within a corresponding threaded bore **546** of the transition element **540,** and comprises a second bevel gear **534** configured for being meshed with the first bevel gear **526.**

It is observed that the central axis X_2' of the threaded shaft **532** is slightly angled to the axis X_2 of the second bevel gear **534.** For the purpose of allowing the bevel gear **534,** turning about the axis X_2 to set the threaded rod **532** in rotary motion about its own axis X_2', the second bevel gear **534** and the threaded shaft **532** are articulated to one another via a universal joint **538,** as known *per se*.

The transition element **540** is essentially a hollow rod **542** with a threaded cavity **546** configured for receiving via one end thereof the threaded shaft **532,** and is articulated at the other end **544** thereof to the latch **560.**

The latch **560** is of similar construction to the previously described latches **360** and **136,** and comprises a latch hook **567** and a latch cradle **568.** The latch **560** is anchored to the housing **510** via a pivot portion **564,** configured for allowing the latch **360** to perform a rotary motion about an axis X_3 thereof.

In operation, when the tool **T** is received within the socket **522,** rotary motion of the former entails a corresponding rotary motion of the latter. The rotary motion is transferred via the bevel gears **526, 534** to the universal joint **538,** and from there to the threaded shaft **532.**

Since the transition element **540** is restricted from rotary motion, rotation of the threaded shaft **532** causes it to be threaded in/out of the cavity **546.** In addition, since the position of the second bevel gear **534** is restricted (i.e. it cannot displace towards the latch **560**), threading of the shaft **532** in and out entails displacement of the transition element **540,** respectively towards and away from the actuation mechanism **520.** The above displacement, in turn, entails rotation of the latch **560** about its axis X_3, thereby allowing latching and unlatching of the latch **560.**

Those skilled in the art to which this invention pertains will readily appreciate that numerous changes, variations, and modification can be made without departing from the scope of the invention, *mutatis mutandis.*

CLAIMS:

1. An attachment arrangement for attaching a battery pack to a battery bay of a vehicle, said arrangement comprising an array of latch units associated with either of said battery pack and battery bay and configured for engagement with a corresponding array of grip portions associated with the other of the battery pack and battery bay, two or more of said latch units being configured for being individually and mechanically switchable between an engaged and disengaged states by a designated tool external to both the battery pack and the vehicle.

2. An attachment arrangement according to Claim 1, wherein each of the latch units is configured for assuming a first, engaged position in which it is mechanically engaged with its corresponding grip portion, and a second, disengaged position, in which it is disengaged from its corresponding grip portion.

3. An attachment arrangement according to Claim 2, wherein, in the disengaged position, the latch unit is configured for disengaged so as to allow the battery pack to be removed from the battery bay.

4. An attachment arrangement according to Claim 2 or 3, wherein each of the latch units is configured for assuming a plurality of intermediary positions between the engaged position and the disengaged position.

5. An attachment arrangement according to Claim 2, 3 or 4, wherein the latch array is configured for assuming various positions in which some of the latch units are in their engaged position while the remainder of the latch units are at their disengaged position or at any other intermediary position.

6. An attachment arrangement according to any one of Claims 1 to 5, wherein the battery bay of the vehicle is provided with the array of latch units while the battery is provided with the array of grip portions.

7. An attachment arrangement according to any one of Claims 1 to 6, wherein the attachment arrangement comprises a controller configured for monitoring operation of the latch units.

8. An attachment arrangement according to Claim 7, wherein the controller is configured for providing a user/operator with an indication regarding the position of each latch unit as well as an indication regarding possible malfunction of any of the latch units.

9. An attachment arrangement according to Claim 7 or 8, wherein the arrangement further comprises a synchronization arrangement configured for operating in conjunction with the controller for assuring that all latch units are at the same respective position during operation thereof.

10. An attachment arrangement according to Claim 9, wherein the synchronization arrangement is facilitated by a pair of contact surfaces located on the grip portion and latch unit, wherein contact between the surfaces entails closing the electric circuit entailing generation of a corresponding signal.

11. An attachment arrangement according to any one of Claims 7 to 10, wherein the controller is configured for monitoring operation of the external tool.

12. An attachment arrangement according to any one of Claims 2 to 11, wherein each latch unit comprises a latch and a drive assembly configured for operating the latch for displacing it between its respective first, engaged position and second, disengaged position.

13. An attachment arrangement according to Claim 12, wherein the drive assembly of the latch unit is configured for translating the displacement/rotation provided by the external designated tool into the appropriate linear/rotational movement of the latch.

14. An attachment arrangement according to Claim 12 or 13, wherein each latch unit further comprises an operation port associated with the drive assembly and configured for mechanical articulation thereto of the external tool to allow actuation of the drive assembly.

15. An attachment arrangement according to Claim 14, wherein articulation of the external tool to the operation port is such that displacement and/or rotation of the external tool mechanically entails corresponding displacement and/or rotation of the drive assembly, which is then translated to the latch.

16. An attachment arrangement according to any one of Claims 12 to 15, wherein, while displacement and/or rotation of the drive assembly entails a corresponding displacement and/or rotation of the latch, the opposite is prevented.

17. An attachment arrangement according to Claim 16, wherein the above is provided via the mechanical engagement between the latch and the drive assembly.

18. An attachment arrangement according to Claim 16, wherein in said first, engaged position, the latch and drive assembly are geometrically locked.

19. An attachment arrangement according to Claim 18, wherein, during operation, the external designated tool is configured for first releasing the geometric lock and only thereafter to displace the latch into a disengaged position.

20. An attachment arrangement according to any one of Claims 12 to 19, wherein the latch has a pivot point and is configured for performing a rotary motion about a pivot axis in its transition between an engaged position and a disengaged position.

21. An attachment arrangement according to any one of Claims 12 to 19, wherein the latch is configured for performing linear displacement in its transition between an engaged position and a disengaged position.

22. An attachment arrangement according to any one of Claims 12 to 21, wherein the drive assembly comprises a rotary element configured for performing rotary motion under operation of the external tool.

23. An attachment arrangement according to Claim 22, wherein the latch is configured for being directly driven by the rotary element.

24. An attachment arrangement according to Claim 22, wherein the drive assembly includes additional transition components articulated to both the latch with the rotary element to provide mechanical connection therebetween.

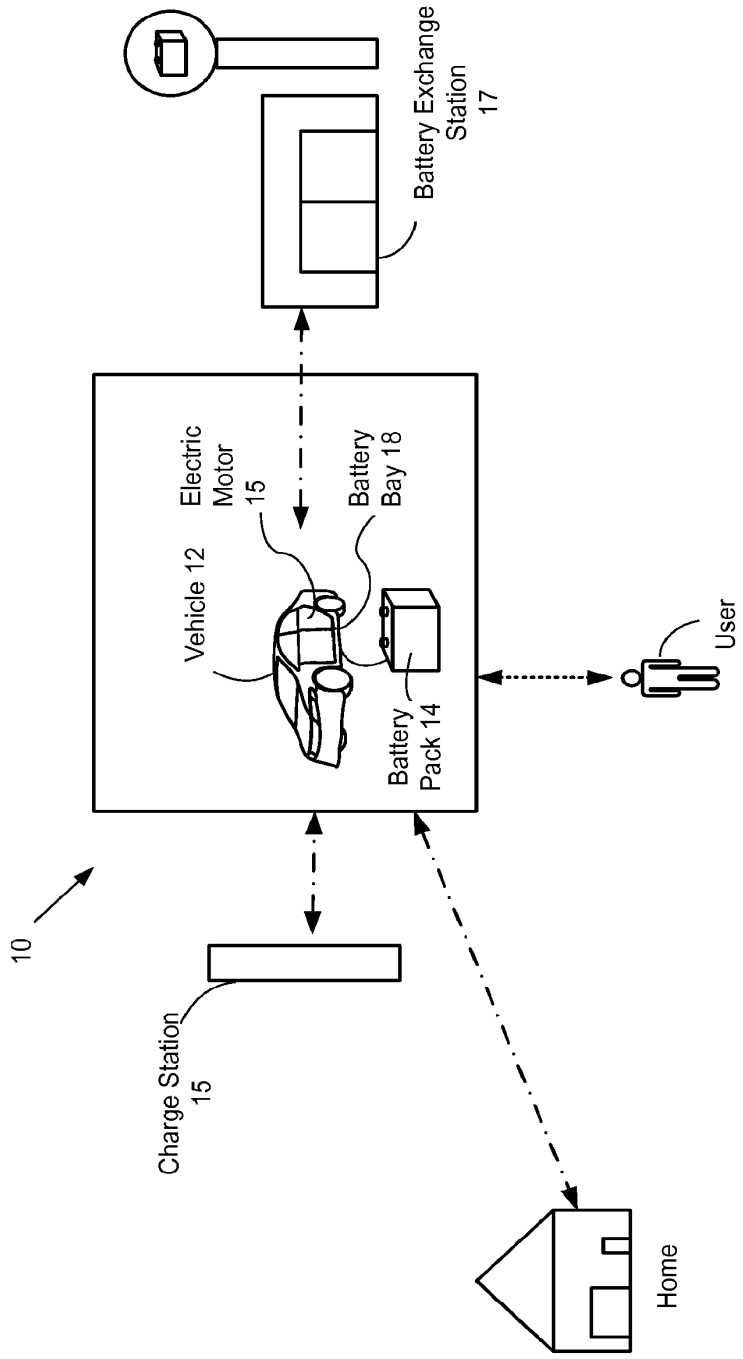

Battery Exchange Station 17
Electric Motor 15
Battery Bay 18
Vehicle 12
Battery Pack 14
User
10
Charge Station 15
Home

FIG. 1A

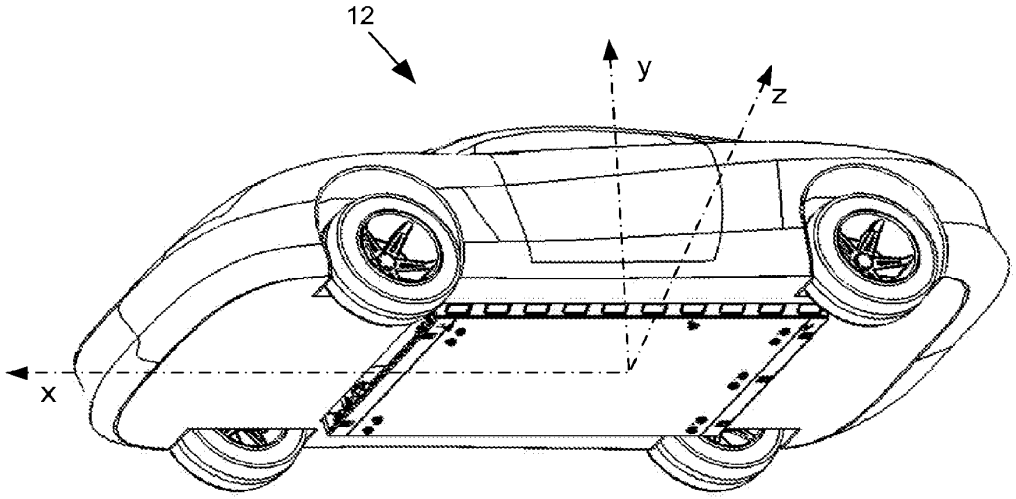


FIG. 1B

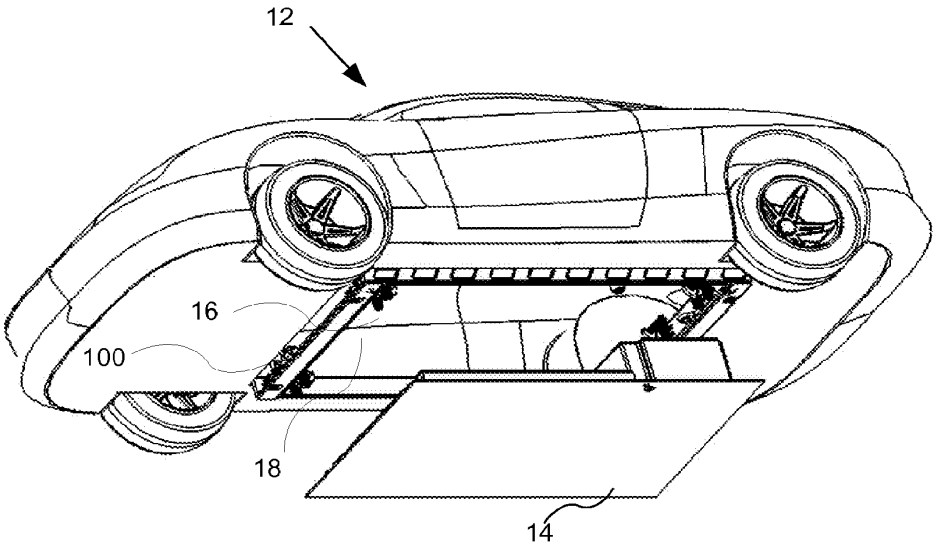


FIG. 1C

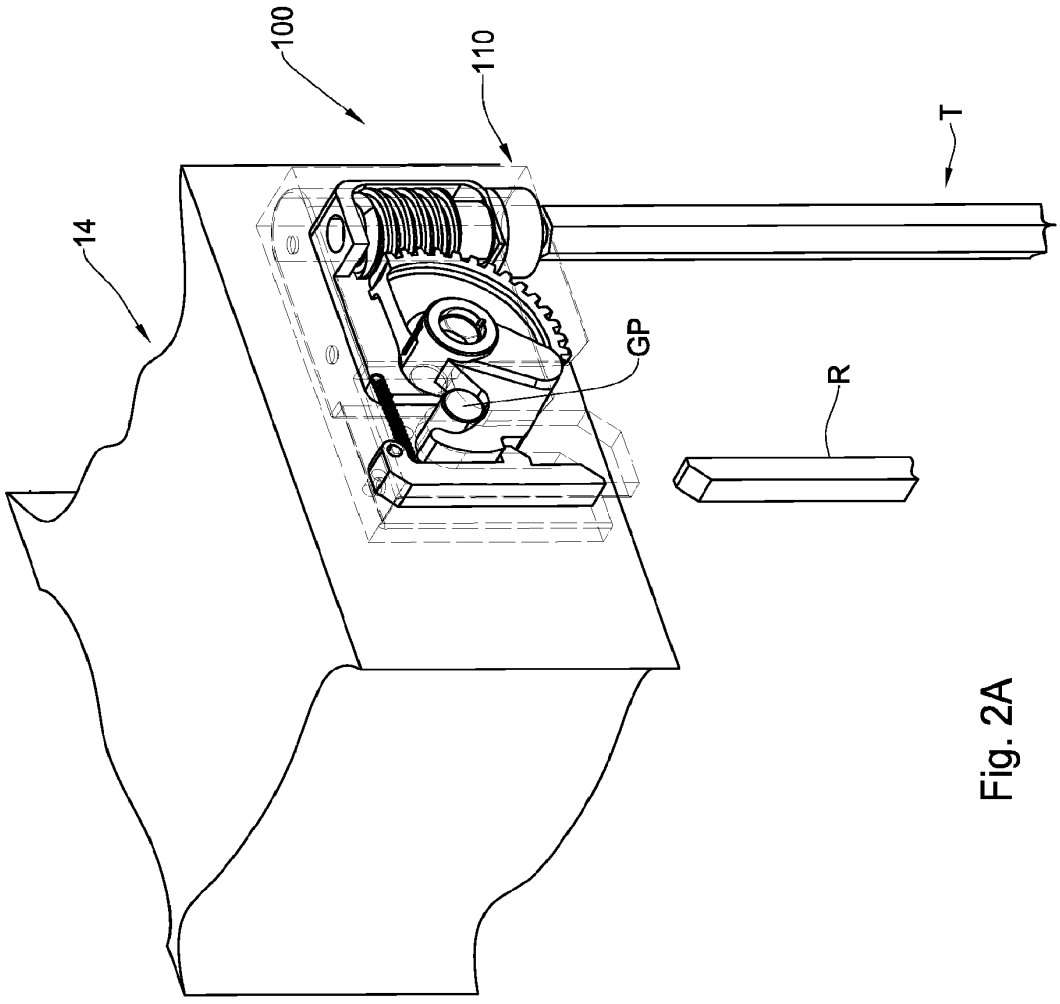


Fig. 2A

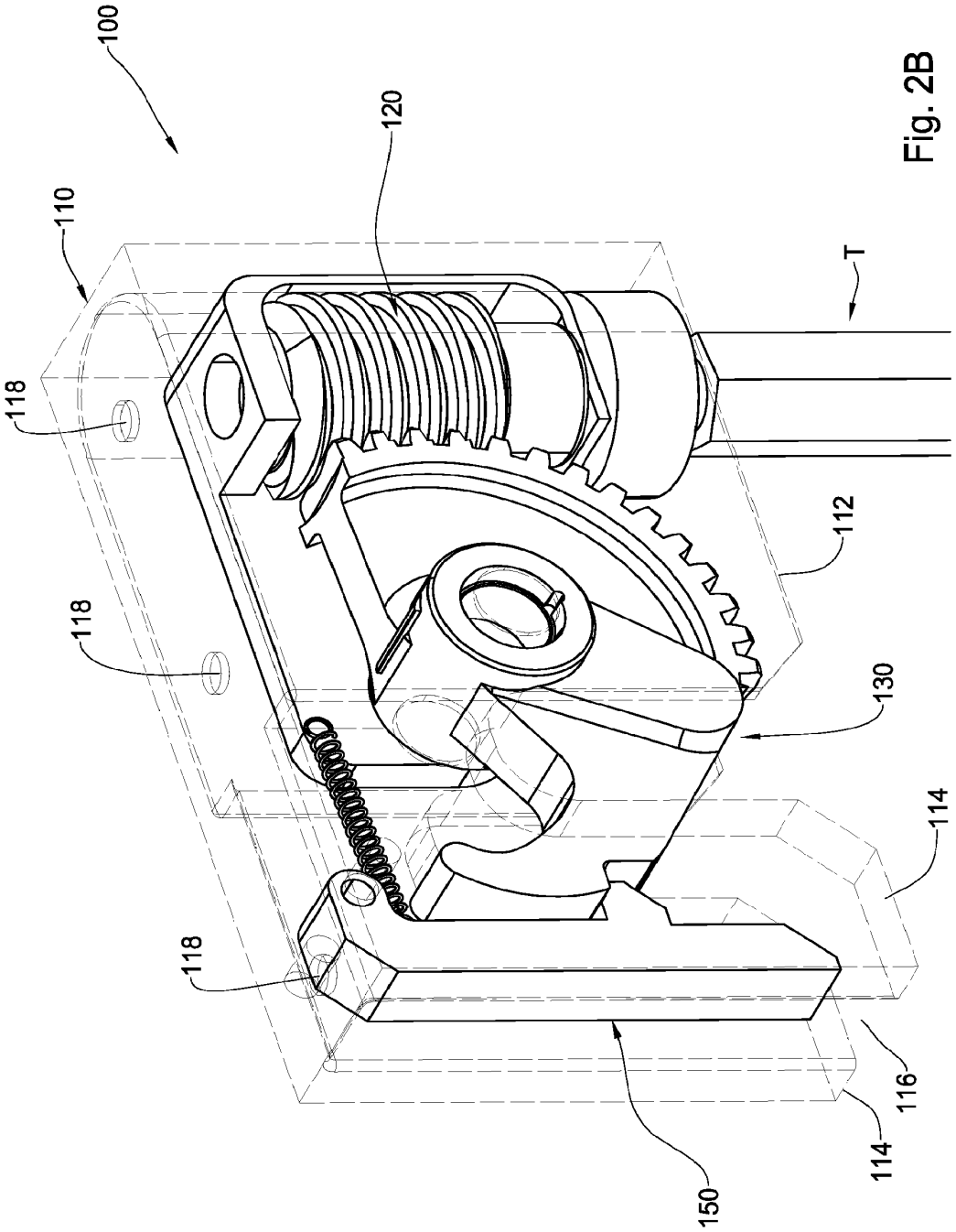


Fig. 2B

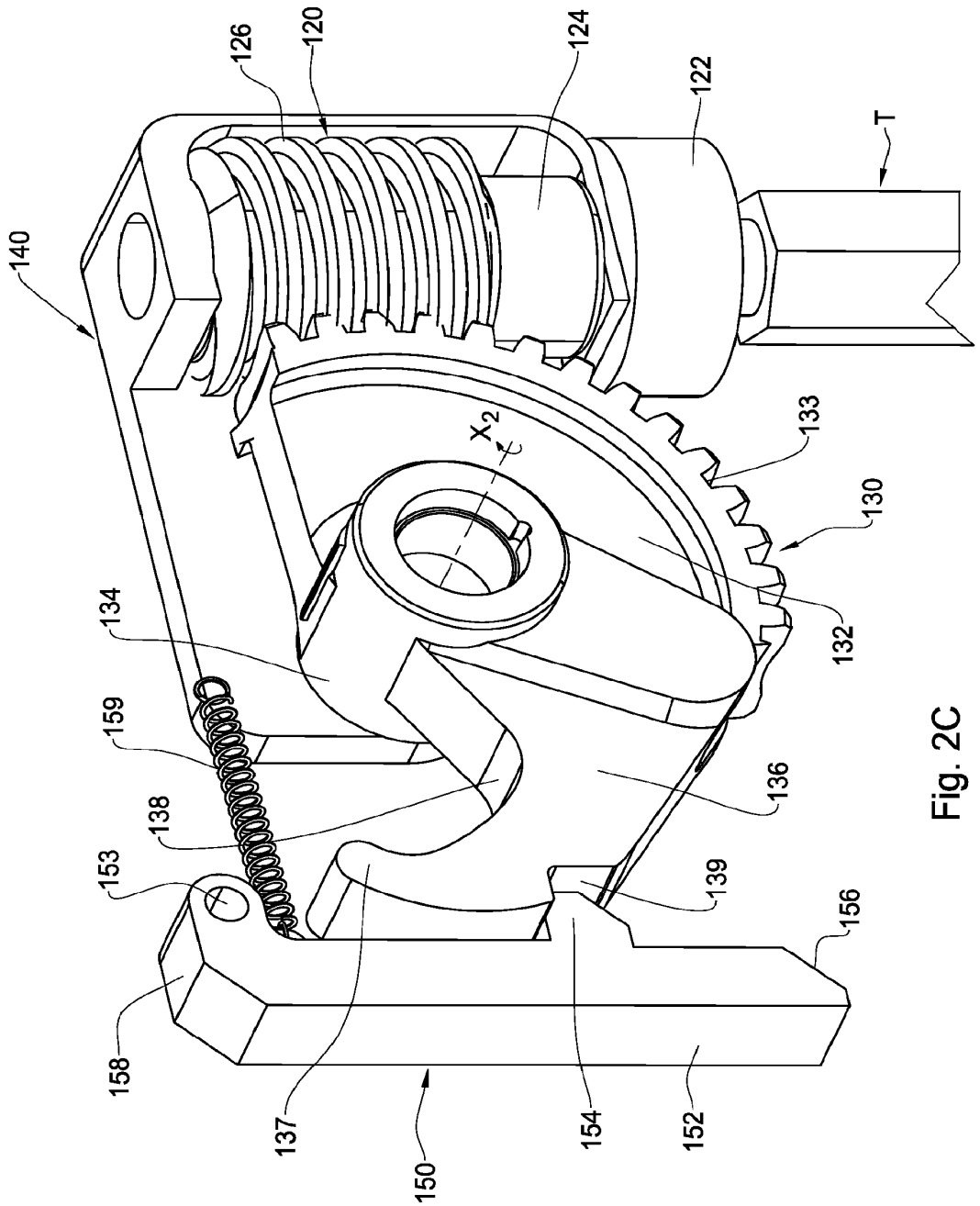

126
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124
122
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X_2
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152
150

Fig. 2C

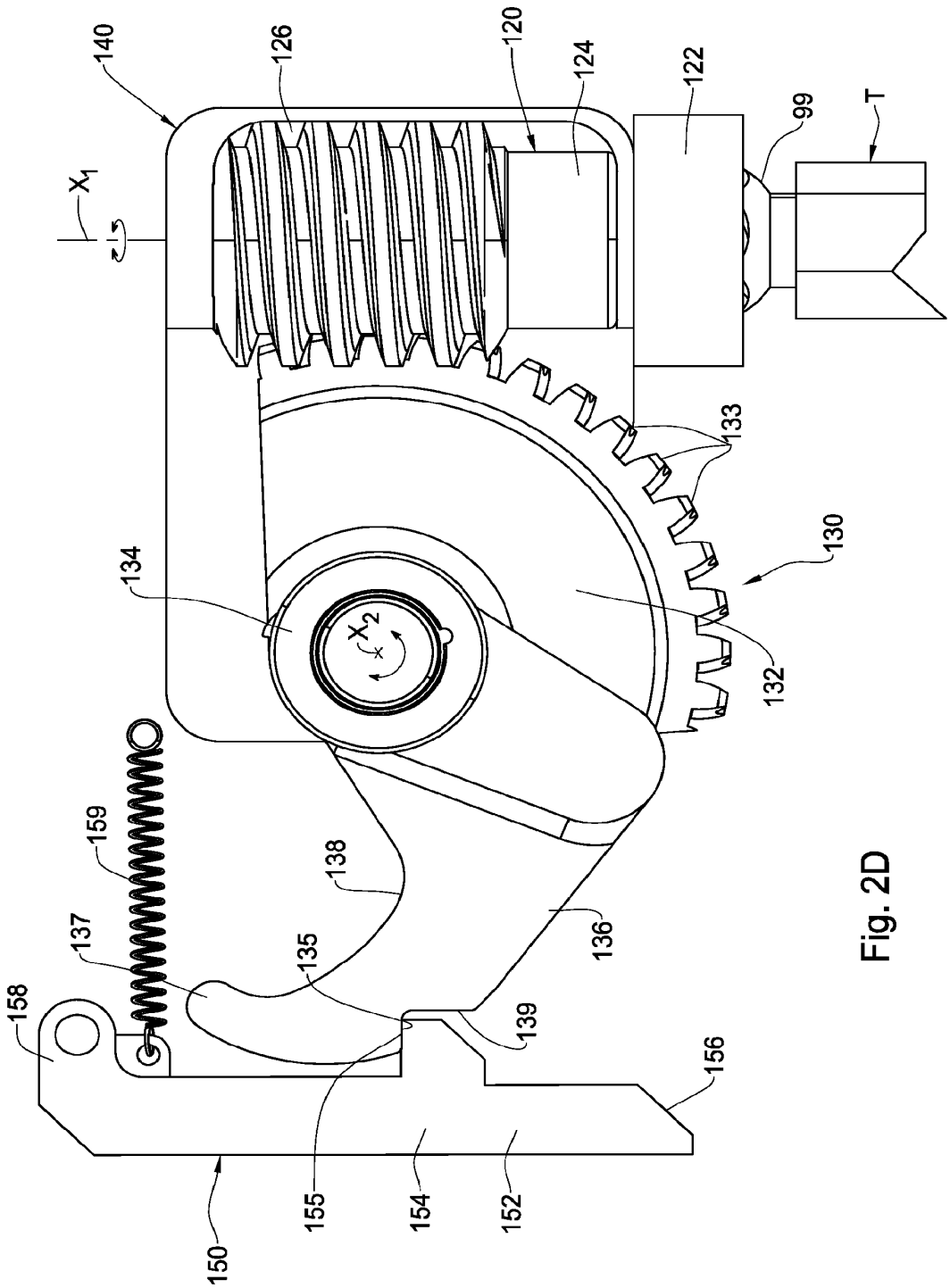

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X2
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Fig. 2D

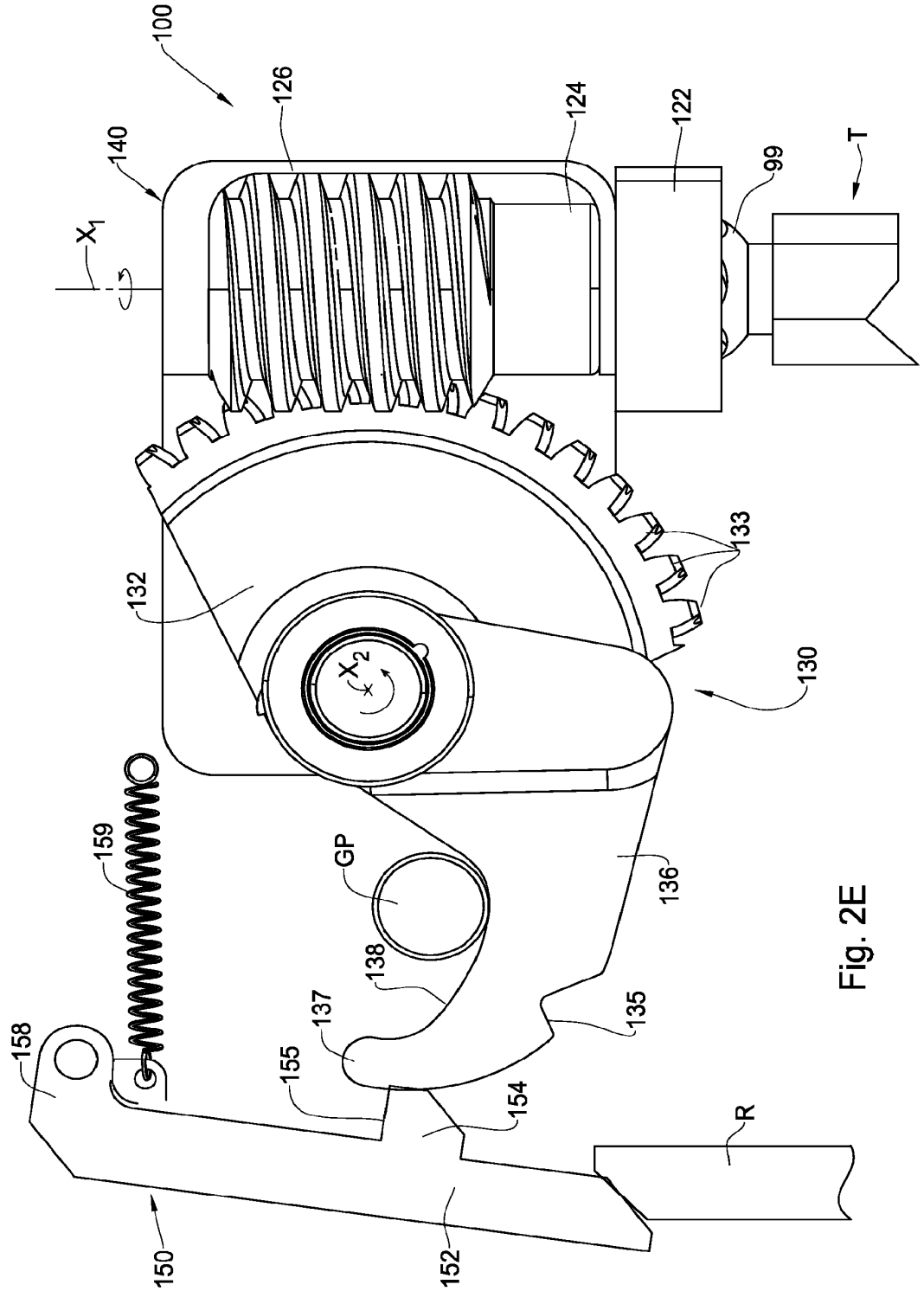

100
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124
122
140
99
T
X1
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132
X2
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159
GP
136
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155
154
R
150
152

Fig. 2E

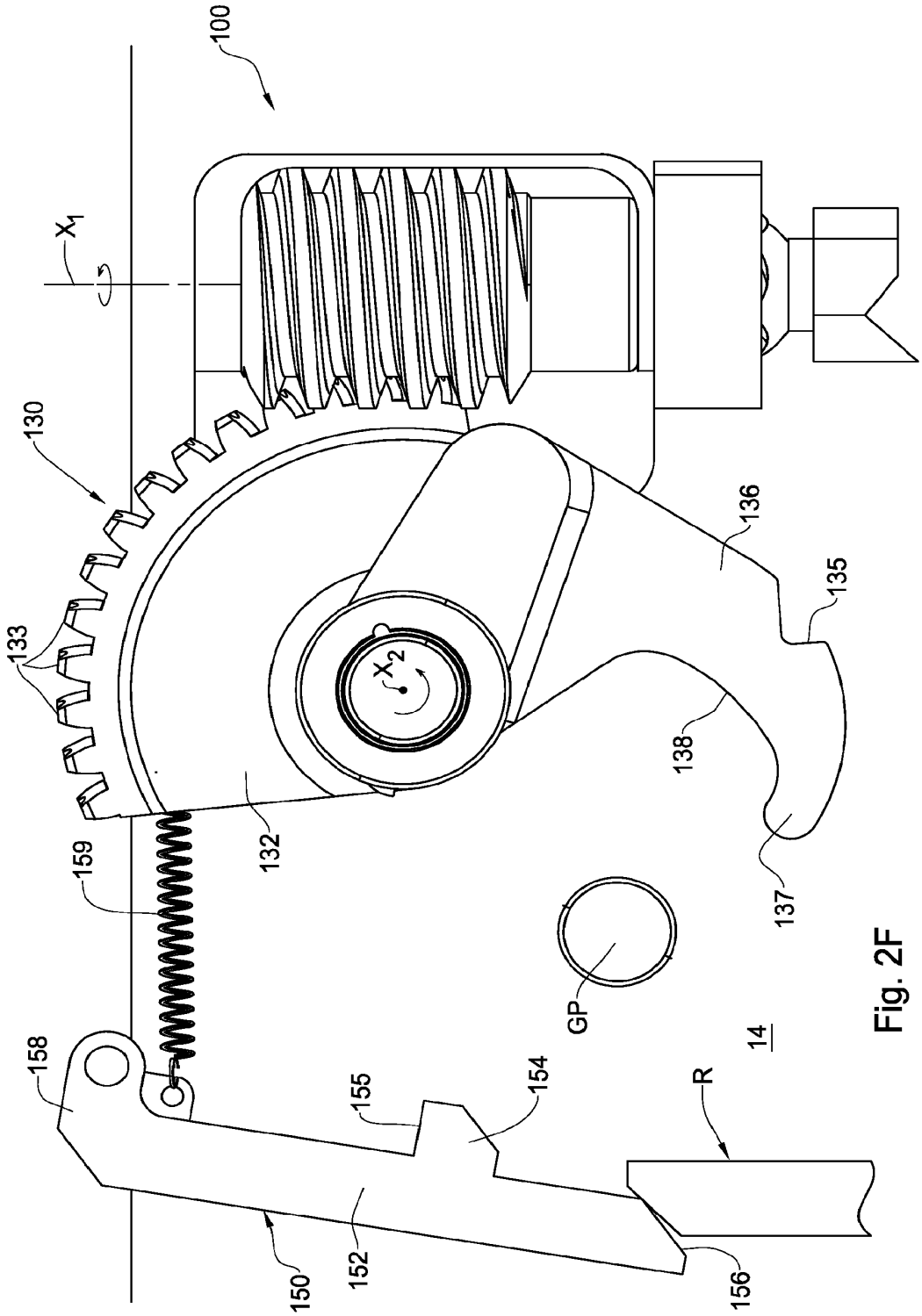

100
X1
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X2
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138
137
GP
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Fig. 2F

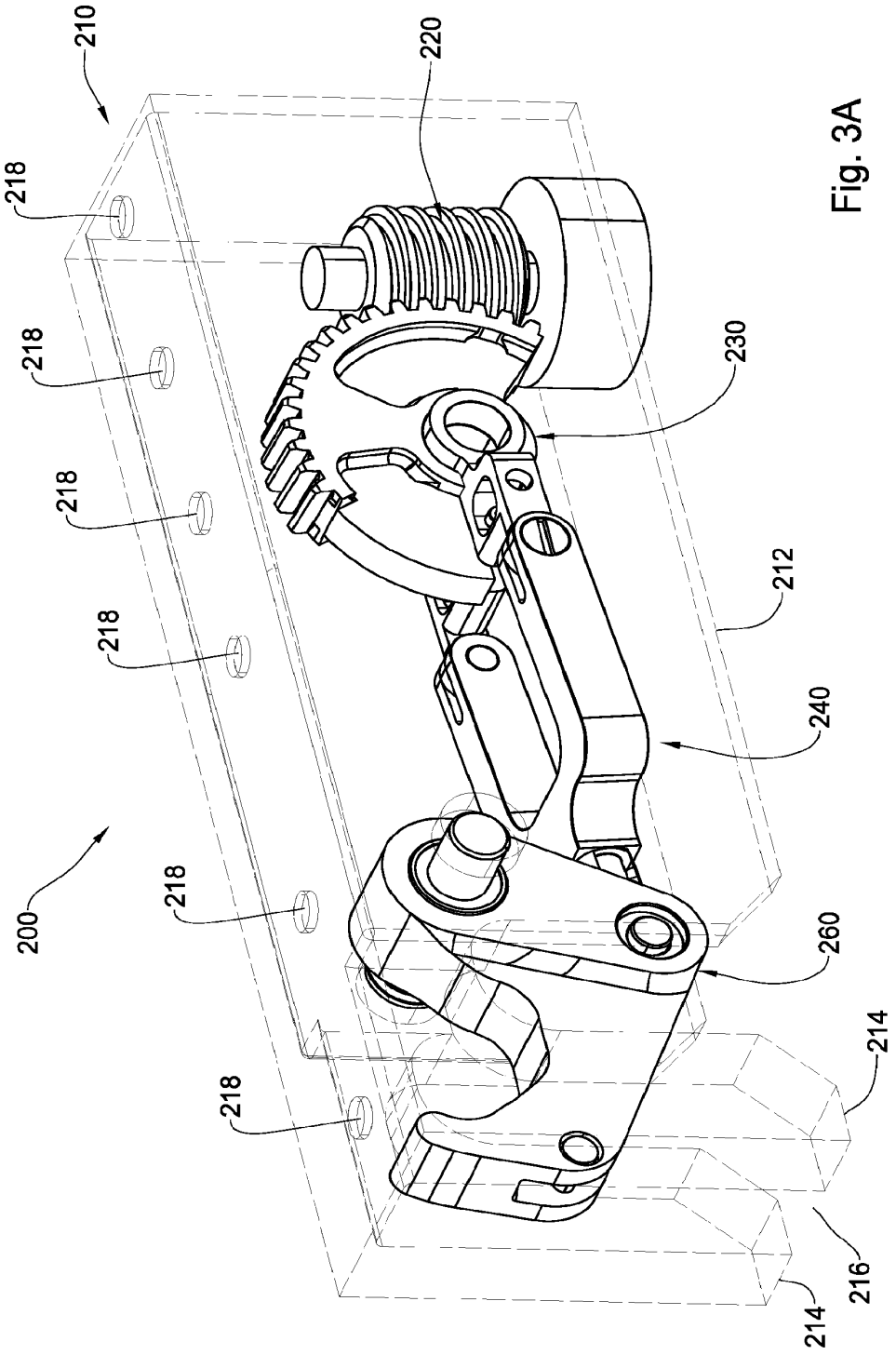


Fig. 3A

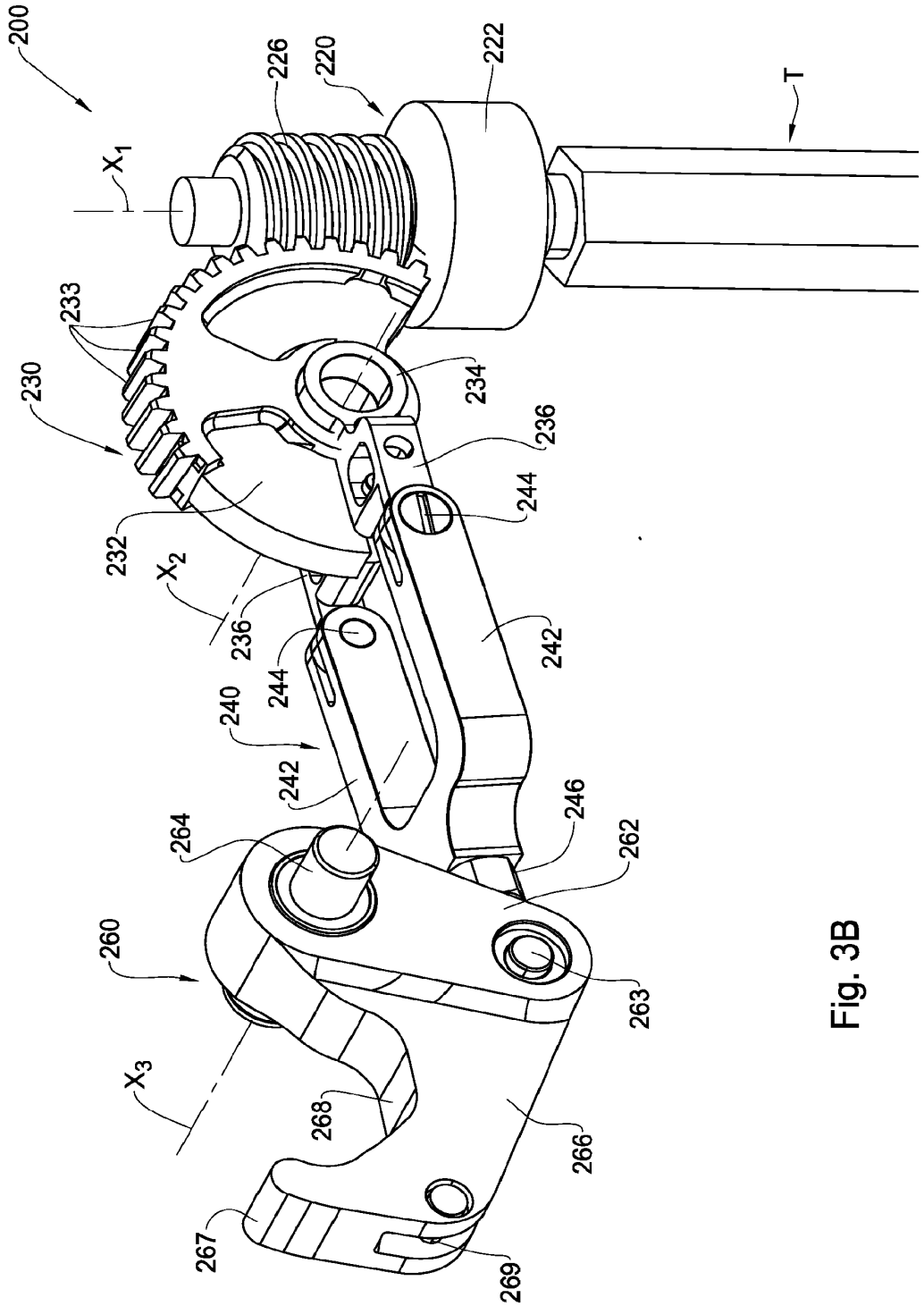

200
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X_1
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232
X_2
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240
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264
262
260
263
X_3
268
266
267
269

Fig. 3B

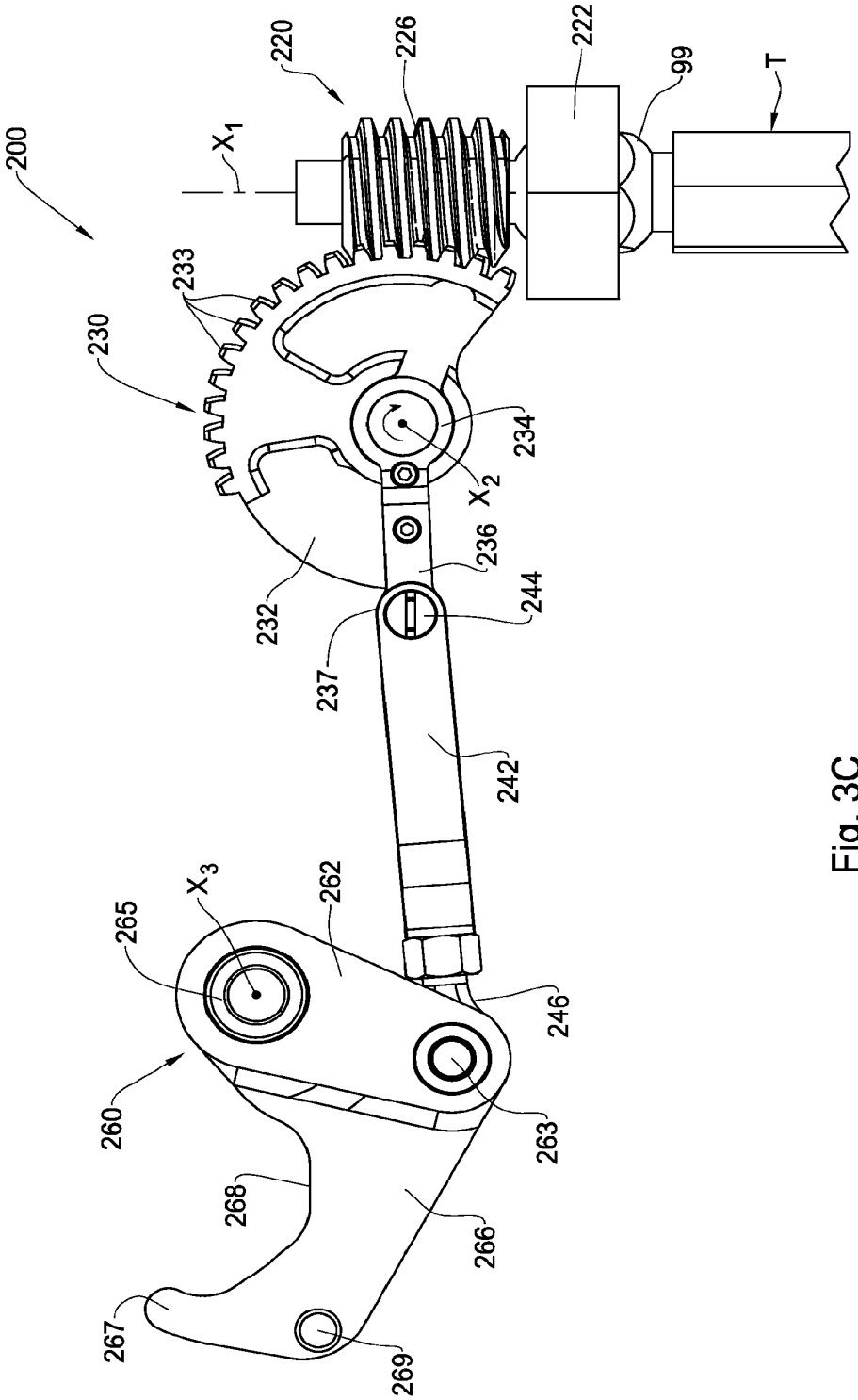

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X_3
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Fig. 3C

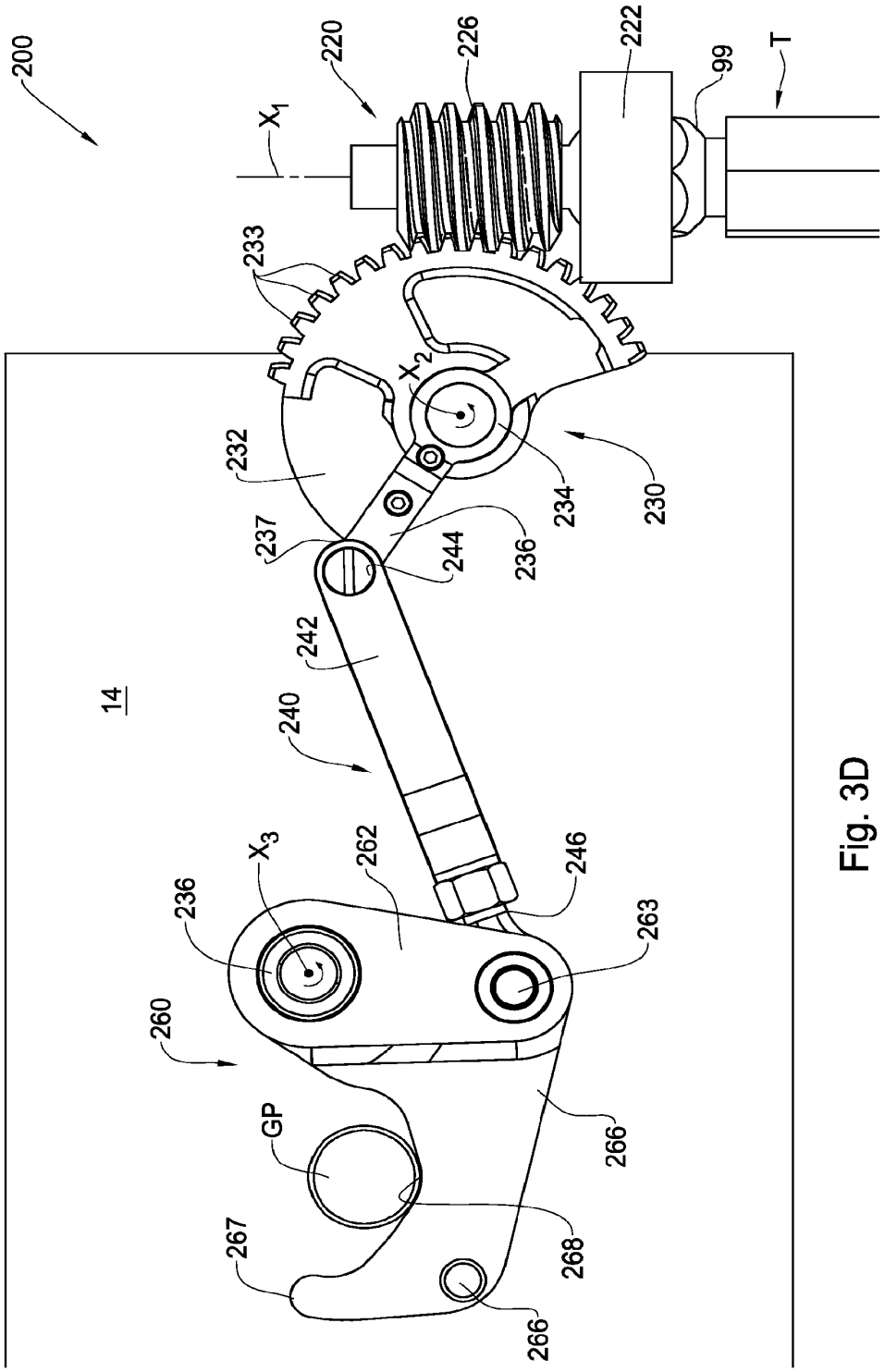

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X_1
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X_2
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X_3
262
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GP
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267
268
266

Fig. 3D

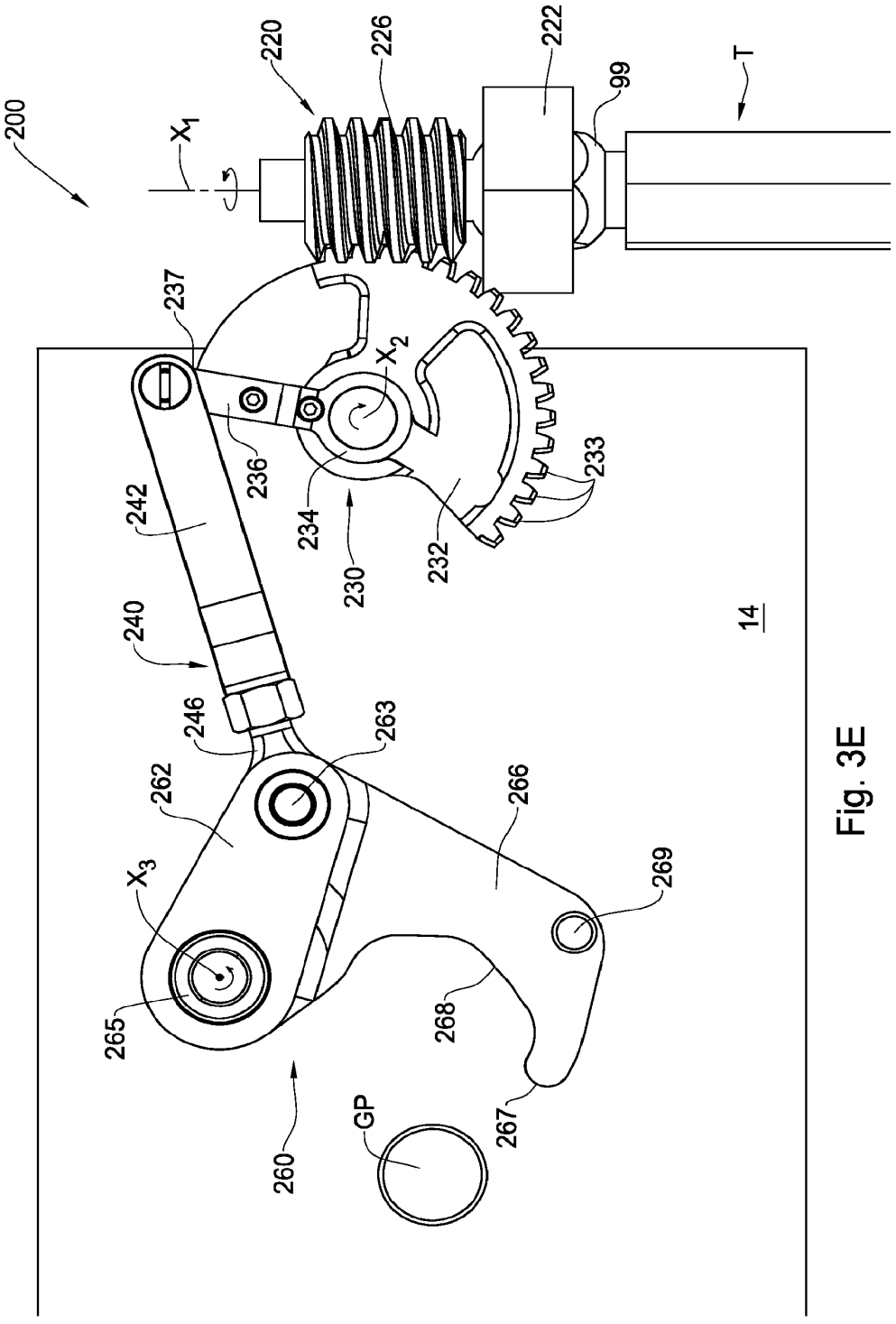

200
X1
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99
T
237
X2
236
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262
266
269
X3
265
268
267
GP
260
14

Fig. 3E

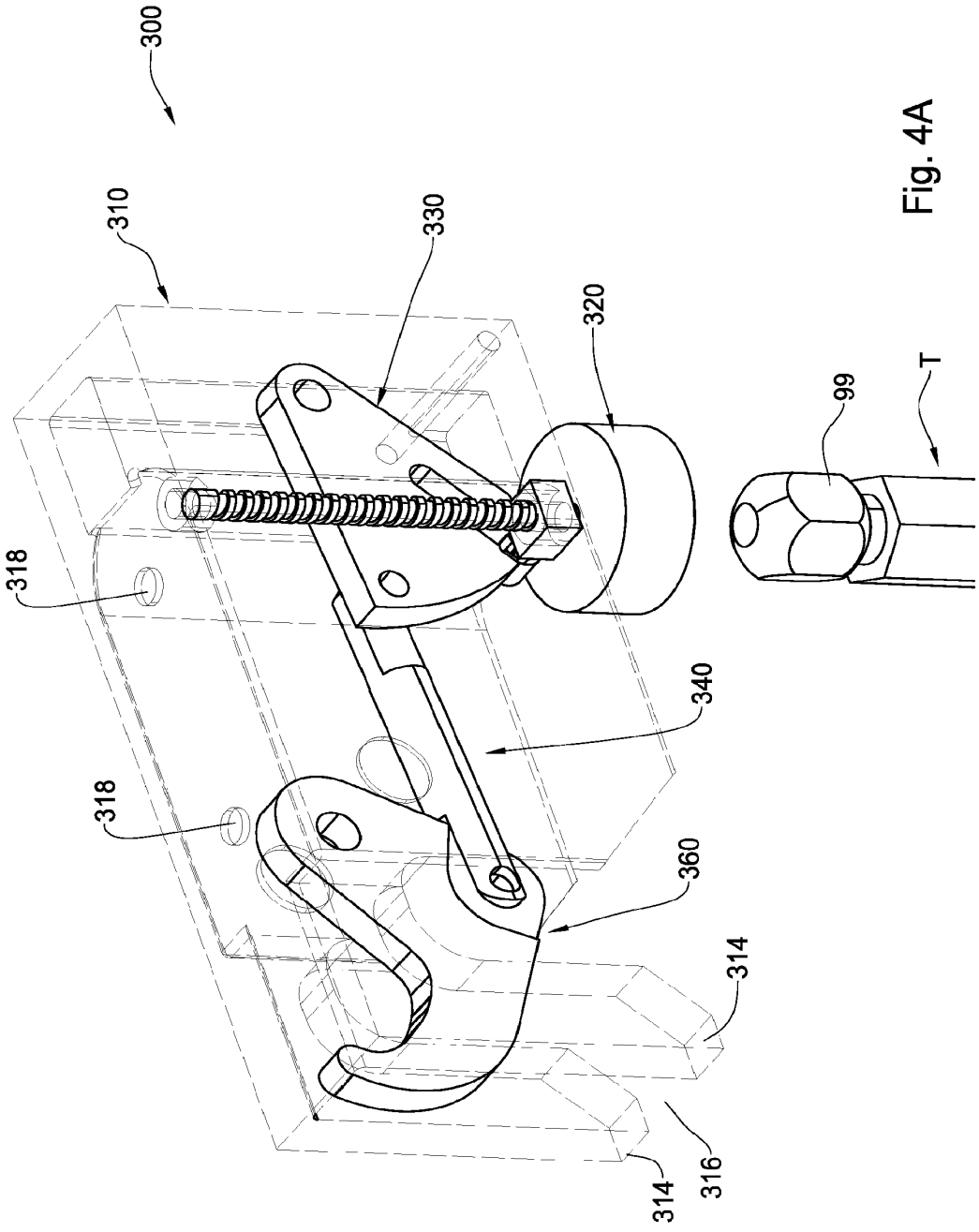


Fig. 4A

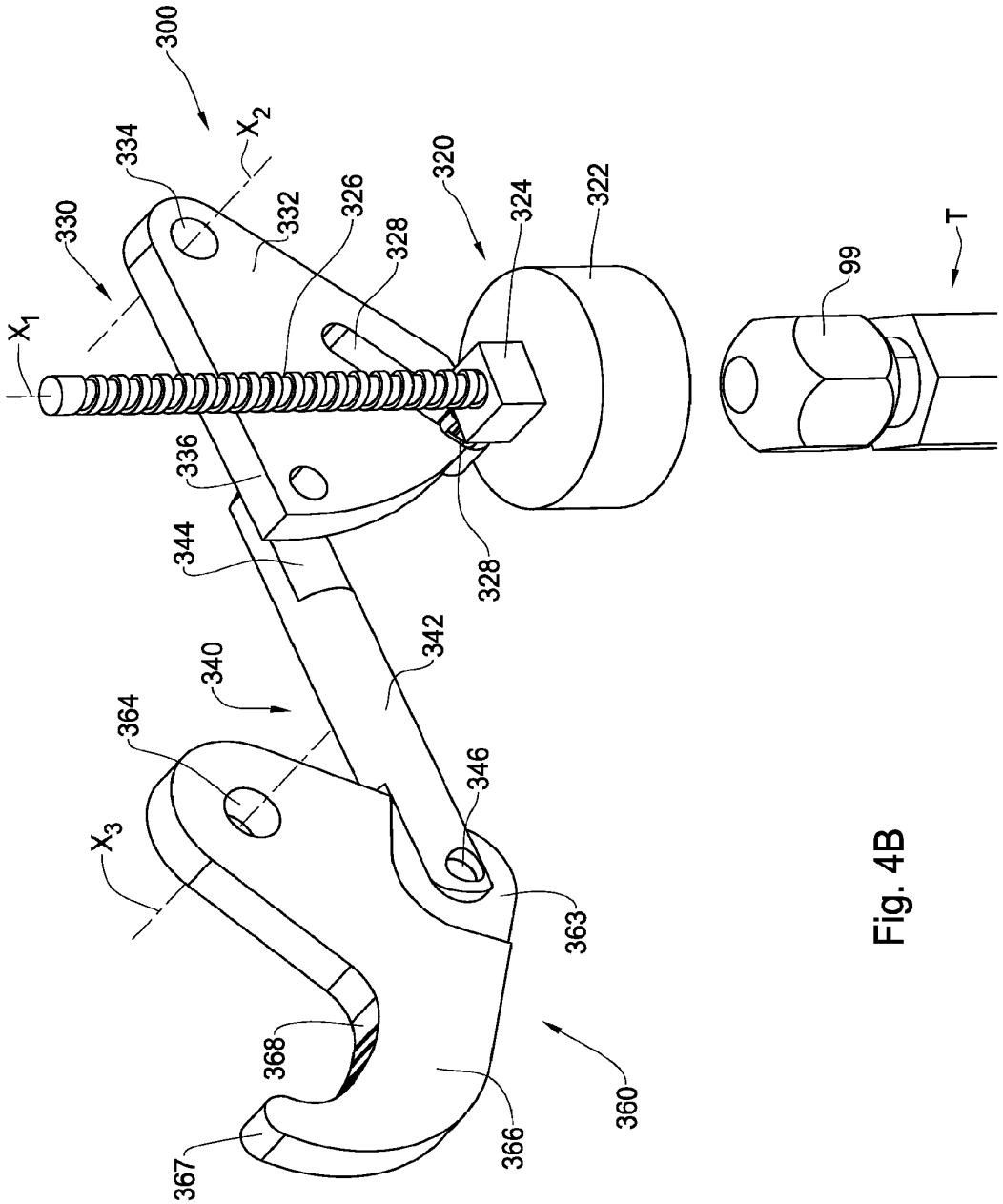

300
X_2
334
330
332
326
328
320
324
322
X_1
99
T
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344
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342
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364
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X_3
363
368
360
366
367

Fig. 4B

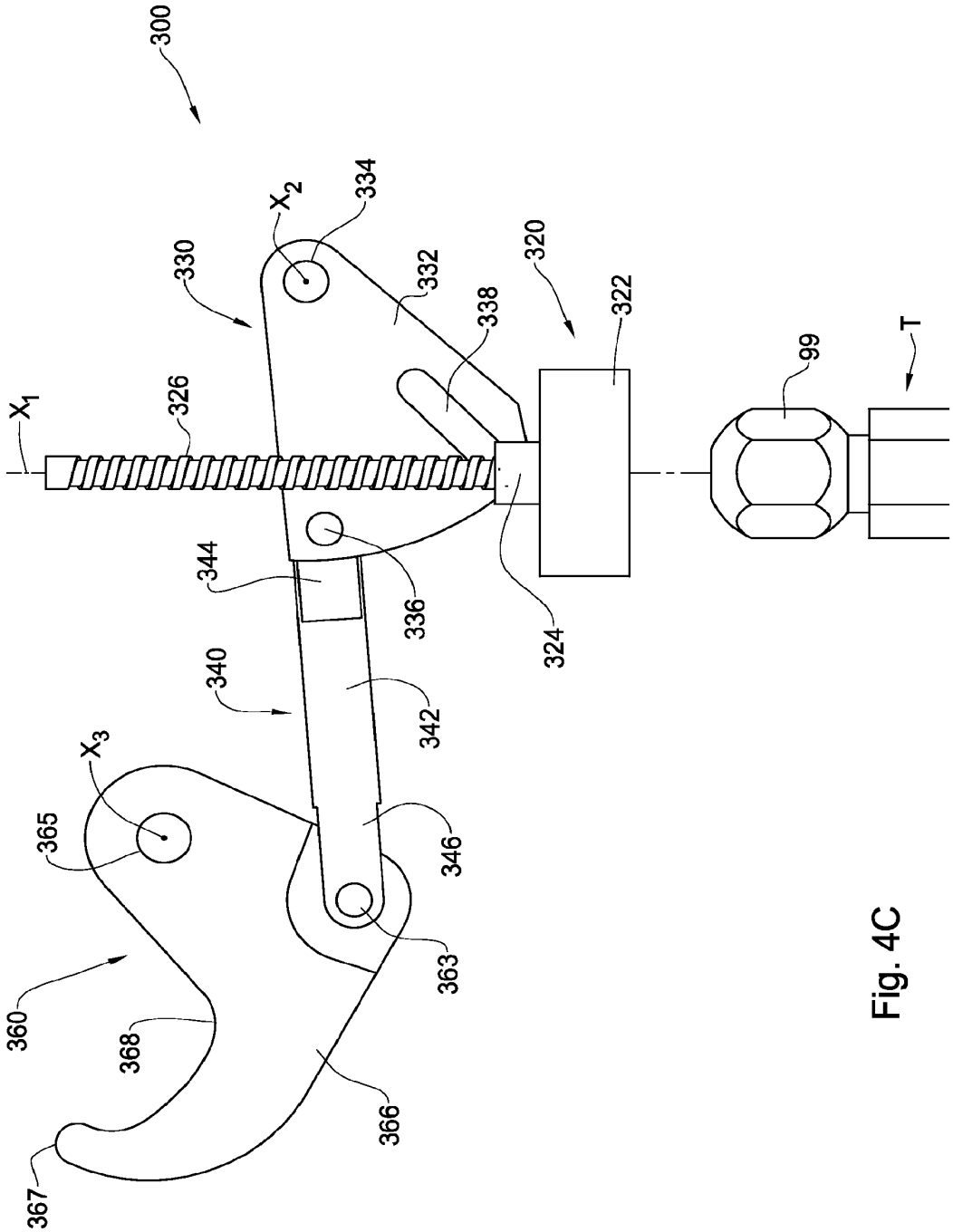

300
X_2
334
330
332
320
322
338
X_1
326
99
T
344
336
324
340
342
X_3
365
346
363
360
368
366
367

Fig. 4C

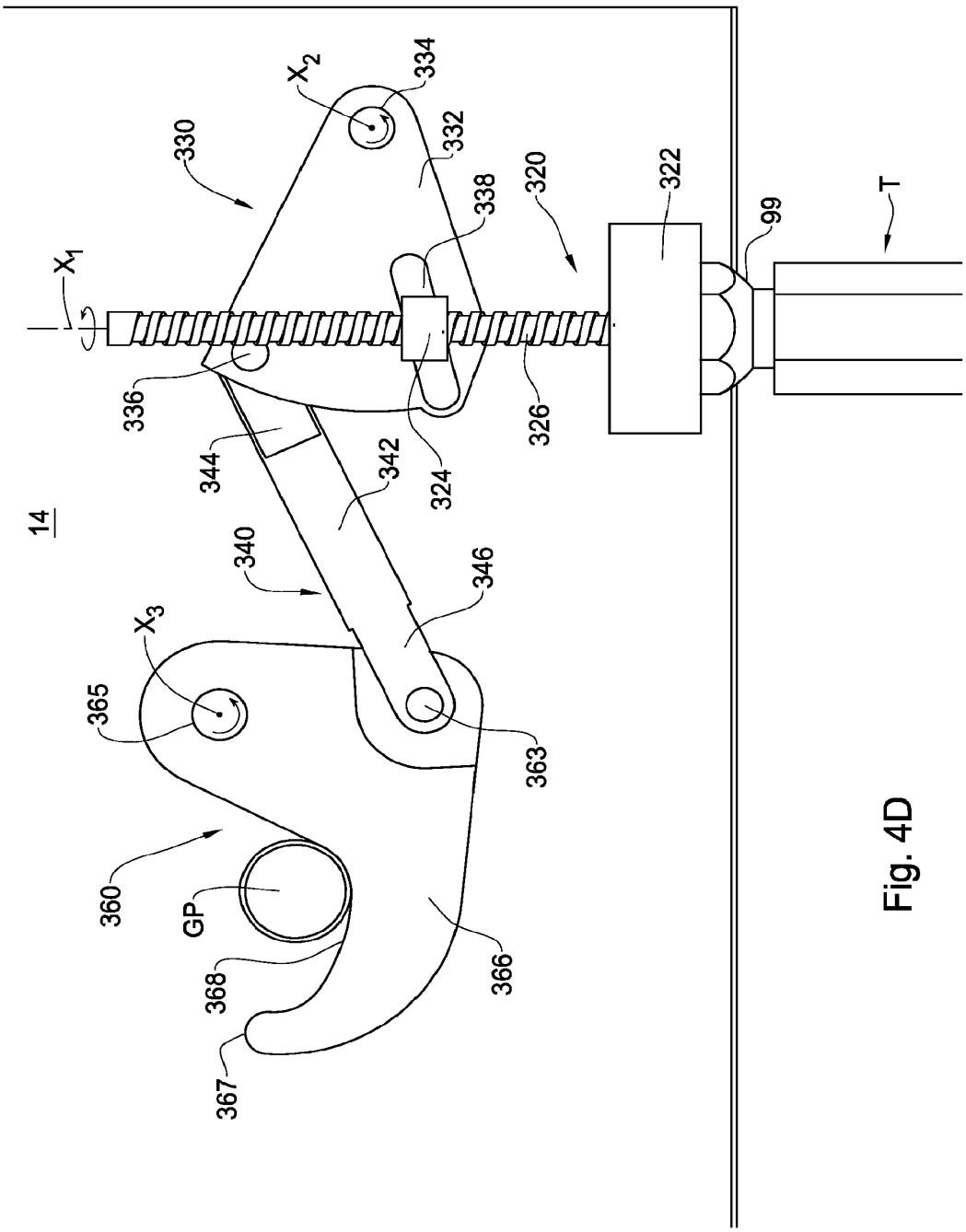

14
X1
X2
X3
330
332
334
336
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322
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T
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GP
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365
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Fig. 4D

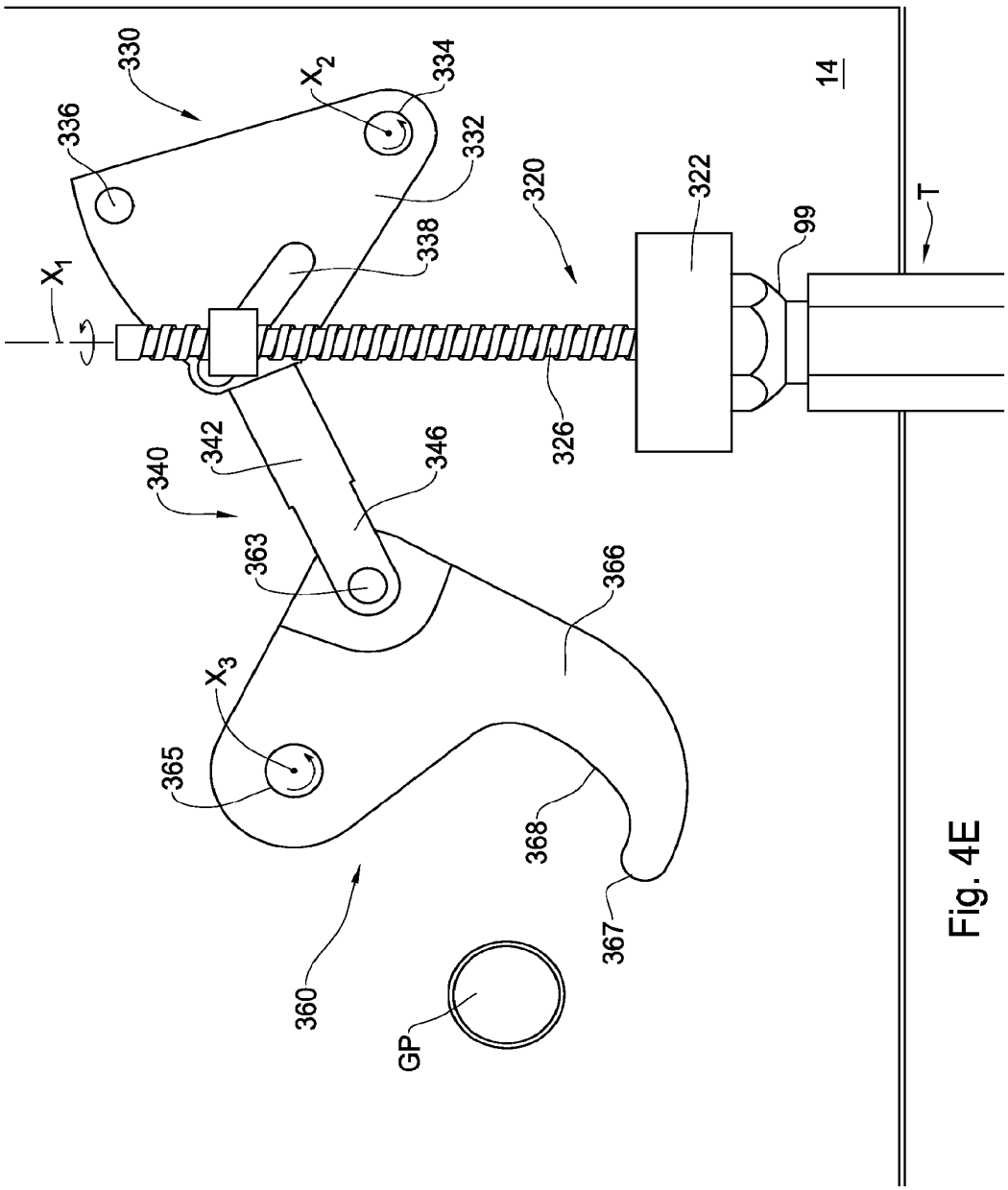

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X_2
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X_3
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368
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360
GP

Fig. 4E

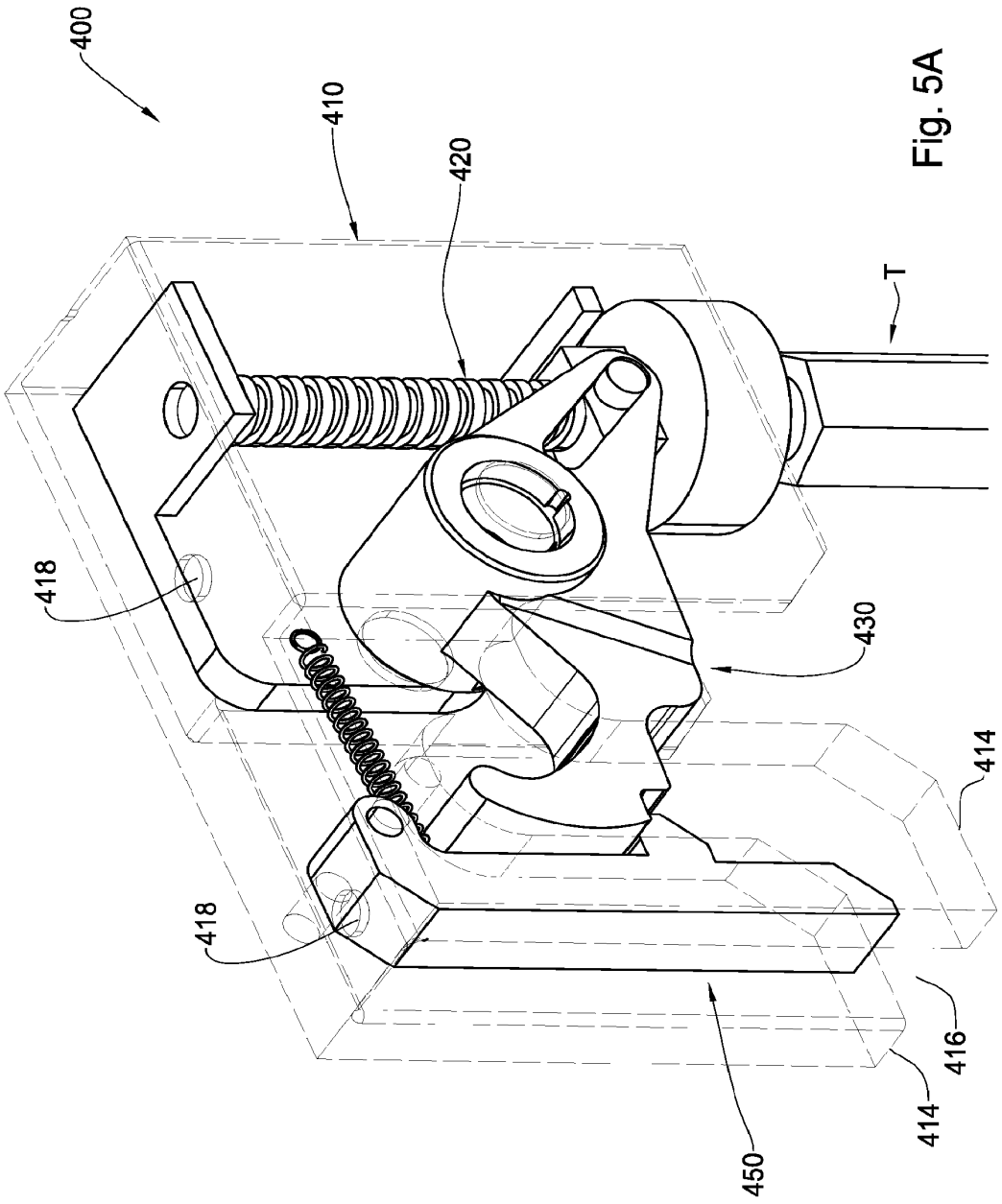


Fig. 5A

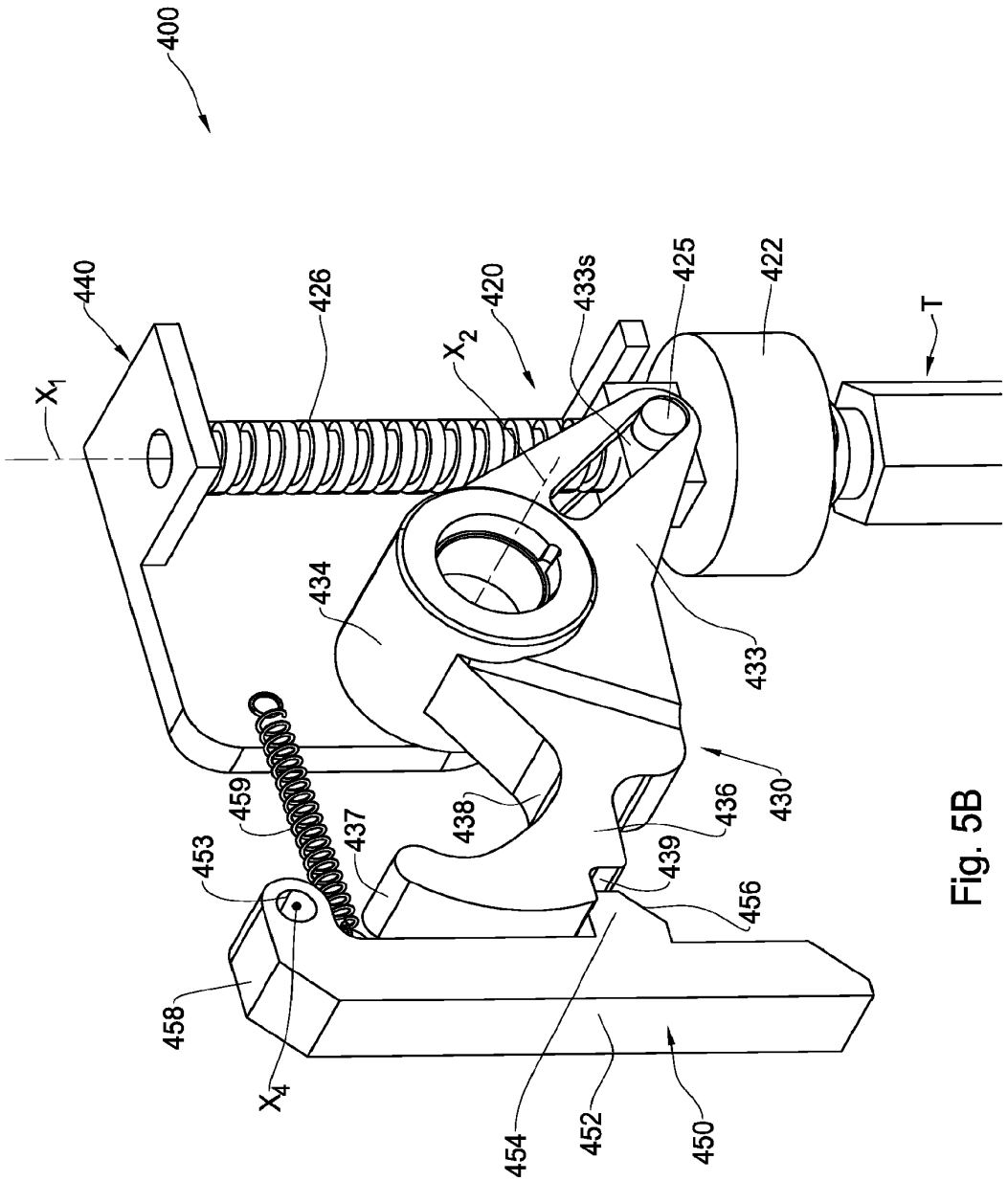

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Fig. 5B

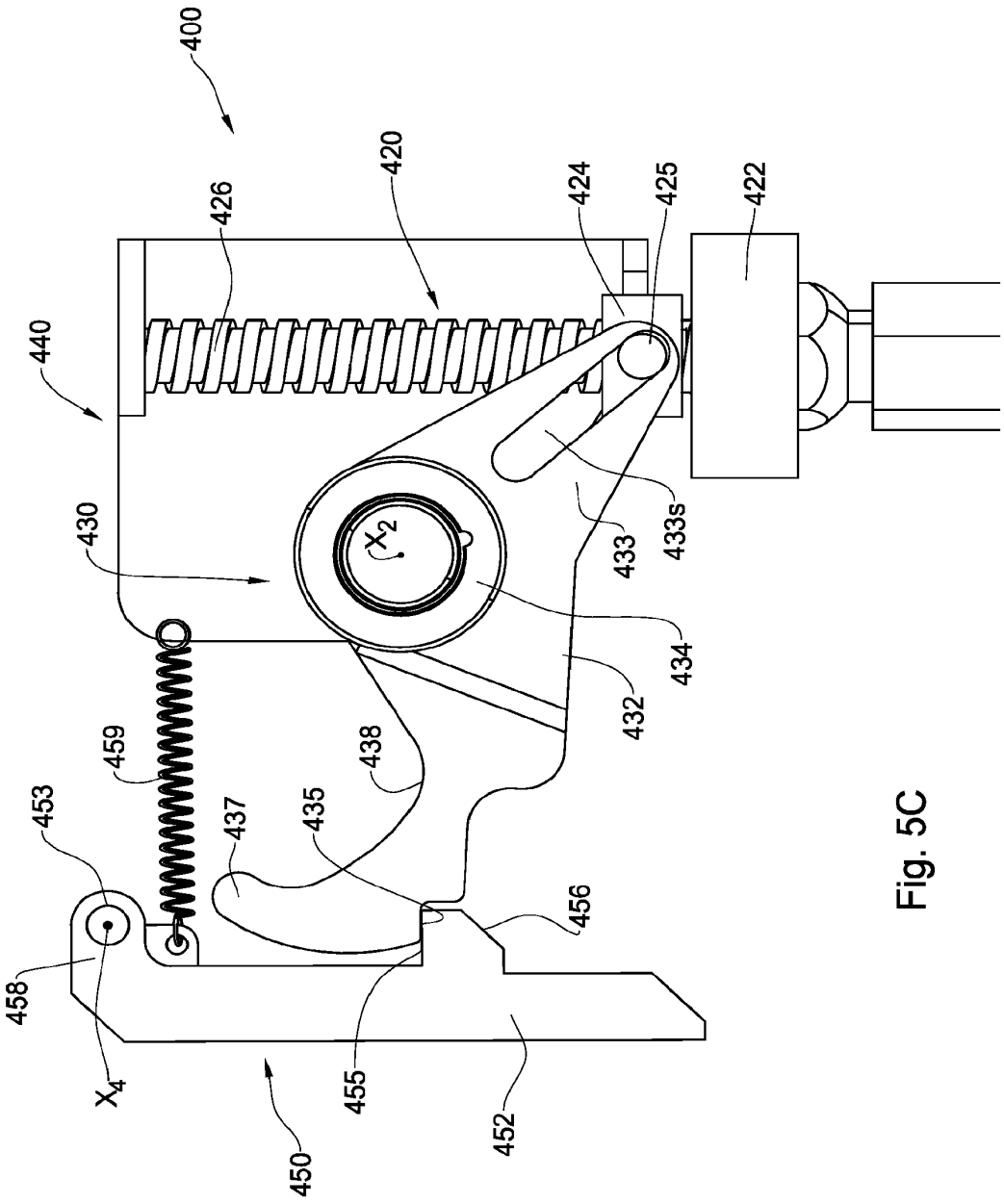

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Fig. 5C

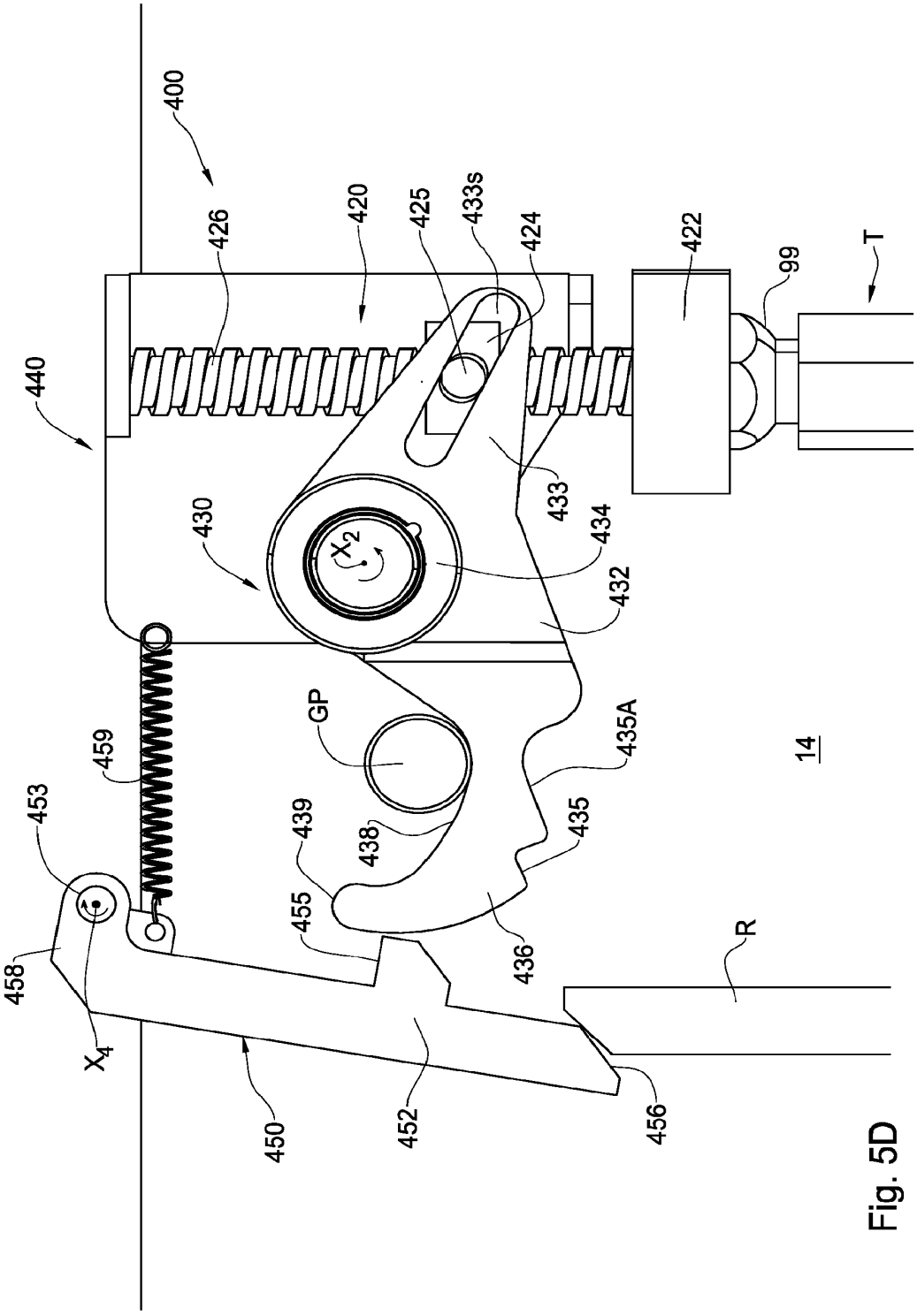

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Fig. 5D

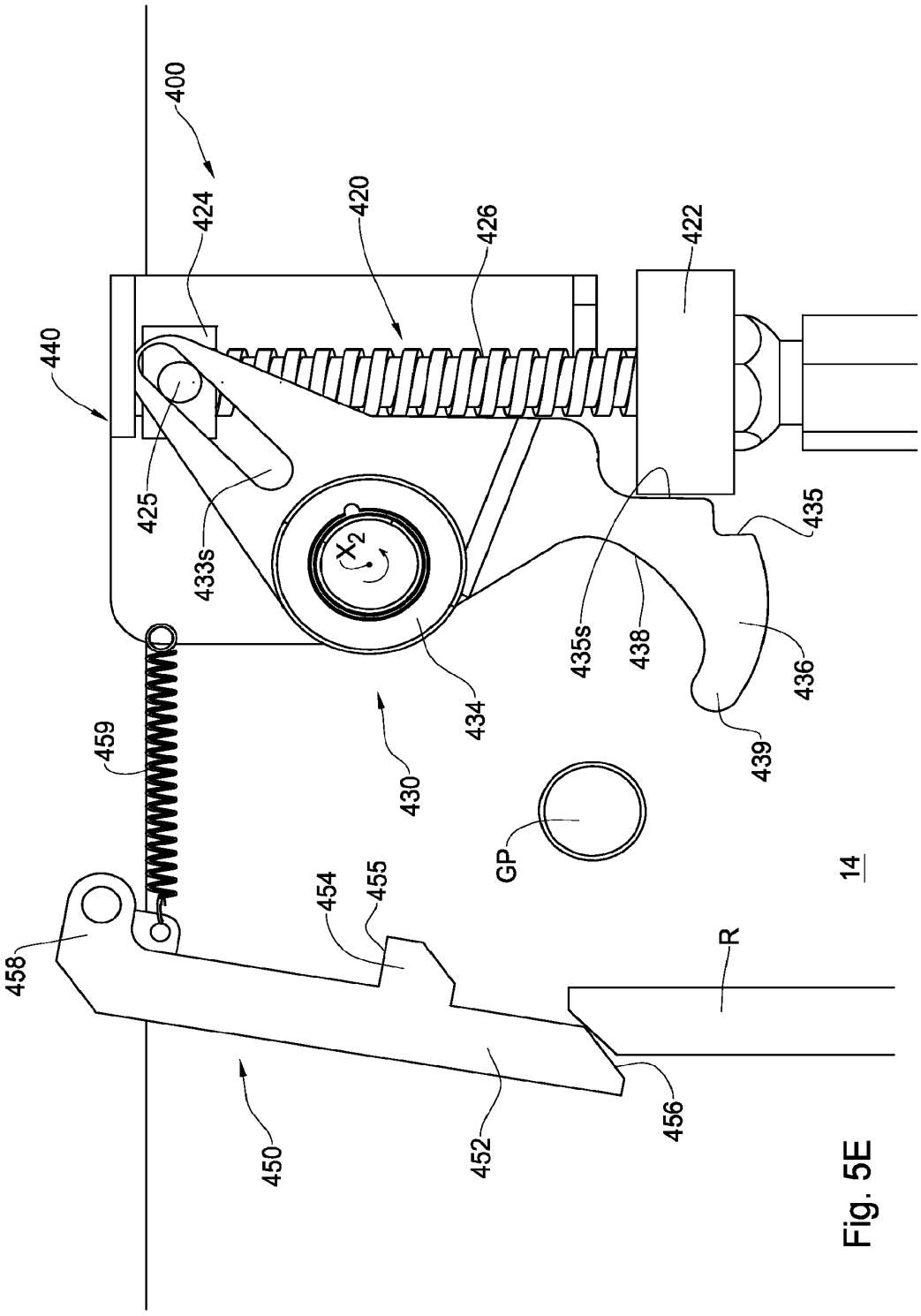

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Fig. 5E

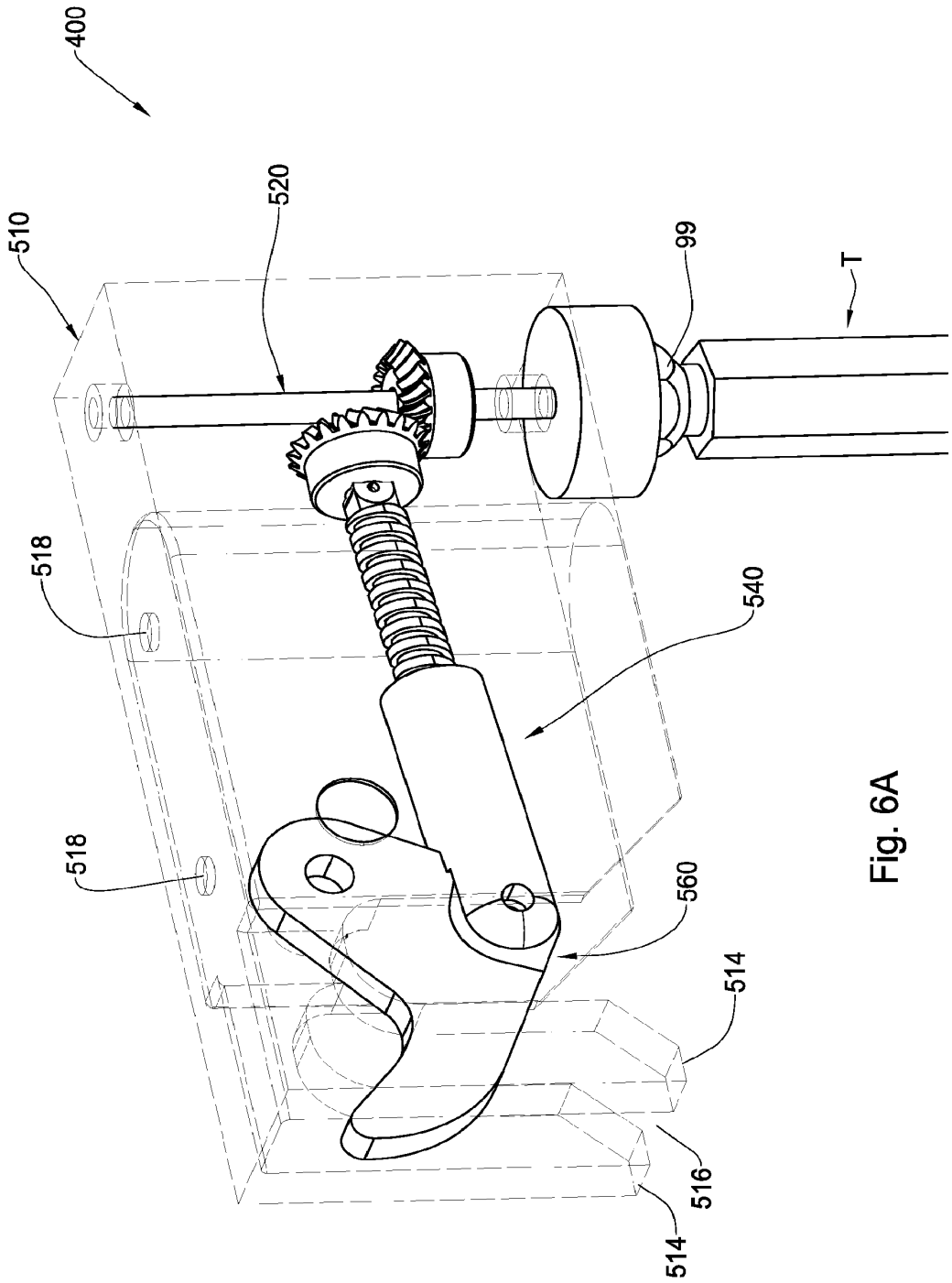


Fig. 6A

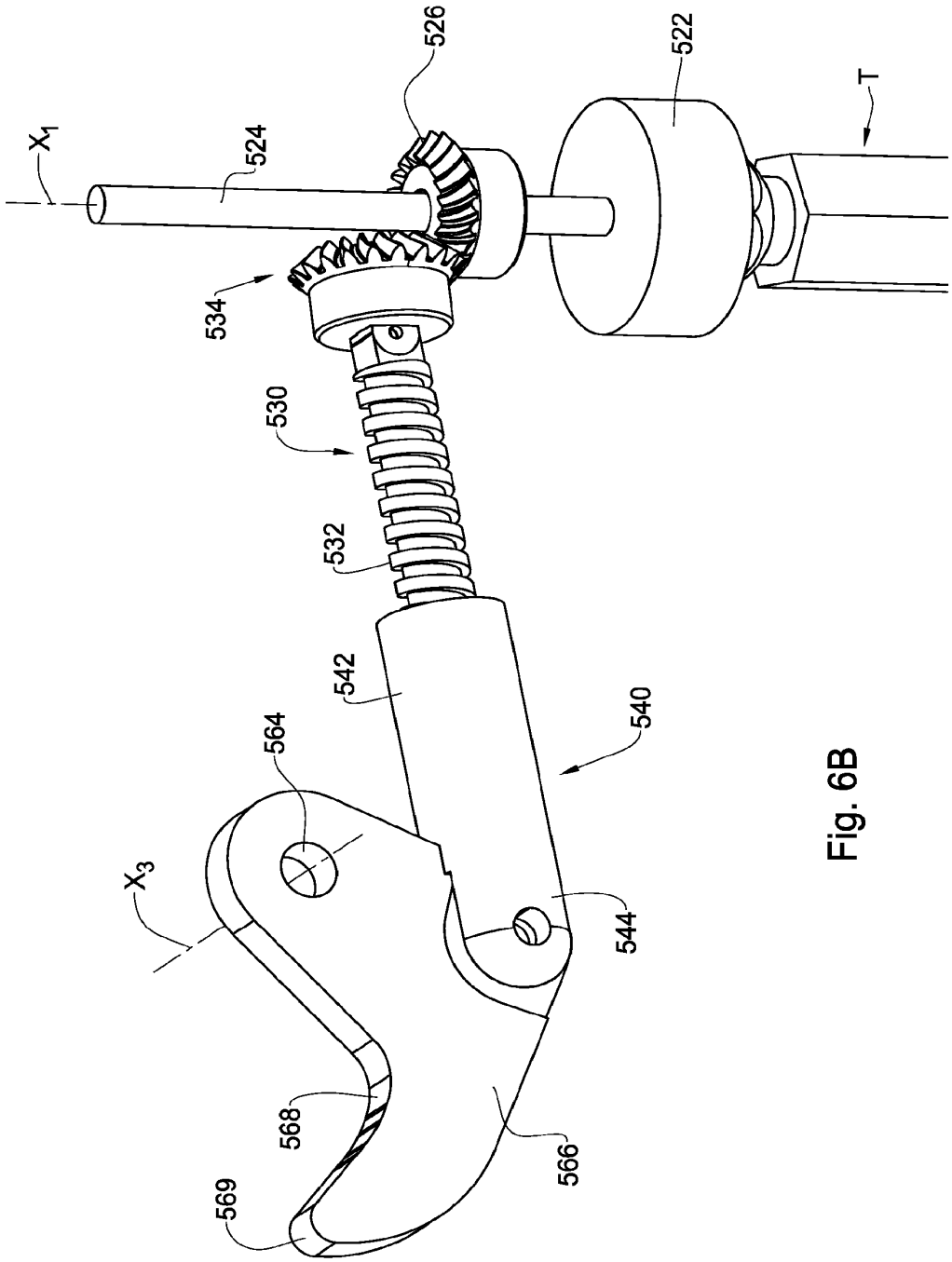


Fig. 6B

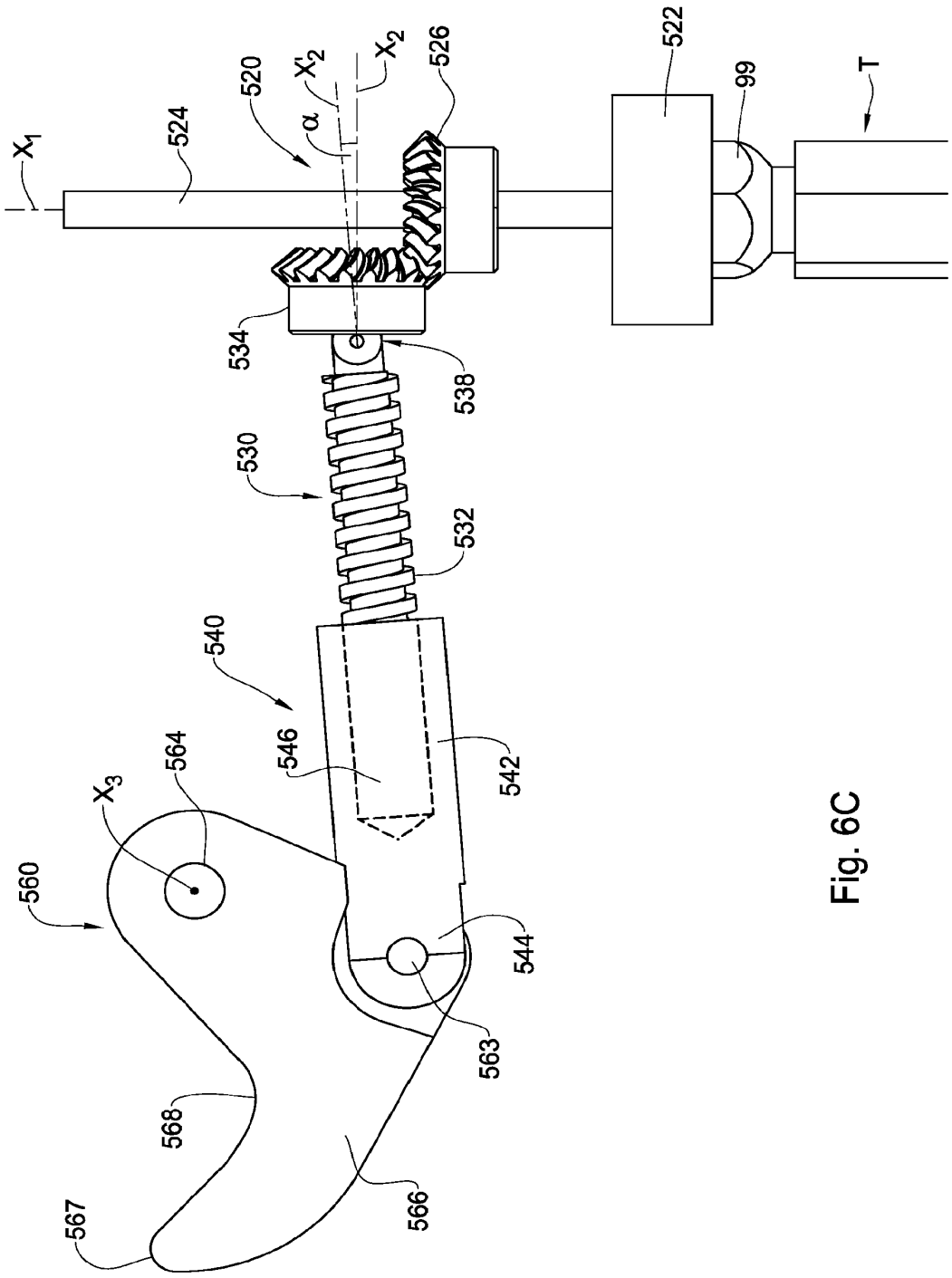

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Fig. 6C

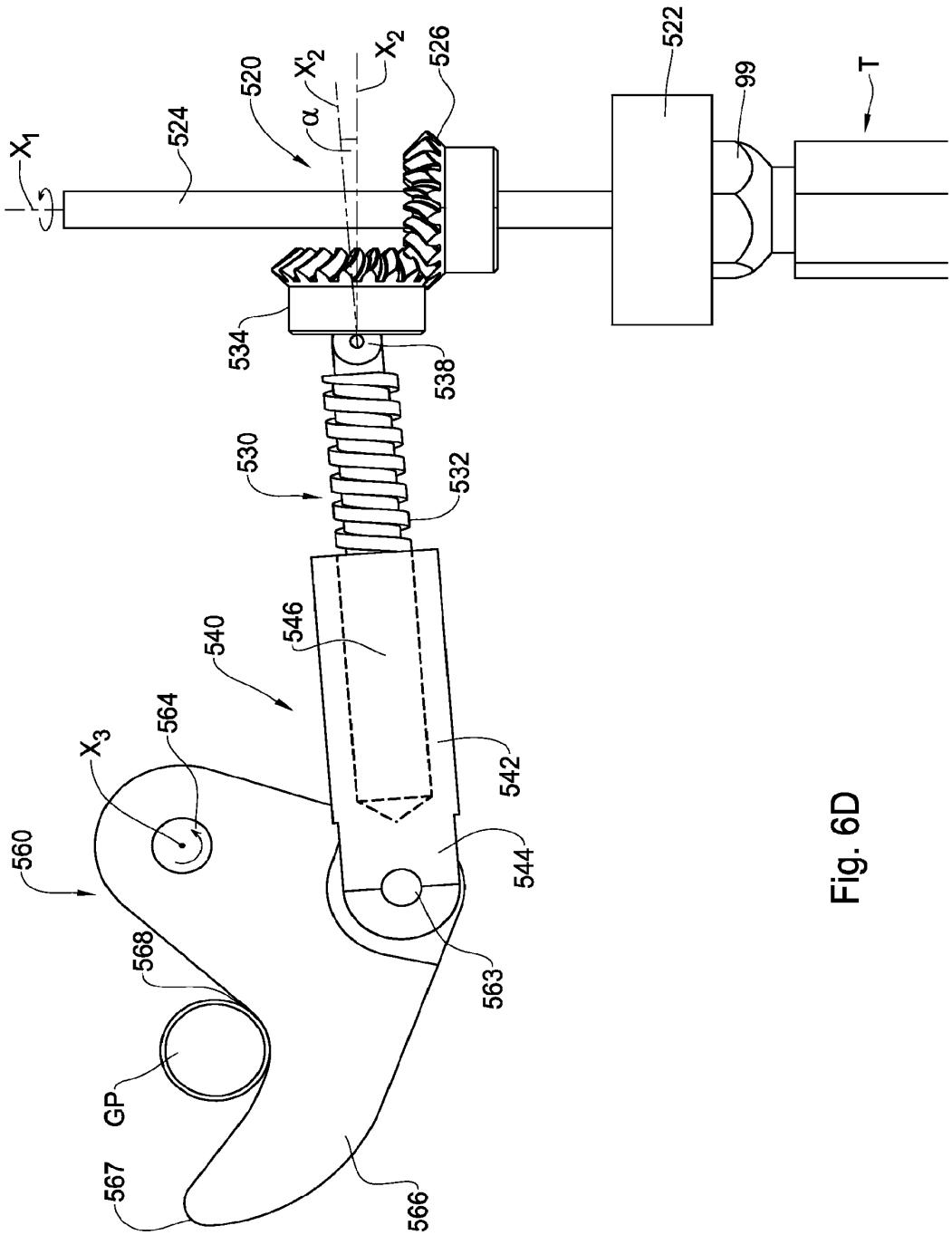

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Fig. 6D

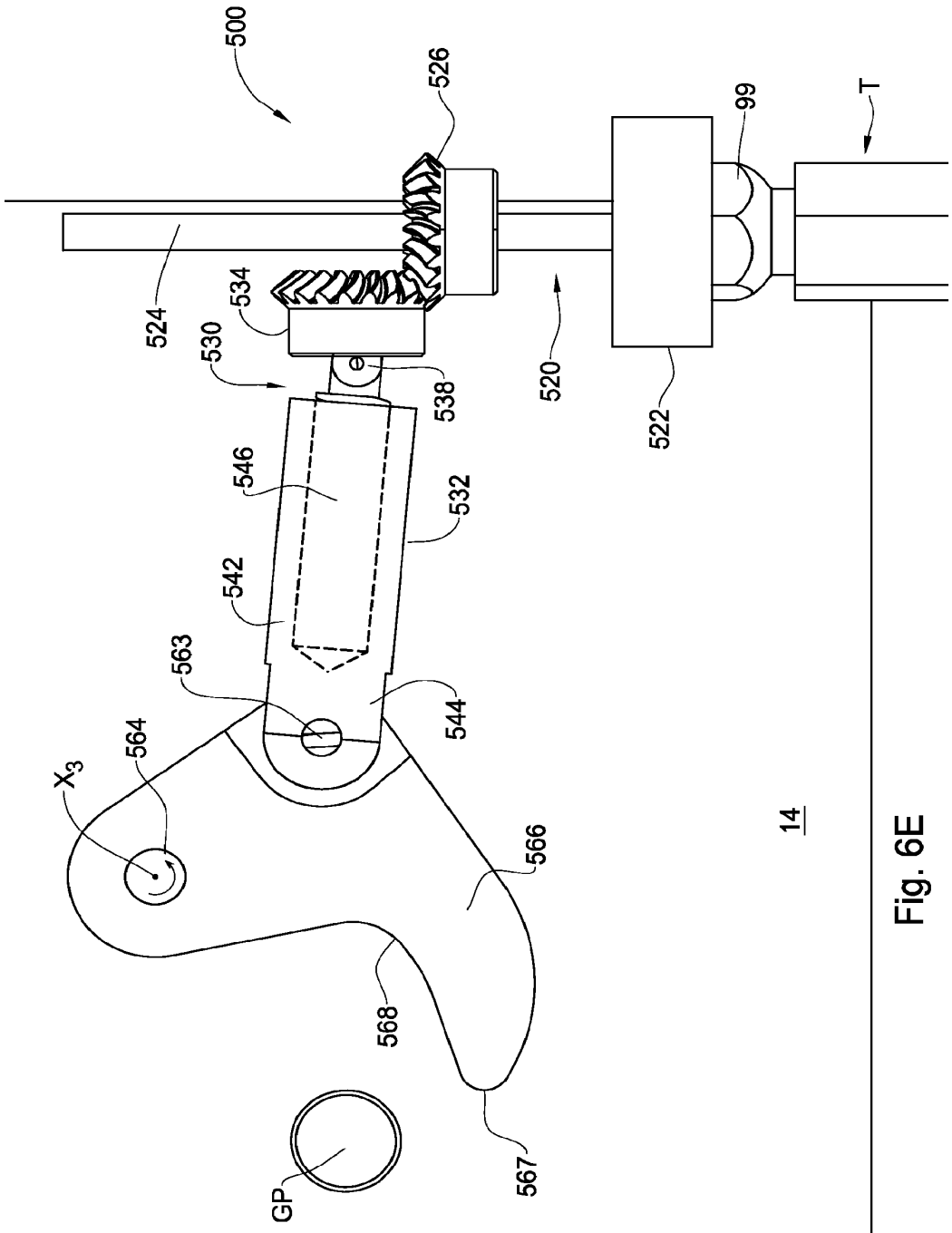

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Fig. 6E

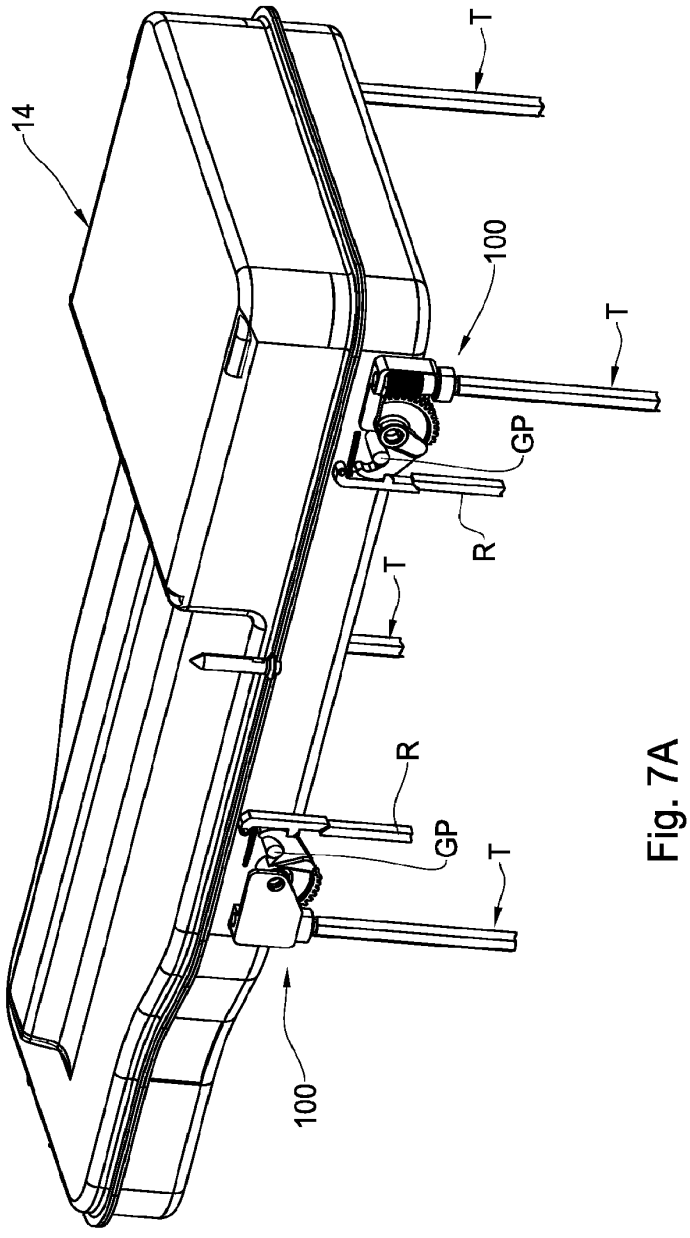


Fig. 7A

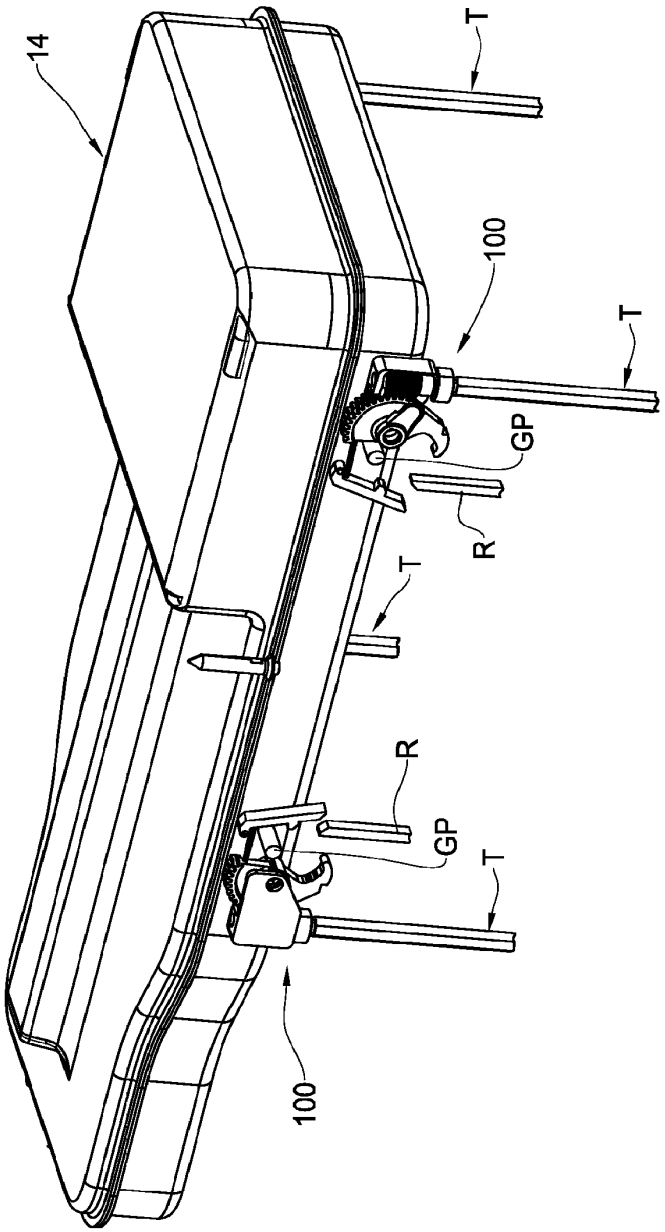


Fig. 7B

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(54) Title: ESTIMATION AND MANAGEMENT OF LOADS IN ELECTRIC VEHICLE NETWORKS

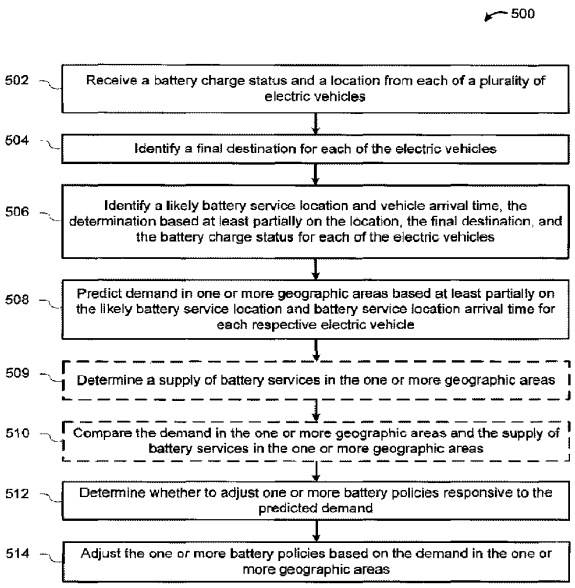


Fig. 5

(57) Abstract: Methods and systems are presented for predicting demand for battery services in an electric vehicle network. The predicted demand may be used for managing the electric vehicle network, for example, by adjusting battery policies in order to provide improved battery services to users of electric vehicles. The battery policies can be adjusted by increasing or decreasing battery charging rates within the electric vehicle network, and recommending alternative battery service locations to users of vehicles who might otherwise choose a congested battery service location.

WO 2013/024484 A1

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ESTIMATION AND MANAGEMENT OF LOADS IN ELECTRIC VEHICLE NETWORKS

TECHNOLOGICAL FIELD

The present disclosure relates generally to estimation of loads in electric vehicle networks and to possible load management approaches relying on such estimations.

BACKGROUND

Vehicles (*e.g.*, cars, trucks, planes, boats, motorcycles, autonomous vehicles, robots, forklift trucks, *etc.*) are an integral part of the modern economy. Unfortunately, fossil fuels, like oil which is typically used to power such vehicles, have numerous drawbacks including: dependence on limited sources of fossil fuels; the sources are often in volatile geographic locations; and such fuels produce pollutants and likely contribute to climate change. One way to address these problems is to increase the fuel efficiency of these vehicles.

Recently, gasoline-electric hybrid vehicles have been introduced, which consume substantially less fuel than their traditional internal combustion counterparts, *i.e.*, they have better fuel efficiency. Fully-electric vehicles are also gaining popularity. Batteries play a critical role in the operation of such hybrid and fully-electric vehicles. However, present battery technology does not provide an energy density comparable to gasoline. On a typical fully charged electric vehicle battery, the electric vehicle may only be able to travel up to 40 miles before needing to be recharged. Therefore, in order for a vehicle to travel beyond the single-charge travel range, the spent battery needs to be charged or exchanged with a fully-charged battery.

Providing a network of battery service stations for charging and/or exchanging batteries of electric vehicles helps ensure that drivers of electric vehicles are able to acquire additional energy for their vehicles when needed. The amount of energy required by the overall network, however, will not necessarily be steady or consistent, and the electricity demands of the battery service stations will thus rise and fall with the aggregated demand of the electric vehicles. Such varying demands often result in unpredictable electrical loads and higher overall energy costs, and can be detrimental to

both power suppliers and operators of electric vehicle networks. As such, a need exists for an easy and efficient way to predict and manage the demand for electrical energy within an electric vehicle network.

GENERAL DESCRIPTION

There is a need in the art for a novel method and system for managing an electric vehicle network, capable of predicting a demand at one or more battery service stations, or within a geographic area, and generating data indicative thereof. It is also a need that the control center is capable of estimating a minimum and maximum charging load of the electric vehicle network and generating data indicative thereof. Based on the generated data, the control center system may then adjust the actual charging load of the electric vehicle network. For example, the control center system may adjust the actual charging load of the electric vehicle network to be between the estimated minimum and the maximum charging loads by adjusting one or more battery policies.

Optionally, the actual charging load can be adjusted in accordance with certain predefined factors. To this end, systems and methods are provided for predicting demand and managing loads in a flexible electric vehicle network, and for adjusting battery policies in response to the predicted demand. Some of the embodiments disclosed herein provide computer-implemented methods of managing an electric vehicle network. These methods may be performed by a computer system having one or more processors and memory storing one or more programs for execution by the one or more processors.

In one exemplary embodiment the methods may include receiving battery charge status data and location data from each of a plurality of electric vehicles, and estimating the load based on the received data. For example, the received data may be used for determining an estimated minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination (*e.g.*, intended destinations selected by users). In some embodiments, the minimum charging load is based on the final destination, current location data, and battery status data of each respective electric vehicle. In some embodiments, final destinations are predicted (*e.g.*, based on one or more prediction parameters). The battery status data may comprise one

or more of the following data: the battery charge level, the battery temperature, battery health, battery charge history, battery age, battery efficiency, and suchlike.

The method may include determining, for each respective electric vehicle, a likely battery service station (i.e. the battery service station where a vehicle might receive battery related services) and a likely vehicle arrival time at such battery service station. For example, this determination may be based at least partially on the location, final destination, and the battery charge status for each of the electric vehicles. In some embodiments, the determination is further based on the speed of the vehicle, speed limits, traffic conditions, and/or the average speed of a group of other vehicles in proximity to the respective electric vehicle.

In some possible embodiments the method includes predicting demand at one or more battery service stations based at least partially on the likely battery service station. The demand prediction may further utilize the likely vehicle arrival time for each of the electric vehicles. In some embodiments, the method includes predicting demand in one or more geographic areas based at least partially on the likely battery service station and the likely vehicle arrival time for each of the electric vehicles. In some embodiments, the method also includes predicting a congestion point based on the predicted demand at the one or more battery service stations, and possibly also determining whether to adjust one or more battery policies responsive to the predicted demand.

Some of the methods may also include determining an estimated maximum charging load that the batteries of the electric vehicles can place on a power grid. For example, the maximum charging load may be at least partially based on an estimated load placed on the power grid if substantially all of the electric vehicles likely to be coupled to the power grid at a certain time were to be simultaneously charged at a maximum rate.

Exemplary methods may include adjusting one or more battery policies of the batteries of the electric vehicles to adjust an actual charging load of the electric vehicle network between the estimated minimum charging load and the estimated maximum charging load based on certain predetermined factors. In some embodiments, the actual charging load is adjusted in accordance with the price of electricity. In some embodiments, the actual charging load is adjusted in accordance with a predicted future energy demand.

In some embodiments, adjusting battery policies includes increasing or decreasing a charge rate of at least one replacement battery coupled to the power grid (*e.g.*, electric vehicle network) at one or more battery service stations, and/or a charge rate of at least one of the electric vehicles coupled to the power grid. In some embodiments, adjusting battery policies includes recommending an alternative battery service station, or a battery exchange instead of a battery charge, to a user of the respective electric vehicle. In some embodiments, adjusting the one or more battery policies includes increasing or decreasing the number of available replacement batteries at one or more of the battery service stations.

In some embodiments, the method further includes providing (displaying) a map illustrating a geographic area having a plurality of battery service stations, and displaying on the map one or more graphical representations indicating a respective demand for one or more of the battery service stations in the illustrated geographic area.

In some embodiments, the method further includes representing the estimated minimum charging load and the estimated maximum charging load as a set of data pieces/points representing energy quantities over a predefined time. In some embodiments, the method further includes fitting at least a subset of the data points to a curve function. In some embodiments, the method includes displaying, on a display device, a graph containing at least a subset of the data points.

In one aspect the present application provides a method of managing an electric vehicle network, comprising receiving battery status data and vehicle location data from each of a plurality of electric vehicles, utilizing the received battery status data and vehicle location data and data about a final destination for each of the electric vehicles, and determining for each respective electric vehicle battery service data including a likely battery service station, and predicting demand at one or more battery service stations based on at least the determined likely battery service station for each of the electric vehicles. The predicted demand may be used to manage consumption loads on the electric vehicle network. For example, the predicted demand may be used to determine whether to adjust one or more battery policies of one or more battery service station on the vehicle electric network.

In some embodiments the determined battery service data includes a likely vehicle arrival time expressing estimation of arrival time of the respective electric vehicle at the likely battery service station. The likely vehicle arrival times determined

for the vehicles may be also used in the prediction of the demand, together with the determined likely battery service stations. For example, the likely vehicle arrival time may be used to refine the predicted demand to show the predicted demand at specific time points and/or during one or more time intervals.

The method may further comprise estimating a minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination, and estimating a maximum charging load that the batteries of the electric vehicles can place on a power grid (*e.g.*, based the respective battery status data of each of the electric vehicles). In possible embodiments the predicted demand is adjusted at least partially based on the estimated minimum charging load and the estimated maximum charging load.

In possible embodiment the estimation of the minimum charging load is determined at least partially based on actual energy demand of the electric vehicle network determined over a predetermined time window based at least partially on data received from the vehicles and/or the battery service stations. Alternatively, estimated minimum charging load may be a sum of estimated minimum individual charging loads placed on the power grid by each respective electric vehicle.

The estimated maximum charging load may be based at least partially on an estimated load placed on the power grid if all of the vehicles coupled to the power grid at a certain time were to be simultaneously charged at a maximum rate.

The determination of whether to adjust one or more battery policies may include determining a supply of battery services at the one or more battery service stations, and comparing the predicted demand at the one or more battery service stations and the supply of battery services at the one or more battery service stations.

Optionally, the one or more battery policies are adjusted based on the demand predicted at the one or more battery service stations. Alternatively, the one or more battery policies are adjusted based on the comparison between the predicted demand at the one or more battery service stations and the supply of battery services at the one or more battery service stations.

In some embodiments determining the final destination comprises receiving respective final destinations from at least a subset of the plurality of electric vehicles.

Alternatively or additionally, the respective final destinations may be intended destinations for some users of the subset of electric vehicles.

According to a possible embodiment, determining the final destination comprises predicting the final destination of a respective electric vehicle when an operator of the respective electric vehicle has not selected an intended final destination. For example, the predicted final destination may be selected from of the following: a home location; a work location; a battery service station; a previously visited location; and a frequently visited location.

In some embodiments the one or more battery service stations are selected from the following: charge stations for recharging the batteries of the electric vehicles; and battery exchange stations for replacing the batteries of the electric vehicles.

The adjustment of the one or more battery policies may comprise increasing or decreasing a charge rate of: at least one replacement battery (i.e. stored at the battery service station) coupled to the electric vehicle network at a battery service station; or of a battery of at least one of the electric vehicles coupled to the electric vehicle network when receiving services at a battery service station. Optionally, the adjustment of the one or more battery policies comprises recommending an alternate battery service station to a user of a respective electric vehicle, and/or changing a number of available replacement batteries at one or more of the battery service stations.

The method may further comprise informing a utility provider about an expected power demand based at least partially on the predicted demand at the one or more battery service stations.

In possible embodiments determining the respective likely battery service station and the respective likely vehicle arrival time for a respective electric vehicle is further based on a speed of the respective electric vehicle.

The method may further comprise increasing the demand predicted at the one or more battery service stations to account for demand from one or more electric vehicles of a second plurality of electric vehicles. For example, the second plurality of vehicles may include vehicles that are not in communication with the computer system.

According to some embodiments a displaying step is used to display on a display device a map illustrating a geographic area having a plurality of battery service stations and one or more graphical representations indicating a respective demand for one or more of the battery service stations in the illustrated geographic area.

In another aspect the present application provides a system for managing an electric vehicle network. The system may comprise a communication module for exchanging data with one or more battery service stations and with a plurality of electric vehicles (i.e. a computer system of the vehicle and/or a user's mobile phone at the vehicle), one or more data processors, and memory storing data and one or more software programs for execution by the one or more processors. The data and the one or more programs stored in the memory may include a battery status module configured to determine a battery charge status based on battery status data received from each of the plurality of electric vehicles, a vehicle location database for maintaining location data received from the vehicles, and a demand prediction module. The demand prediction module is configured and operable to identify a final destination for each of the electric vehicles (*e.g.*, based on data received from the vehicles and/or at least partially on the location data, the final destination, and/or the battery charge status), determine for each respective electric vehicle a location of a likely battery service station; and predict demand at one or more battery service stations based at least partially on the likely battery service location for each respective electric vehicle.

The system may comprise one or more of the following:

- a battery service station module configured and operable to receive and maintain station status data received from the battery service stations;
- a battery policy module configured and operable to determine whether to adjust one or more battery policies based at least on one of the predicted demand and the station status data; and/or
- a map module configured and operable to generate and/or display on a map, displayed in a display device, a graphical representation indicating a respective demand for battery services in one or more geographic areas.

According to yet another aspect, there is provided a method of managing an electric vehicle network comprising a plurality of electric vehicles, the method comprising estimating a minimum charging load a power grid of the electric vehicle network at least partially based on an amount of additional energy required by batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination, estimating a maximum charging load that the batteries of the electric vehicles can place on the power grid, and adjusting one or more battery policies of the battery service stations of the electric vehicles to adjust an actual charging load of the

power grid between the estimated minimum charging load and the estimated maximum charging load based on certain predetermined factors.

The estimating of the minimum and/or maximum charging load may be carried out utilizing any of the techniques described hereinabove or hereinbelow.

Optionally, the one or more battery policies are adjusted at least partially based on a price of energy from the power grid.

The batteries of the electric vehicles typically have an existing charge level, such that the amount of additional energy required by the batteries of the electric vehicles is an amount of energy in addition to an aggregation of the existing charge level. Optionally, each respective electric vehicle may have an associated minimum battery charge level that is determined by one or more service agreements with an owner or an operator of the respective vehicle.

The method may further comprise sending to a utility provider the estimated minimum charging load and the estimated maximum charging load, and receiving from the utility provider an energy plan comprising preferred charging loads for a predetermined time window. In this way, the one or more battery policies may be adjusted in accordance with the energy plan.

In some embodiments, whenever the battery of a respective electric vehicle contains more energy than necessary for the respective electric vehicle to reach its final destination, said battery is capable of providing energy to the power grid.

The adjusting of the one or more charging policies may comprise increasing or decreasing a charge rate of at least one of the replacement batteries coupled to the power grid; and/or at least one electric vehicle coupled to the power grid. In some cases the charge rate may be of negative value.

According to some embodiments the electric vehicle network includes one or more storage batteries coupled to the power grid. In this way, the adjusting of the one or more battery policies may comprise increasing or decreasing a charge rate of at least one of the storage batteries.

As indicated above the estimated minimum charging load and the estimated maximum charging load may be represented by a set of data points representing energy quantities over a predefined time. This presentation may be utilized for fitting at least a subset of the set of data points to a curve function, or alternatively/additionally

displaying, on a display device, a graph containing at least a subset of the set of data points.

In a possible embodiment the one or more battery policies are adjusted in order to minimize energy costs of the electric vehicle network over a predetermined time window.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which like reference numerals are used to indicate corresponding parts, and in which:

Fig. 1 illustrates an electric vehicle network;

Fig. 2 is a block diagram illustrating components of a vehicle, according to some embodiments;

Fig. 3 is a block diagram illustrating components of a control center system, according to some embodiments;

Fig. 4 is a flow diagram illustrating a method of managing an electric vehicle network, according to some embodiments;

Fig. 5 is a flow diagram illustrating another method of managing an electric vehicle network, according to other embodiments;

Fig. 6 illustrates a map for displaying demand data, according to some embodiments;

Fig. 7 illustrates a map for displaying demand data, according to other embodiments;

Fig. 8 illustrates a map for displaying demand data, according to other embodiments;

Fig. 9 is a flow diagram illustrating a method for managing an electric vehicle network, according to some embodiments;

Fig. 10A illustrates a graph displaying estimated minimum and estimated maximum charging curves, according to some embodiments;

Fig. 10B illustrates another graph displaying estimated minimum and estimated maximum charging curves, according to some embodiments;

Fig. 11 schematically illustrates a vehicle data record used in the load estimation process according to some embodiments;

Fig. 12 schematically illustrates a demand table predicted for a specific battery service station; and

Fig. 13 is a flowchart demonstrating a process for adjusting the actual charging rate of a vehicle network according to electricity price and the minimum/maximum charging loads of the network.

DETAILED DESCRIPTION OF EMBODIMENTS

The following is a detailed description of methods and systems for predicting and displaying demand data for battery service stations and/or an electric vehicle network. Reference will be made to certain embodiments of the invention, examples of which are illustrated in the accompanying drawings.

Fig. 1 is a block diagram of an electric vehicle network **100**, according to some embodiments. As exemplified in **Fig. 1**, the electric vehicle network **100** includes at least one electric vehicle **102** having one or more electric motors **103**, one or more batteries **104** (each including one or more batteries or battery cells), a positioning system **105**, a communication module **106**, and any combination of the aforementioned components.

In some embodiments, the one or more electric motors **103** drive one or more wheels of the electric vehicle **102**. In these embodiments, the one or more electric motors **103** receive energy from one or more batteries **104** that are electrically and mechanically attached to the electric vehicle **102**. The one or more batteries **104** of the electric vehicle **102** may be charged at a home of a user **110**. Alternatively, the one or more batteries **104** may be serviced (*e.g.*, exchanged and/or charged, *etc.*) at a battery service station **130** within the electric vehicle network **100**. The battery service stations **130** may include charge stations **132** for charging the one or more batteries **104**, and/or battery exchange stations **134** for exchanging the one or more batteries **104**. Battery service stations are described in greater detail in U.S. Patent Number 8,006,793, which is hereby incorporated by reference in its entirety. For example, the one or more batteries **104** of the electric vehicle **102** may be charged at one or more charge stations **132**, which may be located on private property (*e.g.*, the home of the user **110**, *etc.*), on

public property (*e.g.*, parking lots, curbside parking, *etc.*), or at/near battery exchange stations **134**. Furthermore, in some embodiments, the one or more batteries **104** of the electric vehicle **102** may be exchanged for charged batteries at the one or more battery exchange stations **134** within the electric vehicle network **100**.

Thus, if a user is traveling a distance beyond the range of a single charge of the one or more batteries **104** of the electric vehicle **102**, the spent (or partially spent) batteries may be exchanged for charged batteries so that the user can continue with his/her travels without waiting for the battery pack to be recharged. The term "battery service station" is used herein to refer to battery exchange stations (*e.g.*, battery exchange station **134**), which exchange spent (or partially spent) batteries of the electric vehicle for charged batteries, and/or charge stations (*e.g.*, charge station **132**), which provide energy to charge a battery pack of an electric vehicle. Furthermore, the term "charge spot" may also be used herein to refer to a "charge station."

As illustrated in **Fig. 1**, a communications network **120** may be used to couple the vehicle **102** to a control center system **112**, a charge station **132**, and/or a battery service station **134**. Note that for the sake of clarity, only one vehicle **102**, one battery **104**, one charge station **132**, and one battery exchange station **134** is illustrated, but the electric vehicle network **100** may include any number of vehicles, batteries, charge stations, and/or battery exchange stations, *etc.* Furthermore, the electric vehicle network **100** may include zero or more charge stations **132** and/or battery exchange stations **134**. For example, the electric vehicle network **100** may only include charge stations **132**. On the other hand, the electric vehicle network **100** may only include battery exchange stations **134**. In some embodiments, any of the vehicle **102**, the control center system **112**, the charge station **132**, and/or the battery exchange station **134** includes a communication module that can be used to communicate with each other through the communications network **120**.

The communications network **120** may include any type of wired or wireless communication network capable of coupling together computing nodes. This includes, but is not limited to, a local area network, a wide area network, or a combination of networks. In some embodiments, the communications network **120** is a wireless data network including: a cellular network, a Wi-Fi network, a WiMAX network, an EDGE network, a GPRS network, an EV-DO network, a "3GPP LTE" network, a "4G" network, an RTT network, a HSPA network, a UTMS network, a Flash-OFDM

network, an iBurst network, and any combination of the aforementioned networks. In some embodiments, the communications network **120** includes the Internet.

In some embodiments, the electric vehicle **102** includes a positioning system **105**. The positioning system **105** may include: a satellite positioning system, a radio tower positioning system, a Wi-Fi positioning system, and any combination of the aforementioned positioning systems. The positioning system **105** is used to determine the geographic location of the electric vehicle **102** based on information received from a positioning network. The positioning network may include: a network of satellites in a global satellite navigation system (*e.g.*, GPS, GLONASS, Galileo, *etc.*), a network of beacons in a local positioning system (*e.g.*, using ultrasonic positioning, laser positioning, *etc.*), a network of radio towers, a network of Wi-Fi base stations, and any combination of the aforementioned positioning networks. Furthermore, the positioning system **105** may include a navigation system that generates routes and/or guidance (*e.g.*, turn-by-turn or point-by-point, *etc.*) between a current geographic location of the electric vehicle and a destination.

In some embodiments, the navigation system receives a destination selection from a user **110**, and provides driving directions to that destination. In some embodiments, the navigation system communicates with the control center system **112**, and receives battery service center recommendations (as well as other data) from the control center system **112**.

In some embodiments, the electric vehicle **102** includes a communication module **106**, including hardware and software, that is used to communicate with the control center system **112** (*e.g.*, associated with a service provider of the electric vehicle network **100**) and/or other communication devices via a communications network (*e.g.*, the communications network **120**).

In some embodiments, the control center system **112** periodically provides a list of suitable service stations **130** (*e.g.*, within the maximum theoretical range of the electric vehicle; has the correct type of batteries; *etc.*) and respective status information to the electric vehicle **102** via the communications network **120**. The status of a battery service station **130** may include: a number of charge stations of the respective battery service station that are occupied, a number of suitable charge stations of the respective battery service station that are free, an estimated time until charge completion for respective vehicles charging at respective charge stations, a number of suitable battery

exchange bays of the respective battery service station that are occupied, a number of suitable battery exchange bays of the respective battery service station that are free, a number of suitable charged batteries available at the respective battery service station, a number of spent batteries at the respective battery service station, the types of batteries available at the respective battery service station, an estimated time until a respective spent battery is recharged, an estimated time until a respective exchange bay will become free, a location of the battery service station, battery exchange times, and any combination of the aforementioned statuses.

In some embodiments, the control center system **112** also provides access to the battery service stations to the electric vehicle **102**. For example, the control center system **112** may instruct a charge station to provide energy to recharge the one or more batteries **104** after determining that an account for the user **110** is in good standing. Similarly, the control center system **112** may instruct a battery exchange station to commence the battery exchange process after determining that the account for the user **110** is in good standing.

The control center system **112** obtains information about the electric vehicles **102** and/or battery service stations **130** by sending queries through the communications network **120** to the electric vehicle **102** and to the battery service stations **130** (*e.g.*, charge stations, battery exchange stations, *etc.*) within the electric vehicle network **100**.For example, the control center system **112** can query the electric vehicle **102** to determine a geographic location of the electric vehicle and a status of the one or more batteries **104** of the electric vehicle **102**. The control center system **112** can also query the electric vehicle **102** to identify a user-selected final destination of the vehicle **102**. The control center system **112** may also query the battery service stations **130** to determine the status of the battery service stations **130**. The status of battery service stations includes, for example, information about the replacement batteries **114** at an exchange station **134** (including the number and charge status of those batteries), reservation information for replacement batteries **114** or charge spots, *etc.*

The control center system **112** also sends information and/or commands through the communications network **120** to the electric vehicle **102**. For example, the control center system **112** may send a battery service station recommendation to a user **110** of an electric vehicle **102**. The control center system **112** may alternatively send a

recommendation of type of battery service station to a user **110**. Such recommendations are described in greater detail herein with respect to **Fig. 4**.

The control center system **112** may also send information and/or commands through the communications network **120** to the battery service stations **130**. For example, the control center system **112** may send an instruction to increase or decrease a charge rate of one or more replacement batteries **114** coupled to the electric vehicle network **100** at the battery service station. The control center system **112** may send an instruction to a battery service station **130** to change (*i.e.*, increase or decrease) the number of available replacement batteries **114** at a battery service station (*e.g.*, by acquiring batteries from a different battery service station, or a battery storage location). Such instructions are described in greater detail herein with respect to **Fig. 4**.

In some embodiments, the battery service stations **130** provide status information to the control center system **112** via the communications network **120** directly (*e.g.*, via a wired or wireless connection using the communications network **120**). In some embodiments, the information transmitted between the battery service stations **130** and the control center system **112** is transmitted in real-time. In some embodiments, the information transmitted between the battery service stations **130** and the control center system **112** are transmitted periodically (*e.g.*, once per minute).

As illustrated in **Fig. 1**, the electric vehicle network **100** may include a power network **140**. The power network **140** can include power generators **156**, power transmission lines, power substations, transformers, *etc.*, which facilitate the generation and transmission of electrical power. The power generators **156** may include any type of energy generation plants, such as wind-powered plants **150**, fossil-fuel powered plants **152**, solar powered plants **154**, biofuel powered plants, nuclear powered plants, wave powered plants, geothermal powered plants, natural gas powered plants, hydroelectric powered plants, and a combination of the aforementioned power plants, or the like. The energy generated by the one or more power generators **156** may be distributed through the power network **140** to charge stations **132** and/or battery exchange stations **134**. The power network **140** can also include batteries such as the battery **104** of the vehicle **102**, replacement batteries **114** at battery exchange stations, and/or batteries that are not associated with vehicles, such as storage batteries. Thus, energy generated by the power generators **156** can be stored in these batteries and extracted when energy demand exceeds energy generation.

All of the components connected to the power network **140** (including power generators **156**, and any load source, such as batteries **104**, **114**, etc) may be coupled to (and may be a part of) a power grid for transmitting electrical energy between the various components. The power grid may include transmission components of various capacities, from long distance, high-voltage transmission, to low-voltage, residential and/or commercial wiring.

Fig. 2 is a block diagram illustrating components of a vehicle **102** in accordance with some embodiments. The vehicle **102** in this example includes one or more processing units (CPU's) **202**, one or more network or other communications interfaces **204** (*e.g.*, antennas, I/O interfaces, *etc.*), memory **210**, a positioning system **105**, a battery charge sensor **232** that is connected to or communicates with the battery **104**, and determines the status of the battery **104**, and one or more communication buses **209** for interconnecting these components. The communication buses **209** may include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. The vehicle **102** optionally may include a user interface **205** comprising a display device **206** and input devices **208** (*e.g.*, a mouse, a keyboard/keypad, a touchpad, a touch screen, *etc.*). Memory **210** may include high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices and/or non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. The memory **210** may optionally include one or more storage devices remotely located from the CPU(s) **202**. The memory **210**, or alternately the non-volatile memory device(s) within memory **210**, comprises a computer readable storage medium. In some embodiments, the memory **210** stores the following programs, software modules and data structures, or a subset thereof:

- an operating system **212** that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- a communication module **106** that is used for connecting the vehicle **102** to other computers (*e.g.*, a computer associated with an electric vehicle network provider) via the one or more communication network interfaces **204** (wired or wireless) and one or more communication networks, such as the Internet, other wide area networks, local area networks, metropolitan area networks, and so on;

- a user interface module **216** that receives commands from the user via the input devices **208** and generates user interface objects in the display device **206**;
- in some embodiments, a positioning module **218** that determines and stores the position of the vehicle **102** using a positioning system as described herein; and in other embodiments stores a destination **226** that is selected by the user of the vehicle;
- a battery status module **220** that determines the status of a battery of a vehicle (*e.g.*, employing voltmeters, ammeters, PH-meters, and/or thermometers);
- battery status database **222** that includes present and/or historical information about the status of the battery of the vehicle; and/or
- a geographic location database **224** of the vehicle that stores the present location and/or historical locations or addresses of the vehicle's location.

It should be noted that the positioning system **105** (and the positioning module **218**), the vehicle communication module **106**, the user interface module **216**, the battery status module **220**, the battery status database **222**, and/or the geographic location database **224** can be referred to as the "vehicle operating system."

It should also be noted that although a single vehicle **102** is discussed herein, the methods and systems can be applied to a plurality of vehicles **102**.

Fig. 3 is a block diagram illustrating a control center system **112** in accordance with some embodiments. The control center system **112** can be a computer system of a service provider. In this example the control center system **112** includes one or more processing units (CPU's) **302**, one or more network or other communications interfaces **304** (*e.g.*, antennas, I/O interfaces, *etc.*), memory **310**, and one or more communication buses **309** for interconnecting these components. The communication buses **309** are similar to the communication buses **209** described above. The control center system **112** optionally may include a user interface **305** comprising a display device **306** and input devices **308** (*e.g.*, a mouse, a keyboard, a touchpad, a touch screen, *etc.*). Memory **310** includes high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and may include non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory **310** may optionally include one or more storage devices remotely located from the CPU(s) **302**. Memory **310**, or alternatively the non-volatile memory device(s) within memory **310**,

comprises a computer readable storage medium.In some embodiments, memory **310** stores the following programs, modules and data structures, or a subset thereof:

- an operating system **312** that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- a communication module **314** that is used for connecting the control center system **112** to other computing devices via the one or more communication network interfaces **304** (wired or wireless) and one or more communication networks, such as the Internet, other wide area networks, local area networks, metropolitan area networks, and so on;
- a user interface module **316** that receives commands from a user via the input devices **308** and generates user interface objects in the display device **306**;
- a battery status module **318** that receives (*e.g.*, via communication module **314**) and/or determines (*e.g.*, based on location, route and/or historical data associated with each specific vehicle) the status of the batteries of a fleet of vehicles;
- a battery service station module **320** that tracks the status of battery service stations *e.g.*, based on status data received via the communication module **314**;
- a demand prediction module **322** that predicts demand at battery service stations and/or demand in certain geographic areas *e.g.*, based on one or more of the methods described with reference to **Fig. 4** and **Fig. 5**;
- a battery policy module **323** that determines whether to adjust one or more battery policies of the electric vehicle network;
- a map module **324** that generates maps/displays representing predicted demand values at battery service stations and/or in certain geographic areas;
- a vehicle location database **326** that includes the present location and/or historical locations of vehicles in the vehicle-area network;
- a battery status database **328** that includes the statuses of batteries (*e.g.*, **104** of vehicles and/or replacement batteries **114**) in the vehicle-area network;
- a battery service station database **330** that includes the statuses of battery service stations in the vehicle-area network; and
- a predicted demand database **332** that includes the demand prediction data at battery service stations and/or in certain geographic areas.

Each of the elements identified above in **Figs. 2** and **3** may be stored in one or more of the previously mentioned memory devices, and corresponds to a set of

instructions for performing a function described above. The set of instructions can be executed by one or more processors (*e.g.*, the CPUs **202**, **302**). The above identified modules or programs (*i.e.*, sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, memories **210**, **310** may store a subset of the modules and data structures identified above. Furthermore, memories **210**, **310** may store additional modules and data structures not described above.

The following are some examples of the demand prediction methods.

Fig. 4 is a flow diagram of a method **400** for managing an electric vehicle network **100**, according to some embodiments. In particular, the method **400** allows an electric vehicle network service provider to adjust one or more battery policies based on predicted demand of the electric vehicle network infrastructure, including demand for services provided at battery service stations. In some embodiments, the method **400** is performed at the control center system **112**, using one or more of the components, modules, and databases described above with reference to **Fig. 3**.

The process illustrated in **Fig. 4** is described hereinbelow in conjunction with the vehicle data record **40** illustrated in **Fig. 11**. The vehicle data record **40** may be stored and updated in the memory **310** of the control center system **112** and/or in the memory **210** of vehicle **102**.

The control center system **112** receives (**402**) battery status data **41** and location data **42** from each of a plurality of electric vehicles **102**. In some embodiments, the battery status data **41** and the location data **42** of a respective vehicle **102** are transmitted from the vehicle's communications module **106**, via the communications network **120**, to the control center system **112**. The location data **42** of the respective vehicle **102** corresponds to a current or recent location (*e.g.*, where the vehicle is unable to determine its present location, or where there is a delay in transmission of position data), and is typically represented as a location in a geographic coordinate system (*e.g.*, with a latitude and longitude coordinate pair). In some embodiments, the battery status data **41** includes battery charge status data *e.g.*, the amount of electrical energy remaining in a battery **104** of the respective vehicle **102**. In some embodiments, the battery status data **41** includes data indicative of a remaining driving range *e.g.*,

travelable distance, of the vehicle **102** based on the remaining electrical energy (*i.e.*, charge level) of the battery **104**.

The control center system **112** identifies (**404**) a final destination **43** for each of the electric vehicles **102**. In some embodiments, a user **110** enters a final or intended destination into a navigation system (*e.g.*, the positioning system **105**) of the vehicle **102**. In such cases, the user-identified final destination **43** is transmitted from the vehicle's communication module **106**, via the communications network **120**, and received by the control center system **112**. The control center system **112** then identifies (**404**) the selected destination as the final destination **43** for that vehicle. If a user **110** changes a final or intended destination in the navigation system of the vehicle **102**, the new user-identified final destination is transmitted to the control center system **112**. Thus, the control center **110** can update the final destination **43** data for that vehicle.

In some cases, a user **110** enters an intended destination into the navigation system, but then decides to travel to a different destination without re-entering or otherwise changing the previously entered destination. In these circumstances, the control center **110** can monitor the vehicle's location and movements, and detect when a user has abandoned a user-selected destination **43**. For instance, in some embodiments, if the vehicle's location is within a predetermined distance from a recommended or likely driving route to the user-selected destination, the control center system **112** or the vehicle's navigation system determines that the user **110** has abandoned that destination. The control center system **112** or the vehicle's navigation system then attempts to predict the likely final destination **43** of the vehicle, as described in greater detail below.

In some embodiments, the control center system **112** uses one or more prediction methods to identify the final destination **43** for a respective electric vehicle. *See, e.g.*, U.S. Patent Application No. 12/560,337, which is hereby incorporated by reference in its entirety. In some embodiments, the control center system **112** identifies a final destination **43** for a respective electric vehicle **102** based on historical travel data for a respective user **110** *e.g.*, by querying the vehicle location database **326** to determine historical vehicle location data recorded during certain times of the day, week and/or month. In one example, the control center system **112** determines that a respective user **110** typically travels to a home location, along a particular route, at a particular time each weekday. The control center system **112** then uses this historical

data to determine that, when the user **110** is on that particular route at that particular time, the user **110** is likely traveling home. Thus, the control center system **112** can predict that the home location is the user's final destination **43**. In some embodiments, the control center system **112** predicts that the final destination **43** of a vehicle will be a home location, a work location, a battery service station, a previously visited location, or a frequently visited location.

The control center system **112** can also predict a respective user's final destination **43** irrespective of that user's particular driving history. For example, in some embodiments, the control center system **112** uses a list of frequently visited locations for a population to predict a likely destination **43** of a particular user **110**. For example, if most vehicles on a certain section of highway ultimately travel to San Jose, California, it is more likely that any single vehicle on that same highway is also on its way to San Jose, California. Thus, the control center system **112** can use aggregated destination data from a fleet of vehicles to identify a final destination **43** for a particular vehicle based on that vehicle's location data **42**.

A final destination **43** for a vehicle may be identified (**404**) at any geographic resolution. For example, while the control center system **112** may not be able to predict the exact building or street to which a particular vehicle is traveling, it may be able to determine that the vehicle is most likely traveling to a particular city or town, or a particular area of a city. In some embodiments, when a final destination is predicted for a particular user **110**, the destination is associated (*e.g.*, at the control center system **112**) with a confidence value **43c** indicating the relative confidence of the prediction (*e.g.*, that the prediction has a 70% confidence value), or an uncertainty value of the prediction (*e.g.*, plus or minus 10 miles). One of skill in the art will recognize that other values, factors, or scales can be used to indicate the relative confidence **43c**, error, or resolution of the location prediction **43**. In the instant application, "determining" a final destination simply means that the final destination **43** is established to an acceptable degree of certainty (**43c**), and does not necessarily indicate that a vehicle is guaranteed to travel to that destination.

The control center system **112** can also identify (**404**) a final destination **43** of a vehicle **102** even when the vehicle **102** is not currently moving. In some embodiments, the control center system **112** identifies a likely final destination **43** for a stationary vehicle **102** based on historical data for that particular vehicle *e.g.*, using data stored in

the vehicle location database **326**. For example, the control center system **112** may detect that a certain vehicle **102** is typically parked from 9:00 AM to 5:00 PM at a first location (*e.g.*, a work location), and then at 5:00 PM, the vehicle **102** travels to a second location (*e.g.*, a home location). Thus, in some embodiments, the control center system **112** predicts a final destination **43** for a stationary vehicle **102** based on historical data of the vehicle, or of the user **110** of the vehicle **102**.

In some embodiments, the control center system **112** periodically (or intermittently) receives the battery status data **41** and the location data **42** of the plurality of electric vehicles **102** in the electric vehicle network **100** in order to update the identified final destinations **43** for each of the electric vehicles. In some embodiments, the control center system **112** periodically identifies the likely final destination for each electric vehicle **102**. By periodically identifying the likely final destination of the vehicle **102**, the control center system **112** effectively updates the destination data **43** for the electric vehicles **102**, and thus has the most current destination data when predicting demand at the battery service stations **130**, as discussed below. In some embodiments, the control center system **112** receives the battery status data **41** and the location data **42** of the electric vehicles at a predetermined time interval. In some embodiments, the battery status data **41** and the location data **42** of the vehicles are received by the control center system **112** every minute, thirty seconds, or at other time intervals, or based on other triggering events. For example, the charge and location information may be received more frequently when a vehicle **102** is in a more congested area, and less frequently when it is in a less congested area.

In some embodiments, the control center system **112** determines the frequency and time **44** at which the battery status data **41** and the location data **42** updates of the vehicles are transmitted to the control center system **112**. In some embodiments, each respective vehicle **102** determines the frequency and time **44** at which such information updates are transmitted to the control center system **112**. In some embodiments, the control center system **112** and each respective vehicle **102** share the task of determining when and/or how frequently (**44**) to update the battery status (**41**) and location (**42**) data information.

The control center system **112**, or a vehicle's navigation system, determines (**406**) a likely battery service station **45** and a likely vehicle arrival time **46** for each of the electric vehicles **102**. In some embodiments, users **110** will actually select a

respective battery service station **130** as an intended destination (**45**) in a vehicle's navigation system.

In other embodiments, the control center system **112**, or a vehicle's computer system *e.g.*, navigation system, determines (**406**) a likely battery service station **45** and a likely vehicle arrival time **46** based at least partially on the location data **42**, the final destination **43**, and the battery status data **41** for each of the electric vehicles **102**. For example, because the control center system **112** has the current location data **42**, the final destination **43** (either selected by a user or predicted by the control center system **112**), and the battery status data **41** of a respective electric vehicle **102**, the control center system **112** can determine a particular battery service station **45** that the vehicle is likely to visit.

The data of each vehicle data record **40** may be gathered and updated for each vehicle **102** in the memory **310** of the control center system **112** based on data received from the vehicles **102** and/or based on data extracted/determined from/by the various databases/modules (depicted in **Fig. 3**) of the control center system **112**. The gathered data may be then used by the processor **302** and/or the demand prediction module **322** to determine the likely service stations **45** and arrival times **46**, and the arrival battery status **47**, for each respective vehicle **102**, and based thereon to predict the demand **50** at one or more battery service stations and/or geographical regions.

In some embodiments, the control center system **112** first identifies a set of candidate battery service stations that are reachable by a vehicle. For example, the control center system **112** may determine (or extract) from battery status data **41** the travelable distance of a specific vehicle and then based on the current location data **42** of the vehicle **102** extract from the battery service station database **330** a set of reachable battery service stations located within the range defined by the current location data **42** and the travelable distance of the vehicle **102**. The control center system **112** then determines which one of the candidate service stations the vehicle is likely to visit.

For example, if a vehicle is 100 miles outside of San Francisco, California, and is traveling to San Francisco along a particular highway, and its battery status data **41** indicates that the remaining battery energy (charge level) may provide a travelable distance of about 50 miles, the control center system **112** may predict that the vehicle **102** is likely to stop at a battery service station somewhere along that particular highway

within 50 miles of the vehicle's current location **42**. The control center system **112** can then identify a set of candidate battery service stations that are within 50 miles of the vehicle, and between the vehicle's current location and San Francisco. In some embodiments, the control center system **112** identifies battery service stations that are located within a short distance from the particular highway or road on which the vehicle is traveling, such as near an exit of the highway. In some embodiments, the control center system **112** also determines the battery status (*e.g.*, charge level) at which a particular user is likely to visit a battery service station **130**. For example, the control center system **112** may have stored historical data for a particular user **110** that the user typically exchanges or charges the battery of his vehicle when the vehicle's battery still has enough charge to travel 15 miles. For instance, returning to the previously discussed example, the control center system **112** may determine that the particular user **110** is most likely to pick a service station along his route to San Francisco , approximately 35 miles from his current location (**42**). This can help the control center system **112** narrow the number of candidate battery service stations at which the user **110** is likely to stop.

In some embodiments, the control center system **112** uses aggregated charging behavior of many individual users to help predict the battery status **47** at which a particular user is likely to visit a battery service station **130**. For example, the control center system **112** may aggregate charging data for a group of users and determine that, on average, most drivers recharge or exchange their vehicle's battery when the battery has enough charge to travel 25 miles. Thus, the control center system **112** may determine that an average user is likely to charge or exchange a battery when it has 25 miles of remaining driving range.

The control center system **112** also determines (**406**) a likely vehicle arrival time **46** for each of the electric vehicles. In some embodiments, the vehicle communication module **106** of a vehicle **102** transmits navigation information (*e.g.*, from the positioning system **105**) to the control center system **112**. In some embodiments, the navigation information includes speed, location, and/or direction data. In some embodiments, the communication module **106** periodically sends location data **42** to the control center system **112**, and the control center calculates speed and direction data based on the time change of the vehicle's location. The control center system **112** then uses this information (*e.g.*, the speed of the vehicle and the remaining distance to the likely battery service station **130**) and determines a time **46** at (or near) which the user is

likely to arrive at the likely battery service station. In some embodiments, the navigation system of a vehicle makes this determination, and provides the vehicle arrival time **46** to the control center system **112**.

In some embodiments, the control center system **112** uses additional information to provide more accurate predictions, such as traffic and/or speed limit data **48** for the route to the likely battery service station. In some embodiments, the speed is a calculated likely speed of the respective electric vehicle based on a collective average speed of a group of other vehicles in proximity to the respective electric vehicle. In other words, a respective vehicle **102** may be associated with or assigned an average speed of a group of cars on the same or nearby portion of road as the respective vehicle **102**. In some embodiments, a respective vehicle **102** may be associated with or assigned a speed based on historical speed data for a particular road for that day and time.

The control center system **112** may be configured to predict (**408**) demand at one or more battery service stations. **Fig. 12** schematically illustrates a demand table **50** predicted for a specific battery service station **130** according to some possible embodiments. In some embodiments, the prediction is based at least partially on the likely battery service station **45** for each of the electric vehicles, and may optionally further utilize the likely vehicle arrival time **46** for each of the electric vehicles to predict loads over specific times and/or time ranges. For example, and as described above, the control center system **112** determines a likely battery service station **45** and arrival time **46** for each of a plurality of vehicles. Based on this data, the control center system **112** determines a certain number of the plurality of vehicles that are likely to visit a particular battery service station at (or near) a given time. For example, in some embodiments, the control center system **112** determines that a certain number of vehicles (*e.g.*, $N_{t1\text{-}t2}$) are likely to visit a battery service station *k* within a certain time window (e.g., ***t1-t2***), as exemplified in row **51** of the demand table **50**.

In some embodiments, the demand for a respective battery service station **130** is represented by a number of cars requiring service (either battery charging or battery exchange) at the respective battery service station **130**. In some embodiments, the demand is represented by an amount of energy ($E_{SS-est}^{(k)}$, amount of replenishment energy predicted for service station *k*, where *k* is a positive integer) required by a set of vehicles (E_{EV-est}^{i}, amount of replenishment energy predicted for vehicle *i*, where *i* is a

positive integer) that are likely to visit a respective battery service station (*k*) **130**, *e.g.*, $E_{SS-est}^{(k)} = \sum_{i}^{N} E_{EV-est}^{i}$, as exemplified in row **52** of the demand table **50**.

In some embodiments, the control center system **112** predicts (**409**) demand (*e.g.*, $\sum_{k \in region} E_{SS-est}^{(k)}$) in one or more geographic areas or regions based at least partially on the demand at each of a subset of the one or more battery service stations. In other words, the control center system **112** uses the demand data (**50**) of multiple individual battery service stations (*k*) in order to determine the average demand ($\sum_{k \in region} E_{SS-est}^{(k)} / N_{region}$) for a larger geographic area that encompasses (or is associated with) those individual battery service stations (*k*).

For instance, a geographic area that encompasses many battery service stations **130** may have a substantially lower average demand than any one service station within that area. Accordingly, it is sometimes advantageous for the control center system **112** to assume that most users who need battery services in a particular geographic area will be able to find nearby battery services when they are required, even if a single service station in that area is unable to provide the services at that time. Thus, in some embodiments, the control center system **112** aggregates the predicted demand data **50** for all of (or at least some of) the battery service stations **130** within a particular geographic area to determine the predicted demand for that geographic area. In some embodiments, the control center system **112** averages the predicted demand data for all of (or at least some of) the battery service stations within a particular geographic area to determine the predicted demand for that geographic area.

In some embodiments, the demand prediction may be a demand at a specific time, or a demand over a time range. For example, the control center system **112** may determine that a battery service station will have a certain demand at a specific time (*e.g.*, at 5:30 PM), or over a future time interval (*e.g.*, between 6:45 PM and 7:00 PM).

Demand predictions can be made for many future time intervals, extending several minutes, hours, or days into the future. Predictions for the immediate future are likely to be more accurate than more distant predictions, as the control center system **112** is more likely to accurately identify the final destinations **43** of the vehicles **102** and determine the likely battery service stations **45** and arrival times **46** for the vehicles **102**.

In some embodiments, the control center system **112** also makes longer term predictions of demand based on historical destination data for a population of vehicles.

In some embodiments, the control center system **112** records historical demand data for at least a subset of the service stations **130** in the electric vehicle network **100**. The historical demand data is then analyzed to determine demand trends over time. For example, the historical data may indicate that, on average, fifty vehicles demand battery exchanges at a particular battery exchange station **134** between 5:00 PM and 5:30 PM on Monday evenings. The control center system **112** uses the historical data to make predictions even when final destinations **43** are not available for individual respective vehicles **102**, or in addition to predictions based on final destination of individual vehicles **102**.

As described above, the control center system **112** predicts a demand **50** at one or more battery service stations based on data received from a plurality of vehicles **102**. However, it may not always be possible to predict final destinations **43** for every single vehicle that may visit a battery service station **130**. It may therefore be beneficial to include a factor of safety in the demand prediction algorithms in order to accommodate these vehicles. Thus, in some embodiments, the demand value for one or more battery service stations is increased to account for the added demand resulting from one or more electric vehicles of a second plurality of electric vehicles. In some embodiments, the second plurality of electric vehicles are vehicles for which final destinations **43** cannot be predicted, vehicles that are unable to communicate with the control center system **112** (for example, because they do not have the necessary communication systems, or their communication systems are otherwise inoperative), or vehicles that visit a battery exchange station **130** other than the one predicted (**45**) by the control center system **112** or selected by the user **110**.

In some embodiments, the demand value(s) that is ultimately associated with a battery service station is 150% of the calculated demand (**50**). For example, if a calculated demand indicates that 20 vehicles are likely to require a battery exchange at a particular battery exchange station **134** within a time range, the ultimate associated demand value for that battery exchange station **134** (including the factor of safety) is 30 vehicles. In some embodiments, in order to account for the additional demand from vehicles **102** that are not in active communication with the control center system **112**, historical demand data is used to supplement the demand predictions. For example, in

some embodiments, the control center system **112** determines that an actual historical demand ($E^{(k)}_{SS-act-Hist(ta-tb)}$) at a battery service station was a certain amount (ΔE) above the predicted demand ($E^{(k)}_{SS-est-Hist(ta-tb)}$) on a particular historical date and time ($E^{(k)}_{SS-act-Hist(ta-tb)} = E^{(k)}_{SS-est-Hist(ta-tb)} + \Delta E$). The control center system **112** thus increases the present demand value for that battery service station by that amount (*e.g.*, $E^{(k)}_{SS-est(ta-tb)} + \Delta E$). In some embodiments, the control center system **112** uses actual historical demand values ($E^{(k)}_{SS-act-Hist(ta-tb)}$) from a certain past time period, such as the same day from the previous week (*e.g.*, so that demand values from a corresponding day of the week are used), and/or the same day from the previous year (*e.g.*, so that seasonal or weekly changes in demand are accounted for). Accordingly, the predicted demand values can be augmented or modified based on data from a historical time similar to the present time , which will typically more closely track the actual demand at the present time.

In some embodiments, the control center system **112** informs a utility provider of an expected power demand, where the expected power demand is based at least partially on the predicted demand at the one or more battery service stations. Often, service providers of electric vehicle networks will have close relationships with the utility providers (*e.g.*, providers and/or operators of the power generators **156** or a power grid). It can therefore be beneficial for the control center **112** to inform the utility providers of the expected power demand (**50**) of the battery service stations **130** (or the geographic areas). The utility providers can then be prepared for potentially substantial increases or decreases in the power demand of the electric vehicle network. This may be particularly important during times of peak driving hours, as many thousands of electric vehicles may demand charging services at substantially the same time. In some embodiments, utility providers and electric vehicle network providers may negotiate power pricing based on the service provider's ability to predict demand and provide demand data to the utility providers, or on the service provider's ability to control demand to suit the utility providers.

The control center system **112** determines (**410**) whether to adjust one or more battery policies responsive to the predicted demand. In some embodiments, battery

policies are adjusted to help satisfy battery charging and battery exchange demands for electric vehicles **102** of the electric vehicle network **100**. In some embodiments, battery policies are adjusted in order to alleviate a high demand at a respective battery service station **130**. Battery policies include, but are not limited to: charging rates of replacement batteries **114** at battery exchange stations **134**; charging rates of batteries **104** in vehicles **102** that are currently plugged in to the electric vehicle network **100**; a number of replacement batteries **114** provided at a particular battery exchange station **134**; reservations of services at battery service stations **130** (*e.g.*, battery exchange lanes or charging spots); and recommendations of battery service stations **130** made by the control center system **112**.

In some embodiments, the control center system **112** determines (**420**) a supply of battery services at the one or more battery service stations. The supply of battery services may be any measure of the capacity of a battery exchange station **134** or a charge station **132**. For example, the "supply" of a battery exchange station **134** may be a rate at which vehicle batteries can be exchanged (*e.g.*, 50 batteries per hour), a number of available fully charged replacement batteries **114**, a number or exchange bays, and/or a number of available battery exchange reservations. The "supply" of a charge station **132** may be a rate at which vehicle batteries can be charged from a given charge spot (*e.g.*, 30 minutes to full charge), the number of available charge spots, and/or the number of available charge spot reservations.

In some embodiments, the supply of battery services at the battery service stations **130** in the electric vehicle network **100** is received by the control center system **112**. In some embodiments, the battery service station module queries one or more of the battery service stations **130** in the electric vehicle network to request supply information. Supply information for battery exchange stations **134** and battery charge stations **132** are described above. In some embodiments, supply information is stored in the battery service station database **330**. In some embodiments, the demand prediction module **322** of the control center system **112** accesses the supply information in the battery service station database **330** when comparing (**422**) the supply and demand values within the electric vehicle network **100**, as described in greater detail below.

In some embodiments, the control center system **112** compares (**422**) the demand at the one or more battery services stations and the supply of battery services at the one or more battery service stations. Accordingly, the control center system **112** can

determine whether the demand at a particular battery service station **130** outstrips the supply of battery services available there. In other words, in some embodiments, the control center system **112** determines the level of congestion that is experienced at a respective battery service station **130** based on the supply and the demand of battery services at that service station. Furthermore, the determination and comparison of the supply and the demand of battery services may be granularized for a particular type of battery service. For example, a battery service station **130** that includes both battery charging and battery exchange facilities may have insufficient charge spots to meet a predicted demand for charging, but have adequate supplies of replacement batteries **114** to satisfy the predicted demand for exchange services. Thus, the control center system **112** can separately compare the supply and demand for each of the types of battery services at a respective battery service station **130**.

In some embodiments, the comparison between the supply and demand of battery services results in a determination that the supply of battery services within a larger geographic area (rather than at a specific battery service station) is exceeded by the likely demand for battery services in that area.

In some embodiments, the control center system **112** adjusts (**412**) the one or more battery policies based on the demand at the one or more battery service stations. In some embodiments, adjusting the battery policies includes increasing or decreasing (**414**) a charge rate of at least one replacement battery **114** coupled to the power grid associated with the electric vehicle network **100** at a battery service station **130**. For example, if the control center system **112** predicts that there will be a high demand for replacement batteries **114** at a particular battery exchange station **134**, the control center system **112** may instruct the exchange station **134** to increase the charging rate of a number of replacement batteries **114**. This can help ensure that more fully charged replacement batteries **114** will be available at the battery exchange station **134** to satisfy the demand. In some embodiments, adjusting the one or more battery policies includes decreasing a charge rate of at least one replacement battery **114** at a battery service station **130**. For example, when demand for replacement batteries **114** at a battery exchange station **134** is low, it may be advantageous to decrease the charging rate of those batteries in order to conserve energy and/or save money.

In some embodiments, adjusting the one or more battery policies includes increasing or decreasing (**416**) a charge rate of the battery of at least one of the electric

vehicles coupled to the electric vehicle network at a battery service station. For example, if the control center system **112** predicts that there will be a high demand for a particular battery charge station **132**, the control center system **112** may instruct the charge station **132** to increase the charging rate of the vehicles that are currently being charged, in order to free up charge spots for other vehicles. In some embodiments, adjusting the one or more battery policies includes decreasing a charging rate of the vehicles that are currently being charged, for example, in order to conserve energy and/or save money when demand for the charge spots is low.

In some embodiments, adjusting the one or more battery policies includes recommending (**418**) an alternate battery service station to a user of a respective electric vehicle. For instance, in some cases, a user **110** of a vehicle **102** may have selected a respective battery service station **130** to visit in order to charge or exchange a battery **104**. Alternatively, the control center system **112** predicts that a user **110** is likely to visit a respective battery service station **130**. However, the control center system **112** may also determine that the selected (or predicted) battery service station **130** will experience a high demand at the likely arrival time of the vehicle **102**. Thus, in some embodiments, the control center system **112** will recommend an alternative battery service station **130** to a user. Thus, the control center system **112** can balance the demand between various charge stations **132** and exchange stations **134** by recommending that some vehicles use service stations **130** that are in lower demand.

In some embodiments, the control center system **112** recommends that a user of a vehicle visit a battery exchange station **134** instead of a battery charge station **132**. Charging the battery **104** of an electric vehicle **102** takes significantly longer than exchanging a battery **104** at a battery exchange station **134**. Thus, the control center system **112** may attempt to shift the relative demand toward battery exchange stations **134** in order to more quickly reduce the number of vehicles requiring additional battery charge.

In some embodiments, the control center system **112** adjusts the one or more battery policies by changing a number of available replacement batteries at one or more of the battery exchange stations **130**. For example, if the control center system **112** predicts a high demand for replacement batteries **114** at a respective battery exchange station **134**, the control center system **112** may cause additional replacement batteries **114** to be delivered to that battery exchange station. In some embodiments, the

additional replacement batteries **114** are delivered from other battery exchange station(s) **134** that are not subject to (or are not predicted to be subject to) as such a high of a demand.

In some embodiments, the control center system **112** adjusts (**412**) the one or more battery policies in response to the comparison between the demand and the supply of battery services at the one or more battery service stations. For example, in some embodiments, the control center system **112** determines that demand outstrips supply at one or more battery service stations (or within a larger geographic area), and adjusts a battery policy in order to balance the supply and demand. Such adjustments can help reduce and/or prevent congestion within an electric vehicle network **100**, and can help a service provider to better balance the demands of the electric vehicle network **100**. Particular methods of adjusting battery policies are discussed in greater detail above with respect to steps (**412**)-(**418**).

Fig. 5 is a flow diagram of a method **500** for managing an electric vehicle network, according to some embodiments. In particular, the method **500** allows an electric vehicle network service provider to adjust one or more battery policies based on predicted demand of the electric vehicle network infrastructure, including demand for services provided at battery service stations **130** within one or more geographic areas. In other words, instead of determining a specific battery service station that a vehicle is likely to use, the control center system **112** may determine a region or area in which a vehicle is likely to require a charge or battery exchange. This method may be advantageous where it is difficult or impossible to determine with sufficient accuracy the specific battery service station **130** that a user is likely to visit. Also, it may be preferable for a service provider to visualize, analyze, or interpret demand data for entire geographic areas (usually encompassing multiple battery services stations), rather than for individual battery service stations.

In some embodiments, the method **500** is performed at the control center system **112**. The control center system **112** receives (**502**) battery status data **41** and location data **42** from each of a plurality of electric vehicles. Step (**502**) is similar to step (**402**) described above with reference to **Fig. 4**, and the various embodiments and examples described above apply by analogy where applicable to step (**502**).

The control center system **112** identifies (**504**) a final destination **43** for each of the electric vehicles. Step (**504**) is similar to step (**404**) described above with reference

to **Fig. 4**, and the various embodiments and examples described above apply by analogy where applicable to step (**504**).

The control center system **112**, or a vehicle's navigation system, identifies (**506**) a likely battery service location **45** (*e.g.*, a geographic location rather than a specific battery service station **130**) and service location arrival time **46**. In some embodiments, the determination of the likely battery service location **45** and arrival time **46** is based at least partially on the location data **42**, the final destination **43**, and the battery status data **41** for each of the electric vehicles **102**. For example, because the control center system **112** has the current location **42**, the final destination **43** (either selected by a user or predicted by the control center system **112**, as described above), and the battery status **41** of a respective electric vehicle **102**, the control center can determine a likely battery service location **45** where the vehicle is likely to seek battery service, such as battery charging or battery exchange. Furthermore, in various embodiments, the location identified as the likely charging location **45** for a respective vehicle **102** may be at any geographic resolution. For example, the location may be a specific location (*e.g.*, a location corresponding to a single latitude and longitude coordinate), or a wider geographic region or area (*e.g.*, a block, a town, or a city).

The control center system **112** predicts (**508**) demand at one or more geographic areas. In some embodiments, the prediction is based at least partially on the likely battery service location **45** and service location arrival time **46** for each respective electric vehicle. For example, and as described above, the control center system **112** determines a likely battery service location **45** and arrival time **46** for each of a plurality of vehicles **102**. Based on this data, the control center system **112** determines a certain number of the plurality of vehicles that are likely to visit a particular location at (or around) a given time seeking battery services. In some embodiments, the demand for battery services at a respective location is represented by a number of vehicles (*e.g.*, N_{t1-t2}) requiring service at the respective location within a certain time window (***t1-t2***). In some embodiments, the demand is represented by an amount of energy (*e.g.*, $\sum_{i}^{N_{t1-t2}} E^{i}_{EV-est(t1-t2)}$) required by a set of vehicles that are likely to visit the respective location within a certain time window. Prediction (**508**) of demand is similar to step

(**408**) described above with reference to **Fig. 4**, and the various embodiments and examples described above apply by analogy where applicable to step (**508**).

The size (and location) of the geographic areas for which demand is predicted (**508**) can vary depending on many factors. Criteria for determining the sizes and locations of geographic areas are described in greater detail below with reference to **Fig. 7**.

In some embodiments, the control center system **112** determines (**509**) a supply of battery services in the one or more geographic areas. In some embodiments, the control center system **112** compares (**510**) the demand in the one or more geographic areas and the supply of battery services in the one or more geographic areas. Determining a supply of battery services within a geographic area and comparing the supply and demand for battery services are described in greater detail above with respect to steps (**420**) and (**422**) in **Fig. 4**.

In some embodiments, the control center system **112** determines (**512**) whether to adjust one or more battery policies responsive to the predicted demand. In some embodiments, battery policies are adjusted to help satisfy battery charging and battery exchange demands for electric vehicles **102** of the electric vehicle network **100**. In some embodiments, battery policies are adjusted in order to alleviate a high demand at a respective battery service station **130**, or a predicted congestion point in the electric vehicle network **100**. Battery policies include, but are not limited to: charging rates of replacement batteries **114**; charging rates of batteries **104** in vehicles **102** that are currently plugged into the electric vehicle network **100**; a number of replacement batteries **114**; reservations of services at battery service stations **130** (*e.g.*, battery exchange lanes or charge spots); and recommendations of battery service stations **130** made by the control center system **112**.

In some embodiments, the control center system **112** adjusts (**514**) the one or more battery policies based on the demand at the one or more battery service stations **130**. In some embodiments, adjusting the battery policies includes increasing a charge rate of at least one replacement battery **114** coupled to the power grid of the electric vehicle network **100** at a battery service station **130**. For example, if the control center system **112** predicts that there will be a high demand for replacement batteries **114** within a particular geographic area, the control center system **112** may instruct one or more exchange stations **134** within that geographic area to increase the charging rate of

a number of replacement batteries **114**. This can help ensure that more fully charged replacement batteries **114** will be available within the geographic area to satisfy the demand. In some embodiments, adjusting the one or more battery policies includes decreasing a charge rate of at least one replacement battery **114** within a geographic area. For example, when demand for replacement batteries **114** within a geographic area is low, it may be advantageous to decrease the charging rate of those batteries in order to conserve energy and/or save money.

In some embodiments, adjusting the one or more battery policies includes increasing or decreasing a charge rate of at least one of the electric vehicles coupled to the electric vehicle network within a geographic area. For example, if the control center system **112** predicts that there will be a high demand for battery charging within a geographic area, the control center system **112** may instruct one or more charge stations **132** within a geographic area to increase the charging rate of the vehicles that are currently being charged, in order to free up charge spots for other vehicles. In some embodiments, adjusting the one or more battery policies includes decreasing a charging rate of the vehicles that are currently being charged, for example, in order to conserve energy and/or save money when demand for charge spots is low.

In some embodiments, adjusting the one or more battery policies includes recommending that a user **110** of a vehicle visit a battery service station **130** in an alternate geographic area. For instance, in some cases, a user **110** of a vehicle **102** has selected a respective battery service station **130** within a geographic area where demand for battery services is high. Therefore, in some embodiments, the control center system **112** recommends that the user **110** of a vehicle **102** visit a battery service station **130** in an alternate geographic area. Accordingly, the control center system **112** can balance the demand between various geographic areas by recommending that some vehicles use battery service stations **130** in lower demand areas.

In some embodiments, the control center system **112** adjusts (**514**) the one or more battery policies by changing a number of available replacement batteries at one or more of the battery service stations within a respective geographic area. For example, if the control center system **112** predicts a high demand for replacement batteries **114** at the battery exchange stations **134** within a geographic area, the control center system **112** may cause additional replacement batteries **114** to be delivered to the respective battery exchange station **134**. In some embodiments, the additional replacement

batteries **114** are delivered from battery exchange station(s) in geographic areas that are not experiencing (or are not predicted to experience) as such a high of a demand. As described above with reference to **Fig. 4**, in some embodiments, the control center system **112** adjusts (**514**) the one or more battery policies based on the comparison (**510**) between the supply and demand of battery services in a geographic area.

In some embodiments, certain portions of the methods described above are performed by the vehicle **102**, and in particular, by one or more components of the "vehicle operating system." For example, the vehicle navigation system of the positioning system **106** may determine the likely battery service station **45** and vehicle arrival time **46** at the likely battery services station. In some embodiments, when the vehicle **102** performs any of the above mentioned steps, the vehicle **102** (*e.g.*, using the communication interface(s) **204**) sends related information to the control center system **112** for further processing, storage, and/or analysis.

The following are some example of the graphical representations of predicted demand.

In order to facilitate visualization of the predicted demand at the battery service stations **130**, predicted demand data may be displayed in conjunction with a map on a display device. **Fig. 6** illustrates a map **600** for displaying demand data, according to some embodiments. Maps graphically displaying demand data (**50**) may be displayed to individuals who monitor or operate the electric vehicle network, such as a user of the control center system **112**. In some embodiments, the maps are displayed on display devices at the control center system **112**. Maps can be generated and displayed by one or more computer systems or computer devices, such as the control center system **112**, described in greater detail with reference to **Fig. 3**. In some embodiments, the maps are generated and displayed by a map module **324** of the control center system **112**. Furthermore, in some embodiments, maps are generated using the demand data stored in the demand data database **332** and/or the battery service station data (including battery service supply data) in the battery service station database **330** of the control center system **112**. In some embodiments, maps are displayed on the display device **306** of the control center system **112**.

In some embodiments, the map **600** includes representations of one or more battery service stations **130-n**, as well as indicators **602-n** of the relative demand at the battery service stations **130-n**. As shown in the legend **604**, the map **600** indicates

relative demand at a respective battery service station **130** by displaying circles at certain points on the map **600**, where a larger circle indicates a larger demand value. In some embodiments, when congestion is predicted at a respective battery service station, such as service station **130-1**, the demand indicator further indicates that a threshold for predicting congestion has been reached. In the map **600**, a congestion point is indicated by a double circle enclosing an "X." In some embodiments, this threshold corresponds to a determination (*e.g.*, from the comparing steps (**420**) and (**510**), described above) that the demand for battery services outstrips supply at a particular location.

Fig. 7 illustrates a map displaying demand data for geographic areas, rather than demand data for respective battery service stations. Accordingly map **700** identifies a number of zones/regions **702-n** within a larger geographic area. The zones **702-n** may contain one or more battery service stations **130**, and are defined by any boundary. In some embodiments, a zone/region **702-n** is coextensive with the boundaries of a city, town, or county, or other predefined area. In some embodiments, a zone **702-n** is a predetermined area near an entrance or exit to a highway. In some embodiments, zones **702-n** are arbitrarily defined areas. In some embodiments, zones **702-n** can be of various different sizes, or all the same size. For example, zones encompassing geographic area with a high volume of vehicle traffic (*e.g.*, in or around a large city) may be smaller than zones encompassing areas with less traffic. For example, zones are sometimes sized based on the driving ranges of the vehicles **102** in the electric vehicle network **100**. In some embodiments, zones **702-n** are sized so that electric vehicles **102** with a fully charged battery can travel through the entire zone without requiring battery services. In some embodiments, the zones **702-n** are sized so that electric vehicles **102** with only a quarter of a full battery charge can travel through the entire zone without requiring battery services. Of course, the ranges of different vehicles **102** will vary considerably. Thus, the ranges of the vehicles are sometimes calculated average ranges for a population of vehicles.

Fig. 8 illustrates a map **800** displaying demand data for geographic areas where the zone **802-1** that encompasses a high-volume traffic area (Sacramento, CA) is smaller than the zones **802-2**, **802-3** encompassing low-volume traffic areas that do not incorporate large metropolitan areas.

Returning to **Fig. 7**, map **700** illustrates a zone **702-1** (labeled as **Zone 1**), zone **702-2** (labeled as **Zone 2**), and zone **702-3** (labeled as **Zone 3**). Map **700** also includes a

graph **704** that shows the present demand for each of the zones. Graph **704** is a bar graph where the height of the bar represents the demand for battery services within a respective zone, although one of skill in the art will recognize that other graphs or graphical representations may be used. Each bar (corresponding to a respective zone) in the graph **704** also includes a congestion threshold indicator **706**, showing the point at which that zone will be considered to be congested. Predicting congestion is described in greater detail above with respect to **Fig. 6**. **Fig. 8** illustrates a graph **808** similar to the graph **704**.

Map **700** also illustrates a time selector **708**, depicted as a sliding graphical element. A user **110** may manipulate a slider **709** in order to change the time of the demand values that are displayed on the map **700**. As shown, the map illustrates the present demand. However, a user may move the slider **709** to cause the map to update the demand values for the selected time. As illustrated, the time selector **708** uses one-hour increments, but other time increments may also be employed. Further, the selector need not be limited to discrete time increments. In other words, in some embodiments, the time selector **709** allows a user **110** to select any time or time increment in between the displayed increments, such as fifteen minute increments.

As noted above, the maps **600**, **700**, **800** are sometimes displayed to an individual at the service provider **112** who manages aspects of the electric vehicle network **100**. The operator may use the maps to help determine whether and how to adjust battery policies, as well as what battery policies to adjust. Furthermore, while demand data (*e.g.*, in the predicted demand data database **332**) is sometimes displayed on the maps **600**, **700**, **800**, this is not necessary in all embodiments of the present invention. For example, in some embodiments, demand data can be displayed to a user in tabular or textual form. Furthermore, in some embodiments, demand data is not displayed or provided to an individual at all, but rather is simply used by the control center system **112** so that the control center system **112** (*e.g.*, with the battery policy module **323**) can determine whether and how to adjust battery policies in response to predicted demand values.

While the maps shown in **Figs. 6-8** show relative demand with particular types of graphical indicators, one of skill in the art will recognize that other representations or graphical depictions may be used in some embodiments. For instance, in some embodiments, relative or absolute demand data may be indicated with shapes, numbers,

colors, words, and/or any other graphical or textual element (including differently sized or emphasized graphical elements to indicate relative demand between battery service stations or areas).

The following are some examples of the flexible demand load management.

Fig. 9 is a flow diagram **900** of a method for managing an electric vehicle network, according to some embodiments. In particular, the method **900** allows a service provider of an electric vehicle network **100** to adjust its power draw (*e.g.*, the electrical load caused by charging the batteries of the electric vehicle network **100**) from a power grid based on certain predictions about the energy requirements of the vehicles **102** and/or replacement batteries **114** within the network. For example, as described above, the control center system **112** of an electric vehicle network service provider sometimes uses information for each vehicle and/or battery such as the current location, final destination, and battery charge level to predict the demand for battery services at locations within the electric vehicle network **100**. As described in greater detail below, the control center system **112** may use similar information to determine an estimated and/or predicted charging load that the electric vehicles will place on a power grid. Battery policies of the electric vehicle network can then be adjusted in various ways based on the estimated charging load. For example, battery policies are sometimes adjusted in order to minimize electricity consumption by the electric vehicle network when electricity is expensive, and maximize electricity consumption (*e.g.*, for storage and later use) when electricity is inexpensive.

Returning to **Fig. 9**, the control center system **112** determines (**904**) an estimated minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles *i* to proceed to its respective final destination **43**. For example, some vehicles **102** currently being charged, or vehicles that are travelling, do not have a sufficient charge to reach their final destinations **43**, and will require some additional charge.

In some embodiments, the minimum charging load is a rate of energy consumption by the batteries of the electric vehicle network **100** from the power grid (*e.g.*, the rate of energy consumption caused by their charging, sometimes measured in kilowatts (kW)). This rate, in turn, is calculated or determined by the control center system **112**, and is based on a minimum energy requirement of each vehicle (*e.g.*, the quantity of additional energy required by a battery, sometimes measured in kilowatt-

hours (kW-h)). In other words, the minimum charging load ($E_{Net\text{-}min}$) is sometimes represented as a charging rate that would be experienced by the electric vehicle network if each vehicle were to receive its minimum energy requirement to reach its known or estimated final destination. As described in greater detail below, the minimum charging load may be based on predictions of respective vehicle's energy demands, and can be projected into the future in order to anticipate upcoming charging demands of the electric vehicle network **100**.

In some embodiments, the minimum charging load may be represented not as a rate, as described above, but rather as a quantity of energy. In these cases, the minimum charging load directly represents the estimated quantity of energy (*e.g.*, measured in kW-h) required by each vehicle to satisfy its minimum energy requirements. For clarity, the minimum charging load is described herein as a charging rate. However, one of skill in the art will understand that the disclosed concepts, including the minimum and maximum charging loads, apply by analogy to measurements of energy quantities (*e.g.*, kW-h), energy transfer rate (*e.g.*, kW), or any other suitable metric.

As noted above, in some embodiments, the minimum charging load represents an estimated overall charging load that will likely be placed on a power grid in order to charge the batteries of each of the electric vehicles **102** to its minimum charge level. In some embodiments, this minimum charge level is determined based on the final destination **43**, a current location **42**, and a current battery status (*e.g.*, charge level) **41** of each battery of the respective electric vehicles **102**. As described above, other factors are also sometimes used, including speed and/or current traffic information. In other words, the control center system **112** determines for each vehicle *i* the amount of energy (*e.g.*, in kW-h) that the vehicle requires, in addition to its current battery charge level, to reach its final destination **43**. For example, if a vehicle **102** has enough charge to travel 20 miles, and is 50 miles away from its final destination **43**, the vehicle **102** will require approximately 30 more miles worth of energy in order to reach the final destination.

While energy may be measured or represented in various units, such as kW-h, Joules, British thermal units, *etc.*, it is sometimes referred to herein in terms of the mileage value of energy. One of skill in the art will recognize that due to differences in size, weight, efficiency, *etc.*, different vehicles will be able to travel different distances on a given amount of energy. The final destination **43** of a respective vehicle **102** can be a predicted final destination or an intended destination that is selected by a user **110** of

an electric vehicle **102**. Final destinations **43**, including predicted and intended destinations, are discussed in greater detail above with respect to **Figs. 4-5**.

In some embodiments, the amount of additional energy required by the batteries **104** of the electric vehicles **102** is associated with a time component indicating when the additional energy will be required. For instance, as described in greater detail above, the control center system **112** may determine that a vehicle **102** is likely to require 30 more miles worth of energy at a time 20 minutes in the future. Thus, it is likely that the vehicle will arrive at a battery charge station **132** in 20 minutes to receive the additional 30 miles worth of energy. In some embodiments, the control center system **112** takes the time at which the energy will be required into consideration when determining (**904**) the estimated minimum charging load. Thus, the control center system **112** is able to determine both the amount of charge that a vehicle **102** will require, and the time at which the vehicle **102** is likely to be charged. Using this data, the control center system **112** may determine estimated minimum charging loads, based on the additional energy requirements of the vehicles, over a future time window. In some embodiments, the time window is 1 hour into the future. In some embodiments, the time window is 1 day into the future, or any other suitable time period. Because estimated charging loads may be predicted for times in the future (sometimes themselves being based on predicted final destinations of respective vehicles), the accuracy of the future estimated minimum charging loads will decrease the further out in time that the predictions are made. For example, predictions of a user's final destination **43** a full day in advance may be less accurate than predictions about that user's final destinations **43** one hour in advance.

In some embodiments, the control center system **112** uses historical charging demand data in order to better predict future minimum charging loads. In some embodiments, before the control center system **112** adjusts the one or more battery policies, the control center system **112** measures (**901**) an actual energy demand of the electric vehicle network over a predetermined time window. In some embodiments, the energy demand corresponds to the actual amount of energy used by the electric vehicle network **100** over the predetermined time window (*e.g.*, the amount of energy used within a particular time span of any suitable duration, such as minutes, hours, days, *etc.*). In some embodiments, the energy demand corresponds to the aggregated individual energy usage of each of (or a subset of) the vehicles **102** of the electric vehicle network **100**. In some embodiments, the control center system **112** stores (**902**)

the historical data in order to extract historical trends in energy usage. In some embodiments, the control center system **112** stores the actual energy demand to be used later as historical data in the predicted demand database **332** (**Fig. 3**). In some embodiments, the historical actual energy demand data is used to predict the energy demand of the electric vehicle network **100**, and thus predict the estimated minimum charging load for future time windows.

IIistorical data can be analyzed at a vehicle level, or at a network level. For example, in some embodiments, the control center system **112** may determine that particular users **110** of vehicles **102** have predictable driving habits, and therefore predictable charging behavior. The energy demands and charging behavior of individual users **110** can be aggregated in order to determine overall, network-level energy demand predictions. In some embodiments, the control center system **112** may evaluate the actual energy demand of the overall electric vehicle network **100**, and thus make energy demand predictions directly from the network-level demand data. In some embodiments, the control center system **112** uses one or more prediction methods to identify the final destination for a respective electric vehicle. *See, e.g.*, U.S. Patent Application No. 12/560,337, which is hereby incorporated by reference in its entirety. In some embodiments, the control center system **112** identifies a final destination for a respective electric vehicle based on historical travel data for a respective user **110**. The control center system **112** uses the historical travel data in order to aid in predicting final destinations **43**, and ultimately in predicting charging demands.

Returning to step (**904**), in some embodiments, the control center system **112** combines the additional energy requirements of a number of individual vehicles **102** to determine the overall additional energy requirements of the electric vehicle network **100**. In some embodiments, the control center system **112** increases the amount of additional energy required by the batteries by a predetermined safety factor. In other words, because the amount of additional energy required by any individual vehicle may be determined from factors that may have lower confidence levels, the control center system **112** accounts for variances by including a safety margin. In some embodiments, the calculated amount of additional energy is increased by 10-20%. Furthermore, this safety factor or margin may be applied at an individual vehicle level, so that if it is determined for a respective electric vehicle **102**, that 30 miles worth of additional energy is required, the control center system determines that the vehicle **102** must

receive at least 40 miles worth of additional energy in order to safely reach its final destination. In some embodiments, the particular safety factor or margin is determined at least in part on an individual's driving history or habits. In some embodiments, the safety factor may be applied to the amount of additional energy required by the overall electrical vehicle network **100**, rather than that of the individual vehicles **102**. For example, if it is estimated that, in aggregate, the electric vehicles **102** in the electric vehicle network **100** require a minimum of ten thousand Kilowatt-hours of additional energy, the control center system **112** may increase the requirement to twelve thousand Kilowatt-hours.

In some embodiments, the estimated minimum charging load is a sum of estimated minimum individual charging loads placed on the power grid by each respective electric vehicle. Thus, the control center system **112** may aggregate expected charging loads for individual vehicles **102** to determine an overall minimum charging load of the electric vehicle network **100**. For example, the control center system **112** may predict expected minimum charging loads for individual vehicles **102** (*e.g.*, based on the additional amount of energy required by each of those vehicles to reach their respective final destination), and sum those values to determine the overall estimated minimum charging load of the electric vehicle network **100**.

In some embodiments, some or all of the electric vehicles **102** of the electric vehicle network **100** have an associated minimum battery charge level that is set by one or more service agreements with an owner or an operator of the respective electric vehicle. In some embodiments, this minimum battery charge level represents the lowest charge level that a user **110** of a respective electric vehicle **102** is willing to accept. For example, a user **110** of an electric vehicle **102** may agree that unless the user **110** has specifically requested a full battery charge, the electric vehicle network service provider may adjust charging rates of the battery **104** (and the overall energy stored in the battery **104**) as long as the vehicle remains at least 80% charged at all times. In some embodiments, a user **110** may identify to a control center system **112** (or to the vehicle **102**, which can communicate with the control center system **112**) an intended final destination **43**. The control center system **112** may then override the agreed upon minimum battery charge level of that user's vehicle based on the intended final destination. For example, if a user **110** identifies an intended final destination **43** that requires more than a full battery charge, the control center system **112** may ensure that

the user's vehicle is fully charged. If, however, a user **110** identifies an intended final destination that requires only a smaller amount of charge, the control center system **112** may ignore the agreed upon minimum charge level based on the lower energy requirements for that trip. In some embodiments, when overriding a minimum charge level, the control center system **112** also takes into account the energy required for a return trip. Thus, if a user **110** identifies as an intended destination **43** a grocery store that is 5 miles from the user's home, the control center system **112** may ensure that a vehicle has enough charge to travel 10 miles (sometimes including an additional safety factor, as described above).

As described in more detail below, the control center system **112** sometimes makes use of excess battery capacity (*e.g.*, capacity of a battery **104** above its minimum charge level) as energy storage, and can charge or discharge those batteries at different times in order to optimize the electric vehicle network. In some embodiments, discharging is permitted so long as the battery **104** always contains at least the associated minimum battery charge level. Establishing a minimum battery charge level, as described above, ensures that a battery **104** will always have at least some charge so that the vehicle can be used without advance notice, or in an emergency.

Sometimes, users **110** of vehicles do not require that their vehicles are always charged for immediate use. Thus, in some embodiments, service agreements with owners or operators of electric vehicles do not include minimum battery charge levels. For example, some service agreements may state that the electric vehicle network provider may adjust the overall charge level of those electric vehicles to any level, unless the owner or operator of the vehicle has specifically identified a required charge level, or selected an intended final destination. In some embodiments, service agreements where there is no minimum battery charge level are less expensive than service agreements where minimum battery charge levels are established. Further, service agreements where minimum battery charge levels are higher (*e.g.*, 90%) may be more expensive than those where minimum battery charge levels are lower (*e.g.*, 40%).

Returning to **Fig. 9**, the control center system **112** determines (**906**) an estimated maximum charging load that the batteries of the electric vehicles can place on a power grid. In some embodiments, the estimated maximum charging load represents a rate of energy consumption if substantially all of the electric vehicles **102** likely to be coupled to the power grid at a certain time were to be simultaneously charged at a maximum

rate. Like the estimated minimum charging load, the estimated maximum charging load may alternatively represent a maximum quantity (*e.g.*, in kw-h) of energy that the batteries (or other storage components) of an electric vehicle network 100 can store at any given time. Estimated maximum charging loads may be determined for particular subsets of the electric vehicle network **100**. For example, in some embodiments, maximum charging loads are determined individually per region, city, land area, utility provider, power grid/transmission boundary, *etc.*

In some embodiments, the electric vehicle network **100** includes a plurality of replacement batteries **114** configured to be charged from the power grid. In some embodiments, the estimated maximum charging load represents a rate of energy consumption from the power grid if both the batteries **104** of the electric vehicles **102** and the replacement batteries **114** were to be simultaneously charged at a maximum rate.

In some embodiments, the estimated maximum charging load takes into account the number of batteries that are likely to be coupled to the power grid at a given time. Specifically, batteries that are not or will not be coupled to the power grid should not be considered in the estimation of the maximum charging load, as those batteries cannot receive any electrical energy. For example, if the control center system **112** determines or predicts that a certain subset of vehicles are currently traveling, and/or are not likely to be charging at a certain time (*e.g.*, because the vehicle is historically not coupled to the power grid at that time of day, or because it is already fully charged), then those vehicles are not included in the estimated maximum charging load. Further, if a battery service station **130** has more replacement batteries **114** than it can charge at any one time, those additional replacement batteries **114** are not included in the estimated maximum charging load. Thus, the estimated maximum charging load may be limited to those batteries that are currently coupled to the power grid, or that are predicted to be coupled to the power grid within that time period.

In some embodiments, the electric vehicle network **100** also includes other types of energy storage in addition to the vehicle batteries **104** and the replacement batteries **114**. For example, energy storage components such as storage batteries, mechanical flywheels, fuel cells, and the like may also be included.

In some embodiments, the estimated maximum charging load also accounts for one or more capacity constraints of the power grid or the components of the electric

vehicle network **100**. In some embodiments, battery charging equipment (including power transmission wiring, switchgear, transformers, *etc.*) in the electric vehicle network **100** has electrical load limits that cannot safely be exceeded. Thus, the estimated maximum charging load may account for these limits when determining the maximum load that can be placed on the power grid by the electric vehicle network **100**.

One of skill in the art will recognize that the actual charging load ($E_{Net\text{-}act}$) of the electric vehicle network (including, for example, electric vehicle batteries **104**, replacement batteries **114**, *etc.*) can be varied by altering the charging rates of the batteries that are connected to the power grid. Thus, the actual charging load that the electric vehicles place on the power grid takes into account both the number of batteries that are being charged, as well as the rate at which those batteries are being charged. As described in more detail below, the battery control center **112** may adjust the charging rates of the batteries of the electric vehicle network **100** so that the actual charging load of the batteries is between the estimated maximum charging load $E_{Net\text{-}max}$ and the estimated minimum charging load $E_{Net\text{-}min}$.

Returning to **Fig. 9**, the control center system **112** adjusts (step **908**) one or more battery policies of the batteries of the electric vehicle network **100** so as to adjust an actual charging load $E_{Net\text{-}act}$ of the electric vehicle network between the estimated minimum charging load $E_{Net\text{-}min}$ and the estimated maximum charging load $E_{Net\text{-}max}$ based on certain predetermined factors. The actual charging load $E_{Net\text{-}act}$ corresponds to the actual rate of energy consumption by the batteries that are coupled to the power grid at a current time. In some embodiments, the batteries include batteries **104** in electric vehicles **102**, and replacement batteries **114**. In some embodiments, the actual charging load also includes the charging load caused by other energy storage components, as described above.

Because the control center system **112** of a service provider has determined estimated maximum and minimum charging loads for the electric vehicle network, the service provider may choose to adjust (step **908**) the battery policies (thus adjusting the overall charging load of all the batteries coupled to the power grid) based on a number of different possible factors. As described above, the estimated maximum charging load $E_{Net\text{-}max}$ represents an upper limit on the electrical energy consumption rate of the electric vehicle network **100**, and the estimated minimum charging load $E_{Net\text{-}min}$ represents a lower limit on the electrical energy consumption rate of the electrical

vehicle network **100**. Thus, the control center system **112** adjusts the actual charging rate $E_{Net\text{-}act}$ of the electric vehicle network to be between these two limits (*i.e.*, $E_{Net\text{-}min} < E_{Net\text{-}act} < E_{Net\text{-}max}$). For example, if the estimated maximum charging load is ten thousand kW, and the estimated minimum charging load is eight thousand kW, the control center system **112** will adjust battery charging rates so that the actual charging load is somewhere between those two values, such as nine thousand kW, based on the factors presented below.

Sometimes, the minimum additional energy required by the electric vehicle network **100** is zero, or even negative. This may occur when the energy storage components of an electric vehicle network **100** (*e.g.*, batteries **104** in electric vehicles **102**, replacement batteries **114**, *etc.*) have an overall surplus of energy above the minimum required energy required for each vehicle to reach its final destination. In other words, it may be that each vehicle in the electric vehicle network has more than enough charge to reach its final destination. Thus, the minimum additional amount of energy required by the electric vehicle network is negative, because each vehicle has a surplus of energy. Typically, vehicles will not all have a surplus of energy over and above their minimum requirements at any given time. However, the electric vehicle network **100** can have a negative overall additional energy requirement (*i.e.*, an energy surplus) when the sum of the additional energy requirements of each vehicle **102** (including both positive and negative additional energy requirements) is negative. In some embodiments, the electric vehicle network will have a negative additional energy requirement when the electric vehicle network **100** has enough energy stored in replacement batteries **114** (or other energy storage components) to accommodate the minimum requirements of the electric vehicles **102** that do not have enough charge to reach their final destinations. As discussed in greater detail below, when the electric vehicle network **100** has a negative minimum additional energy requirement (*i.e.*, a surplus of energy), the network may discharge energy to the power grid.

In some embodiments, the control center system **112** adjusts (**908**) one or more battery policies based on certain factors, including the price of energy from the power grid, known upcoming charging demand, predictions of upcoming charging demand, historical charging data, specific requests from power providers, times of minimum or maximum energy use by other entities, air pollution considerations (such as air quality indices or ozone levels), greenhouse gas emission rates or quantities, *etc.*

Often, a service provider of an electric vehicle network **100** will act as an intermediary between the users **110** of electric vehicles **102**, such that the service provider purchases electricity from a utility provider, and subsequently sells the electricity to the users **110** of the electric vehicles **102** as part of an energy purchase contract or subscription plan. Further, the price of electricity from utility providers varies based on a number of different factors, such as the time of day. In order to reduce overall power costs, the service provider of the electric vehicle network **110** sometimes seeks to minimize energy consumption from the power grid when electricity is expensive, and maximize energy consumption when electricity is inexpensive. Specifically, in some embodiments, the control center system **112** uses the estimated minimum and maximum charging loads of the electric vehicle network **100**, in conjunction with price data for electrical power to determine when it is cost efficient to maintain the actual charging load at (or near) the minimum charge load, or at (or near) the maximum charge load. For example, when the price of electricity is low, the control center system **112** may increase the charging load (*e.g.*, by increasing the charge rates of batteries coupled to the power grid) in order to take advantage of the cheap electricity. In contrast, when the price of electricity is high, the control center system **112** may decrease the charging load (*e.g.*, by decreasing the charge rates of batteries coupled to the power grid) in order to reduce the amount of expensive electricity that the service provider must purchase.

As described above, the control center system **112** can adjust the instantaneous (*i.e.*, the current) charging load of the electric vehicle network **100** based on instantaneous estimated maximum and minimum charging loads, as well as the instantaneous pricing of electricity. Furthermore, because the control center system **112** can predict when, in the future, users **110** of electric vehicles **102** will require additional energy, and further predict how much additional energy those vehicles **102** will need, the control center system **112** can further adjust the current actual charging load of the batteries of the electric vehicle network based on its knowledge of these future charging requirements. For example, the control center system **112** at 3:00 PM may predict that a large number of vehicles will be traveling from a work location to a home location at 5:00 PM. The control center system **112** may also identify that each vehicle requires, on average, 10 miles worth of additional battery charge in order to reach their home location (including an appropriate safety margin). Thus, the control center system **112**

can take this future power demand into consideration when adjusting the current charging load.

For example, if electricity is expensive between 3:00 and 5:00 PM, the control center system **112** may adjust the charging rate of the vehicles so that they receive only the minimum amount of additional energy necessary for them to each reach their final destination (*e.g.*, an average of 10 miles worth of additional energy per vehicle). The estimated minimum charging load, in this case, ensures that each vehicle receives adequate energy to reach its final destination. If, on the other hand, electricity is inexpensive between the hours of 3:00 and 5:00 PM, the control center system **112** may increase the charging rates of the vehicles to the maximum charging rates, even if that rate would provide more stored energy than necessary for those vehicles to reach their final destinations.

Fig. 13 is a flowchart demonstrating a possible process for adjusting the actual charging rate $E_{Net\text{-}act}$ of the vehicle network **100** according to the price of electricity and the estimated minimum ($E_{Net\text{-}min}$) and maximum ($E_{Net\text{-}max}$) charging loads of the network **100**. In this example the estimated minimum ($E_{Net\text{-}min}$) and maximum ($E_{Net\text{-}max}$) charging loads of the network **100** are periodically, or intermittently, updated in step **61**, as described hereinabove. For example, the estimated minimum and maximum charging loads may be updated based on the actual state and requirements of the vehicles **102**, of the batteries **102** and **114**, the power network **140** and/or the vehicle network **100**. Next it is checked in step **62** if the network actual charging $E_{Net\text{-}act}$ rate is greater than the minimum charging load $E_{Net\text{-}min}$. If it is found that the network actual charging rate is smaller than the minimum charging load, then the electrical charging current consumption rate of the network is increased in step **66**. Otherwise, if it is found that the network actual charging rate is greater than the minimum charging load, then the current price of electricity is checked in step **63**.

If it is found that the electricity price is currently high, then the electrical charging current consumption rate of the network is decreased in step **64**. Otherwise, if it is found that the electricity price is currently not high, then it is checked in step **65** if the network actual charging $E_{Net\text{-}act}$ rate is greater than the maximum charging load $E_{Net\text{-}max}$. In the event that the network actual charging rate is indeed greater than the network maximum charging load, then the control is passed to step **64** to decrease the electrical charging current consumption rate of the network. On the other hand, if the network

actual charging rate is smaller than the network maximum charging load, then the control is passed to step **66** to increase the electrical charging current consumption rate of the network. After each increase/decrease (**66/64**) in the network electrical charging current the control is passed back to step **61** to update the the minimum and maximum charging loads of the network **100.**

Thus, the ability of the control center system **112** to adjust the actual charging load of the batteries in the electric vehicle network **100**, coupled with the ability of the batteries to store more energy than is required to satisfy a vehicle's transportation demands, allows the control center system **112** control over a "flexible" charging load of the electric vehicle network **100**. In other words, the actual charging load may be adjusted within a range below the maximum available charging load, but high enough to satisfy minimum transportation demands of each vehicle.

As described above, the control center system **112** may determine how or whether to adjust battery policies of the batteries in the electric vehicle network **100**. However, in some embodiments, a utility provider (*e.g.*, an owner or an operator of the power network **140** and/or the power generators **156**) provides a requested charging profile to the electric vehicle network service provider. In some embodiments, the control center system **112** sends, to a utility provider, the estimated minimum charging load and the estimated maximum charging load, and receives from the utility provider an energy plan including preferred charging loads for a predetermined time window. By allowing the utility provider to generate a preferred load profile to the service provider, the utility can use the "flexible" charging load of the electric vehicle network to its benefit. Specifically, the utility provider can use the "flexible" load of the network **100** to help balance the demand placed on the power generators **156**, and to store electricity for later use.

In some embodiments, adjusting the battery policies includes increasing or decreasing (step **910**) a charge rate of at least one replacement battery **114** coupled to the power grid at a battery service station **130**. In some embodiments, adjusting the battery policies includes increasing or decreasing (step **912**) a charge rate of the battery of at least one of the electric vehicles **102**. In some embodiments, adjusting the battery policies includes recommending an alternative battery service station to a user of a respective electric vehicle. In some embodiments, adjusting the battery policies includes increasing or decreasing a charge rate of at least one of the storage batteries **114** of the

electric vehicle network **110**. In some embodiments, adjusting the battery policies includes adjusting the amount of energy that a battery receives from the power grid or discharges to the power grid. In some embodiments, charge rates of batteries are constant, and the control center system **112** only changes the quantity of energy that the batteries receive. In some embodiments, adjusting the battery policies includes recommending (**914**) to a user a battery exchange instead of a battery charge. Further details relating to adjusting battery policies are described in greater detail above with reference to **Fig. 4**. Also, the described battery policy adjustments apply by analogy to other energy storage components as well.

In some embodiments, in order to facilitate analysis and/or display of the information, the estimated minimum and maximum charging load over time are each represented by a set of data points over a predefined time window. Each data point represents an energy measurement at a certain future time. In some embodiments, the energy measurements represent a rate of energy transfer (*e.g.*, in kW). In some embodiments, energy measurements represent a quantity of energy (*e.g.*, in kW-h). In some embodiments, at least a subset of the data points are fit to a curve function, which can then be plotted and displayed on a display device in order to facilitate visualization of the data. An operator of a control center system **112** (or at a utility provider) may view the displayed curve to aid in determining whether and how to adjust the battery policies of the electric vehicle network. In some embodiments, the control center system **112** or the utility provider automatically determines whether and how to adjust the one or more battery policies without direct operator intervention, and/or without displaying any information to a control center operator.

Fig. 10A illustrates a graph **1000** displaying estimated minimum and maximum charging load curves, according to some embodiments. The x-axis of the graph represents time, and the left-hand y-axis represents charging load, measured in rate of energy consumption (*e.g.*, in kW). The right-hand y-axis represents price (*e.g.*, in dollars). **Fig. 10A** illustrates one possible charging load curve for part of a typical day, for example, from 6:00 AM to 10:00 PM.

The estimated maximum charging load curve **1006** (and estimated maximum charging load curve **1012**, **Fig. 10B**) shows the variation of the estimated maximum charging load of the electric vehicle network **100** over time. As shown in **Fig. 10A**, the maximum charging load is relatively stable. However, the stability of the estimated

maximum charging load depends on many factors, and may be significantly different from that shown in **Fig. 10A**. For example, the ratio of replacement batteries **114** and energy storage components to electric vehicles **102** may have a significant impact on the stability of the curve **1006**, as vehicles are not always coupled to the power grid. If there are substantially more replacement batteries **114** than there are vehicles **102** in the electric vehicle network **102**, then the relative impact of the vehicles being decoupled from the power grid will be lower than the impact of the large number of replacement batteries that are coupled to the grid, thus increasing the stability of the maximum charging load.

The estimated minimum charging load curve **1004** shows the variation of the estimated minimum charging load of the batteries in the electric vehicle network over time. This curve shows two peak charging times, corresponding to a morning and an evening time window. These peak charging times may reflect typical charging demands associated with people commuting to and from respective work locations. The price of power curve **1008** illustrates the price of electricity over time, illustrating higher prices during peak demand hours of the day. As shown in **Fig. 10A**, the price of power curve **1008** has two peak pricing time windows, generally corresponding to morning and evening time windows.

The curves shown in **Fig. 10A** are merely illustrative: estimated minimum and maximum charging loads, as well as the price of power, may vary substantially from this illustration. For example, the estimated minimum charging load over time may be substantially different for weekends or holidays, where power demands from commuters are reduced. Further, the price of power curve **1008** may change from one day to the next, and may have more or fewer price levels than illustrated. One of skill in the art will also recognize that the estimated minimum charging load curve **1004** represents the rate of energy consumption over time, and does not directly represent the amount of energy required by the vehicles **102** of the electric vehicle network **100**. However, as described above, the charging rate is calculated based on the minimum amount of additional energy required by the vehicles **102** of the electric vehicle network **100**. Furthermore, the charging load curve **1004** could also be adapted to represent the minimum amount of additional energy required by the vehicles **102** at a given time. Likewise, the maximum charging load curve **1004** could be adapted to represent the

maximum amount of energy that the batteries and storage components in the electric vehicle network **100** could hold at a given time.

The graph of **Fig. 10A** helps to illustrate how the above described information can be used to adjust the actual charging demand of the electric vehicle network **100** in order to optimize the price paid by the electric vehicle network for electricity. In particular, it can be seen that the minimum charging load **1004** has a first peak at a point between times *t1* and *t2*. This peak charging load represents the charging load that will be placed on the system at that time in order for each vehicle to receive enough charge so that it can reach its final destination, which may be a work location. Also, the price of power curve **1008** shows that the price of power is at its highest level around the same time that the minimum charging load is at its morning peak. However, the price of power is at a minimum level between times *t0* and *t1*, and it would be cheaper to purchase the electricity needed between times *t1* and *t2* when power is inexpensive, between times *t0* and *t1*. The control center system **112** (or an operator of the control center system **112**) can recognize this situation, and adjust battery charging policies to increase battery charging rates between times *t0* and *t1*, even though the increased rates may result in vehicles receiving more energy than necessary to reach their intended destinations. In some instances, the actual charging rates of the batteries in the electric vehicle network may be increased to their maximum charging rates. Accordingly, the actual charging load of the electric vehicle network **100** during peak morning commute hours can be reduced, which in turn reduces the amount of expensive electricity that needs to be purchased during that time.

Of course, it may not be possible to charge the batteries of the electric vehicle network to completely satisfy the needs of the morning commute, as some vehicles may still require additional charge between times *t1* and *t2*. Because the price of power is at its peak during this time window, the control center system **112** may keep the amount of charge provided to these vehicles to a minimum (*e.g.*, only enough for that vehicle to reach its final destination) so as to reduce the amount of expensive electricity purchased by the electrical vehicle network. While the curves in **Fig. 10A** are discussed in terms of charging loads (*e.g.*, rate of electrical energy consumption), users who are receiving additional charge during peak usage hours may not be willing to accept a lower charge rate, even if they are willing to accept only a minimum charge level. In other words, while a user may be willing to accept a 10 mile charge instead of a full battery charge,

the user may wish to receive that 10 mile charge at the maximum charging rate. This preference may be accommodated, as the aggregate effect of vehicles receiving smaller charge levels is a reduced overall charging load, even if each individual battery is charged at a maximum rate.

A similar analysis may be made in response to the peak in the estimated minimum charging load curve **1006** seen during the evening (corresponding, for example, to the evening commute hours), between time ***t3*** and time ***t4***. In particular, because electricity is at its most expensive level during this time window, charging rates of the batteries in the electric vehicle network **100** may be increased during the preceding time window, between the time ***t2*** and ***t3***, when electricity is at a comparatively lower price. Similar to the scenario described above, those vehicles requiring additional charge between times ***t3*** and ***t4*** may only be given enough charge to meet that vehicle's minimum charge requirements (*e.g.*, only enough for that vehicle to reach its final destination) in order to minimize the amount of expensive electricity purchased by the electrical vehicle network during the peak commute hours.

Fig. 10A also illustrates a time frame, after time ***t5***, where the estimated minimum charging load is negative. A negative estimated minimum charging load simply indicates that the batteries (or other energy storage components) of the electric vehicle network **100** have more energy than needed to satisfy the minimum transportation requirements. This scenario is likely to occur later at night, when most drivers are home from work or their daily travels and are finished using their cars for the day. In some embodiments, the value of a negative estimated minimum charging load corresponds to a rate at which energy may be discharged from the batteries to the power grid, while still ensuring that the batteries have adequate charge levels to meet a user's transportation requirements. For instance, a vehicle that has 100 miles of charge at 10:00 PM may have an upcoming transportation need of 10 miles, in order to reach a user's work location, at 8:00 AM. Thus, the electric vehicle network **100** may discharge up to 90 miles worth of charge from that respective electric vehicle between 10:00 PM and 8:00 AM and still satisfy the vehicle's transportation requirements.

By adjusting battery policies of the batteries in the electric vehicle network, including replacement batteries and/or additional energy storage components, it may be possible to store more energy than the electric vehicles require for a given time span. Often, the most convenient time to charge batteries beyond their minimum required

levels is during the night, when most vehicles are not being used, and when electricity is typically at its cheapest. The stored energy may then be discharged back to the power grid when electricity is expensive. Such storage and discharge cycles may be implemented based on requests from utility providers, and/or to reduce electricity costs of the electric vehicle network **100**. **Fig. 10B** illustrates a graph **1002** displaying estimated minimum and maximum charging load curves where the electric vehicle network is capable of discharging energy to the power grid, as described above.

As shown in **Fig. 10B**, the estimated minimum charging load curve **1010** is negative between times *t0* and *t2*. As in **Fig. 10A**, time *t0* may correspond to 6:00 AM. Thus, the overall amount of charge stored in the electric vehicle network may be very high, because most of the vehicles in the electric vehicle network were likely charging overnight when electricity was cheap. Furthermore, the replacement batteries **114** and/or additional energy storage components may likewise have been charging overnight. Accordingly, the control center system **112** may have allowed the batteries to charge completely (or at least more than necessary to satisfy upcoming transportation demands) in anticipation of the upcoming morning travel demands, and the upcoming increase in the price of electricity. The control center system **112** may then, at time *t1*, discharge energy from the batteries of the electric vehicle network **100** back to the power grid.

One of skill in the art will recognize that while the net charging rate of the electric vehicle network as described above and illustrated in **Fig. 10B** may be negative (indicating discharge to the power grid), individual vehicles may still receive energy from the power grid. For example, the replacement batteries **114** (and/or other storage components) may contain more energy than is required by the vehicles of the electric vehicle network **100** to reach their respective final destinations, even if an individual vehicle still requires additional energy. This may occur when a vehicle requires more than one battery's worth of charge to reach its final destination. However, because the replacement batteries **114** store more energy than that which is required by the vehicles, the replacement batteries **114** may be discharging to the grid while the vehicles are charging from the grid. The overall energy consumption by the electric vehicle network **100**, therefore, may be negative. In effect, the process of storing and discharging energy as described above allows electric vehicles to use cheap energy, which was received and

stored at periods of low demand, during periods of high demand and high electricity prices.

Figs. 10A and **10B** show predicted values (rather than current or instantaneous values) of the minimum and maximum charging loads over an exemplary time period. However, the actual maximum and minimum charging load curves will not be static over a given time window, but rather will change based on the adjustments to the actual charging load made by the control center system **112**. In other words, when the control center system **112** determines that it is advantageous to increase the charging rate of the batteries in the electric vehicle network, the amount of energy stored in the electric vehicle network will increase. This increase in stored energy, in turn, will likely lower the future estimated minimum charging load, because the electric vehicle network may have acquired a quantity of energy over and above the vehicle's aggregated minimum energy requirements. Accordingly, the curves in **Figs. 10A** and **10B** may change as the battery policies are adjusted in real-time. In some embodiments, when curves or graphs are displayed to operators of the control center system **112**, the curves are iteratively updated to account for the real-time battery policy adjustments.

In some embodiments, the total energy stored in the electric vehicle network **112** (*e.g.*, in the batteries **104** of the vehicles **102**, replacement batteries **114**, storage batteries, etc.) is compared with the minimum energy requirements of the electric vehicle network **112**, and battery policies are adjusted based on the results of the comparison. For example, in some embodiments, battery policies are adjusted so that the total energy stored in the electric vehicle network is always above the minimum energy requirements of the electric vehicle network **112**. In some embodiments, the minimum energy requirements of the electric vehicle network **112** will be zero, such as when the electric vehicle network, in aggregate, requires no net additional energy from the power grid in order to allow each vehicle **102** to reach its final destination. Using the net additional energy is important, as it reflects the fact that some batteries (*e.g.*, vehicle batteries **104** and replacement batteries **114**) may be discharging power to the grid, while other batteries may be drawing power from the grid. Thus, a zero minimum energy requirement does not necessarily mean that every single vehicle in the electric vehicle network **112** has sufficient charge to reach its final destination.

The foregoing description, for purpose of explanation, has been described with reference to specific implementations. However, the illustrative discussions above are

not intended to be exhaustive or to limit the disclosed ideas to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The implementations were chosen and described in order to best explain the principles and practical applications of the disclosed ideas, to thereby enable others skilled in the art to best utilize them in various implementations with various modifications as are suited to the particular use contemplated.

Moreover, in the preceding description, numerous specific details are set forth to provide a thorough understanding of the presented ideas. However, it will be apparent to one of ordinary skill in the art that these ideas may be practiced without these particular details. In other instances, methods, procedures, components, and networks that are well known to those of ordinary skill in the art are not described in detail to avoid obscuring aspects of the ideas presented herein.

CLAIMS:

1. A method of managing an electric vehicle network, comprising:

receiving battery status data and vehicle location data from each of a plurality of electric vehicles;

utilizing the battery status data and the vehicle location data, and utilizing a final destination for each of the electric vehicles, and determining battery service data indluding a likely battery service station;

predicting demand at one or more battery service stations based at least on the battery service data determined for each of the electric vehicles; and

determining whether to adjust one or more battery policies responsive to the predicted demand.

2. The method of claim 1, wheren the battery service dasta includes a likely vehicle arrival time for the respective electric vehicle at the determined likely battery service station.

3. The method of claim 1 or 2, comprising:

estimating a minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination; and

estimating a maximum charging load that the batteries of the electric vehicles can place on a power grid,

said predicting of the demand utilizing the estimated minimum charging load and the estimated maximum charging load.

4. The method of claim 3 wherein the estimating of the minimum charging load is determined at least partially based on actual energy demand of the electric vehicle network determined over a predetermined time window based at least partially on data received from the vehicles.

5. The method of claim 3 wherein the estimated minimum charging load is a sum of estimated minimum individual charging loads placed on the power grid by each respective electric vehicle.

6. The method of any one of claims 3 to 5, wherein the estimated maximum charging load is at least partially based on an estimated load placed on the power grid if all of the vehicles coupled to the power grid at a certain time were to be simultaneously charged at a maximum rate.

7. The method of any one of the preceding claims, wherein the determining of whether to adjust one or more battery policies includes:

determining a supply of battery services at the one or more battery service stations; and

comparing the predicted demand at the one or more battery service stations and the supply of battery services at the one or more battery service stations.

8. The method of any one of the preceding claims, further comprising adjusting the one or more battery policies based on the demand predicted at the one or more battery service stations.

9. The method of claim 7, further comprising adjusting the one or more battery policies based on the comparison between the predicted demand at the one or more battery service stations and the supply of battery services at the one or more battery service stations.

10. The method of any one of the preceding claims, wherein the determining of the final destination comprises receiving respective final destinations from at least a subset of the plurality of electric vehicles.

11. The method of claim 10, wherein the respective final destinations are intended destinations selected by respective users of the subset of electric vehicles.

12. The method of any one of claims 1 to 9, wherein the determining of the final destination comprises predicting the final destination of a respective electric vehicle when an operator of the respective electric vehicle has not selected an intended final destination.

13. The method of claim 12, wherein the predicted final destination is selected from a group consisting of: a home location; a work location; a battery service station; a previously visited location; and a frequently visited location.

14. The method of any one of the preceding claims, wherein the one or more battery service stations are selected from a group consisting of: charge stations for recharging the batteries of the electric vehicles; and battery exchange stations for replacing the batteries of the electric vehicles.

15. The method of any one of the preceding claims, wherein the demand is predicted for a predetermined time or for a predetermined range of time.

16. The method of any one of claims 8 to 15, wherein adjusting the one or more battery policies comprises increasing or decreasing a charge rate of: at least one replacement battery coupled to the electric vehicle network at a battery service station; or of a battery of at least one of the electric vehicles coupled to the electric vehicle network at a battery service station.

17. The method of any one of claims 8 to 15, wherein adjusting the one or more battery policies comprises recommending an alternate battery service station to a user of a respective electric vehicle.

18. The method of any one of claims 8 to 17, wherein adjusting the one or more battery policies comprises changing a number of available replacement batteries at one or more of the battery service stations.

19. The method of any one of the preceding claims, further comprising informing a utility provider of an expected power demand, the expected power demand based at least partially on the predicted demand at the one or more battery service stations.

20. The method of any one of the preceding claims, wherein determining a respective likely battery service station and a respective likely vehicle arrival time for a respective electric vehicle is further based on a speed of the respective electric vehicle.

21. The method of any one of the preceding claims, further comprising increasing the demand predicted at the one or more battery service stations to account for demand from one or more electric vehicles of a second plurality of electric vehicles.

22. The method of claim 21, wherein the second plurality of vehicles includes vehicles that are not in communication with the computer system.

23. The method of any one of the preceding claims, further comprising:

displaying, on a display device, a map illustrating a geographic area having a plurality of battery service stations; and

displaying on the map one or more graphical representations indicating a respective demand for one or more of the battery service stations in the illustrated geographic area.

24. A system for managing an electric vehicle network, comprising:

at least one communication module for exchanging data with one or more battery service stations and with a plurality of electric vehicles;

one or more processors; and

memory for storing data and one or more programs for execution by the one or more processors, comprising:

a battery status module configured to determine a battery charge status based on battery status data received from each of the plurality of electric vehicles;

a vehicle location database for maintaining location data received from the vehicles; and

a demand prediction module configured and operable to identify a final destination for each of the electric vehicles, determine for each respective electric vehicle a location of a likely battery service station based at least partially on the location, the final destination, and the battery charge status for that electric vehicle, and predict demand at one or more battery service stations based at least partially on the likely battery service location for each respective electric vehicle.

25. The system of claim 24, comprising a battery service station module configured and operable to receive and maintain station status data received from the battery service stations.

26. The system of claim 24 or 25, comprising a battery policy module configured and operable to determine whether to adjust one or more battery policies based at least on one of the predicted demand and the station status data.

27. The system of any one of claims 24 to 26, comprising a map module configured and operable to generate a graphical representation indicating a respective demand for battery services in one or more geographic areas.

28. A method of managing an electric vehicle network comprising a plurality of electric vehicles each having one or more batteries, the method comprising:

estimating a minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination;

estimating a maximum charging load that the batteries of the electric vehicles can place on a power grid; and

adjusting one or more battery policies of the batteries of the electric vehicles to adjust an actual charging load of the electric vehicle network between the estimated minimum charging load and the estimated maximum charging load based on certain predetermined factors.

29. The method of claim 28, wherein the estimating of the minimum charging load is determined at least partially based on measured actual energy demand of the electric vehicle network over a predetermined time window.

30. The method of claim 28, wherein the estimated minimum charging load is a sum of estimated minimum individual charging loads placed on the power grid by each respective electric vehicle.

31. The method of any one of claims 28 to 30, wherein the estimated minimum charging load is at least partially based on the final destination, a current location, and a battery charge level of each respective electric vehicle.

32. The method of any one of claims 28 to 31, wherein the estimated maximum charging load is at least partially based on an estimated load placed on the power grid if all of a predicted number of vehicles coupled to the power grid at a certain time were to be simultaneously charged at a maximum rate.

33. The method of any one of claims 28 to 32, wherein the estimated maximum charging load is at least partially based on an estimated load placed on the power grid if all of the vehicles coupled to the power grid at a certain time were to be simultaneously charged at a maximum rate.

34. The method of any one of claims 28 to 33, wherein the one or more battery policies are adjusted at least partially based on a price of energy from the power grid.

35. The method according to any one of claims 28 to 34, wherein the batteries of the electric vehicles each have an existing charge level, and wherein the amount of additional energy required by the batteries of the electric vehicles is an amount of energy in addition to an aggregation of the existing charge level of each of the electric vehicles.

36. The method according to any one of claims 28 to 35, wherein each respective electric vehicle has an associated minimum battery charge level that is determined by one or more service agreements with an owner or an operator of the respective vehicle.

37. The method of according to any one of claims 28 to 36, further comprising:

sending, to a utility provider, the estimated minimum charging load and the estimated maximum charging load; and

receiving from the utility provider an energy plan comprising preferred charging loads for a predetermined time window;

wherein the one or more battery policies are adjusted in accordance with the energy plan.

38. The method according to any one of claims 28 to 37, wherein when the batteries of a respective electric vehicle contain more energy than necessary for the respective electric vehicle to reach its final destination, the battery of the respective electric vehicle being capable of providing energy to the power grid.

39. The method of any one of claims 28 to 38, wherein adjusting the one or more charging policies comprises increasing or decreasing a charge rate of at least one of: at least one of the replacement batteries coupled to the power grid; and at least one electric vehicle coupled to the power grid.

40. The method of claim 39, wherein the charge rate is negative.

41. The method of any one of claims 1 to 40, wherein the electric vehicle network includes one or more storage batteries coupled to the power grid, and wherein adjusting the one or more battery policies comprises increasing or decreasing a charge rate of at least one of the storage batteries.

42. The method of any one of claims 28 to 41, wherein the estimated minimum charging load and the estimated maximum charging load are represented by a set of data points representing energy quantities over a predefined time.

43. The method of claim 42, further comprising:

fitting at least a subset of the set of data points to a curve function; or

displaying, on a display device, a graph containing at least a subset of the set of data points.

44. The method of any one of claims 28 to 43, wherein the one or more battery policies are adjusted in order to minimize energy costs of the electric vehicle network over a predetermined time window.

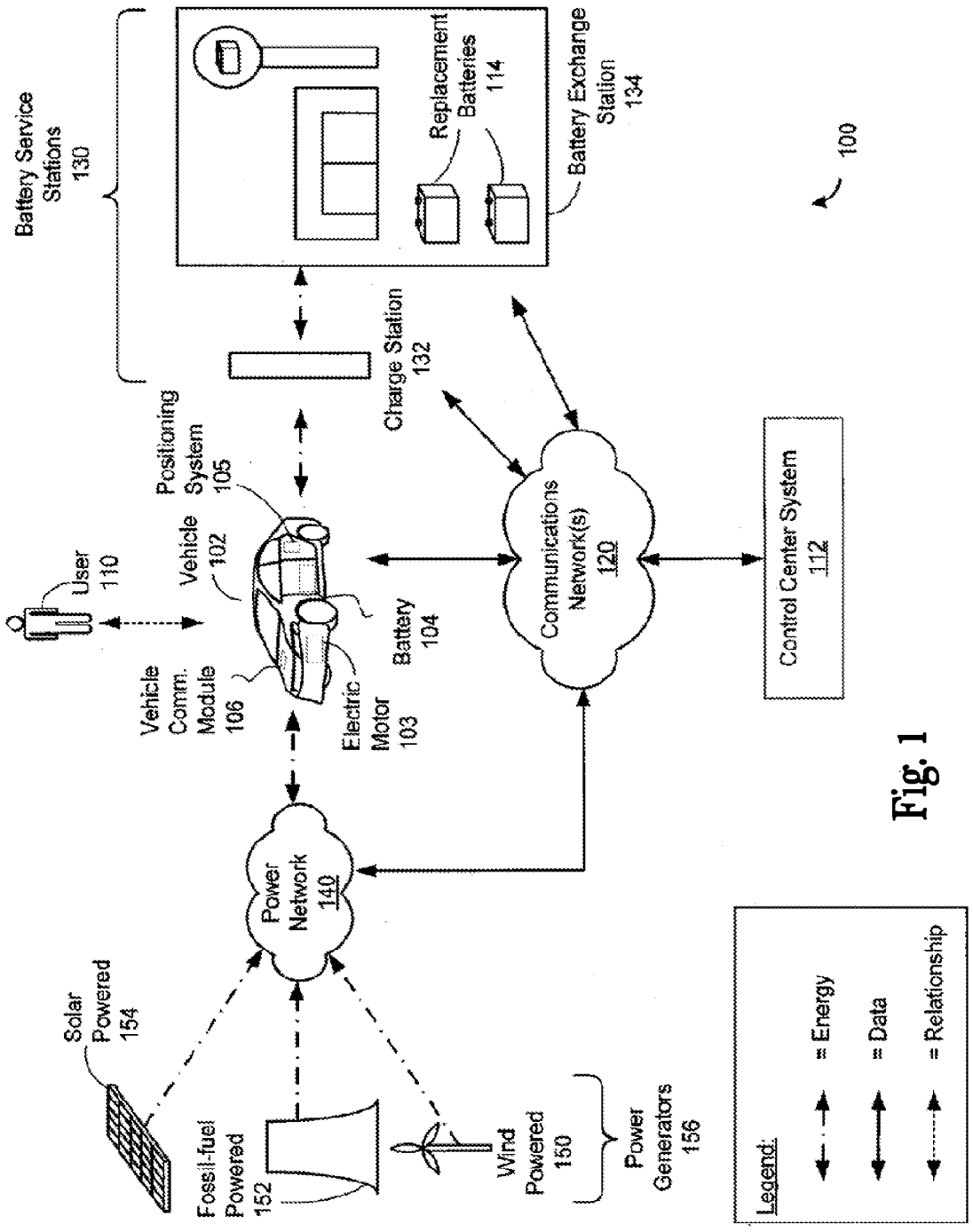

Battery Service Stations 130
Replacement Batteries 114
Battery Exchange Station 134
100
Charge Station 132
Positioning System 105
Vehicle 102
User 110
Vehicle Comm. Module 106
Battery 104
Electric Motor 103
Communications Network(s) 120
Control Center System 112
Power Network 140
Solar Powered 154
Fossil-fuel Powered 152
Wind Powered 150
Power Generators 156
Legend:
= Energy
= Data
= Relationship

Fig. 1

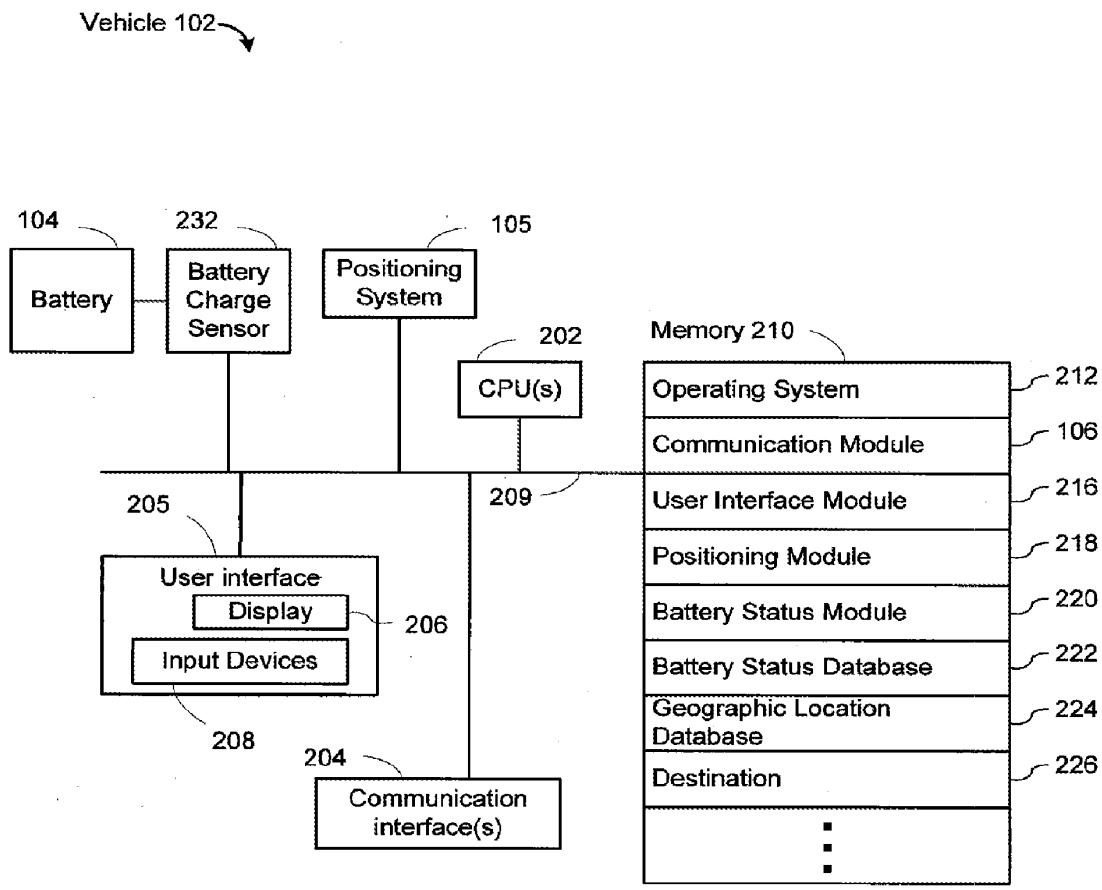

Vehicle 102
104
Battery
232
Battery Charge Sensor
105
Positioning System
202
CPU(s)
Memory 210
Operating System
212
Communication Module
106
User Interface Module
216
Positioning Module
218
Battery Status Module
220
Battery Status Database
222
Geographic Location Database
224
Destination
226
209
205
User interface
Display
Input Devices
206
208
204
Communication interface(s)

Fig. 2

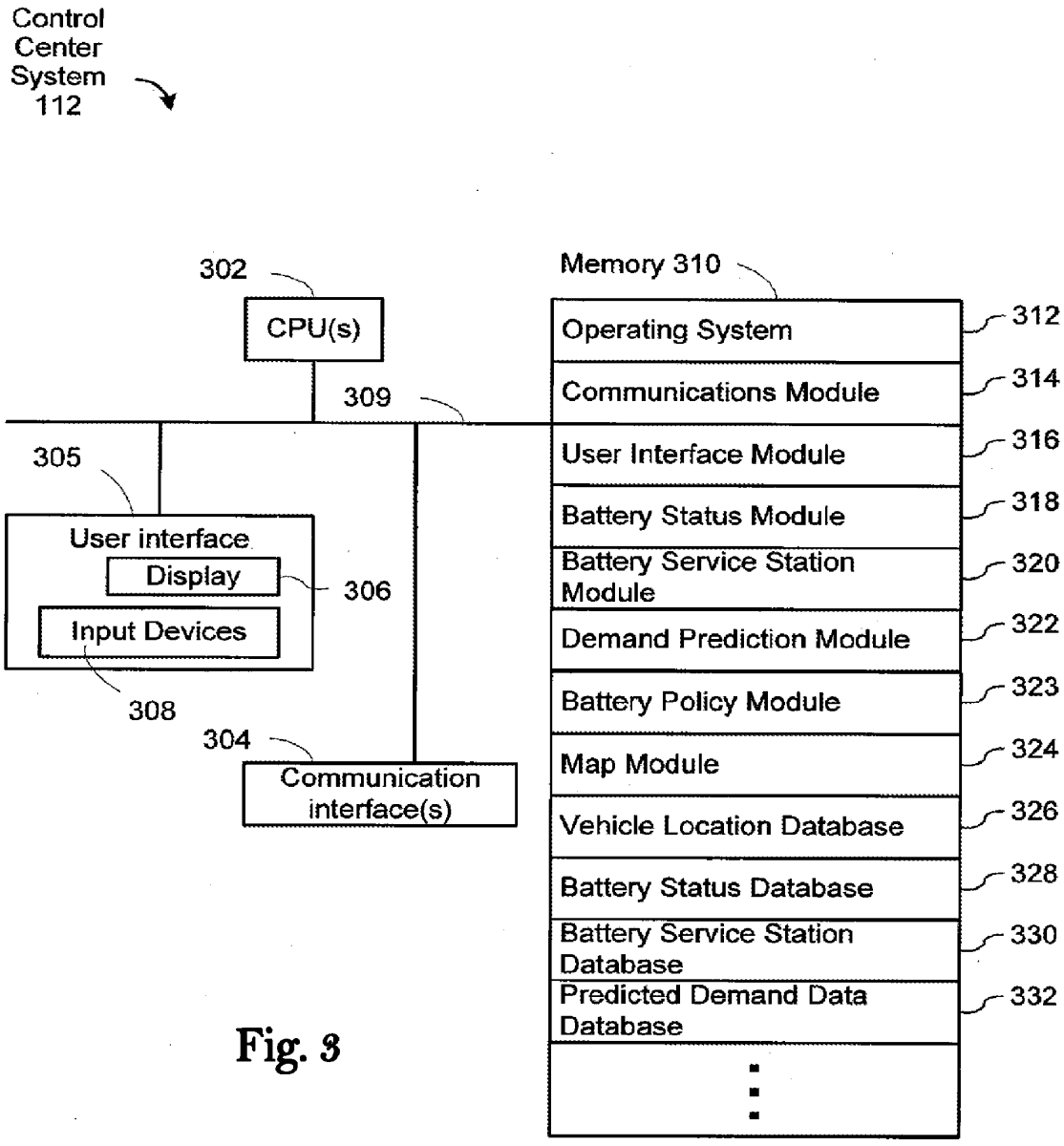

Control Center System 112
302
CPU(s)
309
305
User interface
Display
306
Input Devices
308
304
Communication interface(s)
Memory 310
Operating System
312
Communications Module
314
User Interface Module
316
Battery Status Module
318
Battery Service Station Module
320
Demand Prediction Module
322
Battery Policy Module
323
Map Module
324
Vehicle Location Database
326
Battery Status Database
328
Battery Service Station Database
330
Predicted Demand Data Database
332

Fig. 3

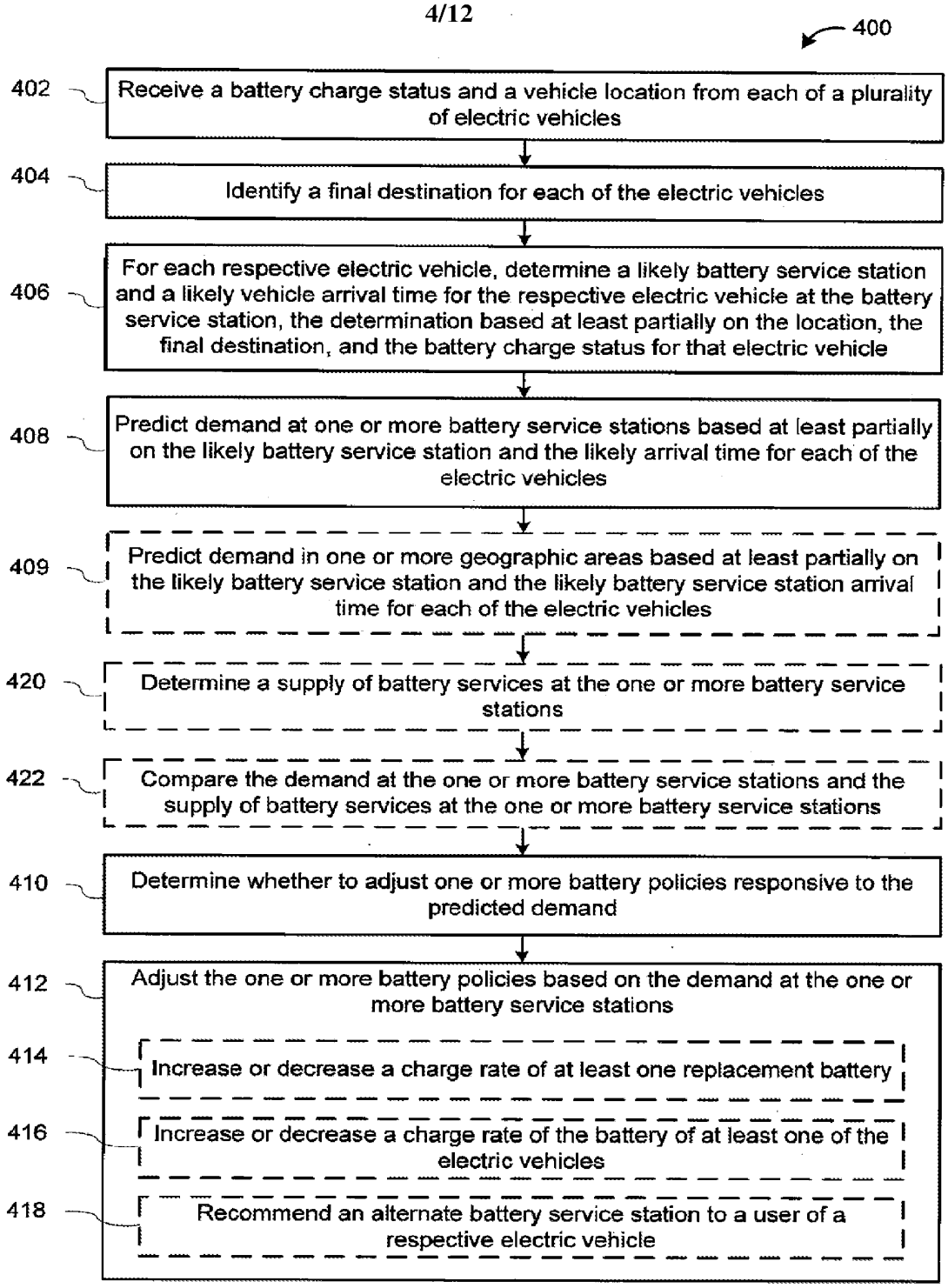

400
402
Receive a battery charge status and a vehicle location from each of a plurality of electric vehicles
404
Identify a final destination for each of the electric vehicles
406
For each respective electric vehicle, determine a likely battery service station and a likely vehicle arrival time for the respective electric vehicle at the battery service station, the determination based at least partially on the location, the final destination, and the battery charge status for that electric vehicle
408
Predict demand at one or more battery service stations based at least partially on the likely battery service station and the likely arrival time for each of the electric vehicles
409
Predict demand in one or more geographic areas based at least partially on the likely battery service station and the likely battery service station arrival time for each of the electric vehicles
420
Determine a supply of battery services at the one or more battery service stations
422
Compare the demand at the one or more battery service stations and the supply of battery services at the one or more battery service stations
410
Determine whether to adjust one or more battery policies responsive to the predicted demand
412
Adjust the one or more battery policies based on the demand at the one or more battery service stations
414
Increase or decrease a charge rate of at least one replacement battery
416
Increase or decrease a charge rate of the battery of at least one of the electric vehicles
418
Recommend an alternate battery service station to a user of a respective electric vehicle

Fig. 4

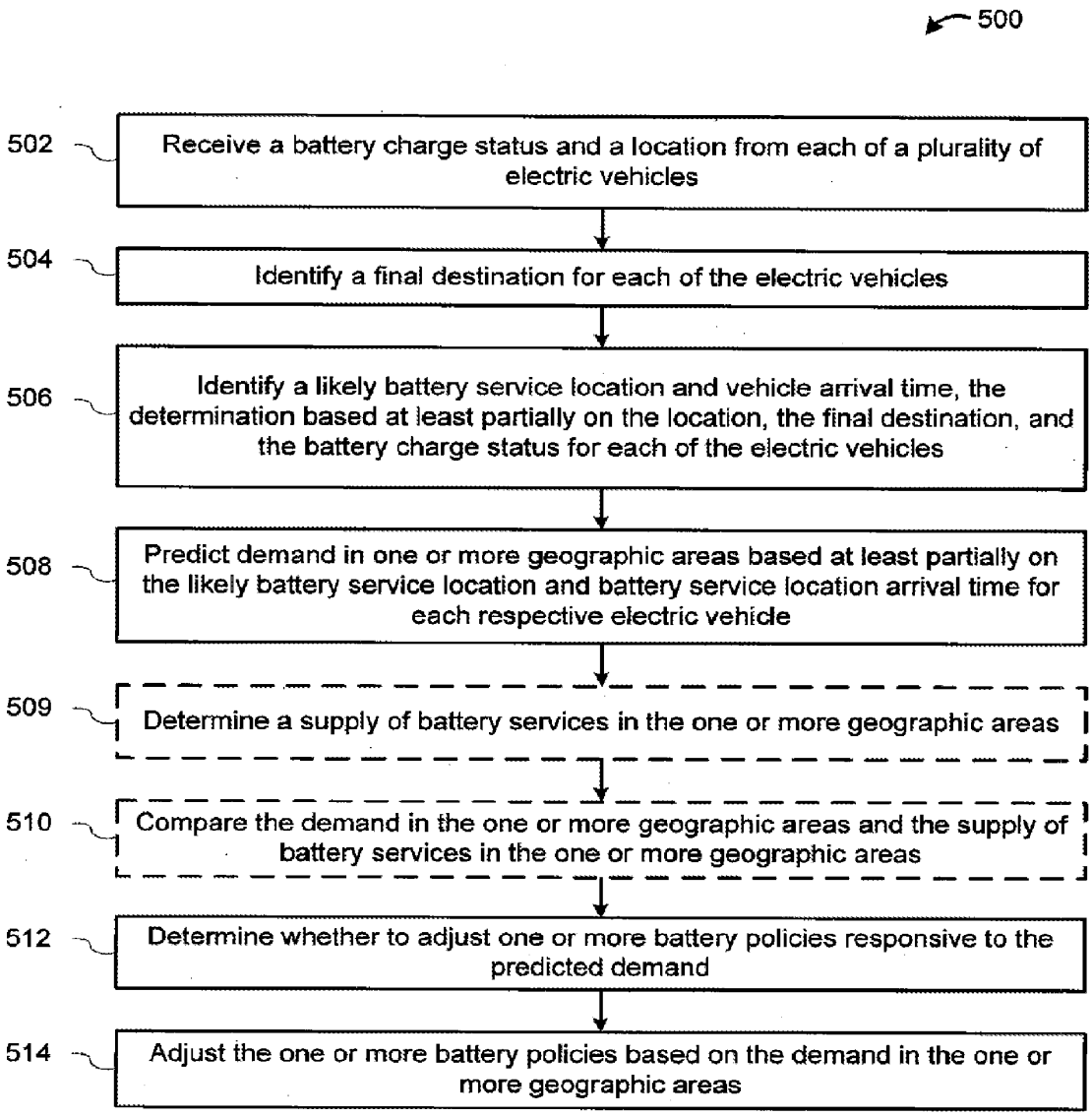

500
502
Receive a battery charge status and a location from each of a plurality of electric vehicles
504
Identify a final destination for each of the electric vehicles
506
Identify a likely battery service location and vehicle arrival time, the determination based at least partially on the location, the final destination, and the battery charge status for each of the electric vehicles
508
Predict demand in one or more geographic areas based at least partially on the likely battery service location and battery service location arrival time for each respective electric vehicle
509
Determine a supply of battery services in the one or more geographic areas
510
Compare the demand in the one or more geographic areas and the supply of battery services in the one or more geographic areas
512
Determine whether to adjust one or more battery policies responsive to the predicted demand
514
Adjust the one or more battery policies based on the demand in the one or more geographic areas

Fig. 5

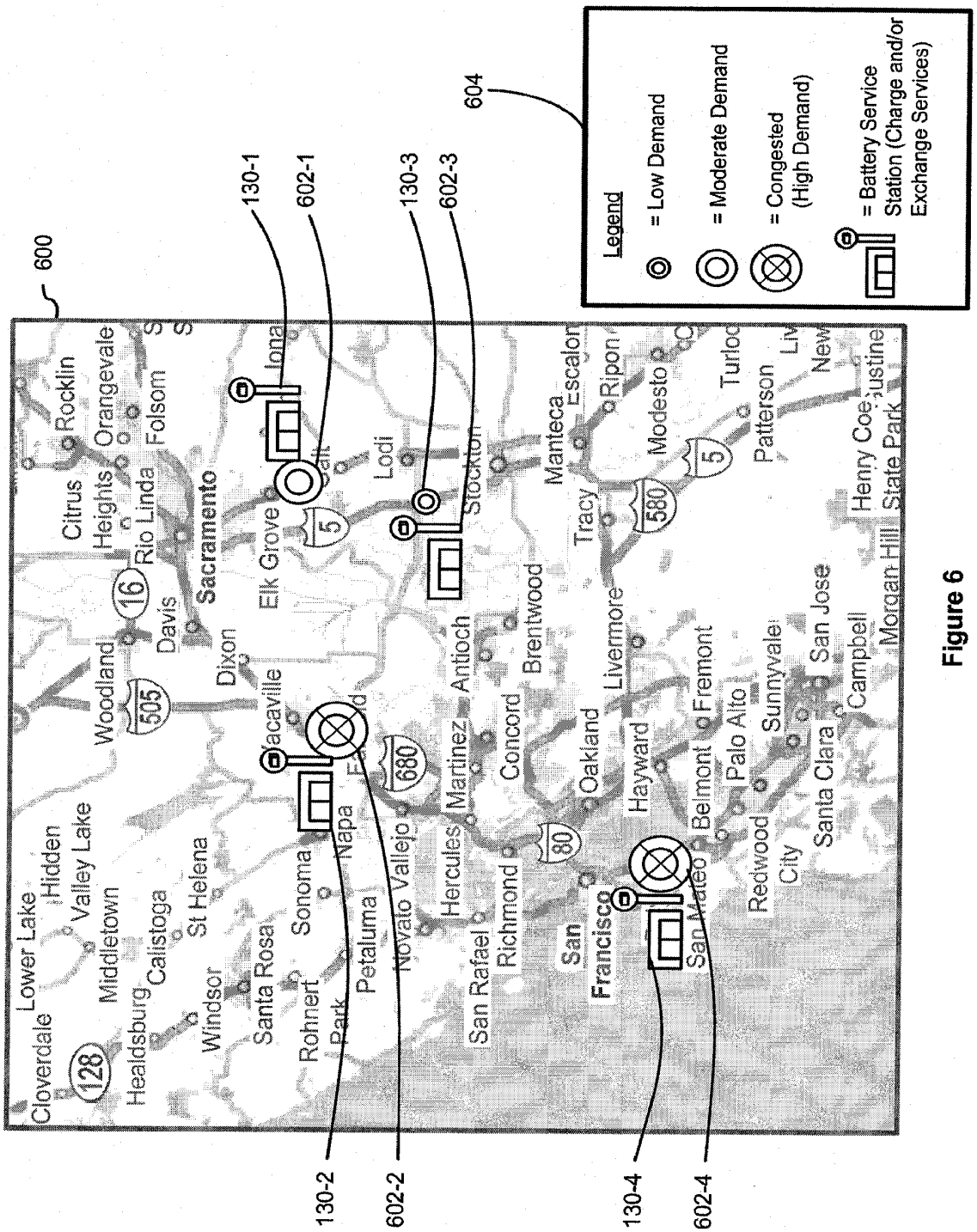

600
604
130-1
602-1
130-3
602-3
130-2
602-2
130-4
602-4
Legend
= Low Demand
= Moderate Demand
= Congested (High Demand)
= Battery Service Station (Charge and/or Exchange Services)
Sacramento
San Francisco
Cloverdale
Lower Lake
Hidden Valley Lake
Middletown
Healdsburg
Calistoga
St Helena
Windsor
Santa Rosa
Rohnert Park
Sonoma
Petaluma
Napa
Vacaville
Woodland
Davis
Dixon
Rocklin
Citrus Heights
Orangevale
Rio Linda
Folsom
Elk Grove
Lodi
Stockton
Manteca
Tracy
Ripon
Modesto
Patterson
Turlock
Livermore
Hayward
Oakland
Alameda
Berkeley
Richmond
San Rafael
Novato
Vallejo
Hercules
Martinez
Concord
Antioch
Brentwood
Fremont
Belmont
San Mateo
Palo Alto
Sunnyvale
Santa Clara
San Jose
Campbell
Morgan Hill
Henry Coe State Park
Redwood City
505
16
5
580
680
80
128

Figure 6

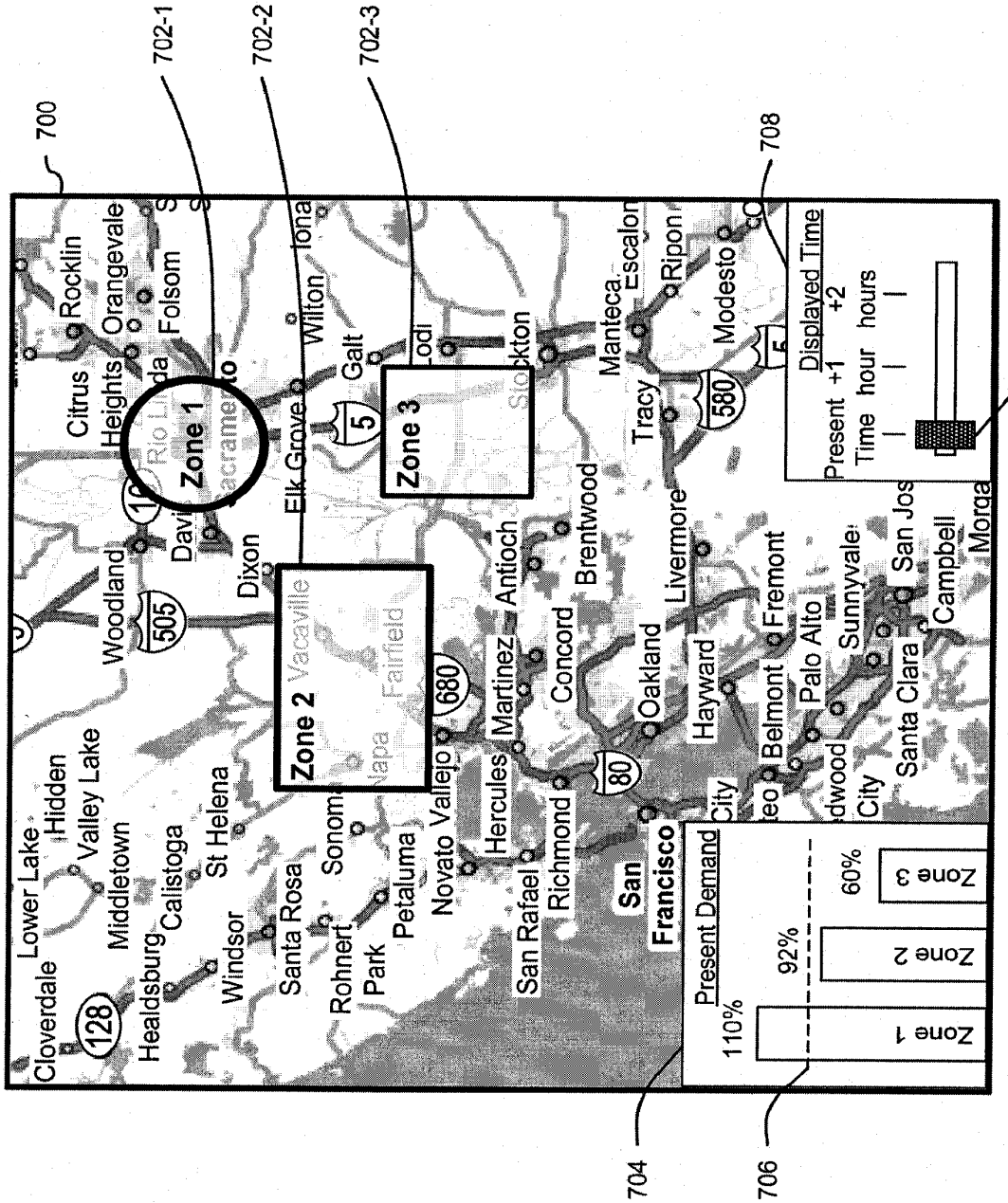

700
702-1
702-2
702-3
708
709
704
706
Zone 1
Zone 2
Zone 3
Present Demand
110%
92%
60%
Zone 1
Zone 2
Zone 3
Displayed Time
Present +1 +2
Time hour hours
Rocklin
Orangevale
Folsom
Citrus Heights
Rio Linda
Sacramento
Wilton
Galt
Elk Grove
Lodi
Stockton
Manteca
Escalon
Ripon
Modesto
Tracy
Dixon
Woodland
Davis
Vacaville
Fairfield
Napa
Sonoma
Petaluma
Novato
Vallejo
Hercules
Martinez
Antioch
Brentwood
Concord
Livermore
Oakland
Hayward
Fremont
Belmont
Palo Alto
Sunnyvale
Santa Clara
San Jose
Campbell
Morgan Hill
San Francisco
San Rafael
Richmond
Lower Lake
Hidden Valley Lake
Middletown
Calistoga
St Helena
Cloverdale
Healdsburg
Windsor
Santa Rosa
Rohnert Park
505
680
80
580
5
128

Figure 7

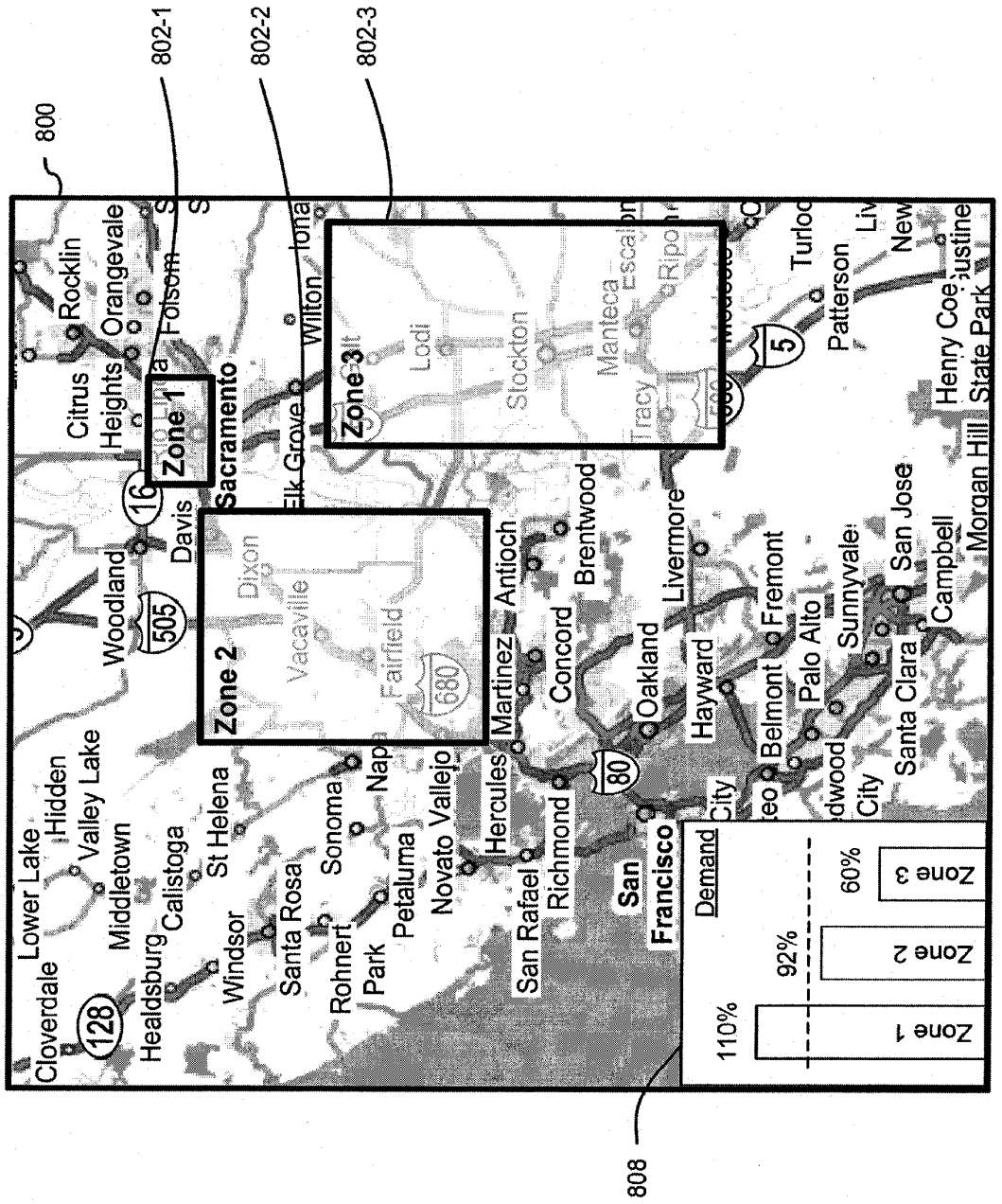

800
802-1
802-2
802-3
808
Zone 1
Zone 2
Zone 3
Sacramento
Demand
110%
92%
60%
Zone 1
Zone 2
Zone 3
Cloverdale
Lower Lake
Hidden Valley Lake
Middletown
Healdsburg
Calistoga
St Helena
Windsor
Santa Rosa
Rohnert Park
Sonoma
Petaluma
Napa
Novato
Vallejo
Hercules
San Rafael
Richmond
San Francisco
Oakland
Martinez
Antioch
Concord
Brentwood
Livermore
Hayward
Fremont
Belmont
Palo Alto
Sunnyvale
Santa Clara
San Jose
Campbell
Morgan Hill
Henry Coe State Park
Patterson
Turlock
Tracy
Manteca
Stockton
Lodi
Elk Grove
Wilton
Folsom
Orangevale
Citrus Heights
Rocklin
Woodland
Davis
Vacaville
Dixon
Fairfield
505
680
80
5
16
128

Figure 8

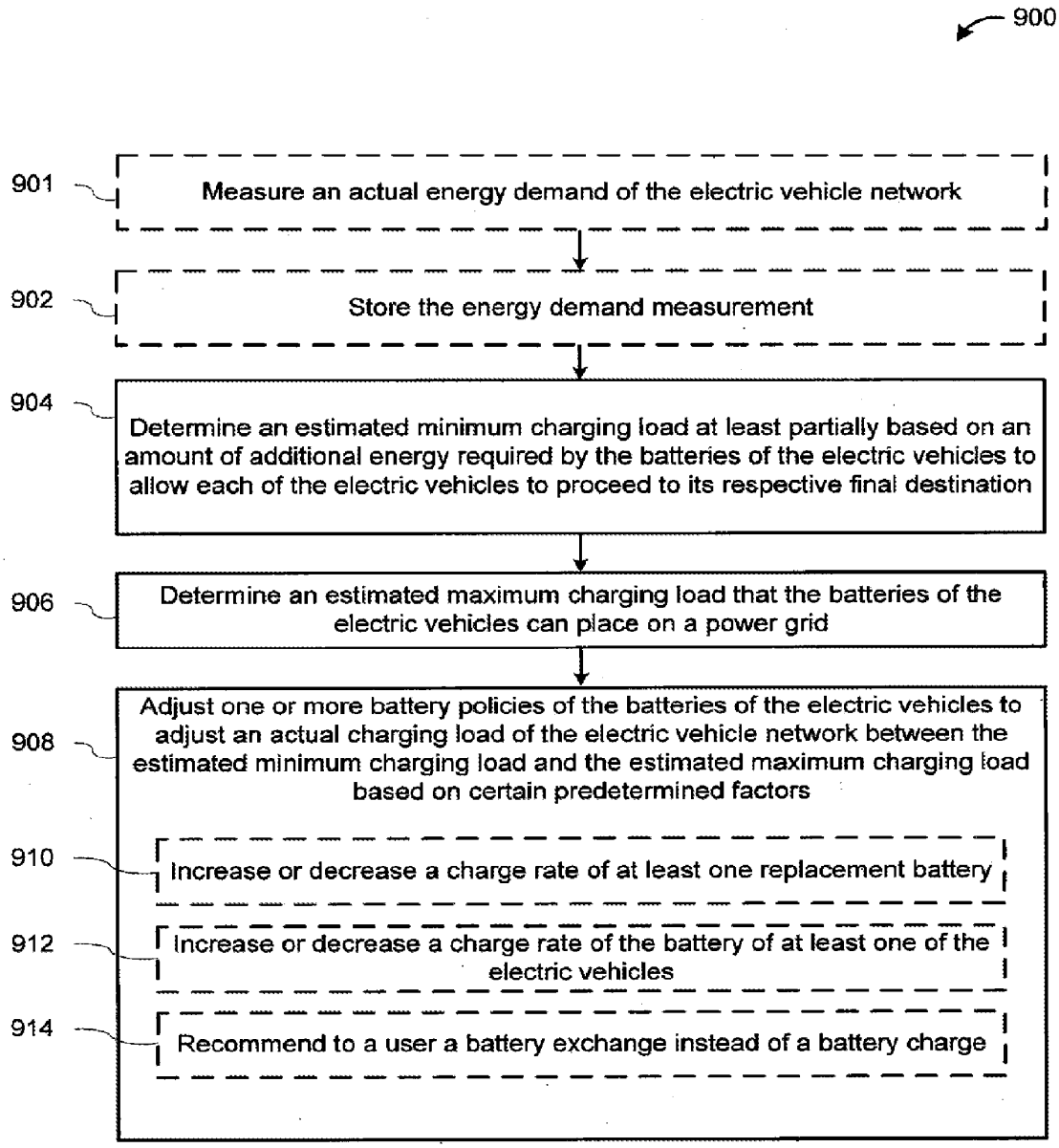

900
901
Measure an actual energy demand of the electric vehicle network
902
Store the energy demand measurement
904
Determine an estimated minimum charging load at least partially based on an amount of additional energy required by the batteries of the electric vehicles to allow each of the electric vehicles to proceed to its respective final destination
906
Determine an estimated maximum charging load that the batteries of the electric vehicles can place on a power grid
908
Adjust one or more battery policies of the batteries of the electric vehicles to adjust an actual charging load of the electric vehicle network between the estimated minimum charging load and the estimated maximum charging load based on certain predetermined factors
910
Increase or decrease a charge rate of at least one replacement battery
912
Increase or decrease a charge rate of the battery of at least one of the electric vehicles
914
Recommend to a user a battery exchange instead of a battery charge

Fig. 9

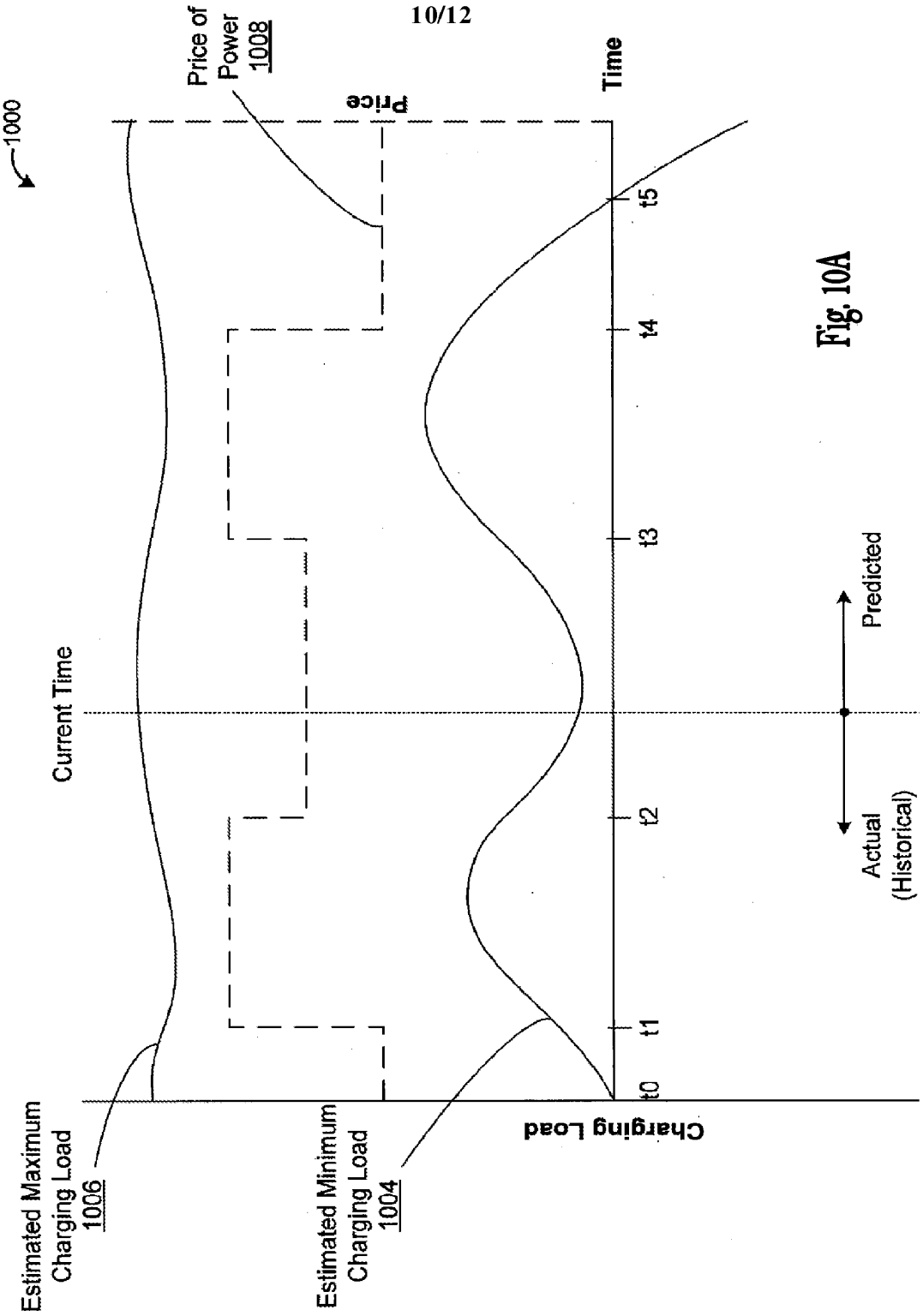

1000
Price of Power 1008
Price
Time
t0
t1
t2
t3
t4
t5
Current Time
Predicted
Actual (Historical)
Charging Load
Estimated Maximum Charging Load 1006
Estimated Minimum Charging Load 1004

Fig. 10A

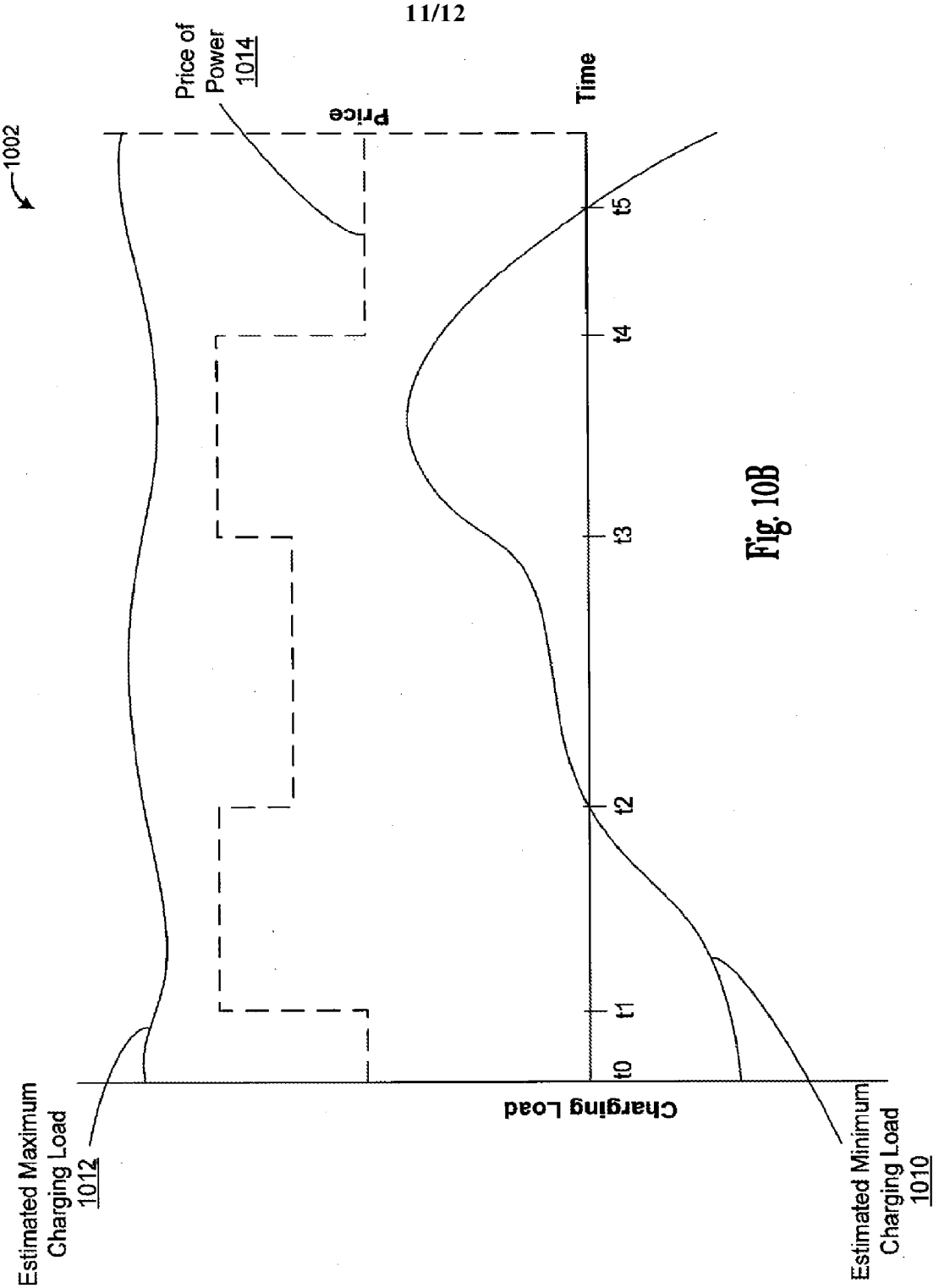

1002
Price of Power 1014
Price
Time
t5
t4
t3
t2
t1
t0
Charging Load
Estimated Maximum Charging Load 1012
Estimated Minimum Charging Load 1010

Fig. 10B

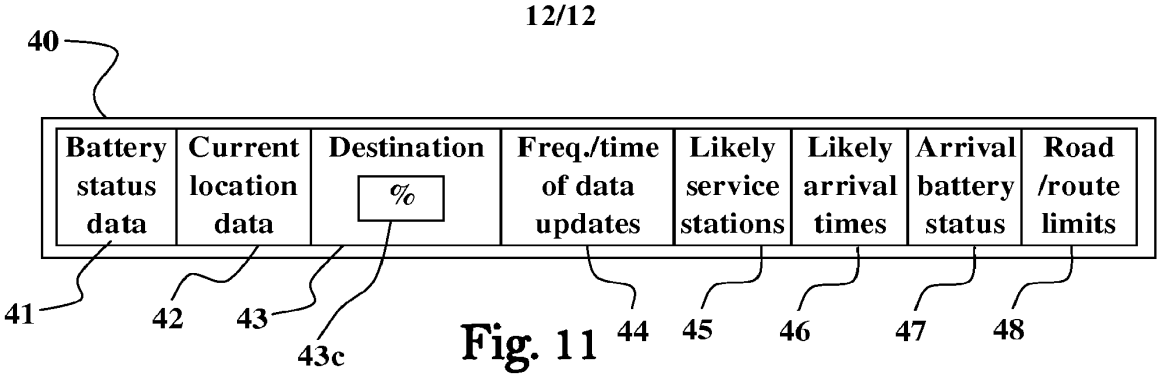


Fig. 11

51

50

Estimated demand for the battery service station *k*				
Time range	t1-t2	t2-t3	t3-t4	...
Predicted number of arriving EVs	N_{t1-t2}	N_{t2-t3}	N_{t3-t4}	...
Predicted replenishment energy for the EVs	$\sum_{i}^{N_{t1-t2}} E^{i}_{EV-est(t1-t2)}$	$\sum_{i}^{N_{t2-t3}} E^{i}_{EV-est(t2-t3)}$	$\sum_{i}^{N_{t3-t4}} E^{i}_{EV-est(t3-t4)}$	...

52

Fig. 12

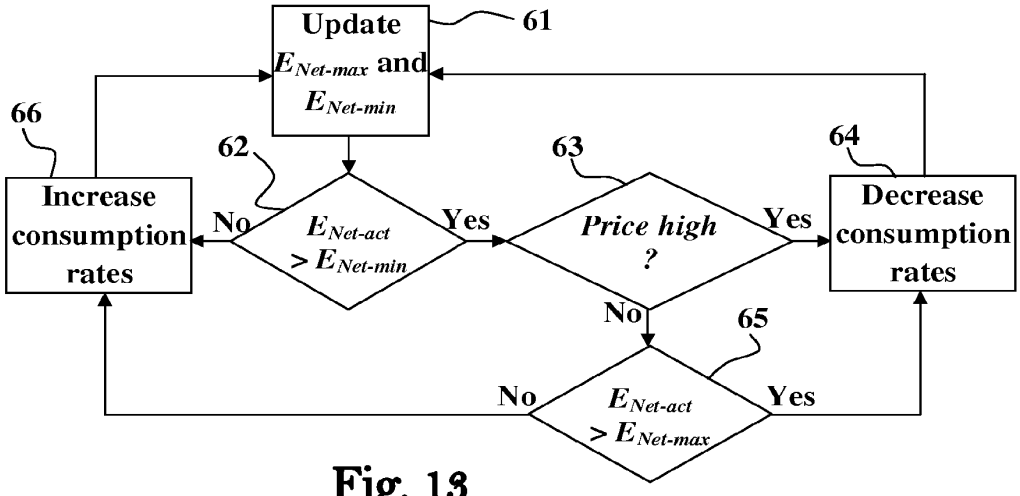


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/033517 A2 (AGASSI S) 25 March 2010 (2010-03-25) abstract figures 1-22 paragraph [0001] - paragraph [0066] paragraph [0096] - paragraph [0294] -----	1-44
X	US 2010/094496 A1 (HERSHKOVITZ BARAK [IL] ET AL) 15 April 2010 (2010-04-15) abstract figures 1-20 paragraph [0002] - paragraph [0067] paragraph [0098] - paragraph [0313] -----	1-44
A	US 6 625 539 B1 (KITTELL ROBERT P [US] ET AL) 23 September 2003 (2003-09-23) the whole document -----	1-44

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

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bassanini, Anna

1

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Information on patent family members

International application No
PCT/IL2012/050313

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010033517 A2	25-03-2010	AU 2009293389 A1	25-03-2010
		CA 2730372 A1	25-03-2010
		CN 102164773 A	24-08-2011
		EP 2323866 A2	25-05-2011
		JP 2012503468 A	02-02-2012
		WO 2010033517 A2	25-03-2010
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		US 2004078141 A1	22-04-2004

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(54) **Title**: IDENTIFICATION OF AN ELECTRIC VEHICLE ADJACENT TO A POWER REPLENISHMENT STATION

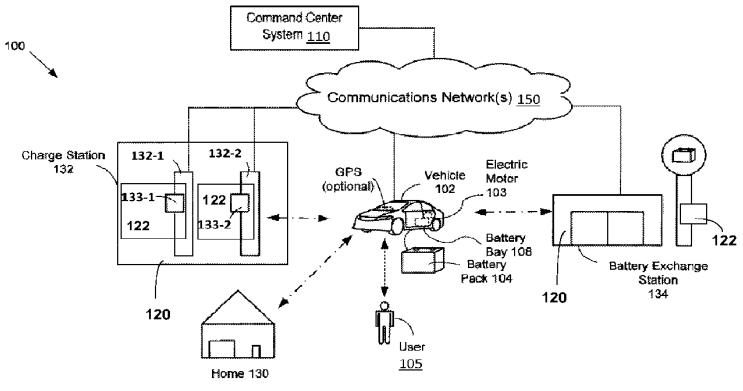


FIG. 1

(57) **Abstract**: The present invention concerns a technique (method and a system) for use in servicing of electric vehicles at power replenishment service stations. The technique of the invention enables identification of a respective vehicle located at the power replenishment service station by carrying out the following: receiving and processing user request data from at least one power replenishment service station for identifying therein user data indicative of a user requesting power replenishment service, receiving and processing data from control systems of vehicles for identifying certain data including at least specific vehicle data, and processing the user data and the specific vehicle data and identifying the respective vehicle located at the power replenishment service station to thereby enable management of services to be provided to the respective vehicle.

WO 2013/024483 A2

IDENTIFICATION OF AN ELECTRIC VEHICLE ADJACENT TO A POWER REPLENISHMENT STATION

TECHNOLOGICAL FIELD

This invention relates to servicing electric vehicles at power replenishment stations and particularly to identification of electric vehicles in the vicinity of the power replenishment stations service stations.

BACKGROUND

A vehicle (*e.g.*, car, truck, plane, boat, motorcycle, autonomous vehicle, robot, forklift truck, *etc.*) is an integral part of the modern economy. Unfortunately, fossil fuels, like oil which is typically used to power such vehicles, have numerous drawbacks including their dependence on limited sources of fossil fuels, the fact that the sources are often in volatile geographic locations, and also that such fuels produce pollutants and likely contribute to climate change. One way to address these problems is to increase the fuel efficiency of the vehicles.

Recently, gasoline-electric hybrid vehicles have been introduced, which consume substantially less fuel than their traditional internal combustion counterparts, i.e., they have better fuel efficiency. Fully-electric vehicles are also gaining popularity. Batteries play a critical role in the operation of such hybrid and fully-electric vehicles. With a typical electric vehicle battery, the electric vehicle may be able to travel within a distance range of about 160 kilometers before a need to recharge / replace the battery. Then, the spent battery needs to be charged or exchanged to allow the vehicle to travel beyond the single-charge travel range.

GENERAL DESCRIPTION

Electric vehicles (EV), including partially electric (hybrid) or fully-electric driven vehicles, typically utilize servicing to replenish their battery charging state. Replenishing power of an EV is generally provided by power replenishment stations (i.e. service stations) such as a battery service station including a charging pole and/or a battery exchange system. For providing suitable service to an EV, it is important to determine/identify at least one of the type/model of the battery to be serviced, a serial/identification number corresponding thereto or to identify the type/model/serial number of the vehicle upon which the battery is installed.

Identifying data corresponding to any one or more of the above enumerated identification options or any other data suitable for identification of an EV or a battery installed thereon is commonly and alternatively referred to herein as vehicle-identification or vehicle related data determination.

Vehicle-identification may, for example, be required to allow one or more of the following: billing for battery replenishment services rendered to the identified EV; determining a suitable charging protocol to be used for charging the EV by a charging pole; determining of a charging plan for charging the EV's battery. The latter may require use of data indicative of the state of the battery in the EV, the typical power consumption of the EV, as well as information on the user of the EV and his driving habits.

It is typically necessary to identify the type/model of the battery to be replenished to allow supplementation of the proper charging plane or to allow exchanging the battery with another compatible battery. Specifically, in order to charge an EV's battery at a charging station, it is, in many cases, desired/required to identify the battery and to gain access to specific battery information such as charging history, battery condition and so forth. Utilizing such specific battery information allows provision of cost effective and efficient battery charging. A battery type or identity may be obtained by identifying the battery itself (e.g. its serial number) or by identifying the type or identity of the EV's upon which the battery is installed.

In order to further improve the efficiency of power replenishment services, it may also be desired to obtain information identifying the EV to be serviced at a service station and/or identifying its user. Such data allows maintaining and utilizing usage related information which may be utilized to provide the EV with a better suited power

replenishment service/plan. Such usage related information may for example include vehicle usage history, expected/predicted usage, user's profile (e.g. driving style or habits, commonly used roots and timings), power consumption etc.

However, there is currently no efficient way to identify the type/model/serial number of an EV or an EV's battery located in the vicinity of a power replenishment station in general and in particular it is difficult to identify the battery of an EV located near a charging station (e.g. charging pole). Current standardized cables used for charging EVs are not configured for data communication between the charging pole and the EV being serviced. As a result, a communication deficiency/gap arises from the inability of EV's to transmit identifying information to service stations. As such, a need exists for n easy and efficient system and method for identifying an electric vehicle (and/or its battery) at a service station.

Particularly, service stations providing battery charging services are typically implemented as charging poles. Charging poles are typically relatively low-cost systems/utilities (e.g. as compared with battery exchange stations) and are deployed in relatively large quantities and with dense distributions (e.g. with down to a few meters apart from one another) in areas where users tend to park their vehicles for several hours (such as in industrial parks and residential areas). As a result, various vehicle identification techniques, such as vehicle-plate identification/recognition, might be inapplicable for charging poles due to relatively complicated and high-cost identification systems, and also due to their poor performance in irregular environment conditions (vehicles may be positioned with various orientations in the vicinity of a charging pole). Also, the identification technique relies on wireless communication, such as WIFI, between the vehicle and a charging pole, may suffer from ambiguous or redundant identification of the vehicle at multiple charging poles and may also suffer from false identification of vehicles which pass near the charging poles.

The present invention allows bridging this communication gap between a power replenishment station and an EV to be serviced thereby and to overcome the above described drawbacks. According to some aspects of the present invention this gap is bridged by utilizing communication with a user's device (e.g. mobile handset associated with the user of the EV). This may be achieved by utilizing various communication abilities/modules with which various mobile handsets are equipped, such as near field

communication (NFC), Radio-frequency identification (RFID), Bluetooth (BT) and wireless-local-area-network (WLAN/WIFI).

For example, the user device can be used to identify the user at a power replenishment service station (service station). The power replenishment station may further transmit this user identification data (user-data) to a central station (control center) to indicate which user currently requests to be serviced by the service station. Such communication between the user device and the service station may be based on wireless communication. In some cases, in which several power replenishment service stations (e.g. charging poles), are located in close proximity to one another, near field communication technologies such as NFC and RFID are preferably used by the service stations for identifying a user, or a user's handset, thus avoiding ambiguous and false identification of the user. For example, service stations may be distant from one another by less than a coverage range of WIFI and BT technologies (e.g. less then a hundred meters). In such cases, the user may approach and identify himself to the service station by utilizing a handheld device equipped with near field communication technology such as NFC and RFID.

It should be noted that communication between the user device and the service station may be based on wireless communication such as those described above in relation to the communication between a user device and the EV. It should also be understood that the user device may be a handheld device such as a mobile handset, phone, or an NFC card, and also a user's device may be integral with the EV's control system in which case the EV itself may be considered as a user's device. In some cases, the user device, in addition to communicating user info to the service station, notifies the in-vehicle control system about initiation of a service plane (e.g. battery charge/exchange) by the station.

In some cases, the user device may also be used to identify the vehicle's user to the control system of the vehicle he is currently using. The vehicle may then communicate this vehicle associated user data to a central station (control center) to indicate its current/contemporary user. A user's handheld device associated with the EV's control system might also be able to consume different services from the vehicle's computer (e.g. Web surfing, etc.). To this end, according to some embodiments of the invention, a communication between the EV and the user's handset may be exploited to identify the user to both the service station and the EV's control system.

As the user is identified at the service station, or before or after the identification process, the EV's control system communicates to the control center certain information including vehicle related data (including data indicative of the vehicle's identity). The control center may then cross reference the data received from various EV's and data received from the service stations and determine an association between the specific service station/charge pole and the specific EV to be serviced/charged thereby. Cross referencing these data for matching between a particular vehicle and a particular power replenishment station/system may possibly be assisted by additional data/information which may be provided/sent from one or more of the vehicles, from one or more of the service stations and/or from another data repository associated with the control center.

For example, additional information/data provided from the vehicle may include one or more of the following: the position of the vehicle as may be received from a GPS system onboard the vehicle, a list of users associated with the vehicle and/or a current vehicle related user data indicating the current user of the EV, as well as other factors associated with the vehicle. In addition, for example additional information/data provided from the service station may include the user-data indicating the user currently requesting service from the service station, the service station location and/or as other factors associated with the user or the service station. Yet additionally, further information/data provided from data repository associated with the control center may for example include a list of EVs that are associated with specific user. A match between the EV and a service station may be determined (e.g. at the control center) by utilizing such additional data and possibly also by utilizing the timing of the data communication events.

Thus, according to the invention, the data obtained at the control center from various electric vehicles (EV's) and from various service stations for determining which vehicle/battery is in the vicinity of which service station, and accordingly determines the type and/or scheme of power replenishment plan to be provided by each station to each vehicle.

According to a broad aspect of the present invention there is provided a service system for use in facilitating servicing of electric vehicles. The service system includes one or more communication modules for connection to a communication network, and a processor utility configured and operable for carrying out the following:

- receiving and processing user request data from at least one power replenishment service station and identifying user data therein;
- receiving and processing data from control systems of vehicles and identifying certain data including at least specific vehicle data; and
- processing the user data and the at least specific vehicle data to identify the respective vehicle located at the power replenishment service station, and generating data indicative thereof thereby enabling management of servicing of the respective vehicle.

According to some embodiments the certain data, which is received from the control systems of vehicles, includes vehicle associated user data indicative of a user using the vehicle. The processor utility may be configured and operable to determine a match between vehicles associated user data obtained from one or more vehicles and user data indicated in one or more user requests (e.g. user request data received from one or more power replenishment stations) and thereby determine a specific vehicle located adjacent to a specific power replenishment station.

Alternatively or additionally, according to some embodiments of the present invention the processing utility is configured and operable for carrying out the following in order to determine a respective vehicle located at the power replenishment service station: (a) identify a list of a plurality of vehicles associated with the user based on the identification of the user requesting service at the power replenishment station; (b) obtain one or more factors associated with at least one of the vehicle and the user and; (c) utilize these one or more factors to determine a match between the respective vehicle and a user requesting service at the power replenishment station thereby determine which respective vehicle of the plurality of vehicles associated with the user is located adjacent to the power replenishment station. In some embodiments at least one of these factors is included in the certain data which is received from the control systems of vehicles. These one or more factors may include for example one or more of the following: a charge event received from the vehicle located adjacent to the power replenishment service station, a vehicle usage history associated with the user, battery service history associated with the user, a location of the vehicle.

Thus, according to some embodiments of the present invention the processing utility is configured and operable for identifying the respective vehicle, which is

adjacent to the power replenishment station, by carrying out at least one of the following:

a. matching user data (e.g. received with the user request for service) with vehicle associated user data indicative of a user using the vehicle; and

b. processing data indicative of a list of a plurality of vehicles associated with the user by filtering the data indicative of the list utilizing one or more factors associated with at least one of the vehicle and the user. The filtering includes at least one of the following:

- utilizing at least one of a vehicle and battery usage history associated with the user and determining that a vehicle frequently used by the user is said respective vehicle;
- matching a charge event data received from a certain vehicle in the list with a charge event received from the power replenishment station;
- matching a location of a certain vehicle in the list with a location of said power replenishment station from which the user request had been received.

According to some embodiments, the system of the invention is configured and operable as a control center connectable to one or more power replenishment service stations via the communication network. The one or more communication modules of the system include: an electric vehicle (EV) communication module configured and operable for communication with control systems of multiple EVs and receiving therefrom at least the vehicle data and a station-communication module configured and operable for communication with the one or more power replenishment stations for receiving therefrom the user request data including at least the user data. In some cases the EV communication module is configured to communicate with the control system of the vehicle by mediation of a power replenishment station in the vicinity thereof the vehicle is located.

According to some embodiments, the system of the invention includes a vehicle locator module. The vehicle locator module is adapted to utilize data received from the control system of the vehicle and data received from the one or more power replenishment stations to determine a certain power replenishment station in the vicinity of which the vehicle is located.

According to some embodiments, the system of the invention includes a battery information module. The battery information module is adapted to utilize the vehicle data and determine corresponding operative data for power replenishment of the

vehicle. Typically the station-communication module is then adapted for sending said operative data to the certain power replenishment station at which the vehicle is located.

According to some embodiments, the system of the invention is associated with a control system of a power replenishment station (e.g. of one or more power replenishment stations/systems). The system includes an identification module adapted for obtaining at least the user data associated with a user requesting power replenishment service from the power replenishment station. The one or more communication modules of the system include a control center communication module connectable to the identification module and adapted for communicating with the control center for sending thereto at least the user-data indicative of the user requesting power replenishment services and receiving therefrom corresponding operative data of the power replenishment service to be provided to the vehicle of the user. In some cases the system further includes a replenishment controller connectable to the control center communication module and adapted for utilizing the operative data for operating the power replenishment system associated with the power replenishment station.

According to some embodiments, in which the system is associated with a control system of a power replenishment station, the identification module may be adapted for carrying out at least one of the following:

- communicate with a user device for receiving therefrom the user-data indicative of a user requesting power replenishment services.
- communicate with the control system of the vehicle for receiving therefrom the vehicle-data.
- communicate with the control system of the vehicle for receiving therefrom user-data indicative of a user requesting power replenishment services.
- obtain, from at least one of the user device and the control system of the vehicle, corresponding vehicle associated data which is to be communicated to the control center.

According to some embodiments of the invention one or more of the power replenishment stations include one or more battery charging poles. Alternatively or additionally one or more of the power replenishment stations include one or more battery exchange systems/stations.

According to some embodiments of the invention at least one power replenishment station includes an identification module including at least one of an

RFID, NFC, BT and WIFI communication devices adapted for communicating with a user device in the vicinity of the service station for receiving the user-data therefrom. In some embodiments one or more of the communication modules of the system are configured and operable for communication with a user device for receiving therefrom at least one of the following: the vehicle data, vehicle associated user data indicative of a user using the vehicle, and one or more factors associated with at least one of the vehicle and the user.

According to some embodiments of the invention, the system (e.g. one of the communication module(s) thereof) is adapted for wireless communication with a control system of the vehicle for at least partially receiving therefrom at least one of the following: the vehicle data, vehicle associated user data indicative of a user using the vehicle, and one or more factors associated with at least one of said vehicle and said user.

According to some embodiments of the invention, after determining the vehicle located in the vicinity of a certain power replenishment station, the system (e.g., the processor utility) is configured and operable for identifying battery information of the vehicle and communicating operational data for servicing the battery to the certain power replenishment station. The operational data may for example include at least one of the following: battery information indicative of the vehicle's battery and/or battery replenishment plan for servicing the battery. In the later case the battery replenishment plan is determined in accordance with the battery information and may include operational data for charging a battery of the vehicle and/or operational data for replacing the battery of the vehicle. In this connection it should be noted that according to some embodiments of the invention the system (e.g. the processing utility) may be also adapted to determine whether the user is authorized to receive power replenishment service for the respective vehicle.

According to another broad aspect of the present invention there is provided a method for use in servicing of electric vehicles. The method includes: receiving and processing user request data from at least one power replenishment service station for identifying therein user data indicative of a user requesting power replenishment service(s); receiving and processing data from control systems of vehicles for identifying certain data including at least specific vehicle data; and processing the user data and the at least specific vehicle data and identifying the respective vehicle located

at the power replenishment service station. Then data indicative of the respective vehicle is generated to thereby enable management of services to be provided to the respective vehicle.

According to some embodiments of the method of the present invention the certain data obtained from control systems of a vehicle includes associated user data indicative of a user using the vehicle. Alternatively or additionally the method includes: identifying a list of a plurality of vehicles associated with the user based on identification of the user requesting power replenishment service(s); obtaining one or more factors associated with at least one of a vehicle to be serviced and the user; and utilizing the one or more factors to determine which respective vehicle of the plurality of vehicles in the list is located adjacent to the power replenishment station. Specifically the one or more factors may be utilized to filter the lists and thereby determine a match between one of the vehicles in the list and the user. The one or more factors may for example include one or more of the following: a charge event received from the vehicle adjacent to the power replenishment service station, a vehicle usage history associated with the user, battery service history associated with the user, and location of the vehicle.

In this connection the method step of identifying the respective vehicle which is located adjacent to the power replenishment station (e.g. which is associated with the user) may include at least one of the following:

- matching vehicle associated user data indicative of a user using the vehicle with the user data,
- providing a list of a plurality of vehicles associated with the user and filtering the list by utilizing one or more factors associated with at least one of the vehicle and the user.

According to some embodiments the method of the present invention includes at least one of the following procedures are performed for receiving at least one of the user data, the vehicle-data and/or one or more factors associated with at least one of the vehicle and the user:

- communicating with a user device for receiving therefrom said user-data.
- communicating with the control system of the vehicle for receiving therefrom the vehicle-data.
- communicating with the control system of the vehicle for receiving the user-data.

- obtaining, from at least one of a user device and a control system of the vehicle, corresponding vehicle associated data including at least one of the following: the vehicle data, a vehicle associated user data indicative of a user using the vehicle, and the one or more factors.

According to some embodiments the method further includes utilizing the vehicle data and determining corresponding operative data for power replenishment of the vehicle. In this connection the method may include identifying battery information of the respective vehicle and communicating operational data for servicing the battery to the certain power replenishment station. The operational data may for example be determined in accordance with the battery information. The operational data may include a battery replenishment plan for performing at least one of the following: charging a battery of the vehicle, and replacing the battery of the vehicle. In some case the method also includes determining/verifying whether the user is authorized to receive power replenishment service for the respective vehicle. Only after determining that the user is entitled to such services, the operational data is provided to the power replenishment service station.

It should be understood that although such utilities as NFC card and GPS might be used for the purposes of the invention, the invention does not need any processing of combined GPS and NFC data, but rather utilizes a match between the user identity embodied in the NFC card, the EV identity stored in the in-vehicle system and the charge pole at the service station. This matching may be achieved by indirect communication between these elements with mediation of a mobile handset.

It should also be understood that the system according to the invention may be a suitably programmed computer. Likewise, the invention contemplates a computer program being readable by a computer for executing one or more of the methods of the invention which are described above and further described in detail below. The invention further contemplates a machine-readable memory tangibly embodying a program of instructions executable by the machine for executing one or more methods of the invention. Accordingly the service system of the present invention may be implemented utilizing computer system capable of communicating with at least one power replenishment service station and with control systems installed in/carried by electric vehicles. The service system may be located at the control center connectable to multiple remote power replenishment service stations via a network, or may be located

at the specific power replenishment service station, or the utilities of the service system may be distributed between the power replenishment service stations and control center.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the disclosure and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 illustrates an electric vehicle network.

Fig. 2 is a high-level block diagram illustrating an exemplary distributed computer system in accordance with some embodiments.

Fig. 3 is a block diagram illustrating a command center system in accordance with some embodiments.

Fig. 4 is a flow diagram illustrating a method of identifying a vehicle adjacent to a battery service system in accordance with some embodiments.

Fig. 5 is a block diagram illustrating information used in identifying a vehicle adjacent to a battery service system in accordance with some embodiments.

Fig. 6 is a schematic illustration of a power replenishment network according to the invention including a control center and service stations.

Fig. 7A is a flow diagram illustrating an embodiment of a method, to be carried out by a control center of a power replenishment network, for identification of a vehicle to be serviced by a service station.

Fig. 7B is a flow diagram illustrating an embodiment of a method, to be carried out by an EV control system, to allow EV identification at a service station.

Fig. 7C is a flow diagram illustrating an embodiment of a method, to be carried out by the service station to allow identification of the EV and obtain operative data to service the vehicle.

For clarity, elements having common or similar functions or purposes may be indicated with the same reference numerals in the figures.

DETAILED DESCRIPTION OF EMBODIMENTS

Methods and systems for identifying electric vehicles adjacent to battery service systems are described. Reference will be made to certain embodiments of the invention, examples of which are illustrated in the accompanying drawings.

In the following description, numerous specific details are set forth to provide a thorough understanding of the present invention. However, it will be apparent to one of ordinary skill in the art that the invention may be practiced without these particular details. In other instances, methods, procedures, components, and networks that are well-known to those of ordinary skill in the art are not described in detail to avoid obscuring aspects of the present invention.

The terminology used in the description of the embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used in the description of the invention and the appended claims, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Fig. 1 illustrates an electric vehicle service system/network 100, according to some embodiments of the present invention. The electric vehicle service system **100** is associated with one or more vehicles (e.g. vehicle **102**) which are in turn associated with one or more battery packs (e.g. battery pack **104**) configured to be mounted to the vehicles. In some embodiments, the battery pack **104** is removably mounted to the vehicle **102.** Also, in some embodiments, the battery pack **104** includes any device capable of storing electric energy such as batteries (e.g., lithium ion batteries, lead-acid batteries, nickel-metal hydride batteries, etc.), capacitors, reaction cells (e.g., Zn-air cell), etc. In some embodiments, the battery pack **104** comprises a plurality of individual batteries or battery cells/chemical modules. In some embodiments, the battery pack **104** also comprises cooling mechanisms, as well as mechanical and

electrical connectors for connecting to the vehicle **102** or the battery pack **104** to various elements of power replenishment service stations **120.**

The electric vehicle service system/network **100** may be implemented as a computerized system capable of communicating via a communication network(s) with one or more power replenishment service stations (e.g., with control-systems/controllers thereof) and with control–systems (e.g. onboard computers) installed in/carried by electric vehicles.

As noted above, due to communication deficiencies in the existing standards for EV charging, accurate and reliable techniques for identification of an EV adjacent to a charging pole are lacking. For reasons described above, existing techniques for vehicle identification may fail to provide accurate and reliable results when used at charging poles, particularly when the poles are located at close proximity to one another. The present invention solves this problem by providing an accurate and reliable EV identification technique which may be used by any type of service stations including battery charging stations (e.g. charging poles). To this end, the service system **100** is configured for identification of EVs in the vicinity of service stations, enabling servicing of the respective vehicles.

The electric vehicle service system **100** may be associated with (e.g. located at) a central station (termed here interchangeably as *command center system* or *control center*) **110** connectable to multiple remote power replenishment service stations via a communication network, or it may be associated with (e.g. located at) the specific power replenishment service station **120,** or the utilities of the service system **100** may be distributed between the power replenishment service stations **120** and the control center **110.** It is noted that the terms *power replenishment service station* and *battery service station* are used here interchangeably for referring to any power replenishment facilities for electric vehicles including, but not limited to, battery exchange stations/systems **134** and battery charge stations/poles **132.** A battery service station includes one or more *power replenishment systems*. As used herein the term "*power replenishment system*" refers to a charging pole and/or battery exchange system of the power replenishment service stations. In some embodiments, these components of the service system **100** are connected to related power and data networks, as explained in more detail in U.S. Patent Application No. 12/234,591, filed September 19, 2008,

entitled Electronic Vehicle Network, the disclosure of which is incorporated herein by reference.

In some embodiments, the vehicle **102** (also called herein an electric vehicle) includes an electric motor **103** that drives one or more wheels of the vehicle. In some embodiments, the electric vehicle **102** may be a hybrid vehicle e.g. also including a gas-powered engine, which may be used to drive one or more wheels of the vehicle independently or in conjunction with the electric motor **103.** In these embodiments, the electric motor **103** receives energy from the battery pack **104** (shown separate from the vehicle for ease of explanation).

The battery pack **104** of the vehicle **102** may be charged at a home **130** of a user **105** or at one or more battery charge stations/poles **132.** For example, a charge station **132** may be located in a shopping center parking lot. The charge stations **132** provide energy to charge the battery pack **104** while it is coupled to the vehicle **102.** A respective charge station **132** may include one or more charging poles (e.g., **132-1** and **132-2**). A charging pole includes an electrical system configured for charging the battery of a respective electric vehicle.

Furthermore, in some embodiments, the battery pack **104** of the vehicle **102** can be exchanged for a charged battery pack at one or more battery exchange stations **134.** Thus, the spent (or partially spent) battery can be exchanged for a charged battery so that the user can continue with his/her travels without waiting for the battery to be recharged. The battery exchange stations **134** are service stations where a user can exchange spent (or partially spent) battery packs **104** of the vehicle **102** for charged battery packs **104.** A respective battery exchange station **134** includes one or more battery exchange systems. A respective battery exchange system includes a mechanical system configured for exchanging batteries for a respective electric vehicle.

In some embodiments, the power replenishment service station **120** (e.g. battery exchange stations **134,** charge station **132,** and/or charging poles **132-1** and **132-2**) may include a user identification module **122** which is capable of obtaining/receiving user identification data (also referred to herein as **UID**). The user identification module **122** may be configured and operable for receiving user-data **UID** via communication with a user (handheld) device **121** such as an RFID/NFC card/unit or a mobile device, cellular phone and the like. For example here the charging poles **132-1** and **132-2** each includes a near-field communication reader (e.g., **133-1** or **133-2**) that is configured to receive

user identification from a near-field communication device (e.g., a transmitter) carried by the user **105.** The user data **UID** may be embedded in an NFC module or other communication module/card of the user's device (e.g. user data may be hard coded data). Alternatively or additionally, user authentication/validation protocol may be executed over communication established between the user identification module **122** and the user device **121.** Such protocols may be used for example in order to prevent fraud and/or ambiguous user identifications. The user-data **UID** is generally indicative of a user seeking battery replenishment services (e.g. battery exchange and/or charging) from the service station **120,** or in other words, user-data **UID** presents or is a part of a user request data for power (battery) replenishment services. Such user request data may further include identifying information or a network address of the respective battery service station/system.

The vehicle **102** is described herein as located adjacent to a power replenishment system when the vehicle **102** is positioned for receiving a battery service from a power replenishment system. For example, the vehicle **102** may be located proximate from a charging pole (typically within reach of a charging cable) when the vehicle is located adjacent to the charging pole. Alternatively, the vehicle **102** may be located on a battery exchange system when the vehicle **102** is located adjacent to the battery exchange system.

In some embodiments, the power replenishment stations/systems are connected to a command center system **110** via communications network **150.** An exemplary distributed computer system corresponding to the electric vehicle service system **100** is described with respect to **Fig. 2.**

Fig. 2 is a high-level block diagram illustrating an exemplary distributed computer system **200** in accordance with some embodiments. System **200** includes one or more electric vehicles **102,** one or more power replenishment systems/stations **120** (e.g., the battery charge station **132** and/or the battery exchange station **134** in Fig. **1**), a communications network **150,** and a command center system **110.** The one or more electric vehicles **102** and the one or more power replenishment systems **120** are connected to the command center system **110** via the communications network **150.** Typically, a plurality of electric vehicles **102** and a plurality of power replenishment systems **120** are associated with the system **200.** In some embodiments, multiple power replenishment systems **120** are located in proximity to one another (e.g., multiple

charging poles at a charge station **132)**. Various embodiments of the command center system **110** implement the methods described in this document.

The command center system **110** may include one or more servers/communication modules connected to communications network **150.** Optionally, the one or more servers are connected to the communications network **150** via a front end server (not shown). In some embodiments, the front end server conveys (and optionally parses) inbound requests to the appropriate server of the command center system **110,** and formats responses and/or other information being sent to other servers or power replenishment systems **120** in response to requests. In some embodiments, the front end server conveys information between the vehicle and the command center system **110**. Such information may include inbound information such as vehicle related data which may be indicative for example of the vehicle's identification, the current user of the vehicle and/or the vehicle's position.

The command center system **110** typically includes one or more applications and one or more databases for managing operations of the power replenishment systems **120.** For example, power replenishment systems **120** may be configured for use by registered users who currently subscribe to respective battery service plans (for charging or exchanging the batteries). When a respective user of a respective electric vehicle **102** requests a service at a respective power replenishment system **120,** the command center system **110** may be asked to confirm whether the requesting user currently is authorized for the service. For example, the command center system **110** may be asked to confirm whether the requesting user subscribes to a battery service plan. Furthermore, in some cases, the battery service plan may have certain restrictions on the battery service (e.g., a total number of battery exchanges per month, total energy to be used in charging the battery, remaining account balance, etc.). In such cases, the command center system **110** may be asked to confirm whether the requesting user can receive the requested service in accordance with his or her battery service plan. Based on the determination, the requesting user may be allowed or denied the requested service, or may be prompted to upgrade his or her battery service plan.

The command center system **110** typically includes a vehicle identification application **118** (e.g. vehicle locator module) for identifying an electric vehicle associated with the requesting user, which is described in detail with respect to Fig. **3.**

Fig. 3 is a block diagram illustrating the command center system **110,** in accordance with some embodiments. The command center system **110** typically includes one or more processing units (also called CPUs, microprocessors, or processors) **302,** memory **304,** one or more network or other communications interfaces/modules **306,** and one or more communication buses **308** for interconnecting these components. In some embodiments, the communication buses **308** include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. In some other embodiments, the command center system **110** includes a user interface (not shown) (e.g., a user interface having a display device, a keyboard, and a mouse or other pointing device), but more typically the command center system **110** is controlled from and accessed by various client systems (e.g., a desktop, a laptop, a portable computer, etc.).

Memory **304** of the command center system **110** may include high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and may include non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory **304** may optionally include one or more storage devices remotely located from the CPU(s) **302.** Memory **304,** or alternately the non-volatile memory device(s) within memory **304,** comprises a non-transitory computer readable storage medium for storing information. In some embodiments, memory **304** or the computer readable storage medium of memory **304** stores the following programs, modules and data structures, or a subset thereof:

- Operating System **310** that includes procedures for handling various basic system services and for performing hardware dependent tasks;
- Network Communication Module (or instructions) **312** that is used for connecting the command center system **110** to other computers (e.g., computers in electric vehicles **102** and/or computers in power replenishment systems **120)** via one or more communications interfaces **306** and one or more communications networks **150** (Fig. **2),** such as the Internet, other wide area networks, local area networks, metropolitan area networks, wireless communication networks (including cellular networks), and so on;

- Application modules **314** typically include a plurality of programs/modules used for managing the command center system **110.** Such modules may include for example vehicle identification application **118** (e.g. vehicle locator module) as well as other application(s) **322** (e.g. battery information application/module); and

- Database module(s) **350** which may include: User Account Database **324** including information about user accounts and associated information; and/or user-location database associating some of the users with specific locations they are known to be at (e.g. users located the service stations and/or users currently utilizing one or more vehicles); and/or battery information data storage associating batteries with EV's and/or storing battery information for the batteries.

The vehicle identification application (vehicle location module) **118** is configured for identifying a respective electrical vehicle located adjacent to a respective power replenishment system. The vehicle identification application **118** (e.g. vehicle locator module) may include the following interfaces, modules, programs, and data structures, or a subset or superset thereof:

- Database Interface **316** that assists searching, retrieving, storing, and/or updating data stored in one or more databases **350** (e.g., the user account database **324**); and

- Identification Module **318** that identifies the respective electrical vehicle located adjacent to the respective power replenishment system in accordance with various inputs (e.g., user identification information).

In some embodiments, the identification module **318** includes a comparator **320** that is configured to compare information received from a respective electric vehicle **102** and data retrieved from at least one of the user account database **324** and the user-location database.

Other applications **322** of the command center system **110** include applications used for managing the command center system **110,** e.g., applications (or instructions) for creating a respective account (e.g. user account), presenting information for the respective account, updating the balance of the respective account (e.g., posting charges and/or credits), archiving account information, etc.

The user account database **324** includes user account information, for example a list of user identifications **326** corresponding to registered users of the electric vehicle service system **100** (Fig. **1**). For example, the registered users of the electric vehicle service system **100** subscribe to respective battery service plans. The user account database **324** may include account information **327**, which includes information about respective users' battery service plans (e.g., account type, remaining balances, remaining numbers of charges or exchanges, expiration dates, etc.). The user account database **324** typically includes a list of vehicles **328** associated with each user. It is common for a single user to be associated with multiple vehicles (e.g., a member of a family that has two or more vehicles, an employee who has access to a company vehicle and a personal vehicle, a user who has access to his/her own vehicle and also to his/her friend's vehicle, a driver who frequently rents cars, etc.).

In some embodiments, the user account database **324** also includes battery information **330** that identifies a respective battery currently associated with each vehicle in the list of associated vehicles **328.** The battery information **330** may include various information regarding respective batteries (e.g., type, age, charge history, temperature history, etc.). If the vehicle includes a removable battery, the identity of the battery will change over time. Alternatively or additionally in some embodiments of the present invention, battery information as well as data associating batteries with respective vehicles at which they are presently installed, may be stored in a separate data base (e.g. or battery information data storage). Utilizing such a separate battery information data base may be advantageous specifically in cases where a service provider owns and/or manages the allocation of batteries to vehicles of different users.

In some embodiments, the user account database **324** includes vehicle usage history **332** that identifies vehicles used by a respective user during a predefined time period. In some embodiments, the user account database **324** includes battery service history **334** that identifies charges or battery exchanges the respective user has requested during a predefined time period. The battery service history **334** typically identifies time, vehicle identification (e.g., a vehicle identification number), and information regarding one or more batteries (e.g., charge history, recommended voltage and current for charging the batteries, a size of the battery, etc.) for which service has been requested by the respective user.

The command center system **110** communicates with one or more databases internal to the command center system **110,** such as the user account database **324** using a local area network, by internal communication busses, or by any other appropriate mechanism or combination of mechanisms.

It should be noted that in some embodiments, fewer and/or additional modules, functions or databases are included in the command center system **110.** The modules shown in the command center system **110** represent functions performed in certain embodiments.

Each of the above identified modules and applications correspond to a set of one or more instructions for performing one or more functions described above. These modules need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, memory **304** may store a subset of the modules and data structures identified above. Furthermore, memory **304** may store additional modules and data structures not described above.

Notwithstanding the discrete blocks in Figs. **2** and **3,** these figures are intended to be a functional description of some embodiments rather than a structural description of functional elements in the embodiments. One of ordinary skill in the art will recognize that an actual implementation might have the functional elements grouped or split among various components. In practice, and as recognized by those of ordinary skill in the art, items shown separately could be combined and some items could be separated. For example, in some embodiments, the user account database **324** may be split into two separate databases (e.g., a user identification database that includes user identifications and associated vehicles and a history database that includes the vehicles usage history and/or the battery service history).

The number of processors and/or servers used to implement the command center system **110** and how features are allocated among them will vary from one implementation to another, and may depend in part on the amount of data stored by the command center system **110,** and may also depend on the amount of data traffic that the system must handle during peak usage periods as well as during average usage periods. Moreover, one or more of the blocks (e.g., command center system **110,** vehicle identification application **118,** etc.) in **Fig. 2** may be implemented on one or more servers designed to provide the described functionality. Although the description herein

refers to certain features implemented in the command center system **110** and certain features implemented in the power replenishment system **120,** the embodiments are not limited to such distinctions. For example, features described herein as being part of the command center system **110** can be implemented in whole or in part in the power replenishment system **120,** and vice versa.

Fig. 4 is a flow diagram illustrating a method of identifying a vehicle adjacent to a power replenishment system in accordance with some embodiments. In particular, **Fig. 4** illustrates respective operations performed by a power replenishment system/station **120**, the command center system **110,** and a vehicle **102.** The command center system **110** is typically located remotely from the electric vehicle **102.** The command center system **110** may be remotely located from the power replenishment system **120** or it may in some cases reside at one or more of the service stations (e.g. residing at one of them or distributed between some of them). For example, the command center system **110** may be located at a control center that is remote and distinct from the battery service station that has the power replenishment system **120.**

According to some embodiments of the present invention the command center system **110** is capable of obtaining information indicative of the identity users seeking battery replenishment services in association with the respective power replenishment systems **120** from which such services are respectively sought by the users**.** To this end, command center system **110** may obtain data associating users with service-stations indicating the current or expected locations at which power replenishments are required for the users' vehicles. In some embodiments further described below, the user-service–station data may be stored in a user-location database. In this connection, in various embodiments of the present invention such user- service–station data is obtained/received at the command center from the service stations (e.g. from the power replenishment systems **120**) or alternatively or additionally such data may be received directly from the users (e.g. from a communication devices of the users).

For example according to some embodiments, the power replenishment system **120** receives (**402**) user identification (the "user ID") of a user. The user ID may comprise a user name (e.g., a full name, code name, nickname, or a pseudo-name) or code (e.g., numbers, alphabets, binary codes, or a combination thereof, etc.) that uniquely identifies the user. In some embodiments, the power replenishment system receives the user identification information from a RFID tag, which may be included in,

or attached to, a key fob or a card (e.g., a credit card or an identification card) of the user. Alternatively, any other device or item that includes any other near field communication (NFC) tag or transmitter may be used. In some embodiments, the power replenishment system **120** receives the user identification from a mobile phone device associated with the user, such as via Bluetooth. In some embodiments, the mobile phone device may send the user identification to the power replenishment system via a short message service (SMS), email, dedicated application etc. Then, having received the user identification, the power replenishment system **120** sends (**404**) the user identification to the command center system **110.** The user identification may be sent from the power replenishment system **120** to the command center system **110** via the communication network(s) **150** (Fig. **2**). The command center system **110** receives (**406**) the user identification of the user from the power replenishment system **120** e.g. together with certain data indicating/identifying the service-station/power-replenishment-system from which the user identification is sent (e.g. such data may be the network address of the power-replenishment-system or other identifier thereof). Accordingly, the command center system **110** obtains user-service–station data associating the particular user with a particular service-station/power-replenishment-system.

Alternatively or additionally, in some embodiments, the user may utilize a communication device (such as a mobile phone) to type in identification information of the power-replenishment-system from which he seeks power replenishment services for his vehicle (e.g., the user may enter the charge pole identification number in his mobile phone) and send the power-replenishment-system identification information, together with user identification information, to the command center system **110.** Accordingly, the command center system **110** obtains the user-service–station data directly from the user (e.g. from a communication device associated therewith). Thus the command center system **110** is capable of associating the particular user with a particular service-station/power-replenishment-system. It should be understood that the user identification may in this case be a data piece stored in the communication-device/mobile-phone of the user or it may be associated with other data pieces associated with the user's communication device (e.g. the phone number may serve as a user identification data). In some embodiments, the mobile phone device may send the user identification information and/or the power-replenishment-system identification information, directly to the command center system **110** without sending the user identification to the power

replenishment system **120.** The data may be sent from the user's communication-device via a short message service (SMS), email, dedicated application, etc.

In some embodiments, the power replenishment system **120** initiates (**408**) a battery service. For example, the power replenishment system **120** may include a charging pole, and the vehicle **102** may be electrically coupled with the charging pole (e.g., a charge plug from the charging pole is plugged into the vehicle **102**). The charging pole may send an electric input to the vehicle **102** for determining that the vehicle **102** is electrically coupled with the charging pole. In some embodiments, the vehicle **102** detects (**410**) the electric input from the charging pole as an initiation of the battery service. In some embodiments, the electric input from the charging pole may initially comprise a small test charge (e.g., in order to indicate initiation of the battery service to the vehicle **102**). In some embodiments, the test charge may be used to determine the type of a battery in the vehicle adjacent to the power replenishment system. Therefore, initiating the battery service may include sending the small test charge, but in some embodiments, initiating the battery service does not in fact charge the battery in the vehicle until the operation **426** is performed as described below.

In some embodiments, the vehicle **102** sends (**412**) vehicle information to the command center system **110.** The vehicle information may include data identifying the vehicle. The vehicle information may include a charge event, which indicates that the vehicle is electrically coupled with the power replenishment system **120.** However, the vehicle information typically does not identify the power replenishment system **120** with which the vehicle **102** is coupled. In some embodiments, the charge event indicates that a battery service (e.g., charging) has initiated for the vehicle **102.**

In some embodiments, the vehicle information sent at **412** includes additional data including a location of the vehicle **102.** When a global positioning system (GPS) receiver is included in the vehicle **102,** the GPS receiver may be used to determine the location of the vehicle **102** (typically expressed as GPS coordinates). Although the GPS coordinates can be used to narrow down a list of potential power replenishment systems, it might be difficult to identify a power replenishment system located adjacent to (e.g., closest to) the vehicle **102** based on the GPS coordinates alone, especially when there are multiple power replenishment systems located in the proximity (e.g., a charge station with multiple closely-located charging poles). The command center system **110**

receives (**414**) the vehicle information from the vehicle **102** (over the communication networks(s) **150,** typically over one or more wireless communication networks).

In some embodiments, the vehicle information sent at **412** includes data identifying the vehicle **102** as well as additional data identifying the user **105** of the vehicle (e.g. the current user of the vehicle and/or a list of one or more users associated with the vehicle). In this regard it is noted that the vehicle **102** may be equipped with a control system (e.g. an onboard computer) adapted for storing information regarding the vehicle's user(s). For example the onboard computer may store information indicative of identities of multiple users which may be associated with using the vehicle **102,** or the onboard computer may be adapted for communicating with the present user of the vehicle (e.g. with a communication device thereof such as a mobile phone or NFC card) for receiving therefrom data identifying the user. The vehicle information, including the data identifying the user **105,** is then sent at **412** from the vehicle's onboard computer. The command center system **110** receives (**414**) the vehicle information from the vehicle **102** and is thus accordingly capable of associating the vehicle **102** with one or more users (typically with one user **105** being the current user who utilizes the vehicle and seeks power replenishment services).

In some embodiments, the power replenishment system **120** sends (**416**) additional information, such as a location of the power replenishment system **120** and/or a power replenishment system identifier that uniquely identifies the power replenishment system **120.** In some embodiments, the additional information includes the charge event. Therefore, in some embodiments, the charge event received from the power replenishment system **120** and the charge event received from the vehicle **102** may be used to determine that the vehicle **102** is located adjacent to the power replenishment system **120.** The command center system **110** receives (**418**) the additional information from the power replenishment system **120.**

The command center system **110** identifies (**420**) the one or more vehicles associated with the user (and/or the user ID of the user). For example, the command center system **110** may retrieve the list of one or more vehicles associated with the user (e.g. associated with the particular user which identity is received at **406** from the service station). The list of one or more vehicles may be retrieved for example from the user account database **324** (Fig. **3**). The command center system **110** may retrieve additional information from the user account database **324** (e.g., the vehicle usage

history **332,** current battery installed in each identified vehicle, and/or battery service history **334**).

Alternatively or additionally, the command center system **110** identifies (**420**) a list of one or more users which are respectively associated with the vehicle **102.** For example, this may be based on the additional information which is sent from the vehicle **102** and which may include the list of one or more users of the vehicle or the identity of the current user of the vehicle. Alternatively or additionally, this may be based on information sent from a communication device of the user **105** which, as noted above, may include identification data indicative of the vehicle **102** currently used by the user **105.** Thus, a match between a particular vehicle **102** and a particular power replenishment system **120,** to which the vehicle is adjacent, is accomplished according to the present invention by utilizing the user identification data received in **406** in association with a user seeking service from the particular power replenishment system **120,** the vehicle info/data which is received in **414** for identifying the vehicle, and the additional information/data received in **416.** As noted above, the additional data may be received from the communication device of the user and/or from the vehicle (e.g. from its on-board computer). The additional data may include data indicative of any one or more of the following: location of the particular vehicle (e.g. its GPS location), the identity of the user currently using the vehicle, a list of users associated with the vehicle, a charge event received from the vehicle and/or from the power replenishment system. The command center system **110** may also utilize one or more data storage systems (e.g. databases) associated therewith for storing said additional data and/or for retrieving therefrom yet further additional data relating users with their respective vehicles associated therewith (for example for retrieving a list of vehicles associated with a particular user and/or for retrieving a list of users associated with a particular vehicle. The further additional data may be used to improve the matching (e.g. the accuracy of the matching and/or the speed of the matching process) relating users seeking power replenishment services from particular power replenishment service stations/systems with their respective vehicles which are to be serviced.

For example, **Fig. 5** illustrates the identifying/matching operation carried out by the command center system **110** in some embodiments of the present invention, for determining which respective vehicle of the plurality (if more than one) of vehicles associated with the user is located adjacent to the power replenishment system. In other

words, the command center system **110** identifies/matches (**422**) the vehicle adjacent to the power replenishment system.

Once the vehicle located adjacent to the power replenishment system **120** (and/or a battery currently carried by the vehicle located adjacent to the power replenishment system **120**) is identified, the command center system **110** may send (**424**) one or more battery service instructions corresponding to the respective vehicle determined to be located adjacent to the power replenishment system **120.** In some embodiments, prior to sending the one or more battery service instructions (e.g., the battery information **330,** Fig. **3**), the command center system **110** identifies battery information for the respective vehicle that is determined to be located adjacent to the power replenishment system **120.**

In some embodiments, the power replenishment system **120** is a charging pole, and the one or more battery service instructions represent instructions for charging a battery of the respective vehicle in accordance with the identified battery information (e.g., recommended charging voltage and/or current, battery capacity, etc.).

In some embodiments, the power replenishment system **120** is a battery exchange system, and the one or more battery service instructions represent instructions for exchanging a battery of the respective vehicle in accordance with the identified battery information (e.g., battery size and capacity, etc.).

Fig. 5 is a block diagram illustrating information used in identifying the vehicle located adjacent to the power replenishment system in accordance with some embodiments. In particular, the command center system **110** determines which respective vehicle of the plurality of vehicles associated with the user is located adjacent to the power replenishment system based on the list of one or more vehicles associated with the user and one or more other factors (additional information/data).

In some embodiments, the one or more other factors include the charge event **430** received from the vehicle **102** (e.g., in the operation **412, Fig. 4)** and/or the power replenishment system **120** (e.g., a charge pole). The command center system **110** determines, among a plurality of vehicles associated with the user, a vehicle that recently sent the charge event as the vehicle adjacent to the power replenishment system **120.** In some embodiments, the charge event sent by the power replenishment system **120** is used to match the charge event sent by the vehicle **102.** In some embodiments, the charge event needs to be received within a predefined time window (e.g., three

minutes) from receiving the user ID in order to avoid erroneous identification of the vehicle (e.g., if the user first connects to one charge pole and then to another charge pole, or if the user connects to one charge pole and his/her spouse connects to another adjacent charge pole).

In some embodiments, the one or more other factors include vehicle usage history **432.** For example, the command center system **110** identifies, among the plurality of vehicles associated with the user, a vehicle that is most frequently used by the user, and determines that the vehicle most frequently used by the user is the vehicle **102** located adjacent to the power replenishment system **120.** In some embodiments, the command center system **110** determines that the vehicle most frequently used by the user around the location of the power replenishment system **120** is the vehicle **102** located adjacent to the power replenishment system **120.**

In some embodiments, the command center system **110** determines among the plurality of vehicles associated with the user, a vehicle that is most frequently used by the user at times corresponding to a current time period. The command center system **110** typically identifies the current time period **438** (e.g., current time and/or a day of the week). For example, the command center system **110** identifies the current time period (**7** pm on Monday); accesses the vehicle usage history to generate a list of one or more vehicles used at times corresponding to the current time period (**7** pm on Mondays) during a predefined time period (e.g., past two months); and determines that a vehicle most frequently used at times corresponding to the current time period is the vehicle located adjacent to the power replenishment system **120.** This assumes that the user drives the same vehicle at a same time each week.

In some embodiments, the one or more other factors include battery service history **434.** In one example, the command center system **110** accesses the battery service history to generate a list of one or more vehicles that are serviced most frequently by the power replenishment system **120** (e.g., based on the location and/or the power replenishment system identifier) during a predefined time period (e.g., past two months), and determines that the vehicle most frequently serviced by the power replenishment system **120** is the vehicle located adjacent to the power replenishment system **120.** Alternatively, the command center system **110** may determine that the vehicle most frequently serviced by a predefined group of power replenishment systems **120** (e.g., power replenishment systems located at the battery service station at which

the specific power replenishment system **120** is located and/or from which the user request for service had been received) is the vehicle located adjacent to the power replenishment system **120.** This assumes that the user services the same vehicle with the same power replenishment system or at the same battery service station.

In some embodiments, the one or more other factors include (**436**) a location of the power replenishment system **120** and a location of the vehicle **102.** As explained previously, it is typically difficult to identify the vehicle located adjacent to the power replenishment system **120** that is located proximate to a plurality of other power replenishment systems solely based on the location of the vehicle **102** and the location of the power replenishment system **120.** Therefore, the location of the power replenishment system **120** and the location of the vehicle **102** are typically used in conjunction with at least one of the other factors (e.g., the charge event **430,** the vehicle usage history **432,** the battery service history **434,** and the location of the power replenishment system and the location of the electric vehicle **436**). However, in some embodiments, the one or more other factors may include the location of the power replenishment system **120** and the location of the vehicle **102** without any other factor. In some embodiments, the command center system **110** uses a last reported location of the vehicle.

In some embodiments, the command center system **110** determines which respective electric vehicle of the plurality of electric vehicles associated with the user is located adjacent to the power replenishment system **120** based on a plurality (e.g., three or more) of the factors. In general, combining additional factors improves the accuracy of the system. In some embodiments, the command center system **110** determines which respective electric vehicle of the plurality of electric vehicles associated with the user is located adjacent to the power replenishment system **120** based on a probability function of a plurality (e.g., three or more) of the factors (e.g., the charge event **430,** the vehicle usage history **432,** the battery service history **434,** and the location of the power replenishment system and the location of the electric vehicle **436**). In some embodiments, the probability function has multiple probability terms, each corresponding to a respective factor. Each probability term in the probability function is weighed by a respective weight.

In some embodiments, the command center system **110** receives user feedback from the power replenishment system **120,** which indicates that the command center

system **110** has accurately determined the vehicle located adjacent to the power replenishment system **120.** In accordance with the user feedback, the command center system **110** may adjust the respective weights of the probability function.

Fig. 6 is a schematic illustration of an electric vehicle service system/network **100** according to another embodiment of the invention. The service system **100** may be implemented as computer system capable of communicating, via a communication network, with power replenishment service stations (four such service stations **120, 120', 120'', 120'''** are shown in the figure) and with control systems **160** installed in/ carried by electric vehicles (not specifically shown). The service system **100** is configured for identification of EVs in the vicinity of service stations, enabling servicing of the respective vehicles.

Here, the electric vehicle service system **100** is responsive to user data (e.g. user request data) received from the power replenishment service station **120** (e.g. charging pole or battery exchange station), and is also responsive to vehicle data received from the control system **160** the EV **120,** and is further responsive to additional data. The additional data may include one or more factors associated with at least one of the users requesting service of at the service station **120** and the vehicle of the user. For example, as noted above, the one or more factors may include vehicle related user data indicative of the identity of the current user of the vehicle (i.e. vehicle related user data) and/or vehicle position data which may indicate the current location of the vehicle or the route of the vehicle. The one or more factors, such as vehicle related user data or vehicle position data, may for example be received from the vehicle's control system **160** or from another source.

The electric vehicle service system **100** operates to process these data pieces (e.g. the user request data, the vehicle data and the additional data) to identify the respective EV located at the service station **120** and to thereby enable/facilitate management of service provision to said vehicle. In this connection the system **100** includes a command center system (i.e. control center) **110** connectable to multiple power replenishment service stations **120** (e.g. via a communication network). The command center system may also reside at one of the service stations **120,** or be distributed between them.

In the specific not limiting example of **Fig. 6,** the service system **100** presents a so-called electric vehicle service network including at least one service station **120** (e.g.

service station control system) and a control center **110** which is capable of communicating with the at least one service station **120.** As noted above, the control center **110** as well as control systems of the service stations **120** may be implemented by utilizing computer systems including *inter alia* one or more processors and memory storing one or more programs/applications for execution by the one or more processors. The one or more programs may include instructions for carrying out methods according to the invention for identifying an EV in the vicinity of the service station. In some embodiments of the present invention, the service stations, or at least some of them, also include one or more processors for executing programmatic instructions as will be exemplified further below.

Service station control system **120** includes a replenishment controller (control system) **124** that is associated with a battery replenishment machinery/circuitry **170** and is configured and operable for operating the battery replenishment machinery/circuitry **170** in accordance with a desired replenishment scheme. A battery replenishment machinery/circuitry **170** may include, for example, a charging pole for charging an EV battery and/or it may include a battery exchange system capable of replacing an EV battery.

In the embodiment of **Fig. 6** the electric vehicle service system **100** is configured and operable for determining a desired replenishment scheme of a user's EV, the service station **120** (e.g. the control system **124** thereof) includes a user identification module **122** and a control center communication module **126** connectable thereto. Communication module **126** is adapted for communicating with the control center associated with the service station. The user identification module **122** is adapted for obtaining user's identification data, which is transmitted to the control center through the communication module **126.**

The communication module **126** communicates the user-data **UID** (e.g. being data indicative of user request for power replenishment service(s) from the service station **120**) to the control center **110.** The data user-data **UID** may be communicated to the control center **110** together with identifying information or a network address of the service station **120.** The communication module **126** receives from the control center **110** in response, operational data **OPD** indicative of power replenishment service to be provided by the service station. More specifically, the operational data **OPD** may be indicative of the type of battery replenishment to be provided to an electric vehicle

associated with the user. Operational data **OPD** may, for example, include operative replenishment instructions/plan **ORI** or it may include indicative data from which such instructions can be obtained/determined.

Replenishment controller **124** is adapted to receive the operative replenishment instructions **ORI** from the communication module **126** and generate operative data to operate a battery replenishment machinery/circuitry **170** associated with the service station **120** to replenish the EV battery in accordance with a replenishment scheme indicated by the operative replenishment instructions **ORI.**

As indicative above, the operational data **OPD** may include operative replenishment instructions **ORI**. Alternatively or additionally, operational data **OPD** may include battery information data **BID** and possibly also data **EUD** indicative of the user's profile and/or EV usage from which such operative replenishment instructions **ORI** can be determined.

In various embodiments of the invention, the operative replenishment instructions **ORI** are determined by a replenishment processing module **128** that is associated with either one of the control center **110** or the service station **120,** or with both of them. Generally, the replenishment processing module **128** utilizes battery information data **BID** to determine one or more preferred battery replenishment schemes. To this end, replenishment processing module **128** may also utilize data indicative of the type of the service station **120** (e.g. being a charging pole or a battery exchange station) and/or data indicative of possible replenishment schemes which are available at the service station **120,** and based on such data determine the preferred replenishment scheme. Also replenishment processing module **128** may utilize EV usage data indicative of a history of the EV usage or its predicted usage to select the most suitable replenishment scheme from those available by the service station **120.**

The service station **120,** associated with either one of a charging pole and a battery exchange system or with both of them, may be operated to provide various battery replenishment services such as various charging schemes (e.g. fast/slow, full/partial charging) and/or exchange batteries of various types and charging levels. Accordingly, the operative replenishment instructions **ORI** may include data indicative of the type and method of battery replenishment service to be supplied to the electric vehicle **EV** of the user, as well as specific preferred replenishment schemes (battery charging scheme and/or battery exchange preferences and/or exchange-priority).

Turning now to the control center **110,** it communicates operative data **OPD** to the service station **120** in response to user-data **UID** received therefrom. As indicated above, the operative data **OPD** typically includes battery-specific and/or vehicle-specific data. Having received the user-data **UID** from the service station **120,** the control center **110** is adapted for determining battery information for the EV to be serviced by service station **120.** The control center **110** identifies the vehicle to be serviced and obtains battery information corresponding to the battery installed thereon (i.e. the battery type and possibly also the specific battery identity).

There is generally no one-to-one correspondence between EV's and users. Also, the service station **120** may not communicate the identity of the vehicle adjacent thereto to the control center **110.** This is because some existing EV replenishment standards lack communication between a service station **120** and a vehicle adjacent thereto, and thus a service station **120** is typically unaware of such a vehicle's identity.

To this end, the control center **110** includes communication modules (e.g. manifested by one or more communication/frontend servers) including an EV communication module **112** and a station-communication module **114,** and includes data-processing modules including a battery information module **116** and a vehicle locator module **118,** which are connectable to the communication modules for exchanging information between them. The EV communication module **112** is adapted for communication with one or more EV's for receiving therefrom vehicle associated user data **VUID** and EV related data **EVD**. The station-communication module **114** is configured and operable for communication with one or more service stations (e.g. **120)** associated with the control center **110.** The station-communication module **114** is adapted for receiving, from the service stations (e.g. **120**), one or more user-data pieces **UIDs** indicative of users seeking/requesting battery replenishment services. The user data pieces **UID**'s are obtained in association with station-data **STID** identifying or indicative of the respective service stations from which they were sent.

Having received user-data piece **UID** from a certain service station, the vehicle locator module **118** operates for identifying/matching that user data piece **UID** with a vehicle associated user data **VUID** that is obtained from an EV by the EV communication module **112.** The vehicle locator module **118** thereby associates the EV related data **EVD** with that certain service station, thus allowing for communicating

proper operative data **OPD** thereto. In other words, the vehicle locator module **118** determines which EV is located in the vicinity of the certain service station.

In some embodiments of the invention, the user data **UID** and the vehicle associated user data **VUID** may include different user related data content. In such embodiments the vehicle locator module **118** may operate a match user data **UID** with vehicle associated user data **VUID** by utilizing user data records which associate these different user related data contents.

Battery information module **116** is configured and operable for utilizing the EV related data **EVD** to determine battery information **BID** corresponding to the type/identity of the battery installed on the corresponding **EV**. Then, in accordance with the determined battery information **BID**, an operative data **OPD** is sent by the station-communication module **114** to the service station, at which the corresponding EV is located.

According to some embodiments of the invention, the control center **110** is associated with user-location data storage **144** (e.g. database). The user-location data base **144** may be configured and operable for storing association data, associating vehicle associated users (**VUID's**) with the EV's (**EVD**'s) they are using (e.g. currently using). Such a **VUID-EVD** association data may for example be provided to the database by EV communication module **112** (e.g. when such data is sent from an EV in response to the user-identification in the EV as described above). Utilizing such **VUID-EVD** data storage, the vehicle location module **118** can operate in response to user-data **UID** received from the service station **120** (e.g. which may be identified by **STID**) to associate the user data **UID** with an EV used (i.e. determine a corresponding EV data **EVD**) and thereby determine association STID-EVD between the EV and the service station.

Alternatively or additionally, the user-location database **144** may be configured and operable for storing association data, associating users (**UID**) with service stations (**STID**) they have recently being identified at (e.g. via their user devices). Such a **UID-STID** association data may for example be provided to the database **144** by station-communication module **112.** Utilizing such **UID-STID** data storage, the vehicle location module **118** can operate in response to vehicle related user-data **VUID** received from an EV to associate the EV data **EVD** with the service stations **STID** (i.e. determine STID-EVD association).

As described above, the vehicle location module **118** provides STID-EVD association between a specific service station (e.g. station-data) and an EV to be serviced thereby. The battery information module **116** utilizes the EV related data **EVD** to determine the EV battery information **BID** and possibly also to determine EV usage data. Optionally, according to some embodiments, the battery information module **116** includes or is associated with a battery information data storage **142,** associating batteries with EV's and storing battery information for the batteries. Battery information module **116** utilizes such battery data storage to acquire battery information **BID** for the EV, thus allowing for determining the type/identity of the batteries that can be serviced at different service stations (e.g. STID-BID association).

As noted above, operative data **OPD** to be sent to a service station may include data indicative of the battery information **BID** and/or operative replenishment instructions **ORI**. In the latter case, the control center may also include a replenishment processing module similar to processing module **128** described above. The replenishment processing module **128** may utilize the battery information **BID** and possibly also other data to determine operative replenishment instructions **ORI** to be sent to the respective service station.

It should be noted that the service station communication module **114** may utilize any suitable wired or wireless communication technology for communicating with the service stations. This may include for example LAN, Wireless LAN (WAN/WIFI), Ethernet, Internet, telephony, cellular (e.g. **3G**) networks. In some types of networks, the network address (MAC/IP) itself may be used as or incorporated in the station-data **STID**. Alternatively or additionally, station-data **STID** may include any data indicative of a specific service station such as a serial number of the station. In some cases, authentication protocols are used to authenticate/validate service-data **STID** stations and/or to secure communication with the service stations.

EV communication module **112** may also utilize wired or wireless communication technology/network to communicate with one or more EV's. It may utilize a network similar to that used by the station communication module **114** or a network of other type. EV communication module **112** may also utilize local Bluetooth or WIFI networks, which exist at the service stations, to connect to EV's in the vicinity of the service stations. Communication module **114** may utilize suitable authentication protocols to communicate data between the vehicle and the control center. Such

protocols may assist in prevention of false or fraud communications of vehicle identifying data **EVD** and vehicle related user data **VUID**.

As noted above, the EV communication module **112** receives (through the network) a vehicle associated user data **VUID** and a vehicle related data **EVD**. According to some embodiments of the invention, the vehicle related data **EVD**, which identifies data, is inherently/implicitly communicated to the control center for example in the form of a network address (e.g. IME/MAC address) of the vehicle's communication device. The vehicle associated user-data **VUID** is typically obtained by the vehicle's computer or vehicle's control system **160** from a user device associated with the user of the vehicle or by direct (manual) input from the user.

The EV control system **160** is appropriately accommodated in the vehicle **EV** and is adapted for receiving vehicle associated user-data **VUID** as an input and communicating this data together with vehicle related data (e.g. vehicle/battery identification data) **EVD** to the control center **110.** Typically, in some embodiments of the invention, the control system **160** includes one or more processors and memory storing one or more programs for execution by the one or more processors. The one or more programs may include instructions for carrying out methods of the invention, as will be exemplified further below.

The EV control system **160** includes at least a user identification module **162** and a vehicle controller **164.** The user identification module **162** is adapted to obtain vehicle associated user-data **VUID**. The vehicle controller **164** is connectable to the user identification module **162** and is adapted to obtain therefrom the vehicle associated user-data **VUID** and to communicate it together with a vehicle related data (**EVD**) to the control center **110** to notify the control center of the user driving the vehicle.

To this end, the user identification modules, **162** and **122,** of the vehicle **160** and the service station **120** may utilize similar data input technology or different technologies. More specifically, vehicle associated user-data **VUID** and user-data **UID** may be directly provided by users to the respective modules **162** and **122,** e.g. by manual data entry by the user through a user input device such as a key-pad, or automatically via a user device **121** associated with one or both of the modules **162** and **122.** A non-limiting list of suitable techniques for automatic identification of user devices to any one of modules **162** and **122** include: Bluetooth communication, Wireless-LAN (WIFI), Radio Frequency Identification (RFID) and Near-Field

communication (NFC). By using some of these techniques, the data indicative of the user may also be securely communicated using suitable authentication/validation techniques/protocols. Also such data may be inherently communicated to the respective vehicle / service station (e.g. to the respective module **162/122**) for example in the form of a network address of the user device **121.** Such data indicative of the user may also be implicitly communicated whenever a connection between the user device **121** and the respective module **162/122** is established.

It should be understood that, generally, different user devices **121** may be used to communicate with the user identification modules **162** and **122.** For example, a credit card may be used to identify the user before the identification module **122** of the service station, while a mobile phone equipped with an NFC/Bluetooth can be used to connect to the user identification module **162** of the EV. In this connection, it should be noted that the user-data **UID** communicated to the control center via the service station may be different from the vehicle associated user data VUID which is communicated from the EV to the control center **110.** Following the above example, the user data **UID** may be a credit card number, and the vehicle associated user data **VUID** may be the MAC address of the user's mobile and/or other authentication data transmitted from a user's device. In such cases, the control center also utilizes a **UID-VUID** association data (not shown, e.g. lookup table or database) to be able to match between the UID and VUID data (i.e. to allow identification of a UID within a list of VUID's or *vice-versa*).

Some specific but not limiting embodiments of methods, according to the invention, for identifying an electric vehicle adjacent to a service station will now be described with reference to **Figs. 7A to 7C**. It should be understood that these methods may be performed utilizing a computerized system or a distributed system/network having one or more processors and one or more memory modules storing one or more programs for execution by the processor(s).

In accordance with some embodiments, the methods are carried out by software modules embodied in a non-transitory computer readable storage medium that stores one or more programs for execution by one or more processors of a computerized system. For example, such one or more programs may include instructions for carrying out any one of the methods described below.

Reference is made to **Fig. 7A** which is a flow diagram **700** illustrating a method for identification of an electric vehicle located in the vicinity of a service station. This

method can be implemented for example by electric vehicle service network **100** described above. More specifically, steps **701** to **710** (communicating with EV, and providing operative data indicative of **ORI** or **BID** to service station) are implemented by the control center **110** of electric vehicle service network **100** to identify an EV in the vicinity of a service station. Steps **701'** and **704'** (obtaining vehicle related user data (UID) in the vehicle's computer and obtaining user data (UID) at a service station), enable the EV's user to be identified by control systems **160** and **120** of the EV and the service station, respectively. These procedures occur prior to the operational steps **701** and **704** at the control center. According to some embodiments of the invention, in the preliminary steps **701'** and **704'**, the user is identified utilizing technologies, such as NFC, which may be embedded in a user's handheld device. For example, user-data **UID** may be wirelessly communicated to the control system **120** of the service station by such a handheld device.

To this end, it should be noted that the EV identification should be construed herein as either identifying the EV's identity or identifying the EV's battery identity or identifying the EV's battery type, all in accordance with the desired embodiment of the invention and with the contents of the electric vehicle related data that is provided by the vehicle.

Step sequence **701 to 703** (communication with an EV, provision of EV data and vehicle-user data and recordation of association data with respect to the user data and service station data) is performed by the control center in response to data coming from the EV and/or from the service station. Step sequence **704 to 706** (communication with a service station, obtaining user data from the service station, and recording association data with respect to the user data and service station data) is performed in connection with each user approaching the service station (i.e. identifying himself at the service station). These procedures **701** to **703** and **704** to **706** can be performed concurrently or in any suitable order.

Thus, in step **701,** communication is established between the control center and the EV. This communication can be initiated by the EV's control system (e.g. **160** in Fig. **1**), for example in response to user/user-device identification by the EV's control system indicating user's usage of the vehicle. Alternatively or additionally, according to some embodiments of the invention, communication can be initiated by the control center for interrogating the EV approaching/located at a certain service station to

generate a request to the respective user to provide his identifying information (user's identity or user data). In case the communication is initiated by the control system, a corresponding notification message may be transmitted via a user's phone device, which may not be part of that user device which communicates with the vehicle's control system. The manner in which the EV's control system communicates with the service system (control center and/or power replenishment service station) is defined according to a previously established agreement between the user/vehicle and the service system.

In step **702,** following communication establishment with the EV, the control center receives an EV related data (**EVD**) and vehicle associated user data (**VUID**) which is provided by the EV's control system. Optionally, in step **703** the vehicle associated user data **VUID** is stored in a **VUID-EVD** data storage in association with the EV (with the EV data). Such data records can thereafter be used to determine relations between users and vehicles.

In step **704,** communication is established between the control center and the power replenishment service station (e.g. **120** in Fig. **1**). Such communication may be initiated by the service station in response to user data received at the service station (i.e. identification of a user seeking to receive services therefrom); or the communication may be initiated by the control center where a request for user data is generated to the service station in response to the vehicle data **EVD** and vehicle associated user data **VUID** received from the vehicle's control system.

The user-data **UID** is communicated to the control center at step **705,** and association between the user data **UID** and data (**STID**) indicative of the service station is obtained. Optionally this association is stored, in step **706,** in a UID-STID data storage (database) indicating users at different service stations.

In step **707,** the data processor of the service system (in this example, the data processor of the control center) operates to analyze the received data to find a match between vehicle associated user data **VUID**, obtained from the EV's control system, and user data **UID** obtained from the service station to determine an association data **UID-VUID**. This association data is indicative of association between the vehicle requesting services and the service station where such a vehicle is currently located. By utilizing the association data **VUID-EVD** between vehicles and users obtained in step **702** and the association data **UID-STID** between users and service stations obtained in

step **705,** an association data **EVD-STID** between the electric vehicle and the service station is obtained. This association data **EVD-STID** indicates the location of a certain EV in the vicinity of a certain service station.

In steps **708** and **709,** which follow the previously described step **702,** operative replenishment instructions **ORI** are generated by the service system (e.g. control center) with respect to the specific EV identified in step **702.** In step **708,** the electric vehicle related data **EVD** is used to determine the battery type/identity of the vehicle, and to obtain battery information relating thereto. It should be noted that in some embodiments of the invention, the electric vehicle related data **EVD** may by itself include or be constituted by data indicative of the battery type/identity or, generally, indicative of battery information (**BID**). In such embodiments, step **708** might be obviated. In some other embodiments, the battery information **BID** may be obtained from a database (data storage) associating contents of the electric vehicle related data **EVD** with the battery information **BID**.

Step **709** can be performed by either the control center or by the power replenishment service station. In this step, the battery information **BID** is processed and used to determine operative replenishment instructions **ORI** with respect to the vehicle. As noted above, such instructions may include preferred/suitable battery replenishment (charging/exchange) schemes. As was also noted above, such instructions may be based on the vehicle data, such as vehicle usage, which may be obtained in step **708.**

In step **710,** the service system (e.g. control center) operates to generate operative data **OPD**, containing the battery information **BID** (obtained at **708)** and/or the operative replenishment instructions **ORI** (obtained at **709**) for the vehicle, and communicate this operative data **OPD** to the service station at which the vehicle is located (as determined at **707**). Optionally, as noted above, step **709** may then be carried out to determine operative replenishment instructions **ORI** at the service station. The operative replenishment instructions **ORI** can then be used by the respective facilities of the service station (charging pole or exchange station) to provide power replenishment services to the vehicle (step **711**).

It should be understood, and is indicated above, that the service system may be associated with a control system of a power replenishment station having a plurality of battery service facilities (charging poles and/or battery exchange stations). Thus, the "control center" described above may be constituted by a control system of the power

replenishment station which is capable of communicating with EV's control systems and control systems of the battery service facilities. Thus, for example, a user identifies himself (i.e. provides user data to) before the control center of the power replenishment station via the data entry to the control unit of a specific charging pole, and the control system of the user's vehicle transmits vehicle related data and vehicle associated user data to the control center of the power replenishment station. The latter processes and analyses these data and generates operative data **OPD** and operative replenishment instructions **ORI** to the corresponding charging pole.

Reference is made now to **Fig. 7B** which is a flow diagram **712** illustrating an example of a method carried out by a vehicle's control system (e.g. **160** in Fig. **1**) to allow its identification when in the vicinity of a service station. First, in step **721,** the vehicle's control system is operated to obtain/identify the user of the vehicle. As noted above, this may be achieved by utilizing communication between the vehicle's control system and a user device (e.g. Bluetooth enabled device and/or NFC, RFID devices) - step **721A**, or may be achieved via a user input to the vehicle's control system (step **721B**). Step **721** may be performed, at any time before replenishment of vehicle's power by the service station is required. For example it may be operated to seek the user's identity/use-data before a user commences use of the vehicle or just before the vehicle receives power replenishment service.

In step **722,** the vehicle's related data (EV-data) **EVD** is provided. This may be performed concurrently, before and/or after step **721.** The provision of vehicle's related data **EVD** includes obtaining vehicle identification data (step **722A**) which is indicative of the type or identity of the battery of the vehicle. The identification data may include a vehicle-unique-identifier such as license-number or chassis-number, or a battery identification data such as a battery unique serial number and/or battery type. The vehicle identification data may be hard or soft coded in a memory accessible by the control system **160** of the vehicle. In case the identification data is battery related data, it may be stored in the memory utility of the battery unit/pack itself and accessed by the control system **160.**

In optional step **722B**, the vehicle's control system is also operated to obtain battery state information to be embedded in the vehicle's related data **EVD**. Such battery state information may for example include data indicative of the current battery charge level and/or the previous characteristic of power usage (so-called "battery history").

Such data can be used to determine the expected replenishment of power of the battery under different charging conditions. Moreover, in optional step **722C**, data indicative of the expected vehicle/battery usage may also be obtained included in the vehicle's related data **EVD**. For example, such data may include data indicative of a trip distance and/or trip destination and/or a vehicle's global position. Such data may be obtained for example from a GPS service/utility that is associated with the vehicle's control system, and may or may not be part of the user device.

Finally, in step **723,** the vehicle's control system communicates with the control center to provide it with the vehicle related data **EVD** and with the vehicle associated user data **VUID**. Such communication may be for example manually instantiated by the vehicle's user. Such communication may also be instantiated automatically when the vehicle is being connected to a charging pole of the service station or when the vehicle's control system identifies an access-point (e.g. WIFI/BT) of a service station (e.g. **120** in Fig. **1**), and/or the communication may be initiated by a control system (command center) of the battery replenishment service station, as well as any other suitable triggering event.

Fig. 7C is a flow chart **730** illustrating an embodiment of a method carried out by the control system of a power replenishment service station (e.g. by **120** in Fig. **1**). This method includes step **731** of receiving user-data from a user requesting service. Similarly to provision of user data **UID** in step **721** of the method described above with reference to **Fig. 7B**, in the present example of **Fig. 7C** the user data can be obtained from a user's device (step **731A**) and/or user's input to the respective system, which may be the vehicle's control system or that of the service station (step **731B**).

In step **732,** communication is established between the service station and the control center, where in step **732A** the service station identification data (**STID**) is provided to the control center together with the user's data (**UID**), and in step **732B** the service station receives, from the control station, response data including operative data for servicing (replenishing the power of) the user's vehicle. In step **733,** operative replenishment instructions (**ORI**) data is extracted from the received operative data, thereby enabling power replenishment by operating the replenishment module utilizing the **ORI** (step **734**).

Thus, the present invention provides for facilitating the servicing of electric vehicles at power replenishment stations. The service system of the present invention

may be associated with a control system of the power replenishment service station and/or control system of the central station connected to multiple power replenishment service stations. The service system operates to identify a user's vehicle at certain power replenishment service stations (or a specific service facility of the service station) and provide optimal replenishment instructions for servicing a specific vehicle.

Those skilled in the art will readily appreciate that various modifications and changes can be applied to embodiments of the invention as hereinbefore described without departing from its scope defined in and by the appended claims. Particularly, persons having ordinary skill in the art would recognize that a computer system located at the power replenishment system **120** may perform one or more of the operations described as performed by the command center system **110.** In other words, the operations described as performed by the command center system **110** may be performed by the computer system located at the power replenishment system **120** or at a battery service station.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS:

1. A service system for use in facilitating servicing of electric vehicles, the service system comprising one or more communication modules for connection to a communication network, and a processor utility configured and operable for carrying out the following: receiving and processing user request data from at least one power replenishment service station for identifying user data, receiving and processing data from control systems of vehicles for identifying certain data comprising at least specific vehicle data, and processing said user data and said at least specific vehicle data, identifying the respective vehicle located at the power replenishment service station, and generating data indicative thereof thereby enabling management of servicing of the respective vehicle.

2. The system of claim 1 wherein said certain data comprises vehicle associated user data indicative of a user using said vehicle.

3. The system of claim 1 or 2, wherein said processing utility is configured and operable for carrying out the following: obtaining one or more factors associated with at least one of said vehicle and said user, identifying a list of a plurality of vehicles associated with the user based on the identification of the user, and utilizing said one or more factors to determine which respective vehicle of the plurality of vehicles associated with the user is located adjacent to the power replenishment station.

4. The system of claim 3 wherein at least one of said factors is included in said certain data.

5. The system of claim 3 wherein the one or more factors comprise one or more of the following: a charge event received from the vehicle located adjacent to the power replenishment service station, a vehicle usage history associated with the user, battery service history associated with the user, a location of the vehicle.

6. The system of any one of claims 1 to 5, wherein said processing utility is configured and operable for identifying said respective vehicle by carrying out at least one of the following:

(a) matching said user data with vehicle associated user data indicative of a user using said vehicle,

(b) processing data indicative of a list of a plurality of vehicles associated with the user by filtering said data indicative of said list by utilizing one or more factors associated with at least one of said vehicle and said user, said filtering comprising at least one of the following:

i) utilizing at least one of a vehicle and battery usage history associated with the user and determining that a vehicle frequently used by the user is said respective vehicle,

ii) matching a charge event data received from a certain vehicle in said list with a charge event received from said power replenishment station,

iii) matching a location of a certain vehicle in said list with a location of said power replenishment station.

7. The system of any one of claims 1 to 6, being configured and operable as a control center connectable to one or more power replenishment service stations via the communication network, said one or more communication modules comprising: an electric vehicle (EV) communication module configured and operable for communication with control systems of multiple EVs and receiving therefrom at least said vehicle data, a station-communication module configured and operable for communication with the one or more power replenishment stations for receiving therefrom the user request data including at least said user data.

8. The system of claim 6 or 7, comprising a vehicle locator module adapted to utilize data received from the control system of the vehicle and data received from said one or more power replenishment stations to determine a certain power replenishment station in the vicinity of which said vehicle is located.

9. The system of any one of claims 6 to 8, wherein said EV communication module is configured to communicate with the control system of the vehicle by mediation of a power replenishment station being said certain power replenishment station in the vicinity of the vehicle.

10. The system of any one of claims 7 to 9 comprising a battery information module adapted to utilize said vehicle data and determine corresponding operative data for power replenishment of the vehicle, said station-communication module being adapted for sending said operative data to said certain power replenishment station.

11. The system of any one of claims 1 to 6, being associated with a control system of the power replenishment station, the system comprising an identification module adapted for obtaining at least the user data associated with a user requesting power replenishment service, said one or more communication modules comprising a control center communication module connectable to said identification module and adapted for communicating with a control center for sending thereto at least said user-data and receiving therefrom corresponding operative data of the power replenishment service, the system further comprising a replenishment controller connectable to said control center communication module and adapted for receiving said operative data for operating the power replenishment system associated with said power replenishment station.

12. The system of claim 11, wherein said identification module is adapted for carrying out at least one of the following:

(a) communicating with a user device for receiving therefrom said user-data.

(b) communicating with the control system of the vehicle for receiving therefrom the vehicle-data.

(c) communicating with the control system of the vehicle for receiving said user-data.

(d) obtaining, from at least one of said user device and control system of the vehicle, corresponding vehicle associated data which is to be communicated to the control center.

13. The system of any one of claims 1 to 12, wherein at least one of the power replenishment stations comprises a battery charging pole.

14. The system of any one of claims 1 to 13, wherein at least one of the power replenishment stations comprises a battery exchange station.

15. The system of any one of claims 1 to 14, wherein at least one power replenishment station comprises an identification module including at least one of an RFID, NFC, BT and WIFI communication devices adapted for communicating with a user device in the vicinity of the service station for receiving said user-data therefrom.

16. The system of any one of claims 1 to 15, wherein said one or more communication modules are configured and operable for communication with a user device for receiving therefrom at least one of the following: said vehicle data, vehicle associated user data indicative of a user using said vehicle, and one or more factors associated with at least one of said vehicle and said user.

17. The system of any one of claims 1 to 16, being adapted for wireless communication with a control system of the vehicle for at least partially receiving therefrom at least one of the following: said vehicle data, vehicle associated user data indicative of a user using said vehicle, and one or more factors associated with at least one of said vehicle and said user.

18. The system of any one of claims 1 to 17, wherein said processor utility is configured and operable for identifying battery information of the vehicle and communicating operational data for servicing the battery to said certain power replenishment station.

19. The system of claim 18, wherein said operational data comprises at least one of said battery information and battery replenishment plan.

20. The system of claim 19, wherein the battery replenishment plan is determined in accordance with the battery information and comprises operational data indicative of at least one of the following: operational data for charging a battery of the vehicle, and operational data for replacing the battery of the vehicle.

21. The system of any one of claims 1 to 20, wherein said processing utility is adapted to determine whether the user is authorized to receive power replenishment service for said respective vehicle.

22. A method for use in servicing of electric vehicles, the method comprising: receiving and processing user request data from at least one power replenishment

service station for identifying user data, receiving and processing data from control systems of vehicles for identifying certain data comprising at least specific vehicle data, and processing said user data and said at least specific vehicle data, identifying the respective vehicle located at the power replenishment service station, and generating data indicative thereof thereby enabling management of servicing of the respective vehicle.

23. The method of claim 22 wherein said certain data comprises vehicle associated user data indicative of a user using said vehicle.

24. The method of claim 22 or 23 comprising: obtaining one or more factors associated with at least one of said vehicle and said user, identifying a list of a plurality of vehicles associated with the user based on identification of the user, and utilizing said one or more factors to determine which respective vehicle of the plurality of vehicles associated with the user is located adjacent to the power replenishment station.

25. The method of claim 24 wherein the one or more factors comprise one or more of the following: a charge event received from the vehicle adjacent to the power replenishment service station, a vehicle usage history associated with the user, battery service history associated with the user, and location of the vehicle.

26. The method of any one of claims 22 to 25, wherein said identifying of the respective vehicle includes at least one of the following:

(a) matching vehicle associated user data indicative of a user using said vehicle with said user data,

(b) providing a list of a plurality of vehicles associated with the user and filtering said list by utilizing one or more factors associated with at least one of said vehicle and said user, said filtering comprising at least one of the following:

i) utilizing at least one of a vehicle and battery usage history associated with the user and determining that a vehicle frequently used by the user is the respective electric vehicle,

ii) matching a charge received from a certain vehicle in said list with a charge event received from said power replenishment station,

iii) matching a location of a certain vehicle in said list with a location of said power replenishment station.

27. The method of any one of claims 22 to 26 comprising utilizing said vehicle data, and determining corresponding operative data for power replenishment of the vehicle.

28. The method of any one of claims 22 to 27, comprising at least one of the following:

(a) communicating with a user device for receiving therefrom said user-data.

(b) communicating with the control system of the EV for receiving therefrom the vehicle-data.

(c) communicating with the control system of the EV for receiving said user-data.

(d) obtaining, from at least one of a user device and control system of the EV, corresponding vehicle associated data including at least one of the following: said vehicle data, a vehicle associated user data indicative of a user using said vehicle, and one or more factors associated with at least one of said vehicle and said user.

29. The method of any one of claims 22 to 28 comprising identifying battery information of the respective vehicle and communicating operational data for servicing the battery to said certain power replenishment station.

30. The method of claim 29 comprising utilizing and determining said operational data in accordance with said battery information; said operational data including battery replenishment plan indicative of at least one of the following: operational data for charging a battery of the vehicle, and operational data for replacing the battery of the vehicle.

31. The method of any one of claims 22 to 30, comprising determining whether the user is authorized to receive power replenishment service for said respective vehicle.

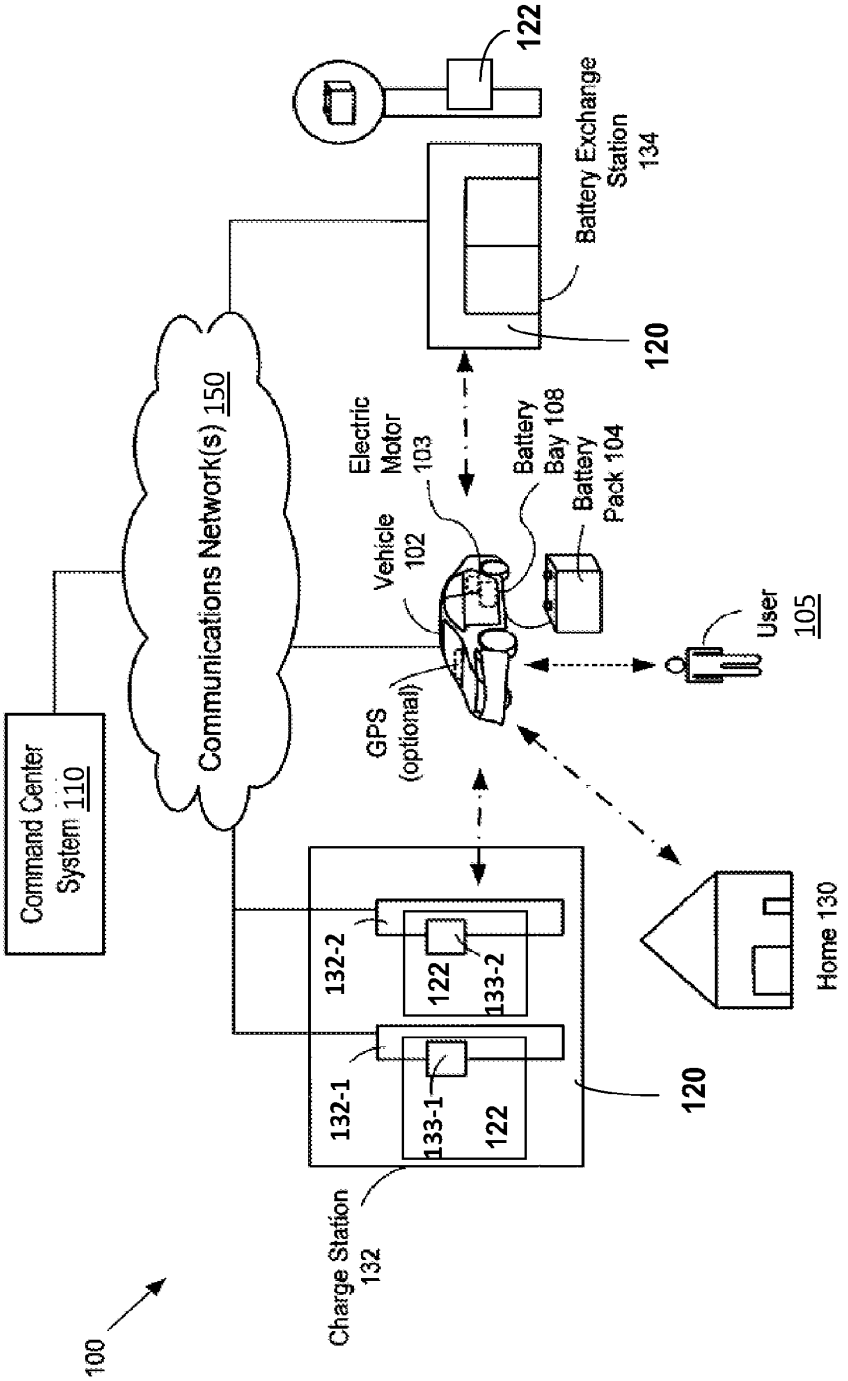

100
Charge Station 132
132-1
133-1
122
132-2
133-2
122
120
Home 130
User 105
GPS (optional)
Vehicle 102
Electric Motor 103
Battery Bay 108
Battery Pack 104
Communications Network(s) 150
Command Center System 110
Battery Exchange Station 134
120
122

FIG. 1

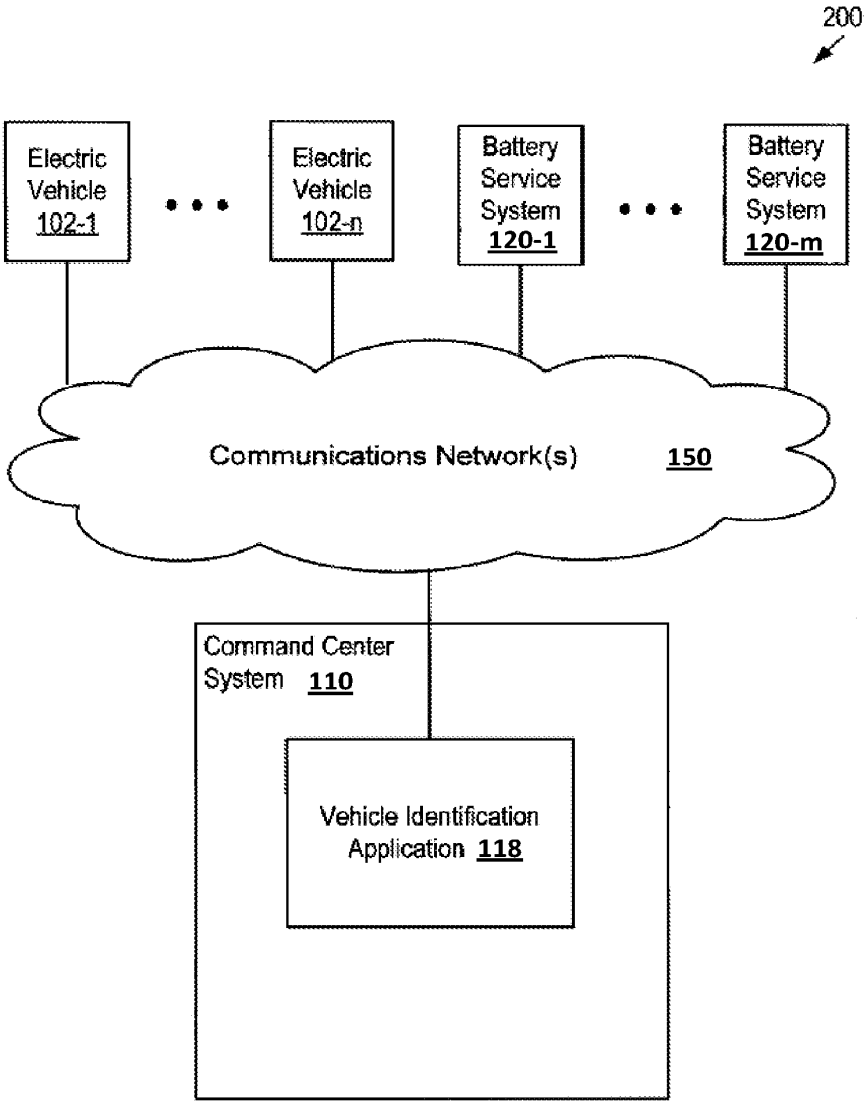

200
Electric Vehicle 102-1
Electric Vehicle 102-n
Battery Service System 120-1
Battery Service System 120-m
Communications Network(s) 150
Command Center System 110
Vehicle Identification Application 118

Fig. 2

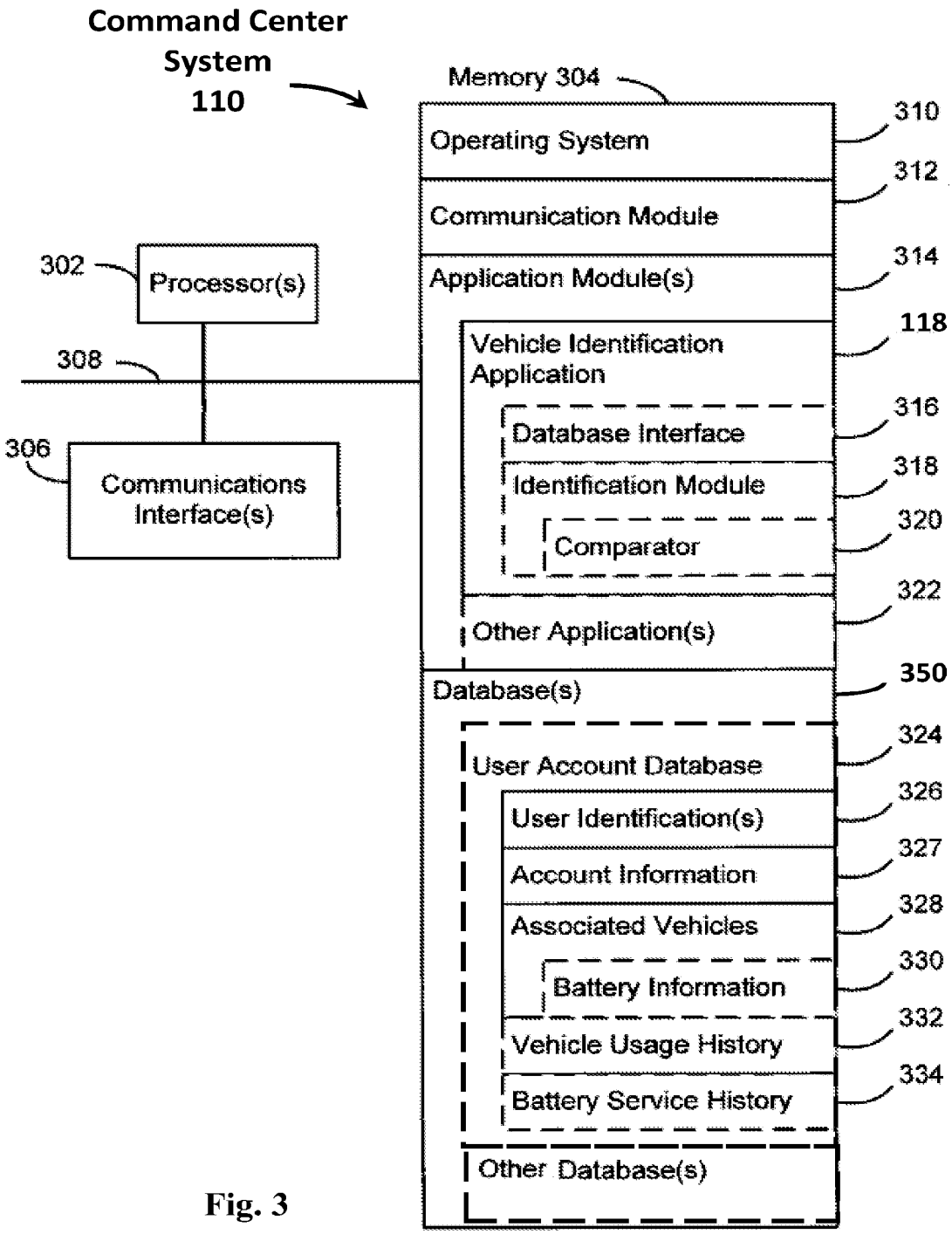

Command Center System 110
Memory 304
Operating System
310
Communication Module
312
Application Module(s)
314
Vehicle Identification Application
118
Database Interface
316
Identification Module
318
Comparator
320
Other Application(s)
322
Database(s)
350
User Account Database
324
User Identification(s)
326
Account Information
327
Associated Vehicles
328
Battery Information
330
Vehicle Usage History
332
Battery Service History
334
Other Database(s)
302
Processor(s)
308
306
Communications Interface(s)

Fig. 3

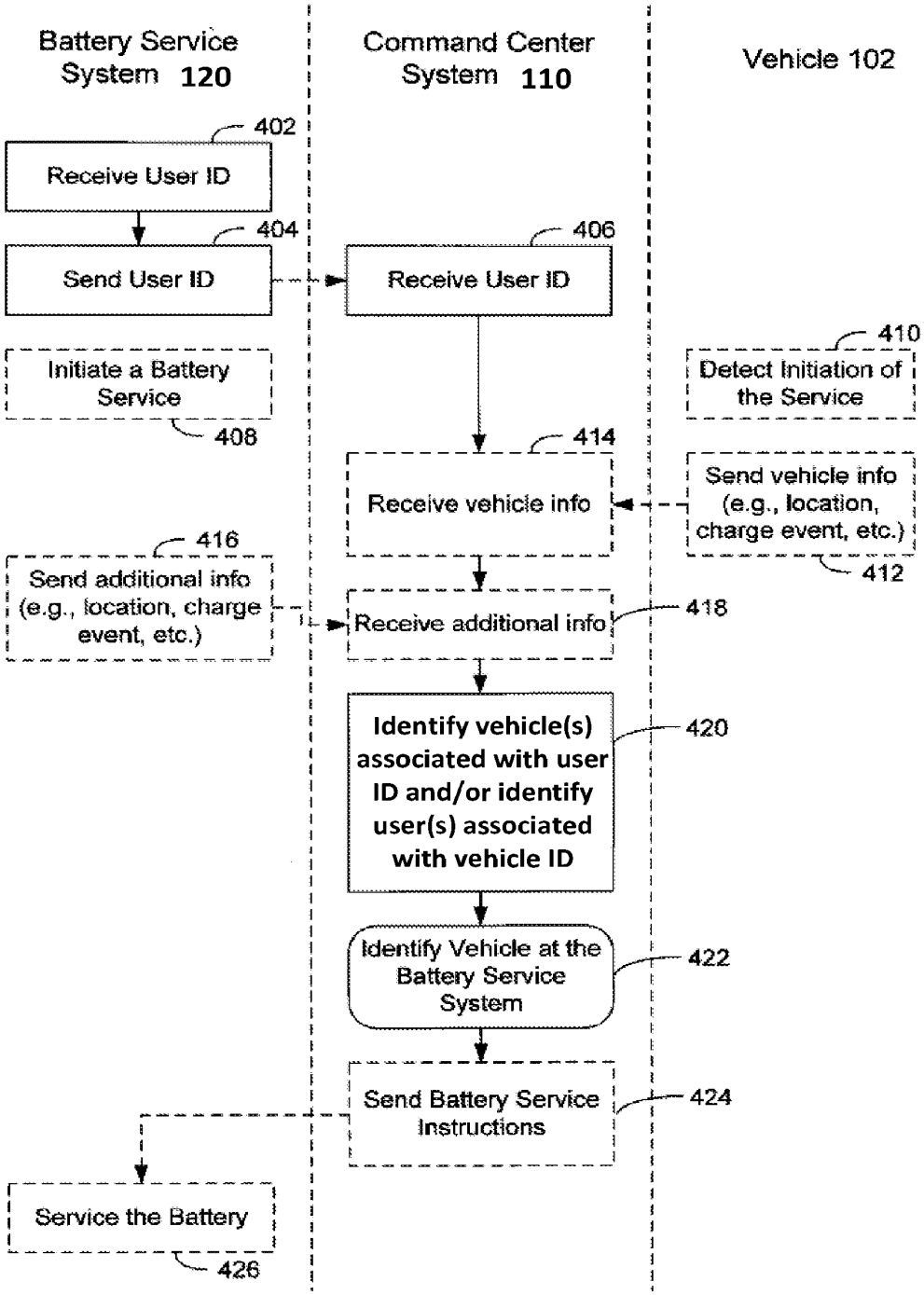

Battery Service System 120
Command Center System 110
Vehicle 102
402
Receive User ID
404
Send User ID
406
Receive User ID
410
Detect Initiation of the Service
Initiate a Battery Service
408
414
Receive vehicle info
Send vehicle info (e.g., location, charge event, etc.)
412
416
Send additional info (e.g., location, charge event, etc.)
Receive additional info
418
Identify vehicle(s) associated with user ID and/or identify user(s) associated with vehicle ID
420
Identify Vehicle at the Battery Service System
422
Send Battery Service Instructions
424
Service the Battery
426

Fig. 4

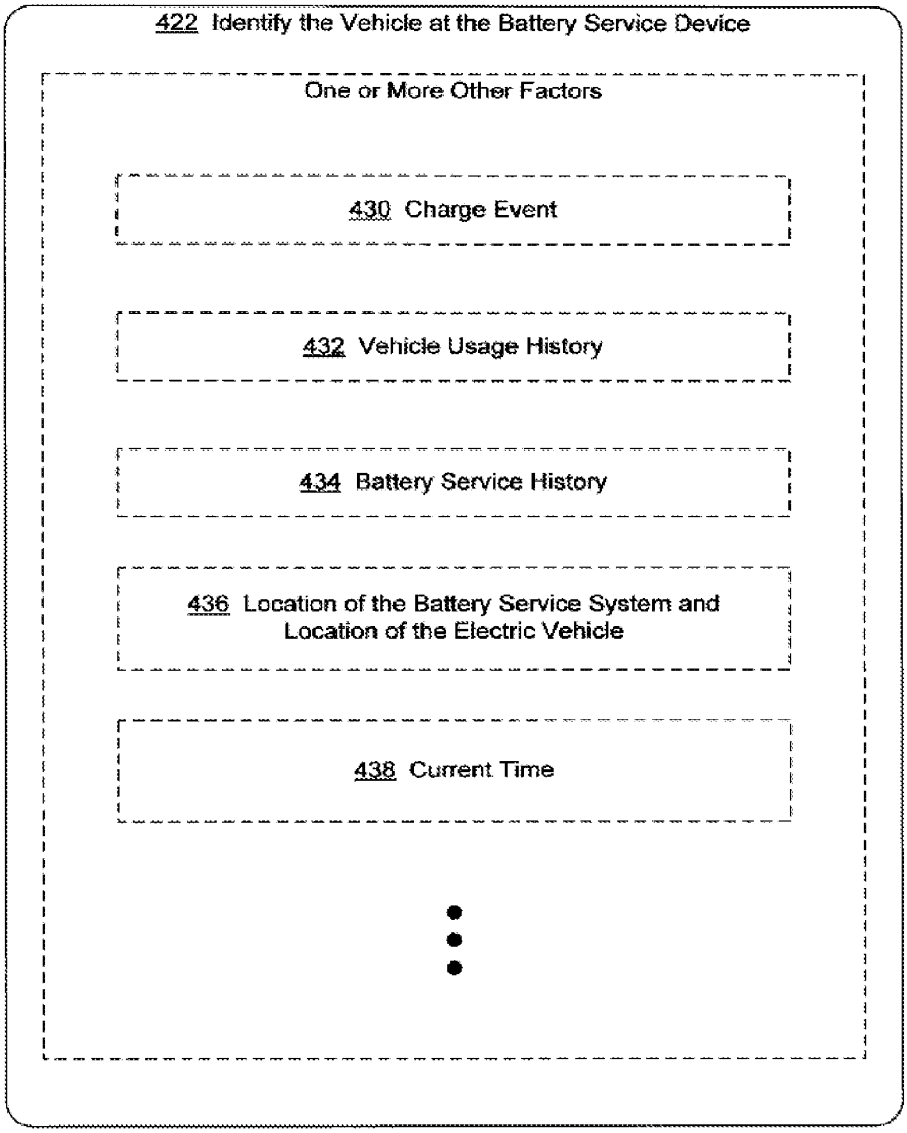

422 Identify the Vehicle at the Battery Service Device
One or More Other Factors
430 Charge Event
432 Vehicle Usage History
434 Battery Service History
436 Location of the Battery Service System and Location of the Electric Vehicle
438 Current Time

Fig. 5

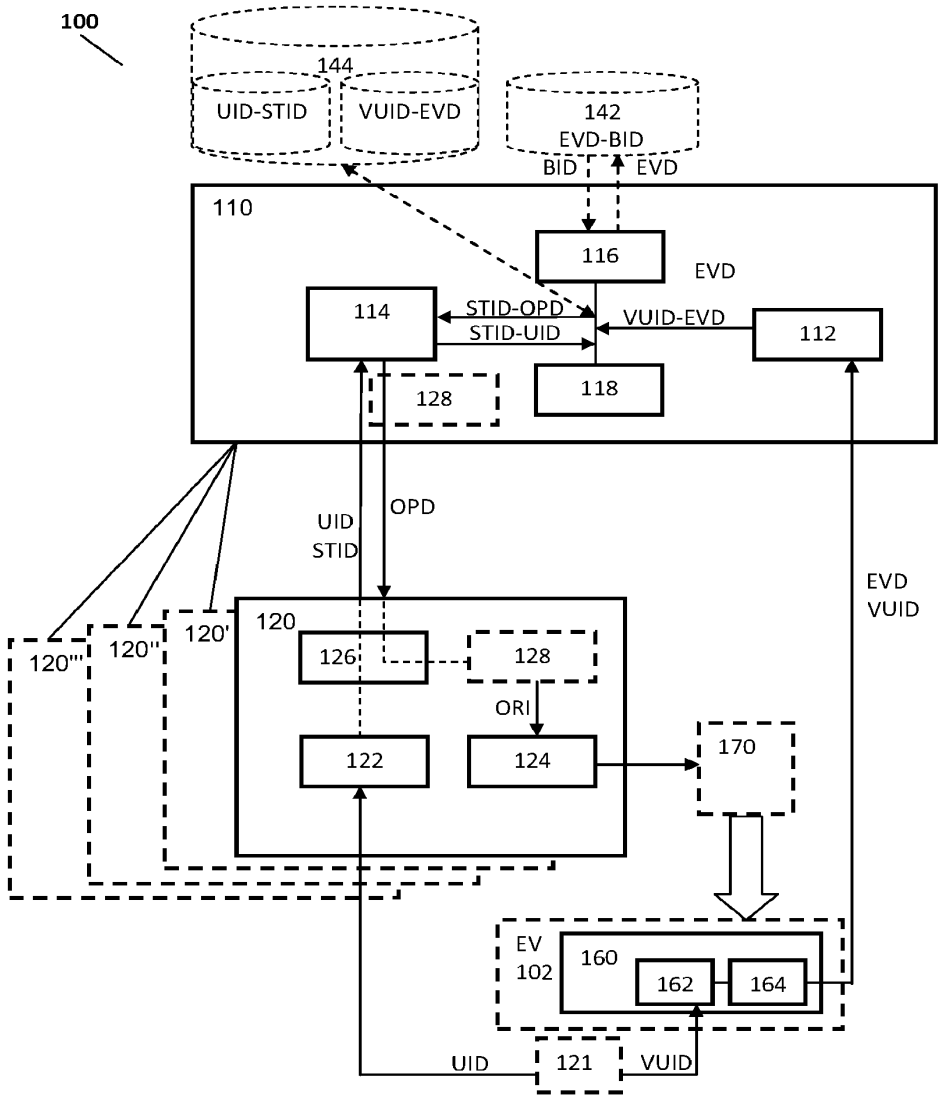

100
144
UID-STID
VUID-EVD
142
EVD-BID
BID
EVD
110
116
EVD
114
STID-OPD
STID-UID
VUID-EVD
112
128
118
UID
STID
OPD
EVD
VUID
120'''
120''
120'
120
126
128
ORI
122
124
170
EV
102
160
162
164
UID
121
VUID

Fig. 6

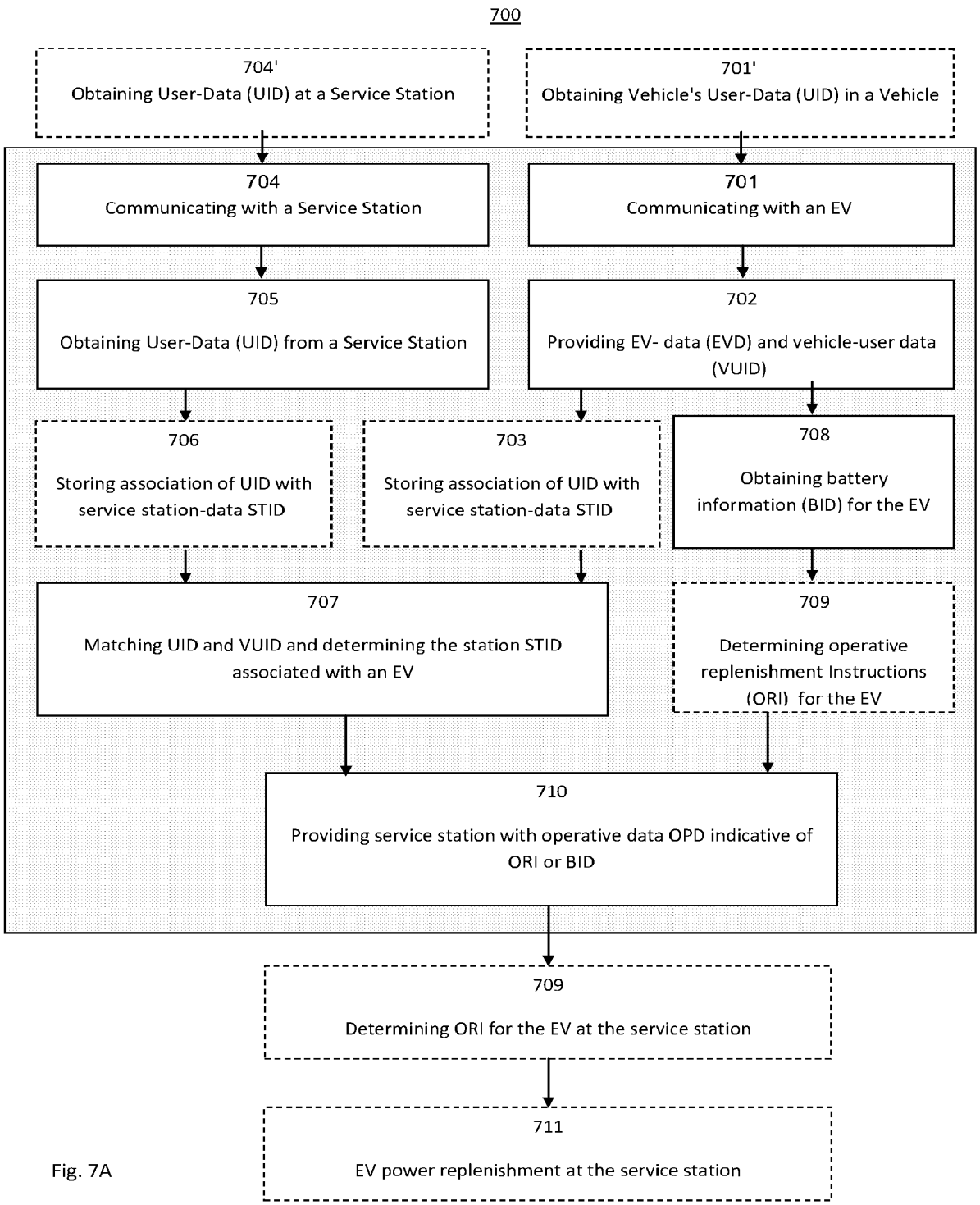

700
704'
Obtaining User-Data (UID) at a Service Station
701'
Obtaining Vehicle's User-Data (UID) in a Vehicle
704
Communicating with a Service Station
701
Communicating with an EV
705
Obtaining User-Data (UID) from a Service Station
702
Providing EV- data (EVD) and vehicle-user data (VUID)
706
Storing association of UID with service station-data STID
703
Storing association of UID with service station-data STID
708
Obtaining battery information (BID) for the EV
707
Matching UID and VUID and determining the station STID associated with an EV
709
Determining operative replenishment Instructions (ORI) for the EV
710
Providing service station with operative data OPD indicative of ORI or BID
709
Determining ORI for the EV at the service station
711
EV power replenishment at the service station

Fig. 7A

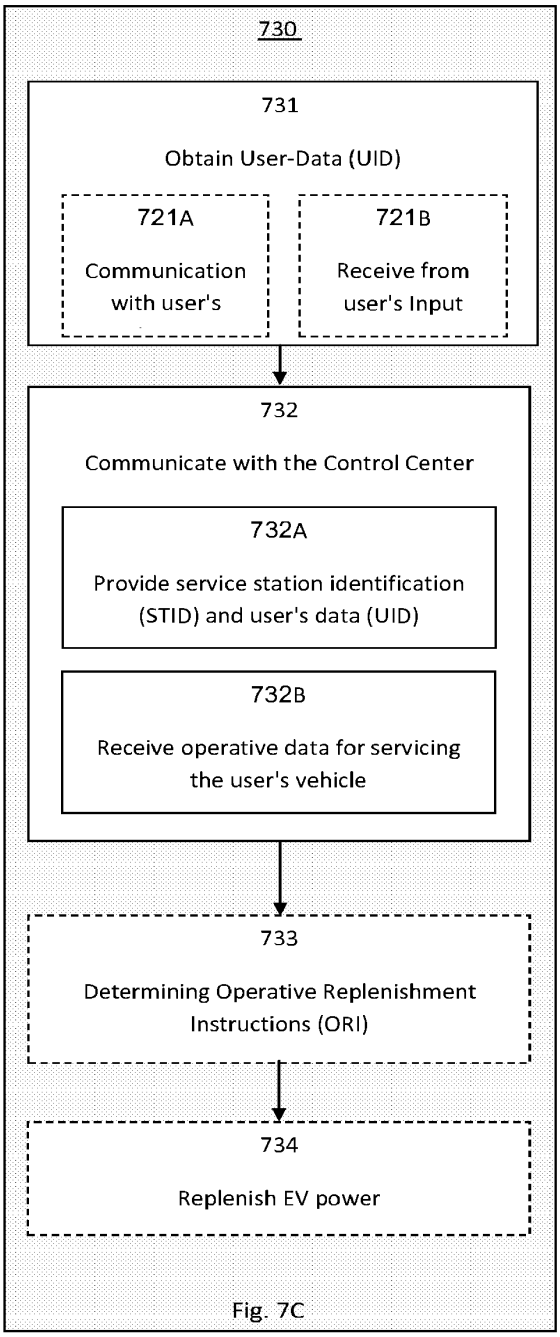

730
731
Obtain User-Data (UID)
721A
Communication with user's
721B
Receive from user's Input
732
Communicate with the Control Center
732A
Provide service station identification (STID) and user's data (UID)
732B
Receive operative data for servicing the user's vehicle
733
Determining Operative Replenishment Instructions (ORI)
734
Replenish EV power

Fig. 7C

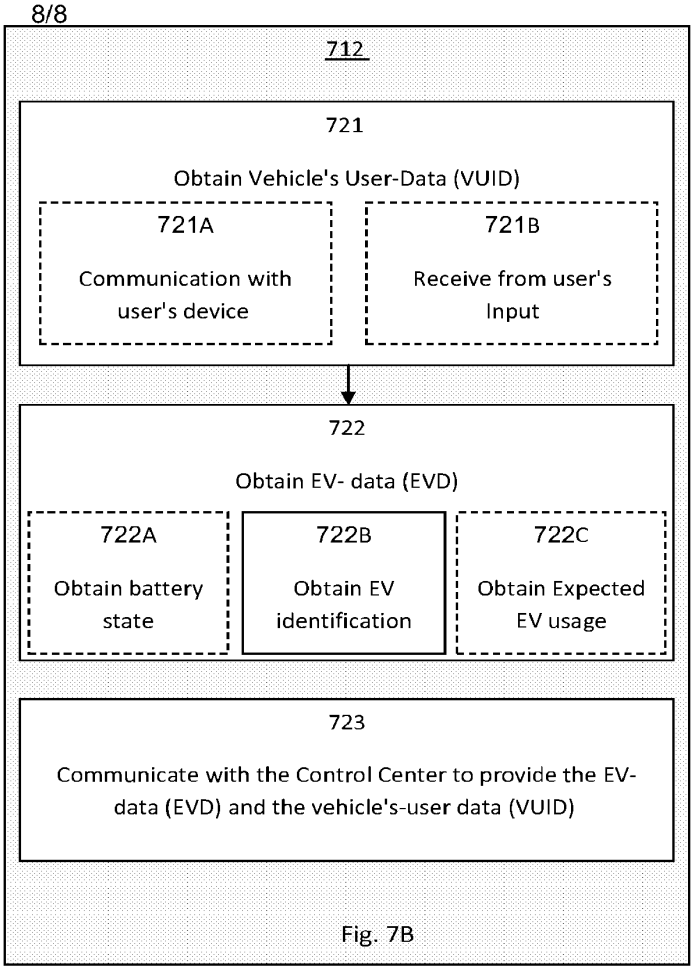

712
721
Obtain Vehicle's User-Data (VUID)
721A
Communication with user's device
721B
Receive from user's Input
722
Obtain EV- data (EVD)
722A
Obtain battery state
722B
Obtain EV identification
722C
Obtain Expected EV usage
723
Communicate with the Control Center to provide the EV-data (EVD) and the vehicle's-user data (VUID)

Fig. 7B

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(54) **Title**: BATTERY SELECTION SYSTEM AND METHOD

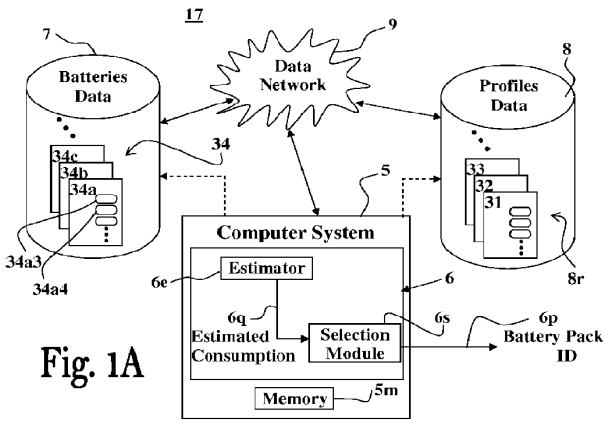


Fig. 1A

(57) **Abstract**: The application provides techniques for selecting a battery for an electric vehicle during, or before exchanging the used battery installed in the vehicle with a fresh one, in a battery exchange station. In some embodiments the battery selection utilizes profile data comprising at least user related data, which may be associated with a specific vehicle, and status data about a plurality of replenished battery packs available in the battery exchange station, and which may comprise at least the amount of stored energy in each of the replenished battery packs. An energy consumption estimate is computed for the vehicle and the status data and the energy consumption estimate are processed to select at least one replenished battery pack from the plurality of replenished battery packs for the vehicle being serviced.

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BATTERY SELECTION SYSTEM AND METHOD

TECHNOLOGICAL FIELD

The present application relates to a system and method for battery selection for an at least partially electrical vehicle.

BACKGROUND

It is now recognized that the use of rechargeable batteries results in longer battery lifespan and use of fewer batteries. Rechargeable batteries have gained wide acceptance mainly due to their environmental benefits, reusability, and as being recyclable and economical. Apart from the reusability and economical aspects, use of rechargeable batteries may further offer reductions in toxic risks, less impact on ozone pollution, and in general, reduced consumption of natural resources (compared to disposable batteries).

One important use of rechargeable batteries is in the electrical vehicle industry, which intends to gradually replace air polluting petrol and diesel internal combustion engine (ICE) vehicles with electric motor engine vehicles powered by rechargeable battery packs, or with the so-called hybrid vehicles which utilize both internal combustion and electric motors.

Various solutions for exchanging and replenishing batteries of electrical vehicles have been developed and are described for example in the following patent publications:

European patent publication No. 0902521 describes a battery rental system aiming to provide appropriate battery maintenance and control over battery charging and discharging, employing an unmanned automatic battery rental apparatus operated with a central control apparatus.

U.S. patent No. 6,014,597 describes a distributed electric vehicle battery exchange network employing a network of E-stops of battery exchange stations having control post units and card reader units.

U.S. patent publication No. 2003/209375 describes an electrical vehicle energy supply system for vehicles using removable cassette-type batteries, employing an

energy supply station having a plurality of cassette-type batteries which charge the batteries and store the charged batteries for servicing electrical vehicles entering the energy supply station.

GENERAL DESCRIPTION

The present application provides a novel approach for battery selection for an electrical vehicle enabling to accommodate suitably charged batteries to serviced vehicles. More particularly, the present application provides a battery selection scheme designed to accommodate user needs and comply with a predetermined battery selection policy.

The term *"vehicle"* as used herein generally refers to electrically powered transporting machinery utilizing a battery as their main power source, such as, but not limited to, electric cars, electric trucks, electric trains, diesel-electric locomotives and ships. It is noted that although the following description mainly refers to electrical vehicles, the present invention is applicable to other types of electric engine machines, such as, but not limited to, forklifts, golf carts, electric wheelchairs, riding floor scrubbers, electric motorcycles, trucks, vans, ships and locomotives. The term *"electrical vehicle"* used herein refers to an at least partially electrical vehicle, *i.e.*, all-electrical vehicle, or other types of electric engine machines as mentioned above.

The energy capacity of a rechargeable battery depends mostly on the size of the battery (*e.g.*, number of cells, cell arrangement and cell capacity), and since the capacity degrades over time, it depends also on usage and recharge history of the battery. Rechargeable batteries based on the Lithium-Ion technology are becoming more acceptable nowadays in electric vehicles. Such batteries, in certain arrangements, offer an average driving range of up to 160km. For many users this range is sufficient, as they typically travel between home and work locations, and in particular in situations where plug-in charging spots are available at home and work locations, allowing recharging of the vehicle batteries during off use time at work and/or at home.

However, there are cases wherein electrical vehicles are required to travel longer distances, which are often greater than the travelable distances feasible for the energy capacity of a typical rechargeable battery of an all-electric or hybrid vehicle. In addition, the route to a desired target destination may have no reachable battery

recharging facilities. In certain circumstances, battery recharging may be overly time demanding for a busy user, and the temperature of the used, partially or fully discharged, battery pack may also impose further recharging restrictions. In order to resolve such situations, a battery exchange station (BES) is to be configured to allow for quick replacement of a discharged, or partially discharged, battery with a replenished battery. Such battery exchange may be an additional service provided to users of electrical vehicles, in addition to typical battery recharge services, during which the electric vehicle is plugged to the charging grid to replenish its battery by an onboard, or offboard, battery charger.

The BES stores a plurality of batteries placed in recharge units or in a battery storage facility of the BES. The BES recharges the discharged batteries, removed from serviced electrical vehicles, in the charge units, and once adequately charged, stores the charged batteries in the battery storage facility, from which the charged batteries are supplied for installation in electric vehicles that are being serviced in the BES.

The recharging process of a battery may take more than an hour, even if high electric currents/voltages, and powerful cooling systems, are used in the BES. The temperature of batteries extracted from vehicles may be relatively high (*e.g.*, about 45°C) due to continuous use. During the time in which the battery is being recharged and stored in the BES, the temperature of the extracted battery may not decrease, or may even rise, in particular due to the aggressive charging process in the BES (e.g., employing high electric voltages/currents).

The amount of energy which can be stored in a specific rechargeable battery does not remain fixed over time and depends on the state and overall condition ("health") of the battery. Such conditions of rechargeable batteries reflect the age and history of the battery, and typically depend on the number of recharge/discharge cycles the battery has undergone and on the magnitude of the recharge/discharge currents/voltages used in these cycles. For example, the higher the number of recharge/discharge cycles a battery has undergone, the lower the effective capacity of the battery. In addition, charging using high electrical currents also degrades battery capacity.

Battery temperature also affects battery usage, since high temperature batteries may give limited performance during the course of driving. For example, charged batteries slowly become discharged even if they are not connected to a load, and such a

slow discharge effect is increased when the temperature of the battery is high (*e.g.*, above 40°C). In addition, rechargeable batteries also age and lose some of their capacity over time (even if not used or go through recharge/discharge cycles), and exposure to high temperatures accelerates the battery aging process significantly.

High temperature conditions of rechargeable batteries accelerate the aging of the battery, which is typically reflected in increase in the internal resistance of the battery. Such increase in the internal resistance of the battery causes higher internal loses, which also diminishes the output voltage that the battery can supply.

Due to the above factors, and since the rate of electric vehicles serviced in the BES may drastically vary between peak and off-peak hours, a typical BES may encounter at any given time situations in which the BES has numerous batteries, each having different maximal energy capacity and different amounts of stored energy, and that need to be serviced to a plurality of electric vehicles, each of which may have different expected needs.

The present application in some of its embodiments provides a system and method for selecting a battery pack to be installed in an electrical vehicle, in a battery exchange station, according to data related to energy consumption patterns of a user of the electric vehicle. The battery selection scheme in some embodiments is designed to study and analyze energy consumption features of the user of the electrical vehicle, and to select a suitable battery pack from a stock of replenished battery packs available in the battery exchange station. In possible embodiments, a replenished battery pack is selected to allow the user to safely reach a desired target destination and/or another battery service station located along, or in the vicinity, of the route the user intends to drive towards the target destination.

The battery selection scheme in some embodiments is performed by providing status data (*e.g.*, amount of stored energy, battery temperature, efficiency, and suchlike) concerning a plurality of replenished battery packs available in the battery exchange station, and collecting profile data comprising the user related data. The profile data is used for calculating an energy consumption estimate, and the status data and the energy consumption estimate are processed for selecting at least one replenished battery pack from the plurality of replenished battery packs for the specific vehicle.

The profile data is analyzed to define expected features required from a replenished battery pack to be installed in the vehicle. The expected features comprise

at least one of the following: battery type or types of compatible battery packs; battery temperature range; battery age; battery health; and battery efficiency. Accordingly, the selecting may be based at least in part on said expected features. The expected features are then used in the battery selection to search in the status data of the available battery packs for at least one replenished battery pack, satisfying the expected features, to be installed in the vehicle from the stock of battery packs available in the battery exchange station.

For example, the profile data may include data about driving habits of the user (*e.g.*, frequently driven routes, driving speeds, tendencies for aggressive accelerations and decelerations), which may be then used to determine a target destination of the user and calculate accordingly a minimal amount of energy required for the specific user to reach the target destination. The profile data may further include indications concerning the vehicle used by the user (*e.g.*, vehicle weight, energy consumption efficiency, motor specifications, and suchlike), which may be used to adjust the calculation of minimal amount of energy required, accordingly. In other exemplary embodiments the profile data further includes indications concerning the battery pack (*e.g.*, type, weight, geometric dimensions, efficiency, and suchlike) currently used in the vehicle, which may be also used in the battery pack selection to ensure that the selected replenished battery pack is of the same, or compatible, type.

In some exemplary embodiments, the profile data indications (*e.g.*, concerning the user, the battery pack currently in use and/or the vehicle) are collected and analyzed in order to determine a battery selection profile reflecting battery features (*e.g.*, amount of stored energy, battery temperature, battery efficiency, and suchlike) required from a replenished battery pack to be installed in a specific vehicle used by the specific user. In these exemplary embodiments the features defined in the battery selection profile are used in the battery selection process to find at least one battery pack from the stock of battery packs available in the battery exchange station that complies with the requirements defined in the battery selection profile.

The battery pack selection process may be adapted to provide users of the vehicles serviced in the battery exchange station replenished battery packs satisfying their needed driving coverage (*e.g.*, battery conditions required for reaching a desired target destination) and which may minimize their need to visit additional battery exchange stations during the drive towards the target destination. Accordingly, in some

possible embodiments, the battery pack selection process is adapted to provide users with battery packs having the highest level of charged energy and lowest temperature level. In other possible embodiments, the battery selection process is adapted to select at least one replenished battery pack having the minimal level of charged energy and certain range of temperatures permitting the vehicle to safely reach a desired target destination and/or a battery exchange/recharge station located along the route to be driven by the user towards the target destination, or adjacent to this route.

In some possible embodiments, the battery pack selection process further employs a battery pack selection policy. The battery pack selection policy may be defined by the battery exchange station or by a service provider managing the, or coordinating with, the battery selection station, to introduce additional considerations in the battery selection process. For example, the battery selection policy may be used to enable the battery exchange stations to meet users' requirements during times of high demands for battery exchange services. Alternatively or additionally, the battery selection policy may be adapted to maintain a desired average level of energy stored in the battery packs available in the battery exchange station, for example, in order to regulate energy supply rates. Yet alternatively or additionally, the battery selection policy may be adapted to equalize the level of wear of all battery packs used, for example, by guiding the battery selection process to give priority in the battery selection process to newer battery packs and/or battery packs having better health conditions.

Therefore, according to an aspect of some embodiments of the present application, there is provided a method for selecting a battery for a vehicle in a battery exchange station. The method comprises providing profile data comprising at least user related data associated with a specific vehicle, providing status data about a plurality of replenished battery packs available in the battery exchange station, calculating an energy consumption estimation based on the profile data, processing the status data and the energy consumption estimate and, based thereon, selecting at least one replenished battery pack from the plurality of replenished battery packs for the specific vehicle.

Preferably, the status data comprises at least the amount of stored energy in each of the replenished battery packs. Optionally the status data comprises a plurality of records, each record comprising data indicative of a specific battery pack from the plurality of replenished battery packs available in the battery exchange station. For example, each of these data records may comprise at least one of the following: battery

identifier; battery maximal capacity; battery charge level; battery temperature; battery location specifying whether said battery is being recharged or being stored after such recharge; and battery health.

The profile data may comprise vehicle related data of the specific vehicle and/or information about driving routes frequently driven by the user of the vehicle. In a variant, the vehicle related data comprises at least one of the following: vehicle type, vehicle weight and motor efficiency. Optionally, the profile data further comprises battery data specifying features of a battery pack currently installed in the vehicle, wherein the battery data may include at least one of the following: battery type, battery age, battery temperature, battery health, battery efficiency, and a battery identifier.

In possible embodiments, the profile data further comprises at least one of the following: energy replenishment patterns specifying user's patterns of battery exchange and/or recharge; service package data specifying terms and agreement of user subscription; and target destination data specifying at least one target destination of said user.

The method may further comprise determining a target destination of the user of the vehicle based on the profile data, and using the target destination for calculating the energy consumption estimation. Optionally, the target destination is determined by generating a query to the user, and the energy consumption estimation is calculated based on user's response to the query.

In possible embodiments the selecting of at least one replenished battery pack comprises selecting from battery packs which temperature is lower than a preset threshold value (*e.g.*, 33°C).

The calculating of energy consumption estimation may further comprise determining expected features for battery pack selection, and the selecting may be based at least in part on the determined expected features. The expected features may comprise at least one of the following: battery type or types of compatible battery packs; battery temperature range; battery age; battery health; and battery efficiency.

The method may further comprise providing a battery selection policy for introducing additional considerations in the selection of the at least one replenished battery pack, wherein the additional considerations may include reservation of replenished battery packs having a desired level of charged energy and/or of temperature. Alternatively, the additional considerations may include maintaining a

desired average level of energy stored in the battery packs available in the battery exchange station. Optionally, the additional considerations may include equalizing the level of wear of all battery packs used.

According to another aspect of some embodiments of the present application there is provided a management system for use in selecting a battery for a vehicle in a battery exchange station. The management system comprises a memory utility for storing data comprising status data about a plurality of replenished battery packs available in the battery exchange station, wherein the status data comprises at least amount of stored energy in each of the replenished battery packs, and a processor utility comprising: an energy consumption estimator module configured and operable for receiving and processing profile data comprising vehicle related data and respective user related data for estimating energy consumption for the vehicle used by the user, and for generating data indicative thereof; and a battery selection module configured and operable for receiving and processing the status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from said plurality of replenished battery packs selected for the specific vehicle.

In possible embodiments, the energy consumption estimator module is configured and operable for determining a target destination of said user, based on said profile data, and for using the target destination for calculating of the energy consumption estimation. Additionally or alternatively, the processor utility may be configured and operable for generating a query to the user for determining a target destination to be used for calculating the energy consumption estimation.

In exemplary embodiments of the present application the energy consumption estimator module is configured to select the battery pack for the specific vehicle from battery packs, in the plurality of replenished battery packs, whose temperature is lower than a preset threshold value (*e.g.*, 33°C).

In a variant, the energy consumption estimator module is further configured and operable for determining expected features for battery pack selection, wherein the expected features comprise at least one of the following: battery type or types of compatible battery packs; battery temperature range; battery age; battery health; and battery efficiency. Advantageously, the selecting may be based at least in part on the determined expected features.

According to yet another aspect of some embodiments of the present application there is provided a management system for use in managing battery selection for vehicles in a battery exchange station. The management system comprises a memory utility accessible from the battery exchange station and comprising status data about a plurality of replenished battery packs available in the battery exchange station, and a control system connectable to said memory utility and connectable to users' service provider utility for receiving profile data comprising vehicle related data and respective user related data. The control system comprises an energy consumption estimator module configured and operable for processing the profile data and estimating energy consumption for the vehicle used by the user and generating data indicative thereof, and a battery selection module configured and operable for receiving and processing the status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from the plurality of replenished battery packs selected for the specific vehicle. Preferably, the status data comprises at least the amount of stored energy in each of the replenished battery packs.

According to yet another aspect of some embodiments of the present application there is provided a management system for use in managing battery selection for vehicles in a battery exchange station. The management system comprises a control system connectable to a storage device for receiving status data about a plurality of replenished battery packs available in the battery exchange station, wherein the status data comprises at least the amount of stored energy in each of the replenished battery packs, and wherein the control system is connectable to users' service provider utility via a communication network for receiving profile data comprising vehicle related data and respective user related data. The control system comprises an energy consumption estimator module configured and operable for processing the profile data and estimating energy consumption for the vehicle used by the user and generating data indicative thereof, and a battery selection module configured and operable for receiving and processing the status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from said plurality of replenished battery packs selected for the specific vehicle.

According to yet another aspect of some embodiments of the present application there is provided a management system for use in managing battery selection for vehicles in a battery exchange station. The system comprises a server system connected

to a communication network, wherein the server system comprises a data input utility for receiving and identifying a request data indicative of a request of a user of a vehicle at the battery exchange station, a first communication utility for communicating with a storage device and receiving status data about a plurality of replenished battery packs available in said battery exchange station, wherein the status data comprises at least amount of stored energy in each of the replenished battery packs, a second communication utility for communicating with a users' service provider utility for receiving profile data comprising vehicle related data and respective user related data, and a processor system. The processor system comprises an energy consumption estimator module for processing the profile data and estimating energy consumption for the vehicle used by the user and generating data indicative thereof, and a battery selection module for processing the status data and data indicative of the estimated energy consumption, and generating battery selection data indicative of at least one selected replenished battery pack from a plurality of replenished battery packs at the battery exchange station selected for the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figs. 1A to **1C** are block diagrams schematically illustrating some embodiments of the battery selection technique of the present application, wherein **Fig. 1A** exemplifies a battery management system, **Fig. 1B** exemplifies a battery service system, and **Fig. 1C** exemplifies a battery exchange station;

Fig. 2A and **Fig. 2B** schematically illustrate a battery exchange process according to possible embodiments of the present application, wherein **Fig. 2A** is a flowchart illustrating a possible battery selection and exchange process and **Fig. 2B** is an event trace diagram demonstrating possible data flow in such a possible battery selection and exchange process; and

Figs. 3A to **Fig. 3E** are block diagrams schematically illustrating possible profile data records and data structures used and determined in possible embodiments of the present application, wherein **Fig. 3A** demonstrates a possible user profile data record, **Fig. 3B** demonstrates a possible battery profile record, **Fig. 3C** demonstrates a

possible vehicle profile data record, **Fig. 3D** demonstrates a possible battery selection profile defining various properties and conditions expected from the selected battery pack, and **Fig. 3E** demonstrates a possible status data report of battery packs available in the battery exchange station.

It is noted that the embodiments exemplified in the figures are not intended to be in scale and are in diagram form to facilitate ease of understanding and description.

DETAILED DESCRIPTION OF EMBODIMENTS

The present disclosure provides a battery selection scheme useful for selecting a battery for an electric machine serviced in a battery exchange station (BES). The battery selection scheme of the present invention is adapted to satisfy user and machine needs, and optionally also a predefined battery selection policy. Though the following description mainly relates to electric vehicles, as will be recognized by those of ordinary skill in the art, the present invention is applicable, *mutatis mutandis*, to almost any electric machine utilizing rechargeable batteries.

In general, the battery selection technique of the present application is carried out by a management system configured and operable for processing profile data related to at least the user of a vehicle, calculating, based on the profile data, an energy consumption estimate for the vehicle when driven by the user to a target destination, and analyzing status data about a plurality of replenished battery packs available in the BES and the calculated energy consumption estimate for selecting from the plurality of available replenished battery packs at least one replenished battery pack capable of satisfying at least the estimated energy consumption. The battery exchange station may be part of, or connectable to, the management system which manages the exchange of batteries of a plurality of vehicles in one or more such battery exchange stations distributed over geographical areas in which the vehicles are used.

Fig. 1A schematically illustrates one possible embodiment of a battery management system **17** configured to select a battery for a vehicle serviced in a battery exchange station. In this example, the system **17** comprises a data storage device **7** (also referred to herein as a memory utility) which stores and manages status data **34** about a plurality of replenished battery packs (**34a**, **34b**, **34c**,...) available in the battery exchange station(s). The status data **34** may comprise for each replenished battery pack

(*e.g.*, **34a**) data indicative of at least the amount of stored energy (*e.g.*, **34a3**) and the temperature (*e.g.*, **34a4**) of the battery pack.

An additional data storage device **8** may be used in the system **17** to store and manage profile data **8r**. It is however noted that in possible embodiments the status data **34** and the profile data **8r** are stored and managed by a single data storage device (*e.g.*, data storage device **7**). As indicated above, the profile data **8r** comprises user related data. Preferably, the profile data **8r** also comprises vehicle related data about the vehicle used by the user. In possible embodiments the profile data **8r** comprises the following: data about the users of each of the vehicles (**31**); data about each of the vehicles (**33**) serviced at the BES; data about the battery pack (**32**) currently installed in each of the vehicles.

System **17** includes a computer system **5** having a processor **6** and a memory **5m**. System **17** is configured to communicate data with the data storage devices **7** and **8** over a data network **9** (*e.g.*, wireless network such as a cellular network or computer network such as the Internet), and manage the battery selection and exchange operations. In some exemplary embodiments the computer system **5** is directly coupled to the data storage devices **7** and **8** (designated by dashed arrowed lines) for communicating data therewith, such that the data network **9** is not necessarily required. The data storage devices **7** and **8** may be hosted and managed by the computer system **5**, *e.g.*, the computer system **5** and storage devices **7** and **8** are located in the same site, room or building, or even operably housed and packaged in the same unit.

In some possible embodiments, data storage device **7** comprising the replenished batteries status data **34** is hosted and managed in the battery exchange station. Computer system **5** may be also part of the battery exchange station, as will be exemplified hereinbelow. In some possible embodiments, the storage device **8** comprising the profile data **8r** is hosted and managed by a service provider which may be located at a remote location and configured to communicate with the battery exchange stations, and possibly also with the vehicles, over the data network **9**. Data storage devices **7** and **8** may be implemented utilizing any suitable volatile and/or non-volatile memory devices (*e.g.*, RAM, magnetic hard disks, FLASH memories, optical disks, and suchlike), and may be hosted on a computer server (*e.g.*, RAID server), as well known to those skilled in the art.

The processor unit **6** includes an energy consumption estimator module **6e** and a battery pack selection module **6s**. The energy consumption estimator module **6e** is configured and operable for receiving and processing the profile data **8r**, calculating energy consumption estimation **6q** for a serviced vehicle when used by the user, and generating data indicative thereof. The battery pack selection module **6s** is configured and operable for receiving and processing the status data **34** and the energy consumption estimation **6q** calculated by the estimator **6e**, and generating output data **6p** indicative of at least one selected replenished battery pack from the plurality of available replenished battery packs, the at least one selected replenished battery pack being capable of at least partially satisfying the calculated energy consumption estimation **6q**.

The management system **17** may include, or be incorporated in, a server system connected to the communication network. The server system is configured to receive data from a data input utility and identify a request data indicative of a request of a user of a vehicle at the battery exchange station. The server system includes a first communication interface (*e.g.*, Ethernet, WiFi, modem, or suchlike) for communicating replenished battery status data **34** with data storage device **7**, and a second communication interface for communicating profile data **8r** with data storage device (**7** or **8**). The server system further includes a control unit or processor utility configured as the above described computer system including, the energy consumption estimator module **6e** for processing the profile data and estimating energy consumption for the vehicle used by the user, and the battery selection module **6s** for processing the status data and the data indicative of the estimated energy consumption and generating battery selection data.

Fig. 1B exemplifies an electrical vehicle battery service system **16** according to some embodiments. Electrical vehicle battery service system **16** includes a central control system **15** (marked in the figure as "control center") configured to communicate data with control units of a plurality of battery exchange stations (BES) **10** and control units installed in electric vehicles (EV) **12**. Each battery exchange station **10** includes its associated control unit **10t**, charger and storage apparatus **10c**, and a service lane **13** providing electrical vehicles **12** visiting the battery exchange station **10** with access to a battery exchange apparatus **10x** of battery exchange station **10**.

Battery exchange apparatus **10x** is configured to remove the battery pack **13d** (shown in **Fig. 1C**) of a serviced vehicle **12** and replace it with a recharged battery pack **13g** (see **Fig. 1C**). More particularly, the battery exchange apparatus **10x** is operable to remove a partially or fully discharged battery pack **13d** from a serviced vehicle **12**, transfer the removed battery pack **13d** to charger and storage apparatus **10c** for recharge and storage, fetch a replenished battery pack **13g** from recharge and storage apparatus **10c**, and install the fetched battery pack **13g** in the serviced electric vehicle **12**.

Data communication between the control units of the battery exchange stations **10** and the central control system **15** may be carried out over wired communication links (*e.g.*, landline telephony, cables), over optical communication links (*e.g.*, fiber optics) and/or wirelessly (*e.g.*, RF cellular network, WiFi, or satellite communication). Optionally, the data communication between the battery exchange stations **10** and the central control system **15** is carried out employing standard data communication networks (*e.g.*, LAN, WAN, WLAN, MAN, SAN) and protocols (*e.g.*, TCP/IP), for example, over the Internet. Data communication between the control units of the electric vehicles **12** and the central control system **15** (indicated by dashed-dotted arrowed lines) may be carried over any suitable state of the art wireless communication (*e.g.*, cellular network, WiFi, IR, Bluetooth, or satellite).

As demonstrated in **Fig. 1B**, the communication between the control units of the vehicles **12** and central control system **15** may be intermittently available due to varying geographical and environmental conditions and/or limited availability of wireless communication nodes. Electric vehicles **12** approaching exchange apparatus **10x** on lane **13** may communicate data with the control unit **10t** of the battery exchange station over wired, or wireless (by establishing WLAN communication between the internal computer of the vehicle and the control unit **10t**), data communication links (indicated by dashed arrowed lines). It should be understood that the same wireless communication links utilized by the control units of the electric vehicles **12** to communicate with the central control system **15** may be also utilized by the electric vehicle **12** to communicate data with the control unit **10t** of the battery exchange apparatus. However, the battery exchange apparatus **10x** may be equipped with appropriate wired communication interfaces (*e.g.*, modems, UART, I2C, USB, Ethernet) connectable to the internal computers of the serviced vehicles **12** during the battery exchange process for exchanging data between them therethrough.

As shown more specifically in the example of **Fig. 1C**, the electrical vehicle **12** includes an internal computer (control unit) **12m** (*e.g.*, onboard telematic device) which is capable of establishing data communication with the central control system **15** and also with various modules of battery exchange apparatus **10**. Such an internal computer **12m** may be configured to monitor and manage the battery pack **13d** of vehicle **12**, and to communicate with central control system **15** and with the control unit **10t** via a communication interface unit **12i** (indicated as interface **I/F** in **Fig. 1C**). The internal computer **12m** may be also configured to receive inputs from the user and display data and images to the user, by means of the respective user interface (not shown).

Vehicle **12** may further comprise a positioning system **12p** (*e.g.*, GPS, or any other type of cellular or satellite positioning system) which may be used together with internal computer **12m** to determine possible routes for vehicle **12** to travel and reach a desired destination indicated by the user. Internal computer **12m** may be adapted to prepare a driving route for reaching a desired target destination indicated by the user. Additionally or alternatively, internal computer **12m** may be configured to transfer from time to time vehicle location data obtained from positioning system **12p,** and/or the desired target destination data obtained from the user, to the central control system **15**. Accordingly, the central control system **15** may be used for determining a driving route for the specific vehicle **12** towards the user's desired target destination based on the location and destination data it receives from the vehicle **12**.

Internal computer **12m** may be further configured to provide the central control system **15** with data about the status (*e.g.*, amount of stored energy and temperature) of the battery pack used in the vehicle **12**. In such possible embodiments the central control system **15** may be further configured to issue alerts whenever the amount of energy stored in the battery pack of the vehicle is below a predetermined threshold. The alerts may be transmitted to the vehicle **12** (its control unit **12m**) and further used by the central control system **15** to place a battery exchange service reservation for vehicle **12** in a battery exchange station located nearby, or along (or adjacent to) the route driven by the user. Alternatively or additionally, the central control system **15** may be configured to plan, or adjust, the route driven by the user based on the vehicle location data, the desired target destination data and the battery state data, received from the internal computer **12m**, and thereby guarantee that the user safely reaches the target destination.

With reference to **Fig. 1C**, battery exchange station **10** may comprise a user identification unit **18** (designated as **UID** in **Fig. 1C**) configured to receive user identification information (*e.g.*, user name and/or password, PIN code, biometric identifier, or any other suitable user identifier) and transmit the same to control unit **10t** over any suitable wired or wireless communication link (indicated by a dotted arrowed line) provided therebetween. For this purpose, user identification unit **18** may comprise a user interface utility including keypad or keyboard and display means, RFID reader unit, personal user card reader, such as credit card reader or smart card reader, biometric scanner or detector, or any combination thereof. Alternatively, user identification may be carried out via internal computer **12m**, using user identification means, such as indicated hereinabove, to communicate the user identification data through the communication link obtained between the electric vehicle **12** and control unit **10t**.

The user identification unit **18** may be further configured to carry out a user authentication and/or authorization procedure(s) for allowing the system **17** to bill a user account, and/or settle payment through a third party (*e.g.*, financial institution, such as, for example, a bank or a credit card company), for the service provided to the user by the BES **10**.

The battery service system **17**, the battery exchange station **10** and/or the battery exchange apparatus **10x**, may be implemented utilizing one or more of the embodiments described in International Patent Publications Nos. WO 2009/039454, WO 2010/033517, WO 2010/033883 and/or WO 2010/033881, all assigned to the assignee of the present application and being incorporated herein by reference.

A possible battery management process will be now described with reference to **Fig. 2A** and **Fig. 2B**.

In the exemplary battery management process **20** illustrated in **Fig. 2A**, a vehicle **12** accesses the exchange apparatus **10x** (step **21**), and identifying information is transmitted from the internal computer **12m** of the vehicle **12** to the control unit **10t** of the battery exchange station (step **22**). Such identifying information comprises user identifying data (*e.g.*, user identification number, passport number, subscription number, or suchlike) and preferably also vehicle identification data (*e.g.*, vehicle registration number, vehicle identification number, manufacturer serial number, or suchlike). However, possible embodiments may include only transmittal of user identification data which may be required for billing the user for the service provided by

the battery exchange station **10**, and in such cases the user identifying data may be securely transmitted to control unit **10t** by means of user identification unit **18**.

The transmittal of identifying data in step **22** to the control unit **10t** may be performed as part of a user request to receive a battery exchange service from the BES **10**. The user identification in step **22** may be aimed at user authentication and authorization which may be carried out utilizing any suitable state of the art authentication/authorization protocol (*e.g.*, user name and password, detection of biometric signatures, or suchlike).

After the user is identified, and if needed also authenticated, control unit **10t** operates to fetch one or more data profiles (step **23**), for example, of the user, of the vehicle and/or of the battery pack used in the vehicle **12** to be serviced. In some embodiments, the data profiles are fetched from databases maintained and accessible by the central control system **15**. Additionally or alternatively, the data profiles are fetched from the control unit **10t** of the battery exchange station and/or the internal computer **12m** of vehicle **12**. While in some preferred embodiments the profile data is fetched from the central control system **15** alone, control unit **10t** of the battery exchange station and/or central control system **15** may be configured to interrogate the internal computer **12m** of the vehicle for updates, for example, concerning recent battery recharge events, vehicle performance over certain routes, user driving habits, and suchlike.

The user data profile may include information concerning user's driving habits (*e.g.*, driving speeds and accelerations/decelerations), frequently driven routes and times during the day in which these frequent routes have been driven, usage of air conditioning, power consumption during specific routes (such as the frequently driven routes) and driving times, the state of user's subscription and/or user's account, and suchlike. The vehicle data profile may include information concerning the vehicle specification and operating conditions, such as, but not limited to, vehicle weight and type, energy consumption characteristics, vehicle efficiency, and suchlike. The battery profile may include information concerning battery type (*e.g.*, Lead-acid, Nickel metal hydride, Zebra, Lithium ion) and make, efficiency and storage capacity, working temperatures, recharge history, and the like.

The control unit **10t** of the battery exchange station may further determine the destination data of the user of the vehicle (step **24**). In certain cases, the destination information may be provided by the internal computer **12m** of the vehicle **12**, however,

if the user did not indicate a desired target destination, it may be determined based on information in the fetched user profile. For example, if the user constantly drives from home to work during regular hours of ordinary business days, in case the user started the ride from home during such usual hours of the day, it may be assumed with a high degree of confidence that the working place is the user's target destination, in particular if the accessed BES **10** is on, or proximal to, the user's frequently used route between the home and work locations. The target destination may be determined by at least one of: the internal computer **12m**, the control unit **10t** of the BES, and the central control system **15**.

Control unit **10t** of the BES then fetches from charger and storage apparatus **10c** (step **25**) a status report concerning all battery packs **13g** that are currently available in storage or that are being recharged, and their charged levels. The control unit **10t** may then use the information determined and fetched in steps **23** to **25** to select a suitable battery for the vehicle **12** to be serviced (step **26**). However, if the state of the user's subscription and/or account indicates that the user's registration needs to be renewed, or that payment is required to settle the user's account, the vehicle servicing process **20** may be halted (or terminated) until the user settles the needed payments and/or registration formalities, optionally, onsite at the battery exchange station **10**.

The control unit of the battery exchange station **10** may be periodically or continuously updated concerning the charging state/level, type, history and conditions (*e.g.*, temperature and health), of all battery packs **13g** that are stored or being recharged at the charger and storage apparatus **10c**. Each of the battery packs **13g** in the charger and storage apparatus **10c** may be uniquely identified using, for example, bar codes, ID chips, RFID, and suchlike. Information concerning each of the batteries (*e.g.*, manufacturer specifications, battery health and/or history) in the charger and storage apparatus **10c** may be further obtained from a centralized server (not shown) communicatively linked to the network of system **17/16**.

Fig. 2B is an event trace diagram **29** exemplifying dataflow in a possible battery selection and exchange process. The battery selection process may be initiated in the user identification step (**S1**) in which one or more user identifiers (*e.g.*, user name, subscription number), and possibly other data (password, PIN, biometric data), are sent from user identification unit **18** to the control unit **10t**. It is noted that the requests for battery pack replacements may be generated by the control units **12m** of the vehicles **12**

or control unit **10t** of the BES **10** when the vehicles arrive to the BES **10**, for example, each time a user is authenticated and/or authorized at a user identification unit **18**.

According to another example, an advance notification (**S1'**, indicated by a broken arrowed line) may be sent from the internal computer **12m** of vehicle **12** to the central control system **15** to reserve a battery replacement slot for the vehicle **12** ahead of time. Upon receipt of such an advance request (**S1'**), central control system **15** transfers (**S1''**, also indicated by a broken arrowed line) the details of vehicle **12** and/or of the user to the control unit **10t** of the BES to schedule the reservation for service of vehicle **12** in the BES **10**. In addition, if such advance notification (**S1'**) is sent from the vehicle's internal computer **12m**, the latter may be further used to carry out the user authentication/authorization process, for example by establishing a secure channel (*e.g.*, SSL may be used over wireless communication) between the internal computer **12m** and the central control system **15** (or control unit **10t** of the BES).

According to yet another example, which may be used as an alternative, or in addition to the above described example, a request for service (**S1'''**, indicated by a broken arrowed line) may be sent to the control unit **10t** of the BES from the vehicle's internal computer, including the user's and/or vehicle identifying information. Possibly, the request (**S1'** or **S1'''**) sent from vehicle **12** (to the central control system **15** or to the control unit **10t**) may be followed by a user identification and authentication/authorization procedure (not shown) which may be carried out through the internal computer **12m** or at the user identification unit **18** of the BES **10**. Accordingly, the user authentication/authorization procedure carried out through the internal computer **12m** may be carried out from a remote location, before the vehicle **12** reaches the BES **10**, or during or after the vehicle **12** accesses the BES **10**.

The control unit **10t** then requests profile data (**S2**) from the central control system **15** concerning the user who has issued the request to service the vehicle **12**, and the user profile data is then extracted and sent (**S4**) to control unit **10t** of the BES. The profile data provided to the control unit **10t** may comprise certain additional information including, but not limited to, battery profile data and/or vehicle profile data.

With reference to **Fig. 3A**, showing an exemplary user profile data record **31**, the user profile data may include one or more of the following data sets: driving data (**31a**), frequent routes (**31b**), energy replenishment patterns (**31c**), service package (**31d**), and list of destinations (**31e**).

Driving data set (**31a**) includes information concerning driving habits/style, road behavior and other driving data of the user, such as captured by drive recorders. For example, the driving data set may include user's driving speeds (*e.g.*, highway and urban roads speeds), frequencies of aggressive accelerations and decelerations, windows state and use of air-conditioning along frequently used routes and/or daily times thereof, and suchlike. This data set may be updated from time to time based on driving data updates recorded by the internal computer **12m** of vehicle **12**.

Frequent routes related data set (**31b**) includes information concerning routes frequently driven by the user and time of day in which these routes are usually driven by the user. The routes may be provided as an ordered set of waypoints (*e.g.*, ten or twelve digits waypoints), of road numbers, and/or of road junctions, for example. This data set may further comprise additional data concerning the roads frequently used by the user, such as, for example, the traffic loads on these roads within the times of the day during which the user access these roads, driving conditions of these roads (*e.g.*, number and uphill and downhill slopes, winds strength and direction), and suchlike. The additional data may also comprise indications about the number of passengers in the vehicle and/or overall vehicle weight during such frequently driven routes. For example, the internal computer **12m** of the vehicle may be configured to determine the number of passengers in the vehicle by using sensors (*e.g.*, pressure or tension sensors) installed in the seats of the vehicle, and/or to measure the overall vehicle weight, for example based on pressure (or tension) sensors installed on the suspension system of the vehicle **12** and configured to provide indications corresponding to vehicle loads to the internal computer of the vehicle **12m**.

Energy replenishment patterns (**31c**) include information concerning the frequencies of battery recharging/discharging and/or replacements, and time durations and locations thereof. For example, a user who uses vehicle **12** mainly to drive between home and work locations may regularly recharge the vehicle battery pack using charging spots at these locations during specific time durations and hours of the day. Other users may drive longer distances and thus may regularly exchange exhausted battery packs with fresh ones during certain times and in certain favorable locations.

Service package data set (**31d**) includes data concerning the user's subscription terms, and services provided therein. For example, this data set may indicate whether the package of services the user subscribed for includes battery exchange services, type

of batteries the subscription covers, any insurance coverage the subscription may provide, and suchlike.

Destination data set (**31e**) includes data concerning the regular driving destinations of the user during certain times of the day and days of the week, and/or the actual driving destination at the time the vehicle is being serviced, if so indicated by the user.

Fig. 3B illustrates data sets possibly included in a battery profile data **32** according to some embodiments. The battery profile data may include: battery type data (**32a**), age and/or health data (**32b**), recharge and exchange history data (**32c**), calculated efficiency (**32d**), and battery ID (**32e**).

Battery type (**32a**) data set includes data concerning the model and specifications of the battery pack **13d** to be replaced *e.g.*, maximal capacity, maximal/nominal working electrical voltages/currents, weight, efficiency, working temperatures, specified recharge electrical voltages and currents and time durations, and suchlike. Age and health (**32b**) data set includes data concerning condition and state of the battery pack **13d** *e.g.*, actual capacity, capacity at high temperatures, discharge rate in an unloaded state, year of manufacture, expected life-span, known fluctuations from battery manufacturer specifications, any known malfunction events, and suchlike. Recharge and exchange history (**32c**) data set includes data concerning all past recharge events and optionally a list of electrical vehicles in which the specific battery pack **13d** was used in the past. This data set may further include details concerning past recharge events (*e.g.*, time durations, electric voltages and currents used during past recharge cycles, and suchlike) and the battery performance recorded in each of the vehicles in which the battery was previously installed. Calculated efficiency (**32d**) data set includes battery efficiency values calculated by the central control system **15** based on recorded battery performance and charging history. The measured battery efficiency may be different from the value specified by the manufacturer and may be used to evaluate the battery state and expected performance. The battery ID (**32e**) data set includes one or more identifiers which may be used to uniquely identify the battery pack **13d** currently used in vehicle **12**.

Data provided in the battery profile **32** may be used in the battery selection process to select a type of battery having suitable specifications (*e.g.*, size and geometrical dimensions, and electrical characteristics). In possible embodiments, the

battery profile **32** is used in the battery selection process to find a battery pack **13g** that is more or less of the same age and has health conditions as those of the battery pack **13d** installed in the vehicle **12** to be serviced. Alternatively or additionally, the battery profile **32** is also used by the control unit to prepare a charging plan to be used in the charger and storage apparatus **10c**, for example, based on the recharge and exchange history **32c** and on the age and health **32b** datasets.

Fig. 3C illustrates data sets possibly included in a vehicle profile data **33** according to some embodiments. The vehicle profile data **33** may include: vehicle type (**33a**), vehicle weight (**33b**), and/or motor efficiency (**33c**), for example.

Vehicle type (**33a**) data set includes information concerning the model and brand of the vehicle **12**. Weight (**33b**) data set includes information concerning vehicle weight, and possibly also concerning maximal weights the vehicle may be loaded with according to manufacturer specifications. Motor efficiency (**33c**) data set includes information concerning the energy consumption efficiency of the motor of the vehicle to be serviced.

If the vehicle **12** to be serviced placed a reservation (**S1'**), the profile(s) data may be sent to the control unit **10t** of the BES by the central control system **15** with the request (**S1''**) to schedule the reservation, before or during access of the vehicle **12** to the BES **10**.

In some possible embodiments, if there is no indication in the user profile **31** concerning the destination of the vehicle, control unit **10t** of the BES may communicate the vehicle **12** to be serviced **12** (**S4'**, indicated by a broken arrowed line) and request this information directly from the internal computer **12m**. If such a request (**S4'**) is received, the internal computer **12m** may request the user to indicate a destination, if user destination is not indicated to it before, and then send a response (**S4''**, also indicated by a broken arrowed line) to control unit **10t** of the BES indicating the destination information. If, after this communication (**S4**, and/or **S4' S4''**), the user destination is still unknown, control unit **10t** may attempt to determine the destination based on the user profile **31**, for example according to regularly routes driven by the users on certain days and at certain times of day, as discussed and exemplified hereinabove.

The data received (**S4**) from the central control system **15** may include a battery selection policy to be used by the control unit **10t** in the battery pack selection process.

For example, the central control system **15** may predict trends of battery exchange demands based on data received from vehicles **12**. Thus, the battery selection policy may be adapted to reserve an adequate amount of battery packs having a certain amount of charged energy and certain ranges of temperatures in order to meet expected demands and loads.

Such expected demands may be determined based on the users' profile data **31** managed by the central control system **15**, by analyzing regularly driven routes during the days of the week and during hours of the day. For example, the central control system may be able to predict a high demand for battery exchange services during afternoon to early evening hours in which certain users living in remote locations may need to drive back home from their work locations. As another example, if the central control system is notified about a football match in a remote location which is the destination of a substantial number of users of vehicles **12**, then the battery selection policy provided by the central control system **15** may be adapted to guide the battery pack selection process to reserve an adequate amount of battery packs having energy content sufficient to guarantee such users to safely reach their destination and thereafter return home or approach another BES **10**, if so needed.

Accordingly, the battery pack selection policy may guide the battery selection process to select battery packs which are partially charged and/or being in certain temperature ranges, considered to be safe for reaching the users' destinations, while reserving battery packs with more capacity and/or with greater amounts of charged energies and/or lower temperatures, to meet expected or current demands of long distance drivers.

Additionally or alternatively, the battery selection policy may guide the control unit **10t** to adapt the battery pack selection process to maintain at all times a desired average amount of charged capacity (*e.g.*, about or above 80%) of all battery packs stored and being charged in the charger and storage apparatus **10c**. In this way the central control system **15** may regulate the energy supplied to users by the battery exchange service and maintain a constant desired level of energy in all BESs **10** available for servicing the vehicles.

After, or simultaneously with, requesting the data profile(s) (**S2**), the control unit **10t** of the BES requests from the charger and storage apparatus **10c** a status report (**S3**) concerning the charging level of all battery packs **13g** in the charger and storage

apparatus **10c**. The status report from the charger and storage apparatus **10c** (**S5**) may be provided periodically without requiring the issue of a request (**S3**) in order to continuously provide the control unit **10t** with updated data concerning charge level of all battery packs **13g** that are being recharged and that are stored after recharge in the charger and storage apparatus **10c**.

Fig. 3E illustrates a data structure **34** of a possible status report (**S5**) provided by the charger and storage apparatus **10c** in some possible embodiments. In this example, the status report includes a plurality of data records (**34a**, **34b**, **34c**,...) each of which includes data pertaining to a particular battery pack **13g** in the charger and storage apparatus **10c**. An exemplary data record **34a** may include the following information:

- Battery ID (**34a1**) indicating the unique one or more identifiers of the battery pack **13g**;
- Maximal capacity (**34a2**) indicating the maximal energy capacity of the battery pack **13g**;
- Charge level (**34a3**), being the level of energy recharged into battery pack **13g**, which may be indicated as the percentage of recharged energy relative to the maximal energy capacity (**34a2**) of the battery pack **13g**, or as the actual amount of energy stored in battery pack (*e.g.*, in Ampere-Hour units);
- Temperature (**34a4**) of the battery pack **13g**;
- Status (**34a5**) indicating whether the battery pack **13g** is currently in the process of being recharged or in storage after a recharge session;
- Health (**34a6**) parameters of battery pack (**13g**)(*e.g.*, number of recharge cycles, internal resistance, actual capacity, discharge rate in unloaded conditions, and such like).

In this way control unit **10t** of the BES may be updated with information concerning the battery pack inventory, such as the state of charge, state of health and battery temperature status of all battery packs **13g** in exchange apparatus **10x**. Optionally, the history of the battery packs and their expected maximal capacity and state of health is obtained directly from battery packs **13g** having an internal battery management module (not shown), or retrieved from central control system **15** based on battery pack identifier **34a1**.

Once received in the control unit **10t** of the BES or at the control center **15**, as the case may be, the profile(s) data (**S4**) and the status report (**S5**) are used by the

respective control unit to determine the best match between the available battery packs **13g** and the needs of the user of vehicle **12**. The status report (**S5**) may be further used by the management system (*e.g.*, control unit **10t** of the BES) to determine a battery selection policy for the BES **10** to allow maintaining a desired average charged energy level of battery packs **13g** in BES **10**, to meet users' requirements during times of high demands for battery exchange services, and/or to equalize the level of wear of all of the battery packs.

In possible embodiments, a battery selection/matching process is employed to provide users with the overall longest driving distances between charging points accessible by the user. For example, the selected battery pack may be the battery pack having the highest state of charge, the lowest battery temperature (**34a4**) and highest state of health (*e.g.*, **34a6** which may indicate newer batteries). The battery pack selection procedure may be adapted to provide battery packs **13g** containing less energy (**34a3**), having higher temperature levels (**34a4**) and lower state of health (**34a6**) to users having smaller energy consumption demands.

For this purpose, the current driving destination (**31e**) data of the users is considered, and if it appears that there is a shortage in fully charged battery packs **13g**, then partially charged battery packs **13g** will be provided to users such that their immediate driving destinations are within the travelable range of the partially charged battery pack **13g** that is selected for the battery exchange.

The service agreement that the user has subscribed for with the service provider as indicated in the service package data set **31d** may be used in certain cases to guide the battery selection procedure. For example, certain service packages **31d** may specify servicing only certain types of battery packs, or battery packs having certain capacities or charge levels. Accordingly, based on the level of service which the user is entitled to, the system may modify the battery selection process to provide a battery pack having higher or lower energy content to the specific user.

The battery pack selection process may take into account the demand of all vehicles **12** that are currently being serviced as well as vehicles **12** that communicated with the central control system **15** via their internal computer **12m** to place an advance notification (**S1'**) requesting battery pack exchange service in a specific BES **10** in the near future.

Based on the above, the battery pack selection process attempts to satisfy the requirement of all serviced vehicles **12**, to allow them to reach their current destinations, or other BESs **10** accessible by the vehicles **12** along the route to the destinations, and provide battery packs whose current energy content can fulfill these requirements.

In possible embodiments, the management system (*e.g.*, the control unit **10t** of BES **10**) optimizes the selection process, such that battery packs **13g** with higher energy content and lower temperatures will be provided to users with typical longer driving distances, in order to minimize battery exchange events. The profile(s) data may be used by control unit **10t** to determine a battery selection profile specifying the requirements expected from the selected battery pack.

In possible embodiments the profile data **8r** may be collected and analyzed in order to determine a battery selection profile reflecting battery features required from a replenished battery pack to be installed in a specific vehicle used by a specific user. An exemplary battery selection profile **35** is illustrated in **Fig. 3D**. In this example the battery selection profile includes the following data sets: battery type (**35a**), needed amount of energy (**35b**), threshold temperature (**35c**), age and health (**35d**), efficiency (**35e**). These features of the battery selection profile **35** are then used in the battery selection process to find at least one battery pack from the stock of replenished battery packs available in the battery exchange station that complies with the requirements defined in the battery selection profile **35**.

Battery type (**35a**) data set specifies one or more types of battery packs which may be used in the battery exchange process. For example, this data set may include the information indicated in the battery type data set **32a** of the battery profile **32**, and or any number of other types of compatible battery packs matching the needs of the specific vehicle **12** and capable of satisfying a user's needs. Needed amount of energy (**35b**) data set specifies the minimal amount of energy required for satisfying the user and vehicle needs for reaching the target destination.

The threshold temperature (**35c**) data specifies a temperature threshold (T_{thresh}) for the battery pack to be selected. For example, in some possible embodiments the battery selection process is configured to select battery packs whose temperature (T_{batt}) is smaller than some predetermined threshold temperature *i.e.*, $T_{batt} < T_{thresh}$. The threshold temperature (**35c**) defined in the battery selection profile **35** may define different threshold values for different battery selection events. For example, the

threshold temperature (**35c**) may be defined for each battery selection event based on the battery type (**35a**), battery age and health (**35d**) and/or battery efficiency (**35e**), fields of the battery selection profile **35**.

In possible embodiments a preset threshold temperature (**35c**) is defined for all battery selection events. In one exemplary embodiment the preset threshold value is generally in the range of 30°C to 36°C, preferably about 33°C, *i.e.*, to preclude selection of battery packs whose temperatures are higher than 33°C.

Age and health (**35d**) data set specifies possible age and health conditions of the battery pack to be selected. For example, if the user agreement so requires, this data set may define parameters that will guarantee that the condition of the selected battery pack be more or less the same as those of the battery pack **13d** currently installed in the vehicle **12**. In other possible embodiments this data set may define parameters determined to satisfy certain insurance conditions as may be defined in the service package data set **31d**. Efficiency (**35e**) data set specifies a range of expected efficiency values expected for the battery pack to be selected in order to guarantee optimal performance.

Accordingly, the battery selection profile **35** may be used by the management system to extract from the status report **34** a set of candidate batteries complying with the requirements specified in the data sets of the battery selection profile **35**. A battery pack to be installed in the vehicle **12** may be then selected from the set of candidates, for example, by constructing a list of the candidates and sorting it in descending order according to one of the data sets **35a** to **35e** and selecting the uppermost candidate in said list.

It should be clear that other selection methods may be used based on the same inputs in order to satisfy other parameters, as an example, a selection process that aims to equalize the level of wear of all battery packs which are used in the system **17/16**.

Once a suitable battery pack is selected, the control unit **10t** instructs (**S6**) the battery exchange apparatus **10x** to use the selected battery pack in the battery exchange process. For example, this may be implemented by simply indicating, to the battery exchange apparatus **10x**, the identifier (*e.g.*, **34a1**) of the selected battery pack. Simultaneously, or shortly thereafter, control unit **10t** instructs (**S7**) the serviced vehicle **12** to release any battery pack locking mechanism which may be active therein. The battery exchange apparatus **10x** then proceeds to remove the discharged, or partially

discharged, battery pack **13d** from the serviced vehicle **12**, and installs the selected battery pack **13g** in the vehicle **12**.

After completing the battery exchange process, the battery exchange apparatus **10x** indicates (**S8**) to the control unit **10t** that the battery exchange is completed, which thereupon instructs (**S9**) the serviced vehicle **12** to activate the locking mechanism for securing the newly installed battery pack in the battery bay of the vehicle **12**. Simultaneously, or shortly thereafter, the control unit **10t** reports (**S10**) to the central control system **15** the details of the battery exchange event, which may also include payment information concerning payable fees for charging the user account and/or any fees paid by the user onsite (if any) during the battery exchange process. The battery exchange report (**S10**) sent to the central control system **15** may include the battery profile **32** of the battery pack installed in the serviced vehicle **12**.

The above examples and description have of course been provided only for the purpose of illustration, and are not intended to limit the invention in any way. As will be appreciated by the skilled person, the invention can be carried out in a great variety of ways, employing more than one technique from those described above, all without exceeding the scope of the invention.

CLAIMS:

1. A method for selecting a battery for a vehicle in a battery exchange station, the method comprising:

providing profile data comprising at least user related data associated with a specific vehicle;

providing status data about a plurality of replenished battery packs available in said battery exchange station, said status data comprising at least amount of stored energy in each of the replenished battery packs;

calculating an energy consumption estimation based on said profile data; and

processing said status data and said energy consumption estimate and selecting at least one replenished battery pack from said plurality of replenished battery packs for the specific vehicle.

2. A method according to claim 1, wherein the profile data comprises vehicle related data of said specific vehicle.

3. A method according to claim 1 or 2, wherein the profile data comprises information about driving routes frequently driven by the user.

4. A method according to any one of claims 1 to 3, further comprising determining a target destination of said user based on said profile data, and using said target destination for calculating the energy consumption estimation.

5. A method according to any one of claims 1 to 4, comprising generating a query to the user for determining of a target destination to be used for calculating the energy consumption estimation.

6. A method according to any one of claims 2 to 5, wherein the vehicle related data comprises at least one of the following: vehicle type, vehicle weight and motor efficiency.

7. A method according to any one of claims 1 to 6, wherein the profile data further comprises battery data specifying features of a battery pack currently installed in the vehicle.

8. A method according to claim 7, wherein the battery data includes at least one of the following: battery type, battery age, battery temperature, battery health, battery efficiency, battery identifier.

9. A method according to any one of claims 1 to 8, wherein the profile data comprises at least one of the following: energy replenishment patterns specifying user's patterns of battery exchange and/or recharge; service package data specifying terms and agreement of user subscription; and target destination data specifying at least one target destination of said user.

10. A method according to any one of claims 1 to 9, wherein the status data comprises a plurality of records, each record comprising data indicative of a specific battery pack from the plurality of replenished battery packs available in the battery exchange station, each data record comprising at least one of the following: battery identifier; battery maximal capacity; battery charge level; battery temperature; battery location specifying whether said battery is being recharged or being stored after such recharge; and battery health.

11. A method according to any one of claims 1 to 10, wherein the selecting comprises selecting from battery packs whose temperature is lower than a preset threshold value.

12. A method according to any one of claims 1 to 10, wherein the calculating of energy consumption estimation further comprises determining expected features for battery pack selection, said expected features comprising at least one of the following: battery type or types of compatible battery packs; threshold temperature; battery age; battery health; and battery efficiency, and wherein said selecting is based at least in part on said expected features.

13. A method according to any one of claims 1 to 12, further comprising providing a battery selection policy for introducing additional considerations in the selecting of the at least one replenished battery pack.

14. A method according to claim 13, wherein the additional considerations include reservation of replenished battery packs having a desired level of charged energy or of temperature.

15. A method according to claim 13, wherein the additional considerations include maintaining a desired average level of energy stored in the battery packs available in the battery exchange station.

16. A method according to claim 13, wherein the additional considerations include equalizing the level of wear of all battery packs used.

17. A management system for use in selecting a battery for a vehicle in a battery exchange station, the system comprising:

a memory utility for storing data comprising status data about a plurality of replenished battery packs available in said battery exchange station, said status data comprising at least amount of stored energy in each of the replenished battery packs; and

a processor utility comprising:

an energy consumption estimator module configured and operable for receiving and processing profile data comprising vehicle related data and respective user related data for estimating energy consumption for said vehicle used by said user and generating data indicative thereof; and

a battery selection module configured and operable for receiving and processing said status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from said plurality of replenished battery packs selected for the specific vehicle.

18. A system according to claim 17, wherein the profile data comprises vehicle related data of said specific vehicle.

19. A system according to claim 17 or 18, wherein the profile data comprises information about driving routes frequently driven by the user.

20. A system according to any one of claims 17 to 19, wherein the energy consumption estimator module is configured and operable for determining a target destination of said user based on said profile data, and using said target destination for calculating of the energy consumption estimation.

21. A system according to any one of claims 17 to 20, wherein the processor utility is configured and operable for generating a query to the user for determining a target destination for further using said target destination for calculating the energy consumption estimation.

22. A system according to any one of claims 18 to 21, wherein the vehicle related data comprises at least one of the following: vehicle type, vehicle weight and motor efficiency.

23. A system according to any one of claims 17 to 22, wherein the profile data further comprises battery data specifying features of a battery pack currently installed in the vehicle.

24. A system according to claim 23, wherein the battery data includes at least one of the following: battery type, battery age, battery temperature, battery health, battery efficiency, battery identifier.

25. A system according to any one of claims 17 to 24, wherein the profile data comprises at least one of the following: energy replenishment patterns specifying user's patterns of battery exchange and/or recharge; service package data specifying terms and agreement of user subscription; and target destination data specifying at least one target destination of said user.

26. A system according to any one of claims 17 to 25, wherein the status data comprises a plurality of records, each record comprising data indicative of a specific battery pack from the plurality of replenished battery packs available in the battery exchange station, each data record comprising at least one of the following: battery identifier; battery maximal capacity; battery charge level; battery temperature; battery location specifying whether said battery is being recharged or being stored after such recharge; and battery health.

27. A system according to any one of claims 17 to 26, wherein the energy consumption estimator module is configured to select from battery packs which temperature is higher than a preset threshold value.

28. A system according to any one of claims 17 to 26, wherein the energy consumption estimator module is configured and operable for determining expected features for battery pack selection, said expected features comprising at least one of the following: battery type or types of compatible battery packs; battery temperature range; battery age; battery health; and battery efficiency, and wherein said selecting is based at least in part on said expected features.

29. A management system for use in managing battery selection for vehicles in a battery exchange station, the system comprising:

a memory utility accessible from said battery exchange station, said memory utility comprising status data about a plurality of replenished battery packs available in said battery exchange station, said status data comprising at least amount of stored energy in each of the replenished battery packs; and

a control system connectable to said memory utility and connectable to users' service provider utility for receiving profile data comprising vehicle related data and respective user related data, said control system comprising:

an energy consumption estimator module configured and operable for processing said profile data and estimating energy consumption for said vehicle used by said user and generating data indicative thereof; and

a battery selection module configured and operable for receiving and processing said status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from said plurality of replenished battery packs selected for the specific vehicle.

30. A management system for use in managing battery selection for vehicles in a battery exchange station, the system comprising:

a control system connectable to a storage device for receiving status data about a plurality of replenished battery packs available in said battery exchange station, said status data comprising at least amount of stored energy in each of the replenished battery packs, and connectable to users' service provider utility via a communication network for receiving profile data comprising vehicle related data and respective user related data, said control system comprising:

an energy consumption estimator module configured and operable for processing said profile data and estimating energy consumption for said vehicle used by said user and generating data indicative thereof; and

a battery selection module configured and operable for receiving and processing said status data and data indicative of the estimated energy consumption, and generating output data indicative of at least one replenished battery pack from said plurality of replenished battery packs selected for the specific vehicle.

31. A management system for use in managing battery selection for vehicles in a battery exchange station, the system comprising:

a server system connected to a communication network, said server system comprising:

a data input utility for receiving and identifying a request data indicative of a request of a user of a vehicle at the battery exchange station;

a first communication utility for communicating with a storage device and receiving status data about a plurality of replenished battery packs available in said battery exchange station, said status data comprising at least amount of stored energy in each of the replenished battery packs,

a second communication utility for communicating with a users' service provider utility for receiving profile data comprising vehicle related data and respective user related data, and

a processor system comprising: an energy consumption estimator module for processing said profile data and estimating energy consumption for said vehicle used by said user and generating data indicative thereof; and a battery selection module for processing said status data and data indicative of the estimated energy consumption, and generating battery selection data indicative of at least one selected replenished battery pack from a plurality of replenished battery packs at said battery exchange station selected for said vehicle.

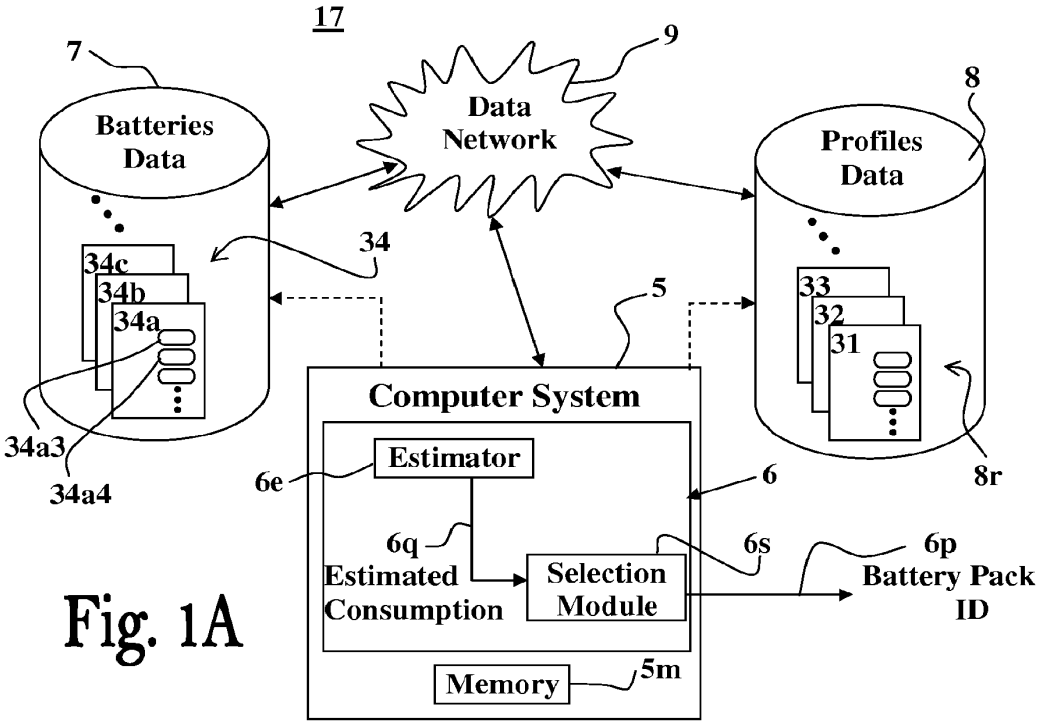

17
7
9
8
Batteries Data
Data Network
Profiles Data
34
34c
34b
34a
5
33
32
31
Computer System
34a3
34a4
Estimator
6e
6
8r
6q
6s
6p
Estimated Consumption
Selection Module
Battery Pack ID
Memory
5m

Fig. 1A

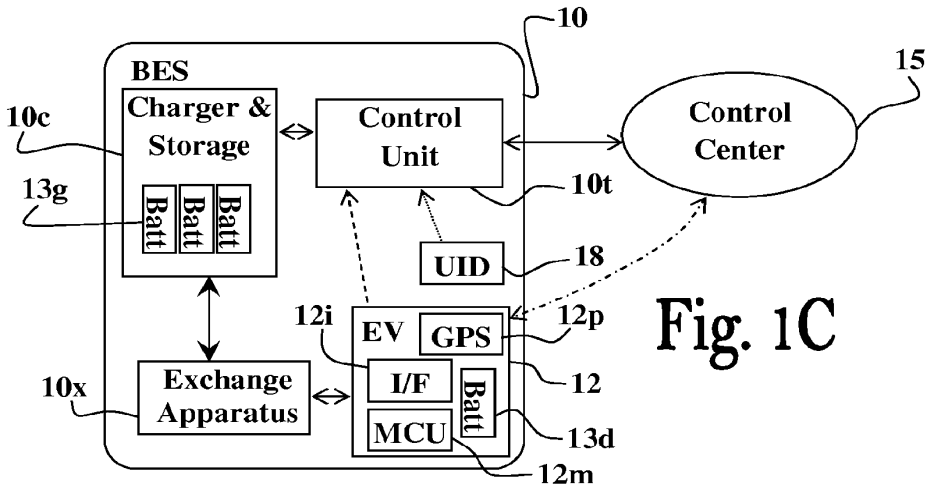

10
BES
15
10c
Charger & Storage
Control Unit
Control Center
13g
Batt
Batt
Batt
10t
UID
18
12i
EV
GPS
12p
10x
Exchange Apparatus
I/F
12
Batt
MCU
13d
12m

Fig. 1C

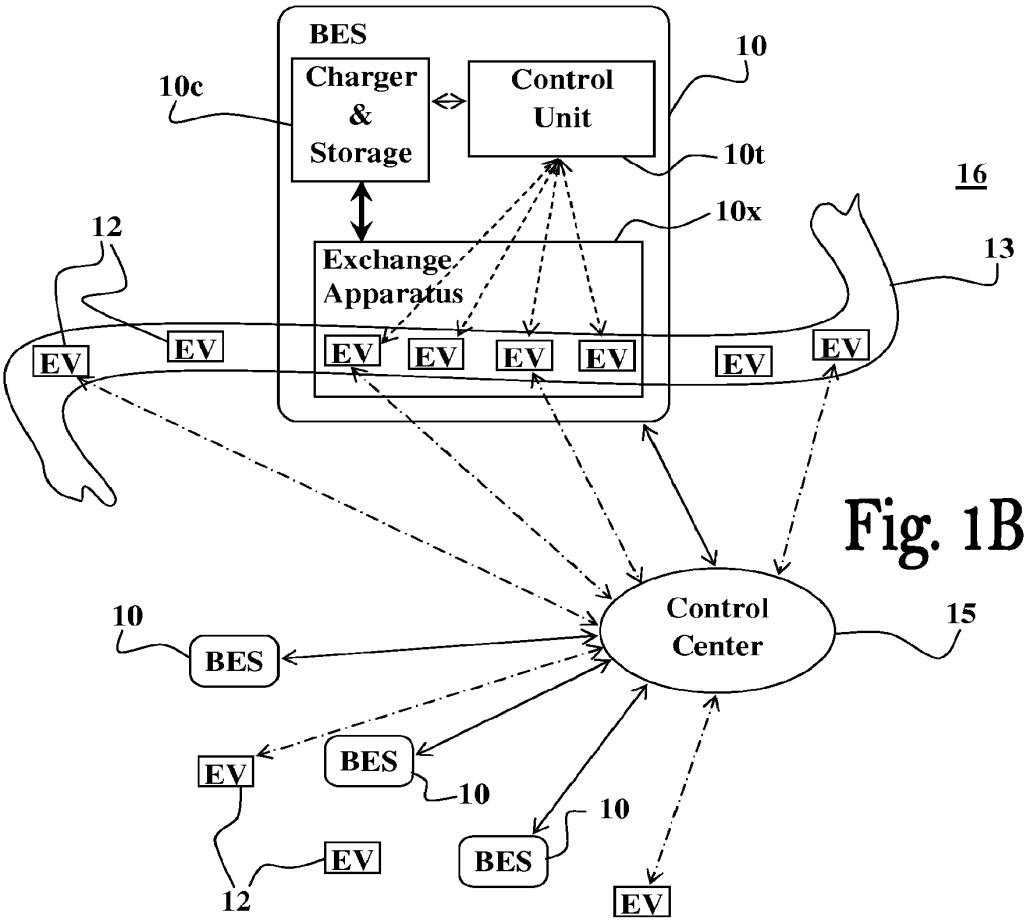

BES
Charger & Storage
Control Unit
10
10c
10t
16
10x
12
13
Exchange Apparatus
EV
EV
EV
EV
EV
EV
EV
EV
Control Center
15
10
BES
EV
BES
10
EV
12
10
BES
EV

Fig. 1B

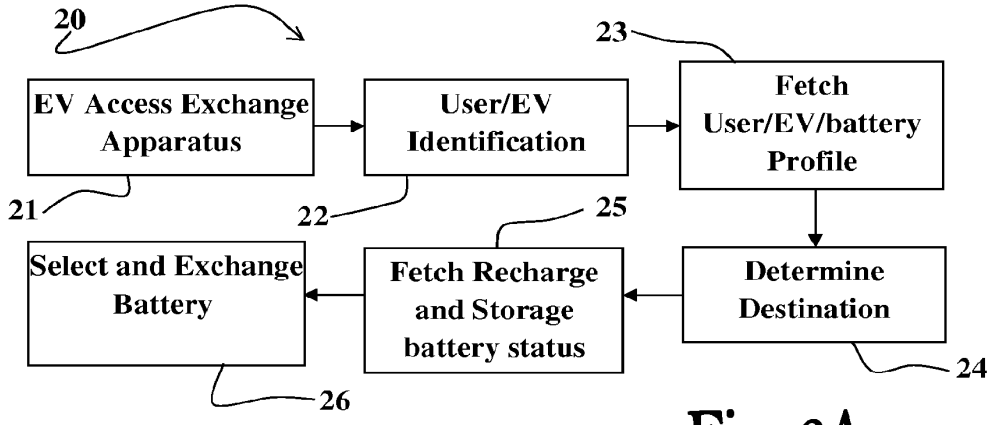

20
23
EV Access Exchange Apparatus
User/EV Identification
Fetch User/EV/battery Profile
21
22
25
Select and Exchange Battery
Fetch Recharge and Storage battery status
Determine Destination
24
26

Fig. 2A

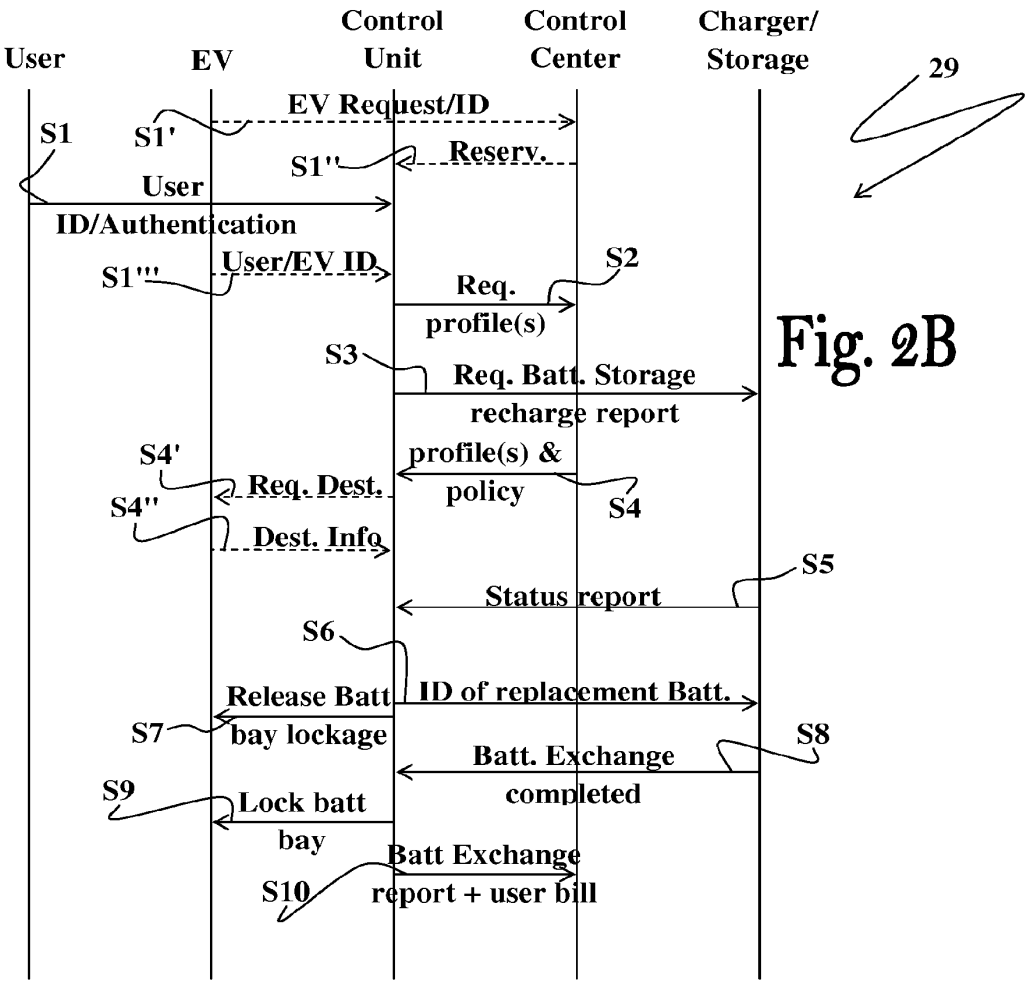

User
EV
Control Unit
Control Center
Charger/ Storage
29
EV Request/ID
S1
S1'
Reserv.
S1''
User ID/Authentication
S1'''
User/EV ID
S2
Req. profile(s)
S3
Req. Batt. Storage recharge report
S4'
profile(s) & policy
S4
Req. Dest.
S4''
Dest. Info
S5
Status report
S6
Release Batt bay lockage
ID of replacement Batt.
S7
S8
Batt. Exchange completed
S9
Lock batt bay
Batt Exchange report + user bill
S10

Fig. 2B

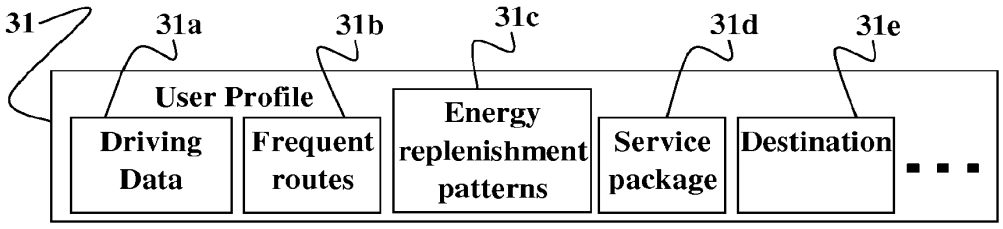

31
31a
31b
31c
31d
31e
User Profile
Driving Data
Frequent routes
Energy replenishment patterns
Service package
Destination
. . .

Fig. 3A

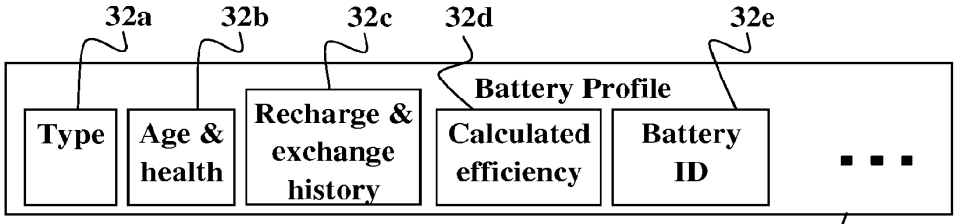


Fig. 3B

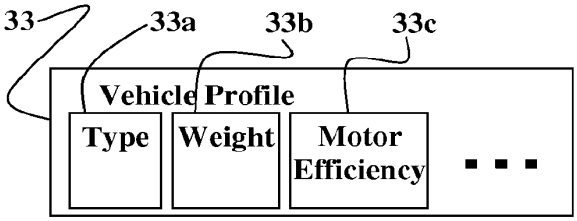


Fig. 3C

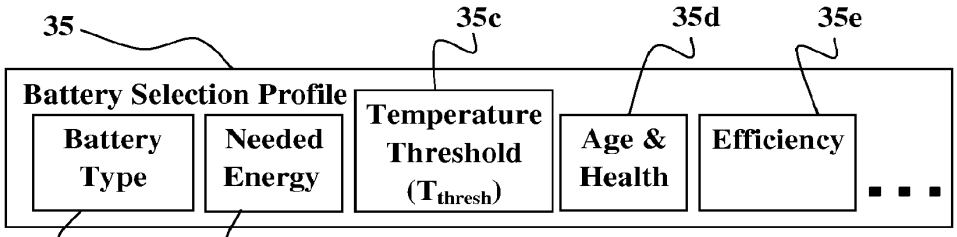


Fig. 3D

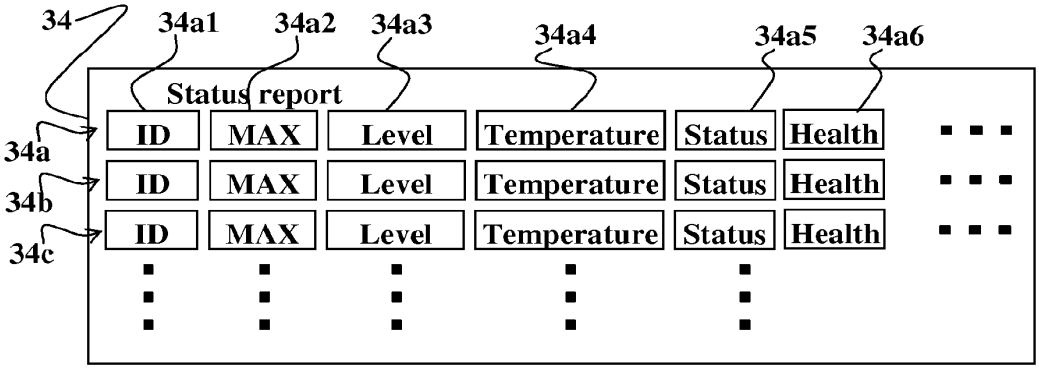


Fig. 3E

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2012/050490

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2013.01) G06Q 10/00, B60L 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (2013.01) G06Q 10/00, B60L 11/00, B60L 11/12, B60L 11/18

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Databases consulted: USPTO, Esp@cenet, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010272142 A Tomonaga 05 Aug 2010 (2010/08/05) whole	1-31
Y	WO 2011138205 A Pettersson 10 Nov 2011 (2011/11/10) whole	1-31
Y	US 20100094496 A Hershkovitz 15 Apr 2010 (2010/04/15) whole	1-31
A	US 20090082957 A Agassi 26 Mar 2009 (2009/03/26) whole	1-31
A	JP 2011096233 A Suganuma 12 May 2011 (2011/05/12) abstract,figs1,2	1-31

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 Mar 2013	21 Mar 2013
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2012/050490

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
JP 2010272142 A	05 Aug 2010	NONE	
WO 2011138205 A	10 Nov 2011	NONE	
US 20100094496 A	15 Apr 2010	NONE	
US 20090082957 A	26 Mar 2009	NONE	
JP 2011096233 A	12 May 2011	NONE	

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(74) Agent: **REINHOLD COHN AND PARTNERS**; P.O. Box 13239, 61131 Tel-Aviv (IL).

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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR MANAGEMENT OF ELECTRIC POWER CONSUMPTION

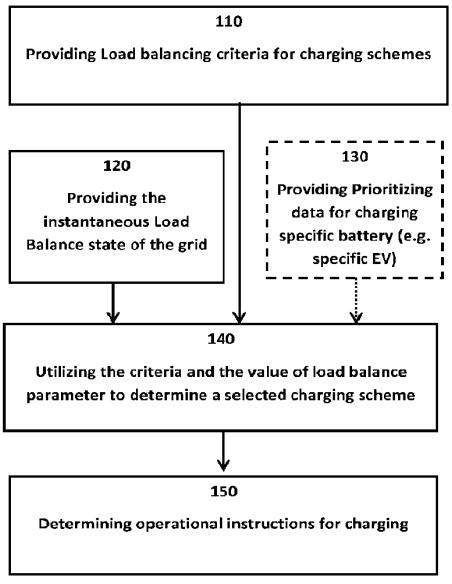


Fig. 1

(57) Abstract: A system and method are provided for use in electric charging of batteries by an electric network while managing and/or optimizing a load balance state of the network. The method includes monitoring the electric network to determine a value of at least one load balance parameter in the electric network. Data indicative of one or more charging criteria is provided associating values of the load balance parameter(s) with various charging schemes corresponding thereto. The one or more criteria and the determined value of the load balance parameter(s) are used to select a charging scheme for charging a battery in consideration with the load balance state of the network.

WO 2013/102894 A1

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

SYSTEM AND METHOD FOR MANAGEMENT OF ELECTRIC POWER CONSUMPTION

FIELD OF THE INVENTION

This invention relates to management of electric power consumption from an electricity network, and more specifically relates to managing the operation of electric vehicle supply systems for charging electric vehicles.

BACKGROUND OF THE INVENTION

Electric power utilities generally have a regulatory obligation to control frequency of electricity within tight limits. For example, the UK national grid is required to control the frequency as specified in the 'Electricity Supply Regulations' (The Electricity Supply Regulations 1988, No. 1057, PART VI, Regulation 30, Section 2) within a range of about ±1% of nominal system frequency (50.00Hz). Therefore, Utilities typically ensure that sufficient generation and / or demand of electricity is controlled, so as to manage all credible circumstances that might result in frequency variations.

As electricity is difficult to store, the instantaneous generation of electricity typically matches the demand (i.e., the electricity being taken from the system). If the instantaneous demand is higher than the generation, the system frequency may fall. Conversely, if the instantaneous generation is higher than the demand, the frequency may rise. System frequency will therefore vary around the base frequency - the 50 or 60 Hz.

There are several types of load-balancing techniques currently used to manage and control the load on an electrical network/grid. These techniques may be schematically classified as *power generation management* techniques and *demand management* techniques.

Generation management is a continuous service provided to manage and control a balanced state of the electric power distribution grid/network. The power utility or the regional operator follows the load (demand). When the demand increases the operator adds more generation power, and when demand is reduced also the generation power is diminished. Generation management is typically obtained by utilizing an *operating reserve* having the capacity to generate additional electric power for a short interval of time. The operating reserve may be used to meet demand, in cases where a generator stops operating, and if a disruption to the electric power supply is present. The operating reserve typically includes several types of power generation services that are capable of responding to changes in the load balance state of the grid in times scales of between several seconds and tens of minutes. For example an operating reserve may include a spinning reserve, a non-spinning or supplemental reserve, a regulating reserve and a replacement reserve (also known as contingency reserve).

Demand management techniques allow control over the rate for power consumption from the electric power distribution grid. Demand management techniques may be used to level the load on the grid by shifting the demand for power consumption from peak times to earlier or later times. This is achieved for example by utilizing price signaling to discourage high demand for power at peak hours. Discrete-demand management techniques utilizes an ability to automatically disconnect users in cases of substantially unbalanced load on the grid (e.g. if an emergency occur). Discrete-load-balancing techniques are typically associated with a very fast response times of less than seconds (e.g. 200 milliseconds). In most of the world big power consumers (e.g. big factories consuming over 3-5 Mega Volt-Amperes) are offered discount on electricity if they agree to install discrete-load-balancing devices in their main power feed.

GENERAL DESCRIPTION OF THE INVENTION

Growing use of electric and hybrid vehicles (referred to herein as EV's) presents challenges to the operation of electric power distribution grids/networks. EV batteries typically need to be charged for several hours to reach their full power capacity. Since multiple vehicles are typically used during traffic rush hours, substantial load on the electricity network is expected to follow the traffic rush hours when those vehicles are plugged for charging.

The present invention addresses this problem and provides a novel technique (system and method) for demand management of electric power consumption from the grid. The technique of the present invention is suitable for use by multiple power consuming utilities such as multiple EVs, electric vehicle supply equipment (EVSE) used for charging batteries, and other power consuming equipment connectable to the grid.

The present invention may be implemented as a standalone independent utility operating in association with an individual power consuming utility to allow connecting such power consuming utility to the grid while not causing the gird to reach an overloaded state in case multiple such utilities are connected to the grid at substantially the same times. To this end, the utility of the present invention may operate, in real time, independently from other utilities thus providing agile real time response to changes in the grid state. Also, the present invention may be used to control and adjust the electric power services consumed by such utilities in order to provide good service-level to those utilities. The service level provided to the power consuming utilities may be controlled and adjusted by prioritizing the power supply to selected utilities.

Specifically, a system according to the invention may be configured and operable for providing power replenishment services to batteries, while allowing demand management of the power consumption from the grid. Systems and methods of the invention may be used for example in association with charging modules and/or EVSEs to manage their electric power consumption. Such systems may be used to charge batteries of electric and/or hybrid vehicles (commonly referred to herein as EVs) while optimizing the operation of the electric grid.

Power replenishment of multiple EVs (EVs' batteries) may be prioritized and distributed over time in order to level the load on the grid. This has particular significance during peak power consumption hours. The distribution of the load over time enables the operator of the power distribution grid to follow the load and meet the power demand at a response time scale available to him. When needed, the grid's operator may operate to increase generation of power to the network (operation which may take between few minutes to one hour) while in the mean time network stability and balanced load state is maintained, at least partially, through demand management/regulation provided by the technique of the present invention.

The invention thus provides a system and a method providing real time response to the load balance state of an electric network. The response is provided, distributed in the network, by independently controlling the operation of one or more power consuming utilities and adapting their electric power consumption in accordance with predetermined criteria. Namely, each power consuming utility makes real-time independent decision as regarding the amount of power to be consumed-from (possibly also provided to) the grid based on predetermined conditions/criteria provided thereto in advance.

To this end, it should be noted that the present invention allows provision of real-time power demand management with short response times which may be below few seconds and optionally less than 1 second (e.g. in the order of few milliseconds to 500 milliseconds). The short response time is attained by the fact that monitoring of the gird's frequency and adapting power consumption may performed locally and in real-time (e.g. by an EVSE system) without a need to communicate with external utilities such as central control system managing power replenishment for EV or batteries thereof. Thus, the invention allows deployment of multiple EVSE's (e.g. charging stations/spots, portable-charging-utilities) which are adapted (according to predetermined instructions) to respond in real-time to variations in the electric grid operation while maintaining overall prioritization for charging electric vehicles. Also, EVSE's configured according to the invention may be adapted to operate independently from one another (e.g. as a standalone units) and may possibly not require real-time use of data communication.

Distributing the power consumption of the multiple EV-power replenishment utilities (e.g. of multiple EVSEs) over time is achieved by monitoring the load-balance state of the electrical network and controlling the instantaneous power consumption of the EVSEs. An EVSE system typically has the ability to sense the frequency of the grid. The technique of the invention may utilize the sensed frequency to determine the grid's load balance state and accordingly manage the power consumption of the EVSE. This, in turn, allows control over the grids frequency by relieving excess demand from the grid (e.g. by selectively and automatically turning-off and on battery/EV charging).

As noted above, the operation of the EVSE's may be prioritized to provide different power replenishment services to different EV's connected thereto. A standard dealing with communication between the EVSE and the Electric vehicle (EV) is

developed in a joint work group between IEC TC 69 and ISO TC 22/SC 21. This standard deals *inter-alia* with the exchange of data between a battery management system (BMS) on board the EV and an EVSE used to replenish the power of the EV's battery. Specifically, data indicative of the state of charge (SOC) of the battery may be obtained by the EVSE. The SOC data may be used according to the invention to prioritize power replenishment services provided to the EV. It should be noted that SOC is only an example of a possible prioritizing parameter. Other examples of prioritizing parameters are also described below. The power consumption of a power-consuming-utility/EVSE may be adjusted by controlling the operation of the utility, for example by selectively disconnecting/connecting the utility from the grid or selectively turning it on and off in accordance with the grid state and the prioritizing data.

For example, when an over-loaded grid state is identified (e.g. when the frequency of the grid drops), an EVSE utility of the invention may operate in accordance with the SOC of the EV for turning off charging and/or to change the power consumption used for charging the battery. EVs with a higher SOC will disconnect from charging at higher grid frequencies and only after that, at lower frequencies and if needed, EVs with lower SOC will disconnect from charging. Reconnection of power for charging the EV's may be performed in a reverse order: EVs with a lower SOC will be connected first and only later will be followed by EVs with high SOC.

Conditions/criteria for the modes/schemes of operation of the power consuming utilities at different grid conditions (different load balance states) may be selected in accordance with requirements from the electric-networks operator/aggregator and also in accordance with certain prioritizing parameters. For example the criteria for operating power consuming utilities may be defined per sub-groups of the power consuming utilities (e.g. per sub section of utilities which are serviced/powered by a certain service provider). Additionally or alternatively, the criteria may in some cases be defined globally (e.g. by a control center of the service provider and/or by the operator of the electric network) and/or in some cases the criteria may be also be defined locally by an electric network aggregator, such as a parking lot controller, providing power replenishment services to multiple EV's.

The relationship between the operation scheme of the power consuming utilities (i.e. referred to herein as *charging schemes*), the load balanced state of the grid, and possibly additional parameters such as prioritizing parameters may be defined in a

criteria (also referred to herein below as *charging criteria*) represented in lookup table (LUT) or by one or more functions or algorithms. The criteria may associate different load balance states of the grids with various operation schemes which may include schemes associated with various power consumption rates and possibly also schemes providing/inputting power to the grid.

The charging criteria may be a fixed function/table or it may be dynamic criteria which might be updated every once in a while. The criteria may be defined statically in a system controlling the power consumption of such power consuming utility and/or it may be updated from time to time possibly through data network communication. Typically, updates to the criteria are made such as to not delay the real time response of the system. For examples such updates may be performed in the background of the system's operation in a manner not affecting the system's real time response to changes in the grid state.

For example, the charging criteria may be calculated locally on power consuming utility/EVSE, by an electric power supplier/aggregator (e.g. a parking lot aggregator) and/or on the provider's control center. Such criteria may also be calculated and updated based on properties of multiple power consuming utilities (for example based on the SOC of multiple/all vehicles associated with a certain fleet) associated with a vehicle network of a certain energy replenishment provider. The calculated criteria may for example defines a specific SOC point(s) and electric grid frequencies at which EVSE's would operate to connect/disconnect batteries for charging. The calculated charging criteria may also, for example, define a LUT sorted according to SOC and service level (SL) parameters.

To this end, SL parameters are considered herein as parameters associated with service levels to be provided to various users (e.g. in accordance with the types of service level agreements (SLA) made with those users). SL parameters may be used to prioritize the receipt of certain power replenishment services by some users over other users.

According to the invention, the criteria (charging criteria) may implement hysteresis operation modes for preventing oscillations in the demand for electric supply. To this end, hysteresis may be implemented by setting the criteria for disconnecting or lowering the power consumption rates of power consuming utilities grid loads (higher overloaded states) to be lower than the load/load balance criteria for reconnection or

restoration of the power consumption rates of the utilities. For example, in an hysteresis operation, an EV with specific SOC is cut off from charging when the frequency of the grid goes below X, and is reconnected again only when frequency goes above X+ Positive Delta.

As noted above prioritizing parameters (e.g. the SOC of the battery), and possibly also other parameters such as battery parameters/characteristics, may be used in determination of the operation/power consumption of the power consuming utility (EVSE/battery charger etc'). Such parameters may be provided directly from the EV via the charging cable and/or wirelessly, and/or they may be communicated by the EV on board computer to the control center and from there to the specific EVSE. As will be also described below, the charging criteria/function may take into account additional information/parameters, such as the type of service guaranteed to the specific EV, the typical or current destination of its trip, and the required charging level to reach the destination. The system of the invention may also use process such additional information to estimate various parameters. For example an approximation of the battery SOC may be determined according to the charging time duration and the current supplied by the EVSE in addition to periodic information from the control center.

Thus according to one broad aspect of the present invention there is provided a method for use in electric charging of batteries by an electric network. The method includes: providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter of the electric network with charging schemes corresponding to the one or more values; monitoring the electric network to determine a value of the load balance parameter in the network; and utilizing the one or more criteria and the determined value to select a charging scheme to be used for charging a battery.

According to some embodiments of the invention at least one of the charging criteria is additionally associating one or more prioritizing parameters, corresponding to prioritized charging of a battery, with a corresponding charging schemes. In such embodiments the method also includes obtaining prioritizing values corresponding to the one or more prioritizing parameters in a battery to be charged, and selecting the charging scheme in accordance with the prioritizing values and the determined value of the load balance parameter.

The prioritizing parameters may include a state of charge (SOC) parameter indicative of the SOC of said battery to be charged. The value of the SOC parameter may be determined based on battery data received from onboard an electric vehicle at which the battery is installed. For example the value of the SOC parameter may be estimated based on battery-usage data indicative of at least one of the following: a previous SOC of the battery, battery service history data, and expected usage of the battery or a vehicle upon which said battery is installed.

The prioritizing parameters may alternatively or additionally include at least one of the following parameters: a service level (SL) parameter indicative of the service level to be provided to a vehicle upon which said battery is installed, and an expected usage (EU) parameter indicative of the expected power consumption to be used for driving said vehicle. The values of the SL and EU parameters or one of them may optionally be at least partially determined based on data received from onboard the vehicle.

According to some embodiments, the method of the present invention also includes obtaining information indicative of an identity of the battery to be charged and communicating that information to a control center for receiving therefrom at least one of the prioritizing values corresponding to the battery and/or one or more of the charging criteria to be used with the battery.

According to some embodiments of the invention the charging criteria are selected to optimize load balancing in the electric network. For example the charging criteria may associate over-load and under-load values of the load balance parameter, which correspond to over-load and under-load states of said electrical network, with the charging schemes having lower and higher power consumptions respectively thereby optimizing load balancing in the electric network. Alternatively or additionally, for a given set of the prioritizing values, the charging criteria associate over-load and under-load values of said load balance parameter with charging schemes having lower and higher power consumptions respectively. This thereby provides for optimizing load balancing in the electric network while also providing prioritized service to users of the batteries and all-to-all improvement of the provided service level.

It should be noted that according to some embodiments of the invention the load balance parameter corresponds to a frequency of electricity in the electric network. To this end, according to some embodiments the method of the invention includes

monitoring the frequency of said electric network to thereby determine a load balance state of the electric network. A frequency of the electric network being higher than a certain nominal frequency value of the network indicating the network operation in an under-load state, and the frequency of the electric network being lower than the nominal frequency indicating an over load state of the network.

According to some embodiments of the invention, at least one of the charging schemes may be indicative of a sequence of one or more charging cycles each including at least a charging period during which the battery is being charged and a recess period during which the battery is not charged. The one or more charging cycles may be, for example, periodic cycles with equal periods.

According to another broad aspect of the present invention there is provided a system for use in charging batteries by an electric network. The system includes a Charging-Protocol module configured and operable for providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter indicative of a load balance in the electric network with corresponding charging schemes. The system also includes an Electric Network Monitoring module associated with an electric network and adapted for providing data indicative of a value of said load balance parameter in the network. Additionally the system includes a Charging controller configured and operable for communication with the charging-protocol module and the electric network monitoring module. The Charging controller is adapted for utilizing the one or more charging criteria and the data indicative of the value of the load balance parameter to select a charging scheme for use in operating a Battery Charging module.

According to some embodiments of the present invention the system also includes a Battery Charging module that is connectable to the Charging controller and adapted for receiving therefrom a signal indicative of the selected charging scheme. The Battery Charging module may be operable for charging an electric vehicle in accordance with the selected charging scheme.

According to some embodiments of the present invention the system also includes a Prioritizing module that is adapted for providing prioritizing values corresponding to one or more prioritizing parameters associated with priority charging of batteries. In such embodiments, at least one of the charging criteria associates one or more values of the prioritizing parameters with a corresponding charging scheme. To

this end, the Charging-Protocol module may be adapted for receiving, from the Prioritizing module, one or more prioritizing values corresponding to a specific battery to be charged and for providing corresponding charging criteria data. Alternatively or additionally, the Charging controller may be adapted for receiving, from the Prioritizing module, one or more prioritizing values corresponding to a specific battery and utilizing prioritizing values in determination of the selected charging scheme.

The prioritizing parameters may include a state of charge (SOC) parameter indicative of the SOC of a battery to be charged. The Prioritizing module may be configured and operable for communicating with a control system on board the vehicle for receiving therefrom battery data indicative of a SOC of the battery. Alternatively or additionally, the Prioritizing module may be configured for estimating said SOC parameter based on at least one of the following: battery-usage data indicative of at least one of a previous battery SOC, battery service history data, and expected usage of a battery or a vehicle upon which said battery is installed.

According to some embodiments of the invention, the prioritizing parameters include at least one of the following: a service level (SL) parameter indicative of the service level to be provided to a vehicle upon which said battery is installed, and an expected usage (EU) parameter indicative of the expected power consumption from the battery. For example the Prioritizing module may be configured and operable for communicating with a control system on board said vehicle and receiving therefrom data indicative of a value of at least one of the SL and EU parameters.

According to some embodiments of the invention the system may include an identification module adapted for obtaining information indicative of an identity of the battery and communicating the information to a control center. The identity information may be indicative of the identity of at least one of the following: said battery, a vehicle upon which said battery is installed, and a user of said vehicle. In response to the communication of identity information, the Prioritizing module may be adapted for receiving, from the control center, values corresponding to one or more of the prioritizing parameters. Alternatively or additionally, the Charging-Protocol module may be adapted for receiving at least one of the charging criteria corresponding to the identity information.

According to some embodiments of the invention, the Charging-Protocol module is operable for providing charging criteria adapted for optimizing load

balancing in the electric network. The charging criteria may associate over-load and under-load values of said load balance parameter, which correspond to over-load and under-load states of said electrical network, with charging schemes having lower and higher power consumptions respectively. Alternatively or additionally, for a given set of prioritizing values, charging criteria associating over-load and under-load values of said load balance parameter with charging schemes having lower and higher power consumptions respectively. This thereby provides for improving load balancing in the electric network while also optimizing the power replenishment services provided to users of the system.

According to some embodiments of the invention, the system includes a Frequency Monitoring module connectable to said electric network and adapted for measuring the load balancing parameter indicative of at least a frequency of electricity in the network. The frequency value corresponds to a load balance state of the network. According to some embodiments of the invention the Charging-Protocol module may be adapted for providing data indicative at least one charging scheme comprising a sequence of charging cycles each including at least a charging period and a recess period. The Charging-Protocol module may be adapted for providing charging schemes having different ratios between durations of the charging periods and durations of the charging cycles thereby providing charging schemes associated with different power consumption rates. The Charging controller may be adapted for utilizing the charging criteria for selecting and utilizing such charging schemes and to charge the battery during charging periods while not charging the battery during recess periods.

According to yet another broad aspect of the present invention there is provided a system for use in charging batteries by an electric network. The system includes a Charging-Protocol module providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter indicative of a load balance in the electric network with corresponding charging schemes associated with different power consumption rates. The charging schemes include sequences of charging cycles including at least charging periods and recess periods having a different ratio between duration of the charging period and recess period, as compared to at least some other schemes. The system also includes an Electric Network Monitoring module and charging controller. The Electric Network Monitoring module is associated with an electric network and adapted for determining a value of the load balance parameter in

the network. The Charging controller is adapted for utilizing the one or more charging criteria and the value of the load balance parameter to select a charging scheme to be used for operating a Battery Charging module to charge a battery in accordance with the selected charging scheme.

According to yet further broad aspect of the present invention there is provided a method for use in charging batteries by an electric network. The method includes: providing data indicative of one or more criteria associating values of frequency of electricity in the network with charging schemes and monitoring the electric network to determine an instantaneous value of the frequency of electricity in said network. Then, the one or more criteria are used to select a charging scheme to be used for charging a battery. The charging schemes may include charging cycles. At least some of the charging schemes may be associated with different power consumption rates corresponding to different ratios between a charging period duration of their charging cycle and the total and duration of their charging cycles.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a flow chart **100** illustrating a method use in charging battery(ies) from an electricity network.

Figs. 2A-2D show four examples of charging criteria, represented in LUTs, which may be used in charging batteries from the electricity.

Fig. 3 is a block diagram schematically illustrating a system for use in charging a battery(ies) according to the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference is made to **Fig. 1** showing a flow chart **100** illustrating a method, according to an embodiment of the present invention, for use in charging battery(ies) from an electricity network. According to some embodiments of the invention method **100** may be partially or entirely implemented in an electric circuitry and/or by software

modules embodied in a non-transitory computer readable storage medium that stores one or more programs for execution by one or more processors of a computerized system.

Method **100** includes: providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter of the electric network with charging schemes corresponding to the one or more values (**110**); providing a value of the load balance parameter in the network (**120**); and utilizing the one or more criteria and the value of the load balance parameter to select a charging scheme to be used for charging a battery (**140**).

Optionally, at least one of said charging criteria additionally associates one or more prioritizing parameters, corresponding to prioritized-charging of the battery, with corresponding charging schemes. In such embodiments, the method also includes the step of obtaining prioritizing values corresponding to the one or more prioritizing parameters in a battery to be charged (**130**). If the step **130** is also present, the selected charging scheme selected in step **140** is also in accordance with the prioritizing values obtained at **130**.

The term *electricity-network* also referred to herein as grid, is the electric network from which electric power is provided for charging batteries. The method **100** may be implemented in association with a battery charging module to improve/optimize load balancing in the network, and optionally to further provide prioritized charging of batteries. The method of the present invention allows changing the load on the network, in order to relieve/avoid overloading the network. This method may be particularly useful in cases where multiple batteries are charged from the network at overlapping time periods. Furthermore, the present method may also allow provision of a desired service level (SL) to users of the batteries.

To this end, the terms *load balancing* and *load balance state* are used herein in association with the balance between the instantaneous amount of electric power supplied to the electricity-network/grid (e.g. by power plants) and the instantaneous load/power-demand from the grid. The term *balanced load state* indicates a state where the instantaneous generation of electric supply to the grid is substantially equal to the instantaneous demand of electricity. The terms *over-loaded* and *under-loaded* states are used herein to respectively describe states where the rate of power demand from the grid is higher than rate of power generated/supplied to the grid and vice-versa.

As was noted above, the expected extensive use of electric-vehicles (EVs) presents significant challenges in provision of electric supply for charging the batteries of such vehicles. This is, inter-alia, because significant electric power is required for charging an EV's battery (e.g. as high as 10kWatts or even higher) and because the majority of electric vehicles are expected to be connected for charging at common schedules (charging-rush-hours), such as during the working hours of the day (e.g. between 09:00 and 17:00) and during the night time (e.g. between 20:00 and 06:00). As a result, in the absence of techniques for controlling and adjusting the vehicles' charging operations, the electric grid might be overloaded during certain charging-rush-hours (e.g. at time frames when many people arrive at their working places). An over-loaded state of the electricity network, at such charging-rush-hours, may cause significant instabilities in the electric supply and possibly damage electric equipment plugged to the network. The present invention solves these problems by presenting technique for charging electric batteries while facilitating the maintenance of a balanced load state in the electric grid. Load balancing systems of the present invention may operate independently of each other for allowing connection of multiple batteries for charging at the substantially the same time frames (e.g. simultaneously) without instigating an over-loaded state of the electricity-network.

Thus, according to the method **100**, one or more charging criteria **CRT** are provided in **110** associating values of a load balancing parameter of the network with several (two or more) charging schemes. The charging schemes are associated with various operational modes (charging parameters) of a battery charging module and at least some of the charging schemes are associated with different power consumption rates from the electric network. For example two such charging schemes may be associated with the battery charging being turned ON and OFF respectively.

In **120**, the data indicative of the value(s) of one or more load balancing parameters in the electric network is provided. Optionally, according to some embodiments of the invention, electric parameters indicative of the load balancing state of the grid are monitored/measured (e.g. at the charging spot). Measuring electric parameters of the grid may be performed at fast rates for providing substantially real-time response to changes in the grid's state.

As noted above, the frequency of the electricity in the grid is typically an indicator to the load balancing state of the grid (as such it may serve as a load balance

parameter). Conventional electric networks worldwide typically provided either 220V or 110V AC voltages alternating at nominal frequencies of either 50 or 60Hz (depending on the electric network and state at which it resides). However, the instantaneous frequency of electric supply through an electric grid/network is typically susceptible to the load balancing state of the network (i.e. to the balance between the power supply-to- and demand-from- the grid). In over-load situations, where instantaneous demand exceeds generation of electric power, the grid's frequency drops below its nominal frequency. In under-load situations, where the instantaneous demand for power is below the rate of electric power generation, the grid's frequency rises above the nominal frequency.

Thus, according to some embodiments of the invention, the load balance state of the grid is provided in **120** by measuring the instantaneous value of the electric frequency of the grid and possibly determining a deviation value between the measured frequency and the nominal electric frequency of the grid. In such embodiments the charging criteria **CRT**, provided in **110**, may be adapted for associating values of the measured instantaneous frequency (or of deviation of the instantaneous grid's frequency from its nominal frequency) with various charging parameters/schemes, possibly having different power consumption rates. Certain charging schemes may in some cases also be associated with provision of power to the grid (e.g. by drawing power from the battery) to relieve overloaded grid states.

Alternatively or additionally, according to some embodiments of the present invention, data indicative of the network load balance state may also be communicated through a data network. For example, a load balancing parameter(s) of the network may be communicated from the utility company operating the electricity network or from a central control system controlling the operation of multiple charging systems (charging spots).

Optionally, according to some embodiments of the invention, not all batteries to be charged have the same charging priority. To this end, prioritizing data/parameters may be also incorporated in the charging criteria to allow prioritized charging of batteries. For example, in charging batteries of electric vehicles, some batteries/EVs/users may be associated with higher service level agreement (SLA) than others thus getting higher priority for charging their batteries. Also for some vehicles, the expected use of the vehicle may be lower than that of other vehicles and/or the state

of charge (SOC) of their batteries may be higher than the SOC of other vehicles. In such a case, a lower charging priority may be set for the vehicles with lower expected use or vehicles with higher SOC.

In addition, a charging module of the present invention may optionally be configured for charging different types of batteries which may be associated with different charging characteristics (e.g. different rates of power consumption during charging). These battery charging characteristics, indicated herein by the term battery parameters, may also be incorporated in the charging criteria and used for selecting a proper charging scheme.

As mentioned above, in the optional step **130**, prioritizing data and/or battery data is provided/obtained for charging a specific battery (e.g. of a specific EV/user). The prioritizing-data and battery-data, being respectively indicative of the values of the prioritizing- and battery- parameters of the specific battery to be charged, may be obtained from one or more controllers associated with the battery to be charged. Such controllers may include the following: the BMS (battery management system) of the battery (e.g. furnished with a device/EV carrying the battery), and a remote central control system (control-center) in communication the battery. Battery data pieces and prioritizing data pieces may be provided from a single controller of from several controllers associated with the specific battery. Also, such data may be obtained through data communication (e.g. via a data network). In some cases, specifically when the controller is associated with several batteries (e.g. central control system), the battery- and/or the prioritizing- data may be provided in response to communication of data indicative of the battery type/identity to the controller. Data indicative of the battery type/identity may be for example data identifying the EV upon which the battery is installed and/or data indicative of the user of the battery/EV.

Optionally, the prioritizing- and battery- data provided at **130** may be partially or entirely in the form of charging criteria **CRT** specifically designed in accordance with the priority, type and/or identity of the specific battery to be charged.

In **140**, the charging criteria (provided in **110** and optionally in **130**) are utilized to select a charging scheme based on the value of the load balance parameter(s) provided in **120**, and possibly also based on the prioritizing- and/or battery- data provided in **130**. The charging criteria may be in the form of a lookup table (LUT) or a formula or algorithm associating values of at least the load balance parameter(s) with

corresponding charging schemes/parameters. Accordingly, in **140**, an appropriate charging scheme selected.

In some embodiments of the invention, the selection of the charging scheme is performed in hysteresis mode to prevent oscillations in the power consumption of the charger and to improve network stability. In an hysteresis mode, the criterion of operating according to a certain charging scheme is different than the criterion for ceasing to operate by that scheme. For example a battery with specific SOC is cut off from charging when the grid's frequency falls below a first threshold X, and reconnects for charging only when the frequency rises above a second threshold higher than the first threshold (X + Positive Delta). Characteristics/parameters of the hysteresis operation mode may be provided together with the charging criteria above or they may be hard coded in the system of the invention.

It is noted that steps **120** and **140** are preferably carried out repeatedly and/or periodically in order to monitor changes in the load balance state of the electric network and to appropriately adjust the charging scheme used for charging the battery. As noted above, it is generally preferable to provide agile response to changes in the load balance state of the grid, with a load balance response time preferably below few seconds and more preferably less than 1 second. Accordingly, steps **120** and **140** may be repeated with fast rate (e.g. about every 500msec) to account for and respond to such changes. Steps **110** and **130** may be carried out once, or every once in a while, for providing/updating the charging criteria and/or when different batteries are connected to be charged by the system.

According to various embodiments of the invention, a charging scheme may be represented by one or more charging parameters indicating the manner by which a battery should be charged. In step **150**, operational instruction (e.g. data and/or signals) for charging a battery are determined based on the charging parameters of the charging scheme selected in **140**. The operational data and/or signals are then used for operating a charger module to charge a battery according to the selected scheme. For example, a charging scheme may be represented by a single parameter indicating charging and un-charging states (ON-OFF states) of the charging module.

According to some embodiments of the invention method **100** may be operated to maintain the grid in slightly off-balance load state. Operation of method **100** in this manner may be used in order to encourage changes in the electric power generation

supplied to the grid. For example, during charging-rush-hours, when multiple EVs are connected for charging, it may desired to "signal" to the grid's operator/utility-company, to increase the electric supply to the grid (increase electric generation). As noted above, the grid's operator is typically monitoring the load on the grid and adjusts the electricity generation accordingly to maintain a load balanced state. Thus, maintaining the grid state slightly overloaded "signals" the operator to increase in the electricity generation and *vice-versa*. Operating method **100** to maintain the grid at slightly off-balance load states can be achieved by utilizing suitable charging criteria. For example slightly overloaded grid states may be obtained by use of charging criteria with associate power consuming charging schemes with such slightly overloaded grid states. Alternatively or additionally, any one of steps **140** and/or **150** described above may be used to bias the selection of the charging scheme and/or to bias the operational charging instructions in order to affect a slightly un-balanced grid states. Preferably, the operation of method **100** to maintain the grid in slightly off-balance load state, does not include "active" over-loading/under-loading of the grid but rather passively refraining from correcting an unbalanced state of the grid when the grid is operating near the optimal load balanced state.

According to some embodiments of the invention, a charging scheme may be represented by one or more parameters indicating the average/nominal rate of power/current consumption to be obtained during charging. This can be achieved for example by adjusting the operation of a charger module to not exceed the desired power/current consumption. However, in some cases, the time required for adjusting the operation of the charger may be greater that the desired load-balance state response time. In such cases, in **150**, in situations of overloaded grid states, the operation of the charger module may be first shutdown/disconnected, then properties of the charge's operation may be adjusted to comply with the required level/rate power consumption and, only afterwards the charger may be turned on again.

Alternatively or additionally, a desired average power/current consumption of the charger module (or of other power consuming utility) may be achieved by operating the power consuming utility in cycles/pulses. For example, a certain charging scheme may be specified/represented by a single charging parameter indicating a certain average/nominal power consumption rate to be used for charging the battery; e.g. nominal power consumption of 2 kWatts. Considering a case where the power

consumption allowed for continuous charging of that certain battery is about 10 kWatts, then in order to charge that battery with average power consumption of 2KW, the battery should be charged during only a fraction 2KW/10KW = 0.2 of the time. This can be obtained according to the invention by operation the charger module in charging cycles including charging time-slots/periods during which the battery is charged and recess time-slots/periods during which the battery is not charged. Thus, in such embodiments of the invention, in **150** operative data/signals are generated for charging the battery in charging cycles where a ratio between duration of the charging period of a charging cycle and the total duration of the cycle substantially equals to the above described ratio 0.2. This provides charging the battery with a nominal power consumption rate of 2 kWatts. Fluctuations in the power consumption of the charger module which may result from such pulsed operation may be averaged out by the operation of multiple un-synchronized chargers operated in this manner and/or such fluctuations might be smoothed out by suitable electric circuits (e.g. by utilizing capacitors). Accordingly, utilizing such technique, substantially constant and reduced rate of power consumption may be obtained for charging multiple batteries form the grid while optimizing load balancing and improving stability of the electrical network.

Reference is now made to **Figs. 2A-2D** which show schematically several specific and non-limiting examples of charging criteria exemplified in the form of LUTs. It should be understood that equivalent, or other, charging criteria may also be provided in the form of one or more formula and/or algorithms as noted above. It should also be noted that other schemes of charging criteria may be used in by various embodiments of the present invention with other parameters and/or with other combinations of the parameters which are described in relation to any one of **Figs. 2A-2D**.

Figs. 2A and 2B illustrates charging criteria arranged in a lookup table LUT and relating different values/ranges of the grid's frequency **Fq** (being a measure of the load-balance state of the grid), with the charging parameters of various charging schemes. In **Fig. 2A** the charging schemes are specified in this example by a single charging parameter being either one of a Boolean charging operation parameter indicating ON and OFF states of the charging (connecting/disconnecting charging current supply) or a charging power parameter CC_P ([kWatts]) indicating the desired charging power consumption rate to be obtained by the corresponding charging scheme. In **Fig. 2B** the

various charging schemes are specified by a Charging Cycle ratio parameter $\mathbf{CC_R}$ ([%]) indicating a fraction of the actual charging time (pulse duration) to the entire duration of the charging cycle. Optionally additional parameter $\mathbf{CC_F}$ ([Hz]) indicative of the repetition rate/frequency of the charging cycles/pulses is also provided (this is the inverse of a pulse duration).

According to the invention, in order to contribute to a balanced load state of the grid and in the absence of additional parameters (such as prioritizing and/or battery parameters described above), the charging criteria is selected such that there is a positive correlation between the value of the load balance state of the grid (grid's frequency **Fq** parameter) and the power consumption rate of the charging scheme. To this end, in connection with the charging criteria of **Figs. 2A and 2B**, a positive correlation should be provided between the grid's frequency **Fq** parameter and at least one of the charging power consumption rate parameter $\mathbf{CC_P}$ and Charging Cycle ratio parameter $\mathbf{CC_R}$. Accordingly, for under-loaded grid states, for which the grid's frequency is relatively high, charging schemes with higher power consumption (e.g. and shorter overall charging time) would be used and *vice-versa* for over-loaded grid states.

Fig. 2C illustrates another example of a charging criterion according to the present invention, associating various charging schemes with parameters indicative of the load balancing state of the grid and with additional parameters including prioritizing-parameters and battery parameters. Here, for example, a load-balance indicator/parameter **LB** is provided in percentage, in terms of the excess load on the grid relative to the power load for a balanced grid state. Optionally, the value of this parameter in the grid may be communicated from an external utility, such as a central control system, rather than being directly measured from the grid. Additionally, in this example, charging schemes are represented by a single charging operation parameter **CO** being a Boolean parameter indicating ON and OFF states of the charger module.

The charging criteria illustrated in **Fig. 2C** includes also prioritizing parameters and battery parameters allowing prioritized charging of certain specific batteries based on properties of the Battery and/or charger associated therewith and also based on a certain desired service level to be provided to the battery or to its associated user/vehicle. To accomplish provision of a desired service level, certain parameters indicative of the expected use of the battery (or EV associated therewith), the state of the battery/EV may also be considered.

It should be noted here that the term prioritizing parameters is referred to herein broadly in association with various properties/parameters indicative of the priority for charging the battery and used in order to affect the selection of the charging scheme. To this end, the prioritizing parameters may include any combination of one or more of the following parameters and possibly also additional parameters:

(i) SOC - state of charge (SOC) of the battery. May be indicated by the amount of energy stored in the battery and/or fraction of the stored energy relative to the fully charged battery state.

(ii) EU - expected usage (EU) of the battery (e.g. in kWattsHour) which is due within a certain time frame. This may also be indicated by the expected use of a device/EV connected to the battery (e.g. driving expectancy in kilometers).

(iii) SL - service-level parameter may be a number indicating the service-level agreement (SLA) associated with charging the battery.

It should also be noted that the term battery-parameters is used herein to indicate any one or more parameters which are indicative of the battery charging characteristics (such as current/power consumption during charging). Such parameters may be associated with the type of the battery itself, and/or charger associated with the battery and/or with any other element(s)/factor(s) which might affect the battery charging operation. Battery-parameters may also be used in the present example for the determination of a suitable charging scheme to be used with specific battery type/identity. A specific non-limiting example of such parameters may in include the following or any combination thereof:

(i) BT - battery installed on the EV, its type or other properties thereof (not present in the figure).

(ii) CG – type of battery controller/charger (e.g. BMS) used for charging the battery (not present in the figure).

(iii) I –current drawn when charging the battery.

(iv) BC – power-storing capacity of the battery.

As noted above, the charging criteria are typically designed to optimize load balancing in the electric grid while preferably also provide improved power replenishment service levels. This may be obtained according to the by designing the charging criteria such that for equal sets of values of the prioritizing- and battery-parameters, there is a negative correlation between the load-balance state of the grid and

the power consumption rate of the corresponding charging schemes provided by the systems for such states. For example for the same prioritizing, higher power consuming schemes would be provided for slower grid frequencies. On the other hand, in order to improve the service level of power replenishment services, the charging criteria may also be designed such that for similar load balance states there is a positive correlation between the prioritizing parameters and the power consumption rate of the corresponding charging schemes. For example, for a certain grid frequency, batteries with higher priority would be charged faster or first.

Turning to **Fig 2D**, there is generally illustrated a charging criteria LUT usable for associating one or more charging schemes with values load-balance parameters and prioritizing parameters. Here, the specific charging schemes parameter(s) and prioritizing parameter(s) are not illustrated. Also, here a hysteresis parameter is indicated for each charging scheme. This parameter may for example designate a difference/delta between the frequency at which the charger should be triggered to operate according to a certain charging scheme and a frequency at which the charger should cease from operating according to that scheme.

It should be noted that according to some embodiments of the invention the charging criteria may include certain one or more criteria indicative of charging schemes with a negative power consumption rate. Namely, charging schemes at which power is drawn from the battery to the grid. For example, for certain overloaded grids states (e.g. low frequency values indicated by **Fq** parameter in **Fig. 2A**), a negative power consumption rate may be provided by the corresponding value(s) of the charging parameter(s) (e.g. negative value of the $\mathbf{CC_P}$ parameter in **Fig. 2A**). To this end, the charging criteria may be configured such that negative power consumption rate is provided in accordance with values of certain prioritizing parameters such as SOC and EU parameters. The values of such parameters may be used to determine whether the battery is more than sufficiently charged for the expected usage of the vehicle, and in such cases to allow drawing power form the battery to the grid.

Reference is now made to **Fig. 3** which is a block diagram **300** schematically illustrating a system for use in charging battery(ies) according to the invention. The system **300** may be implemented in a single charging unit/module or as a distributed system which certain modules thereof reside at different places (e.g. distributed between the charged device/EV/battery, a charger/charging-pole/station and a central control

system). In cases where the system is implemented as a non distributed system, it may be installed in its entirety at a charging station/pole, or installed with the device to be charged (e.g. on board the onboard EV), and/or it may be implemented as a portable system for use in charging batteries from the grid .

System **300** includes an Electric Network Monitoring module **320** and a charging controller **330.** The Electric Network Monitoring module **320** is associated with an electric network and adapted to provide data **LBV** indicative of the load balance state of the grid. The charging controller **330** is connectable to the Electric Network Monitoring module **320** and adapted for utilizing that data **LBV** to determine a suitable charging scheme **SCH** for use in charging a battery. Typically, according to some embodiments of the invention, system **300** also includes a Charging-Protocol module **310** operable for associating different load balance states of the electric grid (e.g. **LBV** data) with suitable charging schemes which are indicative of a certain characteristics of the charging operation. Charging-Protocol module **310** is configured and operable for providing data **CRT** indicative of one or more charging criteria associating one or more values of at least a load balance parameter (e.g. **LBV** data) with corresponding charging schemes. To this end, the Charging controller **330** may be connectable to the charging protocol module **310** for receiving therefrom data **SCH** indicative of the suitable charging scheme **SCH**. Alternatively or additionally, Charging controller **330** may be configured and operable for implementing the functionality of charging protocol module **310** internally; for example charging protocol module **310** may be included/integrated with the Charging controller **330**.

According to some embodiments of the invention, the system **300** also includes a Prioritizing module **340** that is configured and operable for providing values of one or more prioritizing parameters associated with prioritized charging of batteries. In such embodiments the charging criteria **CRT** may also associate values of the prioritizing parameters with corresponding charging schemes.

Also, according to some embodiments of the invention, system **300** includes, or is associated with, a Battery Charging module **350**. The Battery Charging module **350** is connectable to the Charging controller **330** and adapted for receiving therefrom operational instructions for charging a battery in accordance with the selected scheme. The operational instructions may be in the form of data and/or signals communicated to the Battery Charging module **350**. The Battery Charging module **350** may be part of

system **300** or it may be associated with a vehicle/device to be charged utilizing system **300**.

As noted above, according to some embodiments of the invention improving the load balance state of the network may be achieved by utilizing charging schemes which may have negative power consumption rates. In such embodiments, the charging controller **330** may be configured to operate in accordance with the selected scheme for carrying out any of the following: provide power from the grid to the battery for charging the battery at a certain rate; and drawing power/current from the battery to the grid (e.g. to relieve an over-loaded grid state). To this end, the battery charging module **350** may be configured to enable control over the power consumption rate during charging and to enable drawing power/current from the battery. In this respect the charging controller **330** may be adapted to operate in accordance with the capabilities of the battery charging module **350**.

For some types of power consuming utilities (e.g. some types of charging modules **350**) the time required for modifying their operation to changing their power consumption rate is longer than a desired real-time response time that should be provided by system **300**. Thus, according to some embodiments of the invention, in order to provide real-time response to changes in the grids load balance state, the system charging controller **330** is operable to selectively switch (ON/OFF) the current supply to such utilities in accordance with the state of the grid. Switching the current supply can be done extremely quickly and thereby provide real time response to the grid's load balance state. Optionally, meanwhile, after the power consuming utility had been disconnected, the charging controller **330** may operate modify its operation mode to comply with a desired power consumption rate. This operation may, in some cases, take longer then the desired system's response time and is thus made "off-line" after a first action of connecting/disconnection the utility has already been taken. Then, one the operational mode is modified in accordance with the charging criteria, the utility is reconnect again.

It should be noted that according to some embodiments of the invention system **300** or certain modules thereof may be implemented as a computerized system/circuit. To this end, system **300** may be associated with one or more processors and storage modules (not specifically shown in the figure). In this regards one or more modules of the system **300** may be implemented as software and/or hardware modules operating in

association with the one or more processors and storage modules. In this regards, according to some embodiments of the invention, system **300** is configured for utilizing data communication for communicating with a control center **399** and/or with the electric power consuming utilities to be charged by the system (e.g. EV's or battery controllers) and/or with user identification devices. To this end, system **300** may also be associated with one or more data communication modules (not specifically shown in the figure). These may be for example Bluetooth (BT) and wireless-LAN (WIFI) communication modules and also near-field-communication (NFC) modules such as, radio-frequency-identification (RFID).

The Electric Network Monitoring module **320** provides/determines data **LBV** indicative of the grid's load balance state. The Electric Network Monitoring module **320** may be for example connectable to the electric supply of the grid and configured for measuring certain electric parameters, such as the grid's frequency, indicative of the grid's load balance state. Alternatively or additionally, the Electric Network Monitoring module **320** may be adapted receive data/signals indicative of the load balance state. For example, the Network Monitoring module **320** may be associated with a data-communication module (e.g. modem) and adapted to communicate with a control center or grid/network information center for receiving therefrom the load balance state data **LBV**.

Charging-Protocol module **310** utilizes at least the data **LBV** indicating the load balance state of the grid to select a proper charging scheme **SCH** suited for charging a battery under the measured load balance conditions of the grid. Charging-Protocol module **310** may utilize the charging criteria **CRT** to determine suitable charging schemes for different load balanced states. As noted above, the charging criteria may include a rule, a formula and/or a LUT associating different values of the grid's frequency (or other load balancing parameters) with different charging schemes (e.g. charging parameters) having different power consumption rates.

According to some embodiments the Charging-Protocol module **310** may be adapted to determine and/or compute the charging criteria internally. Alternatively or additionally, Charging-Protocol module **310** may be adapted for communication with and another utility for receiving the charging criteria therefrom. In the latter case the charging criteria may be received and/or updated by a central control system **399**

associated with system **300**. Data communication may be carried out by utilizing a suitable data-communication module associated with system **300**.

According to some embodiments of the invention, system **300** is configured for improving the load balance of the network/grid. This is associated with relieving excess power/current demand from the grid when the grid is over-loaded and increasing the power/current consumption when the grid is under-loaded. To this end the Charging-Protocol module **310** may be adapted for associating lower power consuming charging schemes for over loaded grid states (e.g. for low measured frequencies of the grid) and higher power consuming schemes for under-loaded states of the grid (e.g. for high grid frequencies).

System **300** may be configured for providing agile response to changes in the grid's load balance state with response time of less than few seconds and preferably less than 1 second. This may be achieved by configuring the Network Monitoring module **320** for real-time monitoring the load balance state of the grid (preferably by direct monitoring/measuring of the grids frequency) and providing data **LBV** indicative thereof. Charging controller **330** may then also be configured to operate in real time to respond to changes in the load balance state and select a suitable charging scheme **SCHM** for adjusting the charging power consumption of the charger module **350** accordingly and in real time. In order to provide real-time load-balancing responses it may also be advantageous to configure system **300** as a standalone utility that operates independently of other utilities thus allowing it to operate for optimizing the load balance state of the grid without using data communication in real-time. It should be noted that data communication may still be used in such configurations of system **300** for non-real-time (e.g. background) operations such as updating the charging criteria **CRT** and the values of prioritizing- and battery- parameters of the charged batteries.

According to some embodiments of the invention, the Charging Protocol module **310** is adapted for producing/computing one or more charging criteria **CRT** which associate different charging schemes (e.g. different charging parameters) with various values of the load balancing parameter of the grid and possibly with various values of the prioritizing parameters. Alternatively or additionally, Charging Protocol module **310** may adapted for obtaining/updating the charging criteria **CRT** and/or corresponding charging schemes from an external utility **399** such as control center. The Charging Protocol module **310** may be connectable to such external utility via wired or wireless

communication. The Charging Protocol module may also be responsive to updates from the external utility **399**. Such updates may include updates to the charging criteria **CRT** and/or updates to the charging schemes associated therewith. The updates may be provided from the external utility **399** for example in response to changes in a power consumption policy and/or in accordance with a state and/type of the vehicle/battery to be charged. To this end, the Charging Protocol module may also be configured to initiate request to receive updates to the charging criteria for charging specific battery/EV.

As noted above, grid performance and load balancing, together with provision of improved and more accurate power replenishment services, may be provided by selecting the charging schemes in accordance with at least some prioritizing- and/or battery- parameters. According to some embodiments of the invention, system **300** includes the Prioritizing module **340** which is responsive for storing and optionally receiving data indicative of one or more prioritizing-parameters and/or the battery-parameters of the battery/EV to be charged. The Prioritizing module **340** may be configured and operable to obtain such data, or portions thereof, via direct or indirect data communication with the vehicle/device carrying the battery and/or via communication with an external utility **399** (e.g. control center).

In cases where the control center **399** provides prioritizing and/or battery data **PRI**, it needs to be able to determine/identify the battery or vehicle to be charged by system **300**. Such identifying data may be supplied to the control center **399** directly from the vehicle or by system **300**. Thus, according to some embodiments of the present invention, system **300** further includes an identification module **360** configured and operable for allowing identification of the battery to be charged. To this end, data identifying the battery **IDV** may include for example any one of the following: identifying the battery itself and/or its type and/or identifying the device/vehicle carrying the battery and/or identifying a user of the battery. The identification module **360** may be associated with a communication module and/or a user input module (not shown) through which identification data **IDV** can be provided. For example the identification module **360** may utilize radio-frequency-identification (RFID) or near-field-communication (NFC) technologies to identify data **IDV** indicative of the battery and/or its user and/or a vehicle associated with the battery. Alternatively or additionally, the Identification module **360** may be associated with data communication networks

such as Bluetooth (BT) or wireless-LAN (WIFI) and may be configured to communicate with a controller of the vehicle/battery for receiving therefrom Identification data **IDV** and possibly also prioritizing and battery data **PRI**.

Battery identification data **IDV** may be optionally used by the Prioritizing module **340** to determine prioritizing- or battery- parameters **PRI**. In such cases the Identification module may be connectable to the Prioritizing module **340** for communicating identification data **IDV** thereto.

Alternatively or additionally, according to some embodiments of the invention, the identification data **IDV** is communicated from the identification module **360** to the central control system **399**. The central control system **399** may utilize the identification data **IDV** to determine prioritizing and/or battery data **PRI** to be communicated to the Prioritizing module **340**.

CLAIMS:

1. A method for use in electric charging of batteries by an electric network comprising:

providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter of the electric network with charging schemes corresponding to said one or more values,

monitoring the electric network to determine a value of said load balance parameter in the network; and

utilizing said one or more criteria and said determined value to select a charging scheme to be used for charging a battery.

2. The method according to claim 1 wherein at least one of said charging criteria is additionally associating one or more prioritizing parameters, corresponding to prioritized charging of a battery, with a corresponding charging schemes; the method comprising obtaining prioritizing values corresponding to said one or more prioritizing parameters in a battery to be charged, and selecting the charging scheme in accordance with said prioritizing values and said determined value of the load balance parameter.

3. The method according to claim 2 wherein said prioritizing parameters comprise at least a state of charge (SOC) parameter indicative of the SOC of said battery to be charged.

4. The method according to claim 3 wherein a value of said SOC parameter is determined based on battery data received from onboard an electric vehicle at which said battery is installed.

5. The method according to claims 3 or 4 wherein a value of said SOC parameter is estimated based on battery-usage data indicative of at least one of the following: a previous SOC of the battery, battery service history data, and expected usage of the battery or a vehicle upon which said battery is installed.

6. The method according to any one of claims 2 to 5 wherein said prioritizing parameters comprise at least one of the following parameters: a service level (SL) parameter indicative of the service level to be provided to a vehicle upon which said battery is installed, and an expected usage (EU) parameter indicative of the expected power consumption to be used for driving said vehicle.

7. The method according to claim 6 wherein a value of at least one of said SL and EU parameters is at least partially determined based on data received from onboard said vehicle.

8. The method according to any one of claims 2 to 7 comprising obtaining information indicative of an identity of said battery to be charged and communicating said information to a control center for receiving therefrom at least one of said prioritizing values corresponding to said battery.

9. The method according to any one of the preceding claims, comprising obtaining information indicative of an identity of said battery to be charged and communicating said information to a control center for receiving therefrom at least one of said charging criteria to be used with said battery.

10. The method according to any one of the preceding claims, wherein said one or more charging criteria are selected to optimize load balancing in the electric network.

11. The method according to any one of the preceding claims, wherein said charging criteria associate over-load and under-load values of said load balance parameter, which correspond to over-load and under-load states of said electrical network, with the charging schemes having lower and higher power consumptions respectively thereby optimizing load balancing in the electric network.

12. The method according to any one of the claims 2 to 8, wherein for a given set of said prioritizing values, the charging criteria associate over-load and under-load values of said load balance parameter, which correspond to over-load and under-load states of said electrical network, with charging schemes having lower and higher power consumptions respectively thereby optimizing load balancing in the electric network.

13. The method according to any one of the preceding claims, wherein said load balance parameter corresponds to a frequency of electricity in the electric network

14. The method according to claim 13 comprising monitoring the frequency of said electric network to thereby determine a load balance state of said electric network, the frequency of said electric network being higher than a certain nominal frequency value of the network corresponding to the network operation in an under-load state, and the frequency of said electric network being lower than said nominal frequency corresponding to an over load state of the network.

15. The method according to any one of the preceding claims, wherein at least one of said charging schemes is indicative of a sequence of one or more charging cycles

each including at least a charging period during which the battery is being charged and a recess period during which the battery is not charged.

16. The method according to claim 15, wherein said one or more charging cycles are periodic cycles with equal periods.

17. A system for use in charging batteries by an electric network comprising:

Charging-Protocol module configured and operable for providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter indicative of a load balance in the electric network with corresponding charging schemes;

Electric Network Monitoring module associated with an electric network and adapted for providing data indicative of a value of said load balance parameter in the network; and

Charging controller configured and operable for communication with said charging-protocol module and said electric network monitoring module, and adapted for utilizing said one or more charging criteria and said data indicative of the value of the load balance parameter, and selecting a charging scheme for use in operating a Battery Charging module.

18. The system of claim 17 comprising a Battery Charging module connectable to said Charging controller and adapted for receiving therefrom a signal indicative of the selected charging scheme and operating for charging an electric vehicle in accordance with the selected charging scheme.

19. The system according to claims 17 or 18 comprising a Prioritizing module adapted for providing prioritizing values corresponding to one or more prioritizing parameters associated with priority charging of batteries, at least one of said charging criteria associating one or more values of said prioritizing parameters with a corresponding charging scheme.

20. The system according to claim 19 wherein said Charging-Protocol module is adapted for receiving, from said Prioritizing module, one or more prioritizing values corresponding to a specific battery to be charged and for providing said data, indicative of said one or more charging criteria, in accordance with said prioritizing values.

21. The system according to claims 19 or 20 wherein said Charging controller is adapted for receiving, from said Prioritizing module, one or more prioritizing values

corresponding to a specific battery and utilizing prioritizing values in determination of said selected charging scheme.

22. The system according to claim 21 wherein said vehicle prioritizing parameters comprise at least a state of charge (SOC) parameter indicative of the SOC of a battery to be charged.

23. The system according to claim 22 wherein said Prioritizing module is configured and operable for communicating with a control system on board said vehicle and receiving therefrom battery data indicative of a SOC of the battery.

24. The system according to claims 22 or 23 wherein said Prioritizing module is configured for estimating said SOC parameter based on at least one of the following: battery-usage data indicative of at least one of a previous battery SOC, battery service history data, and expected usage of a battery or a vehicle upon which said battery is installed.

25. The system according to any one of claims 19 to 24 wherein said prioritizing parameters comprising at least one of the following: a service level (SL) parameter indicative of the service level to be provided to a vehicle upon which said battery is installed, and an expected usage (EU) parameter indicative of the expected power consumption from said battery.

26. The system according to claim 25 wherein said Prioritizing module is configured and operable for communicating with a control system on board said vehicle and receiving therefrom data indicative of a value of at least one of said SL and EU parameters.

27. The system according to any one of claims 19 to 26 comprising an identification module adapted for obtaining information indicative of an identity of said battery and communicating said information to a control center; said Prioritizing module is adapted for receiving, in response, from said control center, at least one value corresponding to one or more of said prioritizing parameters.

28. The system according to any one of the claims 19 to 26 comprising an identification module adapted for obtaining information indicative of an identity of said battery and communicating said information to a control center; said Charging-Protocol module being adapted for receiving, from said control center, at least one of said charging criteria.

29. The system according to claims 27 or 28 wherein said information is indicative of the identity of at least one of the following: said battery, a vehicle upon which said battery is installed, and a user of said vehicle.

30. The system according to any one of the claims 17 to 29 wherein said Charging-Protocol module is operable for providing charging criteria adapted for optimizing load balancing in the electric network.

31. The system according to any one of the claims 17 to 30 wherein said charging criteria associate over-load and under-load values of said load balance parameter, which correspond to over-load and under-load states of said electrical network, with charging schemes having lower and higher power consumptions respectively thereby optimizing load balancing in the electric network.

32. The system according to any one of the claims 19 to 31 wherein said Charging-Protocol module is operable for providing, for a given set of said prioritizing values, charging criteria associating over-load and under-load values of said load balance parameter, which correspond to over-load and under-load states of said electrical network, with charging schemes having lower and higher power consumptions respectively thereby improving load balancing in the electric network.

33. The system according to any one of the claims 19 to 32 comprising a Frequency Monitoring module connectable to said electric network and adapted for measuring the load balancing parameter indicative of at least a frequency of electricity in the network and determining a frequency value corresponding to a load balance state for the network.

34. The system according to any one of the claims 17 to 33 wherein said Charging-Protocol module is adapted for providing data indicative at least one charging scheme comprising a sequence of charging cycles each including at least a charging period and a recess period.

35. The system according to claim 34 wherein said Charging controller is adapted for utilizing said charging criteria for selecting and utilizing said at least one charging scheme for charging said battery during charging periods of said charging cycles while not charging the battery during recess periods.

36. The system according to claim 35 wherein said Charging-Protocol module is adapted for providing charging schemes having different ratios between durations of the

charging periods and durations of the charging cycles thereby providing charging schemes associated with different power consumption rates.

37. A system for use in charging batteries by an electric network comprising:

Charging-Protocol module providing data indicative of one or more charging criteria associating one or more values of at least a load balance parameter indicative of a load balance in the electric network with corresponding charging schemes associated with different power consumption rates, the charging scheme comprising a sequences of charging cycles including at least charging periods and recess periods having a different ratio between duration of the charging period and recess period, as compared to at least some other schemes.

Electric Network Monitoring module associated with an electric network and adapted for determining a value of said load balance parameter in the network; and

Charging controller adapted for utilizing said one or more charging criteria and said value of the load balance parameter to select a charging scheme to be used for operating a Battery Charging module to charge a battery in accordance with the selected charging scheme.

38. A method for use in charging batteries by an electric network comprising:

providing data indicative of one or more criteria associating values of frequency of electricity in the network with charging schemes, the charging schemes comprising charging cycles and being characterized by power consumption rates, the power consumption rate corresponding to a ratio between a duration a charging period of the charging cycle and a duration of the charging cycle; and

monitoring the electric network to determine an instantaneous value of the frequency of electricity in said network and utilizing said one or more criteria to select the associated charging scheme to be used for charging a battery.

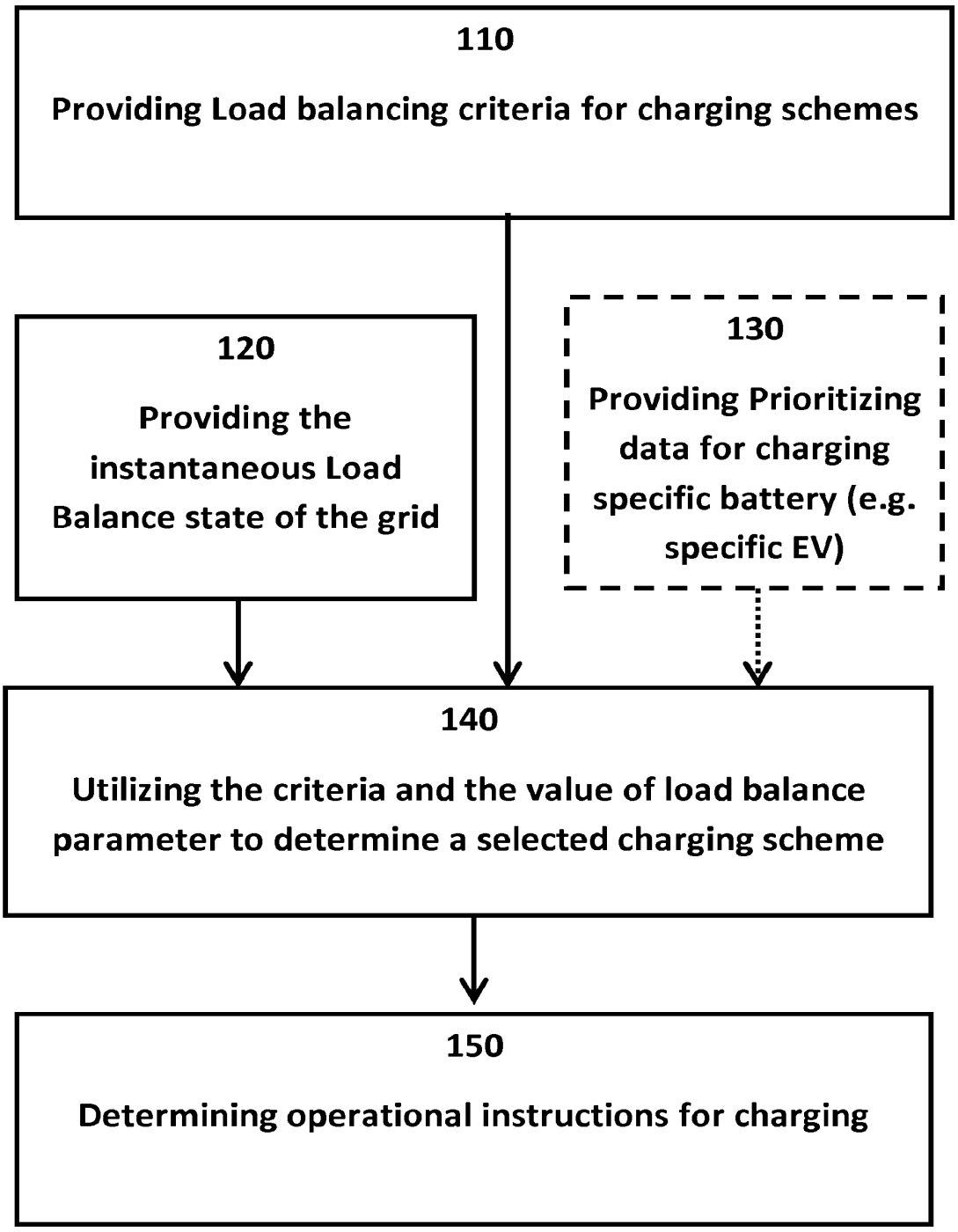

110
Providing Load balancing criteria for charging schemes
120
Providing the instantaneous Load Balance state of the grid
130
Providing Prioritizing data for charging specific battery (e.g. specific EV)
140
Utilizing the criteria and the value of load balance parameter to determine a selected charging scheme
150
Determining operational instructions for charging

Fig. 1

Parameter Category ->	Load-balance state	Charging Scheme
Parameters ->	**Fq** Grid's Frequency	**CO** - or - **CC_P** **CO**: ON/OFF states of charging **CC_P**: Power Consumption Rate
Units ->	[Hz]	Boolean / [kWatts]

Fig. 2A

Parameter Category ->	Load-balance state	Charging Scheme	
Parameters ->	**Fq** Grid's Frequency	**CC_F** Frequency/Rate of Charging Cycles	**CC_R** Charging Cycle Ratio (e.g. ratio between the actual charging duration and total time of a charging cycle).
Units ->	[Hz]	[Hz]	[%]

Fig. 2B

Parameter Category ->	Load-balance parameters	Prioritizing Parameters				Battery parameters		Charging Scheme
Parameters ->	**LB** Load-Balance-State	**SOC** Battery State of Charge	**EU_P** Vehicle's Expected Power Use	**EU_t** Vehicle's Expected schedual of Use	**SL** SLA Priority	**I** Charging current	**BC** Battery Capacity	**CO** ON/OFF states of charging
Units ->	[%]	[%] Or [kWatt*Hour]	[kWatt*Hour] Or [KM]	[HH:MM]	Number	[A]	[kWatt* Hour]	Boolean

Fig. 2C

Parameter Category =>	Load balance parameters		Prioritizing Parameters	Charging Scheme
Parameters ->	**Fq** Grid's Frequency	**HIST** Hysteresis		
Units ->	[Hz]	[Hz]		

Fig. 2D

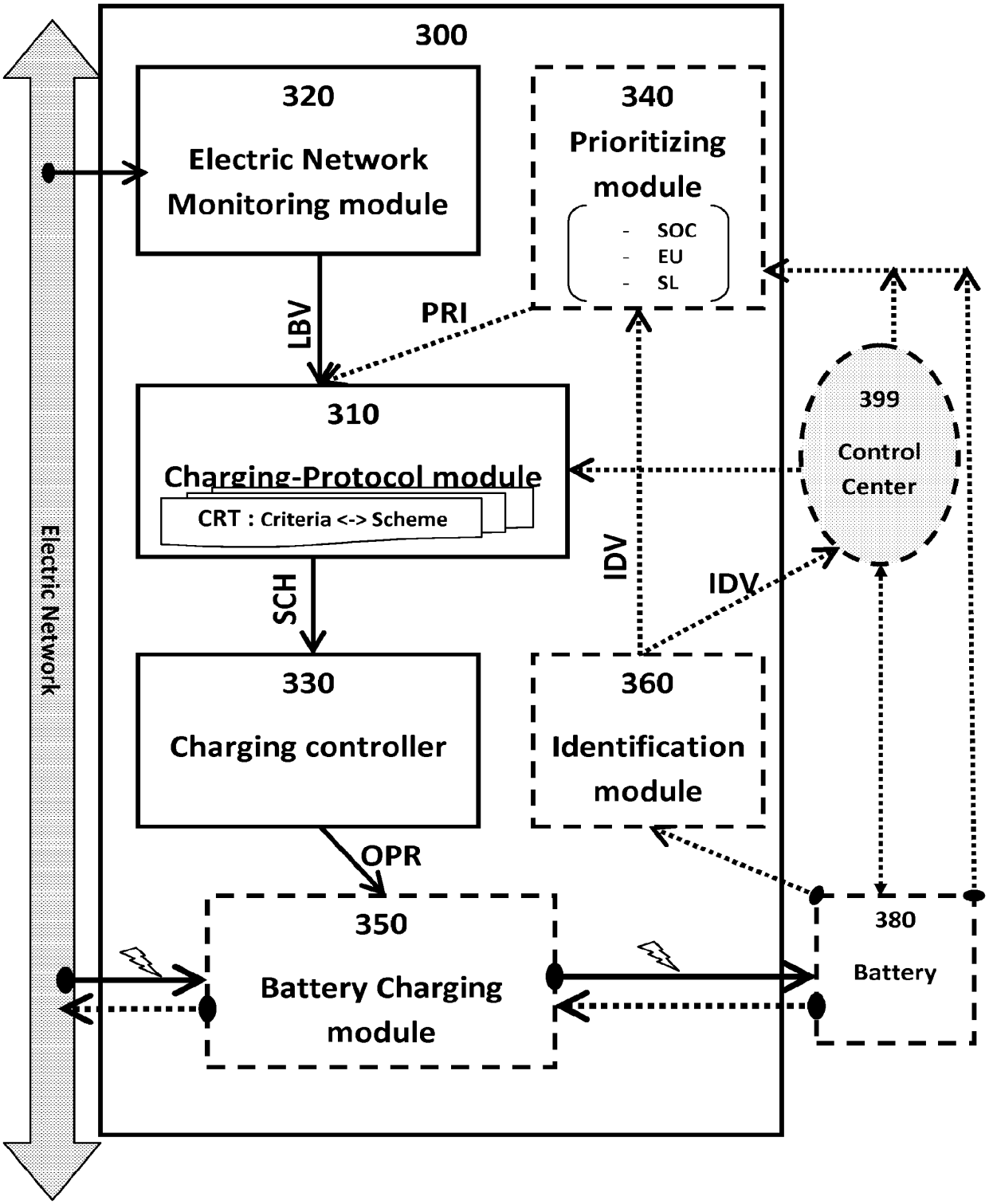

300
320
Electric Network Monitoring module
340
Prioritizing module
- SOC
- EU
- SL
LBV
PRI
310
Charging-Protocol module
CRT : Criteria <-> Scheme
399
Control Center
IDV
IDV
SCH
330
Charging controller
360
Identification module
OPR
350
Battery Charging module
380
Battery
Electric Network

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2012/050537

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J3/32 H02J13/00 H02J3/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02J

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 131 469 A2 (ANDEXLINGER ERICH [AT] ANDEXLINGER RUDOLF [AT]) 9 December 2009 (2009-12-09) abstract -----	1,17,37, 38

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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2

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2012/050537

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2131469 A2	09-12-2009	AT 506911 A1	15-12-2009
		EP 2131469 A2	09-12-2009

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[Continued on next page]

(54) Title: APPROXIMATION OF REMAINING TRAVELABLE DISTANCE OF A VEHICLE POWERED BY A BATTERY

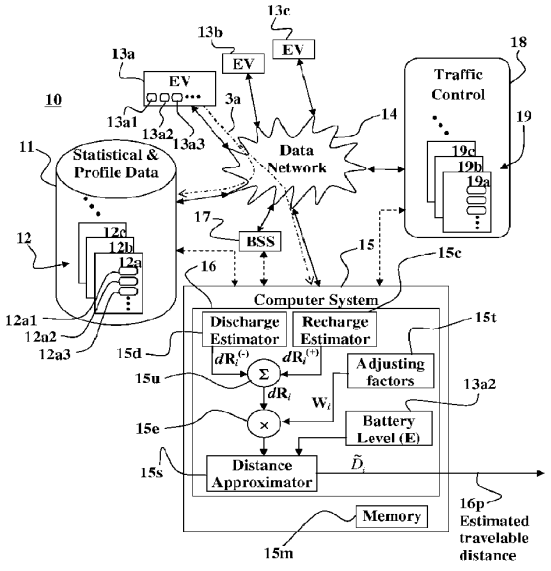


Fig. 1

(57) Abstract: The invention provides a method and system for calculating a remaining travelable distance of a vehicle powered by a battery. In some embodiments the remaining travelable distance is determined using data indicative of a route of the vehicle, statistical data related to a route and to a user of the vehicle, and data about a measured charge level of the battery of the vehicle indicative of an amount of energy stored in the battery. The statistical data may be utilized to determine a rate of battery energy flow for the battery of the vehicle indicative of a rate of discharge and/or recharge of battery energy along at least a segment of road of the route, such that the remaining travelable distance may be determined based on the determined rate of battery energy flow and the charge level of the battery.

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APPROXIMATION OF REMAINING TRAVELABLE DISTANCE OF A VEHICLE POWERED BY A BATTERY

FIELD

The present disclosure relates to a system and method for calculating possible travelable distance of a vehicle powered by a battery.

BACKGROUND

The vehicle industry is encouraged nowadays to shift to hybrid and all-electric vehicles (generally referred to hereinafter as vehicles) employing rechargeable batteries, particularly due to their environmental benefits. The use of rechargeable batteries as a power source provides various advantages, *inter alia* due to their reusability, cost effective power management, and improved performance.

Since the energy capacity of a rechargeable battery is limited, it is important to present to the user of the vehicle accurate information about the remaining travelable distance that can be driven before the battery goes flat. This type of indication exists today in many of the vehicles sold on the market.

Some developments concerning energy management of batteries of electric vehicles are described in the following patent publications.

U.S. Patent No. 5,487,002, to Robert W. Diller and Jeffery W. Pavlat, describes an energy management system for vehicles having limited energy storage that provides energy consumption prediction for range calculation based on standard or memorized driving data.

International Patent Publication No. WO 2009/067810 to Neil S. Simmonds *et al.*, describes a method for improving performance and charging of hybrid electric vehicles which determines whether the battery of the vehicles will fully discharge during a driving period along a route according to the driving conditions therealong.

U.S. Patent No. 5,627,752 to Michael Buck *et al.*, describes a method for assisting a driver of a vehicle in optimum use of on-board energy supply, which determines a permissible consumption rate taking into account external driving resistances along a driven road.

U.S. Patent No. 5,913,917 to Michael D. Murphy describes estimation of fuel consumption of a vehicle over a chosen trip route including a plurality of road segments wherein fuel consumption is estimated for each of the plurality of road segments using certain representative information.

GENERAL DESCRIPTION

The electric motors used in electric vehicles convert energy supplied from the battery of the vehicle into rotary movement of the vehicle's wheels. Energy capacities of the batteries of electric vehicles are limited, and it is therefore important to present to the users of such vehicles accurate information about the remaining travelable distance that can be driven before the batteries installed in their vehicles go flat. This type of indication exists today in many of the vehicles sold on the market.

The estimation of the remaining travelable distance of electric vehicles as implemented nowadays typically provides a basic estimation of a reachable distance that the vehicle can drive based on limited information collected by the internal computer of the vehicle from internal units of the vehicle. It appears that such basic estimations tend to be error-prone, and may incur a large percentage of errors. The effect and price of such errors can be significant as drivers may get stuck out of the range of battery charge or exchange stations (generally referred to herein as battery service stations).

Usually, the remaining travelable distance of electric vehicles is approximated mainly based on the amount of energy stored in the vehicle's battery. However, the remaining travelable distance of an electric vehicle depends on a plurality of factors some of which are related to the vehicle and its battery, to the user driving the vehicle, and to weather and road conditions along the route traveled by the user towards a target destination.

In addition, the approximation of remaining travelable distance of an electric vehicle should also consider energy replenishing factors. For example, electric vehicles may convert rotary movement of the wheels (*e.g.*, through the motor and/or by using alternators), or solar energy (*e.g.*, using photovoltaic cells panels), into electrical energy which may be used for recharging the vehicles' batteries as the vehicles are being driven.

The inventors of the present invention found that the remaining travelable distance of a vehicle powered by a battery may be calculated with improved accuracy based on calculation of a battery energy flow rate reflecting a rate of energy transferred between the battery of the vehicle and other components of the vehicle (*e.g.*, the vehicle's motor, alternators, and vehicle's electrical appliances) along a road section, or throughout the entire length of a planned route. The battery energy flow rate calculation may require analysis of the conditions of roads along the planned route to determine their slope / gradient, and/or any other resisting or propelling road conditions therealong (*e.g.*, back or front wind, road curvature, uphill and downhill slopes, etc.), which are used for calculating amounts of battery energy that will be consumed and/or recharged during the ride, along a road section, or throughout the entire length of a planned route.

For example, in possible embodiments the rate of battery energy flow includes rate of battery energy discharge, and/or rate of battery energy recharge, along at least one segment of road, or along the entire length, of the planned route. The battery energy flow rate may be then used to compute the amount of energy that will be consumed (*i.e.*, discharged from the battery of the vehicle) by the vehicle, or that will be recharged into the battery of the vehicle, over at least one segment of road, or along the entire length, of the planned route, which may be then used to calculate the remaining travelable distance with greater accuracy.

It was also found by the inventors of the present invention that the accuracy of the approximation of the remaining travelable distance may be further improved by introducing adjusting factors into the battery energy flow calculations. In some possible embodiments the adjusting factors reflect driving resisting and/or propelling road conditions. For example, data indicative of driving resisting and/or propelling road conditions may include real-time data comprising traffic and/or weather reports which are received and analyzed to evaluate a traversability factor indicative of the cross-ability of a road section in the planned route. The traffic reports may be indicative of traffic loads or jams in certain road segments of the planned route, and the weather reports may be indicative of resisting or propelling winds along certain road segments.

The inventors of the present invention further found that the accuracy of the approximation of the remaining travelable distance may be also improved by dividing the planned route into discrete road segments, and computing discrete energy flow rate for each of the discrete road segments separately. For example, the planned route may

be divided into a plurality of road segments, each characterized by specific driving resisting and/or propelling road conditions. Accordingly, calculation of the remaining travelable distance may be carried out by calculating a residual battery energy content based on the discrete energy flow rate approximations computed for the respective segments.

For instance, the calculation may include successively calculating a residual battery energy content estimate for each road segment of the planned route, starting with the road segment on which the vehicle is at the (present) time, or that the vehicle is about to approach, and proceeding with the upstream road segments towards the target destination. In this successive computation, for each specific road segment of the planned route, a residual battery energy level (indicative of battery residual charge level after the specific road segment is driven) may be computed by reducing from the current energy content of the battery a sum of energy consumption estimations computed for preceding road segments (*i.e.*, the road segments located downstream in the planned route relative to the specific road segment).

In this way, a discrete energy consumption estimate may be calculated for each road segment based on its respective discrete energy flow rate. The residual battery energy content may be computed for each specific road segment of the planned route by summating the discrete energy consumption estimates computed for preceding road segments (*i.e.*, located downstream relative to the specific road segment for which the residual battery energy content is being computed) and subtracting the summation result from the current energy content of the battery. Thus, the remaining travelable distance may be approximated based on division of a residual battery energy level computed for a specific road segment by the energy flow rate approximated for the specific road segment, or for one or more of the upstream road segments of the route *i.e.*, road segments to be driven from the specific road segment towards the target destination.

The approximation of the remaining travelable distance may include adding to the division result the sum of the lengths of the road segments that are located downstream relative to the specific road segment. For example, the remaining travelable distance may be approximated based on division of a residual battery energy level computed for a specific road segment by some average of the energy flow rates approximated for all of the upstream (or both downstream and upstream) road segments of the route. The approximation of the remaining travelable distance may include

adding to the division result the sum of the lengths of the road segments that are downstream relative to the specific road segment.

The calculation may include computing for each discrete road segment a respective remaining travelable distance approximation by dividing the residual battery energy content computed for a previous road segment by the respective discrete battery energy flow rate of the discrete road segment. If the remaining travelable distance approximation computed for a specific road segment is smaller than the length of the specific road segment, then it is determined that the amount of energy stored in the battery of the vehicle is not sufficient for the user driving the vehicle to complete the entire planned route (*i.e.*, the battery will go flat during the specific road segment).

If it is determined that the battery may go flat during a certain specific discrete road segment then the remaining travelable distance of the vehicle is indicated as the driving distance from the current location of the vehicle to the specific discrete road segment (*e.g.*, by summating the lengths of all road segments between the current location of the vehicle and the certain specific discrete road segment), or to a specific location therealong in which the battery is expected to go flat. The user may be thus advised to visit a battery service station along the planned route, to change driving style and/or road behavior (*e.g.*, drive the vehicle at lower speeds and acceleration/deceleration ranges, fully or partially close one or more windows, reduce or stop use of air-conditioning), and/or to change the planned route to include road segments which are less demanding in terms of energy consumption (having less drive-resistant conditions *e.g.*, having less, or no uphill slopes, having favorable weather conditions, and/or without traffic loads or jams, and suchlike).

In some embodiments the battery energy flow rate for each of the discrete road segments is computed based on external information that may have been recorded by the vehicle itself, or by a control center that manages and stores battery energy flow rates recorded and reported by a plurality of vehicles. Accordingly, the calculation of the remaining travelable distance may be carried out based on battery energy flow rates provided by a control center (or any communicable server system hosting a database of battery energy flow rates), which may utilize energy flow rates recorded for other vehicles and other users, and/or for the same vehicle and/or same user for which the remaining travelable distance is being calculated.

In possible embodiments improved approximation of the remaining travelable distance of the electric vehicle is calculated using various data indications and based on the amount of energy stored in the battery of the vehicle (also referred to herein as the battery charge level). The calculation may utilize various data indications accumulated over time and/or determined in real-time during the ride. The data indications may include: electric vehicle data, such as, for example: vehicle weight and efficiency of vehicle's motor; user driving data reflecting driving patterns of the user driving the vehicle, such as, but not limited to, highway and urban road driving speeds, and acceleration/deceleration ranges; road conditions data, such as for example, uphill and downhill slopes and their lengths, traffic loads and/or jams, number of lanes, and roads' curvature (*i.e.*, relatively straight or tortuous); and/or data about the battery installed in the electric vehicles, such as, battery temperature, battery age and health, battery efficiency, and suchlike.

For example, in some embodiments the approximation of the remaining travelable distance is carried out in accordance with a planned driving route by analyzing the various collected data indications in conjunction with the planned route and calculating, based thereon, an estimation of energy consumption of the vehicle per unit of distance traveled along the planned route. For example, the collected data may include data about amounts of energy consumed by the motor of the vehicle when driven by the user in the past over road segments included in the planned route.

As described hereinabove, the data indicative of the amounts of energy consumed over certain road segments may be based on battery energy flow rates recorded by the vehicle for the same road segments and stored in the internal computer of the vehicle, and/or based on battery energy flow rates collected by the control center for these road segments from a plurality of other users and vehicles. Such data may be used to calculate a battery discharge rate for specific road segments to be driven along the planned route, and/or for its entire length, which may be used to estimate the remaining travelable distance of the vehicle based on the amount of the remaining energy stored in the battery of the vehicle.

In possible embodiments the consumption of energy from the battery of the vehicle over road segments is derived from data indicative of the electric current consumed by the vehicle during the ride along the road segment *e.g.*, using electric current measurement equipment. Alternatively, or additionally, the battery energy

consumed by the vehicle along a specific road segment may be derived from data indicative of changes in the battery electric voltage level, which correlates to the amount of energy being consumed from it. A positioning system may be used to associate the measured electric current and/or voltage indications with specific road segments travelled by the vehicle.

The estimated remaining travelable distance of the vehicle may be modified, by calculating adjusting factors based on the accumulated data indications. For example, such adjusting factors may be calculated according to expected energy losses along the ride, computed based on the efficiency of the vehicle's motor, the efficiency of the vehicle's battery, the battery's age and/or the temperature of the battery. The remaining travelable distance approximation may be continuously or periodically modified by calculating adjusting factors upon receipt of updates received during the drive to the target destination and recalculating the remaining travelable distance approximation based on the newly calculated adjusting factors, the current location of the vehicle, and the current status of the battery (*e.g.*, charge level, temperature, etc.) of the vehicle.

Further adjusting factors may be calculated based on the user's driving data in general, and specifically based on driving data related to road sections included in the planned route. For example, if the user's driving data reflects that the user usually drives the vehicle at high speed and acceleration/deceleration ranges, then a wasteful user's energy consumption adjusting factor is computed and used to modify the calculated battery discharge rate.

Therefore, according to an aspect of the present application there is provided a method for calculating a remaining travelable distance of a vehicle powered by a battery, the method comprising the steps of: providing data related to a route of the vehicle (*e.g.*, road segments of the route, road data indicative of road conditions along the at least one segment of road of the route and/or topographic conditions of the at least one segment of road of the route); providing statistical data related to the route, and/or to other routes, and to a user of the vehicle, and/or other users of other vehicles (*e.g.*, driving patterns of the user, at least one route frequently driven by the user, and/or rate of battery energy flow along at least one segment of road in the at least one route frequently driven by the user); providing data about a measured charge level of the battery indicative of an amount of energy stored in the battery; utilizing the statistical data and determining a rate of battery energy flow for the battery indicative of a rate of

discharge or recharge of battery energy along at least one segment of road in the route; and determining a remaining travelable distance based on the rate of battery energy flow and the battery charge level.

The provided data may comprise vehicle data indicative of conditions of the vehicle and/or of its battery (*e.g.*, vehicle weight, vehicle payload, windows state, amount of energy consumed by electric appliances of the vehicle, motor efficiency, battery efficiency, and/or battery temperature). The road data may include at least one of the following: weather conditions along at least one segment of road of the route; traffic conditions along at least one segment of road of the route; number of lanes in at least one segment of road of the route; road curvature of at least one segment of road of the route; and gradient (slope) of at least one segment of road of the route.

The method may further comprise identifying, based on the provided data, a plurality of discrete road segments in the route, and the calculating of the battery energy flow rate may comprise calculating for each of the plurality of discrete road segments a discrete rate of battery energy flow based at least in part on specific considerations associated therewith.

In possible embodiments the statistical data includes data on a plurality of other users. For example, the statistical data and the data indicative of the route may have at least one common feature selected from the following group: at least one segment of road of a frequently driven route, same time of day in which the route is driven, same day of week in which the route is driven, same day of month in which the route is driven, similar driving style, and similar road behavior.

Optionally, the statistical data is collected from a plurality of users and maintained in data storage (*e.g.*, data server) accessible by the vehicle. The method may further comprise associating data items in the statistical data to road segments of previously driven routes (driven by the user and/or by other users). Accordingly, provision of the statistical data related to the route may include providing data items based on road segments of the route of the vehicle.

The method may also comprise determining based on the retrieved data at least one adjusting factor indicative of energy losses or gains along at least one segment of road of the route, and the calculating of the rate of battery energy flow may be based at least in part on the at least one adjusting factor. In possible applications the determining of the at least one adjusting factor includes determining resisting or propelling

conditions along at least one segment of road of the route based on the retrieved data, and the at least one adjusting factor may be based at least in part on said resisting or propelling conditions. Optionally, the determining of the resisting or propelling conditions includes determining automotive aerodynamic parameters of the vehicle along the at least one segment of road. For example, the at least one adjusting factor may be based at least in part on said automotive aerodynamic parameters.

In some applications the specific considerations are derived from at least one of the following group: the topographic conditions, the road data, the weather conditions, the traffic conditions, the driving patterns of the user, and the automotive aerodynamic parameters of the vehicle. Optionally, the identifying of the plurality of discrete road segments is based at least in part on one of the following: the driving patterns of the user; the rate of battery energy flow along at least one segment of road of route; the road data; the vehicle data; and the topographic conditions along the planned route.

The method may further comprise identifying in the plurality of discrete road segments two or more intersecting discrete road segments and identifying at least one discrete road segment mutual to the two or more discrete road segments according to their intersection. Optionally, the calculating of the battery energy flow rate may comprise calculating for the at least one mutual discrete road segment a discrete rate of battery energy flow based at least in part on specific considerations associated with the two or more intersecting discrete road segments.

In possible applications, the calculating of the remaining travelable distance comprises: calculating for each discrete road segment an amount of expected battery energy discharge along a portion of the route between the first road segment of the route and the specific discrete road segment based on the calculated battery energy flow rates of the specific road segment and of discrete road segments located downstream to the specific discrete road segment, and whenever determining based on the expected battery energy discharge calculated for a specific discrete road segment that the charge level of the battery is not sufficient to complete the route, calculating the remaining travelable distance based on lengths of the discrete road segments located downstream to the specific discrete road segment. Optionally, the remaining travelable distance is calculated based at least in part on calculated residual battery energy indicative of an amount of energy expected to remain in the battery when the specific discrete road segment is reached.

Alternatively, if it is determined based on the expected battery energy discharge calculated for all discrete road segment that the charge level of the battery is sufficient to complete the route, the remaining travelable distance is calculated based on a residual battery energy computed for the last discrete road segment of the route. Optionally, the remaining travelable distance is calculated based on a weighted average of energy flow rates computed for two or more of the discrete road segments.

Advantageously, the method may further comprise adding to the route one or more battery service stations whenever it is determined that the charge level of the battery is not sufficient to complete the route.

The method may further comprise determining corrective measures that the user of the vehicle may perform in order to increase the chances of reaching a target destination of the route, whenever the value of calculated residual battery energy content is negative.

In a variant, determining the route may comprise determining a target destination based on data received from the user or based on the at least one frequently driven route, and on at least one of the following indications: current location of the vehicle, time of day the at least one frequently driven route is being driven, and day of the month the at least one frequently driven route is being driven.

In possible embodiments the method may comprise displaying in a display device provided in the vehicle data related to the route, the displayed data may comprise at least one of the following: distance from current location of the vehicle to the target destination; the calculated remaining travelable distance; data indicative of a portion of the battery energy expected to be contained in the battery after reaching the target destination; and the route, and planned stops in battery service stations included in the route, if any.

In another aspect the present application is directed to a system for use in monitoring a traveling vehicle powered by a battery. The system may comprise a processing utility connectable to a memory utility for receiving data comprising statistical data related to a plurality of routes driven by a plurality of users or that is related to the users (*e.g.*, driving patterns of a user of the vehicle, at least one route frequently driven by the user, and/or rate of battery energy flow along at least one segment of road in the at least one frequently driven routes). In some applications the processing utility comprises a battery energy flow estimator configured and operable to

receive and process a planned route and data comprising statistical data of at least one of the plurality of routes or of at least one of the users, and calculate based on the data a rate of battery energy flow for the battery along at least a segment of road of the planned route. The system may comprise a distance approximating unit configured and operable to receive data indicative of an amount of energy stored in the battery and data indicative of the rate of battery energy flow, and calculate a remaining travelable distance for the vehicle based thereon.

In some implementations the battery energy flow estimator is configured and operable to identify, based on the received data, a plurality of discrete road segments in the planned route, and to calculate a respective discrete rate of battery energy flow for each of the plurality of discrete road segments based at least in part on specific considerations associated therewith and derived from the data received.

The received data may also comprise at least one of: road data indicative of road conditions along the at least one road segment (*e.g.*, weather conditions along at least one segment of road of the planned route; traffic conditions along at least one segment of road of the planned route; number of lanes along at least one segment of road of the planned route; road curvature of at least one segment of road of the planned route; and/or gradient along at least one segment of road of the planned route); vehicle data indicative of conditions of the vehicle or of its battery (*e.g.*, vehicle weight, vehicle payload, windows state, rate of energy consumed by electric appliances of the vehicle, motor efficiency, battery efficiency, and/or battery temperature); topographic conditions of at least one road segment of the planned route.

In some implementations the battery energy flow estimator may be configured and operable to determine based on the received data at least one adjusting factor indicative of energy losses or gains along at least one road segment of the planned route. The battery energy flow estimator may be configured and operable to calculate the rate of battery energy flow based at least in part on the at least one adjusting factor. Optionally, the battery energy flow estimator is configured and operable to determine resisting or propelling conditions along the at least one road segment of the planned route based on the retrieved data. The at least one adjusting factor may be determined based at least in part on the resisting or propelling conditions. Additionally or alternatively, the battery energy flow estimator may be configured and operable to determine automotive aerodynamic parameters of the vehicle along at least one road

segment of the planned route. Optionally, the resisting or propelling conditions are determined based at least in part on the automotive aerodynamic parameters.

In some applications the specific considerations are derived from at least one of the following: the topographic conditions, the road data, the weather conditions, the traffic conditions, the driving patterns of the user, and the automotive aerodynamic parameters of the vehicle.

In possible implementations, the plurality of discrete road segments are identified based at least in part on the driving patterns of the user; the rate of battery energy flow along at least one of the segments of road in the at least one frequently driven routes; the road data; the vehicle data; and/or the topographic conditions.

In a variant, the battery energy flow estimator is configured and operable to identify in the plurality of discrete road segments two or more intersecting discrete road segments and to identify at least one discrete road segment mutual to the two or more discrete road segments according to the intersection. The battery energy flow estimator may calculate a battery energy flow rate for the at least one mutual discrete road segment based at least in part on specific considerations associated with the two or more intersecting discrete road segments.

In possible applications the distance approximating unit is configured and operable to: calculate for each discrete road segment an amount of expected battery energy discharged along a portion of the route between the first road segment of the route and the specific discrete road segment based on calculated battery energy flow rates of the specific road segment and of discrete road segments located downstream to the specific discrete road segment; determine, based on the expected amount of battery energy discharge calculated for a specific discrete road segment, if the charge level of the battery is sufficient to complete the route; and if it is determined that the battery charge level is not sufficient, calculate a remaining travelable distance based on lengths of the discrete road segments located downstream to the specific discrete road segment.

The distance approximating unit may be configured to compute residual battery energy indicative of an amount of energy expected to remain in the battery when the specific discrete road segment is reached, and to calculate the remaining travelable distance based at least in part on said residual battery energy. Whenever it is determined that the charge level of the battery is sufficient to complete the route, the distance approximating unit may compute a remaining travelable distance based on a residual

battery energy computed for the last discrete road segment of the route. Additionally or alternatively, the distance approximating unit may be configured to calculate a weighted average of energy flow rates computed for two or more of the discrete road segments, and to calculate the remaining travelable distance based at least in part on the weighted average.

Advantageously, the processing utility may be configured to add to the route one or more battery service stations whenever it is determined that the charge level of the battery is not sufficient to complete the route.

Optionally, the distance approximating unit is configured and operable to determine corrective measures that the user of the vehicle may perform in order to increase the chances of reaching a target destination of the planned route, whenever determining that the energy in battery is not sufficient to complete the route.

The battery energy flow estimator may be configured and operable to determine the planned route by determining a target destination based on data received from the user of the vehicle or based on the statistical data, and on: the current location of the vehicle, the time of day the frequently driven route is being driven, and/or the day of the month the frequently driven route is being driven.

The system may further comprise a charge level measuring unit configured and operable to measure the amount of energy stored in the battery.

In yet another aspect, the present application is directed to a method for presenting data related to a route of a vehicle. The method may include receiving data indicative of battery energy flow along the route or along discrete road segments thereof; computing based on the received data an estimation of an amount of energy to be consumed from a battery of the vehicle during a ride along the route; receiving data indicative of an amount of energy contained in the battery; computing data indicative of a portion of the battery energy expected to be contained in the battery once the ride along the route is completed; and outputting the computed data to a display utility, a memory utility, or a remote computer system.

Optionally, the data indicative of the portion of the battery energy expected to be contained in the battery once the ride along the route is completed is provided in the form of a percentage relative to a battery energy capacity (*e.g.*, maximal energy content of the battery), or in the form of distance units indicating a remaining travelable distance.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will be now described, by way of non-limiting example only, with reference to the accompanying drawings, in which same reference numerals are used to identify elements or acts with the same or similar functionality, and in which:

Fig. 1 is a block diagram exemplifying a system for approximating a remaining travelable distance of a vehicle according to some possible embodiments;

Fig. 2A and **Fig. 2B** are flowcharts exemplifying a process for calculating a remaining travelable distance approximation according to some possible embodiments;

Fig. 3 exemplifies a technique for approximating possible travelable distance of a vehicle;

Fig. 4 is a flowchart exemplifying a process for approximating possible travelable distance of a vehicle according to some possible embodiments utilizing a centralized control system;

Fig. 5 is a flowchart exemplifying calculation of a remaining travelable distance approximation for a segmented planned route according to a possible embodiment;

Fig. 6 is a flowchart exemplifying a process of a real-time approximation and update of a remaining travelable distance during a ride of a vehicle according to some possible embodiments;

Fig. 7 demonstrates possible presentation of route data and travelable distance approximations with a road map; and

Figs. 8A and **8B** are flowcharts exemplifying a possible method for real time monitoring of vehicle' energy consumption and adding one or more battery service stations to the route whenever needed.

DETAILED DESCRIPTION OF EMBODIMENTS

The present disclosure provides a reliable and improved approximation of a remaining travelable distance of a vehicle utilizing a battery as its main power source, based on a plurality of data indications, including profile data, statistical data and real time data obtained from the vehicle and/or from a centralized control system before or during the ride. In exemplary embodiments of the present intention the profile data includes, *inter alia*: vehicle's profile data, such as, but not limited to, motor efficiency and vehicle's weight; and battery profile data, such as, but not limited to, battery

capacity and battery efficiency, road data, such as, but not limited to, gradient of uphill and downhill road segments and their lengths, road curvature, and number of lanes. The statistical data may include battery energy discharge, and/or recharge, rates along driven road sections and data reflecting driving patterns of the user of the vehicle, for instance, road behavior of the user of the vehicle including driving speeds, accelerations, and decelerations along one or more road segments of the planned route. The real-time data may include, but is not limited to, battery charge level and temperature, traffic load, traffic jams, and weather conditions.

Some of the plurality of indications may be collected from a memory of the specific vehicle for which the remaining travelable distance is being calculated (*e.g.*, using a drive recorder) or based on aggregation of information from numerous vehicles managed by a control center capable of communicating the vehicles and querying them for such driving information. In some embodiments the plurality of data indications are further used to refine the approximation of the remaining travelable distance of the vehicle. The plurality of data indications may be also used to provide additional services to the user of the vehicle, such as, but not limited to, locations of nearby restaurants or shops and locations of pit stops required for recharging or replacing the battery of the vehicle.

For example, in possible embodiments a driving route is planned or determined for a specific vehicle according to the target destination of the user of the vehicle and possibly also according to availability of battery service stations towards the target destination. After determining the driving route (also referred to herein as planned route) the statistical, profile and/or real-time data are retrieved and analyzed, where the statistical data is at least partially based on the planned route. An expected battery discharge rate is then computed based on the retrieved data, which is then used together with the battery energy charge level (*i.e.*, the amount of energy stored in the battery) to calculate the remaining travelable distance approximation.

A battery energy recharge rate may be calculated if the planned route includes conditions for generating electrical energy by the vehicle therealong. For example, when driving downhill road segments, rotary movement of the wheels can be converted by the motor (or by an alternator) of the vehicle into electric energy usable for recharging the battery of the vehicle. As another example, electrical energy may be also generated using a solar recharging system (*e.g.*, using photovoltaic cells), which may be

installed in the vehicle, if the weather conditions and the time of the day permit recharging the battery pack during the ride. The calculated energy recharge rate may be reduced from the calculated energy discharge rate to refine the remaining travelable distance approximation.

In some embodiments the collected statistical and profile data are further used to calculate various adjusting factors which may be combined in the calculation of the battery discharge rate. For example, if the analysis of the driving data of the user of the vehicle reveals wasteful energy driving behavior (*e.g.*, high speeds and/or accelerations/decelerations), a respective adjusting factor may be computed for adjusting the calculated battery discharge rate along certain road segments of the planned route, and/or for the entire route. In a similar fashion, adjusting factors may be computed based on an efficiency factor of the vehicle or of the battery. For example, if the data analysis reveals that the motor of the vehicle, or the battery pack used in the vehicle experience substantial energy loses, corresponding adjusting factors are computed and then combined in the calculation of the battery energy discharge rate.

In possible embodiments the remaining travelable distance is periodically or continuously adjusted during the ride based on real-time data updates retrieved from the vehicle and/or from a control system (*e.g.*, control center such as a service provider, traffic control agency, or battery service station). For example, the retrieved real-time data updates may indicate presence of resistive, or propelling, road conditions (*e.g.*, fog, traffic loads and/or jams, windy/stormy weather), substantial changes in the temperature of the battery or of the motor of the vehicle requiring respective adjusting factors to be introduced due to reduction of battery and/or motor efficiency, substantial changes in the vehicle payload (*e.g.*, due to the upload or discharge of passengers or luggage) or in the automotive aerodynamics of the vehicle (*e.g.*, due to open/closed windows, substantial changes in rolling resistance due to ambient temperature or humidity) and/or in the electrical consumption of the vehicle (*e.g.*, due to use of air-conditioning, use of high beam headlights, and suchlike), each of which may require calculation of a respective adjusting factor to be used in the calculation of the battery discharge rate approximation.

Fig. 1 is a block diagram demonstrating a possible system **10** for approximating remaining travelable distance of a vehicle powered by a battery according to some possible embodiments. In this example the system **10** comprises a computer system **15**,

one or more vehicles **13a**, **13b**, **13c**,... (collectively referred to herein as vehicles **13**), a profile and statistical data storage device **11** for storing and reporting profile data **12** related to at least the vehicles **13** and/or the users' of said vehicles, and a road data storage device **18** (designated as traffic control in **Fig. 1**) for storing and reporting road data **19** related to at least the driving conditions (*e.g.*, road conditions, traffic loads/jams, and suchlike) in the driven roads. The computer system **15** is communicatively coupled to the storage devices **11** and **18** via a data network **14** (*e.g.*, the Internet), or over a direct wired (*e.g.*, landline telephony, cables, and suchlike), optical (*e.g.*, optic fibers) or wireless (*e.g.*, IR, or RF, such as, satellite communication, WiFi, Bluetooth, cellular communication, and suchlike) communication link (designated by dashed arrowed lines).

The computer system **15** is also communicatively linked to the vehicles **13**, preferably over a wireless communication link, such as exemplified hereinabove. For example, vehicles **13** may be configured to establish wireless communication with the data network **14** and therethrough to communicate data with the computer system **15**, using any suitable conventional technique known in the art (*e.g.*, using cellular communication).

The profile and statistical data storage device **11** is configured to store and maintain a plurality of data records **12a**, **12b**, **12c**,... each comprising data related to at least the respective users of the vehicles **13**. For example, a data record **12a** may comprise data indicative of driving patterns (**12a1**, *e.g.*, driving style, road behavior, frequently driven routes and their day times, and such like) of a user of a respective vehicle **13a**. The data profile **12a** may also include information about the vehicle **13a** (**12a2**, *e.g.*, vehicle weight, motor power and motor efficiency) and/or about the battery pack used in the vehicle **13a** (**12a3**, *e.g.*, maximal energy capacity of the battery, battery health and age, battery efficiency).

In some possible embodiments the profile and statistical data storage device **11** is maintained and managed by a service provider (**36** in **Fig. 3**) that provides battery exchange and recharge services to the vehicles **13** by a plurality of battery service stations (BSS) **17**. Alternatively or additionally, the profile and statistical data storage device **11**, or portions thereof, may be stored and maintained in a memory (**35m** in **Fig. 3**) of the vehicles **13**. As demonstrated in **Fig. 1**, the BSS **17** is communicatively coupled to the computer system **15** over the data network **14**, or directly (indicated by a

dashed arrowed line), for example, via land line telephony, cables infrastructures or fiber optics communication.

The data records relating to the user and to the vehicle **13a** may be collected periodically or continuously by the internal computer of each of the vehicles **13**, for example, by utilizing an in-vehicle data recorder (IVDR). Accordingly, in some embodiments the internal computer (**35** in **Fig. 3**) of the vehicle **13a** is configured to collect in real time data pertaining to the user (**13a1**), to the battery pack (**13a2**), and/or the vehicle (**13a3**), and send from time to time such real-time data updates to the profile data storage device **11** and/or to the computer system **15**. Accordingly, the internal computer of each vehicle **13** may be configured to collect and store such profile and statistical data, **13a1 13a2 13a3**..., in a memory (**35m**) of the vehicle's computer, and to transfer some, or all, of the collected data to the storage device **11** or to the computer system **15** (designated by dashed-broken arrowed lines **3a**).

The road data storage device **18** is configured to collect and store real-time temporal data and data considered as unchanging (that usually remains constant) related to the roads used by the users of the vehicles **13**, which may be used by the system **10** to derive various inclusions about the energy consumption of vehicles traveling along these roads. For example, road data storage device **18** may include unchanging data about the conditions of the roads (**19a**, *e.g.*, number of uphill and downhill road segments and their lengths and gradient (slope), number of traffic lanes, road curvature), and contemporary road data about the weather conditions in the roads areas (**19b**, *e.g.*, dry, rainy, foggy or stormy weather conditions, winds directions and strengths, road is dry or wet, ambient temperature, and suchlike), and any possible obstacles therealong (**19c**, *e.g.*, car collisions, bumpers, traffic lights, traffic loads or jams).

The road data storage device **18** may be part of a traffic control agency utilizing sensing devices (not shown *e.g.*, video cameras, car counters, weather sensors, and such like), satellite images weather reports, and/or topographic maps, and suchlike, to collect information about the conditions of the roads. In possible embodiments the data required for calculating the travelable distance approximation is collected from the road data storage device **18** for each vehicle by the control center. The collected data is then transmitted by the control center to each vehicle. The control center may process the collected data and assist in calculating the travelable distance approximation for each vehicle. Alternatively, the control center may process the collected data, calculate the

travelable distance approximation for each vehicle, and transfer the calculated result to the vehicles.

The profile and statistical data storage and the road data storage devices, **11** and **18**, may be implemented employing any suitable memory devices (*e.g.*, RAM, FLASH, magnetic disks, optic disks, and such like). Each of the data storage devices **11** and **18** may be part of a data server (*e.g.*, RAID server) connected to the data network **14**, for example, as known to those versed in the art.

The computer system **15** is configured to retrieve, or plan, a driving route (also referred to herein as planned route) for at least one vehicle **13a**, and to collect the profile and statistical data **12** relevant to the vehicle **13a** and/or to the user of the vehicle, and/or the road data **19** based on the planned route. The computer system **15** analyzes the collected data and calculates, based thereon, the remaining travelable distance approximation for the vehicle **13a**. The computer system **15** utilizes a processor utility **16** and a memory utility **15m** configured to collect and analyze the profile and statistical data **12** and the road data **19**, and to calculate various estimations about the energy recharge and discharge rates along road segments to be traveled by the vehicle, and/or about the traversability of these road segments. The various computed estimations are then used by the computer system **15** to calculate the remaining travelable distance approximation for the vehicle **13a**.

Computer system **15** may be implemented using any suitable combination of processors (CPUs) or controllers (MCUs), and memory devices (e.g., RAM, ROM, FLASH, magnetic/optic disks). In some possible embodiments the computer system **15** is part of a service provider system (*e.g.*, **36** in **Fig. 3**) configured to provide various services to the vehicles **13** and/or to their users. Alternatively or additionally, computer system **15** may be implemented in form, or as part, of an internal computer (*e.g.*, **35** in **Fig. 3**) of the vehicle **13a**.

Fig. 2A is a flowchart demonstrating a process **30** for approximating a remaining travelable distance of a vehicle **13a** according to some embodiments, as may be performed by the computer system **15**. The process **30** may be initiated in determining a target destination (**20**) and/or route (**21**) to be driven by the user of the vehicle **13a**. The determination of target destination and driving route may be based on direct input from the user via the user interface of the control unit of the vehicle (**35** in **Fig. 3**). For example, the user may indicate the target destination in order to receive

driving directions from a positioning system (*e.g.*, **35g** in **Fig. 3**) and/or in order to approximate a remaining travelable distance and, based thereon, receive recommendations for BSS **17** stops along the planned route). In cases where a destination is not provided by the user, the target destination and the route data may be derived based on historical data of the user indicted by the previously driven routes data. The historical data may be locally stored in memory (**35m**) of the vehicle's control unit (**35**), but it may, additionally or alternatively, be also stored and retrieved from a control center (*e.g.*, of service provider **36**), and/or from storage devices (**11**) communicatively linked thereto.

For example, the target destination and route data may be determined by querying the user for the target destination and/or route via the internal computer **35** of the vehicle **13a**, and/or by analyzing the profile data of the user (**12a1**) extracted by the system (in step **22**). More particularly, the computer system **15** may use data relating to the user's frequently driven routes and their times as provided in the user profile data (**12a1**), and determine the user's target destination if the current time and location of the vehicle match with the frequently driven routes and their times data. For instance, if the user of the vehicle **13a** drives during morning hours of regular working days between home and work locations and the time and location of the vehicle comply with this home-work route and its usual day time range data, the system may determine with high level of certainty that the user is driving the regular route between the home and work locations. The target destination determined by the system may be presented to the user of the vehicle, who may be requested to confirm or decline the determined destination.

Possible target destination selection criteria may include selection of the most common destination that the user is targeting when located at the specific location as reported by the positioning system (**35g**). In case the user profile data records do not include route information relating to the road(s) currently driven by the user, profile data records of other users may be used to determine the most common destination driven by other users from the current location of the vehicle, for example, based on time of day and/or day of week data. The system may be further configured to track the actual progress of the vehicle **13a** along the planned route based on position data received from a positioning system (**35g**) installed in the vehicle, and update in real-time the vehicle location data and the remaining travelable distance approximation, accordingly.

The profile and statistical data **12**, and possibly also the road data **19**, relevant to the planned route are then extracted from their respective storage devices and analyzed (**22**) by the computer system **15**. Additional real-time data (*e.g.*, **13a1**, **13a2**, **13a3**,...) may be collected directly from the vehicle **13a**. Based on the collected data a battery energy flow rate is then calculated (**23**). For example, based on the collected data the computer system **15** may calculate a rate of energy discharge from the battery of the vehicle **13a** along the planned route, or along discrete segments thereof. For example, the profile and statistical data (**22**) may include statistical road data comprising various battery discharge rates recorded by the system **10** along road segments in the planned route, for different users and vehicles, or for the same user and/or vehicle **13a** for which the remaining travelable distance approximation is currently being computed.

The computer system **15** may be configured to use in the calculation (**23**) the battery energy discharge rates recorded for the user and/or for the vehicle **13a** of the user, along the planned route or along discrete road segments thereof. Preferably battery energy discharge rates recorded for the same specific user and the vehicle **13a** of the user along the planned route (**21**) or along discrete road segments thereof are used. However, if the statistical road data does not include battery discharge rates related to the user and/or its vehicle **13a**, then the system **10** may use battery discharge rates recorded for other users driving a vehicle having similar characteristics (*e.g.*, of the same type, model, and/or make) along relevant road segments. Alternatively, the system **10** may calculate an averaged battery energy discharge rate based on various battery energy discharge rates recorded for a plurality of users using vehicles **13** having characteristics that are similar to (or different than) those of the vehicle **13a** for which the remaining travelable distance approximation is being computed.

If there is no profile or statistical data related to the user in the statistical data storage device **11**, then profile or statistical data recorded for a number of, or all, other users for the specific planned route or for road segments thereof, or for a route or road segments having similar characteristics (*e.g.*, length and driving resisting and/or propelling road conditions), is used. On the other hand, if the system does not find suitable data, in the statistical data storage device **11** or in the road data storage device **18,** relevant to the planned route, and/or to one or more discrete road segments thereof, data relating to similar routes, and/or to the respective discrete road segments thereof

(*e.g.*, having similar topographic or weather conditions), may be used instead in the remaining travelable distance approximation process.

After computing the battery energy flow rate (**23**) the charge level of the battery (**13a2** *i.e.*, the amount of energy currently stored in the battery) of vehicle **13a** may be fetched (**26**) for computation of the remaining travelable distance approximation (**27**) for the vehicle **13a**, which may be then outputted (**28**), for example, to a display device, to a storage or memory device (*e.g.*, **11/18** or **15m**), to service provider (*e.g.*, **36**) and/or to BSS **17**. In certain embodiments the remaining travelable distance approximation may end in the outputting of the remaining travelable distance approximation (**28**).

In possible embodiments the calculation of the remaining travelable distance approximation may include various adjustments, and in such possible embodiments after the battery energy flow rate is calculated (**23**) the process proceeds (designated by a dashed arrowed lines) to a step of calculating various adjusting factors (**24**) based on the retrieved profile, statistical, and/or road data. The various adjusting factors (**24**) are then used for modifying the computed battery energy flow rate (**25**). Thereafter, the battery charge level (**13a2**) is obtained (**26**) and used together with the modified battery energy flow rate (**25**) for calculating the remaining travelable distance approximation (**27**). In such possible embodiments the remaining travelable distance approximation may end in this stage as the calculated remaining travelable distance approximation is being outputted (**28**).

For example, the adjusting factors (**24**) may include calculation of a traversability factor providing a measure of cross-ability of road segments of the planned route in view of possible obstacles and/or indications of various driving resisting and/or propelling road conditions provided in the road data **19**.

In other possible embodiments the remaining travelable distance approximation may be updated periodically or continuously during the ride along the planned route. In such possible embodiments after each output of a remaining travelable distance approximation (**28**) the process proceeds (designated by dotted arrowed lines) upon retrieval of updates of real-time data (**29**). The real-time data updates (**29**) may be obtained from profile and statistical data storage device **11**, from road data storage device **18**, from the internal status reporting modules (**35d**, in **Fig. 3**) of the vehicle **13a**, and/or from BSS **17** or an external server (not shown) to which the computer system **15** (or vehicle internal computer) may be communicatively linked. For example, the real-

time data updates may comprise reports about traffic loads/jams and/or weather reports, along road segments in the planned route, changes in automotive aerodynamics (*e.g.*, one or more windows been opened, changes in the vehicle drag coefficient) and/or battery temperature of the vehicle **13a**.

These real-time data updates (**29**) entail computation of various adjusting factors (**24**) which are used for calculating a modified energy discharge rate (**25**) for the vehicle **13a**. In this case, however, the calculation of the modified battery energy flow rate is carried out according to the current location of the vehicle **13a** along the residual road segments of the planned route *i.e.*, using data pertaining only to not yet driven road segments of the planned route. The modified battery energy flow rate (**25**) is then used for calculating and outputting the remaining travelable distance approximation (steps **26-28**), as described hereinabove. This loop (steps **23-29**) may be performed periodically or continuously along the entire ride in order to update the user and/or the system **10** in real-time about any changes in the previously computed remaining travelable distance approximations.

The computer system **15** may further calculate estimates of battery recharging rates during the ride of the vehicle along the planned route. These estimates are particularly useful if there are downhill roads along the route of the vehicle **13**, during which the battery of the vehicle may be recharged with energy, or if the vehicle **13a** includes a solar recharging system, for example. With reference to **Fig. 2B**, as seen, the energy flow rate calculation (step **23**) may include calculation of a battery discharge rate (**23d**) and battery recharge rate (**23r**) along the entire planned route and/or along discrete road segments thereof. The energy flow rate (**23**) may be calculated by summating (**23s**) the battery discharge (**23d**) and recharge (**23r**) rates computed for each discrete road segment, and/or for the entire planned route.

The computed energy flow rate (**23**) combining battery discharging and recharging rates may be then used to calculate the remaining travelable distance approximation as described hereinabove (*e.g.*, by performing steps **23** and **26** to **28** in **Fig. 2A**), and may be similarly used in embodiments employing adjusting factors in the remaining travelable distance approximation (*e.g.*, by performing steps **23** to **28** in **Fig. 2A**), and/or in embodiments in which the remaining travelable distance is continuously or periodically updated along the ride based on real-time data updates (*e.g.*, by performing steps **23** to **29** in **Fig. 2A** in repetitions).

The remaining travelable distance approximation may be further refined by considering possible fluctuations in the battery energy flow rate approximation associated with the time of day, day of week and weather conditions. For example, if the statistical data is collected for the specific route at different times of day, and there is significant variability in the energy flow rate data across the different time of day events recorded in the system, then the battery energy flow rate estimation will use data that has been collected for a time of day that is similar to current time of day.

An alternative approach that may be used in possible embodiments, instead, or in cases where no relevant historical data for the specific route is available, is to predict the battery energy flow rate based on classification of the road type and the historical driving style per road type for the specific driver (*i.e.*, to evaluate the discharge rate based on the road conditions data and the driving patterns of the user). For example, if the user usually drives at 90 km/h on 10% uphill and aggressively presses the acceleration, then it is most probable that the user will maintain this driving behavior with similar characteristics on other roads. Thus, previously recorded driving behavior and style of a user related to other road segments may be used to evaluate the energy discharge rate for a road segment about which there is no historical data, based on similarities of the road segment to previously driven road segments.

Fig. 3 exemplifies various components of vehicle **13a** according to possible embodiments. In this example vehicle **13a** comprises a control unit **35** including a processor utility **35p**, a memory utility **35m** (*e.g.*, ROM, RAM, FLASH, and/or magnetic/optic disks), a user interface **35u** operable to display information to the user (*e.g.*, on a LCD or video display device) and receive user inputs (*e.g.*, via keyboard/keypad or touch screen), and a communication module **35c** (*e.g.*, wireless LAN, Cellular, Bluetooth, or suchlike) operable to communicate data with the computer system **15** and/or the data network **14**.

The vehicle **13a** may also include various status reporting modules **35d** operable to measure various parameters and conditions of the vehicle and provide corresponding indicative data based thereon to the control unit **35**, for example, over a data bus (not shown) using a bus interface **35b**. For instance, the status reporting modules **35d** may include a battery status module **35d1** operable to measure and report the current charge level ($\mathbf{E_c}$) of the vehicle's battery **35t** (the amount of energy $\mathbf{E_c}$ stored in the battery *e.g.*, based on battery voltage measurements) and the current temperature of the battery **35t**.

The status reporting modules **35d** may include a payload sensing module **35d2** configured and operable to determine the number of passengers in the vehicle *e.g.*, by using sensors installed in the vehicle's seats, and/or sensors used to measure the vehicle's weight *e.g.*, using pressure or tension sensors installed in the suspension system of the vehicle. Additionally, a window state reporting module **35d3** may be also included for sensing and reporting the state of the vehicle's windows, and/or an energy recharge/discharge rate measuring module **35d4** configured and operable to measure energy consumption of vehicle's motor and possibly of other systems of the vehicle other than its motor (*e.g.*, light system, air-conditioning, etc.).

The vehicle **13a** may further include a positioning system **35g** (global positioning system such as GPS, or any suitable wireless triangulation positioning system *e.g.*, satellite, cellular network, WiFi AP tracking, or suchlike), applicable for determining the current position of the vehicle **13a** and reporting the same to the control unit **35**. Positioning system **35g** may be implemented as an integral part of the control unit **35** as demonstrated in **Fig. 3**, as part of the status reporting modules **35d**, or as a separate unit. Data from the status reporting modules **35d** may be continuously or periodically communicated to the control unit **35** over the internal bus interface **35b** of the vehicle for updating it about the amount of energy stored in the battery pack **35t** of the vehicle **13a** (**13a2**), about the temperature of the battery **35t** of the vehicle, about the rate of energy recharge and discharge, and also for determining whether the vehicle is in a regenerative mode (*i.e.*, mode of slowing the vehicle while converting kinetic energy into electrical energy).

In possible embodiments the control unit **35** is utilized in the vehicle **13a** to collect and record information about driving routes and the driving patterns of the user of vehicle **13a**. For example, the control unit **35** may be configured to record in memory **35m** driving speeds, accelerations/decelerations, driven routes and time of day during which these routes are driven by the user, and battery energy discharge/recharge rates for the recorded driven routes.

Fig. 4 is a flowchart schematically illustrating possible embodiments wherein a centralized control center (*e.g.*, of service provider **36**) is utilized in the calculation of the remaining travelable distance approximation. In this example the target destination (step **42**) and/or the planned route (**43**) are determined by the control unit **35** of the vehicle **13a**, for example, by querying the user via the user interface **35u**. The planned

route is sent through the communication module **35c** to the service provider **36** (step **48**), which analyzes the planned route and retrieves relevant statistical and/or profile data (step **49**), for example from a storage device **11** and/or **18**, and transfers the retrieved data to the control unit **35** of the vehicle **13a**.

The control unit **35** then analyzes the retrieved data and calculates (step **44**) the battery energy flow rate, which is then used by the control unit **35** to calculate the remaining travelable distance approximation (step **45**) that may be outputted to a user display provided in the user interface **35u**, to the memory **35m**, and/or to service provider through the communication module **35c**. The control unit may collect during the ride driving and status data (step **40**) which may be further used in the calculation of the battery energy flow rate (in step **44**) and/or in the calculation of the remaining travelable distance approximation (in step **45**). The collected driving and status data may be transferred to the service provider **36** (steps **41** and **47**) for recordal therein, and/or in the profile data records stored in storage device **11**. It is noted that the approximation of travelable distance (step **45**) may be carried out using any of the methods described hereinabove and hereinbelow.

The status reporting modules **35d** may further comprise a driving speed reporting module (not shown) operable for measuring and reporting driving speeds of the vehicle (**13a1**) to the control unit **35**. The driving speed reporting may be further configured to compute and report acceleration and deceleration ranges, which may be alternatively or additionally computed by the control unit **35**. The control unit **35** and/or the status reporting modules **35d** may further include an energy recharge/discharge rate measuring module (**35d4**) operable for measuring and reporting to the control unit **35** the energy recharge and discharge rates (**13a2**).

For example, the energy recharge/discharge rate measuring module **35d4** may be configured to continuously or periodically measure the electric current supplied by the battery **35t** of the vehicle, and thereby measure a total amount of electric current consumed by the electric devices operating in the vehicle. Alternatively or additionally, the energy recharge/discharge rate measuring module **35d4** may be configured to continuously, or periodically, measure the electrical current consumed by the motor of the vehicle. In possible embodiments the voltage of the battery is also continuously, or periodically, measured by the energy recharge/discharge rate measuring module **35d4**, and used to calculate rate of battery energy flow.

In possible embodiments the estimation of the remaining travelable distance of the vehicle **13a** employ information about allowed driving speeds on roads included in the route of the vehicle, as may be obtained from road data storage device **18** or from a topographic information systems and mapping services.

The control unit **35** and/or the status reporting modules **35d** may be configured to collect information about the driving habits and road behavior (*e.g.*, expressed in acceleration/deceleration patterns and driving speeds in relation to road conditions), and data indicative of routes driven by the user of the vehicle over time. The data indicative of the routes may include target destination data, and may further include data indicative of the time of day and the date (day of week, month, holidays) on which the recorded routes have been driven. The user driving data may further comprise recorded rates of battery energy discharge, and/or rates of battery energy recharge, associated with each type of driving style, driving speeds, and/or accelerations/deceleration recorded for the user. The user driving data preferably also includes battery discharge rates for each of the driving routes, or of discrete road segments thereof, recorded for the user.

In possible embodiments the system may provide an option for the user to request approximation of remaining travelable distance for a plurality of possible target destinations simultaneously. The destination determining (step **20** in **Fig. 2A**) may therefore include determining multiple target destinations, which will be followed by determination of a corresponding plurality of driving routes (in step **21** in **Fig. 2A**) and calculation of corresponding remaining travelable distance approximations for each.

With reference to **Fig. 3**, in possible embodiments the entire length (**S**) of the planned route **33** is segmented into a plurality of road segments (S_1, S_2, S_3,…,S_n; *e.g.*, $S=S_1+S_2+S_3+\ldots+S_n$) based on, for example, resistive or propelling road conditions indicated in the retrieved road data **19**. For example, the planned route may be segmented according to road conditions indications, such as, but not limited to, multilane road segments (*e.g.*, fast highways), heavily traffic loaded road segments, jammed road segments, tortuous and/or uphill or downhill road segments. Based on the road data **19** obtained, the computer system **15** may calculate for each of the road segments S_i (where i in an integer, $1<=i<=n$) a respective rate of battery energy flow (**23**) and adjusting factors (**24**).

The system may classify road segments of the planned route based on topographic information included in the road data and/or based on driving patterns of the user *e.g.*, driving speeds or segmented per time of day, as indicated in the retrieved road data and the statistical and profile data. The system may then use its recorded battery energy flow rates (*e.g.*, battery discharge rate) typical for these conditions for the specific user, and then calculate the overall expected remaining travelable distance approximation. With reference to **Fig. 1**, in possible embodiments computer system **15** comprises an energy discharge rate estimator module **15d** configured to calculate energy discharge rates estimates for the battery of the vehicle **13a** along the planned route, and/or along discrete road segments thereof ($d\mathbf{R}_i^{(-)}$ *e.g.*, expressed as a negative value). An energy recharge estimator **15c** is used in these embodiments in computer system **15** to calculate an estimation of energy recharge rate ($d\mathbf{R}_i^{(+)}$) along the planned route, and/or along discrete road segments thereof. A summation module **15u** may be used in the computer system **15** to calculate an energy flow rate ($d\mathbf{R}_i$) based on the calculated energy discharge rate estimate and energy recharge rate estimate ($d\mathbf{R}_i=d\mathbf{R}_i^{(+)}+d\mathbf{R}_i^{(-)}$).

The computer system **15** may also include adjusting factors calculation unit **15t** configured and operable to estimate various adjusting factors ($\mathbf{W}_i$) for the planned route, and/or for discrete road sections thereof. The computer system **15** may further include a multiplier **15e** operable for adjusting the energy flow rate evaluation ($d\mathbf{R}_i$) by introducing the adjusting factors ($\mathbf{W}_i$) into the computation (*e.g.*, $\mathbf{W}_i \times d\mathbf{R}_i$).

A distance approximator unit **15s** provided in computer system **15** is used to calculate a remaining travelable distance approximation ($\tilde{D}_i$) **16p** based on the calculated energy flow rate ($d\mathbf{R}_i$) and the current charge level **13a2** of the battery (**35t** in **Fig. 3**). For example, if the energy flow rate approximation ($d\mathbf{R}_i$) is provided in units of energy per unit of distance, and planned route includes a single road segment (*i.e.*, $i=1$), then the remaining travelable distance approximation may be calculated in the distance approximator unit **15s** by dividing the current charge level $\mathbf{E_c}$ of the battery by the adjusted energy flow rate approximation ($d\mathbf{R}_i$) *e.g.*, $\tilde{D} = E_c / (dR_i \cdot W_i)$.

On the other hand if the planned route is segmented into two or more discrete road segments $\mathbf{S}_j$ ($j=1,2,3,\ldots,n$, where n is an integer, $n>1$), then the approximation unit **15s** may calculate the remaining travelable distance approximation iteratively based on computation of residual battery energy state ($E_j^{(res)}$) for each road segment $\mathbf{S}_j$ *e.g.*,

$E_j^{(res)} = E_c - \sum_{i=1}^{j-1}(E_i)$, where E_c is the amount of energy currently contained in the battery and $E_i = dR_i \cdot S_i$ designates an amount of battery energy expected to be discharged over road segment S_i (j and i are positive integers, $j \leq n$ and $i \leq n$). If the value of the residual battery energy computed for a certain road segment S_j is negative ($E_j^{(res)} < 0$) then it is assumed that the amount of energy contained in the battery E_c is not sufficient and that the battery is expected to go flat during the previous road segment S_{j-1}. In this case, the remaining travelable distance may be approximated by summating the lengths of the road segments downstream to said previous road segment S_{j-1}, *e.g.*, $\tilde{D} = \sum_{i=1}^{j-2} S_i$. Alternatively, the energy flow rate dR_{j-1} and the residual battery energy $E_{j-1}^{(res)}$ computed for the said previous road segment S_{j-1} may be used to adjust the calculation *e.g.*, $\tilde{D} = (\sum_{i=1}^{j-2} S_i) + E_{j-1}^{(res)} / dR_{j-1}$.

If the value of the residual battery energy computed for all road segments S_j is positive ($E_j^{(res)} > 0$, for j=1,2,3,…,n) then it is assumed that the amount of energy contained in the battery E_c is sufficient for the planned route S, and the remaining travelable distance may be computed in this case by dividing the current battery energy level (E_c) by an average of the energy flow rate values *e.g.*, $\tilde{D} = \sum_{i=1}^{n} dS_i + E_n^{(res)} / dR_W$ where $E_n^{(res)}$ denotes the amount of energy expected to remain in the battery after driving the route S *e.g.*, $E_n^{(res)} = E_c - \sum_{i=1}^{n}(dR_i \cdot S_i)$, and dR_w is a weighted average of some, or all, of the calculated energy discharge rates dR_i, *e.g.*, $dR_W = \sum_{i=1}^{n}\left(dR_i \cdot \frac{S_i}{S}\right) = \left(E_c - E_n^{(res)}\right)/S$.

Fig. 5 exemplifies a possible process for computation of a remaining travelable distance performed for a plurality of discrete road segments S_j of a planned route **S**. In this process after the current battery charge state E_c is retrieved (first step **62**) an iterative process is commenced (**63**) in which the amount of battery energy expected to be discharged E_j (**64**) is computed for each discrete road segment S_j (*e.g.*, $E_j - dR_j \cdot S_j$, where j is a positive integer and $j \leq n$). In each iteration j of this iterative process (steps **63** to **66**) it is checked (**65**) if the total amount of battery energy expected

to be discharged between the first road segment S_1 and the jth road segment S_1, $\sum_{i=1}^{j}(E_i)$, is within a predetermined bound.

For example, in some possible embodiments the predetermined bound may be defined to be some portion ***K1*** (e.g., 90%) of the current charge state of the battery E_c *e.g.*, $\sum_{i=1}^{j}(E_i) < K1 \cdot E_c$. In other possible embodiments the predetermined bound may be defined to reserve a specific portion (e.g., 10%) of the battery energy. For example, the predetermined bound may be set to reserve a certain portion ***K2*** of the maximal energy capacity E_{max} of the battery *e.g.*, $\sum_{i=1}^{j}(E_i) < (K1 \cdot E_c - K2 \cdot E_{\max})$, thereby defining safety margins within the calculation of the remaining travelable distance. While the energy portions factors ***K1*** and ***K2*** may generally be set in the range of 0 to 1, it may be preferable to set energy portion factor ***K1*** in the range of 0.8 to 1 (inclusive) and energy portion factor ***K2*** in the range of 0 to 0.2 (inclusive). For example, in possible embodiments it may be desired that the predetermined bound define only a safety margin defined by a portion ***K2*** of the battery maximal capacity (*e.g.*, by setting ***K1***=1), while in other possible embodiments it may be desired that the predetermined bound be defined as a portion of the current battery energy only (*e.g.*, by setting ***K2***=0).

If the computation of the total energy expected to be discharged is within the predetermined bound for all of the road segments (*e.g.*, $\sum_{i=1}^{j}(E_i) < (K1 \cdot E_c - K2 \cdot E_{\max})$ for j=1,2,3,…,n), it is than assumed that the battery will not go flat during the ride along the planned route, and in this case the process steps **63** to **66** will be carried out for all road segments of the planned route. As the loop of steps **63** to **66** is completed, the remaining travelable distance may be calculated (**68**) based on the residual battery energy computed for the last road segments S_n of the route *e.g.*, by subtracting from the current battery energy state E_c the sum of total battery energy expected to be discharged along the planned route $E_n^{(res)} = E_c - \sum_{i=1}^{n} E_i$. A weighted average energy flow rate dR_W computed for the planned route S may be used in this computation and a sum ($\sum_{i=1}^{n} S_i$) of the lengths of the road segments of the planned route, as exemplified hereinabove.

If it is determined (**65**) that the total energy expected to be discharged computed in a certain iteration j is not within the predetermined bound *i.e.*, $\sum_{i=1}^{j}(E_i) > (K1 \cdot E_c - K2 \cdot E_{\max})$, then it is assumed that the battery may go flat during the specific road segment S_j. In such an event, the process terminates in computation of the remaining travelable distance based on the road segments for which the computed total battery energy expected to be discharged is within the predetermined bound (**67**, *i.e.*, for $1 \leq i \leq j-2$). For example, by summating the lengths of all of the road segments for which the computed total battery energy expected to be discharged was within the predetermined bound, except for the last one (*e.g.*, $\sum_{i=1}^{j-2} S_i$) and adding to the summation result a remaining travelable distance computed for the last discrete road segment (j-1) for which the battery is expected to go flat, *e.g.*, $\tilde{D} = (\sum_{i=1}^{j-2} S_i) + E_{j-1} / dR_{j-1}$.

The process may proceed to determine in step **69** possible corrective measures that may be adopted by the user of the vehicle in order to increase the chances of reaching the target destination. For example, the user may be advised to divert from the planned route towards a reachable battery service station (BSS **17**). Alternatively, the user may be advised to change driving style and/or perform any other possible energy saving actions *e.g.*, close one or more windows, reduce or eliminate use of air-conditioning, discharge heavy payload, and suchlike.

Step **69** may include presenting to the user via the user interface **35u** reachable battery service stations, and allowing the user to select the most suitable battery service station **17** that satisfies the user's needs. Alternatively, the service provider **36** or the control unit of the vehicle **35** may select a suitable battery service station **17** and instruct the user to approach it to replenish the vehicle power source. In certain situations the suitable battery service station **17** may be selected to be the nearest station within the remaining travelable distance of the vehicle, and/or any reachable battery service station offering the best price and/or having compatible battery charging equipment and/or compatible charged batteries (*e.g.*, compatible to the vehicle of the user).

In possible embodiments the process illustrated in **Fig. 5** is continuously, periodically or intermittently, performed during the ride along the planned route. It may happen that planned routes initially having a reachable target destination according to

the computation of the remaining travelable distance approximation, appear along the ride to be unreachable *e.g.*, due to unexpected excess battery consumption along certain road segments. It is important that such situations are identified quickly to provide the user with possible corrective measures (step **69**) as soon as possible.

In case the user chooses to access a battery service station to replenish the vehicle power source, then a new planned route to the target destination may be generated using the selected battery service station as the current location of the vehicle, and the processes illustrated in **Fig. 5** may be carried out for the newly generated planned route by estimating the amount of replenished energy the vehicle will have after being serviced in the battery service station. If it is determined that the target destination is still unreachable after replenishing the vehicle's power source, another one or more suitable battery service stations may be selected towards the target destination until it is determined that the target destination is reachable.

The remaining travelable distance approximation may be adapted in real time during the ride based on data indications collected during the ride in order to adjust the approximated remaining travelable distance to varying conditions that cannot be accurately foreseen. **Fig. 6** demonstrates one possible process wherein the travelable distance approximation is continuously or periodically updated in real-time during the ride. First, current location (**70**) and the target destination of the user (**71**) are determined (**72**). Typically, the current location is obtained from the positioning system **35g,** and the target destination may be determined by querying the user through the user interface **35u** of the control unit **35**. However, if the user did not indicate a target destination, then the system derives a possible destination (**72**) based on statistical data collected in the system. For example, the collected route data may be analyzed by the computer system **15** or by the control unit **35** of the vehicle **13a** to derive a target destination based on the current location of the vehicle **13a** and the current time, as exemplified hereinabove.

After the target destination is determined, a driving route is planned (**73**). Based on the planned route, the relevant statistical, profile and/or roads data are collected (**74**) and analyzed. The analyzed data is then used to identify discrete road segments (**75**) of the planned route for which the energy flow calculation requires specific considerations. Next, a battery energy flow rate is computed (**76**), and adjusting factors are calculated (**77**), for each of the identified discrete road segments, or for the entire length of the

planned route. At this stage the remaining travelable distance may be approximated by measuring the battery charge level (**78**) and, based thereon, computing a travelable distance for the identified discrete road segments (**79**). The remaining travelable distance approximation may be then displayed via the user interface **35u** and/or sent to the service provider for monitoring. It is noted that the data analysis and computations (steps **74** to **79**) may be carried out by the service provider (*e.g.*, employing the computer system **15**) or by the control unit **35** of the vehicle **13a**.

The remaining travelable distance is continuously or periodically updated by obtaining new readings of the current location (**80**) of the vehicle **13a**, of the battery charge state and temperature, and retrieving real-time updates on road conditions and/or driving patterns of the user. For example, it may be determined (**81**) that the remaining travelable distance approximation should be updated if the user has opened one or more windows and/or switched on an air-conditioning system, and/or started to aggressively accelerate the vehicle and drive at high speeds. Or, as another example, if received traffic updates indicate that there are traffic loads on road segments of the planned route.

As yet another example, the vehicle's payload may change along the ride as passengers and/or luggage are loaded onto, or discharged from, the vehicle, which may require applying corresponding adjustments in the remaining travelable distance approximation.

Receipt of such updates may require identification of new sub-segments in the planned route or carrying out the segmentation step (**75**) for the residual planned route according to the current location of the vehicle (**80**), that is carried by passing the control back to the segmentation step (**75**). Based on the new segmentation, or sub-segmentation, the remaining travelable distance is approximated again by repeating the prescribed steps *i.e.*, calculation of energy flow rate (**76**) and adjusting factors (**77**) for the newly identified road segments, measuring the battery charge level (**78**) and travelable distance computation (**79**).

On the other hand, if there are no updates (**81**) , control is passed back to the battery charge level measurement step (**78**), and a new remaining travelable distance approximation is carried out (**79**) based on the previously determined segmentation (**75**), battery energy flow rate (**76**) and adjusting factors (**77**) (*i.e.*, without repeating steps **75**, **76** and **77**).

It is noted that though the reporting of the battery charge state from the vehicle's internal information system may be based on its current voltage state or other electrical features, the relation between the battery voltage and remaining battery energy may change due to aging of the battery, and it also depends on the temperature of the battery and the number of recharge cycles. Accordingly, in certain embodiments, the battery status module **35d1**, and/or the control unit **35,** may be configured to evaluate the charge level of the battery **35t** based on the battery age, battery temperature and/or its charging history.

For example, the vehicle's control unit **35** may be configured to translate a measured electrical property (*e.g.*, voltage) of the battery **35t,** reported by the battery status module **35d1,** to an actual battery charge level based on historical data of the battery **35t** maintained by the control unit **35**, based on information retrieved for the battery **35t** from a control center or service provider, and/or based on the current temperature of the battery **35t**. In possible embodiments the charge level of the battery **35t** is determined using fixed monotonic curves that characterize a relation between the voltage level of the battery and the actual energy stored in it. For example, the control center, or any other communicable server, may be used to store lookup tables (*e.g.*, in the memory **15m** of the computer system **15**) representing monotonic curve relations of various types of batteries, which are used to return an actual amount of energy stored in a battery upon receipt of the battery temperature and/or battery age. Additionally or alternatively, such monotonic curve lookup tables may be stored and used in the internal computer of the vehicle **13a** (*e.g.*, in the memory **35m** of control unit **35**), or in the status reporting modules **35d**, to allow instant extraction of the battery charge level by the internal computer of the vehicle.

The computed remaining travelable distance approximation may be presented to the user on a display device of the user interface **35u**, or alternatively, or additionally, on a dedicated user interface provided in the vehicle **13a**, and it may be also sent for display to other devices such as a mobile handset or tablet of the user (*e.g.*, over a Bluetooth link). In case of a single target destination, the remaining travelable distance approximation may be displayed in a numerical or other textual representation form, and/or graphically on a map showing the planned route and the expected driving distance thereon. In cases where multiple target destinations are analyzed, the computed remaining travelable distance approximations may be presented in the form of a range

of corresponding approximation values, and/or graphically presented on a map showing all analyzed routes and the different distances that can be traveled on each of the routes.

A contour line may be drawn to connect between the maximal distances on each of the routes to present an expected reachable area. **Fig. 7** exemplifies approximation of travelable distances, D_a, D_b, D_c,..., D_e, for a vehicle **13a** to a plurality of respective possible target destinations **37a**, **37b**, **37c**,...,**37e**, and possible display of relevant data in a display device **88** (*e.g.*, may be part of the user interface **35u** or of the positioning system **35g**) provided in vehicle **13a**. In this example, different travelable distances are computed for each of the target destinations, such that the reachable range designated by the closed line **86** presented in the user display on the road map **85** is typically of a curved closed asymmetric shape.

The display **88** may further present a planned route **83** to a selected target destination **37d**, and textual display indications **87** of data associated with the planned route **83**. For example, the textual display **87** may provide indication **87a** of the distance to the target destination **37d** (**D2T**, *i.e.*, D_d) from the current location of the vehicle **13a** according to the planned route **83**, the approximation of the remaining travelable distance (**RTD**) **87b** computed for the planned route **83**, and a ratio **87c** of a the remaining residual battery energy (**RE%**) that will be left in the battery **35t** after reaching the target destination **37d** relative to the maximal energy capacity E_{max} of the battery **35t**. In this example, assuming the planned route includes a single road segment S_1 for which a battery energy flow rate dR_1 was calculated, then the ratio of remaining residual battery energy **RE%** may be computed by dividing the amount of battery energy $E_1^{(res)}$ expected to remain in the battery after reaching the target destination **37d** by the maximal energy capacity E_{max} of the battery *e.g.*, $RE\% = 100 \cdot E_1^{(res)} / E_{\max} = 100 \cdot (E_c - dR_1 \cdot S_1) / E_{\max}$.

The planned route **83** may include stops in one or more battery service stations, **17a** **17b**, presented to the user in the display **88**, for replenishing (charging or exchanging) the battery of the vehicle **13a** along the ride of the planned route **83**. In possible embodiments the remaining travelable distance is continuously, intermittently or periodically, monitored (*e.g.*, based on measured battery energy and/or temperature level, and/or updated road or vehicle data) in real time during the ride along the planned route **83** to verify that the target destination is reachable. If it appears during the ride that the target destination is not reachable (*e.g.*, if the battery energy consumption is

greater than expected), then a new route to the target destination may be generated to include one or more battery service stations for charging or exchanging the battery of the vehicle. For example, generation of the new route may be part of generation of an energy plan computed for the vehicle by the internal computer of the vehicle or by the control center, as described in International Patent Application No. PCT/US2009/057029, of the same applicant hereof, the content of which is incorporated herein by reference.

Fig. 8A exemplifies process steps that may be embedded in the process exemplified in **Fig. 6** for updating a planned route to include one or more battery service stations **17**. In this example, after the remaining travelable distance is determined in step **79** of **Fig. 6** it is determined based on the calculated remaining travelable distance if the target destination is reachable (**90**). If it is determined that the target destination is reachable then the control is passed to the next process step (**80**) in **Fig. 6** which thus proceeds without, or with minimal, interruption. If it is however realized that the target destination is not reachable, then one or more suitable battery service stations **17** are determined (**91**) for replenishing the battery of the vehicle. The one or more suitable battery service stations **17** may include all battery service stations that are reachable (*i.e.*, within the calculated remaining travelable distance), and/or stations having compatible charging equipment or suitable replenished batteries.

Optionally, the one or more suitable battery service stations may be presented to the user for selection (**92**, designated by dotted lines) of a preferable service station for being serviced at. Alternatively, a suitable battery service station is selected without user intervention according to battery stations status report received from the service provider (or from a communicable server), to guarantee timely receipt of the desired service with minimal deviations from the originally planned route to the target destination. Once a suitable battery service station is selected, the original target destination is stored in memory and the selected battery service station is set as the destination (**93**). The control is then passed to step **73** in **Fig. 6** for determining a route to the selected battery service station and proceeding with the real-time approximation and update of the remaining travelable distance approximation during a ride towards the selected battery service station.

Fig. 8B exemplifies further possible adjustments to the real-time remaining travelable distance approximation of **Fig. 6**, wherein after each step of determining the

current location of the vehicle (**80**) it is checked if the target destination was reached (**94**). If it is determined that target destination is not yet reached, then the process of **Fig. 6** proceeds without, or with minimal, interruptions, as the control is passed to step **81** in **Fig. 6**. Otherwise, if it determined that target destination was reached, then it is checked if the target destination is a selected battery station (**95**). If it is determined that the vehicle reached a selected battery service station then the process is halted until receipt of the required service (**96**). Otherwise, if it is determined that the vehicle reached its original target destination, then the process is terminated (**98**). After the vehicle receives the required service in step **96**, the original target destination is fetched from the memory and a new route to the target destination from the current location (*i.e.*, from the battery service station) is planned as the control is passed to step **73** in **Fig. 6**.

The above examples and description have of course been provided only for the purpose of illustration, and are not intended to limit the invention in any way. As will be appreciated by the skilled person, the invention can be carried out in a great variety of ways, employing more than one technique from those described above, all without exceeding the scope of the invention.

CLAIMS:

1. A method for calculating a remaining travelable distance of a vehicle powered by a battery, the method comprising:

providing data indicative of a route of said vehicle;

providing statistical data related to a route and to a user of said vehicle;

providing data about a measured charge level of said battery indicative of an amount of energy stored in the battery;

utilizing the statistical data and determining a rate of battery energy flow for said battery indicative of a rate of discharge or recharge of battery energy along at least a segment of road in said route; and

determining a remaining travelable distance based on said rate of battery energy flow and said battery charge level.

2. The method according to claim 1, further comprising identifying based on the retrieved data a plurality of discrete road segments in the route, wherein the calculating of the battery energy flow rate comprises calculating for each of said plurality of discrete road segments a discrete rate of battery energy flow based at least in part on specific considerations associated therewith.

3. The method according to claim 1 or 2, wherein the statistical data includes at least one of: driving patterns of the user, at least one route frequently driven by the user, and rate of battery energy flow along at least one segment of road in the at least one route frequently driven by the user.

4. The method according to any one of claims 1 to 3, wherein the statistical data includes data about a plurality of other users, wherein said statistical data and the data indicative of the route have at least one common feature selected from the following group: at least one segment of road of a frequently driven route, same time of day in which the route is driven, same day of week in which the route is driven, same day of month in which the route is driven, similar driving style, similar road behavior.

5. The method according to any one of claims 2 to 4 wherein the statistical data is collected from a plurality of users and maintained in a storage accessible by the

vehicle, the method further comprising associating data items of said statistical data to road segments of previously driven routes, and wherein providing statistical data related to the route includes providing data items based on road segments of the route of the vehicle.

6. The method according to claim 5, wherein the storage is hosted by a data server accessible over a data network.

7. The method according to any one of claims 1 to 6, wherein the retrieved data comprises at least one of: road data indicative of road conditions along the at least one segment of road of the route; vehicle data indicative of conditions of the vehicle or of its battery; and topographic conditions of the at least one segment of road of the route.

8. The method according to claim 7, wherein the road data includes at least one of the following: weather conditions along at least one segment of road of the route; traffic conditions along at least one segment of road of the route; number of lanes in at least one segment of road of the route; road curvature of at least one segment of road of the route; and gradient of at least one segment of road of the route.

9. The method according to claim 7 or 8, wherein the vehicle data includes at least one of the following: vehicle weight, vehicle payload, windows state, amount of energy consumed by electric appliances of the vehicle, motor efficiency, battery efficiency, battery temperature.

10. The method according to any one of claims 1 to 9, further comprising determining based on the retrieved data at least one adjusting factor indicative of energy losses or gains along at least one segment of road of the route, wherein the calculating of the rate of battery energy flow is based at least in part on said at least one adjusting factor.

11. The method according to claim 10, wherein determining the at least one adjusting factor includes determining resisting or propelling conditions along at least one segment of road of the route based on the retrieved data, wherein the at least one adjusting factor is based at least in part on said resisting or propelling conditions.

12. The method according to claim 11, wherein determining resisting or propelling conditions includes determining automotive aerodynamic parameters of the vehicle along the at least one segment of road, wherein the at least one adjusting factor is based at least in part on said automotive aerodynamic parameters.

13. The method according to any one of claims 3 to 12, wherein the specific considerations are derived from at least one of the following group: the topographic conditions, the road data, the weather conditions, the traffic conditions, the driving patterns of the user, and the automotive aerodynamic parameters of the vehicle.

14. The method according to any one of claims 7 to 13, wherein identifying the plurality of discrete road segments is based at least in part on one of the following: the driving patterns of the user; the rate of battery energy flow along at least one segment of road of the route; the road data; the vehicle data; and the topographic conditions.

15. The method according to any one of claims 7 to 13, wherein identifying the plurality of discrete road segments is based on data collected from a plurality of users.

16. The method according to any one of claims 2 to 15, further comprising identifying in the plurality of discrete road segments two or more intersecting discrete road segments and identifying at least one discrete road segment mutual to said two or more discrete road segments according to said intersection, wherein the calculating of the battery energy flow rate comprises calculating for said at least one mutual discrete road segment a discrete rate of battery energy flow based at least in part on specific considerations associated with said two or more intersecting discrete road segments.

17. The method according to any one of claims 2 to 16, wherein the calculating of the remaining travelable distance comprises:

calculating for each discrete road segment an amount of expected battery energy discharge along a portion of the route between the first road segment of the route and the specific discrete road segment based on the calculated battery energy flow rates of the specific road segment and of discrete road segments located downstream to the specific discrete road segment, and

whenever determining based on the expected amount of battery energy discharge calculated for a specific discrete road segment that the charge level of the battery is not sufficient to complete the route calculating the remaining travelable distance based on lengths of the discrete road segments located downstream to the specific discrete road segment.

18. The method according to claim 17, further comprising calculating residual battery energy indicative of an amount of energy expected to remain in the battery when said specific discrete road segment is reached, wherein the remaining travelable distance is calculated based at least in part on said residual battery energy.

19. The method according to claim 17, comprising, whenever determining based on the expected battery energy discharge calculated for all discrete road segment that the charge level of the battery is sufficient to complete the route, calculating remaining travelable distance based on a residual battery energy computed for the last discrete road segment of the route.

20. The method according to any one of claims 17 to 19, wherein calculating the remaining travelable distance is based on a weighted average of energy flow rates computed for two or more of the discrete road segments.

21. The method according to any one of claims 17 to 20, comprising adding to the route one or more battery service stations whenever it is determined that the charge level of the battery is not sufficient to complete the route.

22. The method according to any one of the preceding claims, further comprising determining corrective measures that the user of the vehicle may perform in order to increase the chances of reaching a target destination of the route, whenever the value of the calculated battery residual energy content is negative.

23. The method according to any one of the preceding claims, wherein determining the route comprises determining a target destination based on data received from the user or on the at least one frequently driven route, and on at least one of the following indications: current location of the vehicle, time of day the at least one

frequently driven route is being driven, and day of the month the at least one frequently driven route is being driven.

24. The method according to any one of the preceding claims, comprising displaying in a display device provided in the vehicle data related to the route, said data comprising at least one of the following: distance from current location of the vehicle to the target destination; the calculated remaining travelable distance; data indicative of a portion of the battery energy expected to be contained in the battery after reaching the target destination; and the route and any planned stops in battery service stations included in the route.

25. A system for use in monitoring a traveling vehicle powered by a battery, comprising:

a processing utility connectable to a memory utility for receiving data comprising statistical data related to a plurality of routes driven by a plurality of users or related to said users, the processing utility comprising:

a battery energy flow estimator configured and operable to receive and process a planned route and data comprising statistical data of at least one of said plurality of routes or of at least one of said users, and calculate, based on said data, a rate of battery energy flow for said battery along at least a segment of road of said planned route; and

a distance approximating unit configured and operable to receive data indicative of an amount of energy stored in said battery and data indicative of said rate of battery energy flow, and calculate a remaining travelable distance for said vehicle based thereon.

26. A system according to claim 25, wherein the battery energy flow estimator is configured and operable to identify, based on the received data, a plurality of discrete road segments in the planned route, and to calculate a respective discrete rate of battery energy flow for each of said plurality of discrete road segments based at least in part on specific considerations associated therewith and derived from said data.

27. A system according to claim 25 or 26, wherein the statistical data includes at least one of: driving patterns of a user of the vehicle, at least one route

frequently driven by the users, rate of battery energy flow along at least one segment of road in the at least one frequently driven routes.

28. A system according to any one of claims 25 to 27, wherein the statistical data includes data about a plurality of other users, wherein said statistical data and the data indicative of the route have at least one common feature selected from the following group: at least one segment of road of a frequently driven route, same time of day in which the route is driven, same day of week in which the route is driven, same day of month in which the route is driven, similar driving style, similar road behavior.

29. A system according to any one of claims 25 to 28, wherein the retrieved data comprises at least one of: road data indicative of road conditions along the at least one road segment; vehicle data indicative of conditions of the vehicle or of its battery; topographic conditions of at least one road segment of the planned route.

30. A system according to any one of claims 25 to 29, wherein the road data includes at least one of the following: weather conditions along at least one segment of road of the planned route; traffic conditions along at least one segment of road of the planned route; number of lanes along at least one segment of road of the planned route; road curvature of at least one segment of road of the planned route; and gradient along at least one segment of road of the planned route.

31. A system according to claim 29 or 30, wherein the vehicle data includes at least one of the following: vehicle weight, vehicle payload, windows state, rate of energy consumed by electric appliances of the vehicle, motor efficiency, battery efficiency, battery temperature.

32. A system according to any one of claims 25 to 31, wherein the battery energy flow estimator is configured and operable to determine, based on the received data, at least one adjusting factor indicative of energy losses or gains along at least one road segment of the planned route, and to calculate the rate of battery energy flow based at least in part on said at least one adjusting factor.

33. A system according to claim 32, wherein the battery energy flow estimator is configured and operable to determine resisting or propelling conditions

along the at least one road segment of the planned route based on the retrieved data, wherein the at least one adjusting factor is determined based at least in part on said resisting or propelling conditions.

34. A system according to claim 33, wherein the battery energy flow estimator is configured and operable to determine automotive aerodynamic parameters of the vehicle along at least one road segment of the planned route, wherein the resisting or propelling conditions are determined based at least in part on said automotive aerodynamic parameters.

35. A system according to any one of claims 26 to 34, wherein the specific considerations are derived from at least one of the following: the topographic conditions, the road data, the weather conditions, the traffic conditions, the driving patterns of the user, and the automotive aerodynamic parameters of the vehicle.

36. A system according to any one of claims 26 to 35, wherein the plurality of discrete road segments are identified based at least in part on one of the following: the driving patterns of the user; the rate of battery energy flow along at least one of the segments of road in the at least one frequently driven routes; the road data; the vehicle data; and the topographic conditions.

37. A system according to any one of claims 26 to 36, wherein the battery energy flow estimator is configured and operable to identify in the plurality of discrete road segments two or more intersecting discrete road segments and to identify at least one discrete road segment mutual to said two or more discrete road segments according to said intersection, and to calculate a battery energy flow rate for said at least one mutual discrete road segment based at least in part on specific considerations associated with said two or more intersecting discrete road segments.

38. A system according to any one of claims 26 to 37, wherein the distance approximating unit is configured and operable to: calculate for each discrete road segment an amount of expected battery energy discharge along a portion of the route between the first road segment of the route and the specific discrete road segment based on calculated battery energy flow rates of the specific road segment and of discrete road segments located downstream to the specific discrete road segment; determine based on

the expected battery energy discharge calculated for a specific discrete road segment if the charge level of the battery is sufficient to complete the route; and if it is determined that the buttery charge level is not sufficient, calculate a remaining travelable distance based on lengths of the discrete road segments located downstream to the specific discrete road segment.

39. A system according to claim 38, wherein the distance approximating unit is configured and operable to compute a residual battery energy indicative of an amount of energy expected to remain in the battery when the specific discrete road segment is reached, and to calculate the remaining travelable distance based at least in part on said residual battery energy.

40. A system according to claim 38, wherein the distance approximating unit is configured and operable to compute a remaining travelable distance based on a residual battery energy computed for the last discrete road segment of the route, whenever it is determined that the charge level of the battery is sufficient to complete the route.

41. A system according to any one of claims 38 to 40, wherein the distance approximating unit is configured and operable to calculate a weighted average of energy flow rates computed for two or more of the discrete road segments, and calculate the remaining travelable distance based at least in part on said weighted average.

42. A system according to any one of claims 38 to 41, wherein the processing utility is configured and operable to add to the route one or more battery service stations whenever it is determined that the charge level of the battery is not sufficient to complete the route.

43. A system according to any one of claims 25 to 42, wherein the distance approximating unit is configured and operable to determine corrective measures that the user of the vehicle may perform in order to increase the chances of reaching a target destination of the planned route, whenever the value of the calculated battery residual energy content is negative.

44. A system according to any one of claims 30 to 43, wherein the battery energy flow estimator is configured and operable to determine the planned route by determining a target destination based on data received from the user of the vehicle or based on the statistical data, and on at least one of the following indications: current location of the vehicle, time of day the frequently driven route is being driven, and day of the month the frequently driven route is being driven.

45. A system according to any one of claims 25 to 44, further comprising a charge level measuring unit configured to measure the amount of energy stored in said battery.

46. A method for presenting data related to a route of a vehicle, comprising:

receiving data indicative of battery energy flow along said route or along discrete road segments thereof;

computing based on said data an estimation of an amount of energy to be consumed from a battery of the vehicle during a ride along said route;

receiving data indicative of an amount of energy contained in the battery;

computing data indicative of a portion of the battery energy expected to be contained in the battery once the ride along said route is completed; and

outputting the computed data to a display utility, a memory utility, or a remote computer system.

47. A method according to claim 46, wherein the data indicative of the portion of the battery energy expected to be contained in the battery once the ride along the route is completed is provided in the form of a percentage relative to the maximal energy content of the battery, or in the form of distance units indicating a remaining travelable distance.

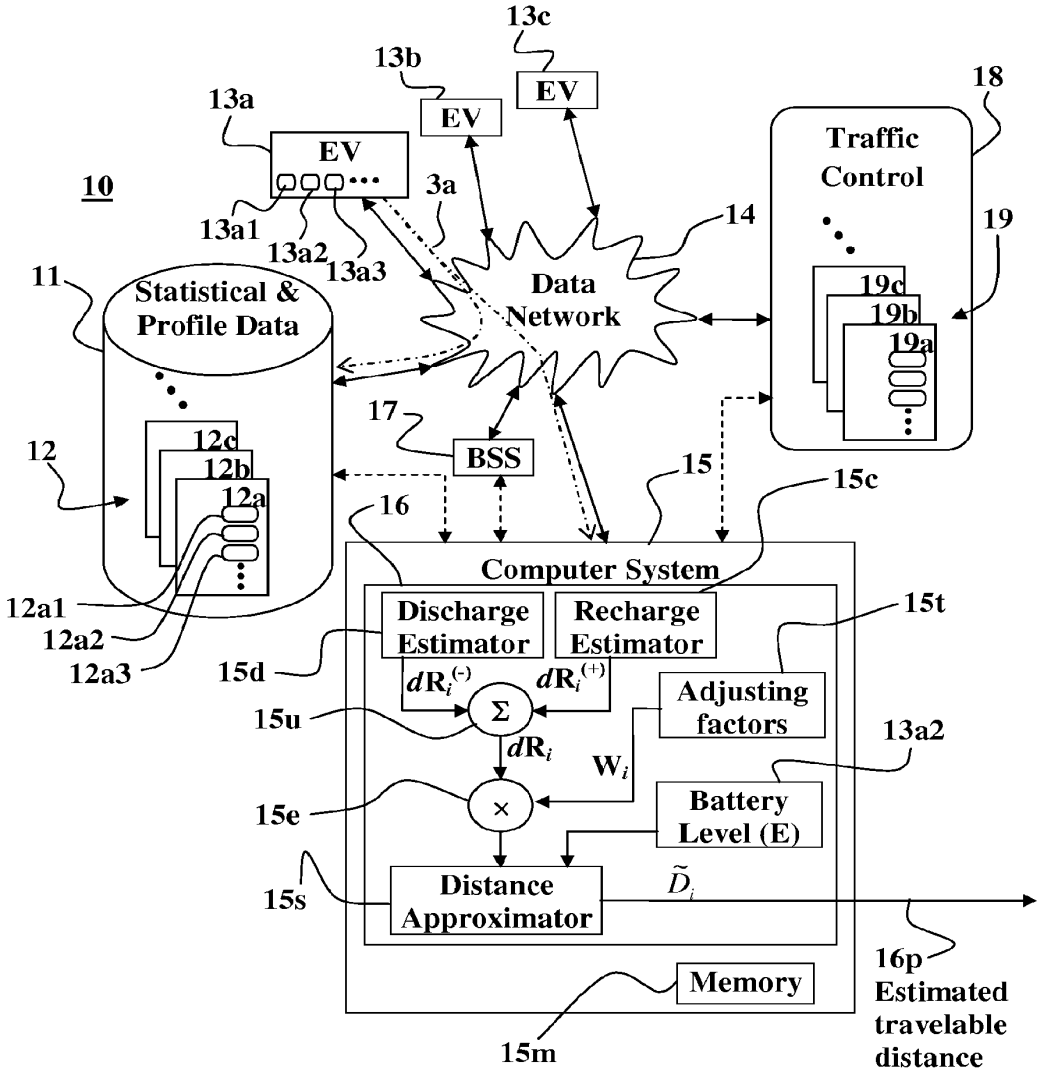

13c
13b
13a
EV
EV
EV
18
Traffic Control
10
3a
14
19
13a1
13a2
13a3
11
Statistical & Profile Data
Data Network
19c
19b
19a
17
BSS
12
12c
12b
12a
15
15c
16
Computer System
12a1
12a2
12a3
Discharge Estimator
Recharge Estimator
15t
15d
$dR_i^{(-)}$
$dR_i^{(+)}$
Σ
Adjusting factors
15u
dR_i
W_i
13a2
15e
×
Battery Level (E)
15s
Distance Approximator
$\tilde{D}_i$
16p
Estimated travelable distance
Memory
15m

Fig. 1

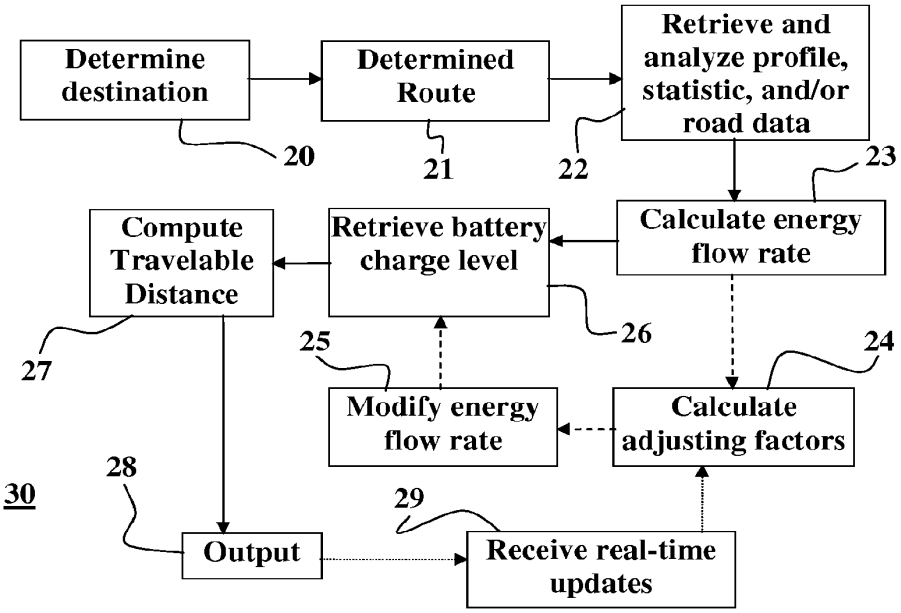

Determine destination
Determined Route
Retrieve and analyze profile, statistic, and/or road data
20
21
22
23
Calculate energy flow rate
Retrieve battery charge level
Compute Travelable Distance
26
27
25
24
Modify energy flow rate
Calculate adjusting factors
28
30
29
Output
Receive real-time updates

Fig. 2A

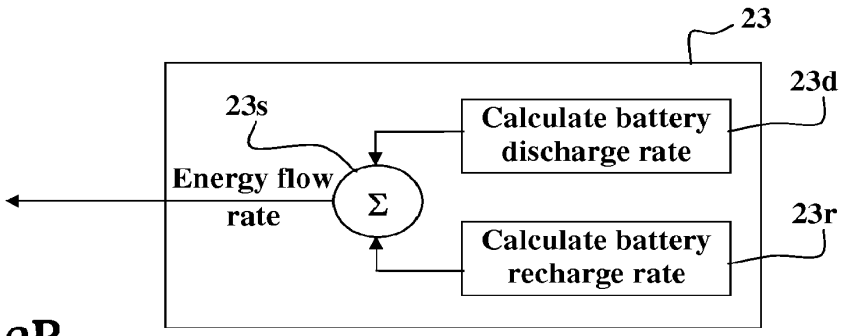

23
23d
23s
Calculate battery discharge rate
Energy flow rate
Σ
23r
Calculate battery recharge rate

Fig. 2B

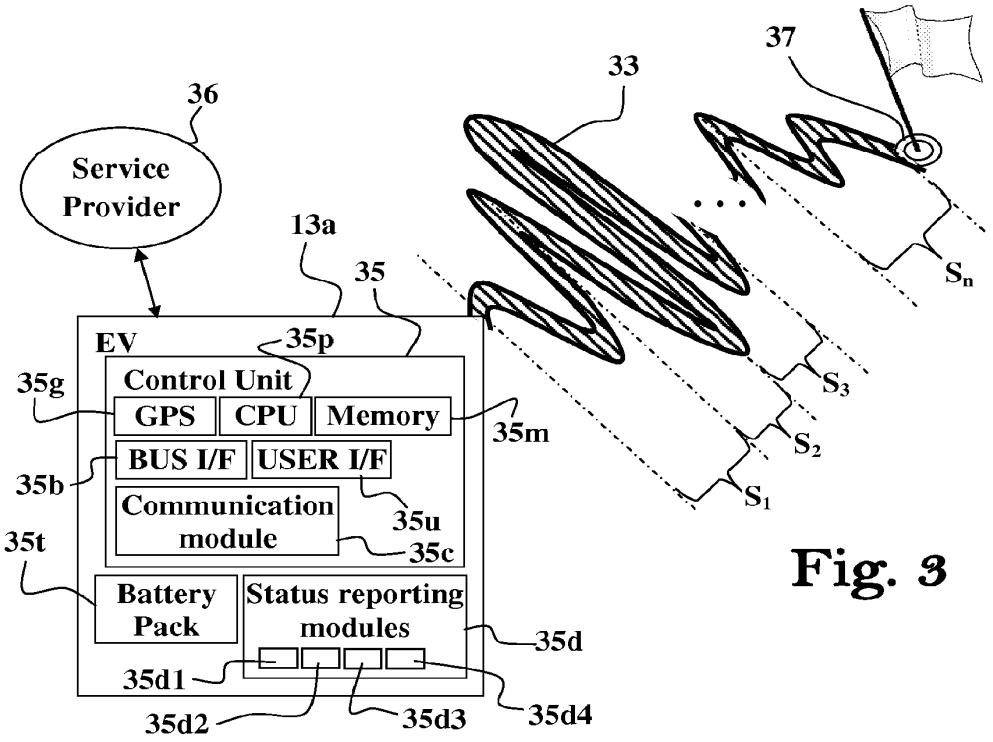

Service Provider
36
37
33
13a
35
EV
35p
Control Unit
35g
GPS
CPU
Memory
35m
BUS I/F
USER I/F
35b
35u
Communication module
35c
35t
Battery Pack
Status reporting modules
35d
35d1
35d2
35d3
35d4
S_n
S_3
S_2
S_1

Fig. 3

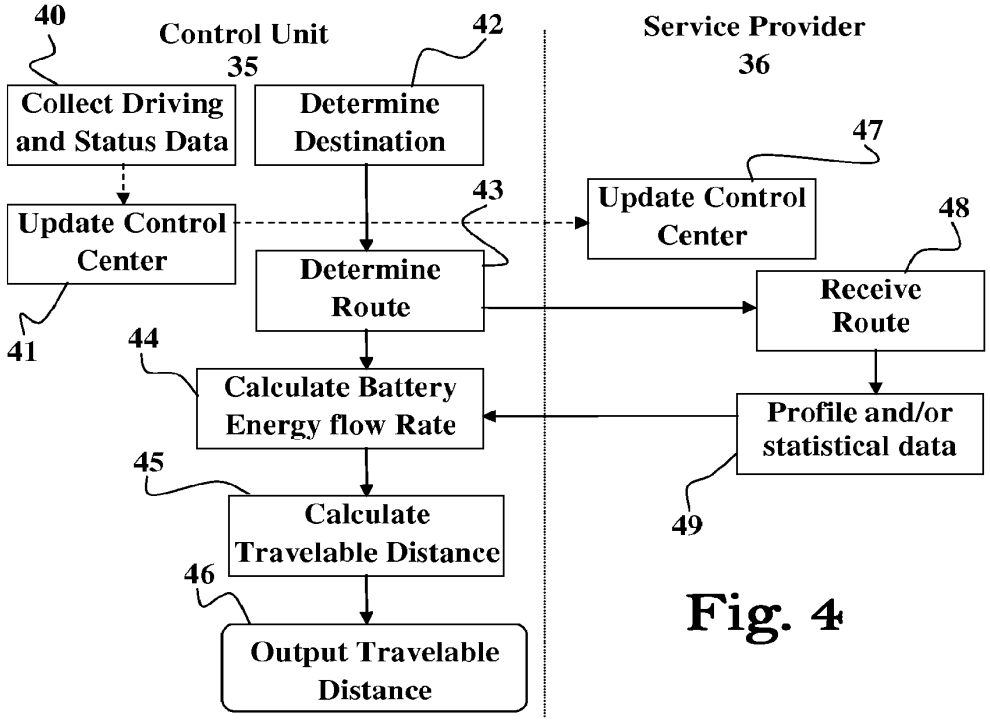

40
Control Unit
35
42
Service Provider
36
Collect Driving and Status Data
Determine Destination
47
Update Control Center
43
48
Update Control Center
Determine Route
Receive Route
41
44
Calculate Battery Energy flow Rate
Profile and/or statistical data
45
49
Calculate Travelable Distance
46
Output Travelable Distance

Fig. 4

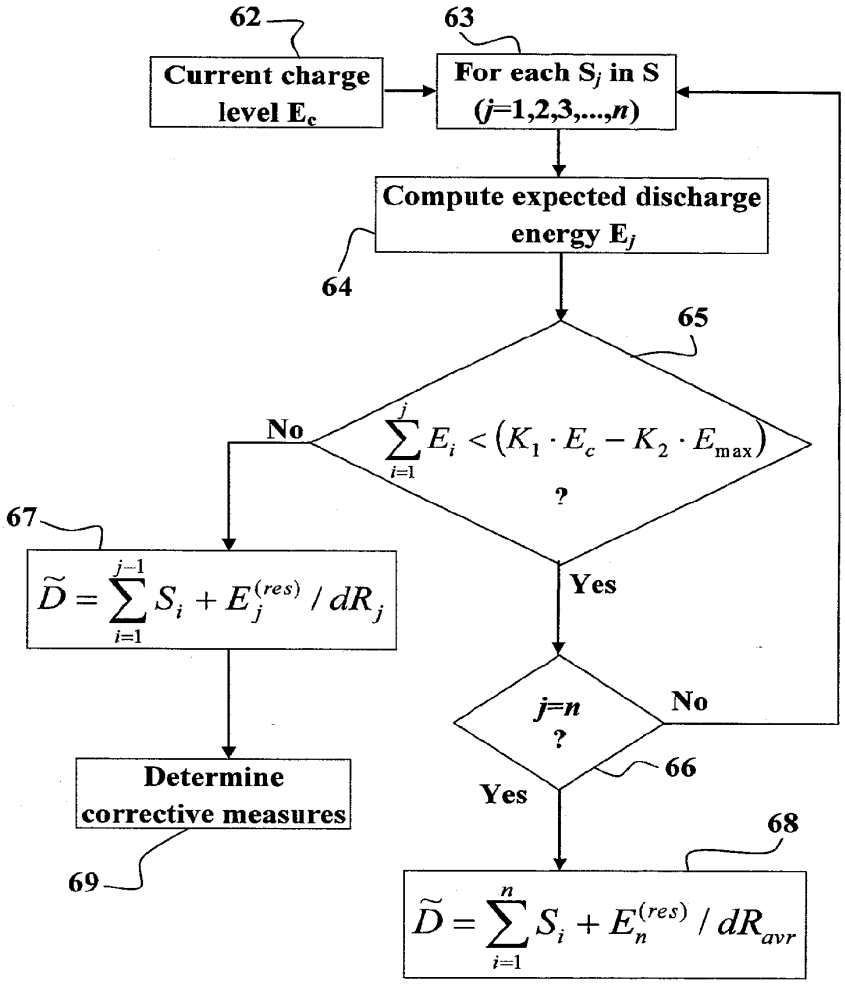

62
Current charge level E_c
63
For each S_j in S (j=1,2,3,...,n)
Compute expected discharge energy E_j
64
65
$\sum_{i=1}^{j} E_i < (K_1 \cdot E_c - K_2 \cdot E_{max})$?
No
Yes
67
$\widetilde{D} = \sum_{i=1}^{j-1} S_i + E_j^{(res)} / dR_j$
j=n ?
No
Yes
66
Determine corrective measures
69
68
$\widetilde{D} = \sum_{i=1}^{n} S_i + E_n^{(res)} / dR_{avr}$

Fig. 5

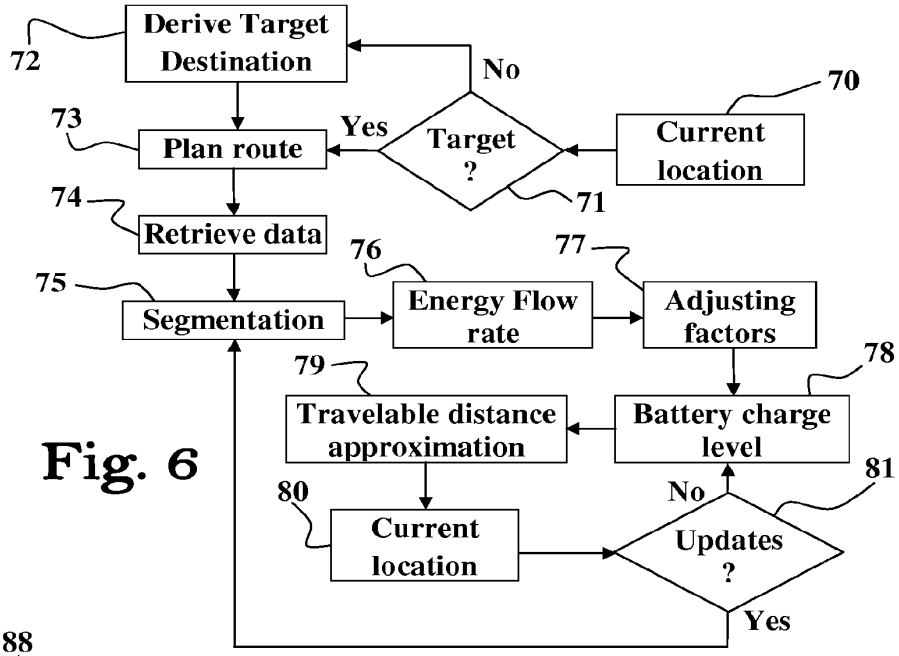

Derive Target Destination
72
No
70
73
Yes
Target ?
Current location
Plan route
71
74
Retrieve data
76
77
75
Segmentation
Energy Flow rate
Adjusting factors
78
79
Travelable distance approximation
Battery charge level
81
80
No
Current location
Updates ?
Yes

Fig. 6

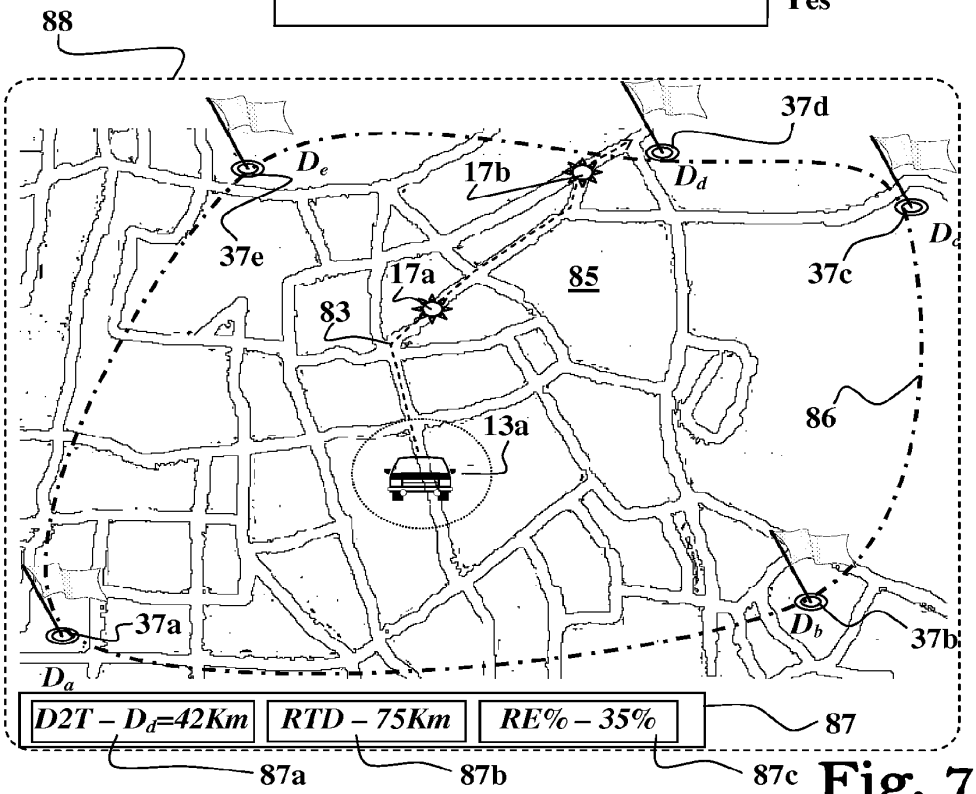

88
37d
D_e
17b
D_d
D_c
37e
17a
85
37c
83
86
13a
37a
D_b
37b
D_a
D2T – D_d=42Km
RTD – 75Km
RE% – 35%
87
87a
87b
87c

Fig. 7

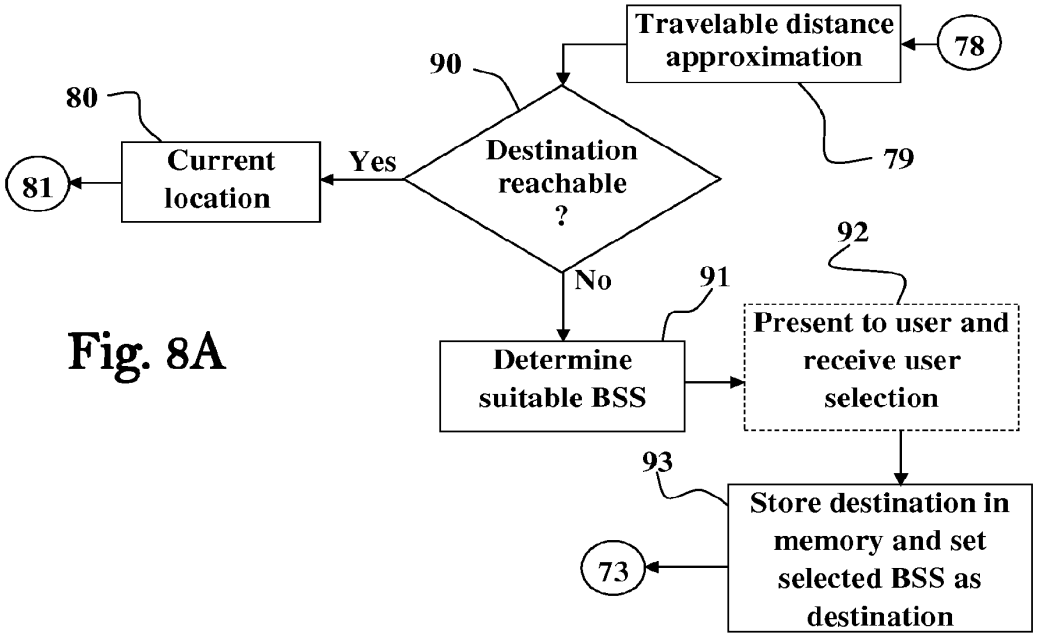

Travelable distance approximation
78
90
80
Current location
Yes
Destination reachable ?
79
81
92
No
91
Present to user and receive user selection
Determine suitable BSS
93
Store destination in memory and set selected BSS as destination
73

Fig. 8A

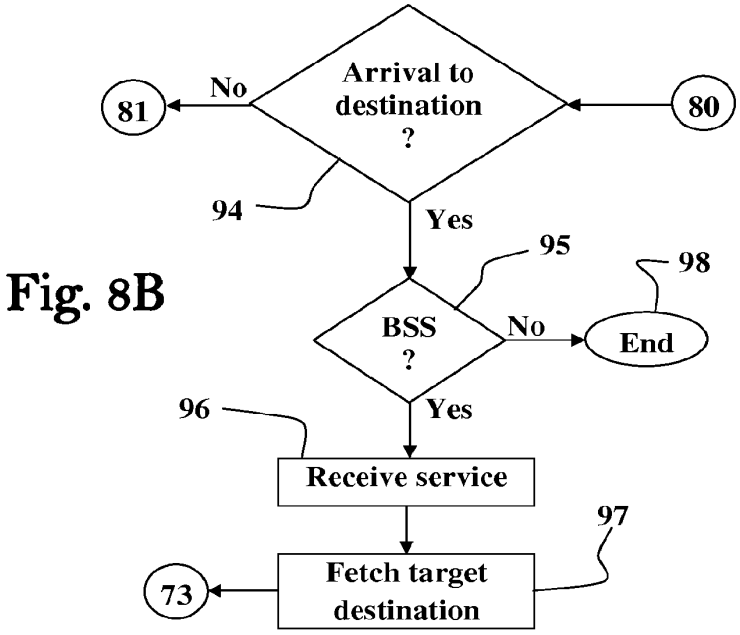

Arrival to destination ?
No
81
80
94
Yes
95
98
BSS ?
No
End
96
Yes
Receive service
97
Fetch target destination
73

Fig. 8B

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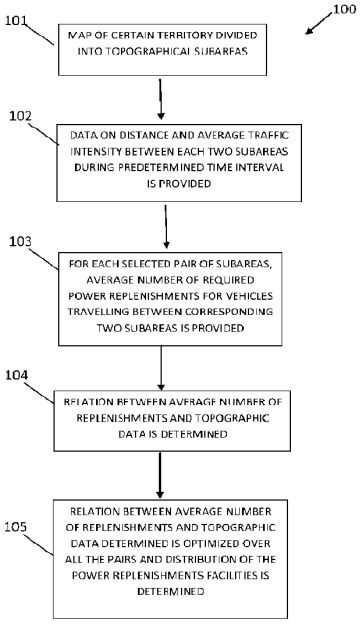


FIG. 1

(57) Abstract: A method for computer-implemented management of deployment of a network of battery service stations for electric vehicles is provided. The method includes dividing the certain territory into topographical subareas and selecting all pairs of the topographical subareas within a certain territory. Then, for each pair of selected topographical subareas, data are provided on a distance and average traffic intensity for electric vehicles therebetween during a predetermined time interval. Further, for each such pair of the topographical subareas, an average number of battery charge replenishments required for the electric vehicles travelling between the corresponding two subareas is estimated during the predetermined time interval. Further, the method includes establishing a relation between the average number of power replenishments and the topographic data. The relation between the average number of power replenishments and the topographic data over all the pairs of the subareas is optimized and a distribution of the power replenishment facilities within the certain territory is established.

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METHOD AND SYSTEM FOR OPTIMIZATION OF DEPLOYMENT OF BATTERY SERVICE STATIONS FOR ELECTRIC VEHICLES

FIELD OF THE INVENTION

This invention relates to deployment of battery service stations for electrical vehicles.

BACKGROUND OF THE INVENTION

Electric vehicles (EVs) that use electric energy to drive the vehicles have been attracting attention for solving problems associated with exhaustion of combustion fuel, such as oil on earth, and to develop environment friendly technology.

Electric vehicles contain electric storage batteries, to store electricity until required to power the vehicles. The electric storage batteries require periodic charging to replenish the electric charge for continued operation. Charging stations can be used to provide charging service for electric vehicles. The charging stations may include battery charging services to electric vehicles as well as battery exchange services where the user can simply replace (i.e., swap) the exhausted battery by a charged battery which can be available for replacement at the station.

Charging stations may, for example, be located in designated charging locations (e.g., similar to locations of gas stations), parking spaces (e.g., public parking spaces and/or private parking space), etc.

GENERAL DESCRIPTION

One of the major challenges to the widespread adoption of vehicles using electric storage batteries for powering the vehicle is the lack of infrastructure support in the form of an organized network of publicly accessible electric vehicle battery charging and/or replacement facilities. For conciseness of the description, the term

"charging and/or replacement facility" should be interpreted broadly as a battery service station that can include *inter alia* such power replenishment facilities, as battery charging and/or battery replacement facilities. Thus, the battery service station may include charging spots providing charging services to electric vehicles, as well as battery exchange stations where the user can simply replace the exhausted battery by a charged battery which can be available for replacement.

Deployment of such a network of battery service stations having charging and/or replacement facilities can be rather costly and require the cooperation, collaboration, and support of electric utility companies, vehicle manufacturers and governments to develop the infrastructure needed to make electric vehicles more practical to consumers.

There is a need for a technique that can optimize deployment of a network of battery service stations on a certain territory that can provide minimization of the number of charging spots and replacement (exchange) stations that should be provided, while still supplying the requested service to electric vehicle users allowing them, with high level of certainty, to complete their scheduled travels by electric vehicle without running out of battery charge.

Thus, it would be advantageous to have the method and system allowing the electric vehicle users to recharge or exchange batteries in locations that are close to their standard travel route when the exhausted battery is to be quickly replaced and/or stop points for a battery charging service, which might require significantly longer time then a battery replacement procedure.

The present invention provides a novel method for computer-implemented management of deployment of a network of battery service stations for electric vehicles traveling within a certain territory. This method can be implemented at a computer system including one or more data processors integral in the same computer or distributed between multiple computers appropriately connectable to one another e.g. via a communication network such as the Internet or phone network. Such a management system comprises a memory utility for storing reference data comprising topographic data on roads and road junctions within the certain territory, and a processor utility configured and operable for determining optimized distribution of battery service stations within the certain territory.

The method includes dividing the certain territory into topographical subareas and selecting all pairs of the topographical subareas within the certain territory. Then, for each pair of selected topographical subareas, data are provided on a distance and average traffic intensity for electric vehicles therebetween during a predetermined time interval. Further, for each such pair of the topographical subareas, an average number of battery charge replenishments required for the electric vehicles travelling between the corresponding two subareas is estimated during the predetermined time interval. Further, the method includes establishing a relation between the average number of power replenishments and the topographic data; and optimizing the relation between the average number of power replenishments and the topographic data over all the pairs of the subareas, and determining a distribution of the power replenishment facilities within the certain territory.

As indicated above, the power replenishment facilities may include charging spots and/or exchange (replacement) stations. Thus, the charge replenishments include battery charging and/or battery replacement.

According to some embodiments, the establishing of the relation between the average number of replenishments for the certain territory and the topographic data includes allocating places within the certain territory for location of the power replenishment facilities. The optimization of the relation between the average number of replenishments for the certain territory and the topographic data may include minimizing the total number of the power replenishment facilities required for deployment within the certain territory.

According to some embodiments, the optimizing of the relation between the average number of replenishments for the certain territory and the topographic data includes evaluating a capacity of the power replenishment facilities required to provide battery related service for the electric vehicles traveling within the certain territory.

According to some embodiments, the method of the present invention further includes providing updated topographic data on the roads and road junctions as well as updated input data on transportation characteristics on the certain territory corresponding to the updated topographic data. According to some embodiments, the method of the present invention further includes providing information about changes in the distribution of the power replenishment facilities within the certain territory. Then,

the method may include establishing an updated relation between the specific number of replenishments for the certain territory and the topographic data; and further optimizing the updated relation to obtain an updated distribution of the power replenishment facilities within the certain territory. The changes in the distribution of the power replenishment facilities within the certain territory include either ceasing operation of at least one power replenishment facility or opening operation of at least one power replenishment facility.

It should be understood that the method of the present invention for computer-implemented optimization of deployment of a network of charging facilities for electric vehicles can be used both in the context of ongoing network optimization, and also for covering the planning phase. Thus, according to an embodiment of the present application, after obtaining a calculated distribution of the charging facilities, the method can further include a planning step that involves checking whether the theoretically calculated locations are really availability. The planning step may, for example, include obtaining approvals from the corresponding authorities to use the theoretically calculated locations, etc. If the theoretically calculated locations are not available for deployment of charging/replacement facilities, then another really suitable location(s) are selected within the territory. These really suitable locations can be taken into account for establishing an updated relation between the specific number of replenishments for the certain territory and the topographic data. After optimizing this updated relation, one can obtain an updated distribution of the power replenishment facilities within the certain territory that takes into account the planning step.

The present invention provides a computer-implemented system for managing deployment of a network of battery service stations for electric vehicles traveling within a certain territory. The system includes a memory utility storing reference data comprising topographic data on roads and road junctions within the certain territory; and a processor utility configured and operable for determining optimized distribution of power replenishment facilities within the certain territory.

The processor utility includes a segmenting module, an identifier module connected to and receiving data from the segmenting module, an estimator module connected to and receiving data from the identifier module, and an optimization module connected to and receiving data from the estimator module. The segmenting module is

configured and operable for processing the topographic data for dividing the certain territory into topographical subareas of certain sizes and shapes. The identifier module is configured and operable for using such segmented topographic data and determining average traffic intensity between corresponding two subareas of each pair of the topographical subareas during a predetermined time interval. The estimator module is configured and operable for analyzing the average traffic intensity data and estimating average number of battery charge replenishments (charging or replacement of the battery) required for the electric vehicles travelling between two subareas, for each pair of the topographical subareas selected within the certain territory. The optimization module is configured and operable for carrying out the following:

(i) establishing a relation between the average number of power replenishments and the topographic data, (ii) optimizing the relation between the average number of power replenishments and the topographic data over all the pairs, and (iii) obtaining a distribution of the power replenishment facilities within the certain territory based on the relation between the average number of power replenishments and the topographic data.

The present invention also provides a program storage device readable by computer, tangibly embodying a program of instructions executable by the computer to perform method steps for optimization of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, the method steps comprising: dividing the certain territory into topographical subareas; selecting all pairs of the topographical subareas within the certain territory; for each pair of the topographical subareas selected within the certain territory, providing data on a distance and an average traffic intensity therebetween during a predetermined time interval; for each pair estimating an average number of power replenishments required for the electric vehicles travelling between any two subareas during the predetermined time interval; for each pair establishing a relation between the average number of power replenishments and the topographic data; and optimizing the relation between the average number of power replenishments and the topographic data over all the pairs, and determining a distribution of the power replenishment facilities within the certain territory.

The present invention also provides a computer program product comprising a computer useable medium having computer readable program code embodied therein for optimization of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, the computer program product comprising: computer readable program code for dividing a map of the certain territory into topographical subareas; computer readable program code for each pair of the topographical subareas selected within the certain territory, providing data on a distance and an average traffic intensity therebetween during a predetermined time interval; computer readable program code for each pair, estimating an average number of power replenishments required for the electric vehicles travelling between any two subareas during the predetermined time interval; computer readable program code for each, establishing a relation between the average number of power replenishments and the topographic data; computer readable program code for optimizing the relation between the average number of power replenishments and the topographic data over all the pairs, and determining a distribution of the power replenishment facilities within the certain territory.

There has thus been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows hereinafter may be better understood. Additional details and advantages of the invention will be set forth in the detailed description, and in part will be appreciated from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawing, in which:

Fig. 1 is a flow diagram of a method of the present invention for managing deployment of a network of battery service stations; and

Fig. 2 is a block diagram of an example of a computer-implemented system of the present invention for managing deployment of a network of battery service stations for electric vehicles traveling within a certain territory.

DETAILED DESCRIPTION OF EMBODIMENTS

The principles and operation of a system and method for computer-implemented management of deployment of a network of battery service stations for electric vehicles traveling within a certain territory according to the present invention may be better understood with reference to the drawings and the accompanying description, it being understood that this drawings and examples in the description are given for illustrative purposes only and are not meant to be limiting.

Some portions of the detailed descriptions, which follow hereinbelow, are presented in terms of algorithms and symbolic representations of operations on data represented as physical quantities within registers and memories of a computer system. An algorithm is here conceived to be a sequence of steps requiring physical manipulations of physical quantities and leading to a desired result. Usually, although not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. In the present description, these signals will be referred to as values, magnitudes, elements, symbols, numbers, or the like. Unless specifically stated otherwise, throughout the description, utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "generating" or "estimating" or the like, refer to the action and processes of an electronic calculating circuit or a computer system or similar electronic computing device, that manipulates and transforms data.

According to some embodiments of the present invention, deployment of a network of battery service stations for electric vehicles by a service center begins from defining a certain territory through which the electric vehicles will travel. The term "territory" is broadly used in the present description and the claims to include various areas, such as states, countries, districts, cities and even parts of the cities. Each kind of territory can, for example, be characterized by topographical data on the roads, road junctions and the number of potential travelers who may use the electric vehicles for transportation within the territory.

In order to replenish the power of electric vehicles (by charging or replacement of the batteries), a network of power replenishment facilities (i.e., battery service stations) for the electric vehicles should be deployed. The power replenishment facilities include charging spots for providing charging services to electric vehicles as

well as battery exchange/replacement facilities where the user can simply replace the exhausted battery by a charged battery which can be available for replacement at the station.

It should be understood that the power replenishment facilities cannot be distributed uniformly within the territory but should take into account the traffic volume, intensity and load within various parts of the territory (as well as limitations on deployment and land procurement, etc.). For example, in certain regions, such as cities, the traffic load may be high on primary roads, leading to long travel and wait time, whereas in less populated areas the load may be light and move smoothly. Depending on the charging requirements for electric vehicles, the power replenishment facilities may be overloaded, generating long delays, or could be idle due to low demand. Accordingly, for deployment of power replenishment facilities, the service center must be able to estimate the right number and distribution (relative accommodation) of power replenishment facilities to provide adequate service at reasonable costs.

Reference is made to **Fig. 1** illustrating a flow diagram **100** of a method of the present invention for computer-implemented management of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory. The method is based on a predetermined deployment model which takes into account various aspects of topographic data on the roads and road junctions as well as traffic characteristics.

According to an example of the deployment model, the certain territory chosen for deployment of power replenishment facilities is divided onto N topographical subareas A_i, where i=1, 2,... N (step **101**). For each pair A_iA_j (where *i, j*=1, 2, ..., *N*) of the topographical subareas selected within the certain territory, a distance D_{ij} between the subareas A_i and A_j, and an average traffic intensity for the electric vehicles travelling between the corresponding two subareas during a predetermined time interval (such as an hour, a day, a week, etc.) is provided (step **102**). It should be note that a size of the subareas A_i should preferably be much smaller than the distance D_{ij} between the subareas A_i and A_j.

For obtaining the average traffic intensity, traffic data can be utilized. This may be "reference data", previously provided and stored data for various purposes including traffic planning targets such as road construction or public transportation. The system of

the invention can thus connect to a respective storage device where such reference data is maintained.

The traffic data may be updated based on measurements of traffic intensity that can be carried out in short-term variations (individual or periodic measurements), with the help of measuring devices (vehicle loops, tube detectors, video detectors, and other counters). Such measuring devices are known *per see* and need not be described in details, except to note the following:

For example, a loop detector is an inductive loop buried in a deep groove cut into asphalt concrete pavement and covered with bitumen. During operation, a frequency signal of 100 kHz is transferred through the loop. With any vehicle passing over the loop, it functions as a metal cord of the loop and, thus, produces changes in the inductive resistance of the loop. Change in resistance is a signal for the detector about the passing vehicle. In order to detect not only a number of vehicles but also their speed and driving direction within vehicle classification regime, it is necessary to install two loops in each traffic lane at a certain fixed distance (e.g., 2 meters) from each other.

A rubber tube is an elastic tube laid across the street. One of his ends is blocked, whereas the other is put on a metal tube taken out in front of the device. With a vehicle passing over the tube, containing air pressure increases and this is the signal for a counter to register the passing vehicle. Counters with rubber tubes are usually used as easily transported devices for a short-term traffic count.

Annual average daily traffic intensity can, for example, be calculated using the data on the annual average daily traffic intensity of short-term measurement. Having traffic intensity data on short-term measurements, the traffic intensity of the day, the traffic intensity of the week, and annual average daily traffic intensity can be calculated. The daily traffic intensity (DTI) can, for example, be calculated as $I_D = M \times K_D$, where: I_D is the DTI of the measured day, car/day; M is the number of vehicles moved during the measured period, K_D is the coefficient of the measured day traffic intensity. Likewise, if traffic intensity is measured over a week without interruption, then, average weekly daily traffic intensity (AWDTI) can be calculated by averaging I_D over a week, month, year, etc.

Moreover, for each pair A_iA_j (where i, j = 1, 2, ..., N) of the topographical subareas selected within the certain territory an average number R_{ij} of power replenishments (typically, battery charging and/or battery replacement events) required for the electric vehicles travelling between the corresponding two subareas is estimated (step **103**). The number of the power replenishments depends on the distance D_{ij} between the subareas A_i and A_j, and possibly also on a time required to travel this distance D_{ij}. The latter varies with a change in the vehicle's speed profile while travelling along the respective route, which in turn depends on the traffic along the route (which might result in that the vehicle practically dos not move while it battery supplies power to various other facilities in the vehicle, like air conditioner, radio, etc.), and topographic data of the route. Thus, average speed v_{ij} of the vehicle travelling between the subareas A_iA_j might be considered as well as being indicative of traffic data. With regard to topographic data, it should be understood that while there is a typical number for electric vehicles following a certain route, the number of such vehicles can be refined taking into consideration the topography: this number increases if the road is uphill and/or there are multiple traffic lights that require stops, and decreases if the road is downhill and/or has little traffic. Hence, on the basis of data about the length of the route (a distance between the two subareas) and traffic data, as well as additional topographic information together with the assumptions regarding the initial charge level of the battery, the need for battery replacement/charging during the route can be predicated and the number of electric vehicles that would require such a change at any given time can be predicted.

The assumption regarding the battery charge level depends on the start and end locations of a trip travel. For example, if no further info is provided, then the assumption can be that the battery is half charged and this allows a full round trip. However, if it is known that the start point is the residential location and the end point is a work place equipped with a charging spot, then the assumption of a fully charged battery can be made for the analysis purposes.

Further, for each pair A_iA_j, a relation between the average number R_{ij} of power replenishments and the topographic data is established (step **104**). For this purpose, topographic data on roads and road junctions within the certain territory are used for determining such a relation. As a result, a list of the preferred places between the

subareas A_i and A_j within the territory are provided for location of the power replenishment facilities (e.g., battery service stations) with the average number R_{ij} of power replenishments for each place between the subareas A_i and A_j. This relation is further optimized over all the pairs A_iA_j to obtain the number of the replenishment facilities (charging spots and/or exchange stations) and their exact location for each subarea located on the way between A_i and A_j. For each subarea A_k located between the subareas A_i and A_j, the contribution due to the neighboring subareas is summed up to obtain the total number of replenishments per period of time required for the subarea A_k. This is used to determine size, type and number of replenishment stations in the subarea A_k. The calculation method can be carried out for all the pairs A_iA_j (where i, j = 1, 2, ..., N) within the territory under consideration. As a result, a distribution of the power replenishment facilities within the chosen territory (step **105**) is provided.

Example

A certain territory is considered which is divided into N subareas. For subareas A_1 and A_3 that are separated by a subarea A_2, all the original values for the power replenishments $R_{12}(0)$, $R_{23}(0)$ and $R_{13}(0)$ were set to 0. During measurements, the average number R_{13} of the power replenishments received for the pair A_1A_3 was 1000. The distance obtained between a central point of A_1 and a central point of A_3 was 200km, that typicality requires one battery replenishment along the way. Suppose that for 70% of electrical vehicles passing through the subarea A_2 from A_1 to A_3, battery replenishments have to be performed in the subarea A_2, while for the other 30% electrical vehicles, replenishments can be done in the subarea A_3. Accordingly, the updated average numbers R_{12} and R_{23} can be obtained by $R_{12} = R_{12}(0) + 1000 \times 0.7 = 700$ and $R_{23} = R_{23}(0) + 1000 \times 0.3 = 300$, correspondingly. The calculation method can be carried out for all the pairs A_iA_j (where i, j = 1, 2, ..., N) within the territory under consideration.

According to some embodiments, the optimization of the relation between the specific number of replenishments and the topographic data includes minimizing the total number of the power replenishment facilities required for deployment within the territory. The optimization may also include evaluating a capacity of the charging facilities and an optimal number of charge sockets required to provide charging service for the electric vehicles traveling within the selected territory. When desired, the

optimization may take into account the distribution of available capacity in batteries in various electrical vehicles at the start of a trip, due to the different battery charge states, battery type, size and/or capacity.

The network of the power replenishment facilities includes charging spots and exchange stations. Accordingly, the power replenishment may include either battery charging or battery replacement. A replacement of the battery is a rather quick process that can be carried out within a few minutes, while a charging of a battery is much longer process, which may require several hours for full replenishment of the battery charge. Therefore, battery exchange stations can, for example, be established in the locations which can be along the roads similar to locations of gas stations, parking, etc. On the other hand, battery charging spots can be located at the end points of the travel to allow for charging while not on travel. The locations that are used as frequent destinations where people spend many hours for business, i.e., business centers, parking places of large companies having many employers, etc. may also be suggested as charging spot locations. Likewise, charging spots can be located at the places where the EV users can entertain themselves during the time required for charging the battery, for example, at shopping molls, cinema theaters, bowling centers, and at other entertainment places. When desired, the cross effect of the exchange stations and charging spot deployment may be investigated and the best deployment strategy that optimizes cost, service quality and/or any other service parameters may be used for selection of these deployments. According to some embodiments, parking time of the vehicles on each location can be used to allow prediction of the electric power level and the value of the electric current supply required for a particular location of each charging facility.

The steps of the process described above can be first performed prior to initial deployment, and then the calculation and optimization steps of the process can be repeated when update topographic data on the roads and road junctions, as well as new input data on transportation characteristics on the selected territory, are received by the service center. In particular, when new roads and/or junctions are built on the territory as well as changes in the number of electric vehicles, vehicle travel patterns and other updated transportation characteristics are provided to the service center, these input data can be introduced in the deployment model for further optimizing the relation between

the specific number of replenishments for this territory and the topographic data for obtaining an updated distribution of the power replenishment facilities within the territory.

For example, an original location of the charging spot and/or exchange station can be changed and a new location of the power replenishment facility can be away from the main routs of the EV users. If so, the change in the location may require increase in capacity of the battery that, in turn, may cause degradation in the service, since such changes of the location of a power replenishment facility (charging spot and/or exchange stations) result in a detour of the vehicles from their primary route. These effects can be taken into account for further optimizing the relation between the specific number of replenishments to obtain an updated distribution of the remaining power replenishment facilities within the territory. Once a new location of the power replenishment facility is fixed, it is fed back to the model and the effect of the new site location on the other required power replenishment facilities is analyzed. It should be understood that the updated outcome may require changes in the arrangement for deployment of the network of the service station, i.e., in the location of the other charging spot and/or exchange facility.

The effect on user perceived service quality can be further analyzed as it does not necessarily correlate linearly to the deviation from the normal travel path. For example, an EV user traveling a long leisure trip will less likely feel a few kilometers detour to an exchange station as a nuisance, than a business traveler traveling a short trip. The deployment model of the application takes this factor into consideration by providing different weights for detour distances according to the type of the traveler as well as the destinations type of the source and target.

According to some embodiments of the present application, the calculation and optimization steps of the process for optimization/management of the deployment of the network of the service stations can also be repeated when the output data of the method, such as the initial arrangement for deployment of the charging facilities has been changed. For example, when one or more charging spots and/or exchange facilities stopped to operate; likewise when one or more new charging spots and/or exchange facilities were built up within the territory, these data can be fed to the deployment model in order to obtain an updated arrangement for deployment of the network of the

power replenishment facilities. The updated outcome may require changes in the arrangement for deployment of the network of the power replenishment facilities, i.e., in the location of the other charging spot and/or exchange stations.

The methods described herein may be governed by instructions that are stored in a computer readable storage medium and that are executed by one or more processors of one or more computer systems.

Referring to **Fig. 2**, there is exemplified, by way of a block diagram, a computer-implemented system **10** for management of deployment of a network of power replenishment facilities (battery service stations) **11** for electric vehicles (not shown) traveling within a certain territory **12**. The management system **10** is associated with a service center **13**, which is a data processor and analyzer system configured and operable for providing management of the power replenishment service to electric vehicles.

The service center **13** is typically a computer system and includes *inter alia* a data processor utility **130** which is connectable to a memory utility **131** (which may be an external storage device accessible via a communication network) storing reference data comprising topographic data on roads and road junctions within the certain territory as well as other required data. The processor utility **130** is configured and operable according to the invention for determining optimized distribution of power replenishment facilities within the certain territory selected for deployment of the network of such facilities **11**.

The processor utility **130** includes a segmenting module **132**, an identifier module **133**, an estimator module **134**, and an optimization module. The segmenting module **132** is configured for dividing a map of the certain territory **12** into N topographical subareas A_i of certain sizes and shapes. The identifier module **133** is configured and operable for using data generated by the segmenting module **132** and data indicative of the traffic in the corresponding subareas, and determining an average traffic intensity between all two subareas A_i and A_j (where $i, j=1, 2, \ldots, N$) for each pair of the topographical subareas during a predetermined time interval. The average traffic intensity is calculated on the basis of the measurements of short-term traffic intensity carried out in short-term variations (individual or periodic measurements), with the help of measuring devices **14** e.g., vehicle loops, tube detectors, video detectors, and other

counters) mounted on roads and road junctions (not shown) within the territory **12**. The traffic intensity measurements, as well other relevant data regarding events in the territory of interest, can be transmitted from measurement equipment installed within the territory to the service center **13** through a communication network **15**.

The estimator module **134** is configured and operable for estimating average number of power replenishments (battery charge replenishments) required for the electric vehicles travelling between two subareas A_i and A_j for each pair A_i A_j (where i, $j = 1, 2, \ldots, N$) of the topographical subareas selected within the selected territory **12**.

The optimization module **135** is configured and operable for determining a relation between the average number of power replenishments and the topographic data. The optimization module **135** is configured and operable for optimizing the relation between the average number of power replenishments and the topographic data over all the pairs A_iA_j (where i, $j = 1, 2, \ldots, N$) of the topographical subareas selected within the territory **12**. During the optimization step, the number of the replenishment facilities and their exact location is determined for each subarea located on the way between A_i and A_j. As described above, for each pair A_iA_j, the average number R_{ij} of the power replenishments and the location of these replenishment facilities are determined, thereby a list of the subareas A_k between A_i and A_j is provided at which the corresponding replenishments are to be made. The contribution from the neighboring subareas is added to each subarea A_k between A_i and A_j, thereby obtaining a total number of replenishment facilities required for each subarea A_k per a certain time period.

The optimization module **135** is also configured for obtaining a distribution of the power replenishment facilities within the territory **12** based on the relation between the average number of power replenishments for the territory **12** and the topographic data on the roads and road junctions within the territory **12**.

It will also be understood that the system according to the invention may be a suitably programmed computer. Thus, the invention contemplates a computer program being readable by a computer for executing the method of the invention. The invention further contemplates a machine-readable memory (storage medium) tangibly embodying a program of instructions executable by the machine for executing the method of the invention. The machine-readable storage medium may include a magnetic or optical disk storage device, solid state storage devices such as Flash

memory, or other non-volatile memory device or devices. The computer readable instructions stored on the computer readable storage medium are in source code, assembly language code, object code, or other instruction format that is interpreted by one or more processors.

As such, those skilled in the art to which the present invention pertains, can appreciate that while the present invention has been described in terms of preferred embodiments, the concept upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, systems and processes for carrying out the several purposes of the present invention.

Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

It should be noted that the word "comprising" as used throughout the appended claims is to be interpreted to mean "including but not limited to".

It is important, therefore, that the scope of the invention is not construed as being limited by the illustrative embodiments set forth herein. Other variations are possible within the scope of the present invention as defined in the appended claims and their equivalents.

CLAIMS:

1. A method for computer-implemented management of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, the method implemented at a computer system associated with a memory utility storing reference data comprising topographic data on roads and road junctions within said certain territory, and comprising a processor utility configured and operable for determining optimized distribution of the power replenishment facilities within said certain territory, the method comprising:

dividing the certain territory into N topographical subareas A_i, where i=1, 2,... N;

selecting pairs A_iA_j of the topographical subareas within said certain territory, where i, j=1, 2, ..., N;

for each pair A_iA_j of the topographical subareas selected within the certain territory, providing data on a distance and an average traffic intensity therebetween during a predetermined time interval;

for each pair A_iA_j, estimating an average number of power replenishments required for the electric vehicles travelling between A_i and A_j during the predetermined time interval;

for each pair A_iA_j, establishing a relation between the average number of power replenishments and the topographic data; and

optimizing said relation between the average number of power replenishments and the topographic data over all the pairs A_iA_j, and determining a distribution of the power replenishment facilities within said certain territory.

2. The method of claim 1, wherein said power replenishment facilities include battery charging facilities and battery replacement facilities.

3. The method of claim 1, wherein said power replenishments comprise charging and replacements.

4. The method of claim 1, wherein said establishing a relation between the average number of power replenishments and the topographic data includes allocating places within said certain territory for location of the power replenishment facilities.

5. The method of claim 1, wherein said optimizing of the relation between the average number of power replenishments and the topographic data includes minimizing the total number of the power replenishment facilities required for deployment within said certain territory.

6. The method of claim 1, wherein said optimizing of the relation between the average number of power replenishments and the topographic data includes evaluating a capacity of the power replenishment facilities required to provide power replenishment service for the electric vehicles traveling within said certain territory.

7. The method of claim 1, further comprising:

providing updated topographic data on the roads and road junctions as well as updated input data on transportation characteristics on said certain territory corresponding to said updated topographic data;

establishing an updated relation between the average number of power replenishments and the topographic data; and

optimizing said updated relation to obtain an updated distribution of the power replenishment facilities within said certain territory.

8. The method of claim 1, further comprising:

providing information about changes in said distribution of the charging facilities within said certain territory;

establishing an updated relation between the average number of power replenishments and the topographic data; and

optimizing said updated relation to obtain an updated distribution of the power replenishment facilities within said certain territory.

9. The method of claim 8, wherein said changes in said distribution of the power replenishment facilities within said certain territory include either ceasing operation of at least one power replenishment facility or opening operation of at least one power replenishment facility.

10. A computer-implemented system for management of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, comprising:

a processor utility being connectable to a memory utility for accessing reference data comprising topographic data on roads and road junctions within said certain territory, and being configured and operable for generating data indicative of optimized distribution of power replenishment facilities within said certain territory, the processor utility comprising:

a segmenting module configured for dividing a map of said certain territory into topographical subareas of certain sizes and shapes;

an identifier module configured and operable for determining average traffic intensity between paired subareas of selected pairs of the topographical subareas during a predetermined time interval

an estimator module configured and operable for estimating average number of power replenishments required for the electric vehicles travelling between the paired subareas;

an optimization module configured and operable for (i) establishing a relation between the average number of power replenishments and the topographic data, (ii) optimizing said relation between the average number of power replenishments and the topographic data over all the pairs, and (iii) obtaining a distribution of the power replenishment facilities within said certain territory based on the relation between the average number of power replenishments and the topographic data.

11. A program storage device readable by computer, tangibly embodying a program of instructions executable by the computer to perform method steps for optimization of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, the method steps comprising:

dividing the certain territory into N topographical subareas A_i, where i=1, 2,... N;

selecting pairs A_iA_j of the topographical subareas within said certain territory, where i, j=1, 2, ..., N;

for each pair A_iA_j of the topographical subareas selected within the certain territory, providing data on a distance and an average traffic intensity therebetween during a predetermined time interval;

for each pair A_iA_j, estimating an average number of power replenishments required for the electric vehicles travelling between A_i and A_j during the predetermined time interval;

for each pair A_iA_j, establishing a relation between the average number of power replenishments and the topographic data; and

optimizing said relation between the average number of power replenishments and the topographic data over all the pairs A_iA_j, and determining a distribution of the power replenishment facilities within said certain territory.

12. A computer program product comprising a computer useable medium having computer readable program code embodied therein for optimization of deployment of a network of power replenishment facilities for electric vehicles traveling within a certain territory, the computer program product comprising:

computer readable program code for dividing a map of said certain territory into topographical subareas;

computer readable program code for each pair A_iA_j of the topographical subareas selected within the certain territory, providing data on a distance and an average traffic intensity therebetween during a predetermined time interval;

computer readable program code for each pair A_iA_j, estimating an average number of power replenishments required for the electric vehicles travelling between A_i and A_j during the predetermined time interval;

computer readable program code for each A_iA_j, establishing a relation between the average number of power replenishments and the topographic data;

computer readable program code for optimizing said relation between the average number of power replenishments and the topographic data over all the pairs A_iA_j, and determining a distribution of the power replenishment facilities within said certain territory.

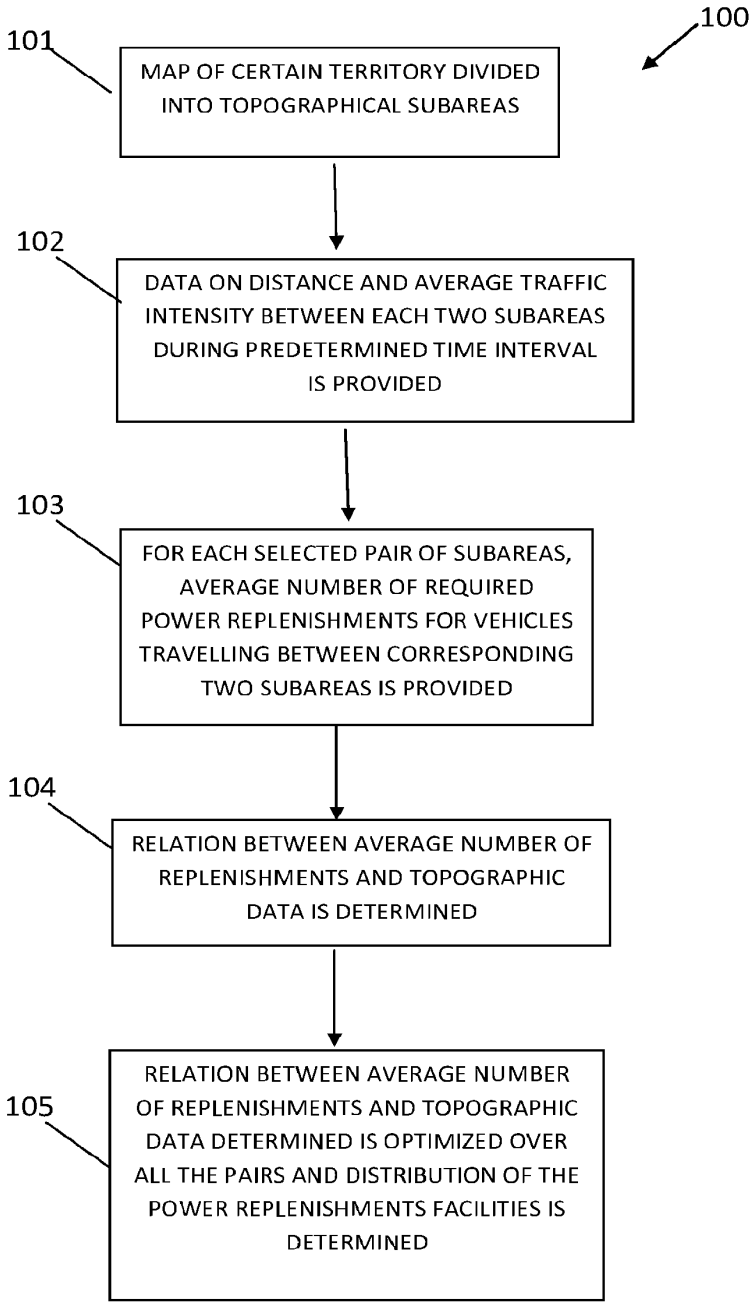

100
101
MAP OF CERTAIN TERRITORY DIVIDED INTO TOPOGRAPHICAL SUBAREAS
102
DATA ON DISTANCE AND AVERAGE TRAFFIC INTENSITY BETWEEN EACH TWO SUBAREAS DURING PREDETERMINED TIME INTERVAL IS PROVIDED
103
FOR EACH SELECTED PAIR OF SUBAREAS, AVERAGE NUMBER OF REQUIRED POWER REPLENISHMENTS FOR VEHICLES TRAVELLING BETWEEN CORRESPONDING TWO SUBAREAS IS PROVIDED
104
RELATION BETWEEN AVERAGE NUMBER OF REPLENISHMENTS AND TOPOGRAPHIC DATA IS DETERMINED
105
RELATION BETWEEN AVERAGE NUMBER OF REPLENISHMENTS AND TOPOGRAPHIC DATA DETERMINED IS OPTIMIZED OVER ALL THE PAIRS AND DISTRIBUTION OF THE POWER REPLENISHMENTS FACILITIES IS DETERMINED

FIG. 1

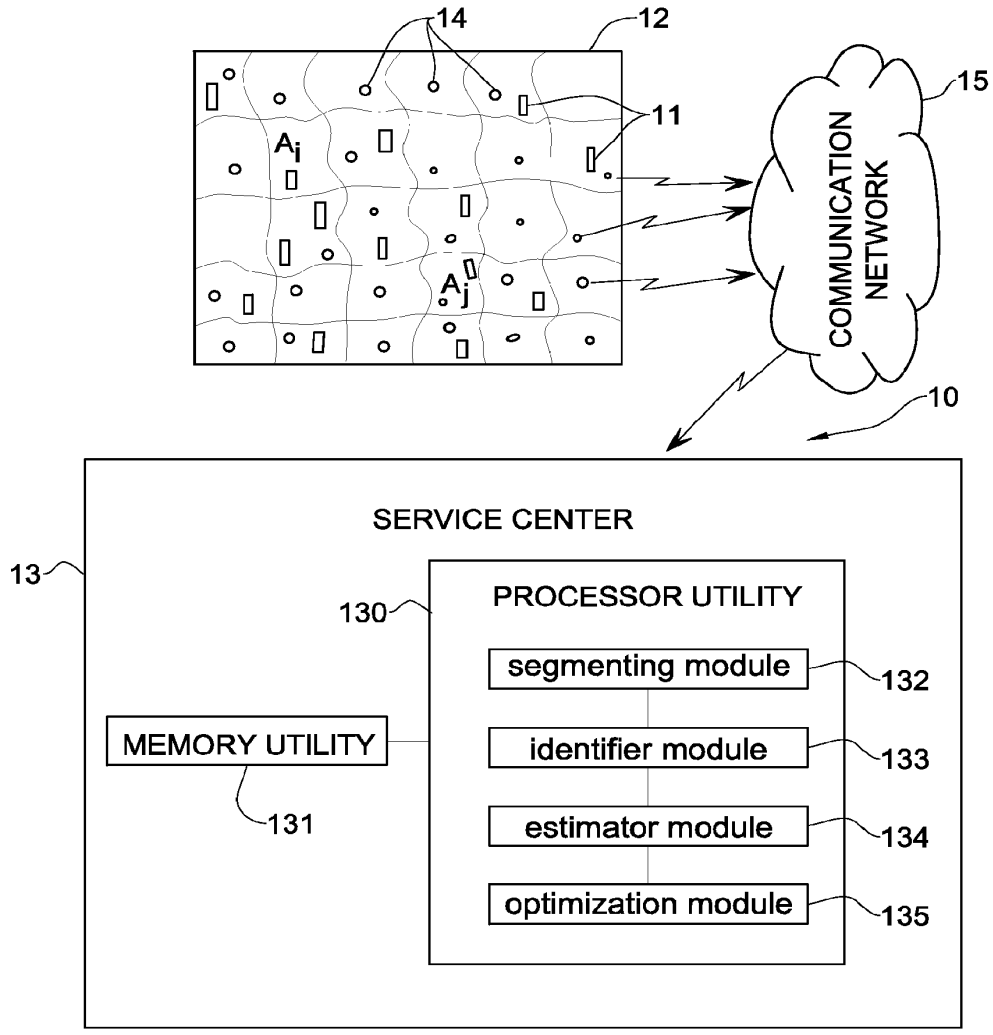

14
12
11
15
A_i
A_j
COMMUNICATION NETWORK
10
SERVICE CENTER
13
130
PROCESSOR UTILITY
segmenting module
132
MEMORY UTILITY
identifier module
133
131
estimator module
134
optimization module
135

FIG. 2

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(54) Method of power management for plug-in hybrid and electric vehicle

(57) A system utilizes vehicle location, direction of travel, battery status, destination, and other data to provide control instruction and information to a plug-in hybrid electric vehicle, electric vehicle, or user.

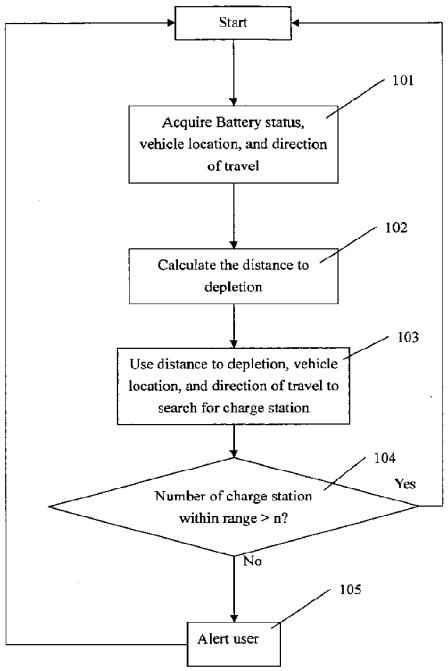


FIG. 1

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EP 2 230 146 A2

Description

[0001] A system utilizes vehicle location, direction of travel, battery status, destination, and other data to provide control instruction and information to a plug-in hybrid electric vehicle, electric vehicle, or user.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] This application claims priority to U.S. application Ser. No. 61/210,222, filed on Mar. 17, 2009. The disclosure of the prior application is considered part of (and is incorporated by reference in) the disclosure of this application.

BACKGROUND

[0003] As plug-in hybrid and electric debut, needs for replenishing electric energy arises.

[0004] In plug-in hybrid vehicles, both electricity and fossil fuel can be used to propel the vehicle, but minimizing the use of fossil fuel can have many befits such as lowering the cost and decrease emissions. If the battery level in plug-in hybrid vehicles are not managed in a particular manner, the user often arrive home, or a charge station, with a relatively high battery level; thus, the benefit of a plug-in hybrid diminishes greatly.

[0005] In electric vehicles, the battery is the only power source; a depleted battery would bring the vehicle to a halt. Before charge station and battery swap station are as fully implemented as gas station, fear of running out of electricity will hinder the sales of electric vehicle.

OBJECTIVE

[0006] The primary objective is to provide a method of power management for plug-in hybrid and electric vehicles in which the use of fossil fuel is minimized.

[0007] It is also an objective to provide a method of power management for electric vehicle which prevents depletion of battery.

SUMMARY

[0008] A method to alert user when an electric vehicle requires imminent charging or battery swap is provided.

[0009] A method to ensure maximum amount of electricity be charged into a plug-in hybrid vehicle is provided.

DESCRIPTION OF THE DRAWING

[0010]

FIGS. 1 to 3 show a flowchart of operation.

DESCRIPTION

[0011] In a first embodiment consistent with the principles of the present invention, as shown in FIG. 1, a power management system capable of locating the vehicle, acquire battery status, providing mode control instructions to the vehicle, and data communication with a database is controlled by method hereafter. While an electric vehicle is in operation, the system will acquire battery status, vehicle location, and direction of travel 101. The battery level will be used to calculate the distance which vehicle can travel before battery depletion 102. The system than take vehicle location as the starting point, and use distance to depletion, and direction of travel to search for charge station within range 103. List of charge stations are acquired from the database via communication link. The charge stations that require a u-turn will not be considered unless it is the last charge station possible. The system may also filter out charge stations that are already full. If the vehicle is designed to cope with battery swap station, the system could show battery swap station as well. The system will then determine if the number of charge station within range are more than a predetermined number n 104. If the number of charge station within range is smaller then the predetermined number n, the user will be alerted 105. This control method can inform the user of an electric vehicle that there is a very limited charge station within range.

[0012] In a second embodiment consistent with the principles of the present invention, as shown in FIG. 2, a power management system capable of locating the vehicle, acquire battery status, providing mode control instructions to the vehicle, and data communication with a database is controlled by method hereafter. While a plug-in hybrid electric vehicle is in operation, the system will acquire a predetermined charge location, vehicle location, direction of travel, and battery status 201. The system then calculates electricity needed from the vehicle's current location to the charge location 202. The direction of travel is used to determine if the vehicle is driving towards or away from the charge location. The system will then compare if the battery level is higher then the electricity needed from the vehicle's current location to the charge position 203. If the battery level is higher than the electricity needed, the system will provide instruction to the vehicle to enter electric mode 204. This can ensure that the vehicle arrive the charge location with a near depleted battery, which the advantage of a plug-in hybrid can be maximized. A button can be provided on the dash of the vehicle which when user press it, the vehicle will automatically record the current location as a useable charge location.

[0013] In a third embodiment consistent with the principles of the present invention, as shown in FIG. 3, a power management system capable of locating the vehicle, acquire battery status, providing mode control instructions to the vehicle, and data communication with a database is controlled by method hereafter. While a plug-in hybrid electric vehicle is in shipping operation with known shipping list and destination, the system will acquire destinations and shipping lists from data base via

data communication and acquire vehicle location and battery level from onboard unit 301. The system will calculate the stop-time at above mentioned destination according to the shipping-list 302. Time required for delivery for each item on the shipping list is to be provided by the database. The system will calculate how much electricity can be charged within the previously calculated stop-time 303. The system will also calculate the electricity needed from the vehicle's current location to the destination 304. The system then determine if the current battery level plus the electricity can be charged with in stop-time less the electricity needed to travel from current location to destination exceeds the total capacity of the battery 305. If the electricity calculated exceeds the total capacity of the battery, the system will instruct the vehicle to enter electric mode 306. This method will ensure maximum amount of electricity be charge while the vehicle depart from each destination with a full battery.

Claims

1. A method comprising:

   a) acquiring vehicle current location;
   b) acquiring battery status;
   c) calculating distance to depletion according to said battery status;
   d) utilizing said vehicle current location and said distance to depletion to search for charge stations within range;
   e) determining if number of charge stations within range is smaller than a predetermined number; and
   f) alerting user if said number of charge stations within range is smaller than said predetermined number.

2. The method as defined in claim 1 further comprising:

   e1) acquiring direction of travel; and
   e2) subtracting number of charge stations that deviates from the said direction of travel from the said number of charge stations within range.

3. The method as defined in claim 1 wherein said charge station includes battery swap station if the vehicle utilizing said method as defined in claim 1 in a type of vehicle that utilizes battery swap station.

4. A method comprising:

   a) acquiring charge location;
   b) acquiring current vehicle location;
   c) acquiring battery level;
   d) calculating electricity needed to travel from said current vehicle location to said charge location;
   e) determining if said battery level is higher than the said electricity needed to travel from said current vehicle location to said charge location; and
   f) instructing the vehicle to enter electric mode if said battery level is higher than the said electricity needed to travel from said current vehicle location to said charge location.

5. The method as defined in claim 4 further comprising recording said current vehicle location as a charge location when user instructs.

6. A method comprising:

   a) acquiring destination;
   b) acquiring current vehicle location;
   c) acquiring shipping list;
   d) acquiring battery level;
   e) calculating stop-time and destination according to said shipping list;
   f) calculating amount of electricity can be charged within said stop-time;
   g) calculating electricity needed to go from current vehicle location to said destination;
   h) determining if the sum of said battery level and said electricity can be charged within said stop-time less said electricity needed to go from current vehicle location to said destination is in excess of total battery capacity; and
   i) instructing the vehicle to enter electric mode if said sum of said battery level and said electricity can be charged within said stop-time less said electricity needed to go from current vehicle location to said destination is in excess of total battery capacity.

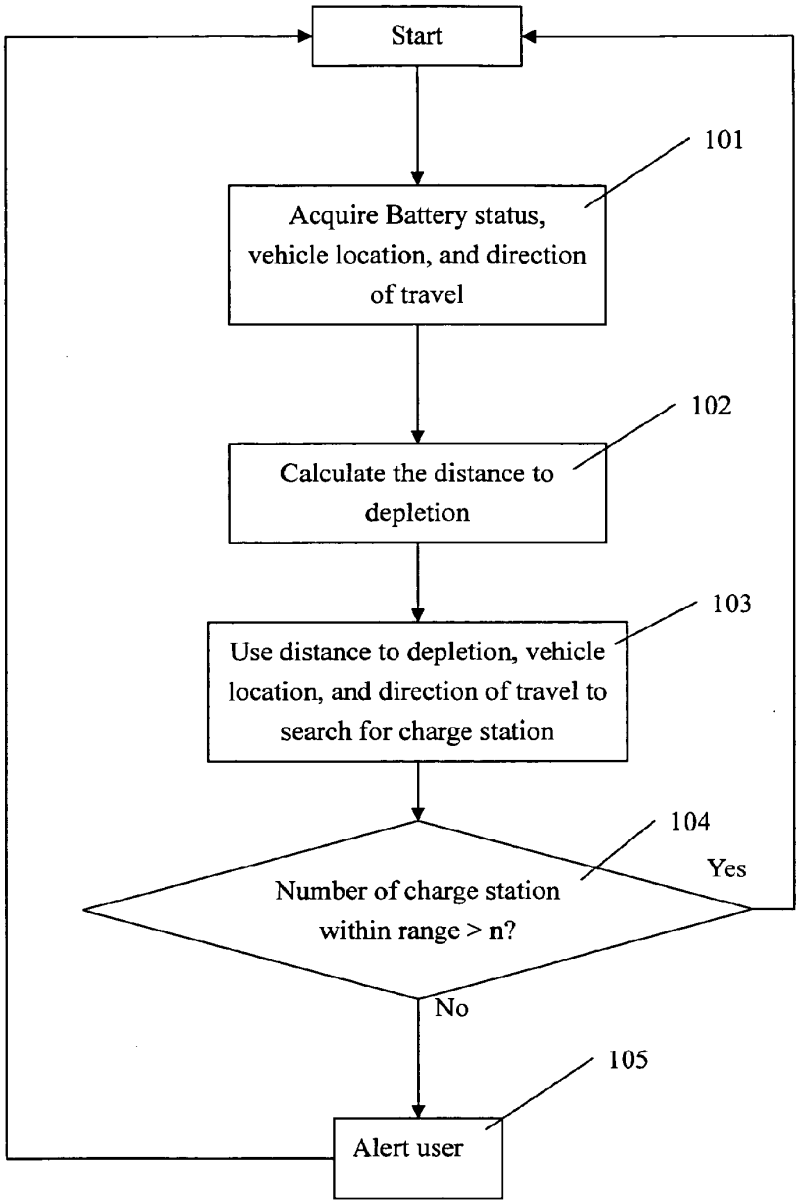

Start
101
Acquire Battery status, vehicle location, and direction of travel
102
Calculate the distance to depletion
103
Use distance to depletion, vehicle location, and direction of travel to search for charge station
104
Number of charge station within range > n?
Yes
No
105
Alert user

FIG. 1

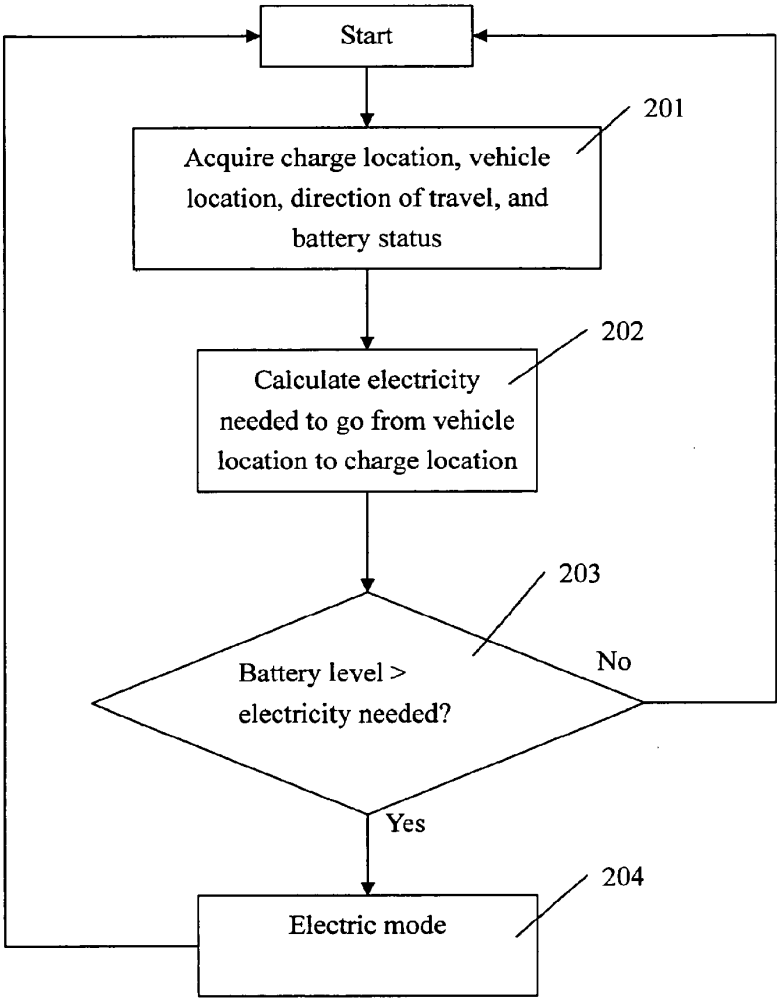

Start
201
Acquire charge location, vehicle location, direction of travel, and battery status
202
Calculate electricity needed to go from vehicle location to charge location
203
Battery level > electricity needed?
No
Yes
204
Electric mode

FIG. 2

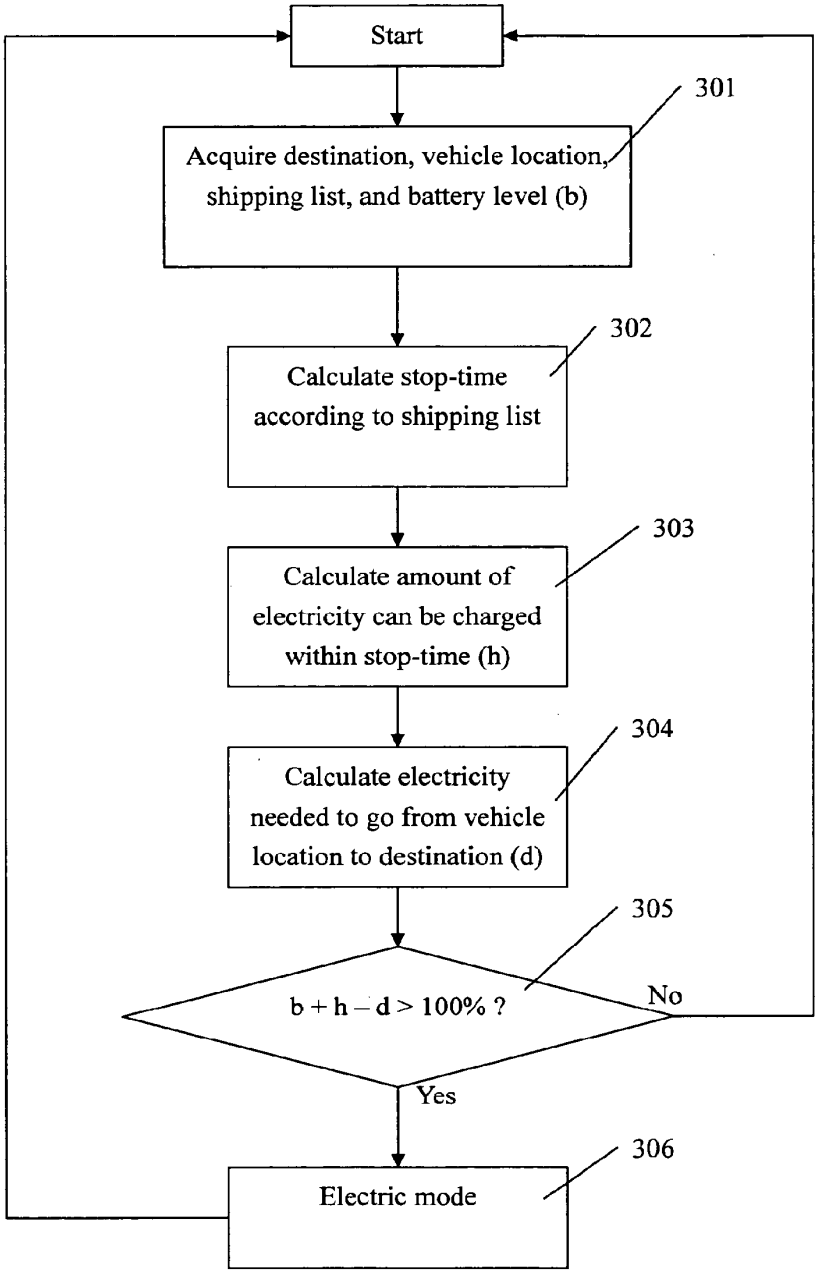

Start
301
Acquire destination, vehicle location, shipping list, and battery level (b)
302
Calculate stop-time according to shipping list
303
Calculate amount of electricity can be charged within stop-time (h)
304
Calculate electricity needed to go from vehicle location to destination (d)
305
b + h – d > 100% ?
No
Yes
306
Electric mode

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 61210222 A **[0002]**

No documents available for this priority number.

Espacenet

Bibliographic data: JP9119839 (A) — 1997-05-06

NAVIGATION SYSTEM FOR ELECTRIC VEHICLE

Inventor(s): ITO YASUMITSU ± (ITO YASUMITSU)

Applicant(s): SUZUKI MOTOR CO ± (SUZUKI MOTOR CORP)

Classification: - international: ***B60L11/18; B60L3/00; G01C21/00; G09B29/00; H02J7/00;*** (IPC1-7): B60L11/18; B60L3/00; G01C21/00; G09B29/00; H02J7/00

- cooperative: B60W2550/142; Y02T10/7005

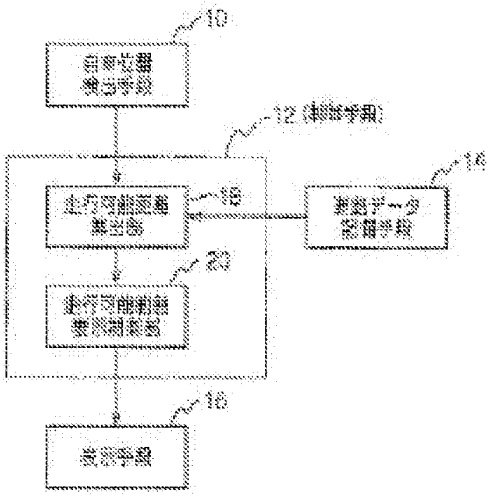
Application number: JP19950299115 19951024

Priority number (s): JP19950299115 19951024

Abstract of JP9119839 (A)

PROBLEM TO BE SOLVED: To obtain a navigation system by which the burden of a judgment regarding a charging operation is reduced for the driver of an electric vehicle. SOLUTION: A system is provided with an own-vehicle-position detection means 10, with a road-data storage means 14 by which road data on the shape of a road to be run by an own vehicle and on the position of a charging service station are stored in advance, with a control means 12 by which the road data are read out from the road-data storage means 14 on the basis of own-vehicle- position information to be output form the own-vehicle-position detection means 10 and with a display means 16 by which road data to be output from the control means 12 is displayed externally. In addition, the control means 12 is provided with a runnable-distance computation part 18 which detects the residual capacity of the main battery, for an electric vehicle, of the own vehicle and which computes the runnable distance of the own vehicle on the basis of information on the residual capacity and with a runnable-range display control part 20 by which a runnable range is synthesized with the road data so as to be output to the display means on the basis of information on the runnable distance computed by the runnable-distance computation part.

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11/18			11/18	Ａ	
Ｇ０９Ｂ　29/00			Ｇ０９Ｂ　29/00	Ｆ	
Ｈ０２Ｊ　7/00			Ｈ０２Ｊ　7/00	Ｘ	

審査請求　未請求　請求項の数４　ＦＤ　（全　９　頁）

(21)出願番号　特願平7－299115

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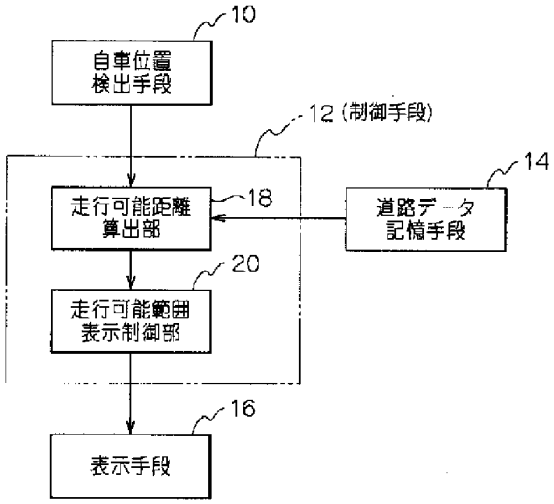
(74)代理人　弁理士　高橋　勇

(54)【発明の名称】　電気自動車用ナビシステム

(57)【要約】

【課題】　電気自動車のドライバーにとっての充電についての判断の負担を軽減すること。

【解決手段】　自車位置検出手段１０と、当該自車が走行する道路の形状及び充電スタンドの位置等の道路データを予め記憶した道路データ記憶手段１４と、自車位置検出手段１０から出力された自車位置情報に基づいて道路データ記憶手段１４から道路データを読み出す制御手段１２と、この制御手段１２から出力された道路データを外部表示する表示手段１６とを備えている。しかも、制御手段１２は、自車の電気自動車用主電池の残存容量を検出すると共に当該残存容量情報に基づいて自車の走行可能距離を算出する走行可能距離算出部１８と、この走行可能距離算出部によって算出された走行可能距離情報に基づいて当該残存容量による走行可能範囲を道路データに合成して表示手段に出力する走行可能範囲表示制御部２０とを備えた。



【特許請求の範囲】
【請求項１】　自車の現在位置を検出する自車位置検出手段と、当該自車が走行する道路の形状及び充電スタンドの位置等の道路データを予め記憶した道路データ記憶手段と、前記自車位置検出手段から出力された自車位置情報に基づいて前記道路データ記憶手段から道路データを読み出す制御手段と、この制御手段から出力された道路データを外部表示する表示手段とを備え、
前記制御手段が、前記自車の電気自動車用主電池の残存容量を検出すると共に当該残存容量情報に基づいて自車の走行可能距離を算出する走行可能距離算出部と、この走行可能距離算出部によって算出された走行可能距離情報に基づいて当該残存容量による走行可能範囲を前記道路データに合成して前記表示手段に出力する走行可能範囲表示制御部とを備えたことを特徴とする電気自動車用ナビシステム。
【請求項２】　前記道路データ記憶手段が、前記道路の高度情報を予め記憶した高度情報記憶領域を有し、
前記走行可能距離算出部が、前記道路データ記憶手段から前記高度情報を読み出すと共に当該高度情報に基づいて道路の勾配を算出する勾配算出機能と、この勾配算出機能によって算出された勾配データに基づいて走行可能距離を補正する勾配別距離補正機能を備えたことを特徴とする請求項１記載の電気自動車用ナビシステム。
【請求項３】　前記道路データ記憶手段が、前記道路のコーナーを示すコーナーマーク及び当該道路が市街地に属するか否かを示す市街地マークとを記憶するマーク記憶領域を有し、
前記走行可能距離算出部が、前記自車が走行する道路について前記走行可能範囲内の前記コーナーマーク又は市街地マークの数に基づいて前記走行可能距離を補正する道路別距離算出機能を備えたことを特徴とする請求項１記載の電気自動車用ナビシステム。
【請求項４】　前記道路データ記憶手段が、前記道路に付設された充電スタンドの位置を記憶した充電可能位置記憶領域を有し、
前記走行可能距離算出部が、前記充電スタンド位置情報に基づいて走行可能範囲に充電可能な場所がないと判定したときに、自車の空調機やオーディオ等補機類の電流消費を削減する制御をする電流消費低減機能を備えたことを特徴とする請求項３記載の電気自動車用ナビシステム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電気自動車用ナビシステムに係り、特に、電気自動車用主電池の残容量に応じて種々の情報を表示手段に表示する電気自動車用ナビシステムに関する。
【０００２】
【従来の技術】従来のナビゲーションシステム（ナビシステム）は、ガソリン自動車用であり基本的にはＧＰＳや自立航法、あるいは両方を用いて地図上の現在位置を表示するものである。図９は従来のナビシステムの構成を示すブロック図である。ナビシステムは、ＧＰＳ信号を受信するＧＰＳアンテナ６０と、このＧＰＳアンテナからの複数のＧＰＳ信号に基づいて自車位置を算出するナビユニット５０とを備えている。
【０００３】また、この従来例ではハイブリッド方式を採用しているため、ナビユニット５０には、自車の進行方向を検出するジャイロユニット６２と、車速を捕捉する車速センサ６４とが併設されている。これは、車速及び走行時間とから自車の走行距離を求め、ジャイロユニット６２により自車の走行方位を捕捉することにより予め設定された位置からの移動方向及び距離を逐次算出するものである。
【０００４】ナビユニット５０は、これらの手法により特定された道路データが予め格納された地図ディスク５４から、自車位置に応じた道路データを読み出して、モニター５６に出力する。
【０００５】一方、電気自動車用残存容量計は、主電池５８の解放端電圧により電池の消耗度を判定する電圧検出方式や、電流の収支を計算して容量を管理する容量検出方式などにより残存走行距離を測定するものがあった。また、電圧を検出するもので、負荷により電圧の落ち込みΔＶを積算して容量を判定する電圧積算方式等がある。
【０００６】残存容量の表示方法としては、ガソリン車の燃料系と同様のアナログ式の表示部７０や、容量をセグメントの明滅で表すセグメント式の表示部７４、容量を判定し距離に換算して表示する残存走行距離計の表示部７６とが挙げられる。
【０００７】図１０は解放端電圧検出手法による残存容量検出を行い、アナログ式で表示する一例を示し、図１１は電流の収支を計算する手法による残存容量検出を行い、デジタル式で表示する一例を示し、図１２はΔＶ積算法により残存容量の検出を行い、距離に換算して表示する一例を示している。
【０００８】
【発明が解決しようとする課題】しかしながら、従来の電気自動車用残存容量計は、電池の状態を示すものであるため、地形の変化や交通状況に対応した走行可能距離の算出をすることができない、という不都合があった。
【０００９】また、従来のナビシステムでは、主電池の残存容量に応じた走行可能範囲の表示を行うことができない、という不都合があった。
【００１０】
【発明の目的】本発明は、係る従来例の有する不都合を改善し、特に、電気自動車のドライバーにとっての充電についての判断の負担を軽減することのできる電気自動車用ナビシステムを提供することを、その目的とする。

【００１１】
【課題を解決するための手段】そこで、本発明では、第１の手段として、自車の現在位置を検出する自車位置検出手段と、当該自車が走行する道路の形状等の道路データを予め記憶した道路データ記憶手段と、自車位置検出手段から出力された自車位置情報に基づいて道路データ記憶手段から道路データを読み出す制御手段と、この制御手段から出力された道路データを外部表示する表示手段とを備えている。しかも、制御手段が、自車の電気自動車用主電池の残存容量を検出すると共に当該残存容量情報に基づいて自車の走行可能距離を算出する走行可能距離算出部と、この走行可能距離算出部によって算出された走行可能距離情報に基づいて当該残存容量による走行可能範囲を道路データに合成して表示手段に出力する走行可能範囲表示制御部とを備えた。
【００１２】この第１の手段では、走行可能距離算出部は、自車の電気自動車用主電池の残存容量を検出し、さらに、当該残存容量情報に基づいて自車の走行可能距離を算出する。残存容量の検出については、電流の積算値などの手法により行う。また、自車の走行可能距離の算出については、車速によって定まる走行可能時間を求め、さらにこれらから走行可能距離を算出するようにしても良い。
【００１３】走行可能距離が算出されると、走行可能範囲表示制御部は、道路データ記憶手段から自車位置に応じて読み出した道路データと共に当該走行可能範囲を表示手段に表示出力する。このため、ドライバーは、主電池の残存容量との関係で走行可能な距離をナビシステムの表示手段で確認する。
【００１４】第２の手段では、第１の手段を特定する事項に加え、道路データ記憶手段が、道路の高度情報を予め記憶した高度情報記憶領域を有し、走行可能距離算出部が、道路データ記憶手段から高度情報を読み出すと共に当該高度情報に基づいて道路の勾配を算出する勾配算出機能と、この勾配算出機能によって算出された勾配データに基づいて走行可能距離を補正する勾配別距離補正機能を備えた。
【００１５】第２の手段では、走行可能距離の算出に際して、道路データ記憶手段から読み出した道路の高度情報に基づいて走行可能距離内の道路の勾配を算出すると共に、当該勾配に基づいて走行可能距離を補正する。
【００１６】第３の手段では、第１の手段を特定する事項に加え、道路データ記憶手段が、道路のコーナーを示すコーナーマーク及び当該道路が市街地に属するか否かを示す市街地マークとを記憶するマーク記憶領域を有している。さらに、走行可能距離算出部が、自車が走行する道路について走行可能範囲内の前記コーナーマーク又は市街地マークの数に基づいて走行可能距離を補正する道路別距離算出機能を備えた。
【００１７】この第３の手段では、道路データ記憶手段から読み出した自車が位置がする道路の属性を示す各種マークに基づいて各道路毎に走行可能距離を算出する。具体的には、市街地での走行又は道路のコーナー数に応じて走行可能距離を補正する。このため、各道路毎に加速、減速による電流消費を考慮した走行可能距離が算出される。従って、ドライバーは、主電池の残存容量が放電深度等との関係で残り少ない場合に、最適な道路を選択することとなる。
【００１８】第４の手段では、第３の手段を特定する事項に加え、道路データ記憶手段が、道路に付設された充電スタンドの位置を記憶した充電可能位置記憶領域を有し、走行可能距離算出部が、充電スタンド位置情報に基づいて走行可能範囲に充電可能な場所がないと判定したときに、空調機やオーディオ等補機類の電流消費を削減する制御をする電流消費低減機能を備えた。
【００１９】本発明は、これらの各手段により、前述した目的を達成しようとするものである。
【００２０】
【発明の実施の形態】以下、本発明の実施の形態を図面を参照して説明する。
【００２１】図１は、本発明による電気自動車用ナビシステムの構成を示すブロック図である。電気自動車用ナビシステムは、自車の現在位置を検出する自車位置検出手段１０と、当該自車が走行する道路の形状及び充電スタンドの位置等のデータを予め記憶した道路データ記憶手段１４と、自車位置検出手段１０から出力された自車位置情報に基づいて道路データ記憶手段１４から道路データを読み出す制御手段１２と、この制御手段１２から出力された道路データを外部表示する表示手段１６とを備えている。
【００２２】しかも、制御手段１２は、自車の電気自動車用主電池の残存容量を検出すると共に当該残存容量情報に基づいて自車の走行可能距離を算出する走行可能距離算出部１８と、この走行可能距離算出部によって算出された走行可能距離情報に基づいて当該残存容量による走行可能範囲を道路データに合成して表示手段に出力する走行可能範囲表示制御部２０とを備えた。
【００２３】これを詳細に説明する。
【００２４】図２は図１に示した電気自動車用ナビシステムの詳細構成を示すブロック図である。自車位置検出手段１０は、ＧＰＳ信号を受信するＧＰＳアンテナ３０と、自車の方位を検出するジャイロユニット３２と、自車の車速を捕捉する車速センサ３４とを備えている。
【００２５】制御手段１２はナビユニット１０を備えており、このナビユニット１０は、ＧＰＳ信号等に基づいて自車位置を算出する。ナビユニット１０には、道路データ記憶手段１４としての地図ディスクが装着されるようになっていて、ＧＰＳ信号等に基づいて算出した自車位置に応じた地図データを当該地図ディスク１４から読み出す。さらに、ナビユニット１０は、当該道路データ

を表示手段１６としてのモニターに出力する。

【００２６】また、ナビユニット１０には、残存容量を演算する機能を有する走行可能距離算出部１８が併設されている。この走行可能距離算出部１８は、電流の収支を計算することで主電池２４の残容量を算出する。さらに、コントローラ２６は、主電池から供給される電力によりモータ２２を駆動する。このモータ２２は、図示しない駆動輪を駆動させるものである。

【００２７】本実施形態による電気自動車用ナビシステムでは、走行可能距離算出部１８は、在来のシステムを利用して車両の速度を検出し、その速度が一定の値を超えると、現在の電池の残容量に基づいて、消費電流（例えば、１０秒間の平均電流）と速度との関係により走行可能距離を次式（１）により計算する。

【００２８】この一定速度が「０」のとき、補機系の電流消費がなければ走行可能距離は計算方法によっては無限大になる。また、補機系電流消費を認めた場合、走行可能距離は「０」となる。このため、ここでは車速が一定値以上の場合に走行可能距離を算出している。

【００２９】Ｌ＝（Ｃ／Ａ）Ｖ　……　式（１）

【００３０】

Ｌ：　走行可能距離［ｋｍ］

Ｃ：　電池の残存容量［Ａｈ］

Ａ：　消費電流［Ａ］

Ｖ：　走行速度［ｋｍ／ｈ］

【００３１】この式（１）により、与えられた車速で継続して走行した場合に、現在の電池の残存容量により走行可能な距離が算出される。この車速Ｖは、現在走行中の車速ではなく、ドライバーから数値として入力を受け付けるようにしても良い。

【００３２】ここで、この残存容量Ｃを求める一手法を示す。電池定格容量C_0の８０％をC_8［Ａｈ］、すでに消費した容量をC_{cum}［Ａｈ］とすると、見かけの残存容量C_R［Ａｈ］は、次式（２）で表される。

【００３３】$C_R = C_8 - C_{cum}$　……　式（２）

【００３４】C_R＝０は容量８０％を消費したことになる。この残り容量２０％は電池の容量が深い放電により劣化するのを防ぐための１つのボーダーラインで、必要があれば７０％放電や別の放電深度を基準としても良い。

【００３５】ここで、δＴ［ＳＥＣ］を残存容量計の測定インターバルとすると、次式（３）のように、消費容量C_{cum}は電流の積算値で表される。

【００３６】

$C_{cum} = \int A\delta T / 3600$　……　式（３）

ここで、３６００は単位をＡｈに直している。

【００３７】しかし、電池の容量は放電電流の大きさによって変化するので、正味の電池容量Ｃ［Ａｈ］は、次式（４）で表される。

【００３８】$C = f(A) \cdot C_R$　……　式（４）

【００３９】ここで、ｆ(A)は補正関数であり、０＜ｆ(A)である。このｆ(A)は、電池固有のＫＴ曲線から求められる。

【００４０】このように残存容量C_0が電流の積算値で定義されるため、走行可能距離Ｌは、次式（５）で表される。

【００４１】

$$L = (f(A) \cdot (0.8C_0 - \int A\delta T / 3600) / A) V$$

……　式（５）

【００４２】走行可能距離算出部１８が、この式（５）に基づいて走行可能距離を算出すると、走行可能範囲表示制御部２０は、自車の現在位置を中心にＬを半径とした円を道路データに重ねて、モニター１６に表示出力する。図３にその一例を示す。電池の容量が十分にあるときには走行可能なルートが多く演算処理に長時間要するため、単純に円で表示するものである。

【００４３】このように、本実施形態では、現在の車速で継続して走行した場合に、予め設定された放電深度との関係でどこまで走行できるのかを、ナビゲーションシステムの地図上に表示する。このため、ドライバーは、この表示によって判断することで最適な速度で充電可能な場所に到達することができる。しかも、ドライバーは、この表示によって充電可能な場所までの走行について、電流消費との関係から現在の速度が適正か否かを判断することができる。

【００４４】次に、この走行可能距離の算出を勾配に基づいて補正する手法を説明する。以下、ここではこの勾配による補正を行う処理を地形補正モードという。

【００４５】ここでは、道路データ記憶手段（地図ディスク）１４が、道路の高度情報を予め記憶した高度情報記憶領域を有している。さらに、走行可能距離算出部１８が、地図ディスク１４から高度情報を読み出すと共に当該高度情報に基づいて道路の勾配を算出する勾配算出機能１９Ａと、この勾配算出機能１９Ａによって算出された勾配データに基づいて走行可能距離を補正する勾配別距離補正機能１９Ｂを備えた。

【００４６】この地形補正モードに入るタイミングとしては、バッテリ（主電池）の容量が減少してきて、設定した基準値以下になった場合がまず挙げられる。容量が少なくなってきた場合には、走行可能距離をより精密に算出する必要があるため、この勾配による補正を行う。また、ドライバーからの設定に応じてこの地形補正を行うようにしてもよい。

【００４７】図５に地形補正の判定例を示す。図５（Ａ）は勾配度が大で、かつ走行距離が短い地形で、図５（Ｂ）は標準とし、図５（Ｃ）は勾配度が小さく、かつ距離が長い場合の例である。

【００４８】車両の現在位置は等高線（低）と道路との交点にあるとする。地形補正モードで考えた場合、走行可能エリアは等高線に沿って変形するために、道路の状態にかかわらず、図５（Ａ）～（Ｃ）は同じ判定を受ける。これは、走行可能エリアを便宜的に円で示しているからであり、これを補正するため、次式（６）により補正を行う。

【００４９】

$$L(1-k\cdot\sin\theta)$$
$$=L(1-k(\Delta H/(L^2+\Delta H^2)^{1/2})) \quad \ldots\ldots \text{式（６）}$$

る走行可能距離が一目で判明する。

【００５０】

θ：　勾配

ｋ：　勾配係数（０＜ｋ≦１）

ΔＨ：　高低差

【００５１】進行方向を０［度］とし全周３６０［度］について単位角度毎に計算を行う。ｋは車両特有の値で、車両重量に比例する定数である。この式（６）を用いて、単位角度毎に測定された到達可能距離を結び、これを走行可能エリアとする。

【００５２】図６は基本モードに地形の等高線に合わせ、走行可能エリアを示す円を現在位置を中心に変形したものである。図６に示すように、勾配に応じて変化する。

【００５３】次に、道路の状態を考慮して走行可能距離を補正する道路別距離算出機能を説明する。ここでは、これをリアルシュミレーションモードという。このリアルシュミレーションモードは、例えば、さらに容量が減少して精度が必要になった場合に用いられる。

【００５４】リアルシュミレーションモードでは、道路の実際の距離が必要で、これは既存のナビシステムからの情報として取得する。実際の道路長さと道路データ上の平面距離と、勾配及び高低差との関係は、次式（７－１）となる。

【００５５】

$$L_{REAL}=L_{MAP}/\cos\theta=(L_{MAP}^2+\Delta H^2)^{1/2} \quad \ldots\ldots \text{式（７－１）}$$

【００５６】

L_{REAL}：　実際の道路長さ

L_{MAP}：　地図上の平面距離

θ：　勾配

ΔＨ：　高低差

【００５７】既存のナビシステムのジャイロセンサは車両の姿勢を示し、その傾きψはしんこうほうこうの直線距離にのみθと等しくなる。したがって、ナビシステムでは地図上の速度$V_{map}=V\cos\psi$が変化することとなるが、電気自動車では現在の地形により影響を受けている電流を平坦値電流に補正するため、電流値が１０秒平均値であれば傾きも１０秒の平均値を使う。電流値と走行距離との関係を考慮すると、姿勢補正距離はＬ／（１－ｋ ｓｉｎ ψ）となる。

【００５８】さらに、この例では、図７に示すように、道路のコーナーの頻度をスタック度Ｓ(Ｎ)として、次式（７－２）により算出する。

【００５９】

$$L\cdot S(N)\cdot(1-k\cdot\sin\theta)$$
$$=LS(N)(1-k(\Delta H/L)) \quad \ldots\ldots \text{式（７－２）}$$

ここで、Ｓ(0)－１

【００６０】

Ｓ(Ｎ)：　スタック関数（(Ｎ)の連続又は不連続の関数）

Ｎ：　コーナー数（コーナーのマーカーの数）

【００６１】また、姿勢補正距離を用いると式（７－２）は次式（７－３）となる。

【００６２】

$$LS(N)(1-k\cdot\sin\theta)/(1-k\cdot\sin\psi) \quad \ldots. \text{式（７－３）}$$

【００６３】電池が最も電力を消費するのが加減速のときであるため、コーナー頻度が重要となる。このため、地図情報データには、コーナーであるか否かの判定用のマーカーが予め格納されている。スタック関数Ｓ(Ｎ)は、自車の特性に特化したコーナー数による電流消費量の補正量を算出するためのものである。この関数は、車両重量、タイヤ、重量バランスなど様々なパラメータを持っているため、望ましくは、車両を実際に走行させてその電流消費量を検出し、この値に基づいて各パラメータを決定する。Ｎが大きくなると速度を維持できなくなり、また、速度が変化することを想定して数値設定をする必要がある。ただし、このスタック関数では、平均電流を扱わずに加速の影響だけを考慮して速度の影響を除去する。ここでは、加速電流値（或いは走行中の加速電流測定値）を設定して、Ｎ回分の消費電流を計算し、残存容量から減じている。

【００６４】また、勾配補正は主要道路のみについて行い、車両位置が主要道以外の場合には主要道への最短距離位置を起算として計算を行う。この場合、起点までの距離は予め減じておく。図７（Ｂ）に示す例では、左上方向への道路のスタック度の方が、右上方向への道路のスタック度よりも大きい。

【００６５】次に、走行パターンによる補正の手法を説明する。

【００６６】市街地や郊外の走行パターンの違いによる補正が必要となるが、走行可能距離Ｌの間に存在する市街地区間（地図データ上のマークに基づく）の存在比率をＵ、市街地係数をＫとして、次式（８）により補正することができる。

【００６７】

Ｌ（１－Ｕ）＋ＬＫＵ　……　式（８）

【００６８】

Ｕ：　市街地区間の存在比率（０＜Ｕ＜１）

Ｋ：　市街地係数（一般に、Ｋ＝０．６～０．７）

【００６９】市街地における勾配補正はＫに吸収されるものと考えて良いので、勾配補正はＬ（１－Ｕ）にのみ行われる。

【００７０】ＶＩＣＳやＡＴＩＳ等による渋滞情報が得られた場合には、その区間が郊外であった場合には市街地として扱う。市街地での渋滞はアイドリングのない電気自動車には大きな影響がないので、Ｌの補正に関しては無視される。また、天候については、雨天などの場合には車両走行抵抗が変化し、走行電流が変化するため、電流値を計測している限り問題ない。

【００７１】上述したように、本実施形態では、地形補正モード、リアルシュミレーションモード、及び走行パターンによる補正を行なっている。これを主電池の残存容量による切り替えではなく、消費電力を予測するために種々混在させて走行可能距離を算出する手法を説明する。

【００７２】まず、地形補正モードでは、自車の進行方向について実際の道路に沿った高低の変化ではなく、電流消費量を算出するための距離の高低差によって補正しているため、平坦路を走行する場合と、低地又は高地を介して目的地まで走行する場合とでは消費電力に差が生じる場合が生じ得る。地形補正モードは、速度及び高低さの２つにパラメータを限定することで消費電力の算出を高速に行なうことがその利点であるため、実際上問題がない精度でかつ良好に実施しうる速度で地形による補正を行なっている。

【００７３】しかし、平坦路の走行と、低地を介しての走行での消費電力の差を詳細に検討する場合には、運転車の下り坂と上り坂の走行パターンを予め検出しておく必要がある。これは、下り坂のブレーキング頻度や、加速の頻度、及びギヤの選択により走行電流が変化するためである。電気自動車は一般に、ブレーキがない場合、には弱回生となり、エンブレに相当する弱い回生（回生率が低い）が用いられるが、ブレーキを他用した場合、ブレーキ時に使われる回生率の高い強回生の頻度が高くなる。このため、ブレーキ頻度による走行可能距離の補正が必要となる。これは、交通量、道路状況、天候、運転方法による走行電流変化、それぞれの回生率のほかに、地形変化がその頻度を決定するパラメータとなる。

【００７４】交通量や道路状況による影響は、市街地判定などで評価しているため、上述した式（６）、（８）による次式（９）が導かれる。

【００７５】

$$L(1-U)(1-k\sin\theta)+KLU \quad \cdots\cdots \text{式（９）}$$

【００７６】原則として、地形変化（勾配）を市街地では評価しないが、ここでは、郊外では地形変化の大きい、等高線の狭い、こうていさの大きい地形を判定する必要がある。したがって、単純化のために大きな加速が必要となるであろう基準高低さ以上の地形変化と急勾配範囲を持つ地形を円周上のある角度方向Ｌで、その存在比率をＷとし、急勾配係数K_sとすると、次式（１０）で表わされる。

【００７７】

$$L(1-U-W)(1-k\sin\theta)+K_sLU \quad \cdots\cdots \text{式（１０）}$$

【００７８】このモードでは十分に到達可能な距離であっても、直線で障害となる高低差（高い山や丘などが該当する。但し、建物や海、河川は考慮しない。）があれば、高低差の原因の裏側に回り込んだ部分を評価しないため、起伏の大きい山地間で幹線道路が少ない場所ではリアルシュミレーションモードでの走行可能距離の算出が適している。このため、「Ｕ」の小さい地域では、電池容量によるモード切り替えの基準値を変更し、早目にリアルシュミレーションモードに切り替えるようにするとよい。

【００７９】また、自車の走行に伴い距離Ｌの高低差は変化し、その都度補正される。従って、Ｌの補正距離はその都度においての確立の高い走行可能な範囲を示すものとなる。

【００８０】さらに、コーナー判定用のコーナーマークを３次元的に定義しておき、すなわち、道路の頂部と底部とをマークしておき、このコーナーマークに基づいてスタック関数Ｓ(Ｎ)を３次元の広がりを持たせるようにしてもよい。

【００８１】このようにして、ナビシステムの地図上に走行可能距離を示し、地図上には充電可能な場所を表示する。ここで、基本モードでは地形のうねりによる生じる距離との差を無視して、単純な処理により走行可能距離を算出しているため、表示する円の中心近くと円周近傍では信頼性に差がある。このため、Ｌの８０％までと残り部分とを色分けして表示するようにしてもよい。

【００８２】図８は電力消費を低減させる制御を行う構成を示すブロック図である。ここでは、道路データ記憶手段１４が、道路に付設された充電スタンドの位置を記憶した充電可能位置記憶領域を有している。さらに、走行可能距離算出部１８が、充電スタンド位置情報に基づいて走行可能範囲に充電可能な場所がないと判定したときに、空調機やオーディオ等補機類の電流消費を削減する制御をする電流消費低減機能４０を備えた。

【００８３】この図８に示す例では、充電可能な場所が走行可能エリア外にあった場合、既存の自動ルート探索を行うことによって、得られた行程距離に到達するための電流量を計算し、補機類の電流消費の削減を行う。

【００８４】この補機類の電流消費の削減として、Ａ／Ｃ，ヒータ等の停止，温度設定の変更，オーディオ類の調整を行う。具体的には、エアコン制御部４２に電流消費の削減をさせる信号を出力する。すると、エアコン制御部４２は、自動空調制御を行っている場合には、風量を減少させ、また目標吹出温度を外気温に近づける。一方、オーディオ制御部４４は、ＣＤやＭＤの演奏を停止する。また、エアコンの停止やラジオ受信の停止をドライバーに依頼する注意表示を行うようにしても良い。

【００８５】さらに、車速も電流に比例関係がり、速度を下げることによって電流量も減少することが経験的に知られている。このため、これを定常走行時に限定して次式（９）と仮定した場合に、定数が特定されると望ましい速度の指定も可能である。

【００８６】

$A = A_{AUX} + k_1 V + k_2 V_2 \cdots$　..... 式（９）

k_1，k_2…：定数

A_{AUX}：　補機電流

【００８７】上述したように本実施形態によると、電気自動車の充電車庫や充電スタンドを走行可能エリアと共にナビシステムの画面に出力するため、ドライバーは、走行可能エリア内の充電スタンド等を目視により確認することができる。しかも、走行可能エリアの算出に際して地形を考慮して算出するため、電池の消耗の少ないコースを画面に出力することができる。さらに、現在の速度が電力消費の点から適切か否か判定できるため、容量が残り少ない場合に最適な速度で充電可能な場所に到達することができる。

【００８８】その他、本実施形態による電気自動車用ナビシステムは、電池の温度を測定して、電池の温度による容量補正を行う手法や、モータコントローラの状態を信号として受信し、異常情報を画面上に表示できるインタフェースとして利用することが可能である。

【００８９】電池の温度補正は、測定した温度の最も低いものを採用し、以下の式（１０）により容量の補正を行う。適用範囲は１０～４０℃である。

【００９０】

$$Ct + C_{30} \cdot (1 + 0.006(t - 30)) \quad \text{..... 式（１０）}$$

【００９１】

C_t：　t℃における容量［Ａｈ］

C_{30}：　３０℃における容量［Ａｈ］＝定格容量

【００９２】異常情報は、コントローラからのパラレル又はシリアル信号により出力されるものと、電池温度、電池電圧のようにアナログ情報とを読み取り判断するものに大別される。表示手法としては、基本となるナビシステムに依存するが、例えば音声ガイドシステムがあれば、それを利用し、また、ソフトに警告画面を付加することにより、画面切替による警告を行う。

【００９３】

【発明の効果】本発明は以上のように構成され機能するので、走行可能距離算出部は、自車の電気自動車用主電池の残存容量情報に基づいて自車の走行可能距離を算出し、走行可能範囲表示制御部が、道路データ記憶手段から自車位置に応じて読み出した道路データと当該走行可能範囲を合成して表示手段に出力するため、ドライバーは、主電池の残存容量との関係で走行可能な距離をナビシステムの表示手段で確認することができ、従って、主電池の残存容量に応じた道路の選択が可能となり、走行可能範囲の充電スタンドを目視により確認することができ、しかも、当該充電スタンドまでの道路が表示手段に表示されるため、ドライバーの判断の負担が軽減される。このように、電気自動車のドライバーにとっての充電についての判断の負担を軽減することができる従来にない優れた電気自動車用ナビシステムを提供することができる。この本発明によると、走行可能範囲表示制御部が、道路データと走行可能範囲を合成するため、走行可能範囲と充電スタンドとの関係が一目瞭然となり、従来例を単に組み合わせた場合と比較して、ドライバーは素早い判断を行なうことが可能となる。

【図面の簡単な説明】

【図１】本発明の一実施形態の構成を示すブロック図である。

【図２】図１に示した電気自動車用ナビシステムのハードウエア資源の構成を示すブロック図である。

【図３】図１及び図２に示した構成での走行可能範囲の表示例を示す説明図である。

【図４】図３に示した走行可能距離を勾配に基づいて補正する勾配補正モードの構成を示すブロック図である。

【図５】等高線と勾配の関係を示す説明図であり、図５（Ａ）は走行距離が短く勾配が大きい例を示す図で、図５（Ｂ）は標準例を示す図で、図５（Ｃ）は走行距離が長く勾配が小さい例を示す図である。

【図６】図４に示した構成での走行可能範囲の表示例を示す説明図である。

【図７】図６に示した走行可能距離を道路別距離補正機能により補正した場合の走行可能範囲の表示例を示す説明図で、図７（Ａ）は走行可能範囲の表示例を示す図で、図７（Ｂ）は実際の道路形状を示す図である。

【図８】図７に示した走行可能範囲に充電スタンドがない場合に補機類の電力消費を削減する処理を行う構成を示すブロック図である。

【図９】従来のガソリン車用のナビゲーションシステムの構成を示すブロック図である。

【図１０】従来の解放端電圧検出手法による電気自動車用残存容量計の一例を示すブロック図である。

【図１１】従来の電流の収支を計算する手法による電気自動車用残存容量計の一例を示すブロック図である。

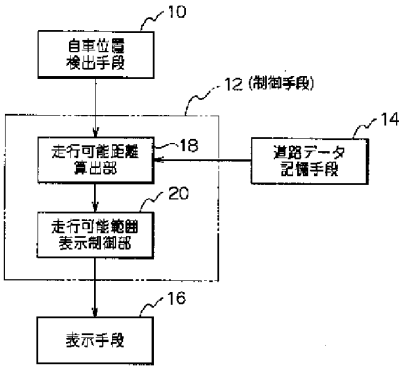
【図１２】従来のΔＶ積算法による電気自動車用残存容

量計の一例を示すブロック図である。

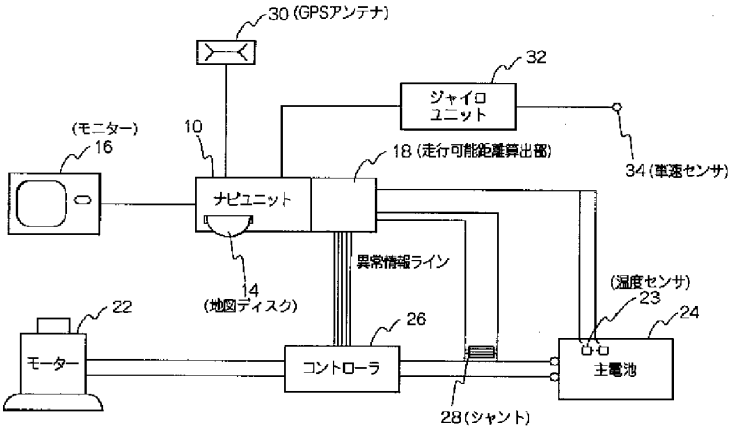
【符号の説明】

１０　自車位置検出手段
１２　制御手段
１４　道路データ記憶手段
１６　表示手段
１８　走行可能距離算出部
２０　走行可能範囲表示制御部

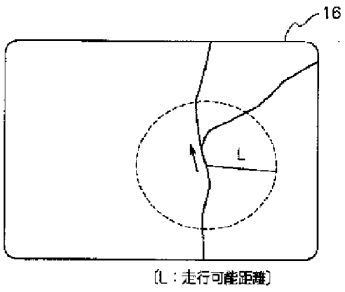
【図１】



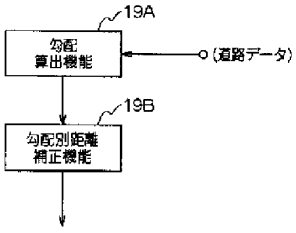
【図２】



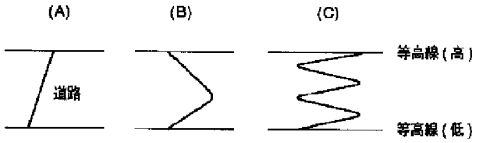
【図３】



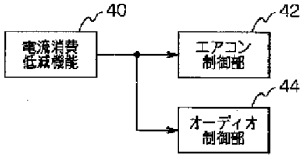
【図４】



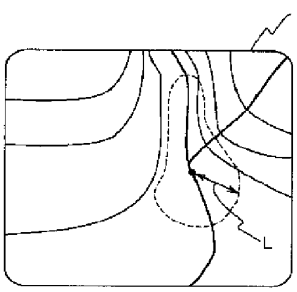
【図５】



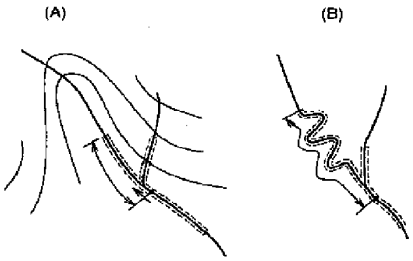
【図８】



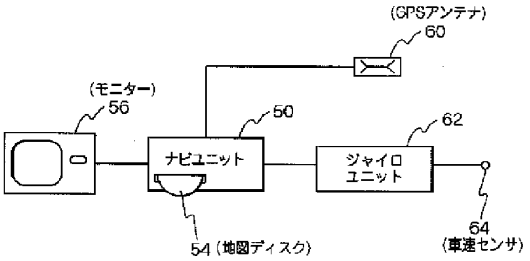
【図６】



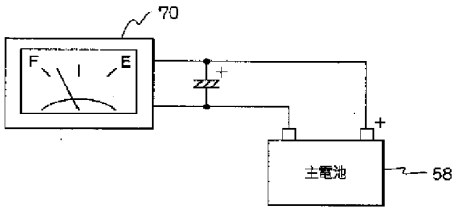
【図７】



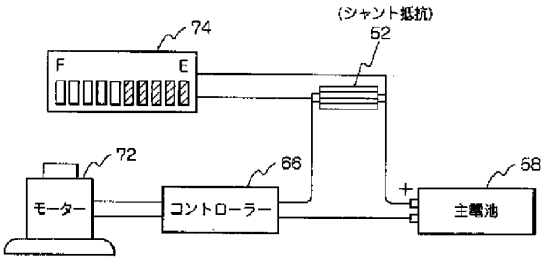
【図９】



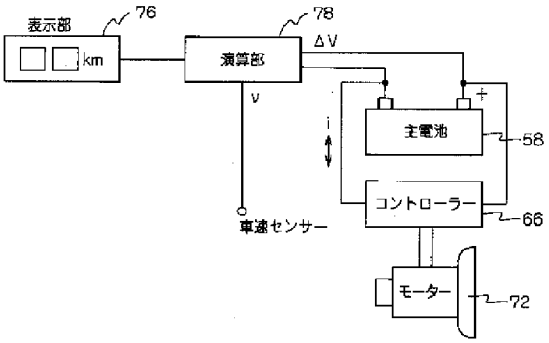
【図１０】



【図１１】



【図１２】



No documents available for this priority number.

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CONTROL OF RESIDUAL ELECTRIC POWER AND METHOD FOR EMERGENT CHARGING OF ELECTRIC VEHICLE AND SYSTEM THEREFOR

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Applicant(s): OKI ELECTRIC IND CO LTD ± (OKI ELECTRIC IND CO LTD)

Classification: **- international:** ***B60L11/18; B60L3/00; B65G61/00; G08G1/00; H02J7/00;*** (IPC1-7): B60L11/18; B60L3/00; G08G1/00; H02J7/00

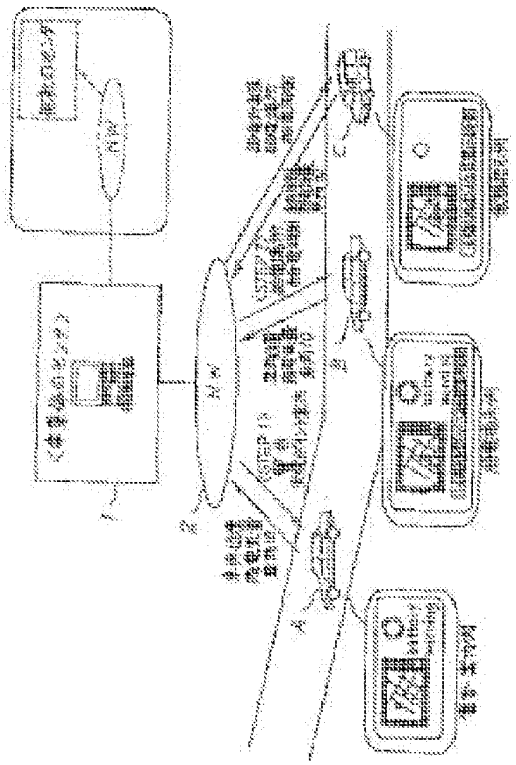
- cooperative: Y02T10/7005

Application number: JP19980265473 19980918

Priority number (s): JP19980265473 19980918

Abstract of JP2000102102 (A)

PROBLEM TO BE SOLVED: To control the residual electric power of a battery mounted on an electric vehicle and to charge the battery speedily and precisely, by transmitting to an operation control center information including the residual electric power of the battery and the position of the vehicle, and by making it possible to feed the electric vehicle with a feeding car. SOLUTION: Information of the position and residual electric power of the battery mounted on electric vehicles A, B is transmitted from the onboard terminal of each vehicle to the operation control center 1. Here, the navigation device of each electric vehicle detects its own position, information of which is received at the operation control center 1. Then, the operation control center 1 transmits information of the vehicles needing a feed, a feeding point and feeding time to a feeding car C so that the feeding of the electric vehicles A, B can be performed by the feeding car C. This system can smoothly control the residual electric power of the electric vehicles and charge them at the time of emergency with the feeding car.



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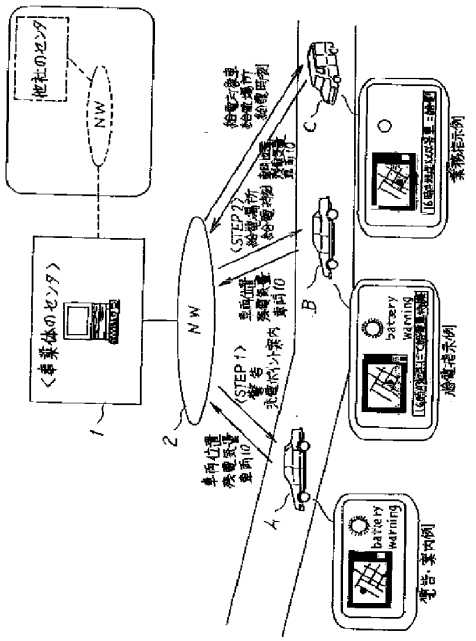
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最終頁に続く

(54)【発明の名称】　電気走行車の残電気量管理及び緊急充電方法及びそのシステム

(57)【要約】
【課題】　電気走行車のバッテリー残電気量の管理とその充電を、迅速、かつ的確に実施できる電気走行車の残電気量管理及び緊急充電方法及びそのシステムを提供する。
【解決手段】　電気走行車の残電気量管理及び緊急充電システムにおいて、電気走行車ＩＤとバッテリー残電気量と車両位置とを含む情報を記憶するとともに、送受信装置を備える電気走行車Ａ，Ｂの車載端末と、この車載端末からの情報を受信するとともに、前記車載端末へ第１段階では充電警告情報とともに最寄りの充電スタンドを案内し、第２段階では給電車Ｃによる給電情報を電気走行車へ送信するとともに、前記給電車Ｃに対しては前記給電情報を送信し、前記電気走行車Ａ，Ｂへの給電指令を送信する電気走行車の運行管理センター１と、この電気走行車Ａ，Ｂの運行管理センター１からの給電情報を受信し、前記電気走行車Ａ，Ｂへの給電情報に従って電気走行車Ａ，Ｂへの充電を行う給電車Ｃとを具備する。



【特許請求の範囲】
【請求項１】（ａ）電気走行車は該電気走行車ＩＤとバッテリー残電気量と車両位置とを含む情報を電気走行車の運行管理センターへ送信し、（ｂ）前記情報を受信した電気走行車の運行管理センターは、前記電気走行車に対しては、第１次段階では充電警告情報とともに最寄りの充電スタンドを案内し、第２段階では給電車による給電情報を送信するとともに、前記給電車に対しては、前記給電情報を送信するとともに、前記電気走行車への給電指令を送信し、（ｃ）前記電気走行車に対して前記給電車による給電を可能にすることを特徴とする電気走行車の残電気量管理及び緊急充電方法。
【請求項２】　請求項１記載の電気走行車の残電気量管理及び緊急充電方法において、前記給電車による給電情報は給電対象車、給電場所、給電時刻を含むことを特徴とする電気走行車の残電気量管理及び緊急充電方法。
【請求項３】（ａ）電気走行車ＩＤとバッテリー残電気量と車両位置とを含む情報を記憶するとともに、送受信装置を備える電気走行車の車載端末と、（ｂ）該車載端末からの情報を受信するとともに、前記車載端末へ第１段階では充電警告情報とともに最寄りの充電スタンドを案内し、第２段階では給電車による給電情報を電気走行車へ送信するとともに、前記給電車に対しては前記給電情報を送信し、前記電気走行車への給電指令を送信する電気走行車の運行管理センターと、（ｃ）該電気走行車の運行管理センターからの給電情報を受信し、前記電気走行車への給電情報に従って電気走行車への充電を行う給電車とを具備することを特徴とする電気走行車の残電気量管理及び緊急充電システム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電気走行車の残電気量管理及び緊急充電方法及びそのシステムに関するものである。
【０００２】
【従来の技術】現在、公共交通（バス、タクシー等）において、電気で走行する車両（以下、電気走行車という）の残電気量については、ドライバーが管理しており、センター等による集中管理は行われていない。このような、電気走行車の場合、充電スタンド（各事業所内充電ポイント、充電スタンドなど）での充電が必要である。
【０００３】その場合、充電には普通８時間程度、急速充電で３０分を要する。現状では、充電スタンドは非常に数が少ないため、ドライバーは電気走行車に充電スタンドに到着できるだけの残電気量が確保されているうちに、充電スタンドに向かう必要があった。その場合の対応は電気走行車のドライバー自らの判断で対処するしか方法がなかった。
【０００４】
【発明が解決しようとする課題】上記したように、従来の方法では、電気走行車のドライバー自らの監視と判断で電気走行車の充電を行う必要があるが、公共車などにおいては、それぞれの主な作業、例えば、ゴミ収集車によるゴミ収集、バスによる乗客の輸送などを主たる業務としており、しかも、これに従事する人数は減らされる傾向にある。
【０００５】したがって、それらの主なる業務のかたわら残電気量の管理やそれに伴う対処には、十分に配慮できないのが現状である。しかし、電気走行車の場合は、電気量がなくなると、立ち往生してしまい、上記したようにその充電スタンドは非常に数が少ないため、その充電には困難が伴うといった問題があった。本発明は、上記問題点を除去し、電気走行車のバッテリー残電気量の管理とその充電を、迅速、かつ的確に実施できる電気走行車の残電気量管理及び緊急充電方法及びそのシステムを提供することを目的とする。
【０００６】
【課題を解決するための手段】本発明は、上記目的を達成するために、
〔１〕電気走行車の残電気量管理及び緊急充電方法において、電気走行車は該電気走行車ＩＤとバッテリー残電気量と車両位置とを含む情報を電気走行車の運行管理センターへ送信し、前記情報を受信した電気走行車の運行管理センターは、前記電気走行車に対しては、第１次段階では充電警告情報とともに最寄りの充電スタンドを案内し、第２段階では給電車による給電情報を送信するとともに、前記給電車に対しては、前記給電情報を送信するとともに、前記電気走行車への給電指令を送信し、前記電気走行車に対して前記給電車による給電を可能にするようにしたものである。
【０００７】〔２〕上記〔１〕記載の電気走行車の残電気量管理及び緊急充電方法において、前記給電車による給電情報は給電対象車、給電場所、給電時刻を含むようにしたものである。
〔３〕電気走行車の残電気量管理及び緊急充電システムにおいて、電気走行車ＩＤとバッテリー残電気量と車両位置とを含む情報を記憶するとともに、送受信装置を備える電気走行車の車載端末と、この車載端末からの情報を受信するとともに、前記車載端末へ第１段階では充電警告情報とともに最寄りの充電スタンドを案内し、第２段階では給電車による給電情報を電気走行車へ送信するとともに、前記給電車に対しては前記給電情報を送信し、前記電気走行車への給電指令を送信する電気走行車の運行管理センターと、この電気走行車の運行管理センターからの給電情報を受信し、前記電気走行車への給電情報に従って電気走行車への充電を行う給電車とを具備するようにしたものである。
【０００８】
【発明の実施の形態】以下、本発明の実施の形態につい

て図面を参照しながら詳細に説明する。図１は本発明の実施例を示す電気走行車の残電気量管理及び緊急充電システムの模式図、図２はその電気走行車に搭載される車載端末の配置を示す斜視図、図３はその車載端末のブロック図、図４はその電気走行車の運行管理センターのブロック図、図５は本発明の電気走行車の残電気量管理及び緊急充電フローチャートである。

【０００９】図１に示すように、電気走行車の運行管理センター１は通信網２を介して電気走行車Ａ，電気走行車Ｂ，給電車Ｃ等の車載端末（後述）との双方向の通信が可能になっている。その電気走行車６（Ａ，Ｂ）には、図２及び図３に示すように、送受信アンテナ１１を有する車載端末１０が配置されている。その車載端末１０には、受信されたビーコンを増幅する増幅器１２と、その増幅されたビーコンを復調する復調器１３と、その復調された信号波を読み取るマイクロコントローラ１４と、このマイクロコントローラ１４に接続される報知装置１５（表示装置１５Ａ、音声装置１５Ｂ）が設けられている。

【００１０】また、マイクロコントローラ１４はＩＣカード（図示なし）からのデータを読み取るリーダ・ライタユニット１８と、電源ユニット１９とを具備している。なお、１６は車載端末１０から電波を送信するための変調器、１７はその送信電波を増幅する増幅器である。更に、電気走行車６（Ａ，Ｂ）の各々の車載端末のマイクロコントローラ１４には、バッテリー残電気量の表示装置３、ナビゲーション装置４、バッテリー残電気量の警告装置５が接続されるようになっている。

【００１１】一方、図４に示すように、電気走行車の運行管理センター１は、ＣＰＵ２０、ＲＯＭ２１、ＲＡＭ２２、送受信装置２３、情報記憶装置（地図情報、充電スタンド情報等を記憶）２４、音声プロセッサ２５、音声装置２６、画像プロセッサ２７、画像メモリ２８、表示装置２９とを備えている。そこで、本発明の電気走行車の残電気量管理及び緊急充電方法を図５を参照しながら説明する。

【００１２】（１）まず、電気走行車ＩＤ、その電気走行車の位置、バッテリー残電気量に関する情報を電気走行車の運行管理センター１へ電気走行車の車載端末１０から送信する（ステップＳ１）。なお、電気走行車ＩＤは予めマイクロコントローラ１４のメモリ（図示なし）に記憶されている。電気走行車の位置は、ナビゲーション装置４によって自車位置を検出しているのでその情報を用いる。バッテリー残電気量は、バッテリーに接続されている電力量計で検知するようにしている。

【００１３】（２）その電気走行車からの上記情報を電気走行車の運行管理センター１で受信する（ステップＳ２）。

（３）そこで、運行管理センター１では、その情報をチェックして、第１段階であるか否かを判断する（ステップＳ３）。ここで第１段階とは、現バッテリー残電気量で走行可能なエリア内に充電スタンドが存在する段階である。

【００１４】（４）この第１段階になると、電気走行車にバッテリー残電気量が少なくなったことを警告するとともに、最寄りの充電スタンドをナビゲーション画面上に表示し、充電スタンドへ案内する（ステップＳ４）。

（５）更に進行して、第２段階であるか否かを判断する（ステップＳ５）。ここで、第２段階とは、走行可能なエリア内に充電スタンドがなく、緊急的に給電車からの給電を要する段階である。

【００１５】（６）この第２段階になると、運行管理センターは、電気走行車に対して、緊急警告を出し、給電場所及び給電時刻を案内する（ステップＳ６）。ここでも、給電場所及び給電時刻を表示装置に表示するのが望ましい。

（７）また、運行管理センター１は、給電車Ｃに対して、給電対象車、給電場所、給電時刻に関する情報を送信し、給電のための出動を指令する（ステップＳ７）。

【００１６】（８）そこで、給電車Ｃによる電気走行車１への給電を行う（ステップＳ８）。ここでは、時間がないような場合は、取り合えず、電気走行車が充電スタンドへ移動できるに足りる電気量の充電を行うようにすることができる。このように、電気走行車の運行管理センターは、例えば、公共交通電気走行車の残電気量を管理、残電気量が僅かになったものに対し、その段階に合わせて充電スタンドへの案内、緊急時の給電車による充電を円滑に実施することができる。

【００１７】ここでは、電気走行車の運行管理センター機能は各公共交通事業体が運行管理を担当するエリアについて述べたが、将来は、各事業体の運行管理センターがネットワークで結ばれて統合管理するように発展させることができる。また、電気走行車とその運行管理センター間の通信は、各事業体の通信インフラに依存し、車載端末－路側ビーコン間の無線通信（以下、路車間通信）や、携帯電話など各種考えられる。

【００１８】なお、本発明は上記実施例に限定されるものではなく、本発明の趣旨に基づいて種々の変形が可能であり、これらを本発明の範囲から排除するものではない。

【００１９】

【発明の効果】以上、詳細に説明したように、本発明によれば、次のような効果を奏することができる。

（Ａ）電気走行車のバッテリー残電気量の管理とその充電を、迅速、かつ的確に実施し、電気走行車のバッテリーの電気量切れによる運行ストップを防止し、電気走行車の円滑な運行を支援することができる。

【００２０】（Ｂ）電気走行車のドライバーによるバッテリー電気量の管理業務を軽減し、ドライバーの主たる業務への専念化を図ることができる。

【図面の簡単な説明】

【図１】本発明の実施例を示す電気走行車の残電気量管理及び緊急充電システムの模式図である。

【図２】本発明の実施例を示す電気走行車に搭載される車載端末の配置を示す斜視図である。

【図３】本発明の実施例を示す電気走行車の車載端末のブロック図である。

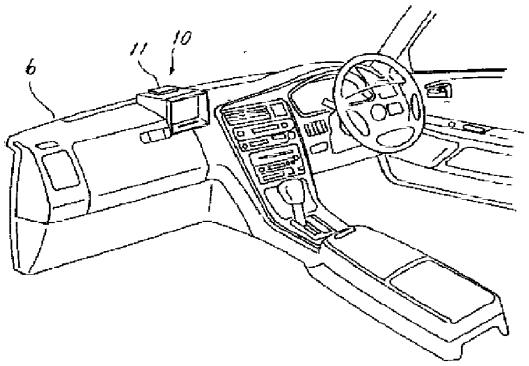
【図４】本発明の実施例を示す電気走行車の運行管理センターのブロック図である。

【図５】本発明の電気走行車の残電気量管理及び緊急充電フローチャートである。

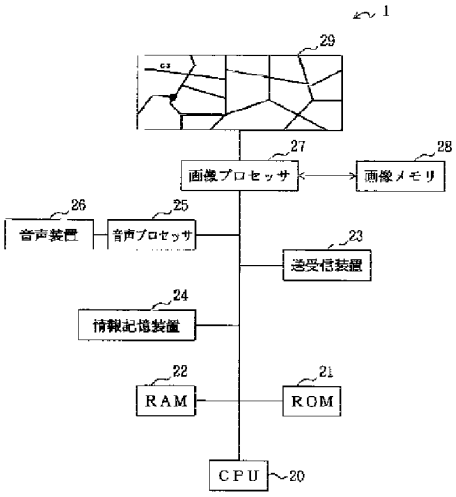
【符号の説明】

１　電気走行車の運行管理センター
２　通信網
３　バッテリー残電気量の表示装置
４　ナビゲーション装置
５　バッテリー残電気量の警告装置
６，Ａ，Ｂ　電気走行車
Ｃ　給電車
１０　車載端末
１１　送受信アンテナ
１２，１７　増幅器
１３　復調器
１４　マイクロコントローラ
１５　報知装置
１５Ａ　表示装置
１５Ｂ　音声装置
１６　変調器
１８　リーダ・ライタユニット
１９　電源ユニット
２０　ＣＰＵ
２１　ＲＯＭ
２２　ＲＡＭ
２３　送受信装置
２４　情報記憶装置（地図情報、充電スタンド情報等を記憶）
２５　音声プロセッサ
２６　音声装置
２７　画像プロセッサ
２８　画像メモリ
２９　表示装置

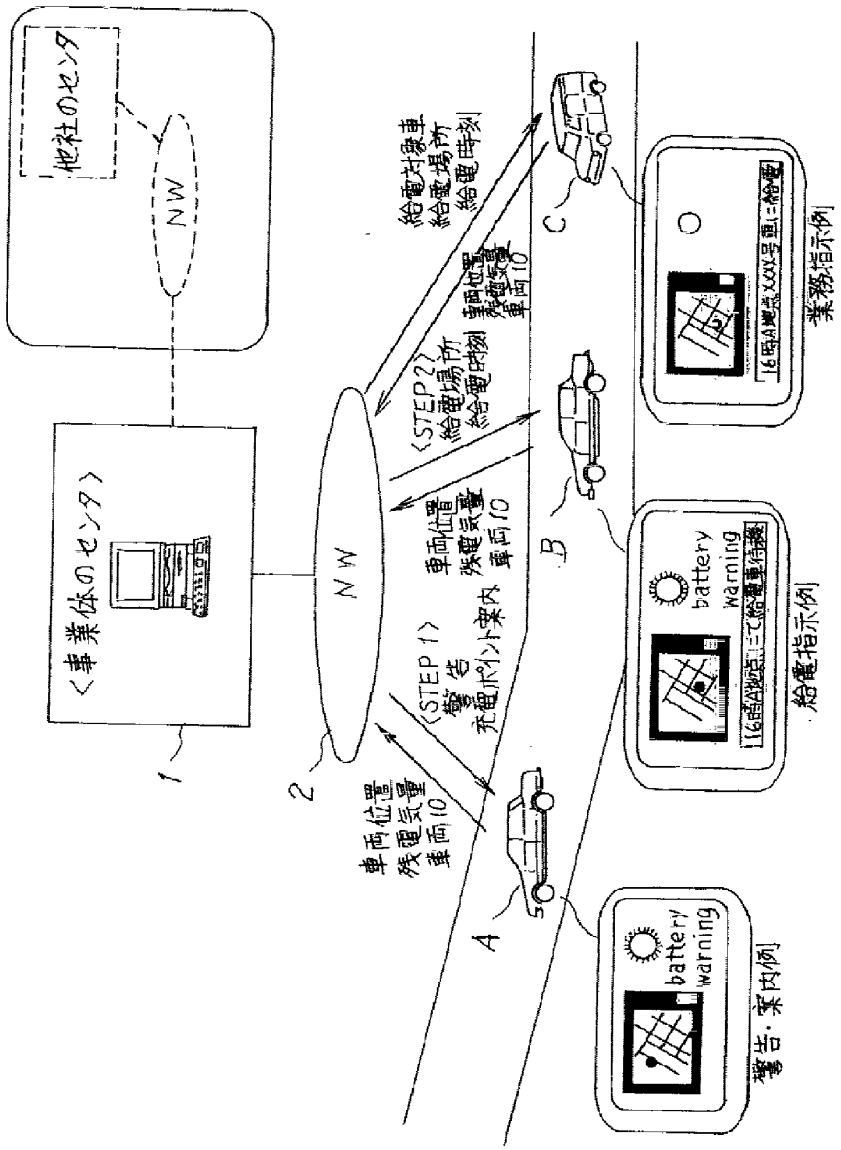
【図２】



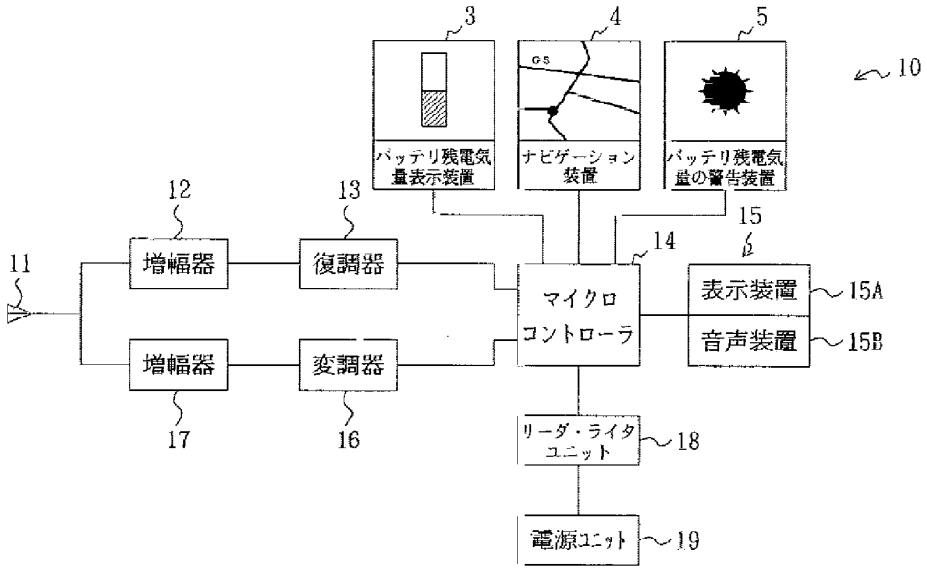
【図４】



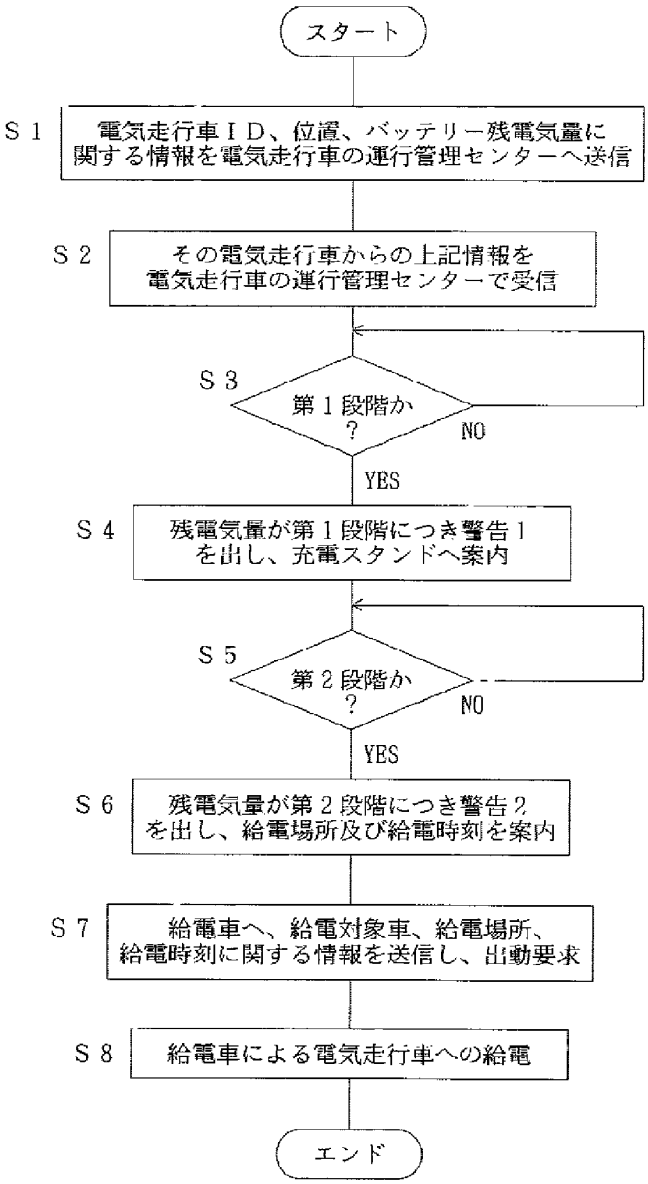
【図1】


他社のセンタ
NW
<事業体のセンタ>
1
2
NW
<STEP1>
警告
充電ポイント案内
車両位置
残電気量
車両ID
<STEP2>
給電場所
給電時刻
給電対象車
車両位置
残電気量
車両ID
A
B
C
battery
warning
警告・案内例
給電指示例
業務指示例

【図3】


3
4
5
10
GS
バッテリ残電気量表示装置
ナビゲーション装置
バッテリ残電気量の警告装置
12
13
15
14
11
増幅器
復調器
マイクロコントローラ
表示装置
15A
音声装置
15B
増幅器
変調器
17
16
リーダ・ライタユニット
18
電源ユニット
19

【図5】


スタート
S1
電気走行車ＩＤ、位置、バッテリー残電気量に関する情報を電気走行車の運行管理センターへ送信
S2
その電気走行車からの上記情報を電気走行車の運行管理センターで受信
S3
第１段階か？
NO
YES
S4
残電気量が第１段階につき警告１を出し、充電スタンドへ案内
S5
第２段階か？
NO
YES
S6
残電気量が第２段階につき警告２を出し、給電場所及び給電時刻を案内
S7
給電車へ、給電対象車、給電場所、給電時刻に関する情報を送信し、出動要求
S8
給電車による電気走行車への給電
エンド

フロントページの続き

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GC05
5H115 PC06 PG04 PI16 PI29 PO06
PO07 PU01 QN03 SL01 SL05
SL06 SL08 TD01 TI02 TO11
TR19 TU17 TZ07 UB05 UB07
UB08 UB11
5H180 AA06 AA07 AA14 AA15 AA16
BB04 BB08 BB12 CC27 EE08
FF03 FF13 FF22 FF27 FF38

No documents available for this priority number.

Espacenet

Bibliographic data: JP2000102103 (A) — 2000-04-07

BATTERY CONTROLLING SYSTEM FOR ELECTRIC VEHICLE

Inventor(s): WAKABAYASHI RYOJI; HIROYA CHIAKI ± (WAKABAYASHI RYOJI, ; HIROYA CHIAKI)

Applicant(s): OKI ELECTRIC IND CO LTD ± (OKI ELECTRIC IND CO LTD)

Classification: **- international:** ***B60L11/18; B60L3/00;*** (IPC1-7): B60L11/18; B60L3/00

- cooperative: Y02T10/7005

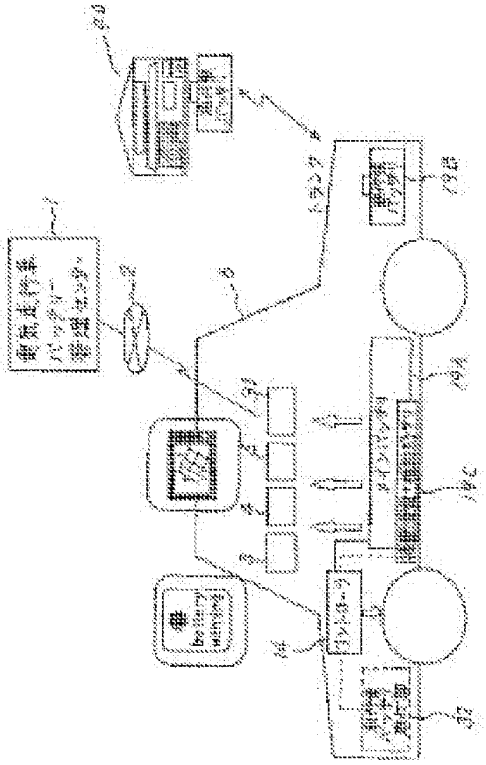
Application number: JP19980265474 19980918

Priority number (s): JP19980265474 19980918

Abstract of JP2000102103 (A)

PROBLEM TO BE SOLVED: To take speedy and precise actions including the control of the residual electric power of a battery mounted on an electric vehicle and the charging of the battery, by providing a battery controlling center for the electric vehicles which receives information from the onboard terminal of each electric vehicle and warns the charging of the battery. SOLUTION: A battery controlling center 1 for electric vehicles is structured in such a way that interactive communication with an electric vehicle 6 can be made possible via a communication network 2. The electric vehicle 6 is provided via an onboard terminal with an indicator 3 of the residual electric power of a battery, a navigation device 4, a warning device 5 of the residual electric power of a battery, and a transmitting and receiving part 31, which are connected to a micro-controller 14. This system enables the charging state of the electric vehicle 6 to be watched with the indicator 3 of the residual electric power of a battery, and the information can be transmitted to and controlled by the battery controlling center 1 for the electric vehicles via the onboard terminal.

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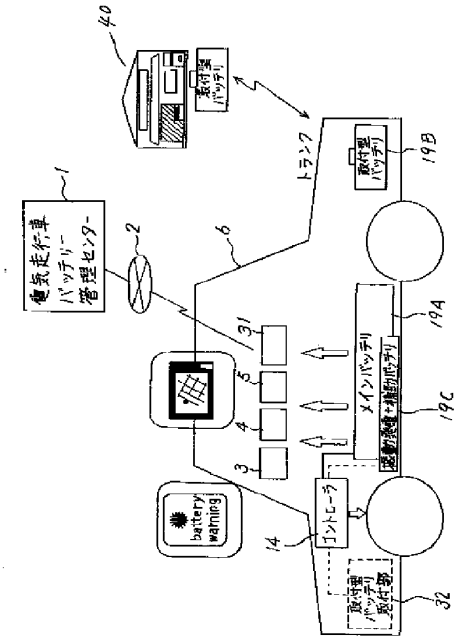
(22)出願日　平成10年９月18日(1998.9.18)

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最終頁に続く

(54)【発明の名称】　電気走行車のバッテリー管理システム

(57)【要約】
【課題】　電気走行車のバッテリー残電気量の管理と、その充電を含めた対応を迅速、かつ、的確に実施できる電気走行車のバッテリー管理システムを提供する。
【解決手段】　電気走行車のバッテリー管理システムにおいて、バッテリー残電気量表示装置３と、ナビゲーション装置４と、バッテリー残電気量警告装置５と、送受信部３１とを有する車載端末と、メインバッテリー１９Ａと、取付型バッテリー１９Ｂとを選択的に使用可能な電源ユニット１９とを具備する電気走行車６と、この電気走行車６の車載端末からの情報を受信し、給電スタンドや取付型バッテリーのショップに関する情報を送信し、バッテリーの充電を案内する電気走行車バッテリー管理センター１とを設ける。



【特許請求の範囲】
【請求項１】（ａ）バッテリー残電気量表示装置と、ナビゲーション装置と、バッテリー残電気量警告装置と、送受信装置とを有する車載端末と、メインバッテリーと、取付型バッテリーとを選択的に使用可能な電源ユニットとを具備する電気走行車と、（ｂ）該電気走行車の車載端末からの情報を受信し、給電スタンドや取付型バッテリーのショップに関する情報を送信し、バッテリーの充電を案内する電気走行車バッテリー管理センターとを具備することを特徴とする電気走行車のバッテリー管理システム。
【請求項２】　請求項１記載の電気走行車のバッテリー管理システムにおいて、前記電源ユニットに電気走行車の振動により電力を発生させ、充電可能な振動発電機能付き補助バッテリーを搭載することを特徴とする電気走行車のバッテリー管理システム。
【請求項３】　請求項１記載の電気走行車のバッテリー管理システムにおいて、前記電源ユニットの取付型バッテリーを電気走行車に予備的に載置することを特徴とする電気走行車のバッテリー管理システム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電気走行車のバッテリー管理システムに関するものである。
【０００２】
【従来の技術】電気走行車のバッテリー残電気量の管理については、ドライバー自らがそれを管理し、それに対処するようにしている。ところで、電気走行車の場合、一般的には夜間充電か、充電スタンドでの充電が必要である。その充電には普通８時間程度、急速充電で３０分を要する。
【０００３】現状では、充電スタンドは数が少ないため、充電スタンドに移動できるだけのバッテリー残電気量が確保されているうちに充電スタンドに向かうようにする必要があった。
【０００４】
【発明が解決しようとする課題】上記したように、従来の方法では、電気走行車のドライバー自らの監視と判断により電気走行車の充電を行っている。しかしながら、公共車などにおいては、ドライバーはそれぞれの主なる作業を担当している。例えば、ゴミ収集車によるゴミ収集、バスによる乗客の輸送などが主たる業務であり、しかも、これに従事する人数は減らされる傾向にある。
【０００５】したがって、バッテリー残電気量の管理やそれに伴う対処には、十分に配慮できないのが現状である。その結果、バッテリーの電気量がなくなると、立ち往生してしまい、上記したように充電スタンドは非常に数が少ないため、その充電には困難が伴うといった問題があった。
【０００６】本発明は、上記問題点を除去し、電気走行車のバッテリー残電気量の管理と、その充電を含めた対応を迅速、かつ、的確に実施できる電気走行車のバッテリー管理システムを提供することを目的とする。
【０００７】
【課題を解決するための手段】本発明は、上記目的を達成するために、
〔１〕電気走行車のバッテリー管理システムにおいて、バッテリー残電気量表示装置と、ナビゲーション装置と、バッテリー残電気量警告装置と、送受信装置とを有する車載端末と、メインバッテリーと、取付型バッテリーとを選択的に使用可能な電源ユニットとを具備する電気走行車と、この電気走行車の車載端末からの情報を受信し、給電スタンドや取付型バッテリーのショップに関する情報を送信し、バッテリーの充電を案内する電気走行車バッテリー管理センターとを具備するようにしたものである。
【０００８】〔２〕上記〔１〕記載の電気走行車のバッテリー管理システムにおいて、前記電源ユニットに電気走行車の振動により電力を発生させ、充電可能な発電機能付き補助バッテリーを搭載するようにしたものである。
〔３〕上記〔１〕記載の電気走行車のバッテリー管理システムにおいて、前記電源ユニットの取付型バッテリーを電気走行車に予備的に載置するようにしたものである。
【０００９】
【発明の実施の形態】以下、本発明の実施の形態について図面を参照しながら詳細に説明する。図１は本発明の実施例を示す電気走行車の残電気量管理及び緊急充電システムの模式図、図２はその電気走行車に搭載される車載端末の配置を示す斜視図、図３はその車載端末のブロック図、図４はその電気走行車バッテリー管理センターのブロック図である。
【００１０】図１に示すように、電気走行車バッテリー管理センター１は通信網２を介して電気走行車６との双方向の通信が可能になるように構成されている。電気走行車６には、図３に示すように、メインバッテリー１９Ａ、取付型バッテリー１９Ｂ、振動発電機付き補助バッテリー１９Ｃが、切り替えスイッチ１９－１によって電源ユニット１９として構成されている。ここで、取付型バッテリー１９Ｂは、通常車両のトランクに予備を収納しておき、緊急時には、その取付型バッテリー１９Ｂを取付型バッテリー取付部３２（図１参照）に配備するようにしている。
【００１１】また、振動発電機付き補助バッテリー１９Ｃは、常時、電気モータ（図示なし）にアダプタを介して、その電気モータの振動するコイルや磁石を有する発電機で充電される補助バッテリーを搭載可能にしている。更に、自動車のサスペンションの振動に応動するコイルや磁石を有する発電機によって充電される振動発電

機付き補助バッテリー１６Ｃを設けることができる。（振動による発電機付きの自動車としては、例えば、実開昭６４－３７３７８号公報、特開昭５２－２２２３８号公報、実開昭６１－７４２７７号公報等参照）。

【００１２】更に、詳細は、後述するが、その他に、バッテリー残電気量表示装置３、ナビゲーション装置４、バッテリー残電気量警告装置５、送受信部３１を備え、マイクロコントローラ１４に接続されるようになっている。その電気走行車６には、図２及び図３に示すように、送受信アンテナ１１を有する車載端末１０が配置され、その車載端末１０は、受信されたビーコンを増幅する増幅器１２と、その増幅されたビーコンを復調する復調器１３と、その復調された信号波を読み取るマイクロコントローラ１４と、このマイクロコントローラ１４に接続される報知装置１５（表示装置１５Ａ、音声装置１５Ｂ）が設けられている。

【００１３】また、マイクロコントローラ１４にはＩＣカード（図示なし）からのデータを読み取るリーダ・ライタユニット１８と、電源ユニット１９とを具備している。なお、１６は車載端末１０から電波を送信するための変調器、１７はその送信電波を増幅する増幅器である。更に、電気走行車６には、バッテリー残電気量表示装置３、ナビゲーション装置４、バッテリー残電気量警告装置５がマイクロコントローラ１４に接続されるようになっている。

【００１４】　方、電気走行車バッテリー管理センター１は、図４に示すように、ＣＰＵ２０、ＲＯＭ２１、ＲＡＭ２２、送受信装置２３、情報記憶装置（地図情報、充電スタンド情報、取付型バッテリーを販売するカー部品ショップ情報等を記憶）２４、音声プロセッサ２５、音声装置２６、画像プロセッサ２７、画像メモリ２８、表示装置２９とを備えている。

【００１５】そこで、図１に示すように、（１）取付型バッテリー１９Ｂを取付型バッテリーの取付部３２に取り付けて、新たな取付型バッテリーによる給電を行うようにすることができる。その間に、電気走行車バッテリー管理センター１からの充電スタンド情報を得て、メインバッテリー１９Ａの充電を依頼することもできる。

（２）また、振動発電機能付きの補助バッテリーを用いることにより、近距離であれば、いつ何どきでもバッテリーによる給電を行い、『電欠』を略皆無にすることができる。

【００１６】また、電気走行車に搭載される取付型バッテリー１９Ｂは、それを販売するカー部品ショップ４０で、取り替えたり、新たな取付型バッテリー１９Ｂを得ることができる。その場合のカー部品ショップ４０の位置情報なども車載端末１０から電気走行車バッテリー管理センター１に問い合わせることにより、その情報を得ることができる。

【００１７】したがって、本発明によれば、電気走行車の電源ユニットは、バッテリー切れによる走行不可能が回避されるような構成となっている。つまり、メインバッテリー１９Ａの残電気量が少なくなると、バッテリー残電気量表示装置３に表示される。このように、本発明の電源ユニットは、増強された電源構成となっている。

【００１８】また、電気走行車の充電状態はバッテリー残電気量表示装置３で見ることができる。また、その情報は、車載端末１０を介して電気走行車バッテリー管理センター１へ発信されて、そのセンター１で管理することができる。更に、標準走行距離（目安）と連動させることができる。

【００１９】また、電気走行車内のナビゲーションシステムと連動して、走行可能エリア内の給電スタンドを表示することができる。また、取付型バッテリーはアタッシュケース型代替バッテリであり、取り付け型代替バッテリーとして、電気走行車内に予備的に載せておくようにする。また、電気走行車バッテリー管理センター１等にガイドされた給電ポイントやカーショップ等でも広く代替品を配備することができる。

【００２０】更に、振動型発電機能付きバッテリー１６Ｃを備えており、バッテリー補助機能として、電気モータや走行中の振動を利用して発電、一定距離の走行を可能にすることができる。なお、本発明は上記実施例に限定されるものではなく、本発明の趣旨に基づいて種々の変形が可能であり、これらを本発明の範囲から排除するものではない。

【００２１】

【発明の効果】以上、詳細に説明したように、本発明によれば、次のような効果を奏することができる。

（Ａ）電気走行車のバッテリー残電気量の管理と、その充電を含めた対応を迅速、かつ的確に実施できる電気走行車のバッテリー管理システムを提供する。

【００２２】（Ｂ）電気走行車のバッテリーを増強して電気走行車のバッテリー切れを回避することができ、電気走行車の走行の円滑化を図ることができる。

【図面の簡単な説明】

【図１】本発明の実施例を示す電気走行車の残電気量管理及び緊急充電システムの模式図である。

【図２】本発明の実施例を示す電気走行車に搭載される車載端末の配置を示す斜視図である。

【図３】本発明の実施例を示す電気走行車に搭載される車載端末のブロック図である。

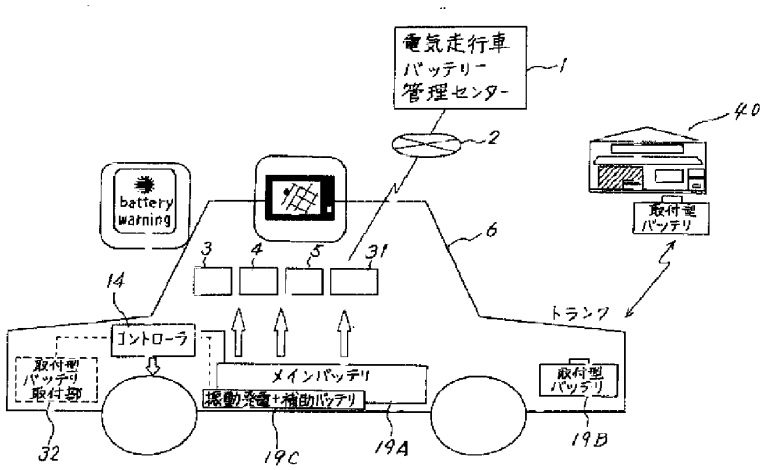
【図４】本発明の実施例を示す電気走行車バッテリー管理センターのブロック図である。

【符号の説明】

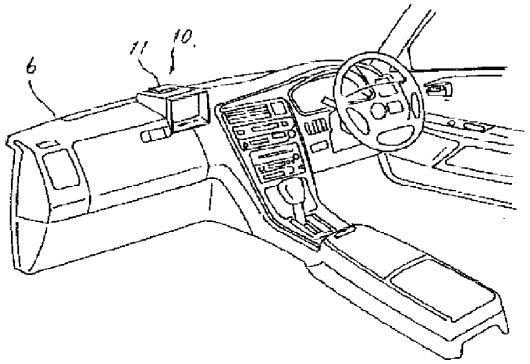
１　電気走行車バッテリー管理センター
２　通信網
３　バッテリー残電気量表示装置
４　ナビゲーション装置
５　バッテリー残電気量警告装置

６　電気走行車
１０　車載端末
１１　送受信アンテナ
１２，１７　増幅器
１３　復調器
１４　マイクロコントローラ
１５　報知装置
１５Ａ　表示装置
１５Ｂ　音声装置
１６　変調器
１８　リーダ・ライタユニット
１９　電源ユニット
１９－１　切り替えスイッチ
１９Ａ　メインバッテリー
１９Ｂ　取付型バッテリー
１９Ｃ　振動発電機付き補助バッテリー
２０　ＣＰＵ
２１　ＲＯＭ
２２　ＲＡＭ
２３　送受信装置
２４　情報記憶装置（地図情報、充電スタンド情報、取付型バッテリーを販売するカーパーツショップ情報等を記憶）
２５　音声プロセッサ
２６　音声装置
２７　画像プロセッサ
２８　画像メモリ
２９　表示装置
３１　送受信部
３２　取付型バッテリーの取付部
４０　カー部品ショップ

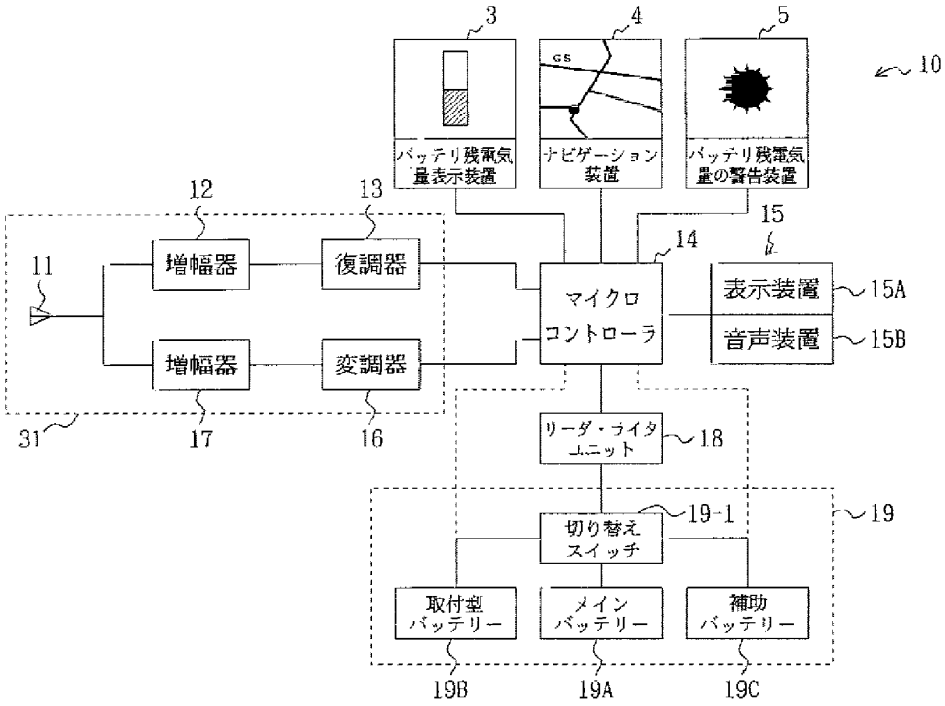
【図１】



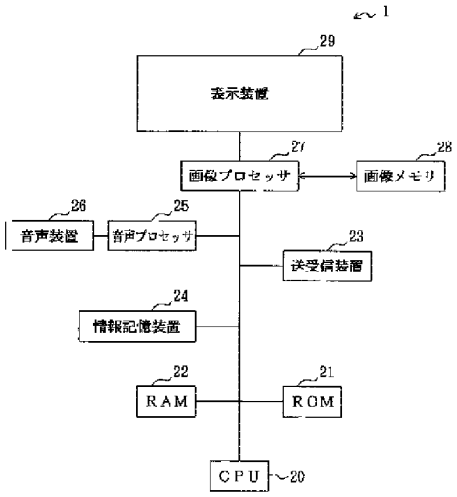
【図２】



【図3】


3
4
5
10
GS
バッテリ残電気量表示装置
ナビゲーション装置
バッテリ残電気量の警告装置
12
13
15
14
11
増幅器
復調器
マイクロコントローラ
表示装置
15A
音声装置
15B
増幅器
変調器
31
17
16
リーダ・ライタユニット
18
19
19-1
切り替えスイッチ
取付型バッテリー
メインバッテリー
補助バッテリー
19B
19A
19C

【図4】


1
29
表示装置
27
画像プロセッサ
28
画像メモリ
26
音声装置
25
音声プロセッサ
23
送受信装置
24
情報記憶装置
22
RAM
21
ROM
CPU
20

フロントページの続き

Fターム(参考) 5H115 PA14 PC06 PG04 PI11 PI16
PI29 PO01 PO07 QN03 SF30
SL01 SL05 TI02 TR19 TU17
TW10 TZ01 TZ07 TZ14 UB01
UB02 UB05 UB07 UB08 UB11

No documents available for this priority number.

Espacenet

Bibliographic data: JP2003262525 (A) — 2003-09-19

CHARGING STAND INFORMATION-SUPPLYING APPARATUS

Inventor(s): SUGIMOTO TOMONAGA; SAKAI KENICHI ± (SUGIMOTO TOMONAGA, ; SAKAI KENICHI)

Applicant(s): NISSAN MOTOR ± (NISSAN MOTOR CO LTD)

Classification: **- international:** ***G01C21/00; G08G1/0969;*** (IPC1-7): G01C21/00; G08G1/0969

- cooperative:

Application number: JP20020062986 20020308

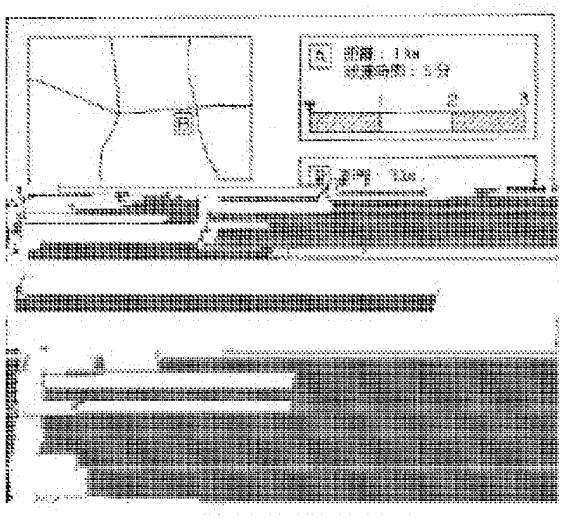
Priority number (s): JP20020062986 20020308

Abstract of JP2003262525 (A)

PROBLEM TO BE SOLVED: To provide information on a charging stand for rapidly starting charging after arrival. ; SOLUTION: The charging stand information-supplying apparatus extracts a charging stand that is present around the current location of an electric car from stored charge stands, and provides the position of the extracted charge stand and availability information of chargers that are installed at the charging stand. ; COPYRIGHT: (C)2003,JPO

Last updated: 19.12.2012 Worldwide Database 5.8.4; 92p

[図７]



(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2003－262525
（P2003－262525A）
(43)公開日　平成15年９月19日(2003.9.19)

(51)Int.Cl.[7]	識別記号	Ｆ Ｉ		ﾃｰﾏｺｰﾄﾞ(参考)
Ｇ０１Ｃ　21/00		Ｃ０１Ｃ　21/00	Ｂ	２Ｆ０２９
Ｇ０８Ｇ　1/0969		Ｃ０８Ｇ　1/0969		５Ｈ１８０

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(21)出願番号　特願2002－62986(P2002－62986)

(22)出願日　平成14年３月８日(2002.3.8)

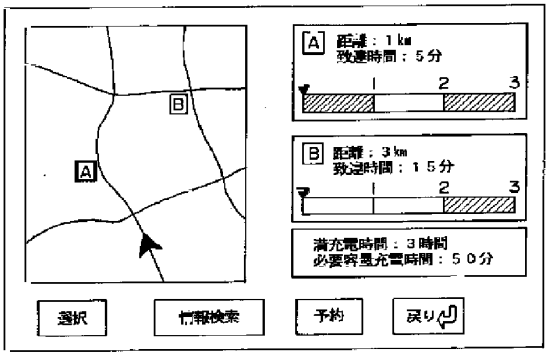
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最終頁に続く

(54)【発明の名称】　充電スタンド情報提供装置

(57)【要約】
【課題】　到着してから速やかに充電を開始できる充電スタンドの情報を提供する。
【解決手段】　記憶されている充電スタンドの中から、電気自動車の現在地周辺に存在する充電スタンドを抽出し、抽出された充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを提供する。

【図７】



【特許請求の範囲】
【請求項１】充電スタンドの位置を記憶するスタンド位置記憶手段と、
充電スタンドに設置されている充電器ごとの利用可能情報を入手する充電器情報入手手段と、
電気自動車の現在地を検出する現在地検出手段と、
前記スタンド位置記憶手段に記憶されている充電スタンドの中から、電気自動車の現在地周辺に存在する充電スタンドを抽出するスタンド抽出手段と、
前記スタンド抽出手段により抽出された充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを提供する充電器情報提供手段とを備えることを特徴とする充電スタンド情報提供装置。
【請求項２】請求項１に記載の充電スタンド情報提供装置において、
前記利用可能情報は、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始できる利用可能な充電器に関する情報であることを特徴とする充電スタンド情報提供装置。
【請求項３】請求項２に記載の充電スタンド情報提供装置において、
道路地図データに基づいて現在地から充電スタンドまでの経路を探索するスタンド経路探索手段を備え、
前記充電器情報提供手段は、充電スタンドの位置、その充電スタンドに設置されている充電器の利用可能情報、およびその充電スタンドまでの経路を提供することを特徴とする充電スタンド情報提供装置。
【請求項４】請求項２または請求項３に記載の充電スタンド情報提供装置において、
電気自動車のバッテリーの残容量を検出する残容量検出手段と、
道路地図データに基づいて現在地から目的地までの経路を探索する目的地経路探索手段と、
前記目的地までの経路に沿って現在地から目的地まで走行するためのバッテリーの必要容量を推定する必要容量推定手段と、
バッテリーの前記残容量と前記必要容量とに基づいてバッテリーを充電せずに目的地まで走行可能か否かを判定する走行判定手段とを備え、
前記充電器情報提供手段は、前記走行判定手段によりバッテリーの前記残容量では目的地まで走行できないと判定された場合に、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始でき、且つ少なくとも前記必要容量まで充電可能な充電器に関する情報を提供することを特徴とする充電スタンド情報提供装置。
【請求項５】請求項４に記載の充電スタンド情報提供装置において、
前記充電器情報提供手段は、バッテリーの前記残容量から前記必要容量までの所要充電時間と、前記残容量から満充電容量までの所要充電時間とを演算して提供することを特徴とする充電スタンド情報提供装置。
【請求項６】請求項２～５のいずれかの項に記載の充電スタンド情報提供装置において、
前記利用可能な充電器の中から乗員により選択された充電器に対して利用予約を行う充電予約手段を備えることを特徴とする充電スタンド情報提供装置。
【請求項７】請求項１～６のいずれかの項に記載の充電スタンド情報提供装置において、
前記充電器情報提供手段は、道路地図データからバッテリーの充電中に利用可能な施設の情報を抽出し提供することを特徴とする充電スタンド情報提供装置。
【請求項８】充電スタンドを管理する管理センターと電気自動車の車載情報端末とから成る充電スタンド情報提供装置であって、
前記管理センターは、充電スタンドの位置を記憶するスタンド位置記憶手段と、
充電スタンドに設置されている充電器ごとの利用可能情報を入手する充電器情報入手手段とを備え、
充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを無線通信により前記車載情報端末へ配信することを特徴とする充電スタンド情報提供装置。
【請求項９】請求項８に記載の充電スタンド情報提供装置において、
前記車載情報端末は、電気自動車の現在地を検出する現在地検出手段を備え、検出した現在地を前記管理センターへ送信し、
前記管理センターは、前記スタンド位置記憶手段に記憶されている充電スタンドの中から、電気自動車の現在地周辺に存在する充電スタンドを抽出するスタンド抽出手段を備え、抽出された充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを配信することを特徴とする充電スタンド情報提供装置。
【請求項１０】請求項８または請求項９に記載の充電スタンド情報提供装置において、
前記利用可能情報は、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始できる利用可能な充電器に関する情報であることを特徴とする充電スタンド情報提供装置。
【請求項１１】請求項１０に記載の充電スタンド情報提供装置において、
前記車載情報端末は、道路地図データに基づいて現在地から充電スタンドまでの経路を探索するスタンド経路探索手段を備え、充電スタンドの位置、その充電スタンドに設置されている充電器の利用可能情報、およびその充電スタンドまでの経路を提供することを特徴とする充電スタンド情報提供装置。
【請求項１２】請求項１０または請求項１１に記載の充電スタンド情報提供装置において、
前記車載情報端末は、電気自動車のバッテリーの残容量

を検出する残容量検出手段と、
道路地図データに基づいて現在地から目的地までの経路を探索する目的地経路探索手段と、
前記目的地までの経路に沿って現在地から目的地まで走行するためのバッテリーの必要容量を推定する必要容量推定手段と、
バッテリーの前記残容量と前記必要容量とに基づいてバッテリーを充電せずに目的地まで走行可能か否かを判定する走行判定手段とを備え、
前記走行判定手段によりバッテリーの前記残容量では目的地まで走行できないと判定された場合に、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始でき、且つ少なくとも前記必要容量まで充電可能な充電器に関する情報を提供することを特徴とする充電スタンド情報提供装置。
【請求項１３】請求項１２に記載の充電スタンド情報提供装置において、
前記車載情報端末は、バッテリーの前記残容量から前記必要容量までの所要充電時間と、前記残容量から満充電容量までの所要充電時間とを演算して提供することを特徴とする充電スタンド情報提供装置。
【請求項１４】請求項１０～１３のいずれかの項に記載の充電スタンド情報提供装置において、
前記車載情報端末は、前記利用可能な充電器の中から乗員により選択された充電器の情報を前記管理センターへ送信し、
前記管理センターは、前記乗員により選択された充電器に対して利用予約を行うことを特徴とする充電スタンド情報提供装置。
【請求項１５】請求項８～１４のいずれかの項に記載の充電スタンド情報提供装置において、
前記車載情報端末は、道路地図データからバッテリーの充電中に利用可能な施設の情報を抽出し提供することを特徴とする充電スタンド情報提供装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電気自動車のための充電スタンドに関する情報を提供する装置に関する。
【０００２】
【従来の技術】電気自動車のバッテリー残量がなくなる前に充電できるように、現在位置と道路地図データとに基づいて現在のバッテリー残量で到達可能な充電スタンドを探し、その充電スタンドまで乗員を誘導するようにした充電スタンド情報提供装置が開示されている（特開平０９－２１０７０２号公報参照）。
【０００３】
【発明が解決しようとする課題】ところで、電気自動車のバッテリーを充電するには時間がかかり、充電スタンドがあっても他の電気自動車が充電中で充電器が空いていなければ充電することができない。したがって、充電スタンドまで乗員を誘導するだけでは、電気自動車の安全な運行計画を立てることができないという問題がある。
【０００４】本発明の目的は、到着してから速やかに充電を開始できる充電スタンドの情報を提供することにある。
【０００５】
【課題を解決するための手段】（１）　請求項１の発明は、充電スタンドの位置を記憶するスタンド位置記憶手段と、充電スタンドに設置されている充電器ごとの利用可能情報を入手する充電器情報入手手段と、電気自動車の現在地を検出する現在地検出手段と、前記スタンド位置記憶手段に記憶されている充電スタンドの中から、電気自動車の現在地周辺に存在する充電スタンドを抽出するスタンド抽出手段と、前記スタンド抽出手段により抽出された充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを提供する充電器情報提供手段とを備える。
（２）　請求項２の充電スタンド情報提供装置の前記利用可能情報は、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始できる利用可能な充電器に関する情報である。
（３）　請求項３の充電スタンド情報提供装置は、道路地図データに基づいて現在地から充電スタンドまでの経路を探索するスタンド経路探索手段を備え、前記充電器情報提供手段によって、充電スタンドの位置、その充電スタンドに設置されている充電器の利用可能情報、およびその充電スタンドまでの経路を提供するようにしたものである。
（４）　請求項４の充電スタンド情報提供装置は、電気自動車のバッテリーの残容量を検出する残容量検出手段と、道路地図データに基づいて現在地から目的地までの経路を探索する目的地経路探索手段と、前記目的地までの経路に沿って現在地から目的地まで走行するためのバッテリーの必要容量を推定する必要容量推定手段と、バッテリーの前記残容量と前記必要容量とに基づいてバッテリーを充電せずに目的地まで走行可能か否かを判定する走行判定手段とを備え、前記充電器情報提供手段によって、前記走行判定手段によりバッテリーの前記残容量では目的地まで走行できないと判定された場合に、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始でき、且つ少なくとも前記必要容量まで充電可能な充電器に関する情報を提供するようにしたものである。
（５）　請求項５の充電スタンド情報提供装置は、前記充電器情報提供手段によって、バッテリーの前記残容量から前記必要容量までの所要充電時間と、前記残容量から満充電容量までの所要充電時間とを演算して提供するようにしたものである。
（６）　請求項６の充電スタンド情報提供装置は、前記利用可能な充電器の中から乗員により選択された充電器

に対して利用予約を行う充電予約手段を備える。
（７） 請求項７の充電スタンド情報提供装置は、前記充電器情報提供手段によって、道路地図データからバッテリーの充電中に利用可能な施設の情報を抽出し提供するようにしたものである。
（８） 請求項８の発明は、充電スタンドを管理する管理センターと電気自動車の車載情報端末とから成る充電スタンド情報提供装置であって、前記管理センターは、充電スタンドの位置を記憶するスタンド位置記憶手段と、充電スタンドに設置されている充電器ごとの利用可能情報を入手する充電器情報入手手段とを備え、充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを無線通信により前記車載情報端末へ配信する。
（９） 請求項９の充電スタンド情報提供装置の前記車載情報端末は、電気自動車の現在地を検出する現在地検出手段を備え、検出した現在地を前記管理センターへ送信し、前記管理センターは、前記スタンド位置記憶手段に記憶されている充電スタンドの中から、電気自動車の現在地周辺に存在する充電スタンドを抽出するスタンド抽出手段を備え、抽出された充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを配信する。
（１０） 請求項１０の充電スタンド情報提供装置の前記利用可能情報は、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始できる利用可能な充電器に関する情報である。
（１１） 請求項１１の充電スタンド情報提供装置の前記車載情報端末は、道路地図データに基づいて現在地から充電スタンドまでの経路を探索するスタンド経路探索手段を備え、充電スタンドの位置、その充電スタンドに設置されている充電器の利用可能情報、およびその充電スタンドまでの経路を提供する。
（１２） 請求項１２の充電スタンド情報提供装置の前記車載情報端末は、電気自動車のバッテリーの残容量を検出する残容量検出手段と、道路地図データに基づいて現在地から目的地までの経路を探索する目的地経路探索手段と、前記目的地までの経路に沿って現在地から目的地まで走行するためのバッテリーの必要容量を推定する必要容量推定手段と、バッテリーの前記残容量と前記必要容量とに基づいてバッテリーを充電せずに目的地まで走行可能か否かを判定する走行判定手段とを備え、前記走行判定手段によりバッテリーの前記残容量では目的地まで走行できないと判定された場合に、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始でき、且つ少なくとも前記必要容量まで充電可能な充電器に関する情報を提供する。
（１３） 請求項１３の充電スタンド情報提供装置の前記車載情報端末は、バッテリーの前記残容量から前記必要容量までの所要充電時間と、前記残容量から満充電容量までの所要充電時間とを演算して提供する。
（１４） 請求項１４の充電スタンド情報提供装置の前記車載情報端末は、前記利用可能な充電器の中から乗員により選択された充電器の情報を前記管理センターへ送信し、前記管理センターは、前記乗員により選択された充電器に対して利用予約を行う。
（１５） 請求項１５の充電スタンド情報提供装置の前記車載情報端末は、道路地図データからバッテリーの充電中に利用可能な施設の情報を抽出し提供する。
【０００６】
【発明の効果】本発明によれば、到着してから速やかに充電を開始できる充電スタンドの情報を提供することができ、充電スタンド情報利用者の利便性が向上する。
【０００７】
【発明の実施の形態】一実施の形態の充電スタンド情報提供装置は、電気自動車ごとに搭載される複数の車載装置と、充電スタンド管理センターと、複数の充電スタンドから構成される。
【０００８】図１は一実施の形態の車載装置の構成を示す。三相交流モーター１は電気自動車の走行駆動源であり、減速機２とプロペラシャフト３ａ、３ｂを介して駆動輪４ａ、４ｂを駆動する。インバーター５はバッテリー６の直流電力を三相交流電力に変換し、モーター１に印加する。
【０００９】なお、三相交流モーター１には同期モーターや誘導モーターなどを用いることができる。また、この一実施の形態では電気自動車の走行駆動源として三相交流モーターを用いた例を示すが、走行駆動源として直流モーターを用いてもよい。その場合は、インバーター５の代わりにＤＣ－ＤＣコンバーターを用いる。さらに、バッテリー６の種類は特に限定されず、例えばリチウム・イオン電池やニッケル・水素電池などを用いることができる。
【００１０】ＥＶ（Electric Vehicle）コントローラー１０はマイクロコンピューターとメモリなどの周辺部品を備え、アクセルペダル踏み込み量、ブレーキペダル踏み込み量、車速、バッテリー電圧などに基づいてインバーター５とバッテリー６を制御する。ナビゲーションコントローラー１１はマイクロコンピューターとメモリなどの周辺部品を備え、目的地および充電スタンドまでの経路探索と経路誘導、自立航法による現在位置検出、道路地図の表示制御などを行う。
【００１１】電圧センサー１２はバッテリー６の端子電圧を検出する。アクセルセンサー１３はアクセルペダルの踏み込み量を、ブレーキセンサー１４はブレーキペダルの踏み込み量をそれぞれ検出する。通信装置１５は後述する充電スタンド管理センターと通信を行うための装置である。ＧＰＳ受信機１６は衛星航法により車両の現在位置を検出する。入力装置１７は、乗員が目的地などの各種情報を入力したり、充電スタンドの利用可能な充

電器などを選択したり、充電スタンドの利用可能な充電器の予約などを行う操作入力装置である。

【００１２】記憶装置１８は道路地図データや施設データなどを記憶するＤＶＤ－ＲＯＭなどの記憶装置である。方位センサー１９は車両の進行方位を検出するジャイロなどの検出器であり、車速センサー２０は車両の走行速度を検出する検出器である。ナビゲーションコントローラー１１は、方位センサー１９からの進行方位と車速センサー２０からの車速に基づいて自立航法により車両の現在位置を検出する。ディスプレイ２１は道路地図、車両の現在地と目的地、目的地までの誘導経路、充電スタンドの位置などを表示する。

【００１３】図２は一実施の形態の充電スタンド管理センターと充電スタンドの構成を示す。充電スタンド管理センター３０はコンピューター３１、データベース３２、通信装置３３、３４を備え、多くの充電スタンドを管理する。コンピューター３１は、通信装置３３を介して図１に示す多くの車載装置と通信を行うとともに、通信装置３４を介して多くの充電スタンドと通信を行う。ＤＢ３２には充電スタンドの設置場所、充電器の個数、現在の各充電器の使用状況と予約状況などの充電器利用可能情報が記憶されている。

【００１４】充電スタンド４０は管理装置４１、充電器４２、４３、通信装置４４などを備えている。管理装置４１は、通信装置４４を介して管理センター３０と通信を行い、各充電器４２、４３の使用状況や予約状況などを管理する。各充電器４２、４３には電気自動車のコネクターへ接続するための充電ケーブル・コネクターの他に、充電電圧、電流、時間などを表示するディスプレイ、充電開始操作スイッチなどが備えられている。

【００１５】なお、図２では１つの充電スタンド４０のみを示すが、実際には他に多くの充電スタンドが管理センター３０の管理下にある。以下では、それらの多くの充電スタンドを代表し、符号４０を付して説明する。また、充電スタンド４０ごとに設置される充電器の個数は異なる。さらに、図２では１つの管理センター３０のみを示すが、管理センター３０は地域ごとに設置され、各地域内に存在する多くの充電スタンド４０と結ばれている。以下では、地域ごとに設置される多くの管理センターを代表し、符号３０を付して説明する。管理センター３０と充電スタンド４０との間の通信形態は無線であっても有線であっても構わない。

【００１６】図３は充電スタンド管理プログラムを示すフローチャートである。充電スタンド管理センター３０のコンピューター３１は、所定時間ごとにこのプログラムを実行する。ステップ１において、管理センター３０が管理する多くの充電スタンド４０の内の１つへ通信を要求する。管理センター３０から通信要求を受信した充電スタンド４０は、通信可能な旨を返信する。続くステップ２で、充電スタンド４０の管理装置４１から返信があったか、すなわち通信可能か否かを確認し、通信可能な場合はステップ４へ進み、返信がなく通信不可能なときはステップ３へ進む。

【００１７】返信がなく通信不可能な場合は、ステップ３でその充電スタンド４０に対して通信要求を開始してから所定時間が経過したか否かを確認する。すでに所定時間が経過しているときはステップ１へ戻り、他の充電スタンド４０に対して通信要求を行う。一方、所定時間が経過していないときはステップ２へ戻り、充電スタンド４０からの返信を待つ。

【００１８】充電スタンド４０から返信があって通信可能な場合は、ステップ４でその充電スタンド４０に設置されている各充電器４２、４３に関する利用可能情報を要求する。これらの利用可能情報には、各充電器４２、４３ごとの使用状況や予約状況などが含まれる。各充電器の利用可能情報を要求された充電スタンド４０は、各充電器４２、４３の使用状況や予約状況などの利用可能情報を管理センター３０へ送信する。

【００１９】ステップ５において、充電スタンド４０から各充電器４２、４３の使用状況や予約状況などの利用可能情報を入手し、データーベース３２に記憶されている利用可能情報を更新する。ステップ６では、管理下にあるすべての充電スタンド４０から利用可能情報を入手したか否かを確認し、未入手の充電スタンド４０があればステップ１へ戻って上述した処理を繰り返し、すべての充電スタンド４０から利用可能情報を入手したら処理を終了する。

【００２０】図４は、車載装置のナビゲーションプログラムを示すフローチャートである。図１に示す車載装置のナビゲーションコントローラー１１は、所定時間ごとにこのプログラムを実行する。ステップ１１において、入力装置１７により目的地が設定されたか否かを確認し、目的地が設定されていない場合は処理を終了する。

【００２１】目的地が設定された場合はステップ１２へ進み、衛星航法と自立航法により車両の現在地を検出する。ステップ１３では、記憶装置１８に記憶されている道路地図データに基づいて現在地から目的地までの最適な経路を探索する。続くステップ１４で、ディスプレイ２１に現在地周辺の道路地図を表示するとともに、その道路地図上に現在地と目的地までの最適な経路を表示し、目的地までの経路誘導を開始する。ステップ１５で、目的地が設定されたことを示すフラグＦに１を設定して記憶する。なお、走行中に運転者により目的地がキャンセルされた場合には、この目的地設定フラグＦが０にリセットされる。

【００２２】ステップ１６において、後述する充電情報表示プログラムにより車載バッテリー６の充電が予約されているかどうかを確認する。充電が予約されていなければ処理を終了する。充電が予約されている場合はステップ１７へ進み、現在地から充電を予約した充電スタン

ド４０までの最適な経路を探索する。そして、ステップ１８で充電予約した充電スタンド４０とそこまでの探索経路をディスプレイ２１の道路地図上に表示し、充電スタンド４０までの経路誘導を行う。

【００２３】図５～図６は、車載装置の充電情報表示プログラムを示すフローチャートである。車載装置のナビゲーションコントローラー１１は、所定時間ごとにこのプログラムを実行する。ステップ２１において、目的地設定フラグＦにより目的地が設定されているかどうかを確認する。目的地が設定されていないときは処理を終了する。目的地が設定されているときはステップ２２へ進み、衛星航法と自立航法により車両の現在地を検出する。

【００２４】ステップ２３では、すでに探索されている誘導経路に沿った現在地から目的地までの残距離を計算する。続くステップ２４で、電圧センサー１２によりバッテリー６の端子電圧を検出し、予め記憶装置１８に記憶したバッテリー電圧に対するバッテリー残容量のマップデータからバッテリー電圧検出値に対応するバッテリー残容量を表引き演算する。ステップ２５において、誘導経路に沿って現在地から目的地へ到達するために必要なバッテリー容量（以下、必要容量という）を計算する。

【００２５】必要容量の計算において、最新のバッテリー６の放電容量と走行距離との関係のデータを蓄積しておき、この実績データに基づいて平均燃料消費量を算出し、現在地から目的地までの残距離を平均燃費で走行した場合の必要容量を求める。なお、予め単位距離あたりの一義的な平均燃費を記憶しておき、それに残距離を乗じて必要容量を計算するようにしてもよい。ここで、電気自動車はバッテリー６の充電電力を消費して走行するから消費電力量とすべきであるが、従来のガソリン車やディーゼル車に対応して、この明細書では電力消費量を燃料消費量または燃費という。

【００２６】ステップ２６において、バッテリー６の現在の残容量と目的地までの必要容量とを比較し、現在の残容量で目的地まで走行できるかどうかを確認する。この判断は、残容量が必要容量以上であれば走行可能としてもよいが、目的地へ到着してからある程度の距離は走行できるように、残容量と必要容量との差が少なくとも所定容量以上あれば走行可能とするのが望ましい。現在の残容量で目的地まで走行可能な場合は、充電情報を表示する必要はないので処理を終了する。

【００２７】バッテリー６の現在の残容量で目的地まで走行できない場合はステップ２７へ進み、バッテリー６の現在の残容量から満充電容量まで充電するのに要する時間を計算する。ここで、満充電容量は予め記憶装置１８に記憶しておくものとする。次にステップ２８で、現在のバッテリー残容量から必要容量まで充電するのに要する時間を計算する。

【００２８】ステップ２９において、管理センター３０と通信を行い、現在地周辺の充電スタンド４０の充電器の中から少なくとも必要容量まで充電を行うことができる充電器を検索する。具体的には、管理センター３０の記憶装置１８に記憶されている充電スタンド４０の中から、現在地を中心とする所定範囲内の充電スタンド４０を検索し、それらの充電スタンド４０の中で少なくとも必要容量まですぐに利用できる充電器を選択する。

【００２９】ただし、すぐに利用できる充電器、あるいはある程度の時間待ちをすれば利用できる充電器があったとしても、次の充電予約が入っていて空き時間の間に必要容量まで充電することができない充電器は選択しない。また、必要容量までの充電中に営業時間が終了してしまう充電器も選択しない。つまり、現在地周辺にあって、到着後、直ちにまたは所定時間以内の待ち時間で必要容量まで充電できる充電器を検索する。

【００３０】なお、充電可能な充電器の検索において、この実施の形態では管理センター３０と通信を行って記憶装置１８のデーターベースを利用する例を示すが、充電可能な充電器の検索に先だって、管理センター３０の記憶装置１８から現在地周辺の充電器の空き情報を予め入手しておき、それらの充電器の空き情報の中から上記条件に合致する充電可能な充電器を選択するようにしてもよい。

【００３１】ステップ３０では、選択した充電可能な充電器をディスプレイ２１に表示する。このとき、必要容量までの所要充電時間、満充電までの所要充電時間、充電可能な充電器を備えた充電スタンド４０までの距離と所要走行時間などの情報も合わせて表示する。

【００３２】図７は充電可能な充電器を備えた充電スタンドの表示例を示す。ディスプレイ２１の表示画面には、道路地図上に車両の現在地（矢印）マークと充電可能な充電器を備えた充電スタンドＡ、Ｂの位置を表示するとともに、充電スタンドＡ、Ｂまでの距離、到達時間、使用状況および予約状況を示すグラフ、満充電までの所要充電時間、必要容量までの所要充電時間をそれぞれ表示する。使用状況および予約状況を示すグラフは、三角マークで示す現在時刻以後、使用中および予約が入っている時間をハッチングで表し、利用可能な空き時間を白抜きで表す。なお、表示画面下部には「選択」、「情報検索」、「予約」および「戻り」の操作スイッチが配置されている。

【００３３】電気自動車の乗員は、図７に示す充電情報の表示画面を見て、どの充電スタンドを利用するのがよいか、その充電スタンドで満充電できるのか必要容量までしか充電できないのか、などを判断することができる。乗員が「選択」スイッチを押すたびに、表示画面の道路地図上の充電スタントＡ、Ｂが順次、点滅し、表示枠が太く強調表示される。

【００３４】例えば充電スタンドＡが点滅し表示枠が太

く強調表示されているときに「情報検索」スイッチが操作されると、充電スタンドAが利用スタンドに選択され、充電スタンド情報に代わって図8に示すような充電スタンドAの周辺施設の情報が表示される。図8に示す表示例では、道路地図上の充電スタンドAのマークが点滅して表示枠が太く強調表示されたままになり、充電待ち時間および充電中に利用可能な充電スタンドAの周辺の施設、例えばレストランa、パチンコ店bなどの施設の位置と、それらの施設の詳細な情報が表示される。

【００３５】ステップ３１において、ディスプレイ２１の「情報検索」スイッチが操作され、詳細情報が要求されたか否かを確認し、詳細情報の要求がなければステップ３６へ進む。一方、詳細情報の要求があった場合はステップ３２へ進み、選択した充電器で充電を開始するまでの時間に充電に要する時間を加え、充電スタンドAに到着してから充電が終了するまでの時間（以下、充電終了までの時間という）を計算する。

【００３６】ステップ３３では、記憶装置１８に記憶されている施設データから、選択した充電スタンドAの周辺の娯楽施設や遊技施設、あるいはレストラン、喫茶店などの、充電終了までの時間中に利用可能な施設を検索する。続くステップ３４で、ディスプレイ２１に図8に示すような充電スタンドA周辺の施設の詳細な情報を表示する。

【００３７】ステップ３５で乗員が表示画面の「戻り」スイッチを操作したかどうかを確認し、「戻り」スイッチが操作されるまで施設情報の表示を継続する。「戻り」スイッチが操作されたらステップ３６へ進み、乗員が表示画面の「充電予約」スイッチを操作したかどうかを確認する。選択した充電器の予約操作がない場合はステップ３１へ戻り、上述した処理を繰り返す。

【００３８】充電器の予約操作があった場合はステップ３７へ進み、選択した充電器の利用予約情報を充電スタンド管理センター３０へ送信する。充電器の利用予約情報には、利用したい充電スタンドと充電器番号、利用者のＩＤ、利用時間などが含まれる。充電器の利用予約情報を受信した管理センター３０は、利用対象の充電器を備えた充電スタンド４０の管理装置４１へ充電器の利用情報を転送し、充電器の予約を行う。

【００３９】このように一実施の形態によれば、充電スタンド管理センターにおいて、充電スタンドの位置を記憶するとともに、充電スタンドに設置されている充電器ごとの利用可能情報、すなわち充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始できる利用可能な充電器に関する情報を入手し、充電スタンドの位置と、その充電スタンドに設置されている充電器の利用可能情報とを無線通信により車載装置へ配信し、乗員に提供するようにしたので、到着してから速やかに充電を開始できる充電スタンドの情報を提供することができ、充電スタンド情報利用者の利便性が向上する。

【００４０】また、一実施の形態によれば、充電スタンドの位置、その充電スタンドに設置されている充電器の利用可能情報、およびその充電スタンドまでの経路を提供するようにしたので、利用可能な充電器が設置されている充電スタンドを改めて目的地として設定し、経路探索を行う手間が省略され、充電スタンド情報利用者の利便性が向上する。

【００４１】一実施の形態によれば、バッテリーの残容量では目的地まで走行できないと判定された場合に、充電スタンドに到着後、直ちにまたは所定時間以内に充電を開始でき、且つ少なくとも必要容量まで充電可能な充電器に関する情報を提供するようにしたので、利用可能な充電器の正確な情報を提供することができ、提供情報の信頼性を向上させることができる。

【００４２】さらに、一実施の形態によれば、バッテリーの残容量から必要容量までの所要充電時間と、残容量から満充電容量までの所要充電時間とを演算して提供するようにしたので、電気自動車の適切且つ安全な運行計画を立てることができる。

【００４３】一実施の形態によれば、利用可能な充電器の中から乗員により選択された充電器に対して利用予約を行うようにしたので、乗員が利用予約を行う手間が省かれ、充電スタンド情報利用者の利便性が向上する。

【００４４】さらにまた、一実施の形態によれば、道路地図データからバッテリーの充電中に利用可能な施設の情報を抽出し提供するようにしたので、利用者はバッテリーの充電が終了するまでの待ち時間を有意義に過ごすことができる。

【００４５】特許請求の範囲の構成要素と一実施の形態の構成要素との対応関係は次の通りである。すなわち、データーベース３２がスタンド位置記憶手段を、管理センター３０のコンピューター３１が充電器情報入手手段および充電予約手段を、ＧＰＳ受信機１６、方位センサー１９、車速センサー２０およびナビゲーションコントローラー１１が現在地検出手段を、ナビゲーションコントローラー１１がスタンド抽出手段、充電器情報提供手段、スタンド経路探索手段、目的地経路探索手段、必要容量推定手段および走行判定手段を、ナビゲーションコントローラー１１および電圧センサー１２が残容量検出手段を、ナビゲーションコントローラー１１およびディスプレイ２１が車載情報端末をそれぞれ構成する。なお、本発明の特徴的な機能を損なわない限り、各構成要素は上記構成に限定されるものではない。

【図面の簡単な説明】

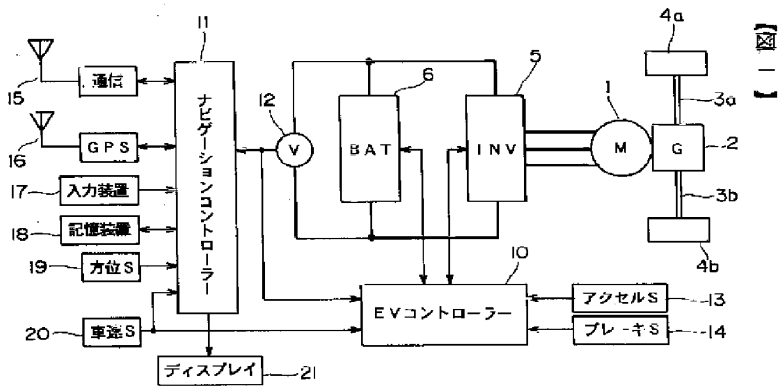
【図１】　一実施の形態の充電スタンド情報提供装置の車載装置の構成を示す図である。

【図２】　一実施の形態の充電スタンド情報提供装置の充電スタンド管理センターと充電スタンドの構成を示す図である。

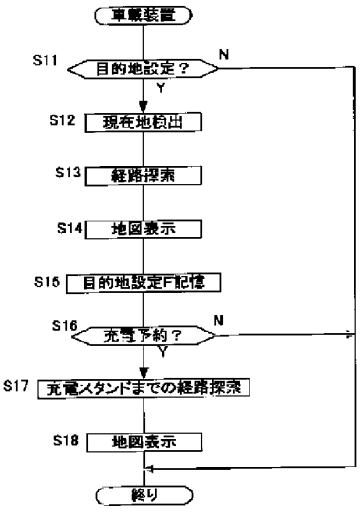
【図３】　一実施の形態の充電スタンド管理プログラム

を示すフローチャートである。
【図４】　一実施の形態の車載装置のナビゲーションプログラムを示すフローチャートである。
【図５】　一実施の形態の車載装置の充電情報表示プログラムを示すフローチャートである。
【図６】　図５に続く、一実施の形態の車載装置の充電情報表示プログラムを示すフローチャートである。
【図７】　充電可能な充電器を備えた充電スタンドの表示例を示す図である。
【図８】　充電スタンドＡ周辺の詳細情報の表示例を示す図である。
【符号の説明】
１　三相交流モーター
２　減速機
３ａ、３ｂ　プロペラシャフト
４ａ、４ｂ　駆動輪
５　インバーター
６　バッテリー
１０　ＥＶコントローラー
１１　ナビゲーションコントローラー
１２　電圧センサー
１３　アクセルセンサー
１４　ブレーキセンサー
１５　通信装置
１６　ＧＰＳ受信機
１７　入力装置
１８　記憶装置
１９　方位センサー
２０　車速センサー
２１　ディスプレイ
３０　充電スタンド管理センター
３１　コンピューター
３２　データーベース
３３、３４　通信装置
４０　充電スタンド
４１　管理装置
４２、４３　充電器
４４　通信装置

【図１】

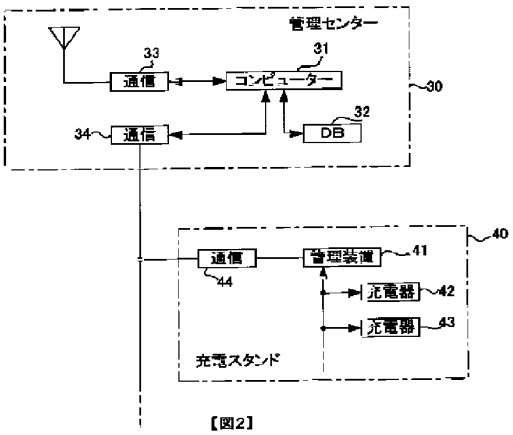


【図４】



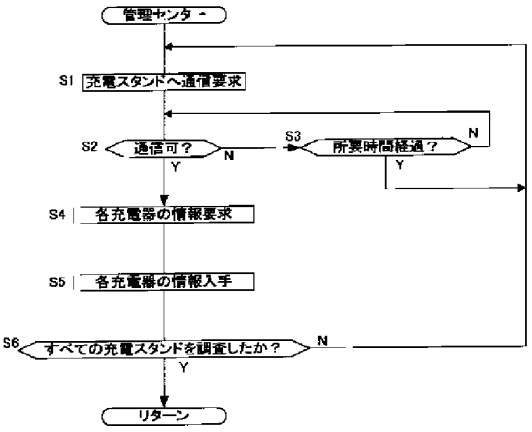
【図4】

【図2】



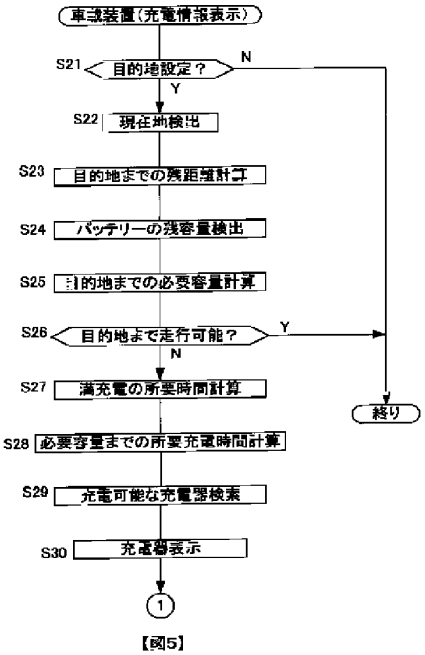
【図2】

【図3】



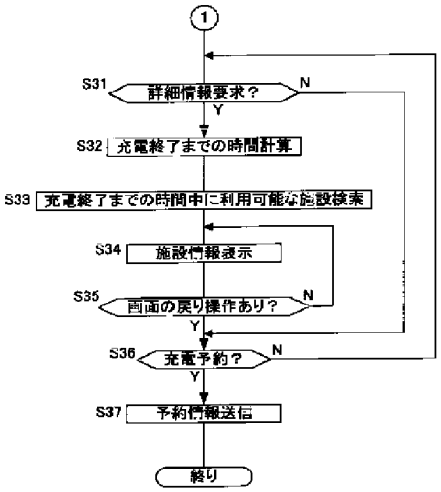
【図3】

【図5】



【図5】

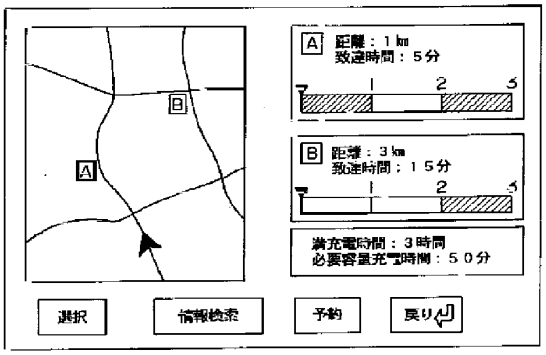
【図6】



【図6】

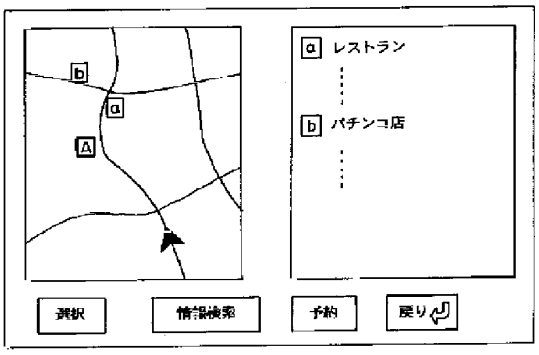
【図7】

【図７】



【図8】

【図８】



フロントページの続き

Fターム(参考) 2F029 AA02 AB07 AC02 AC14 AC16
5H180 AA01 BB04 BB05 FF04 FF05
FF13 FF22 FF32

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Angel A. Penilla

Application No: 13/452,882

Filed: April 22, 2012

For: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

Group Art Unit: 2859

Examiner: Yalkew Fantu

Atty. Docket No: VOLTP001

Date: Jan. 30, 2015

THIRD PRELIMINARY AMENDMENT

Honorable Commissioner for Patents
Alexandria VA 22313-1450

Dear Sir:

Please enter this preliminary amendment and remarks.

Amendments to the claims are reflected in the listing of claims which begin on page 2 of this paper.

Remarks/Arguments begin on page 12 of this paper.

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A system for providing ~~auxiliary~~ charge units usable to supply charge to a main battery of an electric vehicle, comprising:

(a) an auxiliary battery for holding a plurality of charge units, the auxiliary battery being connectable to the main battery of the electric vehicle, the plurality of charge units being rechargeable and being replaceable from the auxiliary battery, such that replacing particular ones of the plurality of charge units with charge units with more charge increases a total charge of the auxiliary battery; and

(b) a kiosk for storing a plurality of charge units, the kiosk having,

(i) slots for storing and recharging the plurality of charge units;

(ii) control systems for communicating over a network, the control ~~system~~ systems include ~~includes~~ logic for identifying inventory of charging units in the kiosk and logic for processing payments ~~and fee adjustments~~ for charge units provided and/or received in the slots of the kiosk; and

(iii) [[(b)]] a display for providing an interface for enabling transactions to provide and/or receive charge units ~~to customers~~;

(c) a processing server that communicates over a network with,

(i) the control systems of the kiosk, the kiosk being one of a plurality of ~~said~~ kiosks ~~kiosk over a network~~, the processing server configured to provide for centralized [[rate]] changes to a price ~~prices~~ to charge for the charge units at each of the plurality of kiosks, wherein ~~changing~~ the price of the charge units at ~~is specific to~~ each of the plurality of kiosks ~~and~~ is adjusted based on at least one of a plurality of metrics [[,]] including availability at particular ones

of the plurality of kiosks or ~~each kiosk and~~ discounts to incentivize exchanging charge units at specific kiosks, and

(ii) a plurality of user accounts, the user accounts provided with access to information regarding one or more of the plurality of kiosks, the information including ~~vehicles, the plurality of vehicles being provided with access to~~ availability information of charge units at the one or more of the plurality of kiosks, wherein each of the kiosks having an associated ~~of charge units at each of said kiosks, the availability information being custom provided to the plurality of vehicles based on their~~ geo-location.

2. (Currently amended) The system of claim 1, wherein the processing server provides access to the user accounts via mobile devices or computing devices to provide or push ~~regarding~~ the availability information.

3. (Currently amended) The system of claim 1, wherein the processing server provides notifications to select ones of the user accounts ~~predefined computing devices~~ regarding the availability information for certain ones of the plurality of kiosks.

4. (Currently amended) The system of claim 1, wherein the processing server provides data to the user accounts via a mobile application, or a web application or an application of the electric vehicle ~~mobile applications or applications of one of the plurality of vehicles, the data being provided for an account of a user that is associated with a particular auxiliary battery~~,

wherein the data is for one or more of, status of charge units in the ~~particular~~ auxiliary battery of a vehicle, an approximate range of miles or distance provided by the particular auxiliary battery, identification of closest kiosks to a current geo-location, deals provided at certain kiosks ~~locations~~, reservation options ~~reservations~~ for reserving charge units ahead of arrival at a particular kiosk, gifts available, loyalty points for past use of charge units, history of use of charge units, or carbon footprint consumption by use of the charge units, or combinations of two or more thereof.

5. (Currently amended) The system of claim 1, wherein the processing server communicates notifications to particular user accounts ~~uses having a registered account~~ concerning availability of charge units for particular geo-locations, and options for making reservations.

6. (Currently amended) The system of claim 1, wherein the processing server communicates route options leading [[,]] to particular ~~uses having a registered account, to particular~~ kiosks having available charge units proximate to a current location, the route options being associated with a map or a distance, or a reservation option, or a discount option, or combinations of two or more thereof.

7.-9. (Cancel).

10. (Currently amended) The system of claim 6, wherein each route option having the [[a]] discount includes identification of a type of discount in fee, or a discount in goods, or a discount in services or a combination of two or more thereof.

11. (Currently amended) The system of claim 1,

wherein the processing server is a cloud processing system that has access to one or more cloud services, including a traffic service, or a route generation service, or a driver location service, or a charge kiosk location service, or a combination of two or more ~~combinations~~ thereof;

wherein the electric vehicle is one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

12.- 19. (Cancel)

20. (Currently amended) A method for providing information regarding batteries available for use by electric vehicles, comprising:

(a) providing access to a processing server that communicates locally or over a network with,

(i) a plurality of kiosks having one or more batteries with charge available for ~~exchanging~~ exchange with batteries with reduced charge, the batteries of the kiosks being ~~available~~ for use by the electric vehicles to power electric motors of the electric vehicles;

(ii) a plurality of user accounts that are accessed via computing devices, the plurality of user accounts being associated with users that registered to obtain the information regarding the batteries and enable access to exchange at least one battery at one of the plurality of kiosks; and

(b) providing the processing server with access to a database that stores data

or update data regarding one or more of the plurality of kiosks and batteries located at each of the plurality of kiosks;

wherein the processing server receives requests from one or more of the plurality of user accounts via one or more computing devices to locate one or more kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies at least one location having a kiosk ~~locations~~ proximate to the particular geo-location and availability of batteries at the kiosk of the identified location ~~locations~~, the processing server further identifying discounts or rates chargeable for batteries at the kiosk of the identified location or other kiosks of the plurality of ~~located~~ kiosks;

wherein each of the plurality of kiosks is part of a network of geographically dispersed kiosks that are each configured for [[in]] communication with the processing server ~~that operates cloud processing logic~~, the processing server collects or receives information from each of the plurality of kiosks and forwards instructions to ones of the plurality of ~~programming to each of the~~ kiosks,

wherein the processing server is further configured to ~~make available~~ process requests for ~~selected~~ information regarding particular kiosks and provide data to enable ~~cause~~ generation of routing options to one or more of the plurality of kiosks, ~~to the computing devices~~ the requests being received by the processing server from one or more of the computing devices which include one or more of hand held-devices, or computers, or vehicle computers, or tablet computers, or smartphones;

wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

21. (Currently amended) A system for processing ~~managing~~ batteries usable in electric vehicles, the batteries being exchangeable for charged batteries, comprising,

(a) a processing server that ~~manages and communicates with~~,

(i) communicates with a plurality of kiosks having one or more batteries available for use by the electric vehicles;

(ii) accesses a plurality of user accounts;

(iii) communicates with a plurality of applications, each of the plurality of applications being executed by a computing device ~~rendered by computing devices~~, each of the plurality of applications being associated with ~~application usable via~~ a respective user account;

(b) a database being accessible by the processing server, the database ~~that~~ stores and provides access to data regarding the plurality of kiosks and batteries located at respective ones of the plurality of kiosks;

wherein the processing server processes requests from one or more of the plurality of applications to locate kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies a least one location of a kiosk ~~locations~~ proximate to the particular geo-location and availability of batteries for exchange at the kiosk of the at least one location ~~identified locations~~, the processing server further providing information regarding ~~identifying~~ discounts or cost ~~rates chargeable~~ for batteries at the kiosk of the at least one location ~~located kiosks~~;

wherein each kiosk has a plurality of receptacle slots configured for hand-insertion of batteries into the receptacle slots and hand-removal of batteries out of the receptacle slots, wherein at least one ~~some~~ of the receptacle slots of at least one kiosk enables charging of a battery ~~charge batteries~~ when disposed in the at least one of the receptacle slots ~~of the each kiosk~~.

22. (Currently amended) The system of claim 21, wherein the processing server ~~manages~~ processes the discounts or cost, wherein at least one of the discounts or cost is set ~~rates~~ to provide an incentive to obtain batteries where battery excess inventory exists at particular kiosks or provide a disincentive to obtain batteries where battery inventory is low at particular kiosks.

23. (Currently amended) The system of claim 21, wherein the processing server processes the discounts or cost ~~rates~~ at the plurality of kiosks to maintain a load balancing of inventory of batteries in a geographical region or at particular ones of the plurality of kiosks.

24. (Currently amended) The system of claim 21, wherein batteries include tracking identifiers, the tracking identifiers being used to track a current location of batteries when in kiosks or at least a last used kiosk for particular batteries.

25. (Currently amended) The system of claim 21, wherein each kiosk receives electronic payments or at least processes electronic payments in coordination with the processing server from users of the user accounts, wherein records of the electronic payments provide a historical tracking of battery usage for particular accounts [[and]] or determination of associated discounts for the user accounts based on the historical tracking of battery usage.

26. (Currently amended) The system of claim 21, wherein the processing server is configured to receive reservations of batteries at specific kiosks from applications associated with particular user accounts, the reservation enables confirmation that

one or more reserved batteries will be held available at the kiosk when the electric vehicle arrives at the kiosk or for a limited period of time before a reservation is caused to expire.

27. (Currently amended) The system of claim 21, wherein the processing server generates notifications to be sent to the user accounts regarding battery availability or discounts, or processes data for rendering one or more of status of batteries in the kiosks, or processes data to determine nearby kiosks relative to a geo-location, or processes data to identify deals provided at certain kiosks, or processes data to make reservations for reserving batteries at a particular kiosks, or processes data to identify gifts available at particular kiosks, or processes data to identify loyalty points for past use of batteries, or processes data to render a history of use of batteries, or processes data to determine a carbon footprint ~~consumption~~ from use of the batteries, or combinations of two or more thereof.

28. (Currently amended) The system of claim 21, wherein each of the kiosks is part of a network of geographically dispersed kiosks that are each capable of being in communication with the processing server, and the processing server collects information from each of the kiosks and forwards programming or instructions to each or select ones of the kiosks, the processing server is further configured to make available options for requesting selected information regarding particular kiosks to the applications.

29. (Currently amended) The system of claim 21, wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or

an industrial vehicle.

30. (New) A system of a network of distributed kiosks for exchanging batteries usable to power an electric motor of an electric vehicle, comprising,

a plurality of kiosks being part of the network of distributed kiosks, wherein each of the plurality of kiosks is associated with a respective geo-location, wherein each kiosk has a plurality of slots for holding at least one battery, the at least one battery having a form factor to fit in the plurality of slots of the kiosks and at least one slot of the electric vehicle, wherein each of the plurality of kiosks having a computer;

a processing server for communicating with the computer of each of the plurality of kiosks and a plurality of applications, each of the plurality of applications being associated with a respective user account that is setup for enabling access to the server for locating particular ones of the plurality of kiosks and receiving information regarding availability of batteries at particular ones of the plurality of kiosk locations;

wherein the processing server, in response to a request from an application, is configured to provide data to the application or take an action;

wherein when the request is to locate at least one of the plurality of kiosks, the data provided to the application is to enable generation of a map that identifies a current location of an electric vehicle associated with the application and a location of at least one of the plurality of kiosks, the map enables display of at least one route from the current location of the electric vehicle to the location of the at least one of the plurality of kiosks;

wherein when the request is to reserve at least one battery at the at least one of the plurality of kiosks, the processing server takes an action by

designating the at least one battery is reserved for a user account associated with the application making the request;

wherein the processing server is configured to receive information from the at least one of the plurality of kiosks when at least one battery is dispense or received;

wherein the electric vehicle is one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle;

wherein the application is processed by a computing device capable of making internet access for communicating with the processing server, the computing device being one of a hand held-device, or a vehicle computer, or a tablet computer, or a smartphone, or a computer.

31. (New) The system of claim 30, wherein the processing server generates notifications to be sent to the user accounts regarding new discounts, or processes data to modify or set deals provided at certain kiosks, or processes data to set gifts available at particular kiosks, or processes data to update loyalty points for past use of batteries for particular user accounts, or processes data to render a history of use of batteries by particular user accounts, or processes data to determine a carbon footprint from use of the batteries by particular user accounts, or processes data to update or post social network data regarding one or more of the kiosks, or combinations of two or more thereof.

REMARKS

This paper provides a preliminary amendment. No new matter has been added by way of this amendment.

If the Examiner has any questions concerning the present amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6903. If any other fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No VOLTP001).

Respectfully submitted,
MARTINE PENILLA GROUP, LLP

/Albert Penilla/

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Reg. No. 39,487

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Electronic Patent Application Fee Transmittal

Application Number:	13452882
Filing Date:	22-Apr-2012
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Filer:	Albert S. Penilla
Attorney Docket Number:	VOLTP001

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Independent Claims in Excess of 3	2201	1	210	210
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**210**

Electronic Acknowledgement Receipt	
EFS ID:	21355812
Application Number:	13452882
International Application Number:	
Confirmation Number:	6203
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Customer Number:	25920
Filer:	Albert S. Penilla
Filer Authorized By:	
Attorney Docket Number:	VOLTP001
Receipt Date:	30-JAN-2015
Filing Date:	22-APR-2012
Time Stamp:	12:53:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$210
RAM confirmation Number	10661
Deposit Account	500805
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	VOLTP001_PrelimAmendment_3_Efiled.pdf	61136 bb876e41d593a953cfb4636e3fe59f2539548d7f	no	12
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30849 4a746461aa4301beba7b518b7e5e9557b8e5e50b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	91985		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/452,882	Filing Date 04/22/2012	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 01/30/2015

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 4	Minus	***3	= 1	X $210 =	210
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**210**

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DORIS KING/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

25920 7590 02/19/2015

MARTINE PENILLA GROUP, LLP
710 LAKEWAY DRIVE
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SUNNYVALE, CA 94085

EXAMINER	
FANTU, YALKEW	

ART UNIT	PAPER NUMBER
2859	

MAIL DATE	DELIVERY MODE
02/19/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/452,882	Applicant(s) PENILLA ET AL.	
	Examiner YALKEW FANTU	Art Unit 2859	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04/22/2012*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-6, 10-11, 20-31* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☐ Claim(s) _____ is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☒ Claim(s) *1-6,10,11 and 20-31* are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

This application contains claims directed to the following patentably distinct specie:

Species I: Figs 1, 2, 11, 12, 13b-13d, and 14a

Species II: Figs. 6, 8, 10, 13a, 14b, 15

Species III: Figs. 13e, 16a, 17-23

Species I: the embodiment providing a system for auxiliary battery carrier designed to receive one or more volt bars. As shown, auxiliary battery carrier can include a number of slots that are defined for receiving volt bars, can be classified in battery structures - 320/107.

Species II: the embodiment providing a system of a network of distributed kiosks for exchanging batteries with a processing server for communicating with the computer of each of the plurality of kiosks and a plurality of applications, each of the applications being associated with a respective user account that is setup for enabling access-mainly dedicated to data communications, can be classified under 705/17

Species III: the embodiment providing a system where a main battery and an auxiliary battery are each capable of providing power to a motor directly, and a directing charging ports include a retractable charging cord with charging plug so that vehicle drive up to receive charge form a station charging the main battery, and can be classified under 320/109.

Upon further consideration, the present application contains, at least, three distinct species which restriction deemed proper. The species are independent or distinct because claims to different species recite mutually exclusive characteristics of such species. In addition, these species are not obvious variants of each other based on the current record; can be grouped into different class/subclass.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, no claim is generic.

There is an examination and search burden for these patentably distinct Species due to their mutually exclusive characteristics. The Species require a different field of search (e.g., searching different classes/subclasses or electronic resources, or employing different search queries); and/or the prior art applicable to one Species would not likely be applicable to another Species; and/or the Species are likely to raise different non-prior art issues under 35 U.S.C. 101 and/or 35 U.S.C. 112, first paragraph.

Applicant is advised that a reply to this requirement must include an identification of the species that is elected consonant with this requirement, and a listing of all claims readable thereon, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election. Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by

37 CFR 1.141. If claims are added after the election, applicant must indicate which are readable upon the elected species. MPEP § 809.02(a).

The election of an invention or species may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse.

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a petition under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(l).

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YALKEW FANTU whose telephone number is (571)272-8928. The examiner can normally be reached on M-F: 7 - 4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DREW A. DUNN can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/YALKEW FANTU/
Primary Examiner, Art Unit 2859

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Angel A. Penilla

Application No: 13/452,882

Filed: April 22, 2012

For: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

Group Art Unit: 2859

Examiner: Yalkew Fantu

Atty. Docket No: VOLTP001

Date: Feb. 25, 2015

Response to Restriction Requirement

Honorable Commissioner for Patents
Alexandria VA 22313-1450

Dear Sir:

This paper is in response to the Office action of Feb. 19, 2015. Please enter this preliminary amendment and remarks.

Amendments to the claims are reflected in the listing of claims which begin on page 2 of this paper.

Remarks/Arguments begin on page 12 of this paper.

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1.-19. (Cancel)

20. (Previously presented) A method for providing information regarding batteries available for use by electric vehicles, comprising:

(a) providing access to a processing server that communicates locally or over a network with,

(i) a plurality of kiosks having one or more batteries with charge available for exchange with batteries with reduced charge, the batteries of the kiosks being for use by the electric vehicles to power electric motors of the electric vehicles;

(ii) a plurality of user accounts that are accessed via computing devices, the plurality of user accounts being associated with users that registered to obtain the information regarding the batteries and enable access to exchange at least one battery at one of the plurality of kiosks; and

(b) providing the processing server with access to a database that stores data or update data regarding one or more of the plurality of kiosks and batteries located at each of the plurality of kiosks;

wherein the processing server receives requests from one or more of the plurality of user accounts via one or more computing devices to locate one or more kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies at least one location having a kiosk proximate to the particular geo-location and availability of batteries at the kiosk of the identified

location, the processing server further identifying discounts or rates chargeable for batteries at the kiosk of the identified location or other kiosks of the plurality of kiosks;

wherein each of the plurality of kiosks is part of a network of geographically dispersed kiosks that are each configured for communication with the processing server, the processing server collects or receives information from each of the plurality of kiosks and forwards instructions to ones of the plurality of kiosks,

wherein the processing server is further configured to process requests for information regarding particular kiosks and provide data to enable generation of routing options to one or more of the plurality of kiosks, the requests being received by the processing server from one or more of the computing devices which include one or more of hand held-devices, or computers, or vehicle computers, or tablet computers, or smartphones;

wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

21. (Previously presented) A system for processing batteries usable in electric vehicles, the batteries being exchangeable for charged batteries, comprising,

(a) a processing server that,

(i) communicates with a plurality of kiosks having one or more batteries available for use by the electric vehicles;

(ii) accesses a plurality of user accounts;

(iii) communicates with a plurality of applications, each of the plurality of applications being executed by a computing device, each of the plurality of

applications being associated with a respective user account;

(b) a database being accessible by the processing server, the database stores and provides access to data regarding the plurality of kiosks and batteries located at respective ones of the plurality of kiosks;

wherein the processing server processes requests from one or more of the plurality of applications to locate kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies a least one location of a kiosk proximate to the particular geo-location and availability of batteries for exchange at the kiosk of the at least one location, the processing server further providing information regarding discounts or cost for batteries at the kiosk of the at least one location;

wherein each kiosk has a plurality of receptacle slots configured for hand-insertion of batteries into the receptacle slots and hand-removal of batteries out of the receptacle slots, wherein at least one of the receptacle slots of at least one kiosk enables charging of a battery when disposed in the at least one of the receptacle slots.

22. (Previously presented) The system of claim 21, wherein the processing server processes the discounts or cost, wherein at least one of the discounts or cost is set to provide an incentive to obtain batteries where battery excess inventory exists at particular kiosks or provide a disincentive to obtain batteries where battery inventory is low at particular kiosks.

23. (Previously presented) The system of claim 21, wherein the processing server processes the discounts or cost at the plurality of kiosks to maintain a load balancing of inventory of batteries in a geographical region or at particular ones of the plurality

of kiosks.

24. (Previously presented) The system of claim 21, wherein batteries include tracking identifiers, the tracking identifiers being used to track a current location of batteries when in kiosks or at least a last used kiosk for particular batteries.

25. (Previously presented) The system of claim 21, wherein each kiosk receives electronic payments or at least processes electronic payments in coordination with the processing server from users of the user accounts, wherein records of the electronic payments provide a historical tracking of battery usage for particular accounts or determination of associated discounts for the user accounts based on the historical tracking of battery usage.

26. (Previously presented) The system of claim 21, wherein the processing server is configured to receive reservations of batteries at specific kiosks from applications associated with particular user accounts, the reservation enables confirmation that one or more reserved batteries will be held available at the kiosk when the electric vehicle arrives at the kiosk or for a limited period of time before a reservation is caused to expire.

27. (Previously presented) The system of claim 21, wherein the processing server generates notifications to be sent to the user accounts regarding battery availability or discounts, or processes data for rendering one or more of status of batteries in the kiosks, or processes data to determine nearby kiosks relative to a geo-location, or processes data to identify deals provided at certain kiosks, or processes data to make reservations for reserving batteries at a particular kiosks, or processes data to

identify gifts available at particular kiosks, or processes data to identify loyalty points for past use of batteries, or processes data to render a history of use of batteries, or processes data to determine a carbon footprint from use of the batteries, or combinations of two or more thereof.

28. (Previously presented) The system of claim 21, wherein each of the kiosks is part of a network of geographically dispersed kiosks that are each capable of being in communication with the processing server, and the processing server collects information from each of the kiosks and forwards programming or instructions to each or select ones of the kiosks, the processing server is further configured to make available options for requesting selected information regarding particular kiosks to the applications.

29. (Previously presented) The system of claim 21, wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

30. (Previously presented) A system of a network of distributed kiosks for exchanging batteries usable to power an electric motor of an electric vehicle, comprising,

a plurality of kiosks being part of the network of distributed kiosks, wherein each of the plurality of kiosks is associated with a respective geo-location, wherein each kiosk has a plurality of slots for holding at least one battery, the at least one battery having a form factor to fit in the plurality of slots of the kiosks and at least

one slot of the electric vehicle, wherein each of the plurality of kiosks having a computer;

a processing server for communicating with the computer of each of the plurality of kiosks and a plurality of applications, each of the plurality of applications being associated with a respective user account that is setup for enabling access to the server for locating particular ones of the plurality of kiosks and receiving information regarding availability of batteries at particular ones of the plurality of kiosk locations;

wherein the processing server, in response to a request from an application, is configured to provide data to the application or take an action;

wherein when the request is to locate at least one of the plurality of kiosks, the data provided to the application is to enable generation of a map that identifies a current location of an electric vehicle associated with the application and a location of at least one of the plurality of kiosks, the map enables display of at least one route from the current location of the electric vehicle to the location of the at least one of the plurality of kiosks;

wherein when the request is to reserve at least one battery at the at least one of the plurality of kiosks, the processing server takes an action by designating the at least one battery is reserved for a user account associated with the application making the request;

wherein the processing server is configured to receive information from the at least one of the plurality of kiosks when at least one battery is dispense or received;

wherein the electric vehicle is one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle;

wherein the application is processed by a computing device capable of making internet access for communicating with the processing server, the computing device being one of a hand held-device, or a vehicle computer, or a tablet computer, or a smartphone, or a computer.

31. (Previously presented) The system of claim 30, wherein the processing server generates notifications to be sent to the user accounts regarding new discounts, or processes data to modify or set deals provided at certain kiosks, or processes data to set gifts available at particular kiosks, or processes data to update loyalty points for past use of batteries for particular user accounts, or processes data to render a history of use of batteries by particular user accounts, or processes data to determine a carbon footprint from use of the batteries by particular user accounts, or processes data to update or post social network data regarding one or more of the kiosks, or combinations of two or more thereof.

REMARKS

This paper is in response to the Office action of Feb. 19, 2015. In the Office action, the Examiner identified three species, namely:

Species I: Figs. 1, 2, 11, 12, 13b-13d, and 14a

Species II: Figs. 6, 8, 10, 13a, 14b, 15

Species III: Figs. 13e, 16a, 17-23

The Applicants hereby elect Species II. However, upon reading the definition provided for Species II by the Examiner, the Applicants note that Species II include Figs. 6, 8, 10, 13a 14b, 15, and also Figs. 13b-13d, and 14a (grouped with Species I) and Figs. 13e, 16a and 17-23 (grouped with Species III). Based on the Examiner's classification, Species III could include embodiments from Figs. 3, 7 and 10.

Election:

- **Species II**, shall include at least **Figs. 6, 8, 10, 13a, 14b, 15, 13b-13d, and 14a and 13e, 16a and 17-23**, directed toward the system of networked and distributed kiosks for exchanging batteries and applications for user accounts to enable access to obtain batteries from said kiosks.
- **Claims** readable on the elected Species II include **claims 20-31**.

Amendment:

- Claims 1-6 and 10-11 have been canceled, as being directed to Species I and Species III.

If the Examiner has any questions concerning the present amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6903. If any other fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No VOLTP001).

Respectfully submitted,
MARTINE PENILLA GROUP, LLP

/Albert Penilla/

Albert S. Penilla, Esq.
Reg. No. 39,487

710 Lakeway Drive, Suite 200, Sunnyvale, CA 94085, Telephone: (408) 749-6903

Electronic Acknowledgement Receipt

EFS ID:	21598637
Application Number:	13452882
International Application Number:	
Confirmation Number:	6203
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Customer Number:	25920
Filer:	Albert S. Penilla
Filer Authorized By:	
Attorney Docket Number:	VOLTP001
Receipt Date:	25-FEB-2015
Filing Date:	22-APR-2012
Time Stamp:	15:46:12
Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	VOLTP001_Restriction_Response_Efiled.pdf	51148 d3af37442328e137eef7c2aa1ef94e90b8157278	no	9

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/452,882	Filing Date 04/22/2012	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 = *		X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 = *		X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 02/25/2015

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 12	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***4	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/LINDA A. WASHINGTON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

25920 7590 06/17/2015

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EXAMINER	
FANTU, YALKEW	

ART UNIT	PAPER NUMBER
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06/17/2015	PAPER

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The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/452,882	Applicant(s) PENILLA ET AL.	
	Examiner YALKEW FANTU	Art Unit 2859	AIA (First Inventor to File) Status No

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Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 April 2012*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *20-31* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *20-31* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *22 April 2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *01/27/15,01/23/15,12/18/14,10/13/14,5/15/13*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. /.

4) ☐ Other: _____.

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions. The instant application with Application Number 13/452,882 filed on 04/22/2012 is presented for examination.

Election/Restrictions

Applicant's election without traverse of restriction made on 02/19/2015 in the reply filed on 02/25/2015 is acknowledged. As further indicated in the remarks, claims 1-19 have been cancelled. Claims 20-31 are pending.

Information Disclosure Statement

The information disclosure statements filed 12/18/2014, 05/15/2013 and 10/13/2014 fails to comply with 37 CFR 1.98(a)(1), which requires the following: (1) a list of all patents, publications, applications, or other information submitted for consideration by the Office; (2) U.S. patents and U.S. patent application publications listed in a section separately from citations of other documents; (3) the application number of the application in which the information disclosure statement is being submitted on each page of the list; (4) a column that provides a blank space next to each document to be considered, for the examiner's initials; and (5) a heading that clearly indicates that the list is an information disclosure statement. The information disclosure statement has been placed in the application file, but the information referred to therein has not been considered.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

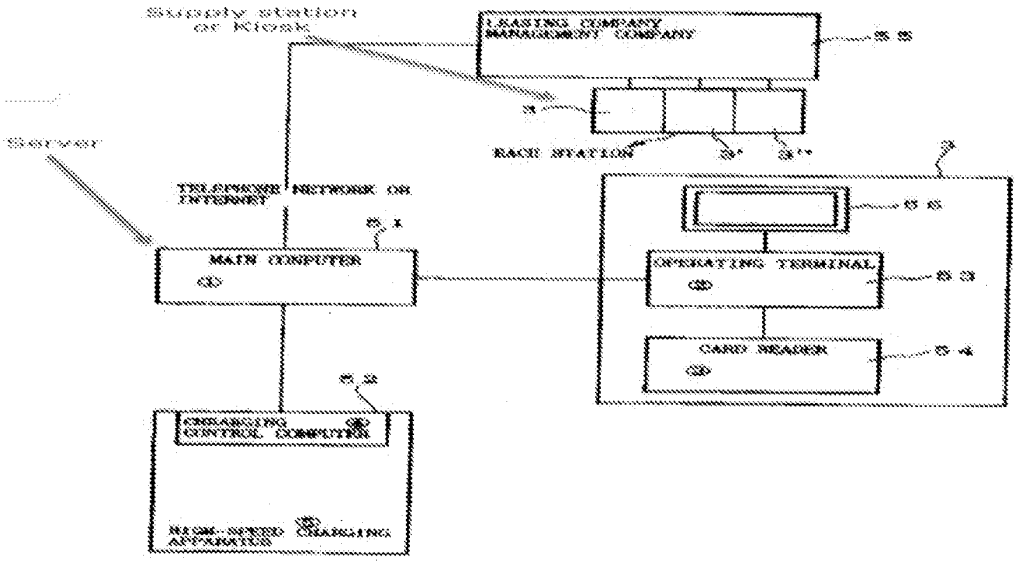
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 20-31 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Suzuki et al (US 2003/0209375) (hereinafter, Suzuki) in view of Agassi et al. (WO2009/039454) (Hereinafter, Agassi).

With respect to claims 20, 21, and 28-30, Suzuki discloses a system for processing batteries usable in electric vehicles, the batteries being exchangeable for charged batteries **(Para. # 0024-0025)**, comprising, (a) a processing server that **(Fig. 5, 51: computer server)**, (i) communicates with a plurality of kiosks having one or more batteries available for use by the electric vehicles **(Fig. 5, Kiosk or station 3, 3', 3"; Para. # 0090)**; (ii) accesses a plurality of user accounts **(Para. # 0079-0080)**; (iii) communicates with a plurality of applications, each of the plurality of applications being executed by a computing device, each of the plurality of applications being associated with a respective user account **(Fig. 6, 62- using communication control; Para. # 0083-0090)**;

Fig 6



wherein the processing server processes requests from one or more of the plurality of applications to locate kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies a least one location of a kiosk proximate to the particular geo-location and availability of batteries for exchange at the kiosk of the at least one location, the processing server further providing information regarding discounts or cost for batteries at the kiosk of the at least one location **(Para. # 0060, 0079-0080)**; wherein each kiosk has a plurality of receptacle slots configured for hand-insertion of batteries into the receptacle slots and hand-removal of batteries out of the receptacle slots, wherein at least one of the receptacle slots of at least one kiosk enables charging of a battery when disposed in the at least one of the receptacle slots **(Para. # 0133- 0135)**; wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle **(see figs. 3A-3D).**

Suzuki, however, does not expressly disclose a database being accessible by the processing server, the database stores and provides access to data regarding the plurality of kiosks and batteries.

Agassi, on the other hand, discloses a database being accessible by the processing server, the database stores and provides access to data regarding the plurality of kiosks and batteries located at respective ones of the plurality of kiosks **(Fig. 19, 1926, 1949 and 1942)**.

SUZUKI and Agassi are analogous art because they are from the same field of endeavor namely Electrical Vehicle Energy Supply System, and Vehicle Network System.

At the time of the invention, it would have been obvious to a person of ordinary skill in the art to have incorporated a database being accessible by the server to the power supply device of SUZUKI in view of the teachings of Agassi. The motivation for doing so would have been obvious in view of the teachings of Agassi that the database is used to store battery status, battery exchange parameters, and general accounts in order to identify the amount of power used, the rate and the corresponding price can be calculated **(see Fig. 19, items 1926, 1940, 1942 and 1944).**

With respect to claim 22, Suzuki discloses, the system as disclosed above, wherein the processing server processes the discounts or cost, wherein at least one of the discounts or cost is set to provide an incentive to obtain batteries where battery excess inventory exists at particular kiosks or provide a disincentive to obtain batteries where battery inventory is low at particular kiosks **(Para. # 0079-0081)**.

With respect to claim 23, Suzuki discloses, the system as disclosed above, wherein the processing server processes the discounts or cost at the plurality of kiosks to maintain a load balancing of inventory of batteries in a geographical region or at particular ones of the plurality of kiosks **(Para. # 0079-0080)**.

With respect to claim 24, Suzuki discloses, the system as disclosed above, wherein batteries include tracking identifiers, the tracking identifiers being used to track

a current location of batteries when in kiosks or at least a last used kiosk for particular batteries **(Para. # 0079 and 0087)**.

With respect to claim 25, Agassi discloses, the system as disclosed above, wherein each kiosk receives electronic payments or at least processes electronic payments in coordination with the processing server from users of the user accounts, wherein records of the electronic payments provide a historical tracking of battery usage for particular accounts or determination of associated discounts for the user accounts based on the historical tracking of battery usage **(See Figures 12-15)**.

With respect to claim 26, Agassi discloses, the system as disclosed above, wherein the processing server is configured to receive reservations of batteries at specific kiosks from applications associated with particular user accounts, the reservation enables confirmation that one or more reserved batteries will be held available at the kiosk when the electric vehicle arrives at the kiosk or for a limited period of time before a reservation is caused to expire **(See Para. # 129-135)**.

With respect to claims 27 and 31, Agassi discloses, the system as disclosed above, wherein the processing server generates notifications to be sent to the user accounts regarding battery availability or discounts, or processes data for rendering one or more of status of batteries in the kiosks, or processes data to determine nearby kiosks relative to a geo-location, or processes data to identify deals provided at certain kiosks, or processes data to make reservations for reserving batteries at a particular kiosks, or processes data to identify gifts available at particular kiosks, or processes

data to identify loyalty points for past use of batteries, or processes data to render a history of use of batteries, or processes data to determine a carbon footprint from use of the batteries, or combinations of two or more thereof **(Para. # 130-144).**

Examiner Notes

Examiner cites particular columns and line numbers in the references as applied to the claims below for convenience of the applicant. Although the specified citations are representative of the teachings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested that, in preparing response, the applicant fully consider the references in its entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the examiner.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YALKEW FANTU whose telephone number is (571)272-8928. The examiner can normally be reached on M-F: 7 - 4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DREW A. DUNN can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/YALKEW FANTU/
Primary Examiner, Art Unit 2859

Notice of References Cited	Application/Control No. 13/452,882	Applicant(s)/Patent Under Reexamination PENILLA ET AL.	
	Examiner YALKEW FANTU	Art Unit 2859	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,548,200 A	08-1996	Nor et al.	320/109
*	B	US-2014/0028255 A1	01-2014	Brimacombe, Bruce	320/109
*	C	US-2003/0209375 A1	11-2003	Suzuki et al.	180/65.3
*	D	US-2009/0304101 A1	12-2009	LoPorto et al.	375/260
*	E	US-7,489,993 B2	02-2009	Coffee et al.	701/32.3
*	F	US-6,940,254 B2	09-2005	Nagamine et al.	320/109
*	G	US-2005/0035741 A1	02-2005	Elder et al.	320/116
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
*	N	WO2009/039454	03-2009	wipo	Agassi et al	
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	5	((Angel) near2 (Penilla)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 15:37
L3	2	"20120330494".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:48
L8	424	701/29.3.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:50
L9	74	8 and (server)(account)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:51
L10	68	9 and (network)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:51
L11	57	10 and (vehicle or car)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:51
L13	16	11 and (charge rate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 15:52
S1	5	((Angel) near2 (Penilla)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 11:40
S2	2883	320/109.ccls.	US-PGPUB; USPAT;	AND	ON	2015/06/14 11:40

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S3	2758	320/104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S4	1753	320/116,339.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S5	185	S4 and ((AC power)(vehicle)(plurality or multiple))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S6	117	S5 and (vehicle)(battery)(voltage detect$3)(control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S7	7	S6 an (second control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S8	3583	180/65.31,69.6,54.1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S9	303	S8 and ((AC power)(vehicle)(plurality or multiple))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S10	127	S9 and (vehicle)(battery)(voltage detect$3)(control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40

S11	2090	307/149.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S12	47	S11 and ((AC power)(vehicle)(plurality or multiple))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S13	26	S12 and (vehicle)(battery)(voltage detect$3)(control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S14	4	US-20030059654-$.DID. OR JP-2006158124-$.DID.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S15	19	US-5099186-$.DID. OR US-6104160-$.DID. OR JP-6292304-$.DID. OR JP-2004173388-$.DID. OR JP-20028673-$.DID. OR JP-4295202-$.DID. OR JP-20018380-$.DID. OR JP-2002247769-$.DID. OR JP-2005210843-$.DID. OR JP-2003264906-$.DID. OR JP-10117444-$.DID. OR JP-2000209707-$.DID. OR JP-11178234-$.DID.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S16	325	((SHINJI) near2 (ICHIKAWA)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 11:40
S17	325	((SHINJI) near2 (ICHIKAWA)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 11:40
S18	179	((TETSUHIRO) near2 (ISHIKAWA)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 11:40
S19	8479	701/22.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S20	1489	S19 and ((AC power)(vehicle)(plurality or multiple))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40

S21	874	S20 and (vehicle)(battery)(voltage detect$3)(control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S22	581	S21 and (AC power)(vehicle)(supply line)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S23	2	US-3020125-$.DID.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S24	6	("20100060231" |7982439|20100315046).pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S25	5994	320/116,339,107.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S26	2100	S25 and (charg$3)(vehicle or automobile or car)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S27	444	S26 and (communication module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S28	35	S27 and (charg$3 near switch)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S29	35	S28 and (charg$3 control)(module)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	ON	2015/06/14 11:40

			DERWENT; IBM_TDB			
S30	24	S29 and (charg$3 mode)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S31	9	S30 and (charg$3 near control)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S32	72	"320"/$.ccls. and (charg$3) (communicat$3 module)(charg$3 near mode)(set$4 mode)(charg$3 near switch) (battery)(vehicle or car)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S33	28	S32 and (charg$3 near control)(power information)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S34	9	S32 and (charg$3 near control)(power near information)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:40
S35	64	(("KI SEOK") near2 (KIM)).INV.	US-PGPUB; USPAT; USOCR	AND	ON	2015/06/14 11:40
S36	24540	y02t90/14.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:51
S37	1052	S36 and ((volt bar) or (charge bar) or (charge slot))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:53
S38	22	S37 and ((volt near bar) or (charge near bar) or (charge near slot))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:53

S39	4017	b60l11/1824.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:56
S40	255	S39 and ((volt bar) or (charge bar) or (charge slot))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:56
S41	255	S40 and ((volt bar) or (charge bar) or (charge slot))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:56
S42	9	S41 and ((volt near bar) or (charge near bar) or (charge near slot))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 11:56
S43	88	US-20110202218-$.DID. OR US-5488283-$.DID. OR US-20120229056-$.DID. OR US-20130020139-$.DID. OR US-8006793-$.DID. OR US-3690397-$.DID. OR US-3799063-$.DID. OR US-4052655-$.DID. OR US-4102273-$.DID. OR US-4347472-$.DID. OR US-4383210-$.DID. OR US-4789047-$.DID. OR US-5202617-$.DID. OR US-5297664-$.DID. OR US-5306999-$.DID. OR US-5315227-$.DID. OR US-5327066-$.DID. OR US-5585205-$.DID. OR US-5701706-$.DID. OR US-5998963-$.DID. OR US-6014597-$.DID. OR US-20090011639-$.DID. OR US-20120041624-$.DID. OR US-20120268076-$.DID. OR US-8366371-$.DID. OR EP-3490104-$.DID. OR US-4450400-$.DID. OR US-5612606-$.DID. OR US-5760569-$.DID. OR US-6498454-$.DID. OR US-20080294283-$.DID. OR US-5449995-$.DID. OR US-5549443-$.DID. OR US-5694019-$.DID. OR US-6940254-$.DID. OR US-7869576-$.DID. OR US-20120306445-$.DID. OR US-8350526-$.DID. OR US-20120316671-$.DID. OR US-20090058355-$.DID. OR US-8256553-$.DID. OR US-20120303397-$.DID. OR US-20110074350-$.DID. OR US-8294420-$.DID. OR US-20130110653-$.DID. OR US-8266075-$.DID.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 13:13
S44	129	US-8521599-$.DID. OR US-8294420-$.DID. OR US-7201384-$.DID. OR US-8836281-$.DID. OR US-8725551-$.DID.	US-PGPUB; USPAT; USOCR;	AND	ON	2015/06/14 13:18

		OR US-5049802-$.DID. OR US-5184058-$.DID. OR US-5343970-$.DID. OR US-5441122-$.DID. OR US-5487002-$.DID. OR US-5492190-$.DID. OR US-5548200-$.DID. OR US-5563491-$.DID. OR US-5594318-$.DID. OR US-5627752-$.DID. OR US-5642270-$.DID. OR US-5736833-$.DID. OR US-5778326-$.DID. OR US-6067008-$.DID. OR US-6081205-$.DID. OR US-6225776-$.DID. OR US-6234932-$.DID. OR EP-3490104-$.DID. OR US-6252380-$.DID. OR US-6285931-$.DID. OR US-6301531-$.DID. OR US-6307349-$.DID. OR US-6373380-$.DID. OR US-6434465-$.DID. OR US-6456041-$.DID. OR US-6466658-$.DID. OR US-6480767-$.DID. OR US-6487477-$.DID. OR US-6614204-$.DID. OR US-6629024-$.DID. OR US-6727809-$.DID. OR US-6789733-$.DID. OR US-6794849-$.DID. OR US-6850898-$.DID. OR US-6915869-$.DID. OR US-7013205-$.DID. OR US-7402978-$.DID. OR US-7698078-$.DID. OR US-7740092-$.DID. OR US-7885893-$.DID. OR US-7956570-$.DID. OR US-7991665-$.DID. OR US-8054048-$.DID. OR US-20020064258-$.DID. OR US-20030137277-$.DID. OR US-20060282381-$.DID. OR US-20060287783-$.DID. OR US-20070126395-$.DID. OR US-20070282495-$.DID. OR US-20080039979-$.DID. OR US-20080040223-$.DID. OR US-20080040295-$.DID. OR US-20080052145-$.DID. OR US-20080086411-$.DID. OR US-20080097904-$.DID. OR US-20080228613-$.DID. OR US-20080312782-$.DID. OR US-20090021213-$.DID. OR US-20090030712-$.DID. OR US-20090082957-$.DID. OR US-20110077809-$.DID. OR US-20090144001-$.DID.	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S74	16	US-20110106329-$.DID. OR US-20110191186-$.DID. OR US-7051458-$.DID. OR US-20100042519-$.DID. OR US-20090174365-$.DID. OR US-20080312782-$.DID. OR US-20120025765-$.DID. OR US-20110175569-$.DID.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2015/06/14 14:28

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	21	((auxiliary battery)(charge unit)(kiosk or store or house)(control)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 15:43
S45	0	((batteri$2)(vehicle)(server)(multiple or plurality)(kiosk or shope or place)(account)	US-PGPUB;	AND	ON	2015/06/14 12:00

		(dtabase)(proximate or near$4)(rate)(vehicle or automobile or car or bicykle)).clm.	USPAT; UPAD			
S60	1	((auxiliary near battery)(charge near unit)(kiosk or store or house)(display)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 12:56
S64	22	((auxiliary near battery)(charge)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 13:04
S70	57	((auxiliary near battery)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 13:10
S71	88	((auxiliary battery)(charge)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 13:10
S72	104	((auxiliary battery)(charge)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 13:10
S73	183	((auxiliary near battery)(charge)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/14 13:11

6/14/2015 4:09:15 PM
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Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	*Complete if Known*	
	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	
	Examiner Name	
	Attorney Docket Number	VOLTP001

U.S. Patent Documents

Examiner Initials	Initials	Reference	REF. NO.	
Examiner Initials		US8818622	Reference No.	1
Examiner Initials		US8818725	Reference No.	2
Examiner Initials		US8819414	Reference No.	3
Examiner Initials		US8825222	Reference No.	4
Examiner Initials		US8799037	Reference No.	5
Examiner Initials		US8816845	Reference No.	6
Examiner Initials		US8751065	Reference No.	7
Examiner Initials		US8751271	Reference No.	8
Examiner Initials		US8760432	Reference No.	9
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Examiner Initials		US8624719	Reference No.	18
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Examiner Initials		US8527146	Reference No.	21
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Examiner Initials		US8027843	Reference No.	40

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	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	
	Examiner Name	
	Attorney Docket Number	VOLTP001

Examiner Initials		US7778746	Reference No.	41
Examiner Initials		US7796052	Reference No.	42
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	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	
	Examiner Name	
	Attorney Docket Number	VOLTP001

Examiner Initials		US5691695	Reference No.	83
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Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	
				Examiner Name	
				Attorney Docket Number	VOLTP001

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				First Named Inventor	Angel Penilla
				Art Unit	
				Examiner Name	
				Attorney Docket Number	VOLTP001

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Examiner Initials		US20100049610	Reference No.	206
Examiner Initials		US20100017045	Reference No.	207

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				First Named Inventor	Angel Penilla
				Art Unit	
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Examiner Initials		US20100017249	Reference No.	208
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Examiner Initials		US20030205619	Reference No.	249

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	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	
	Examiner Name	
	Attorney Docket Number	VOLTP001

Examiner Initials		US20030234325	Reference No.	250
Examiner Initials		US20020085043	Reference No.	251
Examiner Initials		US20020133273	Reference No.	252

Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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BIB DATA SHEET

CONFIRMATION NO. 6203

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/452,882	04/22/2012 RULE	320	2859	VOLTP001

APPLICANTS

INVENTORS

Angel A. Penilla, San Jose, CA;
Albert S. Penilla, Sunnyvale, CA;

**** CONTINUING DATA ***************************

This appln claims benefit of 61/478,436 04/22/2011

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
05/01/2012

Foreign Priority claimed	❑ Yes ☑ No	❑ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	❑ Yes ☑ No		CA	40	1	1
Verified and Acknowledged	/YALKEW FANTU/ Examiner's Signature	Initials				

ADDRESS

MARTINE PENILLA GROUP, LLP
710 LAKEWAY DRIVE
SUITE 200
SUNNYVALE, CA 94085
UNITED STATES

TITLE

ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

FILING FEE RECEIVED		
740	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other _____ ❑ Credit

BIB (Rev. 05/07).

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	Attorney Docket No:	13/452,882
	VOLTP001	
	Applicant: Angel Penilla	
	Filing Date: April 22, 2012	Group:

Other Documents

Examiner		
Initial	No.	Author, Title, Date, Place (e.g. Journal) of Publication
	A	Angel Penilla, Related Application Specification for U.S. Application No. 14/595,186, filed Jan. 12, 2015
	B	Angel Penilla, Related Application Specification for U.S. Application No. 14/599,541, filed Jan. 18, 2015
	C	Angel Penilla, Related Application Specification for U.S. Application No. 14/602,256, filed Jan. 21, 2015

Examiner	Date Considered
/Yalkew Fantu/	06/14/2015

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /Y.F./

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	
				Examiner Name	
				Attorney Docket Number	VOLTP001

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Examiner Initial	Patent	Issue Date	Inventor(s)
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				Attorney Docket Number	VOLTP001

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				Examiner Name	
				Attorney Docket Number	VOLTP001

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/Yalkew Fantu/ 06/14/2015

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PTO/SB/08A(08-03)

Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	1	of	2	Attorney Docket Number	VOLTP001

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Examiner Signature		Date Considered	

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Substitute for form 1449/PTO	Complete if Known

[1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by two-letter code (WIPO Standard ST.3). [4]For Japanese patent documents, the indication of the year of the reign of Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6]Applicant is to place a check mark here if English language translation is attached.

PTO/SB/08A(08-03)

				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	2	of	2	Attorney Docket Number	VOLTP001

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Examiner Initials	US Patent/Application	
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Examiner Signature		Date Considered	

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PTO/SB/08A(08-03)

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				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	1	of	2	Attorney Docket Number	VOLTP001

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				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	2	of	2	Attorney Docket Number	VOLTP004

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Examiner Initials	US Patent/Application	
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13452882	PENILLA ET AL.
	Examiner	Art Unit
	YALKEW FANTU	2859

CPC- SEARCHED		
Symbol	Date	Examiner
Y02T	06/11/2015	YF

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner
Y02T90/14	06/121/2015	YF

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
320	109,107,104	06/11/2015	YF
180	65.1, 65.21	06/11/2015	YF
307	10.1	06/11/2015	YF
701	22	06/11/2015	YF

SEARCH NOTES		
Search Notes	Date	Examiner
320/109,116,339;180/65.1,65.21;307/10.1,149;701/22 with text search was conducted	06/11/2015	YF
Inventor's search in PALM and eDAN was codnucted	06/11/2015	YF
foreign and IDS search was conducted	06/11/2015	YF
interference search was codncuted	06/11/2015	YF
EAST Search (See Printout)	06/11/2015	YF
PLUS search was copndcuted	06/11/2015	YF

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
320/Y02T	109/ 90/14	03/19/2015	YF

	/YALKEW FANTU/ Primary Examiner.Art Unit 2859

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	2859
				Examiner Name	Fantu, Yalkew
				Attorney Docket Number	VOLTP001

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Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	2859
				Examiner Name	Fantu, Yalkew
				Attorney Docket Number	VOLTP001

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Angel A. Penilla

Application No: 13/452,882

Filed: April 22, 2012

For: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

Group Art Unit: 2859

Examiner: Yalkew Fantu

Atty. Docket No: VOLTP001

Date: June 22, 2015

AMENDMENT

Honorable Commissioner for Patents
Alexandria VA 22313-1450

Dear Madam:

This paper is in response to the Office action of June 17, 2015. Please enter this amendment and remarks.

Amendments to the specification are reflected on page 2.

Amendments to the claims are reflected in the listing of claims which begin on page 7 of this paper.

Remarks/Arguments begin on page 15 of this paper.

IN THE SPECIFICATION

Please amend the specification as follows:

[0087] It should be understood that any number of volt bar's 20 can be installed in an auxiliary battery carrier 16. The larger the auxiliary battery carrier 16 becomes, the heavier the carrier will be for human **lifting** ~~**listing**~~ and installation. If the auxiliary battery carrier 16 is designed for commercial purposes, auxiliary battery carrier 16 can be defined to have a larger footprint, and can be installed using suitable machinery. For example, auxiliary battery carrier 16 can be defined for use in construction vehicles, and the number of volt bars 20 capable of being installed in a larger auxiliary battery carrier 16 can be numerous. To handle the increase in weight, specialized vehicles, or standard construction vehicles (e.g. forklifts) can be used to lift auxiliary battery carrier 16 into and out of vehicle 10. Thus, the size of auxiliary battery carrier 16 is modular, and can be made to receive more or less volt bars 20. In still another embodiment, the size of volt bars 20 can be varied, such that larger sized volt bars 20 can be inserted into a suitably sized auxiliary battery carrier 16 having associated slots.

[00113] Again, CPU 31 can be used to control the charge flow between the main battery 14 and auxiliary battery carrier 16. In some embodiments, CPU 31 will direct that no charge between the two systems will occur, and the auxiliary battery carrier will directly supply charge to the electric motor for power. As such, it is not necessary that the auxiliary battery carrier be directly or indirectly connected to main battery 14, as vehicles can provide their own separate connection between the auxiliary battery carrier 16 and the electric motor. It is again noted that the auxiliary battery carrier 16 can be integrated as part of the **vehicle** **[[car]],** by way of a plurality of slots defined in some compartment on the vehicle. Those particular slots can then be coupled to the electric motor, or coupled to the main battery, or both.

[00218] Potentially, the owners of the particular business that sponsored the discounts can increase traffic to their business and increase sales. In another embodiment, the owners of the particular business can offer discounts to their business products or services, if the business products or services or located near or beside the charging station. As will be described below, other embodiments can

include having charging station pumps or handles or plugs, located in nontraditional charging station configurations. For example, charging plugs can be installed at various nontraditional locations, such as parking lots of retail stores. Other examples locations can include, without limitation, parks, city streets, parking garages, post offices, government areas, schools, **office** ~~**offices**~~ complexes or campuses, coffee shops, malls, strip malls, box store parking lots, beach parking, homes, public roads, etc. If a large retail store has a large parking lot, a portion of that parking lot can be dedicated for charging plugs, which can be used by customers while the customers shop at the retail location. In such a situation, the owners of the retail store that have charging plugs assigned to particular parking spots, can publish availability of those charging plugs through the cloud processing network.

[00221] If the charging plug is reserved, no other user can park in front of the parking spot, or else **will receive** ~~**received**~~ a ticket or fine for parking in a parking spot that's been reserved. The parking spot reservation for charge can be made in advance, such as while user is driving around looking for charge and the reservation is made by smart phone, or an integrated device of the vehicle that has access to the Internet. The transaction can also allow a user that is searching for charge to prepay for the charge using a graphical user interface or other exchange mechanism, associated with the route and reservation of a particular charge station or slot. In some embodiments, the charge stations or plugs can be placed in shared parking lots or locations where multiple retail outlets reside.

[00234] This path would then generate a recommendation to the user to charge the vehicle at charging **station** ~~**stations**~~ C1. In another embodiment, the user may wish to traverse the path between A and B, but receive some sponsored assistance in the charge or discount on a good or service. In this example, the system can generate a path between A and B, where the user may stop and charge at charging station C2 (or plug location). In this embodiment, the system will calculate that the user can traverse from point A to C2 with the current charge availability in the vehicle, and then arrive at point B. In another embodiment, the user may wish to select a different path 2, which is also a sponsored path that takes the user to charging stations or plugs C3 and C4, before reaching point B.

[00237] The drivers can also be provided with information of the duration of the discount, so that drivers can obtain the discount if they have the time to **traverse** ~~**traversed**~~ the path, or avoid the path if the discount will not be present when the driver arrives at that application. In another embodiment, the logic in the vehicle or the processing system in the cloud processing can determine whether or not the user would be able to arrive at each of the charging stations or plugs to receive the sponsor discounts. This analysis can include, for example, reviewing traffic patterns, travel speeds and estimates to traversed the different distances, time of day, etc.

[00237] In another embodiment, the user may select to **traverse** ~~**traversed**~~ path 3, which takes the user to charge provider C5 and C6 before progressing on path B. In this illustration, it is shown that the user must go off path to travel to charge C6. However, it may be more beneficial for the user to travel to charge C6, as that location is offering a larger discount. In some embodiments, even though the user travels off path, the discounts offset the cost of going off path. In some embodiments, going off path can actually be faster if the particular charge stations or pumps or plugs are more available and there is less wait. In still another embodiment, the user may not actually have a path in mind, and the user may select to simply obtain charge and would be provided with path 4.

[00238] In this example, the users looking to charge the vehicle along a path that is sponsored. A currently sponsored path may be to charge C7. The user can be provided with an option of charge discounts, which can include discounting the cost of the charge itself, or discounts to retail or service providers that are proximate to the charge outlet. In such an embodiment, the data can be provided to the display of the **user's** ~~**users**~~ car or vehicle, or can be provided to the **user's** ~~**users**~~ device. For example, if the user wishes to obtain charge, and the **user is** ~~**users**~~ currently sitting in his or her office, (and the car is in the parking lot) the user can select it obtain a sponsored path to obtain charge. That sponsored path can identify the closest station, or a number of stations or plugs their offering particular discounts.

[00241] Again, the information displayed to the user can be displayed in the vehicle's display screen or can be displayed on the users display device (e.g. smart phone, computer, tablet, etc.). In this example, path 1 can be selected such that the user simply wishes to obtain charge and the path is not a sponsored path. In this example, the user is provided with information, such as the mapping of the path, whether the reward or sponsor is provided, the estimated trip time with charge **stop** ~~**stopped**~~, and estimated cost. This information is generated dynamically for the particular point in time when the user wishes to obtain charge. In path 1, the number stops is still 1, but the sponsored path is sponsored by big coffee company.

[00244] Big coffee company is providing a $1 off the charge bill (or a free coffee or discount on coffee), and the estimated time with charge **stop** ~~**stopped**~~ is 5 min. This example would be one where the user simply wishes to obtain charge now, but also wishes to obtain a discount. Map information (e.g., dynamically generated maps (street and satellite) on a display using internet provider data) can also be displayed on the users device or vehicle display, including any other options and discounts provided. This information can be provide using a global positioning map, with turn by turn directions, voice directions, voice activation, etc. Voice input and voice output is also possible for providing information regarding the sponsored paths. As the discounts changed during the day or different times, the different map options can also change. The providers of the discounts can also dynamically change your discounts over time based on the desired need to drive traffic to their locations or charge spots.

[00245] Accordingly, the generated maps/paths for users are incentivized to provide the user with the desired sponsored path for obtaining charge. Broadly speaking and without limitation, obtaining charge will include plugging the vehicle into a charging receptacle so as to charge the native battery of the vehicle. In another embodiment, obtaining charge can also include refilling on volt bars to replenish volt bars that have been used during the vehicle usage. In other embodiments, charge can be transferred to a vehicle wirelessly (e.g., without plugging in an outlet or receptacle). Examples can include a transfer surface that the vehicle ~~**parts**~~ **parks** over, and the charge can be transferred wirelessly to the

vehicle via conductors on the underside of the vehicle. The vehicle can simply **park** ~~**part**~~ in the slot and once payment is made, the charge can start to flow capacitively or wirelessly to the electric vehicle.

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1.-19. (Cancel)

20. (Currently amended) A method for providing information regarding batteries available for use by electric vehicles, comprising:

(a) providing access to a processing server that communicates ~~locally or~~ over a network with,

(i) a plurality of kiosks having one or more batteries with charge available for exchange with batteries with reduced charge, the batteries of the kiosks being for use by the electric vehicles to power electric motors of the electric vehicles, each of the plurality of kiosks having a computer that is configured to communicate with the processing server;

(ii) a plurality of user accounts that are accessible ~~accessed~~ via computing devices of users for accessing the processing server, the plurality of user accounts being associated with users that registered to access ~~obtain~~ the information regarding the batteries and enable access to exchange at least one battery at one of the plurality of kiosks; and

(b) providing the processing server with access to a database that stores data or update data regarding one or more of the plurality of kiosks and the information regarding the batteries located and available at each of the plurality of kiosks;

wherein the processing server receives requests from one or more of the plurality of user accounts via one or more computing devices to locate one or more kiosks proximate to a particular geo-location, and in response to each request, the

processing server identifies at least one location having a kiosk proximate to the particular geo-location and identifies availability of batteries at the kiosk of the identified location, the processing server further identifying discounts or rates chargeable for batteries at the kiosk of the identified location ~~or other kiosks of the plurality of kiosks~~;

wherein each of the plurality of kiosks is part of a network of geographically dispersed kiosks that are each configured for communication availability of batteries to [[with]] the processing server, the processing server communicates with respective computers of the plurality of kiosks to collect and receive ~~collects or receives~~ information from each of the plurality of kiosks and to forward ~~forwards~~ instructions to ones of the plurality of kiosks,

wherein the instructions forwarded by the processing server include a reservation instruction for reserving at least one battery in response to the processing server receiving a reservation request for at least one battery of the batteries identified to be available,

wherein the processing server is further configured to process requests for information regarding particular kiosks and provide data to enable generation of routing options to one or more of the plurality of kiosks, the requests being received by the processing server from one or more of the computing devices which include one or more of hand held-devices, or computers, or vehicle computers, or tablet computers, or smartphones;

wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

21. (Currently amended) A system for processing batteries usable in electric vehicles, the batteries being exchangeable for charged batteries, comprising,

(a) a processing server that,

(i) communicates with a plurality of kiosks having one or more batteries available for use by the electric vehicles, each of the plurality of kiosks includes a computer;

(ii) accesses a plurality of user accounts;

(iii) communicates with a plurality of applications, each of the plurality of applications being executed by a computing device, each of the plurality of applications being associated with a respective user account;

(b) a database being accessible by the processing server, the database stores and provides access to data regarding the plurality of kiosks and batteries located at respective ones of the plurality of kiosks;

wherein the processing server processes requests from one or more of the plurality of applications to locate kiosks proximate to a particular geo-location, and in response to each request, the processing server identifies a least one location of a kiosk proximate to the particular geo-location and availability of batteries for exchange at the kiosk of the at least one location, the processing server further providing information regarding discounts or cost for batteries at the kiosk of the at least one location, the processing server further manages the plurality of user accounts to process requests to exchange at least one battery from at least one of the plurality of kiosks;

wherein each kiosk has a plurality of receptacle slots configured for hand-insertion of batteries into the receptacle slots and hand-removal of batteries out of the receptacle slots, wherein at least one of the receptacle slots of at least one kiosk enables charging of a battery when disposed in the at least one of the receptacle

slots;

wherein the computer of each kiosk is configured to release one or more of the batteries for hand-removal and hand-insertion based in part on communication between an electric vehicle having at least one battery and a kiosk, the communication acts to in part confirm validity of requests and to release at least one battery from the at least one of the plurality of kiosks.

22. (Previously presented) The system of claim 21, wherein the processing server processes the discounts or cost, wherein at least one of the discounts or cost is set to provide an incentive to obtain batteries where battery excess inventory exists at particular kiosks or provide a disincentive to obtain batteries where battery inventory is low at particular kiosks.

23. (Previously presented) The system of claim 21, wherein the processing server processes the discounts or cost at the plurality of kiosks to maintain a load balancing of inventory of batteries in a geographical region or at particular ones of the plurality of kiosks.

24. (Previously presented) The system of claim 21, wherein batteries include tracking identifiers, the tracking identifiers being used to track a current location of batteries when in kiosks or at least a last used kiosk for particular batteries.

25. (Previously presented) The system of claim 21, wherein each kiosk receives electronic payments or at least processes electronic payments in coordination with the processing server from users of the user accounts, wherein records of the electronic payments provide a historical tracking of battery usage for particular

accounts or determination of associated discounts for the user accounts based on the historical tracking of battery usage.

26. (Previously presented) The system of claim 21, wherein the processing server is configured to receive reservations of batteries at specific kiosks from applications associated with particular user accounts, the reservation enables confirmation that one or more reserved batteries will be held available at the kiosk when the electric vehicle arrives at the kiosk or for a limited period of time before a reservation is caused to expire.

27. (Previously presented) The system of claim 21, wherein the processing server generates notifications to be sent to the user accounts regarding battery availability or discounts, or processes data for rendering one or more of status of batteries in the kiosks, or processes data to determine nearby kiosks relative to a geo-location, or processes data to identify deals provided at certain kiosks, or processes data to make reservations for reserving batteries at a particular kiosks, or processes data to identify gifts available at particular kiosks, or processes data to identify loyalty points for past use of batteries, or processes data to render a history of use of batteries, or processes data to determine a carbon footprint from use of the batteries, or combinations of two or more thereof.

28. (Previously presented) The system of claim 21, wherein each of the kiosks is part of a network of geographically dispersed kiosks that are each capable of being in communication with the processing server, and the processing server collects information from each of the kiosks and forwards programming or instructions to each or select ones of the kiosks, the processing server is further configured to make

available options for requesting selected information regarding particular kiosks to the applications.

29. (Previously presented) The system of claim 21, wherein the electric vehicles are one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle, or a motorcycle, or a car, or a truck, or a pickup, or a utility car, or a delivery vehicle, or an industrial vehicle.

30. (Currently amended) A system of a network of distributed kiosks for exchanging batteries usable to power an electric motor of an electric vehicle, comprising,

a plurality of kiosks being part of the network of distributed kiosks, wherein each of the plurality of kiosks is associated with a respective geo-location, wherein each kiosk has a plurality of slots for holding at least one battery, the at least one battery having a form factor to fit in the plurality of slots of the kiosks and at least one slot of the electric vehicle, wherein each of the plurality of kiosks having a computer;

a processing server for communicating with the computer of each of the plurality of kiosks and a plurality of applications, each of the plurality of applications being associated with a respective user account that is setup for enabling access to the server for locating particular ones of the plurality of kiosks and receiving information regarding availability of batteries at particular ones of the plurality of kiosk locations;

wherein the processing server, in response to a request from an application, is configured to provide data to the application or take an action;

wherein when the request is to locate at least one of the plurality of kiosks, the data provided to the application is to enable generation of a map that identifies a current location of an electric vehicle associated with the application and a location of at least one of the plurality of kiosks, the map enables display of at least one route from the current location of the electric vehicle to the location of the at least one of the plurality of kiosks;

wherein when the request is to reserve at least one battery at the at least one of the plurality of kiosks, the processing server takes an action by designating the at least one battery as [[is]] reserved for a user account associated with the application making the request;

wherein the processing server is configured to receive information from the at least one of the plurality of kiosks when at least one battery is dispensed ~~dispense~~ or received;

wherein the electric vehicle is one of a two-wheel vehicle, or a three-wheel vehicle, or a four-wheel vehicle;

wherein the application is processed by a computing device capable of making internet access for communicating with the processing server, the computing device being one of a hand held-device, or a vehicle computer, or a tablet computer, or a smartphone, or a computer.

31. (Previously presented) The system of claim 30, wherein the processing server generates notifications to be sent to the user accounts regarding new discounts, or processes data to modify or set deals provided at certain kiosks, or processes data to set gifts available at particular kiosks, or processes data to update loyalty points for past use of batteries for particular user accounts, or processes data to render a history of use of batteries by particular user accounts, or processes data to determine

a carbon footprint from use of the batteries by particular user accounts, or processes data to update or post social network data regarding one or more of the kiosks, or combinations of two or more thereof.

32. (New) The system of claim 29,

wherein the processing server is configured to receive a reservation of one or more available batteries for a specific kiosk from an application associated with one of the plurality of user accounts;

wherein the processing server is configured to send instructions to the specific kiosk to enable a hold of one of more of the available batteries at the specific kiosk, the hold associated with the reservation having an expiration time.

33. (New) The system of claim 29, wherein the processing server processes data to update or post social network data regarding one or more of the kiosks or battery availability or discounts or promotions.

34. (New) The method of claim 20, wherein an expiration time is associated with the reserving of the at least one battery.

35. (New) The system of claim 30, wherein an expiration time is associated with the at least one battery that is reserved.

REMARKS

This paper is in response to the Office action of June 16, 2015. Reconsideration is respectfully requested. Minor typographical amendments were made to the Specification. No new matter has been introduced by way of this amendment. New dependent claims 32-35 have been added.

Information Disclosure Statement (IDS)

An IDS is being filed with this response. This IDS is a re-submission of references cited in an earlier IDS, but were not considered due to improper format. The newly filed IDS includes all of the identifying information, as required by the rules. Accordingly, the Examiner is respectfully requested to consider the IDS in responding to this Office action.

Examiner Interview Summary

An Examiner Interview was conducted on June 18, 2015. In the Interview, discussion has had regarding cited art to Suzuki et al. and Agassi et al. Further discussion was had regarding suggested claim amendments. In particular, discussion was had regarding certain features, which are believed to be patentable over the combination of the cited art. Without limitation to other patentable features, discussion was had regarding a reservation function that enables users to reserve batteries at kiosks. Other feature discussed was with regard to server processing and communication with kiosk computers, and processes to obtain battery availability data. Still further, discussion was had regarding communication with kiosks to validate requests to exchange batteries, so that batteries can be dispensed and accessed by hand. These features have been added to some of the claims, and reconsideration is respectfully requested in light of the amended claims and additional remarks presented below.

In the Interview, agreement was reached that the presented amendments overcame the present rejection. The Examiner indicated that he would need to conduct a new search and consider the art in the IDS that is being resubmitted, before determining if allowance is appropriate.

Related Applications

The Applicant wishes to bring to the Examiner's attention the pendency of three other related continuation applications. These applications include Application Numbers: **14/595,186**, **14/599,541**, and **14/602,256**. Each of these applications are continuations of the present applications and share the same specification. As obviousness-type double patenting is considered based on comparison on the claims, the Applicant submits that a terminal disclaimer is not needed.

The Examiner is however kindly requested to opine if a terminal disclaimer is needed based on his analysis. If one is needed, the Applicant will electronically file a terminal disclaimer to obviate any obviousness-type double patenting issues.

Rejection under 35 USC 103

Claims 20-31 were rejected under 35 USC 103 over Suzuki et al. (US 2003/0209375) (hereinafter, Suzuki) in view of Agassi et al. (WO2009/039454) (hereinafter, Agassi). This rejection is respectfully traversed in light of the clarifying amendments presented herein and associated remarks.

Suzuki teaches a battery supply apparatus, wherein vehicles can drive to certain stations 3 to obtain batteries. The vehicles are configured to enter the energy supply stations, where part or all of the batteries are removed and replaced. See ¶025. Drivers locate the stations by driving along paths of travel or nearby. There is no teaching regarding methods for locating stations, nor teachings regarding searching for batteries, nor receiving information regarding available batteries at the stations. In the teachings of Suzuki, users can have membership cards, and in order to obtain batteries, the user need to enter their card into card readers. See ¶59, ¶85. Once a user arrives at a station, a transport robot is used to remove the cassette batteries 2 and are inserted into shelves of a storage space 12. See ¶99, ¶103. As indicated in paragraph ¶100, the user does not need to be involved in the battery exchange, as a robot will do the work. See also ¶104. Further, the system shown in Figure 5 of Suzuki does not teach any communication or process for allowing user devices to access the server to get or access battery availability at specific stations. The communication is only between the stations 3

and the leasing company 55. The Applicant therefore submits that more features are missing than what was noted on page 5 of the Office action.

The Examiner is using Agassi to teach features not present in Suzuki. Agassi relates to systems to enable vehicles to swap batteries at battery swapping stations. The stations enable drivers to pull into a station wherein a battery can be mechanically installed on the vehicle. A positioning system is used to install the battery for the user. The system of Agassi also discusses reserving time at a station, so that the vehicle can have its battery replaced.

In claim 20 and claim 30, the Applicant recite methods and systems for making reservations for batteries, which are available, not time. Claim 20 was amended to recite that instructions are forwarded by the processing server and they include a reservation instruction for reserving at least one battery in response to the processing server receiving a reservation request for at least one battery of the batteries identified to be available. Claim 30 already recites the battery reservation feature. In addition to the other features recited in claim 20, when viewed as a whole, provide for the ability to locate kiosks and also make reservations for batteries at kiosks; wherein the battery or batteries reserved, will be available to the user when the user arrives at the kiosk. In Agassi, batteries are stocked in stations, but the user is limited to reserving time. The reason time needs to be reserved, as described throughout Agassi, is that a user needs to be able to access an open bay in which the vehicle will be serviced. The service, as noted above, requires a positioning system to remove the battery and install a new battery (e.g., typically from below ground). Thus, even if a user were to know that batteries are available at a service station, the main concern for the user is that the service station has the time to mechanically service the removal and installation. For this reason, Agassi limits is reservation function to time, as time for servicing is critical to the mechanical removal by its positioning systems.

In claim 21, an amendment was made to recite another feature. This feature recites that the computer of each kiosk is configured to release one or more of the batteries for hand-removal and hand-insertion based in part on communication between an electric vehicle having at least one battery and a kiosk. The

communication acts to in part to validate requests and release at least one battery from the at least one of the plurality of kiosks. As described throughout the specification, communication is provided with user devices, vehicles, servers managing the kiosks, and computing systems of the kiosks. This communication enables the validity of requests. In contrast to the embodiments of Suzuki and Agassi that require mechanical removal and insertion, claim 21 recites hand-removal and insertion. Because batteries can be hand removed and inserted, battery requests need to verified and batteries released in such a way that batteries are not stolen or removed when not authorized to do so. Support for these features are described throughout the specification and drawings, in for example, paragraphs ¶¶ 38, 50, 53, 59, 60, 128, 129, 130, 150 165, 175, 186, 201, etc. of the as-filed application. It is respectfully submitted that the features of claim 21, as a whole, are not taught nor suggested by Suzuki and Agassi.

For at least these reasons, the Examiner is respectfully requested to withdraw the Section 103 rejections of independent claims 20, 21, and 30.

The Applicant has added new dependent claims 32-35. These dependent claims are believed to be patentable over the cited art of record for at least the same reasons discussed above, and additionally in light of the features described therein.

A Notice of Allowance is respectfully requested.

If the Examiner has any questions concerning the present amendment, the Examiner is kindly requested to contact the undersigned at (408) 749-6903. If any other fees are due in connection with filing this amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No VOLTP001).

Respectfully submitted,
MARTINE PENILLA GROUP, LLP

/Albert Penilla/

Albert S. Penilla, Esq.
Reg. No. 39,487

710 Lakeway Drive, Suite 200, Sunnyvale, CA 94085, Telephone: (408) 749-6903

Electronic Patent Application Fee Transmittal

Application Number:	13452882
Filing Date:	22-Apr-2012
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Filer:	Albert S. Penilla
Attorney Docket Number:	VOLTP001

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Claims in excess of 20	2202	4	40	160
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
		Total in USD ($)		**250**

Electronic Acknowledgement Receipt	
EFS ID:	22697319
Application Number:	13452882
International Application Number:	
Confirmation Number:	6203
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Customer Number:	25920
Filer:	Albert S. Penilla
Filer Authorized By:	
Attorney Docket Number:	VOLTP001
Receipt Date:	22-JUN-2015
Filing Date:	22-APR-2012
Time Stamp:	13:45:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$250
RAM confirmation Number	10683
Deposit Account	500805
Authorized User	PENILLA, ALBERT S.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS_June2015_Efiled.pdf	20298 9df0bb50efd7607de01bb83bdff378e0e9d2caf5	no	1
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IDS1449_June2015.pdf	129297 3ec14a036d740afbeeb3cab0d2f3ec5569e12855	no	10
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Amendment/Req. Reconsideration-After Non-Final Reject	VOLTP001_OA_Response_6222015_Efiled.pdf	90734 460d07d2c9beab5f071f29abb8145c4aaa8a0f4d	no	18
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32792 b661715722b6fe014f6181dc88b5280a68491cf6	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	273121		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Angel A. Penilla

Application No: 13/452,882

Filed: April 22, 2012

For: Electric Vehicle (EV) Range Extending Charge Systems, Distributed Networks of Charge Kiosks, and Charge Locating Mobile Apps

Group Art Unit: 2859

Examiner: Yalkew Fantu

Atty. Docket No: VOLTP001

Date: June 22, 2015

Conf. No. 6203

CERTIFICATE OF E-FILING

I hereby certify that this correspondence is being transmitted to the United States Patent and Trademark Office via electronic filing with EFS-Web on **June 22, 2015.**

_____/Albert Penilla/_____

Albert Penilla

INFORMATION DISCLOSURE STATEMENT
UNDER 37 CFR §§1.56 AND 1.97(c)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The references listed in the attached PTO Form 1449, may be material to examination of the above-identified patent application. Applicant submits these references in compliance with his duty of disclosure pursuant to 37 CFR §§1.56 and 1.97. The Examiner is requested to make these references of official record in this application.

This Information Disclosure Statement (IDS) is not to be construed as a representation that a search has been made, that additional information material to the examination of this application does not exist, or that these references indeed constitute prior art.

This Information Disclosure Statement is being filed after a first Office action. The filing fee is being filed via EFS web. However, if it is determined that any fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-0805 (Order No. VOLTP001)

Respectfully submitted,

MARTINE PENILLA GROUP, LLP
/Albert Penilla/
Albert S. Penilla, Esq.
Reg. No. 39,487

710 Lakeway Drive, Suite 200
Sunnyvale, CA 94085
Telephone: (408) 749-6900 **Customer Number 25920**

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/452,882	Filing Date 04/22/2012	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 06/22/2015	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***4	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/TAMIE JARRETT/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

25920 7590 07/08/2015

MARTINE PENILLA GROUP, LLP
710 LAKEWAY DRIVE
SUITE 200
SUNNYVALE, CA 94085

EXAMINER
FANTU, YALKEW

ART UNIT	PAPER NUMBER
2859	

DATE MAILED: 07/08/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

TITLE OF INVENTION: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	10/08/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

25920 7590 07/08/2015
MARTINE PENILLA GROUP, LLP
710 LAKEWAY DRIVE
SUITE 200
SUNNYVALE, CA 94085

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

TITLE OF INVENTION: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	10/08/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
FANTU, YALKEW	2859	320-109000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

25920 7590 07/08/2015

MARTINE PENILLA GROUP, LLP
710 LAKEWAY DRIVE
SUITE 200
SUNNYVALE, CA 94085

EXAMINER	
FANTU, YALKEW	

ART UNIT	PAPER NUMBER
2859	

DATE MAILED: 07/08/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/452,882	Applicant(s) PENILLA ET AL.	
	Examiner YALKEW FANTU	Art Unit 2859	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *06/22/2015*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *20-35*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 06/22/15,1/23/15,5/15/13,10/13/14,12/18/14
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/YALKEW FANTU/
Primary Examiner, Art Unit 2859

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions. As per applicant amendments and remarks filed on 06/22/2015, claims 1-19 were previously cancelled; claims 32-35 are added.

REASONS FOR ALLOWANCE

The following is the examiner's statement of reasons for allowance. The prior art, and any art of record does not disclose or suggest the following Claims 20, 21 and 30 limitations: " … providing information regarding batteries for electric vehicle …**providing access to a processing server that communicates over a network with a plurality of kiosks having one or more batteries with charge available for exchange with batteries with reduced charge … each of the plurality of kiosks having a computer that is configured to communicate with the processing server … a plurality of user accounts that are accessible via computing devices of users for accessing the processing server, the plurality of user accounts being associated with users that registered to access the information regarding the batteries and enable access to exchange at least one battery at one of the plurality of kiosks …. providing the processing server with access to a database that stores data or update data regarding one or more of the plurality of kiosks and the information regarding the batteries located and available at each of the plurality of kiosks, where the processing server receives requests from one or more of the plurality of user accounts via one or more of computing devices to locate one or more kiosks proximate to a particular go-location**, and in response to each request the

processing server identifies at least one location having a kiosk proximate to the particular geo-location and identifies availability of batteries the kiosk ....” in combination with the remaining claim elements as set forth in claims 20, 21 and 30 and their depending claims 34, 22-29, 32-33 and 31-35. *Therefore c*laims 20-35 are allowed.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YALKEW FANTU whose telephone number is (571)272-8928. The examiner can normally be reached on M-F: 7 - 4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, DREW A. DUNN can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/YALKEW FANTU/
Primary Examiner, Art Unit 2859

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13452882	PENILLA ET AL.
	Examiner	Art Unit
	YALKEW FANTU	2859

CPC- SEARCHED		
Symbol	Date	Examiner
Y02T	06/11/2015	YF

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner
Y02T90/14	06/121/2015	YF

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
320	109,107,104	06/11/2015	YF
180	65.1, 65.21	06/11/2015	YF
307	10.1	06/11/2015	YF
701	22	06/11/2015	YF

SEARCH NOTES		
Search Notes	Date	Examiner
320/109,116,339;180/65.1,65.21;307/10.1,149;701/22 with text search was conducted	06/11/2015	YF
Inventor's search in PALM and eDAN was codnucted	06/11/2015	YF
foreign and IDS search was conducted	06/11/2015	YF
interference search was codncuted	06/11/2015	YF
EAST Search (See Printout)	06/11/2015	YF
PLUS search was copndcuted	06/11/2015	YF
IDS and an updated search was conducted	06/25/2015	YF
INterference search was condcuted	06/25/2015	YF

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
320/Y02T	109/ 90/14	03/19/2015	YF

	/YALKEW FANTU/ Primary Examiner.Art Unit 2859

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	*Complete if Known*	
	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	
	Examiner Name	
	Attorney Docket Number	VOLTP001

U.S. Patent Documents

Examiner Initials	Initials	Reference	REF. NO.	
Examiner Initials		US8818622	Reference No.	1
Examiner Initials		US8818725	Reference No.	2
Examiner Initials		US8819414	Reference No.	3
Examiner Initials		US8825222	Reference No.	4
Examiner Initials		US8799037	Reference No.	5
Examiner Initials		US8816845	Reference No.	6
Examiner Initials		US8751065	Reference No.	7
Examiner Initials		US8751271	Reference No.	8
Examiner Initials		US8760432	Reference No.	9
Examiner Initials		US8706394	Reference No.	10
Examiner Initials		US8713121	Reference No.	11
Examiner Initials		US8717170	Reference No.	12
Examiner Initials		US8686864	Reference No.	13
Examiner Initials		US8694328	Reference No.	14
Examiner Initials		US8635091	Reference No.	15
Examiner Initials		US8648329	Reference No.	16
Examiner Initials		US8660734	Reference No.	17
Examiner Initials		US8624719	Reference No.	18
Examiner Initials		US8630741	Reference No.	19
Examiner Initials		US8527135	Reference No.	20
Examiner Initials		US8527146	Reference No.	21
Examiner Initials		US8552686	Reference No.	22
Examiner Initials		US8589019	Reference No.	23
Examiner Initials		US8483907	Reference No.	24
Examiner Initials		US8490005	Reference No.	25
Examiner Initials		US8508188	Reference No.	26
Examiner Initials		US8483775	Reference No.	27
Examiner Initials		US8405347	Reference No.	28
Examiner Initials		US8482255	Reference No.	29
Examiner Initials		US8336664	Reference No.	30
Examiner Initials		US8392065	Reference No.	31
Examiner Initials		US8265816	Reference No.	32
Examiner Initials		US8333492	Reference No.	33
Examiner Initials		US8036788	Reference No.	34
Examiner Initials		US8072318	Reference No.	35
Examiner Initials		US8103391	Reference No.	36
Examiner Initials		US8262268	Reference No.	37
Examiner Initials		US7979198	Reference No.	38
Examiner Initials		US7986126	Reference No.	39
Examiner Initials		US8027843	Reference No.	40

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	Examiner Name	
	Attorney Docket Number	VOLTP001

Examiner Initials		US7778746	Reference No.	41
Examiner Initials		US7796052	Reference No.	42
Examiner Initials		US7850351	Reference No.	43
Examiner Initials		US7683771	Reference No.	44
Examiner Initials		US7693609	Reference No.	45
Examiner Initials		US7751945	Reference No.	46
Examiner Initials		US7630802	Reference No.	47
Examiner Initials		US7650210	Reference No.	48
Examiner Initials		US7674536	Reference No.	49
Examiner Initials		US7532965	Reference No.	50
Examiner Initials		US7565396	Reference No.	51
Examiner Initials		US7289611	Reference No.	52
Examiner Initials		US7376497	Reference No.	53
Examiner Initials		US7379541	Reference No.	54
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Examiner Initials		US7269416	Reference No.	56
Examiner Initials		US6937140	Reference No.	57
Examiner Initials		US7089389	Reference No.	58
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Examiner Initials		US6922629	Reference No.	60
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Examiner Initials		US6085131	Reference No.	76
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Examiner Initials		US5790976	Reference No.	80
Examiner Initials		US5892598	Reference No.	81
Examiner Initials		US5666102	Reference No.	82

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Examiner Initials		US5691695	Reference No.	83
Examiner Initials		US5595271	Reference No.	84
Examiner Initials		US5596258	Reference No.	85
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Examiner Initials		US5555502	Reference No.	89
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Examiner Initials		US20140120829	Reference No.	122
Examiner Initials		US20140125355	Reference No.	123

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Examiner Initials		US20140089016	Reference No.	124
Examiner Initials		US20140106726	Reference No.	125
Examiner Initials		US20140118107	Reference No.	126
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Examiner Initials		US20120232965	Reference No.	164
Examiner Initials		US20120136802	Reference No.	165

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Examiner Initials		US20120158244	Reference No.	166
Examiner Initials		US20120179323	Reference No.	167
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Examiner Initials		US20100049737	Reference No.	202
Examiner Initials		US20100057306	Reference No.	203
Examiner Initials		US20100049396	Reference No.	204
Examiner Initials		US20100049533	Reference No.	205
Examiner Initials		US20100049610	Reference No.	206
Examiner Initials		US20100017045	Reference No.	207

Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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Examiner Initials		US20100017249	Reference No.	208
Examiner Initials		US20090313104	Reference No.	209
Examiner Initials		US20090313174	Reference No.	210
Examiner Initials		US2010/0280956	Reference No.	211
Examiner Initials		US20100013434	Reference No.	212
Examiner Initials		US20090313033	Reference No.	213
Examiner Initials		US20090313034	Reference No.	214
Examiner Initials		US20090313098	Reference No.	215
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Examiner Initials		US20090076913	Reference No.	229
Examiner Initials		US20080203973	Reference No.	230
Examiner Initials		US20080281663	Reference No.	231
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Examiner Initials		US20040064235	Reference No.	246
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Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	*Complete if Known*	
	Application Number	13/452,882
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	First Named Inventor	Angel Penilla
	Art Unit	
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EAST Search History

EAST Search History (Prior Art)

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EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	((batteri$2)(vehicle)(server)(multiple or plurality)(kiosk or shope or place)(account)(dtabase)(proximate or near$4)(rate)(vehicle or automobile or car or bicykle)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:26
L2	1	((auxiliary near battery)(charge near unit)(kiosk or store or house)(display)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:26
L3	22	((auxiliary near battery)(charge)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:26
L4	57	((auxiliary near battery)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:26
L5	88	((auxiliary battery)(charge)(control)(proces$4)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:27
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L7	185	((auxiliary near battery)(charge)(vehicle or automobile or car)).clm.	US-PGPUB; USPAT; UPAD	AND	ON	2015/06/27 19:28

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PTO/SB/08A(08-03)

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				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
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Examiner Signature	/Yalkew Fantu/	Date Considered	07/06/2015

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Substitute for form 1449/PTO	Complete if Known

[1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by two-letter code (WIPO Standard ST.3). [4]For Japanese patent documents, the indication of the year of the reign of Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6]Applicant is to place a check mark here if English language translation is attached.

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				Application Number	13/452,882
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				First Named Inventor	Angel Penilla
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				Examiner Name	Unassigned
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Examiner Signature	/Yalkew Fantu/	Date Considered	07/06/2015

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Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	2859
				Examiner Name	Fantu, Yalkew
				Attorney Docket Number	VOLTP001

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	First Named Inventor	Angel Penilla
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Examiner Initials	Issue Date	Reference	Name of Patentee or Applicant	Cite No.
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Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /Y.F./

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	*Complete if Known*	
	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	2859
				Examiner Name	Fantu, Yalkew
				Attorney Docket Number	VOLTP001

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/Yalkew Fantu/ 06/27/2015

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PTO/SB/08A(08-03)

Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	1	of	2	Attorney Docket Number	VOLTP001

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Examiner Initials	US Patent/Application	
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	US8836281	
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	US6234932	

Examiner Signature	/Yalkew Fantu/	Date Considered	07/06/2015

[1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by two-letter code (WIPO Standard ST.3). [4]For Japanese patent documents, the indication of the year of the reign of Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6]Applicant is to place a check mark here if English language translation is attached.

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PTO/SB/08A(08-03)

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				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	Unassigned
				Examiner Name	Unassigned
Sheet	2	of	2	Attorney Docket Number	VOLTP004

U.S. Patent Documents

Examiner Initials	US Patent/Application	
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Examiner Signature	/Yalkew Fantu/	Date Considered	07/06/2015

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13452882	PENILLA ET AL.
	Examiner	**Art Unit**
	YALKEW FANTU	2859

CPC						
Symbol					**Type**	**Version**
G06Q		20	/	18	F	2013-01-01
G07F		15	/	005	I	2013-01-01
Y02T		90	/	128	A	2013-01-01
B60S		5	/	06	I	2013-01-01
B60L		11	/	1816	I	2013-01-01
B60L		11	/	1822	I	2013-01-01
B60L		11	/	1861	I	2013-01-01
Y02T		10	/	7044	A	2013-01-01
Y02T		10	/	7005	A	2013-01-01
Y02T		10	/	705	A	2013-01-01
Y02T		90	/	16	A	2013-01-01
Y02T		10	/	7072	A	2013-01-01
Y02T		90	/	124	A	2013-01-01
Y02T		90	/	14	A	2013-01-01
B60L		2240	/	547	A	2013-01-01
G01C		21	/	3679	I	2013-01-01
G06Q		10	/	20	I	2013-01-01
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H04B		5	/	0037	I	2013-01-01
H04W		4	/	02	I	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 16	
/YALKEW FANTU/ Primary Examiner.Art Unit 2859 (Primary Examiner)	06/26/2015 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 13A

U.S. Patent and Trademark Office

Part of Paper No. 20150626

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13452882	PENILLA ET AL.
	Examiner	**Art Unit**
	YALKEW FANTU	2859

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
320	109	H	0	2	J	7 / 00 (2006.01.01)						
CROSS REFERENCE(S)												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											
180	65.1	65.21										
307	10.1	149										

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	16	
/YALKEW FANTU/ Primary Examiner.Art Unit 2859	06/26/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	20	13A

U.S. Patent and Trademark Office — Part of Paper No. 20150626

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13452882	PENILLA ET AL.
	Examiner	**Art Unit**
	YALKEW FANTU	2859

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17	13	33										
	2		18	2	34										
	3		19	16	35										
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	13	11	29												
	14	14	30												
	15	15	31												
	16	12	32												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 16	
/YALKEW FANTU/ Primary Examiner.Art Unit 2859 (Primary Examiner)	06/26/2015 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 13A

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Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	Attorney Docket No:	13/452,882
	VOLTP001	
	Applicant: Angel Penilla	
	Filing Date: April 22, 2012	Group:

Other Documents

Examiner		
Initial	No.	Author, Title, Date, Place (e.g. Journal) of Publication
	A	Angel Penilla, Related Application Specification for U.S. Application No. 14/595,186, filed Jan. 12, 2015
	B	Angel Penilla, Related Application Specification for U.S. Application No. 14/599,541, filed Jan. 18, 2015
	C	Angel Penilla, Related Application Specification for U.S. Application No. 14/602,256, filed Jan. 21, 2015

Examiner /Yalkew Fantu/	Date Considered 07/06/2015

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Albert Penilla	(Depositor's name)
/Albert Penilla/	(Signature)
July 8, 2015	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/452,882	04/22/2012	Angel A. Penilla	VOLTP001	6203

TITLE OF INVENTION: ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	10/08/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
FANTU, YALKEW	2859	320-109000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
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5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Albert Penilla/ Date July 8, 2015

Typed or printed name Albert S. Penilla Registration No. 39,487

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	13452882
Filing Date:	22-Apr-2012
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Filer:	Albert S. Penilla
Attorney Docket Number:	VOLTP001

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	2501	1	480	480

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**480**

Electronic Acknowledgement Receipt	
EFS ID:	22855182
Application Number:	13452882
International Application Number:	
Confirmation Number:	6203
Title of Invention:	ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS
First Named Inventor/Applicant Name:	Angel A. Penilla
Customer Number:	25920
Filer:	Albert S. Penilla
Filer Authorized By:	
Attorney Docket Number:	VOLTP001
Receipt Date:	08-JUL-2015
Filing Date:	22-APR-2012
Time Stamp:	12:51:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$480
RAM confirmation Number	8587
Deposit Account	500805
Authorized User	PENILLA, ALBERT S.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	13452882_Issue_fee_Efiled.pdf	328281 9925d85fed22b9ceffeb925e33f785f97227e991	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30784 6e9185ffd80fc22170fa6ceac10c2ebb1c097f62	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	359065		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

ELECTRIC VEHICLE (EV) RANGE EXTENDING CHARGE SYSTEMS, DISTRIBUTED NETWORKS OF CHARGE KIOSKS, AND CHARGE LOCATING MOBILE APPS

By Inventors:
Angel A. Penilla
Albert S. Penilla

CLAIM OF PRIORITY

[0001] The present invention claims priority to U.S. Provisional Patent Application No. 61/478,436, filed on April 22, 2011, and entitled Electric Vehicle (EV) Range Extending Charge Systems, Distributed Networks of Charge Kiosks, and Charge Locating Mobile Apps", which is herein incorporated by reference.

CROSS REFERENCE TO RELATED APPLICATION

Change(s) applied to document, /J.L.B./ 7/14/2015

[0002] This application is related to US Patent Application No. 13/452,881 ~~(Atty. Docket No. VOLTP002)~~ entitled "Methods and Systems for Processing Charge Availability and Route Paths for Obtaining Charge for Electric Vehicles", filed on the same date as the present application, and which is herein incorporated by reference.

Field of the embodiments

[0003] The present invention relates to systems and methods that enable operators of electric vehicles (EV) to extend their range by utilizing auxiliary charging batteries. Also disclosed are systems for defining a network of charge dispensing kiosks, and mobile applications for obtaining information about available dispensing kiosks, availability of charge, reservations for charge, and purchasing of charge remotely.

BACKGROUND

[0004] Electric vehicles have been utilized for transportation purposes and recreational purposes for quite some time. Electric vehicles require a battery that

[00236] The drivers can also be provided with information of the duration of the discount, so that drivers can obtain the discount if they have the time to **traverse** ~~**traversed**~~ the path, or avoid the path if the discount will not be present when the driver arrives at that application. In another embodiment, the logic in the vehicle or the processing system in the cloud processing can determine whether or not the user would be able to arrive at each of the charging stations or plugs to receive the sponsor discounts. This analysis can include, for example, reviewing traffic patterns, travel speeds and estimates to traversed the different distances, time of day, etc.

[00237] In another embodiment, the user may select to **traverse** ~~**traversed**~~ path 3, which takes the user to charge provider C5 and C6 before progressing on path B. In this illustration, it is shown that the user must go off path to travel to charge C6. However, it may be more beneficial for the user to travel to charge C6, as that location is offering a larger discount. In some embodiments, even though the user travels off path, the discounts offset the cost of going off path. In some embodiments, going off path can actually be faster if the particular charge stations or pumps or plugs are more available and there is less wait. In still another embodiment, the user may not actually have a path in mind, and the user may select to simply obtain charge and would be provided with path 4.

[00238] In this example, the users looking to charge the vehicle along a path that is sponsored. A currently sponsored path may be to charge C7. The user can be provided with an option of charge discounts, which can include discounting the cost of the charge itself, or discounts to retail or service providers that are proximate to the charge outlet. In such an embodiment, the data can be provided to the display of the **user's** ~~**users**~~ car or vehicle, or can be provided to the **user's** ~~**users**~~ device. For example, if the user wishes to obtain charge, and the **user is** ~~**users**~~ currently sitting in his or her office, (and the car is in the parking lot) the user can select it obtain a sponsored path to obtain charge. That sponsored path can identify the closest station, or a number of stations or plugs their offering particular discounts.

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	*Complete if Known*	
	Application Number	13/452,882
	Filing Date	April 22, 2012
	First Named Inventor	Angel Penilla
	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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Change(s) applied to document, /R.T.H./ 7/28/2015

Examiner: Initial if reference is considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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	First Named Inventor	Angel Penilla
	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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	First Named Inventor	Angel Penilla
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	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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	Attorney Docket Number	VOLTP001

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	Art Unit	2859
	Examiner Name	Fantu, Yalkew
	Attorney Docket Number	VOLTP001

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Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	13/452,882
				Filing Date	April 22, 2012
				First Named Inventor	Angel Penilla
				Art Unit	2859
				Examiner Name	Fantu, Yalkew
				Attorney Docket Number	VOLTP001

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ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 520 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

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Albert S. Penilla, Sunnyvale, CA;

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