

InductEV, Inc. (*Petitioner*)
v.
WiTricity Corporation (*Patent Owner*)

Case No.: IPR2013-01208
U.S. Patent No.: 8,912,687
November 19, 2024

WiTricity Corporation
Exhibit 2004
InductEV Inc. v.
WiTricity Corp.
IPR2023-01208

The Challenged '687 Patent Claims



All claims require an **“authorization facility”** to:

- “confirm compatibility of the resonators” and
- “provide authorization for the initiation of transfer of power”



Petitioner **improperly** collapses these two functions into a single authorization step

“Confirm Compatibility of The Resonators”

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be completely integrated into a computer or behind the computer. The circuit boards and housing of the computer may contain lossy material or metallic materials that may attenuate, block, or redirect the magnetic field, reducing the efficiency of the power transfer to the resonators of the peripherals. An additional passive repeater resonator 15042 may be placed below the active resonator 15041, for example, to transfer energy around the blocking material to the resonators in the computer peripherals 14717, 14716. When the passive resonator is placed in the base 14715 power is transferred through the resonator in the base without requiring a separate power connection to the base.

While the invention has been described in connection with certain preferred embodiments, other embodiments will be understood by one of ordinary skill in the art and are intended to fall within the scope of this disclosure, which is to be interpreted in the broadest sense allowable by law. For example, designs, methods, configurations of components, etc. related to transmitting wireless power have been described above along with various specific applications and examples thereof. Those skilled in the art will appreciate where the designs, components, configurations or components described herein can be used in combination, or interchangeably, and that the above description does not limit such interchangeability or combination of components to only that which is described herein.

All documents referenced herein are hereby incorporated by reference.

What is claimed is:

1. A vehicle powering wireless receiver for use with a first electromagnetic resonator coupled to a power supply, the first electromagnetic resonator having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the wireless receiver comprising:

a load configured to power the drive system of a vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator; and
an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

2. The wireless receiver of claim 1, wherein the authorization facility uses public key infrastructure.

3. The wireless receiver of claim 1, wherein the authorization facility uses a secure communication channel.

4. The wireless receiver of claim 1, wherein the channel is an in-band communication channel.

5. The wireless receiver of claim 1, wherein the channel is an out-of-band communication channel.

6. The wireless receiver of claim 1, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

7. A power source for wirelessly providing power to a wireless receiver of an at least partially electrically powered vehicle, the power source comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

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a first electromagnetic resonator coupled to the power supply and having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

wherein the first electromagnetic resonator is configured to be wirelessly coupled to a second electromagnetic resonator located on the vehicle and coupled to a load associated with the drive system of the vehicle to provide non-radiative wireless power to the second electromagnetic resonator, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$; and
an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

8. The power source of claim 7, wherein the authorization facility uses public key infrastructure.

9. The power source of claim 7, wherein the authorization facility uses a secure communication channel.

10. The power source of claim 7, wherein the channel is an in-band communication channel.

11. The power source of claim 7, wherein the channel is an out-of-band communication channel.

12. The power source of claim 7, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

13. A vehicle wireless power system, comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

a first electromagnetic resonator coupled to the power supply and having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

a load configured to power the drive system of the vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator; and
an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

14. The wireless power system of claim 13, wherein the authorization facility uses public key infrastructure.

15. The wireless power system of claim 13, wherein the authorization facility uses a secure communication channel.

16. The wireless power system of claim 13, wherein the channel is an in-band communication channel.

17. The wireless power system of claim 13, wherein the channel is an out-of-band communication channel.

18. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

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Claim language itself indicates that “confirm compatibility” **AND** “provide authorization” are two different functions.

“An authorization facility to confirm compatibility of the resonators **AND** provide authorization for initiation of transfer of power.” (Ex. 1001, 230: 51-53)

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information regarding device identification, device power requirements, handshaking protocols, and the like.

The source and device may sense, transmit, process and utilize position and location information on any other sources and/or devices in a power network. The source and device may capture or use information such as elevation, tilt, latitude and longitude, and the like from a variety of sensors and sources that may be built into the source and device or may be part of a component the source or device connect. The positioning and orientation information may include sources such as global positioning sensors (GPS), compasses, accelerometers, pressure sensors, atmospheric barometric sensors, positioning systems which use Wi-Fi or cellular network signals, and the like. The source and device may use the position and location information to find nearby wireless power transmission sources. A source may broadcast or communicate with a central station or database identifying its location. A device may obtain the source location information from the central station or database or from the local broadcast and guide a user or an operator to the source with the aid of visual, vibrational, or auditory signals. Sources and devices may be nodes in a power network, in a communications network, in a sensor network, in a navigational network, and the like or in kind of combined functionality network.

The position and location information may also be used to optimize or coordinate power delivery. Additional information about the relative position of a source and a device may be used to optimize magnetic field direction and resonator alignment. The orientation of a device and a source which may be obtained from accelerometers and magnetic sensors, and the like, for example, may be used to identify the orientation of resonators and the most favorable direction of a magnetic field such that the magnetic flux is not blocked by the device circuitry. With such information a source with the most favorable orientation, or a combination of sources, may be used. Likewise, position and orientation information may be used to move or provide feedback to a user or operator of a device to place a device in a favorable orientation or location to maximize power transmission efficiency, minimize losses, and the like.

The source and device may include power metering and measuring circuitry and capability. The power metering may be used to track how much power was delivered by a source or how much power was transferred by a source. The power metering and power usage information may be used in fee based power delivery arrangements for billing purposes. Power metering may be also be used to enable power delivery policies to ensure power is distributed to multiple devices according to specific criteria. For example, the power metering may be used to categorize devices based on the amount of power they received and priority in power delivery may be given to those having received the least power. Power metering may be used to provide tiered delivery services such as “guaranteed power” and “best effort power” which may be billed at separate rates. Power metering may be used to institute and enforce hierarchical power delivery structures and may enable priority devices to demand and receive more power under certain circumstances or use scenarios.

Power metering may be used to optimize power delivery efficiency and minimize absorption and radiation losses. Information related to the power received by devices may be used by a source in conjunction with information about the power output of the source to identify unfavorable operating environments or frequencies. For example, a source may compare the amount of power which was received by the devices and the amount of power which it transmitted to determine if the transmission losses may be unusually or

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unacceptably large. Large transmission losses may be due to an unauthorized device receiving power from the source and the source and other devices may initiate frequency hopping of the resonance frequency or other defensive measures to prevent or deter unauthorized use. Large transmission losses may be due to absorption losses for example, and the device and source may tune to alternate resonance frequencies to minimize such losses. Large transmission losses may also indicate the presence of unwanted or unknown objects or materials and the source may turn down or off its power level until the unwanted or unknown object is removed or identified, at which point the source may resume powering remote devices.

The source and device may include authentication capability. Authentication may be used to ensure that only compatible sources and devices are able to transmit and receive power. Authentication may be used to ensure that only authentic devices that are of a specific manufacturer and not clones or devices and sources from other manufacturers, or only devices that are part of a specific subscription or plan, are able to receive power from a source. Authentication may be based on cryptographic request and respond protocols or it may be based on the unique signatures of perturbations of specific devices allowing them to be used and authenticated based on properties similar to physically unclonable functions. Authentication may be performed locally between each source and device with local communication or it may be used with third person authentication methods where the source and device authenticate with communications to a central authority. Authentication protocols may use position information to alert a local source or sources of a genuine device.

The source and device may use frequency hopping techniques to prevent unauthorized use of a wireless power source. The source may continuously adjust or change the resonant frequency of power delivery. The changes in frequency may be performed in a pseudorandom or predetermined manner that is known, reproducible, or communicated to authorized device but difficult to predict. The rate of frequency hopping and the number of various frequencies used may be large and frequent enough to ensure that unauthorized use is difficult or impractical. Frequency hopping may be implemented by tuning the impedance network, tuning any of the driving circuits, using a plurality of resonators tuned or tunable to multiple resonant frequencies, and the like.

The source may have a user notification capability to show the status of the source as to whether it is coupled to a device resonator and transmitting power, if it is in a standby mode, or if the source resonator is detuned or perturbed by an external object. The notification capability may include visual, auditory, and vibrational methods. The notification may be as simple as three color lights, one for each state, and optionally a speaker to provide notification in case of an error in operation. Alternatively, the notification capability may involve an interactive display that shows the status of the source and optionally provides instructions on how to fix or solve any errors or problems identified.

As another example, wireless power transfer may be used to improve the safety of electronic explosive detonators. Explosive devices are detonated with an electronic detonator, electric detonator, or shock tube detonator. The electronic detonator utilizes stored electrical energy (usually in a capacitor) to activate the igniter charge, with a low energy trigger signal transmitted conductively or by radio. The electric detonator utilizes a high energy conductive trigger signal to provide both the signal and the energy required to activate the igniter charge. A shock tube sends a controlled explosion through a hollow tube coated with explosive from the genera-



Specification **Confirms** that Confirming Compatibility and Providing Authorization are **Not** Equivalent

The source and device may include authentication capability.

Authentication may be used to **ensure that only compatible sources and devices are able to transmit and receive power.** Authentication may be

used to **ensure that only authentic devices that are of a specific manufacturer and not clones or devices and sources from other manufacturers, or only devices that are part of a specific subscription or plan, are able to receive power** from a source. Authentication may be

based on **cryptographic request and respond protocols** or it may be based on the **unique signatures of perturbations of specific devices**

allowing them to be used and authenticated based on properties similar to physically unclonable functions. Authentication may be performed locally between each source and device with local communication or it may be used with third person authentication methods where the source and device authenticate with communications to a central authority.

Authentication protocols **may use position information to alert a local source or sources of a genuine device.**

(Ex. 1001, 102: 14-31)

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be completely integrated into a computer or behind the computer. The circuit boards and housing of the computer may contain lossy material or metallic materials that may attenuate, block, or redirect the magnetic field, reducing the efficiency of the power transfer to the resonators of the peripherals. An additional passive repeater resonator 15042 may be placed below the active resonator 15041, for example, to transfer energy around the blocking material to the resonators in the computer peripherals 14717, 14716. When the passive resonator is placed in the base 14715 power is transferred through the resonator in the base without requiring a separate power connection to the base.

While the invention has been described in connection with certain preferred embodiments, other embodiments will be understood by one of ordinary skill in the art and are intended to fall within the scope of this disclosure, which is to be interpreted in the broadest sense allowable by law. For example, designs, methods, configurations of components, etc. related to transmitting wireless power have been described above along with various specific applications and examples thereof. Those skilled in the art will appreciate where the designs, components, configurations or components described herein can be used in combination, or interchangeably, and that the above description does not limit such interchangeability or combination of components to only that which is described herein.

All documents referenced herein are hereby incorporated by reference.

What is claimed is:

1. A vehicle powering wireless receiver for use with a first electromagnetic resonator coupled to a power supply, the first electromagnetic resonator having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the wireless receiver comprising:

a load configured to power the drive system of a vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator; and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

2. The wireless receiver of claim 1, wherein the authorization facility uses public key infrastructure.

3. The wireless receiver of claim 1, wherein the authorization facility uses a secure communication channel.

4. The wireless receiver of claim 3, wherein the channel is an in-band communication channel.

5. The wireless receiver of claim 3, wherein the channel is an out-of-band communication channel.

6. The wireless receiver of claim 1, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

7. A power source for wirelessly providing power to a wireless receiver of an at least partially electrically powered vehicle, the power source comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

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a first electromagnetic resonator coupled to the power supply and having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

wherein the first electromagnetic resonator is configured to be wirelessly coupled to a second electromagnetic resonator located on the vehicle and coupled to a load associated with the drive system of the vehicle to provide non-radiative wireless power to the second electromagnetic resonator, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$; and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

8. The power source of claim 7, wherein the authorization facility uses public key infrastructure.

9. The power source of claim 7, wherein the authorization facility uses a secure communication channel.

10. The power source of claim 9, wherein the channel is an in-band communication channel.

11. The power source of claim 9, wherein the channel is an out-of-band communication channel.

12. The power source of claim 7, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

13. A vehicle wireless power system, comprising:

a power supply, the power supply configured to supply power at a rate sufficient to charge the battery of a vehicle that is driven at least in part by electrical power;

a first electromagnetic resonator coupled to the power supply and having a mode with a resonant frequency ω_1 , an intrinsic loss rate Γ_1 , and a first Q-factor $Q_1 = \omega_1/2\Gamma_1$, the first electromagnetic resonator housed in a housing configured to be disposed in proximity to the vehicle;

a load configured to power the drive system of the vehicle using electrical power;

a second electromagnetic resonator adapted to be housed upon the vehicle and configured to be coupled to the load, the second electromagnetic resonator having a mode with a resonant frequency ω_2 , an intrinsic loss rate Γ_2 , and a second Q-factor $Q_2 = \omega_2/2\Gamma_2$,

wherein the second electromagnetic resonator is configured to be wirelessly coupled to the first electromagnetic resonator to provide resonant, non-radiative wireless power to the second electromagnetic resonator from the first electromagnetic resonator; and

an authorization facility to confirm compatibility of the resonators and provide authorization for initiation of transfer of power.

14. The wireless power system of claim 13, wherein the authorization facility uses public key infrastructure.

15. The wireless power system of claim 13, wherein the authorization facility uses a secure communication channel.

16. The wireless power system of claim 15, wherein the channel is an in-band communication channel.

17. The wireless power system of claim 15, wherein the channel is an out-of-band communication channel.

18. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

19. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

20. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

21. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

22. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

23. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

24. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

25. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

26. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

27. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

28. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

29. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

30. The wireless power system of claim 13, wherein the authorization facility further determines a safety condition for initiation of transfer of power.

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Petitioner’s Reliance on Dependent Claims is **Misplaced** (Reply 4)

14. The wireless power system of claim 13, wherein the authorization facility **uses public key infrastructure.**

15. The wireless power system of claim 13, wherein the authorization facility **uses a secure communication channel.**

16. The wireless power system of claim 15, wherein **the channel is an in-band communication channel.**

17. The wireless power system of claim 15, wherein **the channel is an out-of-band communication channel.**

18. The wireless power system of claim 13, wherein the authorization facility **further determines a safety condition** for initiation of transfer of power.

(Ex. 1001, 230: 55-65)



Dependent claims **confirm** the use of specific cryptographic methods or channels **≠** confirming resonator compatibility

“Confirm Compatibility of The Resonators”



Dr. Allen: Confirming resonator compatibility includes confirming various resonator parameters such as:

- “resonator frequencies”
- “physical size”
- “lateral extent of the resonators”
- “many others”

(Ex. 2003, 54:9-55:9)

Cook Does Not Disclose Confirming Resonator Compatibility

Patent US 2009/0299918 AI – Ex. 1007

US 2009/0299918 AI

Dec. 3, 2009

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WIRELESS DELIVERY OF POWER TO A MOBILE POWERED DEVICE

BACKGROUND

[0001] Wireless delivery of power may be used to provide power to a load. For example, U.S. patent application Ser. No. 12/018,069, filed Jan. 22, 2008, entitled “Wireless Apparatus and Methods”, the disclosure of which is herewith incorporated by reference, describe wireless transfer of power to a load. This may be done by forming a magnetic field and receiving a magnetic field in a resonant antenna that is resonant with at least one characteristic of a magnetic field. The power transmission may also be done inductively. The magnetic delivery of power, however, has the advantage of being capable of delivering power over a longer distance.

SUMMARY

[0002] The present application describes wireless delivery of power to a mobile powered device such as an automobile. An embodiment describes how power can be delivered to the automobile in a number of different locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:
[0004] FIG. 1 shows an overall block diagram of a system for delivering power wirelessly to a load; and
[0005] FIG. 2 illustrates a flowchart of operation that may be carried out in controller 180 or in hardware that is distributed at various locations throughout the network.

DETAILED DESCRIPTION

[0006] Delivery of electric power to automobiles may become more prevalent as electrically powered automobiles enter and occupy a more significant portion of the market. For example, as of the time of writing of this document, there are many different forms of hybrid automobiles which operate based both on internal combustion engines, and also on stored charge in a battery. There are fewer forms of electric automobiles such as plug-in hybrids or plug-in electric vehicles.
[0007] Commercial success of such a vehicle would require that either the vehicle have a sufficient mileage range to make an entire round-trip without recharging, or that the user recharge the vehicle at some intermediate point. Currently, there are vehicle charging stations mostly associated with public areas, for example airports and public parking places. This is done in many ways as a public service to allow or encourage more people to use electric automobiles. However, this is not a long-term practical solution.

[0008] The inventors also recognize that it may be desirable to wirelessly deliver power to an electric powered mobile device, such as an automobile.

[0009] FIG. 1 illustrates a block diagram of a system according to the present application. An electrically powered automobile includes at least one battery 102 which may operate at least one electronic mobile system of the automobile. For example, in one embodiment, the battery 102 may be the primary power source of the automobile. In other embodiments, the battery may be a partial driver, such as a hybrid vehicle which can operate based on electric power from the battery, or from electromotive force such as gas power, or both.

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[0014] The charger 150 also includes an information detecting part. This may be a send and receive portion 160 that wirelessly detects a unique identifier indicative of the vehicle 100. In one embodiment, the vehicle 100 may include an RFID device 121 that uniquely identifies the vehicle. Information from the RFID device may be detected by the send and receive device 160. Another embodiment may use a camera or scanner to **detect some written item on the automobile, e.g., the license plate or serial number or barcode on the automobile.**

(Ex. 1007, ¶ 14)



The “*unique identifier*” of Cook is wholly **unrelated** to the resonator

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SUMMARY

[0002] The present application describes wireless delivery of power to a mobile powered device such as an automobile. An embodiment describes how power can be delivered to the automobile in a number of different locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:
[0004] FIG. 1 shows an overall block diagram of a system for delivering power wirelessly to a load; and
[0005] FIG. 2 illustrates a flowchart of operation that may be carried out in controller 180 or in hardware that is distributed at various locations throughout the network.

DETAILED DESCRIPTION

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[0007] Commercial success of such a vehicle would require that either the vehicle have a sufficient mileage range to make an entire round-trip without recharging, or that the user recharge the vehicle at some intermediate point. Currently, there are vehicle charging stations mostly associated with public areas, for example airports and public parking places. This is done in many ways as a public service to allow or encourage more people to use electric automobiles. However, this is not a long-term practical solution.

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[0009] FIG. 1 illustrates a block diagram of a system according to the present application. An electrically powered automobile includes at least one battery 102 which may operate at least one electronic mobile system of the automobile. For example, in one embodiment, the battery 102 may be the primary power source of the automobile. In other embodiments, the battery may be a partial driver, such as a hybrid vehicle which can operate based on electric power from the battery, or from electromotive force such as gas power, or both.

[0010] The battery 102 is shown driving an electric motor 104, 106 which may drive vehicle wheels, for example.

[0011] In the embodiment, the automobile also includes at least one magnetic resonant antenna shown as 110 formed from an inductive loop 111 in parallel with a capacitor 112. This forms an LC circuit with a relatively high Q, for example a Q that is higher than 1000. In the embodiment, when the antenna 110 comes into range of an appropriate transmitter, it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current. That power can be used for directly driving the motors 104, 106, but more preferably is used for charging the battery 102.

[0012] In the embodiment, the battery is automatically charged whenever the antenna 112 comes into range of a wireless charging circuit of appropriate type, e.g. the right frequency. A number of different places, such as parking lots, and more specifically public places, may have appropriate chargers such as 150 in specified locations. In the embodiment, the charger 150 may be located within the ground near a parking space.

[0013] Charger 150 may include a coil 152, a capacitor 154, and a charging circuit 156 that produces signal of appropriate frequency for magnetic transmission. Charger 150 may produce a magnetic field shown generally as 158. Whenever an appropriate vehicle comes into range of the magnetic field 158, it may receive power from that magnetic field, and hence be charged thereby.

[0014] The charger 150 also includes an information detecting part. This may be a send and receive portion 160 that wirelessly detects a unique identifier indicative of the vehicle 100. In one embodiment, the vehicle 100 may include an RFID device 121 that uniquely identifies the vehicle. Information from the RFID device may be detected by the send and receive device 160. Another embodiment may use a camera or scanner to detect some written item on the automobile, e.g., the license plate or serial number or barcode on the automobile.

[0015] In operation, the vehicle charging operation may operate as follows. FIG. 2 illustrates a flow chart in which step 200 detects the identification of the vehicle. At 205, a detection is made of whether that detected identification has an account associated therewith. This is sent to a controller that has the ability to detect whether there is an existing account, e.g. controller 180. This may be at a remote location that stores the vehicle identification information. If the controller verifies the ID as being one that is associated with an account at 205, charging is enabled. This causes power to be delivered from the AC Main, through a meter 175, to the charging device 150. The meter 175 is an integrating meter which automatically keeps track of exactly how much power is delivered to the charging antenna 150. The amount of power delivered is monitored by the controller as an amount of power that will be added to the bill.

[0016] A premium over utility costs may also be added to the bill. In essence, this system is reselling power from the electricity manufacturer, to any vehicle with an appropriate account that comes into range of the antenna.

[0017] Another embodiment may recognize that the detection of an ID could be cloned, and use encryption techniques to verify the ID. For example, one embodiment might use a real-time token type system. The vehicle has a real time clock which is used to display time. The time is encrypted by the vehicle's private encryption key. The controller has a decryption key that can decrypt the encrypted message. The control-

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(Ex. 1007, ¶ 15)

Cook Does Not Disclose Confirming Resonator Compatibility

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SUMMARY

[0002] The present application describes wireless delivery of power to a mobile powered device such as an automobile. An embodiment describes how power can be delivered to the automobile in a number of different locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:
[0004] FIG. 1 shows an overall block diagram of a system for delivering power wirelessly to a load; and
[0005] FIG. 2 illustrates a flowchart of operation that may be carried out in controller 180 or in hardware that is distributed at various locations throughout the network.

DETAILED DESCRIPTION

[0006] Delivery of electric power to automobiles may become more prevalent as electrically powered automobiles enter and occupy a more significant portion of the market. For example, as of the time of writing of this document, there are many different forms of hybrid automobiles which operate based both on internal combustion engines, and also on stored charge in a battery. There are fewer forms of electric automobiles such as plug-in hybrids or plug-in electric vehicles.
[0007] Commercial success of such a vehicle would require that either the vehicle have a sufficient mileage range to make an entire round-trip without recharging, or that the user recharge the vehicle at some intermediate point. Currently, there are vehicle charging stations mostly associated with public areas, for example airports and public parking places. This is done in many ways as a public service to allow or encourage more people to use electric automobiles. However, this is not a long-term practical solution.

[0008] The inventors also recognize that it may be desirable to wirelessly deliver power to an electric powered mobile device, such as an automobile.

[0009] FIG. 1 illustrates a block diagram of a system according to the present application. An electrically powered automobile includes at least one battery 102 which may operate at least one electronic mobile system of the automobile. For example, in one embodiment, the battery 102 may be the primary power source of the automobile. In other embodiments, the battery may be a partial driver, such as a hybrid vehicle which can operate based on electric power from the battery, or from electromotive force such as gas power, or both.

[0010] The battery 102 is shown driving an electric motor 104, 106 which may drive vehicle wheels, for example.

[0011] In the embodiment, the automobile also includes at least one magnetic resonant antenna shown as 110 formed from an inductive loop 111 in parallel with a capacitor 112. This forms an LC circuit with a relatively high Q, for example a Q that is higher than 1000. In the embodiment, when the antenna 110 comes into range of an appropriate transmitter, it receives a magnetic signal from that transmitter, and the receiving circuit 115 converts that power into output current. That power can be used for directly driving the motors 104, 106, but more preferably is used for charging the battery 102.

[0012] In the embodiment, the battery is automatically charged whenever the antenna 112 comes into range of a wireless charging circuit of appropriate type, e.g. the right frequency. A number of different places, such as parking lots, and more specifically public places, may have appropriate chargers such as 150 in specified locations. In the embodiment, the charger 150 may be located within the ground near a parking space.

[0013] Charger 150 may include a coil 152, a capacitor 154, and a charging circuit 156 that produces signal of appropriate frequency for magnetic transmission. Charger 150 may produce a magnetic field shown generally as 158. Whenever an appropriate vehicle comes into range of the magnetic field 158, it may receive power from that magnetic field, and hence be charged thereby.

[0014] The charger 150 also includes an information detecting part. This may be a send and receive portion 160 that wirelessly detects a unique identifier indicative of the vehicle 100. In one embodiment, the vehicle 100 may include an RFID device 121 that uniquely identifies the vehicle. Information from the RFID device may be detected by the send and receive device 160. Another embodiment may use a camera or scanner to detect some written item on the automobile, e.g., the license plate or serial number or barcode on the automobile.

[0015] In operation, the vehicle charging operation may operate as follows. FIG. 2 illustrates a flow chart in which step 200 detects the identification of the vehicle. At 205, a detection is made of whether that detected identification has an account associated therewith. This is sent to a controller that has the ability to detect whether there is an existing account, e.g. controller 180. This may be at a remote location that stores the vehicle identification information. If the controller verifies the ID as being one that is associated with an account at 205, charging is enabled. This causes power to be delivered from the AC Main, through a meter 175, to the charging device 150. The meter 175 is an integrating meter which automatically keeps track of exactly how much power is delivered to the charging antenna 150. The amount of power delivered is monitored by the controller as an amount of power that will be added to the bill.

[0016] A premium over utility costs may also be added to the bill. In essence, this system is reselling power from the electricity manufacturer, to any vehicle with an appropriate account that comes into range of the antenna.

[0017] Another embodiment may recognize that the detection of an ID could be cloned, and use encryption techniques to verify the ID. For example, one embodiment might use a real-time token type system. The vehicle has a real time clock which is used to display time. The time is encrypted by the vehicle's private encryption key. The controller has a decryption key that can decrypt the encrypted message. The control-

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[0016] A premium over utility costs may also be added to the bill. In essence,

this system is reselling power from the electricity manufacturer, to any vehicle with an appropriate account that comes into range of the antenna.

(Ex. 1007, ¶ 16)



Cook discloses **NOTHING** about confirming resonator compatibility

Bennett Does Not Disclose Confirming Resonator Compatibility

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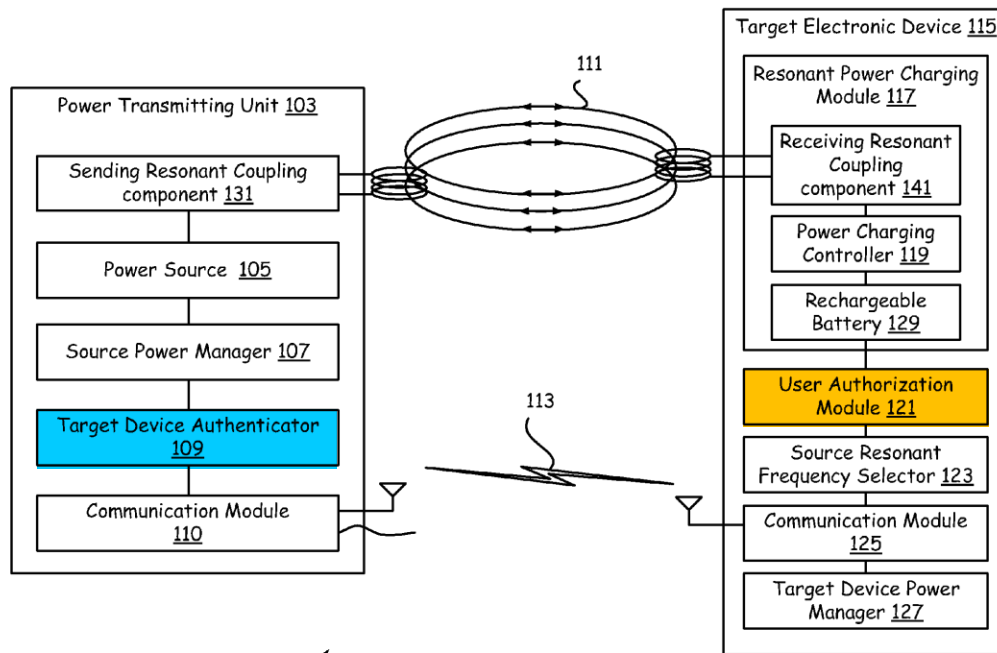


FIG. 1

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[0037] The user authorization module 121 facilitates the authentication of the target electronic device 115, for resonant power delivery, with the target device authenticator 109 of the power transmitting unit 103. During resonant power delivery the user authorization module 121 exchanges the authentication information with the power transmitting unit 103. The power transmitting unit 103 compares the information (or a computed value thereof) with the subscriber's information in its database accessed by the target device authenticator 109. **If the match is determined, then resonant power delivery is initiated.** The authentication is followed by optional frequency selection and directional adjustments of a non-radiated magnetic field in the direction of the target electronic device 115. In a related embodiment, the magnetic field steering is done based on the analysis of the determined or perceived location (egg. employing arrival direction) of the target electronic device 115.

(Ex. 1005, ¶ 37)

Bennett Does Not Disclose Confirming Resonator Compatibility

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adjusted to achieve the optimum reception from an antenna/resonant coupling mechanism such as coils.

[0039] The communication module 125 facilitates the normal communication functionality of the target electronic device 115. It consumes the battery power when powered using the rechargeable battery 129. The power control communication that takes place between the target electronic device 115 and the power transmitting unit 103 during the resonant charging request, etc. is also performed using the communication module 125. A power control signal exchange operation is required for the authentication of the target electronic device 115 before a successful resonant power delivery. The target device power manager 127 manages the battery level of the rechargeable battery 129 by regulating the battery discharge and by initiating resonant power charge operation. For example, it monitors the battery level of the rechargeable battery 129 and initiates its recharge employing power delivered via resonant magnetic field.

[0040] In general, the battery charge (power in the battery) of the rechargeable battery 129 has to be replenished before the battery voltage falls below a threshold limit or before its power level falls below an acceptable level. If the battery voltage falls below a threshold limit, the critical part of the target electronic device 115 is likely to lose power supply, because the battery fails to operate. This situation is avoided with constant monitoring of battery levels and automatic triggering of recharge operations. Thus battery recharging and voltage restoration is automated and does not require any human intervention charge the rechargeable battery 129. The target device power manager 127 facilitates battery level monitoring and automatic recharge triggering.

[0041] The target device power manager 127 tracks the total charging time, amount of charge delivered, etc. The amount of charge acquired by the rechargeable battery 129 is communicated to the power transmitting unit 103. The source power manager 107 conducts similar monitoring function associated with power management from the power transmitting unit 103. The target device authenticator 109 authenticates the resonant power requests made by the target electronic device 115, and works in coordination with the user authorization module 121 of the target electronic device 115.

[0042] In one embodiment, a rechargeable electronic device, such as the target electronic device 115, typically includes the rechargeable battery 129. The rechargeable electronic device authenticates with the power transmitting unit 103 and receives a token that is used for subsequent communication and power charging (in one or more charging sessions). The rechargeable electronic device requests the power transmitting unit 103 for power, with the power to be transmitted employing non-radiated magnetic field waves of a target resonant frequency. The rechargeable electronic device 115 receives power transmitted over non-radiated magnetic field waves of the target resonant frequency from the power transmitting unit 103. It recharges the rechargeable battery 129 of the rechargeable electronic device 115.

[0043] According to various embodiments of the present invention, the power source 105 is operable to source alternating current power and the sending resonant coupling component 131 is operable to couple the alternating current power to a coil for wireless power transmission by a non-radiated magnetic field at a target resonant frequency. The power transmitting unit 103 is capable of dynamically tuning the wireless power transmission to the target resonant frequency wherein the target resonant frequency is specified dynamically.

cally. Further, the communication module 110 is operable to couple the communication signal to the non-radiated magnetic field 111.

[0044] In some operations, the sending resonant coupling component 131 forms the non-radiated magnetic field 111 substantially omni-directionally. Further, in other operations the communication module 110 is operable to communicate the target resonant frequency to the target device. The power transmitting unit 103 may adjust the target resonant frequency based upon feedback received from the target device 115 via the communication module 110.

[0045] The communication module 110 may communicate with the target device 115 in an RF spectrum via the communication module 125 of the target device 115. The communication module 110 may communicate the target resonant frequency to the target device via the RF interface. The RF interface may also be operable to receive data from the target device that includes at least one of a target device identity, target device billing information, target device power receipt level(s), and a target device battery charge state. The RF interface may be operable to receive a request for power delivery from the target device and also to receive authentication information from the target device. The power transmitting unit may be operable to select the target resonant frequency based upon the target device authentication information.

[0046] The power transmitting unit may also include a token generator that generates a token for delivery to the target device during a target device registration operation. The power transmitting unit is then operable to authenticate the target device during subsequent power transmission operations based partially on the token. The token generator may include a pseudorandom number generator operable to generate the token. With these operations, the power transmitting unit may be operable to deliver power to the target device only after authenticating the target device.

[0047] The target electronic device 115 having the rechargeable battery 129 may be operable to authenticate with the power transmitting unit 103 by receiving a token from the power transmitting unit, requesting power transmission by a non-radiated magnetic field from the power transmitting unit, receiving power non-radiated magnetic field at the target resonant frequency from the power transmitting unit and recharging the rechargeable battery 129. Recharging of the rechargeable battery 129 by the target electronic device 115 may include applying received power to a rechargeable battery, periodically sending a charging status to the power transmitting unit, monitoring the charging status until it exceeds a high charging limit, and communicating a request for termination of power delivery to the power transmitting unit when the high charging limit is reached. The token is may be communicated to the power transmitting unit along with the request for power transmission with the token updated and stored when a new token is communicated by the power transmitting unit. The rechargeable electronic device may authenticate with the power transmitting unit employing a username and password.

[0048] FIG. 2 is a block diagram illustrating a power transmitting network that employs resonant magnetic coupling for wireless power transfer from a power source 203 to a magnetic resonant target device 211, in accordance with another embodiment of the present invention. The power source 203 includes a magnetic resonant power charging circuitry 205, a source power manager 207, and a target device authenticator

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Par. 39 of Bennett **does not** disclose confirming resonator compatibility

“A power control signal exchange operation is required for the authentication of the target electronic device 115 before a successful resonant power delivery.”

(Ex. 1005, ¶ 39)



A “power control signal exchange operation” **does not** expressly or inherently include confirming resonator compatibility

Bennett Does Not Disclose Confirming Resonator Compatibility

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communications 113. The RF communications 113 may include Wireless Local Area Network (WLAN) communications such as IEEE 802.11x communications, Wireless Personal Area Network (WPAN) communications such as Bluetooth communications, cellular communications, proprietary interface communications, or other RF communication techniques. The communication module 110 may also include a wired communication link, e.g., Local Area Network (LAN) such as Ethernet, Cable Modem, Wide Area Network (WAN) and/or other wired communication means. For example, the wired communication link could provide a high speed uplink to the Internet.

[0030] The target electronic device 115 includes a resonant power charging module 117, a user authorization module 121, a source resonant frequency selector 123, a communication module 125, and a target device power manager 127. The resonant power charging module 117 includes a receiving resonant coupling component 141, a power charging controller 119, and a rechargeable battery 129. The receiving resonant coupling component 141, also sometimes referred to as a receiving resonant charging component, is used to receive the power transmissions provided by the power transmitting unit 113 employing the target resonant frequency. The target electronic device 115 employs the received power for operation of the target electronic device 115 as well as for charging the rechargeable battery 129 in the target electronic device 115. The power delivery system 101 employs the sending resonant coupling component 113 of the power transmitting unit 103 to generate magnetic fields that are used to transmit power to the target devices, such as the target electronic device 115. Typically, the sending resonant coupling component 113 includes a resonant coil that fills the space around it with a non-radiated magnetic field oscillating at the target resonant frequency that is received by the target electronic device 115 employing the receiving resonant coupling component 141. The target device also includes a communication module operable 125 to communicate with the communication module 110 of the power transmitting unit 103 via the magnetic coupling and/or via RF communications.

[0031] The power transmitting unit 103 that includes the power source 105 and the target electronic device 115 are communicatively coupled with each other during the resonant power delivery from the power source 105 to the target electronic device 115. The resonant coupling is achieved wirelessly using a “wireless field” 111, which is non-radiated magnetic field in some embodiments. The “wireless field” 111 is the power delivery channel and a “wireless link” 113 is the control signal channel. In one embodiment of the present invention, communicating the power and a control signal are conducted employing the same frequency, or in other words, on the same channel, i.e. the wireless field 111. In another embodiment the power link (such as the magnetic field), the control signal, and the normal communication (i.e. the normal function) operation takes place in separate channels. For e.g. the power transmitting unit 103 is implemented in the base station of a mobile phone, where the normal communication operations with the mobile phone (from the base station), resonant power delivery, and the control signal transmission are all conducted between the mobile phone (as a target electronic device) and the base station employing different channels.

[0032] The power source 105 is a module which generates the required power to be transmitted in a non-radiated magnetic or radiated magnetic mode, employing an essentially

“wireless means” 111. The power source 105 provides power to the sending resonant coupling component 131 which transmits it, for example, creating a non-radiated magnetic field. A source power manager 107 manages the wireless power transmission.

[0033] In one embodiment, the power source 105 generates an alternating current signal that is sufficiently power amplified and radiated using highly directional antenna in the direction of the target device 115. In a different embodiment, the required directionality for the power transmitted is achieved using an antenna array or a dish antenna, as appropriate.

[0034] The resonant power charging module 117 of the target electronic device 115 includes the receiving resonant coupling component 141 that is capable of receiving the transmitted power. In one embodiment, receiving resonant coupling component 141 includes a resonating coil and associated tuning elements such as capacitors.

[0035] Isolation of the resonating circuitry of the receiving resonant coupling component 141 from other internal circuitry of the target electronic device 115 is supported, such as by the use of a buffer (isolation) amplifier, a diode, and capacitor voltage multiplier. In a related embodiment, the diode and the capacitor voltage multiplier are part of the resonating (antenna) circuitry of the receiving resonant coupling component 141. The required high quality factor and the resonant effect are achieved through the right choice of the diode, the capacitors, etc.

[0036] In one embodiment, voltage multipliers in the resonant power charging module 117 builds up the required voltage across a capacitor array to achieve the recharging of the rechargeable battery 129 of the target electronic device 115. During the process of power charging the power charging controller 119 regulates the electric charge that flows into the rechargeable battery 129. The power charging controller 119 of the resonant power charging module 117 senses the battery voltage for its high voltage limit or the low voltage limits to stop charging or start charging, respectively. The high voltage limit protects the battery and the low voltage limit initiates a resonant power request that results in the subsequent battery charging operation.

[0037] The user authorization module 121 facilitates the authentication of the target electronic device 115, for resonant power delivery, with the target device authenticator 109 of the power transmitting unit 103. During resonant power delivery the user authorization module 121 exchanges the authentication information with the power transmitting unit 103. The power transmitting unit 103 compares the information (or a computed value thereof) with the subscriber's information in its database accessed by the target device authenticator 109. If the match is determined, then resonant power delivery is initiated. The authentication is followed by optional frequency selection and directional adjustments of a non-radiated magnetic field in the direction of the target electronic device 115. In a related embodiment, the magnetic field steering is done based on the analysis of the determined or perceived location (e.g., employing arrival direction) of the target electronic device 115.

[0038] The source resonant frequency selector 123 provides a tuning mechanism in order to achieve the required resonant coupling effect. For example, it facilitates the tuning of capacitors where capacitors are used for tuning. Some tuning capacitors are voltage controlled, and they are basically, diode varactors. The tuning voltage is automatically

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Par. 38 of Bennett **does not** disclose confirming resonator compatibility

“The source resonant frequency selector 123 provides a tuning mechanism in order to achieve the required resonant coupling effect.”

(Ex. 1005, ¶ 38)



Describes function of “frequency selector 123,” **NOT** “user authorization module 121”

“The authentication is followed by **optional** frequency selection...”



Optional frequency selection **after required** authentication is necessarily not part of authentication process

Bennett Does Not Disclose Confirming Resonator Compatibility

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[0060] FIG. 4 is a block diagram illustrating the magnetic resonant power charging circuitry 205 of FIG. 2 that is used to transmit power to multiple target devices located in a current direction of a non-radiated magnetic field/beam. Each of the target devices use randomly generated unique token for an authenticity check in accordance with one embodiment of the present invention. The magnetic resonant power charging circuitry 403, in addition to a resonant coupling circuitry 405 and a power generator circuitry 421, includes a token generator 407, a transmit signal frequency synthesizer 413, a transmit signal power manager 415, a transmit resonant frequency controller 417, and communication coupling circuitry 418.

[0061] If two or more target devices receive power on a same resonant frequency then the power source 203 has to manage the power delivery by generating a unique token for each of the target devices so as to track individual power consumption/delivery. The exchange of a token between the target device and the power source 203 authorizes that target device for receiving the power delivery on the same/common power resonant frequency. This technique helps when the multiple target devices are charging from a same/common magnetic resonant field/beam. During the resonant power delivery session the power source 203 and an individual target device, such as the magnetic resonant target device 211, synchronize token and related authentication information to authenticate a target device as a legitimate power receiver. This token based resonant power delivery can be used to serve all the target devices simultaneously.

[0062] During configuration of a target device for power delivery, a generated token is communicated to the target device 211 employing encryption for security, confidentiality and non-repudiation. The decryption of the generated token at the target device requires a key that is communicated out-of-band or generated using a key generation technique. For example, in one embodiment, the key is generated in the target device employing a seed provided for generating keys using a random seed generator 411, the same seed being used by the pseudo random key generator 409 to generate the key in the token generator 407.

[0063] The seed may be pre-configured in the target device or set initially by the user or the system. This key is thus generated in the target device or otherwise received as part of a configuration. In a related embodiment, a different key is generated for each communication/charging session using a seed provided to the target device. The key is generated in the target device randomly by using the seed sent by the random seed generator 411 of the magnetic resonant power charging circuitry 403.

[0064] The transmit signal frequency synthesizer 413 synthesizes stable reference frequency for magnetic coupling. In one embodiment, all other frequencies used for power delivery are a function of this stable frequency. The power level of the synthesized signal is managed by the transmit signal power manager 415 so as to adequate power level is delivered. It also manages power delivery in a particular pattern or beam form. The power level of the magnetic field which is resonant coupled with the target device 211, 115 is sensed and amplified to a power level that is adequate for transmission to a maximum range. This functionality of the power level management is provided by the transmit signal power manager 415.

[0065] The transmit resonant frequency controller 417 ensures that the magnetic power resonant field that charges the rechargeable battery of the target device 211, 215 is

always stable. If for some reasons, the frequency drifts, then an automatic frequency controller mechanism is initiated to correct the magnetic coupling field frequency to its original predefined value.

[0066] FIG. 5 is a block diagram illustrating the target device authenticator of FIG. 1 (and FIG. 2) which identifies and authenticates each of target devices using their unique identity during wireless resonant power charging operation in accordance with the present invention. The target device authenticator 503 consists of a target device identification database 507, a communication protocol setup circuitry 509, a target device power metering circuitry 511 and a target device billing unit 513.

[0067] The target device identification database 507 consists of the information of all subscribers who have subscribed with the power source 203 of FIG. 2. Typically the database information contains a pre-assigned identification number of the target device, relevant personal details of the user, a preferred magnetic resonant frequency for the target device, etc. When the target device 211 communicates with the power source 203 during the power request it also sends its identity information so that the power source 203 cross-verifies with its target device identification database 507 contents. If the communicated information matches the database 507 contents then the resonant power delivery is initiated.

[0068] In one embodiment of the present invention the target device 211 tries to communicate with the power source 203 on its control channel 231 after setting up a communication protocol using the communication protocol setup circuitry 509. This circuitry sets up the target device 211 to communicate with the power source 103. This is required because, in general, the target device 211 performs some regular functionality other than charging, and in order to initiate the specific communication of the control operation for power transmission with the power source 203, it needs to be configured and it may require a protocol setup.

[0069] The target device power metering circuitry 511 records the resonant power delivered to the target device 115, 211. This module is also coordinated with the source power manager 107, 207 during the resonant source power delivery. It essentially monitors the total battery charging duration at a possible rate of power delivery. The target device billing unit 513 performs the billing functionality for the service provided by the power source 203 to the target device 115, 211.

[0070] FIG. 6 is the block diagram illustrating a resonant power charging module 117 of FIG. 1 that receives power on a single frequency on a wireless power & communication channel 111 in accordance with one embodiment of the present invention. The target device resonant power charging module 603 consists of a receiving resonant coupling component 625, a resonant frequency seeking module 605, a target device authentication module 607, a power charging circuitry 609, a power request module 611 and a power charging controller 619.

[0071] The receiving resonant coupling component 625 facilitates magnetic coupling, such as for non-radiated magnetic fields that are used for wireless power transmission. It has the antenna, tuning elements, etc. needed for coupling. The resonant frequency seeking module 605 tries to receive optimum incoming power signal by proper coupling by way of tuning the frequency of magnetic coupling. The maximization of the power signal reception is achieved by the automatic tuning of the resonant coupling circuit component, so that the tuning matches with the incoming magnetic field

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Par. 67 of Bennett **does not** disclose confirming resonator compatibility

“When the target device 211 communicates with the power source 203 during the power request it also sends it **identity information** so that the power source 203 cross-verifies with its target device identification database 507 contents.”

(Ex. 1005, ¶ 67)

“If the **communicated information** matches the database 507 contents then the resonant power delivery is initiated.”

(Ex. 1005, ¶ 67)



Bennett **does not** disclose that matching “identity information” to the database includes confirming resonator compatibility

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209. The magnetic resonant power charging circuitry 205 includes a magnetic field source (such as coupling circuitry) and power generator/amplifier to generate a magnetic field and to power amplify that field, respectively. The power amplified magnetic field is used to setup a magnetic field in air using a solenoid (or a coil) as indicated by a plurality of magnetic field lines 225, 227, and 229. These magnetic lines 225-229 are coupled with a magnetic resonant power charging module 213 of the magnetic resonant target device 211.

[0049] In one embodiment, a magnetic resonant power charging circuitry 213 converts the time varying magnetic flux linkages to the induced voltage across a resonating coil associated with a plurality of diodes, and a plurality of (special) capacitors. The voltage that is developed across the coil is rectified into DC form and stored in a special capacitor bank (array) resulting in voltage multiplier action. When the voltage across the voltage multiplier builds up gradually over several magnetic flux cycles to a required level the rechargeable battery 233 starts charging. The power charging controller 215 controls the power charging operation of a rechargeable battery 233 in the magnetic resonant target device 211.

[0050] The power charging controller 215 senses the low voltage limit and high voltage limit of the rechargeable battery 233. When the voltage levels falls below the preset low voltage limit the power charging controller 215 issues signal to the target device power manager 223. In response, the target device power manager 223 sends a power request to the power source 203. The power source 203 then sets up the necessary magnetic field/flux in the air for wireless power transmission. In the meantime the magnetic resonant target device 211 starts receiving the electric power converted from the magnetic flux linkages received by a coil associated with the magnetic resonant power charging circuitry 213. In one embodiment, the received magnetic power is converted into induced electric power, and then to a DC power using a rectifier and capacitor array. The DC power is used to charge the "rechargeable battery" 233 when the voltage across the capacitor array builds up to a battery charging limit.

[0051] The source power manager 207 ensures adequate magnetic power level required to setup magnetic flux. Also it facilitates focusing magnetic flux lines 225-229 in one particular direction, if necessary, so that the magnetic resonant target device 211 will have an effective coupling with the power source 203.

[0052] The target device authenticator 209 receives the identity of the magnetic resonant target device 211 and verifies a user's authentication or user's subscription to a power charging service. The user authorization module 219 provides the identity information of the magnetic resonant target device 211 and information about a subscription if any (if necessary). The confirmation of the user's subscription is conducted by comparing information available with the target device authenticator 209 (or a database maintained or accessed by it) with the information provided by the user authorization module 219.

[0053] The target device power manager 223 initiates a power request using a wireless link 231 between the power source 203 and the magnetic resonant target device 211. The power charging controller 215 provides information periodically during the resonant power charging to the target device power manager 223. The target device power manager 223 communicates with the power source 203 during the resonant power charging activity so as to provide continued verification

tion of access—the power source 203 can therefore eliminate/avoid unauthorized power access (by an unauthorized device).

[0054] The source resonant frequency selector 217 helps in making fine adjustments to the resonant operation, with synchronization to the incoming power signal frequency. This results in effective coupling between the power source 203 and the magnetic resonant target device 211 for an efficient resonant power transfer.

[0055] An user authorization module 219 delivers the identity of the magnetic resonant target device 211 to the power source 203, as necessary. The identity is sent on the "wireless link" 231. This information is processed by the target device authenticator 209. On confirming the identity of the magnetic resonant target device 211 the power source 203 delivers the resonant power signal. In one embodiment, different frequencies are assigned to a plurality of the magnetic resonant target devices. The assigned frequency value is configured into the magnetic resonant target device 211. Sending of this information to power source 203 with a request for power helps in resonant locking/effective resonant coupling by the power source 203 with magnetic resonant target device 211.

[0056] The communication module 221 includes a circuit that sets up communication for the control operation between the magnetic resonant target device 211 and the power source 203. For example, it communicates with the power source 203 via its communication module 212 on the standard pre-assigned frequency using the wireless link 231.

[0057] FIG. 3 is a flowchart illustrating resonant power transfer operations performed using the power system of FIG. 1 wherein a wireless power transmitting unit 103 transmits power to the target electronic device 115 in accordance with an embodiment of the present invention. At a start block 303 the target electronic device 115 of FIG. 1 determines that power needs to be charged into the rechargeable battery 129. Then, at a next block 305, the target electronic device 115 communicates a request for resonant power signal to the power transmitting unit 103. During this step the target electronic device 115 sends its identity and its (tuned) resonant frequency information to the power transmitting unit 103. At a next block 307 the power transmitting unit 103 requests the current power level, billing information, etc. from the target electronic device 115.

[0058] In response to the request made at the block 307, the target electronic device 115 sends the requested information to the power transmitting unit 103 in the next block 309. The power transmitting unit 103 then generates power employing the requested resonant frequency and delivers it in the form of magnetic field/waves at the next block 311. In one embodiment, the magnetic field is in non-radiated mode, while in another, it is in radiated mode. The power transmitting unit 103 and the target electronic device 115 periodically exchange information on the current status of the battery charge during the resonant battery charge operation at the next block 313.

[0059] When the battery is charged completely (fully charged) at block 315 the target electronic device 115 communicates this status so that the power transmitting unit 103 can disconnect the power transmission (magnetic coupling). At this point of time the power transmitting unit 103 has the details of the amount of power delivered to the target electronic device 115. This information is used for metering and subsequent billing. The resonant power charge operation ends at the next block 317.

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Par. 57 of Bennett *(first relied upon in Petitioner's Reply)* **does not** disclose confirming resonator compatibility

“...the target electronic device 115 sends its identity and its (tuned) resonant frequency information to the power transmitting unit 103.”
(Ex. 1005, ¶ 57)



But Bennett **does not** confirm resonator compatibility using the resonant frequency information

No Reason to Combine Cook and Bennett



Petitioner Provides Multiple Insufficient Motivations

- POSA “could” look to Bennett for “details” of authorization scheme
- Cook and Bennett are “analogous art”
- Benefits of unrelated features provide motivation
- Both references relate to monetizing wireless power transfer

POSA Would Not Look to Bennett for “Details”

Deposition of Mark Allen, Ph.D. May 7, 2024 – Ex. 2003

Mark Allen, Ph.D. - ('687 Patent)
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May 7, 2024

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1 the vehicle is compatible, presumably compatible with
2 the charger, but I do not see the words, you know, the
3 ID contains the resonator frequency explicitly in Cook.

4 Q. You said the ID tells us whether the device
5 is presumably compatible with the charger. Why do you
6 say presumably?

7 A. I suppose someone who wanted to -- I think
8 it depends on the motivation of the -- a call than the
9 electricity seller, for want of a better term. Some
10 might want to be very restrictive and say only my 23
11 cars will be allowed to charge here, and others might
12 try to be more permissive and have any car try to
13 charge here, and if it doesn't work, it doesn't work.
14 I don't know that I would set up a system in that way,
15 but I suppose someone could have a motivation to do
16 that.

17 Q. At the end of paragraph 179, you say that:
18 Cook left the details for how to implement
19 authorization between the charger and vehicle to the
20 person skilled in the art. Do you see that?

21 A. I do.

22 Q. Is it your opinion that a person of skill
23 in the art would not know how to implement the
24 authorization in Cook?

25 A. I think a person of ordinary skill would be

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Exhibit
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Simply because a POSA could look to Bennett does establish a motivation to combine. *InTouch Techs., Inc. v. VGO Comm's Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014) (“The obviousness inquiry does not merely ask whether a skilled artisan could combine the references, but instead asks whether ‘they would have been motivated to do so.’”)

(Ex. 2003, Pg. 50, Lln. 13-19)

Analogous Art ≠ Motivation

Petition for IPR of US8912687 (51292792.1)

Petition for *Inter Partes* Review of USP 8,912,687

plurality of the magnetic resonant target devices”); BProv 15:12-16:15; Allen Decl. 113-14.

Cook further disclosed an “information detecting part” that can be used for “detect[ing] the identification of the vehicle” and allowing power only to be dispensed to authorized IDs corresponding to one that has an “account” with charging enabled. Cook [0015]. Cook explained that detection of an ID may require encrypted signals exchanged between the resonators (Cook [0017]-[0018]) but did not detail the communication link that would be used to transmit those encrypted signals in a magnetic resonant charging system. Allen Decl. 115. A POSA would have turned to Bennett for those implementation details, including the use of in-band and out-of-band channels for the communication link, as well as additional compatibility, safety, and security checks that would be useful in a resonant wireless power transfer system like Cook’s. Allen Decl. 113, 116-17.

Cook and Bennett are analogous art—both to each other and to the ‘687 patent. Allen Decl. 108-11. Cook and Bennett are each directed to wirelessly charging electronic devices using the non-radiative magnetic fields of electromagnetic resonators, the same wireless energy transfer mechanism employed in the ‘687 patent. See Bennett Abstract, [0003], [0010], [0021]-[0022], [0029]-[0030], Fig. 1 (discussing the use of “non-radiated magnetic field waves” to transmit energy through a between “a power source and a target device”); BProv 1:6-8, 4:2-

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Petitioner’s “analogous art” argument is legally wrong

“Cook and Bennett are analogous art — both to each other and to the ‘687 patent.”

(Petition, p. 22)



Simply because references are analogous art “is an insufficient articulation for motivation to combine.” *Sisvel Int’l S.A. v. Sierra Wireless, Inc.*, 82 F.4th 1355, 1364 (Fed. Cir. 2023)

Benefits of Unrelated Features ≠ Motivation



Motivation cannot be “based on functionally irrelevant features of references that happen to exhibit a benefit for altogether different reasons.” *Medtronic, Inc. v. Teleflex Innovations S.a.r.l.*, 69 F.4th 1341, 1351 (Fed. Cir. 2023)



Petitioner relies on: (*Paper 1, 24-29*)

- post-authentication function of tuning the transmitting resonator frequency
- use of encrypted communication channels
- token-based encryption systems
- battery level detection to improve safety

Benefits of Unrelated Features ≠ Motivation



None of these benefits relate to confirming resonator compatibility
(Ex. 2001, ¶¶ 60-63, 71)

- Tuning the source resonator frequency occurs after authentication
- Using encrypted communication channels and specific token-based systems are unrelated to resonator compatibility
- Monitoring the battery level to prevent overcharging is also unrelated to resonator compatibility

Cook Already Discloses the Authentication of Bennett

Patent US 2010/0036773 AI – Ex. 1005

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Feb. 11, 2010

communications 113. The RF communications 113 may include Wireless Local Area Network (WLAN) communications such as IEEE 802.11x communications, Wireless Personal Area Network (WPAN) communications such as Bluetooth communications, cellular communications, proprietary interface communications, or other RF communication techniques. The communication module 110 may also include a wired communication link, e.g., Local Area Network (LAN) such as Ethernet, Cable Modem, Wide Area Network (WAN) and/or other wired communication means. For example, the wired communication link could provide a high speed uplink to the Internet.

[0030] The target electronic device 115 includes a resonant power charging module 117, a user authorization module 121, a source resonant frequency selector 123, a communication module 125, and a target device power manager 127. The resonant power charging module 117 includes a receiving resonant coupling component 141, a power charging controller 119, and a rechargeable battery 129. The receiving resonant coupling component 141, also sometimes referred to as a receiving resonant charging component, is used to receive the power transmissions provided by the power transmitting unit 103 employing the target resonant frequency. The target electronic device 115 employs the received power for operation of the target electronic device 115 as well as for charging the rechargeable battery 129 in the target electronic device 115. The power delivery system 101 employs the sending resonant coupling component 113 of the power transmitting unit 103 to generate magnetic fields that are used to transmit power to the target devices, such as the target electronic device 115. Typically, the sending resonant coupling component 113 includes a resonant coil that fills the space around it with a non-radiated magnetic field oscillating at the target resonant frequency that is received by the target electronic device 115 employing the receiving resonant coupling component 141. The target device also includes a communication module operable 125 to communicate with the communication module 110 of the power transmitting unit 103 via the magnetic coupling and/or via RF communications.

[0031] The power transmitting unit 103 that includes the power source 105 and the target electronic device 115 are communicatively coupled with each other during the resonant power delivery from the power source 105 to the target electronic device 115. The resonant coupling is achieved wirelessly using a "wireless field" 111, which is non-radiated magnetic field in some embodiments. The "wireless field" 111 is the power delivery channel and a "wireless link" 113 is the control signal channel. In one embodiment of the present invention communicating the power and a control signal are conducted employing the same frequency, or in other words, on the same channel, i.e. the wireless field 111. In another embodiment the power link (such as the magnetic field), the control signal, and the normal communication (i.e. the normal function) operation takes place in separate channels. For e.g. the power transmitting unit 103 is implemented in the base station of a mobile phone, where the normal communication operations with the mobile phone (from the base station), resonant power delivery, and the control signal transmission are all conducted between the mobile phone (as a target electronic device) and the base station employing different channels.

[0032] The power source 105 is a module which generates the required power to be transmitted in a non-radiated magnetic or radiated magnetic mode, employing an essentially

"wireless means" 111. The power source 105 provides power to the sending resonant coupling component 131 which transmits it, for example, creating a non-radiated magnetic field. A source power manager 107 manages the wireless power transmission.

[0033] In one embodiment, the power source 105 generates an alternating current signal that is sufficiently power amplified and radiated using highly directional antenna in the direction of the target device 115. In a different embodiment, the required directionality for the power transmitted is achieved using an antenna array or a dish antenna, as appropriate.

[0034] The resonant power charging module 117 of the target electronic device 115 includes the receiving resonant coupling component 141 that is capable of receiving the transmitted power. In one embodiment, receiving resonant coupling component 141 includes a resonating coil and associated tuning elements such as capacitors.

[0035] Isolation of the resonating circuitry of the receiving resonant coupling component 141 from other internal circuitry of the target electronic device 115 is supported, such as by the use of a buffer (isolation) amplifier, a diode, and capacitor voltage multiplier. In a related embodiment, the diode and the capacitor voltage multiplier are part of the resonating (antenna) circuitry of the receiving resonant coupling component 141. The required high quality factor and the resonant effect are achieved through the right choice of the diode, the capacitors, etc.

[0036] In one embodiment, voltage multipliers in the resonant power charging module 117 builds up the required voltage across a capacitor array to achieve the recharging of the rechargeable battery 129 of the target electronic device 115. During the process of power charging the power charging controller 119 regulates the electric charge that flows into the rechargeable battery 129. The power charging controller 119 of the resonant power charging module 117 senses the battery voltage for its high voltage limit or the low voltage limits to stop charging or start charging, respectively. The high voltage limit protects the battery and the low voltage limit initiates a resonant power request that results in the subsequent battery charging operation.

[0037] The user authorization module 121 facilitates the authentication of the target electronic device 115, for resonant power delivery, with the target device authenticator 109 of the power transmitting unit 103. During resonant power delivery, the user authorization module 121 exchanges the authentication information with the power transmitting unit 103. The power transmitting unit 103 compares the information (or a computed value thereof) with the subscriber's information in its database accessed by the target device authenticator 109. If the match is determined, then resonant power delivery is initiated. The authentication is followed by optional frequency selection and directional adjustments of a non-radiated magnetic field in the direction of the target electronic device 115. In a related embodiment, the magnetic field steering is done based on the analysis of the determined or perceived location (e.g., employing arrival direction) of the target electronic device 115.

[0038] The source resonant frequency selector 123 provides a tuning mechanism in order to achieve the required resonant coupling effect. For example, it facilitates the tuning of capacitors where capacitors are used for tuning. Some tuning capacitors are voltage controlled, and they are basically, diode varactors. The tuning voltage is automatically

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The authentication process in Bennett ***provides*** authentication information and ***compares*** it to subscriber information in a database

“...the user authorization module 121 exchanges the authentication information with the power transmitting unit 103.”

(Ex. 1005, ¶ 37)

“The power transmitting unit 103 ***compares the information... with the subscriber's information in its database*** accessed by the target device authenticator 109.”

(Ex. 1005, ¶ 37)

Cook Already Discloses the Authentication of Bennett

Patent US 2009/0299918 AI – Ex. 1007

US 2009/0299918 AI

Dec. 3, 2009

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WIRELESS DELIVERY OF POWER TO A MOBILE POWERED DEVICE

BACKGROUND

[0001] Wireless delivery of power may be used to provide power to a load. For example, U.S. patent application Ser. No. 12/018,069, filed Jan. 22, 2008, entitled “Wireless Apparatus and Methods”, the disclosure of which is herewith incorporated by reference, describe wireless transfer of power to a load. This may be done by forming a magnetic field and receiving a magnetic field in a resonant antenna that is resonant with at least one characteristic of a magnetic field. The power transmission may also be done inductively. The magnetic delivery of power, however, has the advantage of being capable of delivering power over a longer distance.

SUMMARY

[0002] The present application describes wireless delivery of power to a mobile powered device such as an automobile. An embodiment describes how power can be delivered to the automobile in a number of different locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:
[0004] FIG. 1 shows an overall block diagram of a system for delivering power wirelessly to a load; and
[0005] FIG. 2 illustrates a flowchart of operation that may be carried out in controller 180 or in hardware that is distributed at various locations throughout the network.

DETAILED DESCRIPTION

[0006] Delivery of electric power to automobiles may become more prevalent as electrically powered automobiles enter and occupy a more significant portion of the market. For example, as of the time of writing of this document, there are many different forms of hybrid automobiles which operate based both on internal combustion engines, and also on stored charge in a battery. There are fewer forms of electric automobiles such as plug-in hybrids or plug-in electric vehicles.

[0007] Commercial success of such a vehicle would require that either the vehicle have a sufficient mileage range to make an entire round-trip without recharging, or that the user recharge the vehicle at some intermediate point. Currently, there are vehicle charging stations mostly associated with public areas, for example airports and public parking places. This is done in many ways as a public service to allow or encourage more people to use electric automobiles. However, this is not a long-term practical solution.

[0008] The inventors also recognize that it may be desirable to wirelessly deliver power to an electric powered mobile device, such as an automobile.

[0009] FIG. 1 illustrates a block diagram of a system according to the present application. An electrically powered automobile includes at least one battery 102 which may operate at least one electronic mobile system of the automobile. For example, in one embodiment, the battery 102 may be the primary power source of the automobile. In other embodiments, the battery may be a partial driver, such as a hybrid vehicle which can operate based on electric power from the battery, or from electromotive force such as gas power, or both.

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Cook already discloses comparing an identifier to subscriber database

“[S]tep 200 detects the identification of the vehicle”

(Ex. 1007, ¶ 15)

“At 205, a detection is made of whether that detected identification has an account associated therewith.”

(Ex. 1007, ¶ 15)



No motivation where Cook already achieves the authentication function of Bennett. See e.g., *Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1368-69 (Fed. Cir. 2012)

Conclusion

✓ Petitioner has failed to show that the challenged claims are obvious over Cook and Bennett

- Neither reference discloses confirming resonator compatibility
- There is no motivation to combine Bennett with Cook.