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(54) **WIRELESS CHARGING AND POWERING OF ELECTRONIC DEVICES IN A VEHICLE**

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CPC ***H02J 7/025*** (2013.01); ***H02J 7/007*** (2013.01); ***H02J 7/0021*** (2013.01)

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CPC . H02J 7/025; H02J 7/00; H01F 38/14; H04W 52/38; H04B 5/0037
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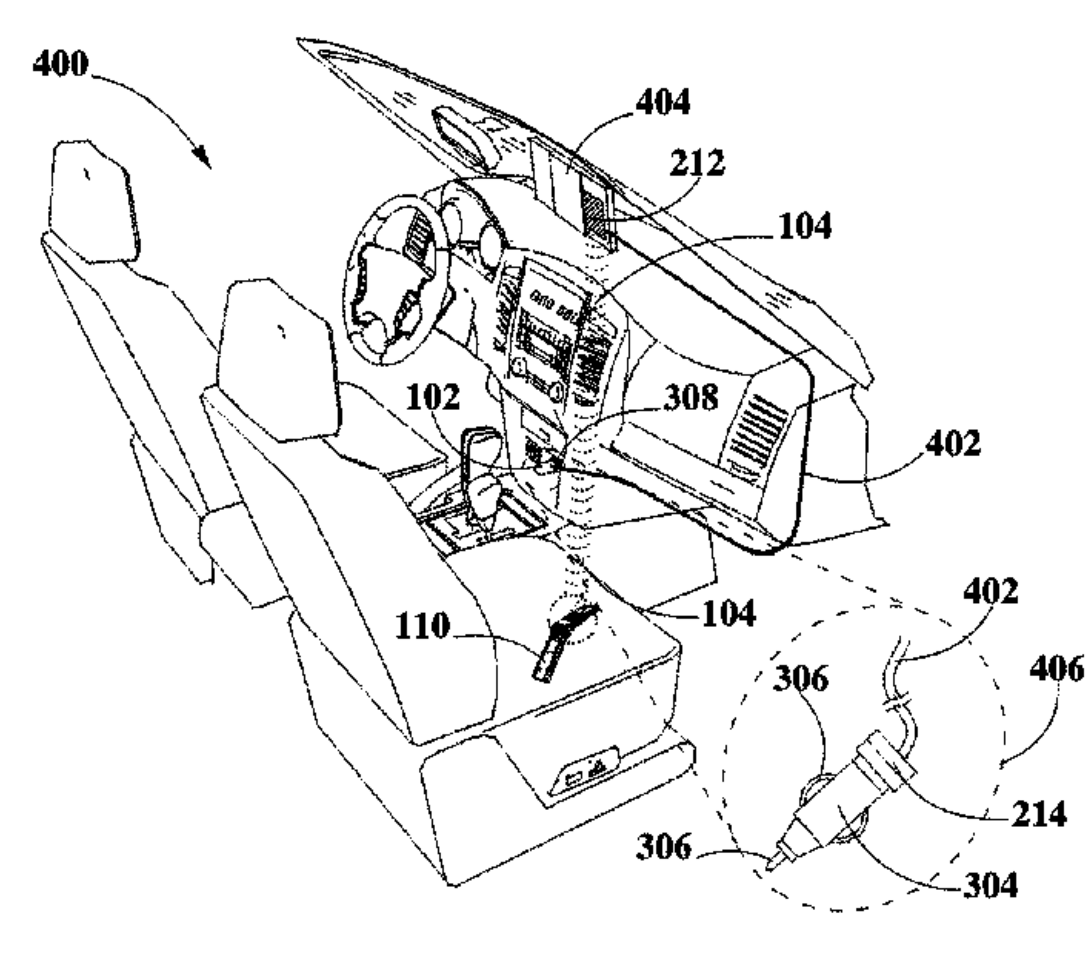
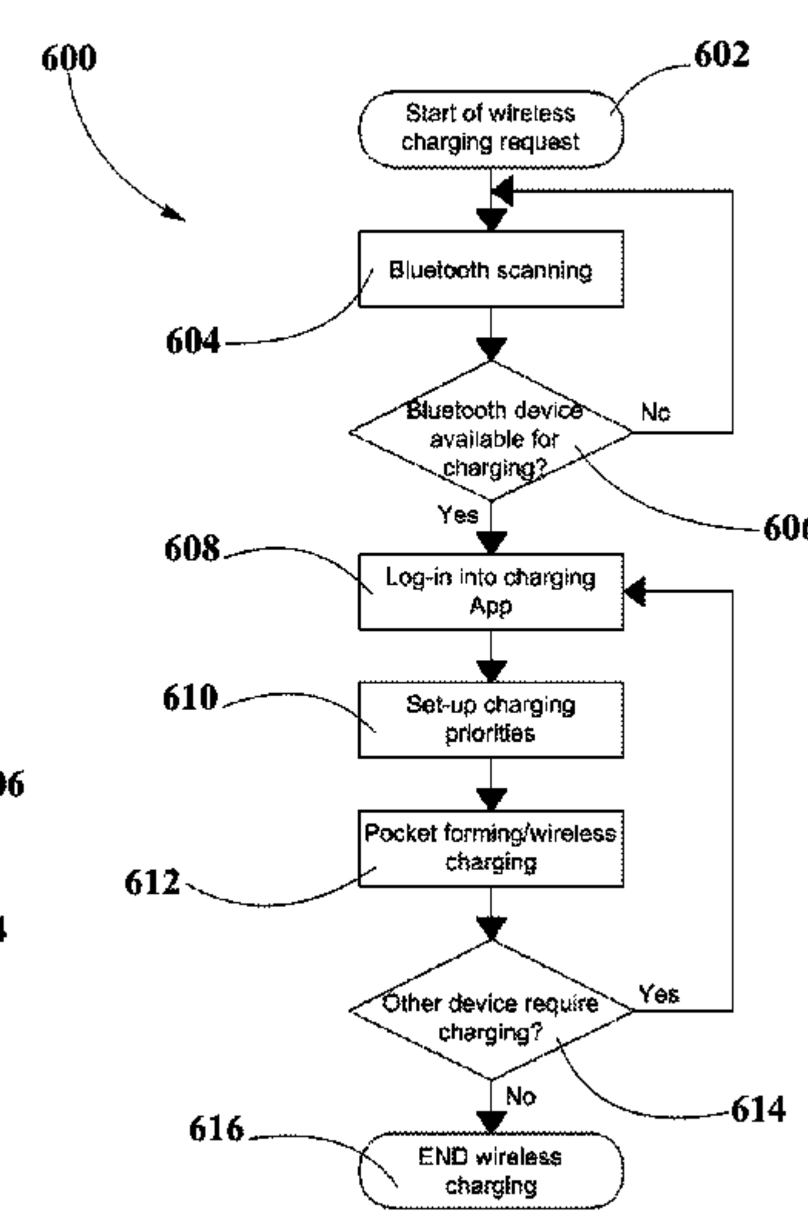
(57) **ABSTRACT**

Configurations and methods of wireless power transmission for charging or powering one or more electronic devices inside a vehicle are disclosed. A transmitter capable of single or multiple pocket-forming may be connected to a car lighter, where this transmitter may include a circuitry module and an antenna array integrated within the transmitter, or operatively connected through a cable. This cable may allow the positioning of the antenna array in different locations inside the vehicle suitable for directing RF waves or pockets of energy towards one or more electronic devices. Transmitter's configuration can be accessed by one or more electronic devices through Bluetooth communication in order to set up charging or powering priorities.

24 Claims, 6 Drawing Sheets





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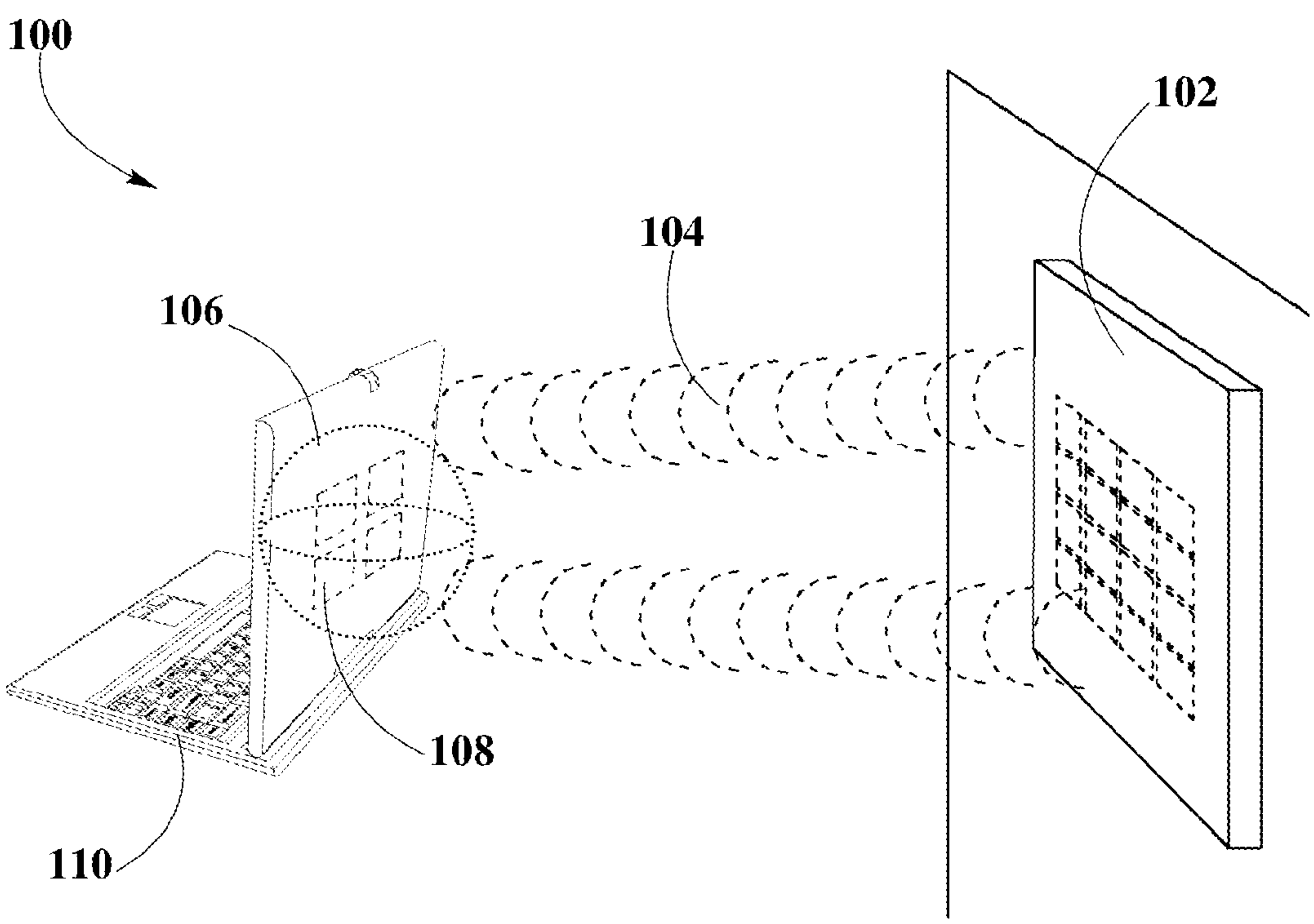
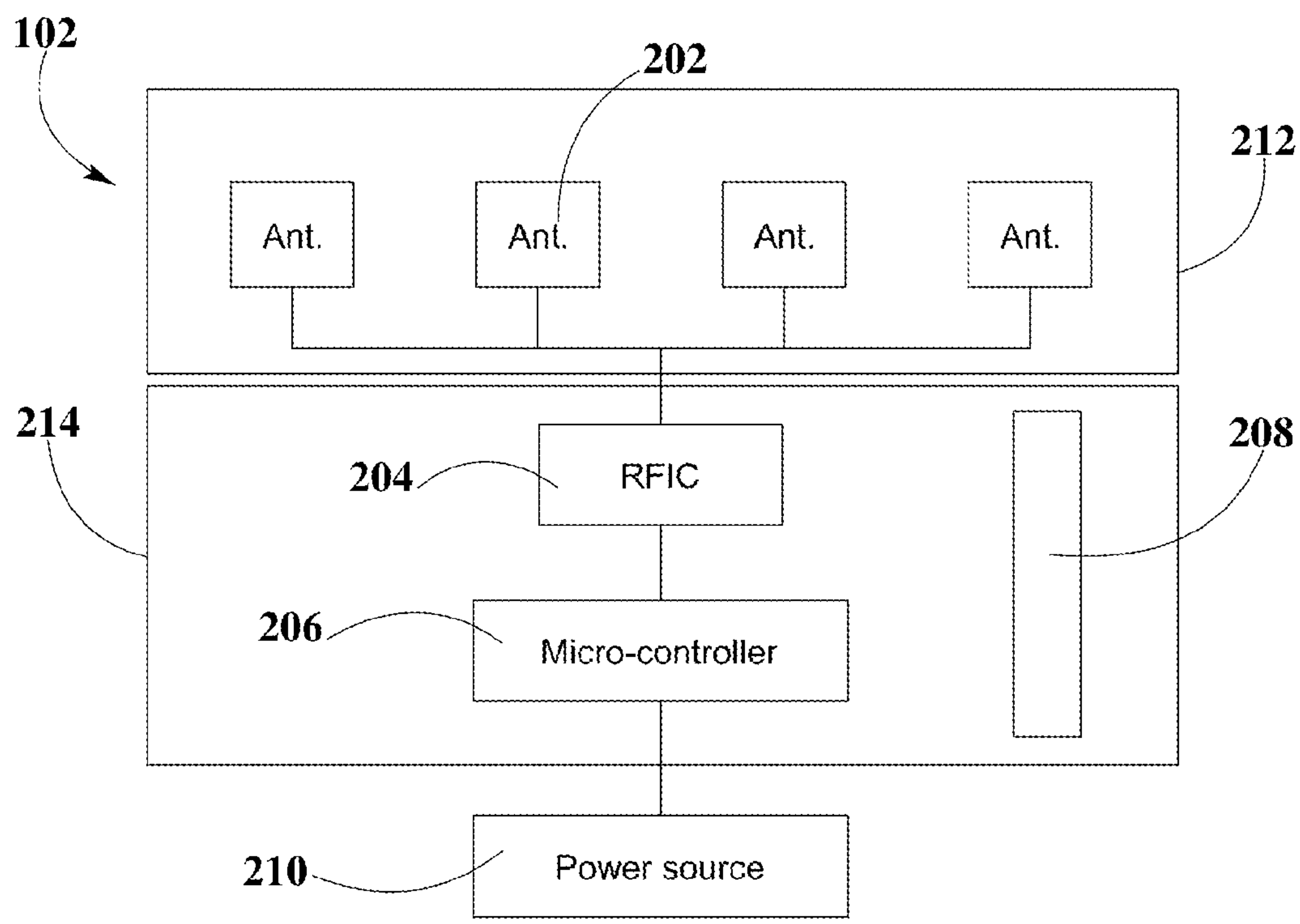


FIG. 1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202
212
Ant.
Ant.
Ant.
Ant.
214
208
204
RFIC
206
Micro-controller
210
Power source

FIG. 2

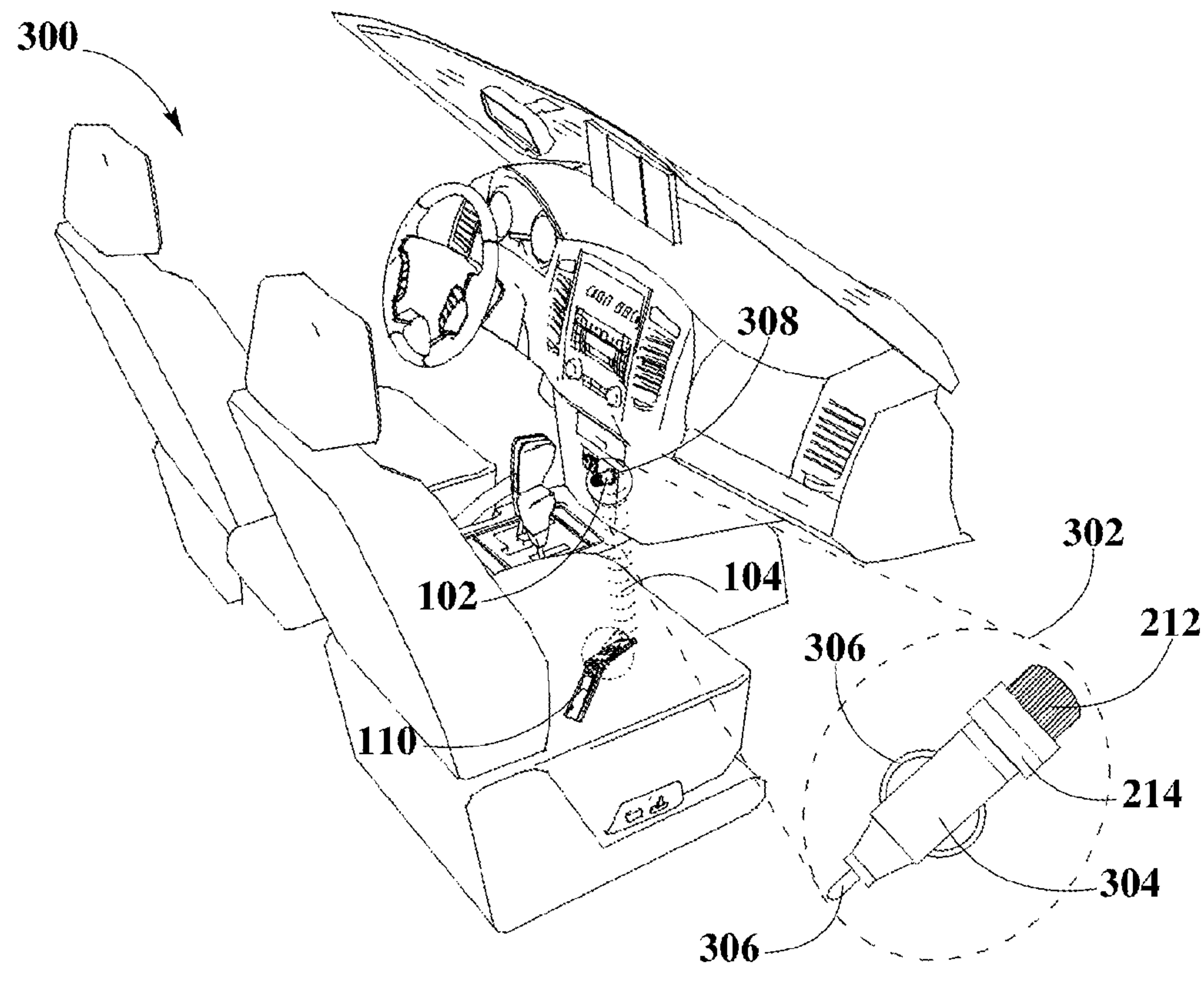

FIG. 3

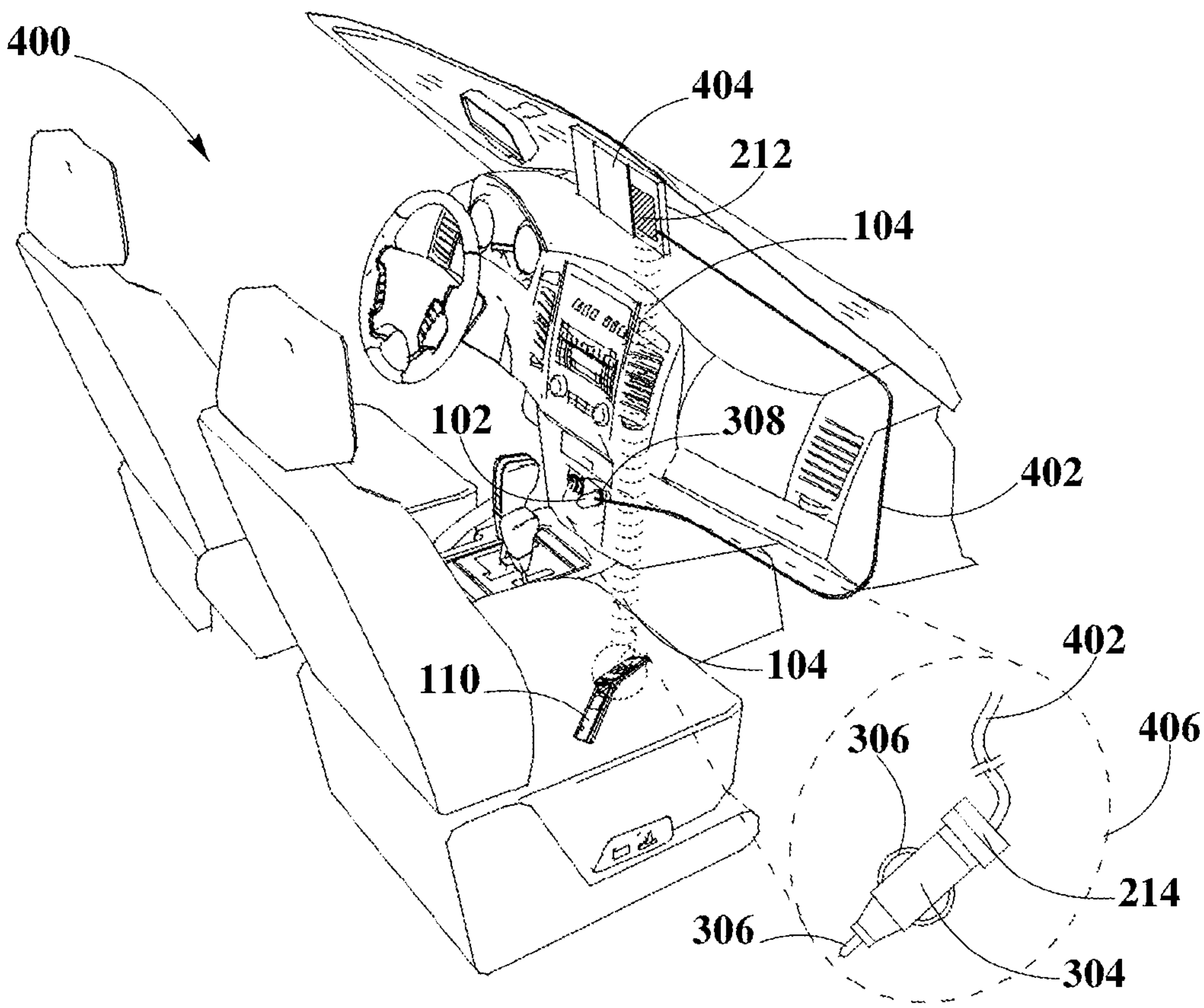

FIG. 4

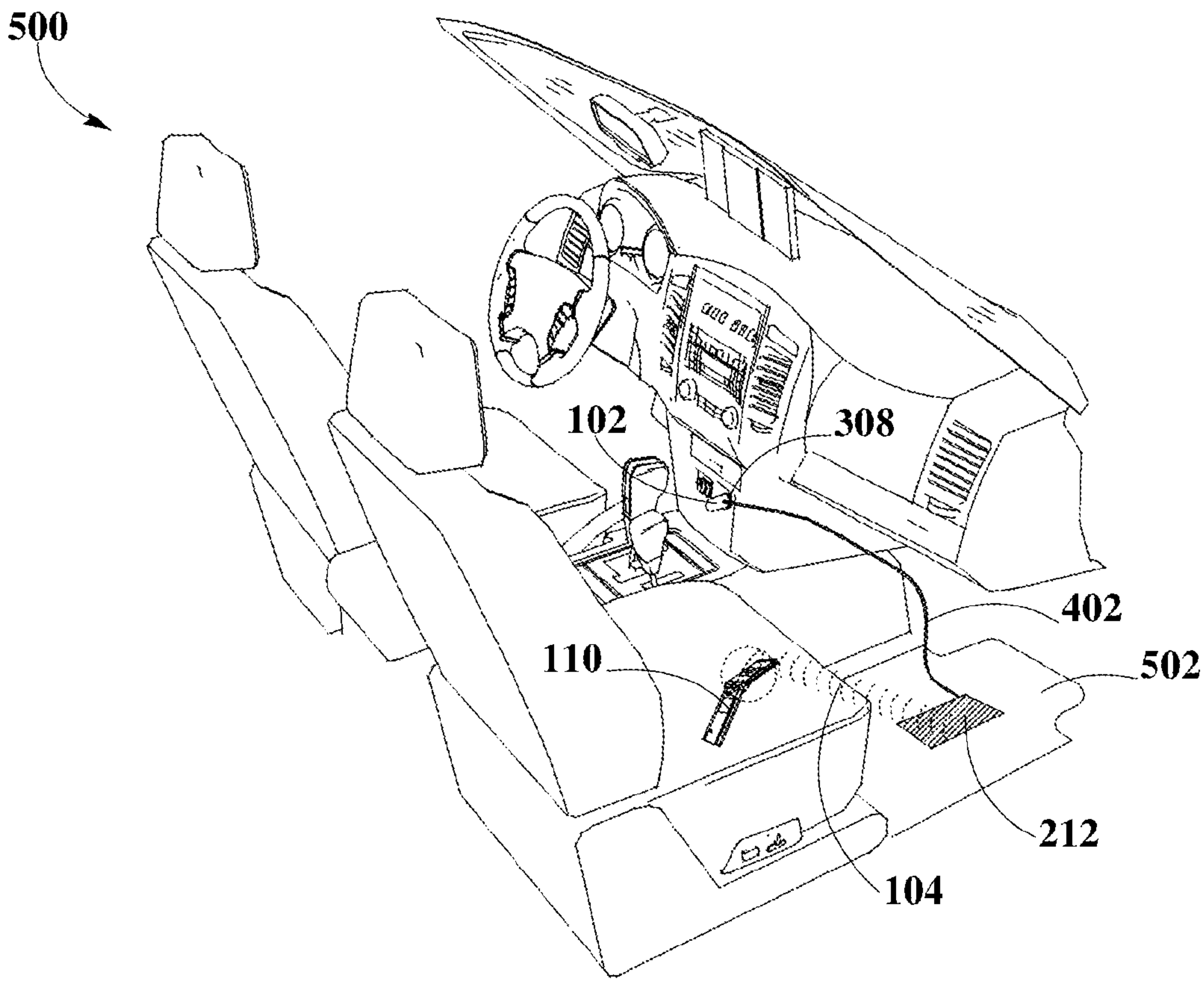

FIG. 5

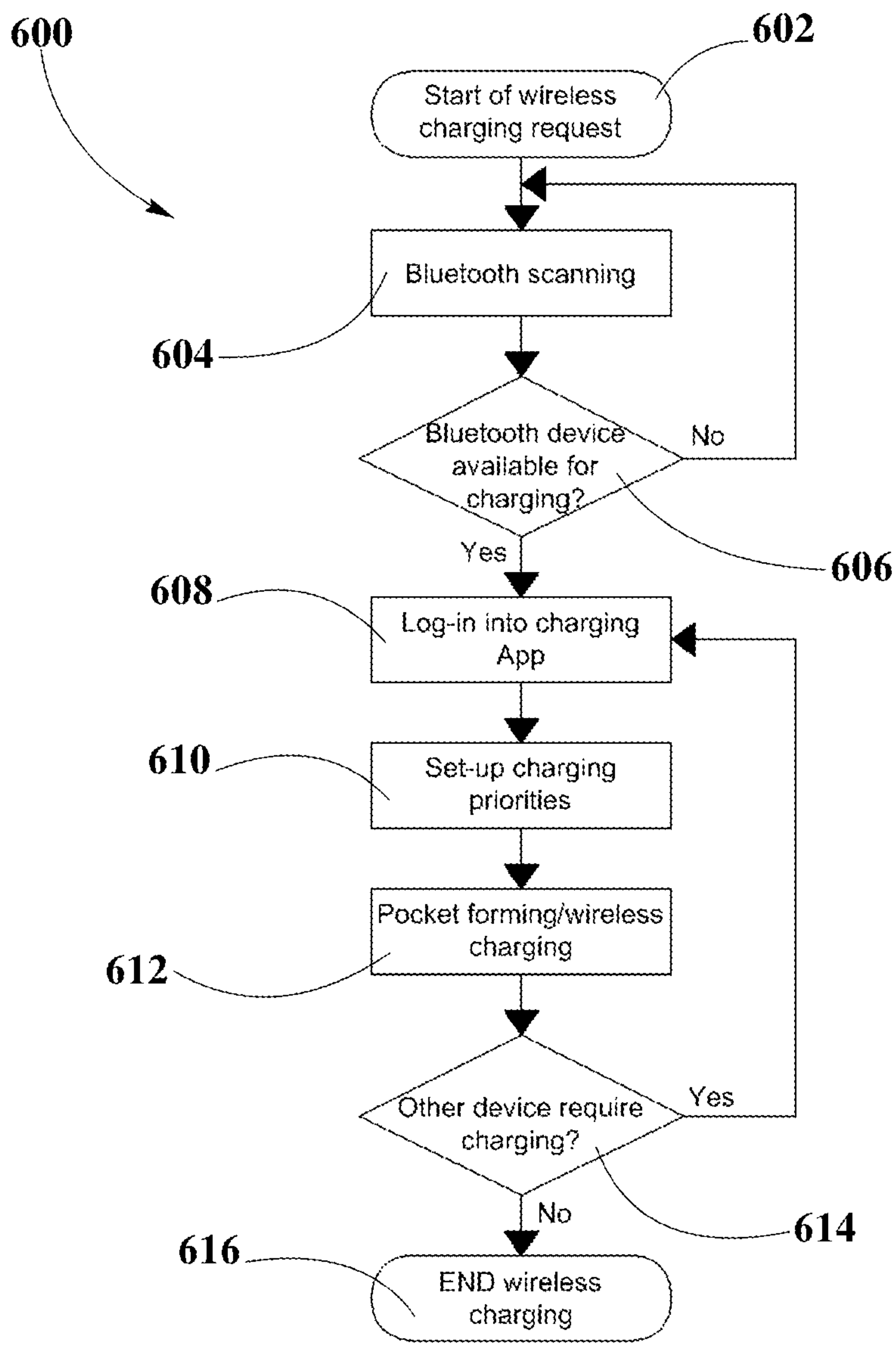
600
602
Start of wireless charging request
Bluetooth scanning
604
Bluetooth device available for charging?
No
Yes
606
608
Log-in into charging App
610
Set-up charging priorities
Pocket forming/wireless charging
612
Other device require charging?
Yes
No
614
616
END wireless charging

FIG. 6

WIRELESS CHARGING AND POWERING OF ELECTRONIC DEVICES IN A VEHICLE

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/939,655, filed Jul. 11, 2013, which is herein fully incorporated by reference in its entirety for all purposes.

This application is related to U.S. patent application Ser. No. 13/891,430, filed May 10, 2013; U.S. patent application Ser. No. 13/925,469, filed Jun. 24, 2013; U.S. Non-Provisional patent application Ser. No. 14/583,625, filed Dec. 27, 2014, entitled "Receivers for Wireless Power Transmission," U.S. Non-Provisional patent application Ser. No. 14/583,630, filed Dec. 27, 2014, entitled "Methodology for Pocket-Forming," U.S. Non-Provisional patent application Ser. No. 14/583,634, filed Dec. 27, 2014, entitled "Transmitters for Wireless Power Transmission," U.S. Non-Provisional patent application Ser. No. 14/583,640, filed Dec. 27, 2014, entitled "Methodology for Multiple Pocket-Forming," U.S. Non-Provisional patent application Ser. No. 14/583,641, filed Dec. 27, 2014, entitled "Wireless Power Transmission with Selective Range," U.S. Non-Provisional patent application Ser. No. 14/583,643, filed Dec. 27, 2014, entitled "Method for 3 Dimensional Pocket-Forming," all of which are fully incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

The present disclosure relates generally to wireless power transmission, and more particularly, to configurations and methods of wireless power transmission in vehicles.

BACKGROUND

The charging or powering of electronic devices in vehicles may include several limitations. Typically, electronic devices, such as laptop computers, smartphones, portable gaming devices, tablets, and the like, may require the use of different car charger adapters for each type of electronic device, depending on the model and electrical ratings. This can represent an inconvenience for a user, from an economical and practical perspective, who would need to invest in and carry several car charger adapters. In addition, when using the car's cigarette lighter, charging may be limited to a sequential operation, meaning that the user would have to connect one electric device after the other for suitable charging. This may prove to be inefficient and cumbersome for the user.

For the foregoing reasons, there may be a need for wireless charging methods and configurations that may allow efficient and simultaneous charging or powering of one or more electronic devices inside a vehicle.

SUMMARY

Configurations and methods for wireless power transmission in vehicles are disclosed. Wireless power transmission for powering or charging one or more electronic devices inside a vehicle may include a transmitter capable of emitting RF waves for the generation of pockets of energy; and one or more electronic devices operatively coupled with one or more receivers that may utilize these pockets of energy for charging or powering.

A method for wireless power transmission in a vehicle comprises pocket-forming for generating pockets of energy from a transmitter connected to a power source in the vehicle and coupling a receiver to an electronic device located within the vehicle for receiving the pockets of energy and utilizing the pockets of energy for powering and charging the electronic device.

The transmitter utilized for pocket-forming may include an array of antennas, a circuitry module, and a power source for the transmitter, where this power source may be in the form of a car lighter socket. The array of antennas may include two or more antenna elements, while the circuitry module may include a Radio frequency integrated circuit (RFIC), a microcontroller, and a communication component.

According to an embodiment, a wireless power transmission for charging one or more electronic devices inside a vehicle may include a transmitter operatively connected to a car lighter socket, where this transmitter may function as a standalone device integrating the circuitry module and antenna array in a cylindrical or rectangular housing. This transmitter may generate single or multiple pocket-forming for charging or powering one or more electronic devices which may be located in different positions inside the vehicle.

According to another embodiment, a wireless power transmission for charging one or more electronic devices inside a vehicle may include a transmitter operatively connected to a car lighter socket, where this transmitter may include a cable for connecting the circuitry module and the antenna array. This cable may allow positioning the antenna array in the vehicle's sun visor or in any suitable location inside the vehicle, and separately from the circuitry module which may be connected to the car lighter socket.

Yet in another embodiment, a wireless power transmission for charging one or more electronic devices inside a vehicle may include a transmitter operatively connected to a car lighter socket, where this transmitter may include a cable for connecting the circuitry module and the antenna array. This cable may allow positioning the antenna array underneath the vehicle's floor mats or in any suitable location inside the vehicle, and separately from the circuitry module which may be connected to the car lighter socket.

In a further embodiment, a wireless power transmission process for charging one or more electronic devices inside a vehicle may begin with a wireless charging request, followed by a Bluetooth scanning that may identify one or more electronic devices available for wireless charging. Available electronic devices can log in into a charging application that may provide access to the transmitter's configuration, where charging or powering priorities can be set for each of the available electronic devices. Based on these charging or powering priorities, the transmitter may direct pocket-forming towards the designated electronic devices which can be charged, sequentially or simultaneously, according to the established charging or powering order.

The disclosed configurations and methods of wireless power transmission may provide efficient and simultaneous charging of one or more electronic devices, while using a single transmitter that may position its antenna array in suitable locations across the vehicle for optimal pocket forming. Additional features and advantages can become apparent from the detailed descriptions which follow, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present disclosure are described by way of example with reference to the accompanying figures which are schematic and may not be drawn to scale. Unless indicated as representing the background information, the figures represent aspects of the disclosure.

FIG. **1** shows a wireless power transmission using pocket-forming, according to the present disclosure.

FIG. **2** illustrates a simplified block diagram of a transmitter which may be utilized for a wireless power transmission according to FIG. **1**.

FIG. **3** depicts a wireless power transmission that can be implemented for charging, or powering one or more electronic devices inside a vehicle according to FIG. **1**.

FIG. **4** illustrates a wireless power transmission where a transmitter may include a cable for positioning antenna array in a vehicle's sun visor according to the present disclosure.

FIG. **5** shows a wireless power transmission where a transmitter may include a cable for positioning an antenna array underneath the vehicle's floor mats according to the present disclosure.

FIG. **6** depicts a simplified flowchart of a wireless power transmission process that may be implemented for charging one or more electronic devices inside a vehicle according to the present disclosure.

DETAILED DESCRIPTION

"Pocket-forming" refers to generating two or more radio frequency ("RF") waves which converge in three-dimensional ("3-D") space, forming controlled constructive and destructive interference patterns.

"Pockets of energy" refers to areas or regions of space where energy or power accumulates in the form of constructive interference patterns of RF waves.

"Null-space" refers to areas or regions of space where pockets of energy do not form because of destructive interference patterns of RF waves.

"Transmitter" refers to a device, including a chip which generates two or more RF signals, at least one RF signal being phase shifted and gain adjusted with respect to other RF signals, substantially all of which pass through any number of RF antennas, such that focused RF signals are directed to a target.

"Receiver" refers to a device that includes at least one antenna element, at least one rectifying circuit and at least one power converter, which utilizes pockets of energy for powering, or charging an electronic device.

"Adaptive pocket-forming" refers to dynamically adjusting pocket-forming to regulate power on one or more targeted receivers.

"Reflector" refers to a device capable of efficiently reflecting the power of RF waves from a transmitter towards a receiver for the wireless charging of an electronic device.

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, which may not be to scale or to proportion, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings and claims, are not meant to be limiting. Other embodiments can be used and/or and other changes can be made without departing from the spirit or scope of the present disclosure.

FIG. **1** illustrates a wireless power transmission **100** using pocket-forming. A transmitter **102** may transmit controlled Radio Frequency (RF) waves **104** which may converge in 3-d space. These RF waves **104** may be controlled through phase and/or relative amplitude adjustments to form constructive and destructive interference patterns (pocket-forming). Pockets of energy **106** may be formed at constructive interference patterns and can be 3-dimensional in shape, while null-spaces may be generated at destructive interference patterns. A receiver **108** may then utilize pockets of energy **106** produced by pocket-forming for charging or powering an electronic device **110**, for example, a smartphone, a tablet, a laptop computer (as shown in FIG. **1**), a music player, an electronic toy, and the like. In some embodiments, there can be multiple transmitters **102** and/or multiple receivers **108** for powering various electronic devices **110** at the same time. In other embodiments, adaptive pocket-forming may be used to regulate the power transmitted to electronic devices **110**.

FIG. **2** illustrates a simplified block diagram of a transmitter **102** which may be utilized for wireless power transmission according to the scope of the present disclosure. Transmitter **102** may include one or more antenna elements **202**, one or more Radio frequency integrated circuit (RFIC) **204**, one or more microcontroller **206**, a communication component **208**, and a power source **210**. Components in transmitter **102** may be manufactured using meta-materials, micro-printing of circuits, nano-materials, and the like. Transmitter **102** may be responsible for pocket-forming, adaptive pocket-forming and multiple pocket-forming through the use of the components mentioned in the foregoing paragraph.

Antenna elements **202** may include flat antenna elements, patch antenna elements, dipole antenna elements, or any suitable antenna for wireless power transmission **100**. Shape and orientation of antenna elements **202** may vary in dependency of the desired features of transmitter **102**, where orientation may be flat in X, Y, and Z axis, as well as various orientation types and combinations in three dimensional arrangements. Antenna elements **202** materials may include any suitable material that may allow Radio signal transmission with high efficiency, good heat dissipation and the like. Number of antenna elements **202** may vary in relation with the desired range and power transmission capability on transmitter **102** where the more antenna elements **202**, the wider range and higher power transmission capability.

Antenna elements **202** may include suitable antenna types for operating in frequency bands such as 900 MHz, 2.5 GHz or 5.8 GHz as these frequency bands conform to Federal Communications Commission (FCC) regulations part **18** (Industrial, Scientific and Medical equipment). Antenna elements **202** may operate in independent frequencies, allowing a multichannel operation of Pocket-forming.

In addition, antenna elements **202** may have at least one polarization or a selection of polarizations. Such polarization may include vertical pole, horizontal pole, circularly polarized, left hand polarized, right hand polarized, or a combination of polarizations. The selection of polarizations may vary in dependency of transmitter **102** characteristics. In addition, antenna elements **202** may be located in various surfaces of transmitter **102**.

The combination of two or more antenna elements **202** may form antenna array **212**, where these antenna elements **202** may operate in single array, pair array, quad array and any other suitable arrangement, which may be designed in accordance with the desired application.

The circuitry module **214** of transmitter **102** may include RFIC **204**, microcontroller **206**, and communication component **208**. RFIC **204** may include a plurality of RF circuits which may include digital and/or analog components, such as, amplifiers, capacitors, oscillators, piezoelectric crystals and the like. RFIC **204** may control features of antenna elements **202**, such as gain and/or phase for pocket-forming and manage through it direction, power level, and the like.

The phase and the amplitude of pocket-forming in each antenna elements **202** may be regulated by the corresponding RFIC **204** in order to generate the desired pocket-forming and null steering. RFIC **204** may be connected to microcontroller **206**, which may include a digital signal processor (DSP), PIC-Class microprocessor, central processing unit, computer and the like. Microcontroller **206** may control a variety of features of RFIC **204** such as, time emission of pocket-forming, direction of the pocket-forming, bounce angle, power intensity and the like. Furthermore, microcontroller **206** may control multiple pocket-forming over multiple receivers **108** or over a single receiver **108**.

Microcontroller **206** may manage and control communication protocols and signals by controlling communication component **208**. Microcontroller **206** may process information received by communication component **208** which may send and receive signals to and from a receiver **108** in order to track it and concentrate the pocket of energy **106** on it. In addition, other information may be transmitted from and to receiver **108**, where such information may include authentication protocols among others. Communication component **208** may include and combine Bluetooth technology, infrared communication, WI-FI, FM radio among others. Microcontroller **206** may determine optimum times and locations for pocket-forming, including the most efficient trajectory to transmit pocket forming in order to reduce losses due to obstacles. Such trajectory may include direct pocket-forming, bouncing, and distance discrimination of pocket-forming.

Transmitter **102** may be fed by a power source **210** which may include AC or DC power supply. Voltage, power and current intensity provided by power source **210** may vary in dependency with the required power to be transmitted. Conversion of power to radio signal may be managed by microcontroller **206** and carried out by RFIC **204**, which may utilize a plurality of methods and components to produce radio signals in a wide variety of frequencies, wavelength, intensities and other features. As an exemplary use of a variety of methods and components for radio signal generation, oscillators and piezoelectric crystals may be used to create and change radio frequencies in different antenna elements **202**. In addition, a variety of filters may be used for smoothing signals as well as amplifiers for increasing power to be transmitted.

Transmitter **102** may emit pocket-forming with a power capability from few watts to over hundreds of watts. Each antenna element **202** may manage a certain power capacity. Such power capacity may be related with the application.

Referring now to FIG. **3**, a wireless power transmission **300** can be implemented in order to charge or power one or more electronic devices **110** inside a vehicle. According to some aspects of this embodiment, transmitter **102** can be configured within a cylindrical shape, exhibiting a longitude between about 2 and 3 inches, and a diameter ranging from about 0.5 inch to about 1 inch. As illustrated in close-up view **302**, transmitter **102** can include a suitable connector **304** with pins **306** that can be inserted into car lighter socket **308** for powering transmitter **102**. Transmitter **102** can function as a standalone, self-contained device that can integrate circuitry module **214** and antenna array **212**, along with connector **304** and pins **306**.

Car lighter socket **308** can supply 12 or 24 DC volts for powering transmitter **102**, which may be sufficient power for most portable electronic devices **110** such as smartphones, DVD players, portable gaming systems, tablets, laptops computers, and the like. In some embodiments, circuitry module **214** of transmitter **102** can include a DC-to-DC converter or a DC-to-AC converter, depending of the electrical charging requirements of electronic device **110**. Yet in other embodiments, circuitry module **214** can include a switchable power converter that can be configured according to the charging requirements of electronic device **110**.

Operation of transmitter **102** in FIG. **3** may be similar to the operation described in FIG. **2** where transmitter **102** can be driven by a power source **210**, in this case, car lighter socket **308**. Transmitter **102** can use communication component **208** (not shown in FIG. **3**) in circuitry module **214** to locate a receiver **108** (not shown in FIG. **3**) embedded in electronic device **110**. Microcontroller **206** (not shown in FIG. **3**) in circuitry module **214** may determine the optimum path for the generation of pocket-forming, according to the location of electronic device **110** within the vehicle. As depicted in FIG. **3**, electronic device **110** can be located in the passenger seat, right beside the driver seat. Microcontroller **206** may communicate with RFIC **204** (not shown in FIG. **4**) in circuitry module **214** so as to control the generation and transmission of RF waves **104** through antenna array **212** which may include two or more antenna elements **202**. Transmission of RF waves **104** can be aimed at electronic device **110** in the passenger seat for the generation of pocket-forming suitable for charging or powering electronic device **110**.

Wireless power transmission **300** can also be used for powering or charging an electronic device **110** located in the backseats of the vehicle, or any other locations inside vehicle. In this case, transmitter **102** can use any suitable reflecting surface of the vehicle, preferably metallic, in order to transmit RF waves **104** and redirect the formation of pockets of energy **106** (not shown in FIG. **3**) towards electronic device **110**, with minimal or no power loss. For example, transmitter **102** can use the vehicle ceiling to bounce off transmitted RF waves **104** towards electronic device **110** for the generation of pockets of energy **106** capable of providing suitable charging or powering to electronic device **110**.

According to other aspects of this embodiment, wireless power transmission **300** can power or charge two or more electronic devices **110** inside vehicle, where transmitter **102** can be capable of producing multiple pocket-forming. In such case, transmitter **102** can generate multiple RF waves **104** directly aimed at or reflected towards electronic devices **110** through the use of suitable reflecting surfaces of the vehicle, thereby powering or charging one or more electronic devices **110** at the same time.

FIG. **4** illustrates a wireless power transmission **400** where transmitter **102** can include a cable **402** for positioning antenna array **212** in different areas inside a vehicle. As seen in close-up view **406**, transmitter **102**, through the use of connector **304** and pins **306**, can be connected to car lighter socket **308** to receive power necessary for operation. According to some aspects of this embodiment, circuitry module **214** of transmitter **102** can be operatively coupled with car lighter socket **308**, while antenna array **212** can be operatively connected with circuitry module **214** through cable **402**, thereby allowing antenna array **212** to be separately positioned across vehicle, as required by the application or according to the relative position of one or more electronic devices **110**. For example, as shown in FIG. **4**, cable **402** can be run from circuitry module **214** to antenna array **212** which can be slipped in one of the vehicle's sun visor **404**. In this way, antenna array **212** can emit RF waves **104** from a high-up position down to one or more electronic devices **110** for the generation of pockets of energy **106** that may provide suitable charging or powering. This configuration may be particularly beneficial for charging or powering electronic devices **110** in the vehicle's backseats.

Antenna array **212** in FIG. **4** can exhibit a flat rectangular shape, with dimensions between about 4×2 inches to about 8×4 inches, depending on the number and configuration of antenna elements **202**. Cable **402** can include a suitable conductor covered by an insulating material, it may be flexible and may exhibit a suitable length as required by the application. Preferably, cable **402** can be positioned between circuitry module **214** of transmitter **102** and antenna array **212** in such a way as to not obstruct the visibility of the windshield, as illustrated in FIG. **4**.

Referring now to FIG. **5**, a wireless power transmission **500** may include a transmitter **102** with its circuitry module **214** connected to car lighter socket **308**, while its antenna array **212** can be positioned on the vehicle's floor **502**. Similarly as in FIG. **4**, antenna array **212** may exhibit a flat rectangular shape with dimensions between about 4×2 inches to about 8×4 inches, depending on the number and configuration of antenna elements **202**. According to some aspects of this embodiment, antenna array **212** can be covered by the vehicle floor mats (not shown in FIG. **5**), where this antenna array **212** can emit RF waves **104** from the bottom of the vehicle floor **502** upwards to one or more electronic devices **110** that may be positioned in the passenger seat, as illustrated in FIG. **5**, or in any another suitable location within the vehicle.

Similarly as in FIG. **4**, cable **402** can operatively connect circuitry module **214** (not shown in FIG. **5**) to antenna array **212** for the transmission of RF waves **104** that may produce pockets of energy **106** suitable for charging or powering one or more electronic devices **110** inside the vehicle. In this particular embodiment, antenna array **212** may include a suitable combination of flexible and conducting materials that may allow transmission of RF waves **104**, while avoiding fractures or breakdown when a passenger step on antenna array **212** placed underneath the vehicle's floor **502** mats.

Although these exemplary embodiments of wireless power transmission may describe transmitter **102** as a standalone device that may be connected to a car lighter socket **308**, including the different configurations and positions for its antenna array **212**, other transmitter **102** configurations and features may be contemplated as well. For example, antenna array **212** of transmitter **102** may be positioned in any suitable areas inside the vehicle such as passenger seats and backseats, storage compartments, and center, console among others. In other embodiments, transmitter **102** may be configured as built-in device that may be factory-integrated in suitable areas or parts of the vehicle such as sun visors, sunroofs, sound speakers, dashboards, and the like.

FIG. **6** shows a simplified flowchart of a wireless power transmission process **600** that may be implemented for charging one or more electronic devices **110** inside a vehicle. This process may be applicable in the embodiments of wireless power transmission **300**, **400**, **500**.

Wireless power transmission process **600** may begin with a wireless charging request, at block **602**. Subsequently, transmitter **102** may perform a Bluetooth scanning for identifying any suitable electronic device **110** that may require wireless charging or powering, at block **604**. Specifically, this Bluetooth scanning may be carried out by communication component **208** integrated in circuitry module **214** of transmitter **102**.

Using Bluetooth scanning, transmitter **102** may determine if there are one or more electronic devices **110** available for charging or powering, at block **606**. Basically, any suitable electronic device **110** operatively coupled with a receiver **108** and capable of Bluetooth communication may be considered "available" for wireless charging or powering if there are no available electronic devices **110** for wireless charging or powering, then Bluetooth scanning can be repeated until there is at least one electronic device **110** available. If one or more electronic devices **110** are available, then wireless power transmission process **600** may continue at block **608**, where one or more electronic devices **110** may log in into a charging application developed in any suitable operating systems such as iOS, Android, and Windows, among others. This charging application may establish a suitable communication channel between transmitter **102** and electronic device **110**, where configuration of transmitter **102** can be accessed and reprogrammed according to the charging or powering requirements of electronic devices **110**.

One or more electronic devices **110** may access the charging application in order to modify the configuration of transmitter **102**. Specifically, one or more electronic devices **110** can communicate with transmitter **102** via Bluetooth and log in into the charging application to set-up charging or powering priorities as necessary, at block **610**. For example, in a long family trip, charging or powering priorities can be established to first charge or power-up electronic devices **110** for kids' entertainment such as portable gaming consoles and tablets, followed by the charging or powering of parents' electronic devices **110** such as smartphones and laptops. Other transmitter **102** parameters such as power intensity and pocket-forming focus/timing can also be modified through the use of this charging application. However, authorization access to transmitter **102** configuration may be restrained to certain users who may be required to provide corresponding user-credentials and passwords.

After charging priorities in transmitter **102** are set, transmission of RF waves **104** towards the designated electronic devices **110** can begin, at block **612**, where these RF waves **104** may generate pockets of energy **106** at receivers **108** for powering or charging one or more electronic devices **110** sequentially or simultaneously. In other embodiments, different charging or powering thresholds may be established for maintaining suitable operation. For example, minimum and maximum charging thresholds may be established at about 20% and 95% of total charge respectively, where charging or powering of electronic devices **110** may be stopped when reaching 95% of total charge, and may resume when total charge of electronic devices **110** falls below 20%.

Bluetooth scanning may continue throughout the process in order to identify additional electronic devices **110** that may require wireless charging or powering, at block **614**. If new or additional electronic devices **110** are identified, then transmitter **102** may be accessed through the charging application to set charging or powering priorities for these additional electronic devices **110**. If no further electronic devices **110** are recognized by Bluetooth scanning, then wireless power transmission process **600** may end, at block **616**.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments are contemplated. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

What is claimed is:

1. A method for wireless power transmission, the method comprising:

scanning, using a wireless communication component of a transmitter, for available receivers within a vehicle that are authorized to receive wirelessly delivered power from the transmitter;

detecting, by the transmitter, a first receiver and a second receiver of the available receivers within the vehicle based on the scanning;

while continuing to scan for available receivers within the vehicle:

receiving, by a connector of the transmitter, where the connector is coupled to a power source of the vehicle, electrical current from the power source that is used by the transmitter to generate a plurality of power waves;

transmitting, by a plurality of antennas of the transmitter, a first set of the plurality of power waves, such that the first set of the plurality of power waves converge to form a first constructive interference pattern in proximity to a location of the first receiver within the vehicle;

receiving, by the wireless communication component of the transmitter, a charging request from the second receiver within the vehicle, wherein the charging request:

(i) corresponds to a request for wirelessly delivered power from the transmitter, and

(ii) is sent by the second receiver when a charge level of the second receiver is less than a minimum level of charge; and

adjusting, by a controller of the transmitter, respective gains and phases of at least a second set of the plurality of power waves, and

transmitting the second set of the plurality of power waves such that the second set of the plurality of power waves converge to form a second constructive interference pattern, distinct from the first constructive interference pattern, in proximity to a location of the second receiver within the vehicle.

2. The method of claim 1, wherein the electrical current from the power source is received by the connector of the transmitter via a vehicle lighter socket that is operatively connected to the transmitter.

3. The method of claim 2, wherein the transmitter is positioned within a cylinder configured for the vehicle lighter socket.

4. The method of claim 1, wherein the first receiver is associated with an electronic device selected from a group consisting of a laptop computer, a mobile phone, a gaming device, a tablet computer, a music player, and a portable device comprising a rechargeable battery.

5. The method of claim 1, further comprising, before transmitting the first set of the plurality of power waves, receiving, by the wireless communication component of the transmitter, a charging request from the first receiver.

6. The method of claim 5,

wherein the charging request comprises a power level of a battery of an electronic device associated with the first receiver, and wherein the charging request uses a wireless communication protocol selected from the group consisting of Bluetooth, Wi-Fi, and Zigbee.

7. The method of claim 5, wherein the charging request comprises authentication data, wherein the transmitter is configured to compare the authentication data with data indicating whether an electronic device associated with the first receiver is authorized to be charged by the transmitter.

8. The method of claim 1, wherein:

the connector is configured to couple the transmitter with a car lighter socket of the vehicle, and

the electrical current from the power source is received by the connector of the transmitter via the car lighter socket.

9. The method of claim 1, wherein the transmitter is positioned in a location in the vehicle selected from a group consisting of on a sun visor of the vehicle and under a floor mat of the vehicle.

10. The method of claim 1, further comprising, receiving a user-configured charging priority for the first and second receivers,

wherein the controller adjusts the respective gains and phases of the second set of the plurality of power waves in response to a processor in the transmitter determining that the second receiver has a higher charging priority than the first receiver.

11. The method of claim 1, wherein the scanning is performed before transmitting any of the plurality of power waves.

12. The method of claim 1, wherein the first set of the plurality of power waves and the second set of the plurality of power waves are simultaneously transmitted by the transmitter.

13. A method for wireless power transmission, the method comprising:

scanning, using a wireless communication component of a transmitter, for available receivers within a vehicle that are authorized to receive wirelessly delivered power from the transmitter;

detecting, by the transmitter, a first receiver associated with a first electronic device and a second receiver associated with a second electronic device within the vehicle based on the scanning;

while continuing to scan for available receivers within the vehicle:

receiving, by a connector of the transmitter, where the connector is coupled to a power source of the vehicle, electrical current from the power source that is used by the transmitter to generate a plurality of power waves;

receiving, by the wireless communication component of the transmitter, a first wireless charging request sent from the first electronic device within the vehicle, wherein the first wireless charging request:

(i) corresponds to a request for wirelessly delivered power from the transmitter, and

(ii) is sent by the first electronic device when a charge level of the first electronic device is less than a minimum level of charge;

receiving, by the wireless communication component of the transmitter, a second wireless charging request sent from the second electronic device within the vehicle, wherein the second wireless charging request:

(i) corresponds to a request for wirelessly delivered power from the transmitter, and

(ii) is sent by the second electronic device when a charge level of the second electronic device is less than a minimum level of charge;

determining, by a processor of the transmitter, a charging priority associated with each of the first electronic device and the second electronic device based on the first and second wireless charging requests;

transmitting, by a plurality of antennas of the transmitter, a first set of the plurality of power waves such that the first set of the plurality of power waves form a first constructive interference pattern in proximity to a location of the first receiver associated with the first electronic device in response to the processor determining that the first electronic device is associated with a higher charging priority than the second electronic device; and

transmitting, by the plurality of antennas of the transmitter, a second set of the plurality of power waves such that the second set of the plurality of power waves is phase-shifted and gain-adjusted to form a second constructive interference pattern, distinct from the first constructive interference pattern, in proximity to a location of the second receiver associated with the second electronic device in response to the processor determining that the second electronic device is associated with a higher charging priority than the first electronic device.

14. The method of claim **13**, wherein the connector is configured to couple the transmitter with a car lighter socket of the vehicle, and the electrical current from the power source is received by the connector of the transmitter via the car lighter socket.

15. The method of claim **13**, wherein the scanning is performed before transmitting any of the plurality of power waves.

16. A transmitter for wireless power transmission, comprising:

a wireless communication component configured to scan for available receivers within a vehicle that are authorized to receive wirelessly delivered power from the transmitter, wherein the transmitter detects a first receiver and a second receiver of the available receivers within the vehicle based on the scanning;

a connector that is coupled to a power source of the vehicle and configured to, while the wireless communication component continues to scan for available receivers within the vehicle, receive electrical current from the power source that is used by the transmitter to generate a plurality of power waves,

a plurality of antennas configured to, while the wireless communication component continues to scan for available receivers within the vehicle, transmit a first set of the plurality of power waves, such that the first set of the plurality of power waves converge to form a first constructive interference pattern in proximity to a location of the first receiver within the vehicle,

the wireless communication component is further configured to, while continuing to scan for available receivers within the vehicle, receive a charging request from the second receiver within the vehicle, wherein the charging request: (i) corresponds to a request for wirelessly delivered power from the transmitter, and (ii) is sent by the second receiver when a charge level of the second receiver is less than a minimum level of charge; and

a controller configured to, while the wireless communication component continues to scan for available receivers within the vehicle:

adjust respective gains and phases of at least a second set of the plurality of power waves, and

cause the plurality of antennas to transmit the second set of the plurality of power waves such that the second set of the plurality of power waves converge to form a second constructive interference pattern, distinct from the first constructive interference pattern, in proximity to a location of the second receiver within the vehicle.

17. The transmitter of claim **16**, wherein the wireless communication component is further configured to receive a charging request from the first receiver in the vehicle before the plurality of antennas transmit the first set of the plurality of power waves.

18. The transmitter of claim **17**, wherein the charging request from the first receiver is transmitted using a wireless communication protocol selected from the group consisting of Bluetooth, Wi-Fi, Zigbee, and a frequency modulation (FM).

19. The transmitter of claim **18**, wherein the charging request from the first receiver includes data that indicates a power level of a battery associated with the first receiver.

20. The transmitter of claim **16**, wherein the connector is configured to couple the transmitter with a car lighter socket of the vehicle and a circuitry module is configured to couple to the connector,

wherein the plurality of antennas is configured to couple to the connector via a cable, and

wherein the connector is configured to power the plurality of antennas via the cable.

21. The transmitter of claim **16**, wherein the transmitter is configured to transmit the first set of the plurality of power waves by aiming the first set of the plurality power waves toward at least one reflecting surface in the vehicle, wherein the at least one reflecting surface is configured to reflect the first set of the plurality power waves towards the first receiver.

22. The transmitter of claim **16**, wherein the controller is configured to adjust the respective gains and phases of the second set of the plurality of power waves in response to a processor in the transmitter determining that the second receiver has a higher charging priority than the first receiver.

23. The transmitter of claim **16**, wherein the scanning is performed before transmitting any of the plurality of power waves.

24. The transmitter of claim **16**, wherein the first set of the plurality of power waves and the second set of the plurality of power waves are simultaneously transmitted by the transmitter.

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