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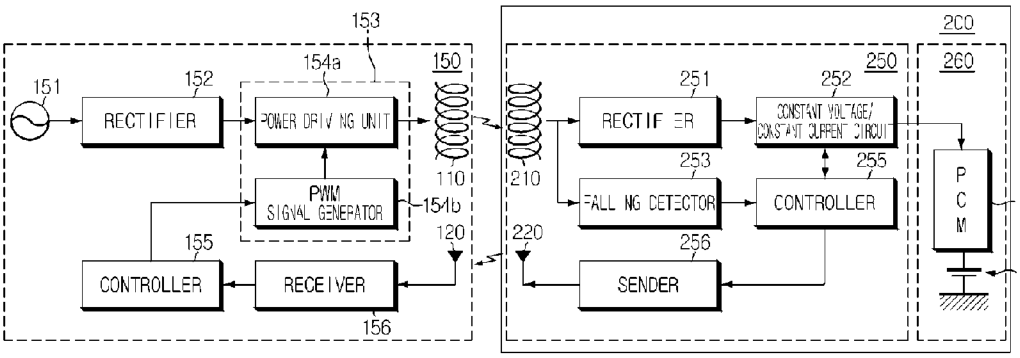
(54) **Title:** RECHARGEABLE POWER SUPPLY, BATTERY DEVICE, CONTACT-LESS CHARGER SYSTEMS AND METHOD FOR CHARGING RECHARGEABLE BATTERY CELL



(57) **Abstract:** A contact- less charger system includes a primary charging unit having a primary coil and a contact- less receiving module, a secondary charging unit having a secondary coil magnetically coupled to the primary coil and a contact- less sending module, and a battery for receiving a charging voltage from the secondary charging unit. The primary charging unit has means for generating an AC power pulse over common frequency according to application of common AC power, and applying it to the primary coil to induce a high frequency AC power pulse to the secondary coil. The secondary charging unit has means for transmitting charging status in-> formation of battery to the primary charging unit using a ceasing time between AC voltage pulses induced by the secondary coil. Thus, power signals between the primary and secondary coils and communication signals between the contact-less sending and receiving modules are not overlapped in aspect of time.

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Description

RECHARGEABLE POWER SUPPLY, BATTERY DEVICE, CONTACT-LESS CHARGER SYSTEMS AND METHOD FOR CHARGING RECHARGEABLE BATTERY CELL

Technical Field

[1] The present invention relates to a charging device of a portable electronic device, and particularly to a contact-less charger system using induced coupling.

Background Art

[2] A rechargeable secondary battery is mounted to a portable electronic device such as a mobile communication terminal and PDA. For charging the secondary battery, a charging device for providing an electric energy to a battery of a portable electronic device using a home common power is separately required. Commonly, contact terminals are separately provided to the charging device and the battery, so the battery and the charging device are electrically connected in a way of connecting two contact terminals.

[3] However, the contact terminal protruded out as above gives bad appearance, and the contact terminal may be contaminated due to exterior impurities, which may result in bad connection. Also, if the battery is short-circuited or exposed to moisture due to the carelessness of a user, the charged energy may be easily lost.

[4] In order to solve the problems of the contact-type charging method, a contact-less charger system was proposed to charge a battery in a contact- less way.

[5] A contact-less charger system for charging a battery without any contact terminal by using induced coupling between a primary coil of a charging part and a secondary coil of a battery pack is disclosed in Korean Laid-open Patent Publication No. 2002-57468, Korean Laid-open Patent Publication No. 2002-57469, Korean Patent Registration No. 363,439, Korean Patent Registration No. 428,713, Korean Laid-open Patent Publication No.2002-35242, Korean Utility Model Registration No. 217,303, GB Patent Publication No. 2,314,470 and US Patent Publication No. 2003/0,210,106.

[6] Also, Korean Laid-open Patent Publication No. 2004-87037 discloses a contact-less charging battery pack including a control circuit for measuring voltage and current of a battery to accumulate information such as use time and charging capacity, and compensating charging/discharging capacity of the battery based on the accumulated information. In particular, the control circuit further includes a compensating circuit for compensating a charging voltage and a battery temperature based on a charging voltage detected from the battery and a temperature of the battery detected by a temperature sensor.

[7] However, Korean Laid-open Patent Publication No. 2004,87037 fails to disclosing a power supply or a contact-less charger system, which receives a feedback charging status information of a battery (e.g., a charging current, a charging voltage), and then generating a charging power corresponding to the charging status information.

[8] In addition, in the contact-less charger system, a magnitude of AC current induced to the secondary coil is varied according to a relative position between the primary coil and the secondary coil. That is to say, in case the primary and secondary coils are placed at a point where a relatively very great high frequency AC current is induced, the circuit of the secondary coil may be damaged.

[9] Thus, there is needed a new technical alternative scheme capable of protecting an interior circuit of a secondary charging unit against overvoltage regardless of a relative position between a primary charging unit (a charging part) and a secondary charging unit (a battery pack).

Disclosure of Invention

Technical Problem

[10] A first object of the present invention is to provide a contact-less charger system using induced coupling between a primary coil and a secondary coil, which may contact-less receive a feedback status information of a battery and then generate a charging power most suitable for the status of the battery.

[11] A second object of the present invention is to solve interference phenomenon of a power signal and a communication signal between a primary charging unit (a charging part) and a secondary charging unit (a battery pack).

[12] A third object of the present invention is to supply a charging power after the primary coil and the secondary coil are magnetically completely coupled, so as to prevent unnecessary power consumption.

[13] A fourth object of the present invention is to classifying the charging status of a battery into a standby mode, a charging mode and a full-charged mode, and then supply a charging power most suitable for each mode by checking a mode state of the battery.

[14] A fifth object of the present invention is to solve a limitation on relative positions of the primary charging unit (a charging part) and the secondary charging unit (a battery pack) and also prevents an internal circuit of the secondary charging unit from being damaged.

[15] A sixth object of the present invention is to provide a contact-less charging device whose deviation of charging efficiency according to a position of the battery device is improved.

[16] A seventh object of the present invention is to provide a contact-less charging

device capable of efficiently transferring an induced electromotive force to the secondary coil regardless of a relative position between the primary and secondary coils.

[17] An eighth object of the present invention is to provide a contact-less charging device capable of charging a plurality of portable electronic devices at the same time.

[18] A ninth object of the present invention is to provide a contact-less charging device capable of minimizing energy waste while ensuring high charging efficiency.

[19] A tenth object of the present invention is to provide a contact-less charging device capable of freely changing a design of the coil unit.

[20] An eleventh object of the present invention is to provide a contact-less charging device capable of exchanging only one of a charging circuit and a coil unit, selectively.

[21] A twelfth object of the present invention is to provide a contact- less charging device capable of using contact-type charging and contact- less charging together such that the battery may be charged together with using an electronic device.

[22] A thirteenth object of the present invention is to provide a contact-less charging device capable of keeping an optimum charging status by detecting generation of overcurrent caused by metallic impurities existing in a charging region of a charging part at an early stage, and also capable of improving a charging efficiency.

[23] Other objects and advantages of the present invention will be described below and understood from embodiments of the present invention. Also, the objects and advantages of the present invention may be implemented by means or their combinations defined in the appended claims.

Technical Solution

[24] In order to accomplish the above object, in a first aspect of the present invention, there is provided a charging power supply device contact- less coupled to a battery device including a secondary coil for induced coupling, a contact- less sending module for contact- less transmission of data, a charging control circuit for controlling a charging status of a battery, and a rechargeable battery.

[25] The charging power supply device according to the first aspect of the present invention includes a primary coil for inducing a charging power to the secondary coil; a contact- less receiving module for receiving charging status information from the contact-less sending module; and means for driving the primary coil such that a power signal between the primary and secondary coils and a communication signal between the contact- less sending and receiving modules are not overlapped in aspect of time.

[26] In addition, in a second aspect of the present invention, there is provided a charging device for contact- less receiving a power from a charging power supply device that generates an AC (Alternating Current) voltage pulse over a common frequency, and

charging a rechargeable battery using the power.

[27] The charging device according to the second aspect of the present invention includes a secondary coil magnetically coupled to a primary coil of the charging power supply device to generate an induced electromotive power pulse corresponding to the AC voltage pulse; a charging control circuit for generating a constant voltage and a constant current used for charging a battery based on the induced electromotive power pulse; and a feedback control means for checking a falling time of the induced electromotive power pulse, and then contact- less feeding back a feedback response signal including charging status information of the battery to the charging power supply device in case the falling is detected.

[28] In addition, the charging device of the present invention may further include a monitoring circuit for monitoring a charging status of the battery to generate charging status information and storing the charging status information into a memory; a memory for storing the charging status information and battery specification information; and a contact-less sending module for generating a feedback response signal based on the charging status information and contact-less transmitting the feedback response signal to the charging power supply device.

[29] In a third embodiment of the present invention, there is also provided a battery device for contact-less receiving a charging power from a charging power supply device that generates a pulse width-modulated signal over a common frequency using a common AC power.

[30] This battery device includes a rechargeable battery; a secondary coil magnetically coupled to a primary coil of the charging power supply device to generate an induced electromotive power pulse corresponding to the pulse width-modulated signal; a charging control circuit for generating a constant voltage and a constant current used for charging a battery based on the induced electromotive force, and charging the battery using the constant voltage and the constant current; a falling detector for detecting a falling time of the induced electromotive power pulse; a memory for storing charging status information and specification information of the battery; a monitoring circuit for monitoring a charging status of the battery to generate charging status information and storing the charging status information into the memory; a contact-less sending module for modulating the charging status information to generate a feedback response signal and contact-less transmitting the feedback response signal to the charging power supply device; and a feedback controller for reading the charging status information from the memory in case the falling time is detected, and then transmitting the charging status information to the contact-less sending module.

[31] In a fourth embodiment of the present invention, three is provided a contact- less charging method for charging a battery using a contact- less charger system that

includes a primary charging unit having a primary coil and a contact- less receiving module, a secondary charging unit having a secondary coil magnetically coupled to the primary coil and a contact-less sending module, and a battery for receiving a charging voltage from the secondary charging unit.

[32] The contact- less charging method includes (A) applying a power pulse train with a width of W_1 to the primary coil to emit a corresponding magnetic field outward; (B) contact-less receiving a charging start signal informing that the primary coil and the secondary coil are magnetically coupled, from the secondary charging unit; (C) generating a charging power pulse train with a pulse width W_2 at least greater than W_1 according to the charging start signal, and applying the charging power pulse train to the primary coil to generate an induced electromotive power pulse corresponding to the secondary coil; (D) charging the battery using the induced electromotive power pulse; (E) receiving charging status information of the battery from the secondary charging unit as a feedback signal; and (F)controlling a pulse width of the charging power pulse based on the charging status information, whereby the contact-less feedback signal from the secondary charging unit is synchronized with a falling time of the induced electromotive power pulse.

[33] In addition, the step (B) may also include the steps of: generating an induced electromotive power pulse from the secondary coil as the primary and secondary coils are magnetically coupled; checking a falling time of the induced electromotive power pulse to read the charging status information from a memory; determining as an initial charging in case the charging status information is not recorded in the memory, and then generating an initial charging signal; and transmitting the initial charging signal to the contact- less receiving module of the primary charging unit via the contact- less sending module.

[34] The step (A) may also include the steps of: rectifying a common AC voltage into DC; generating an AC voltage over a common frequency using the rectified DC; generating a power pulse train with a width of W_1 by means of pulse width modulation of the AC voltage; and applying the power pulse train to the primary coil.

[35] The step (D) may also include the steps of: rectifying the induced electromotive force (AC voltage) into DC; generating a constant voltage and a constant current of a predetermined level to be used for charging a battery using the rectified DC voltage; charging the battery in a constant current mode until a battery voltage reaches a predetermined level, and then, in case the voltage reaches the predetermined level, controlling intensity of the charging current to charge the battery in a constant voltage mode.

[36] Also, the step (E) may also include the steps of: checking a falling time of induced electromotive power pulse induced from the secondary coil; reading charging status in-

formation from the memory in case a falling time is checked; and generating a feedback response signal based on the charging status information and transmitting the feedback response signal to the contact-less receiving module of the primary charging unit via the contact-less sending module.

[37] The step (F) may also include the steps of: analyzing the charging status information to determine whether the battery is fully charged; and controlling a pulse width of the power pulse applied to the primary coil to correspond to the charging status in case the battery is not fully charged.

[38] In a fifth aspect of the present invention, there is also provided a contact-less charger system including a primary charging unit having a primary coil and a contact-less receiving module, a secondary charging module having a secondary coil magnetically coupled to the primary coil and a contact-less sending module, and a battery for receiving a charging power from the secondary charging unit, wherein the primary charging unit includes means for generating an AC power pulse over a common frequency as a common AC power is applied thereto, and applying the AC power pulse to the primary coil to induce a high frequency AC voltage pulse to the secondary coil, and wherein the secondary charging unit includes means for transmitting charging status information of the battery to the primary charging unit using a cessation time between AC voltage pulses induced by the secondary coil. Thus, a power signal between the primary and secondary coils and a communication signal between the contact-less sending and receiving modules are not overlapped in aspect of time.

[39] The transmitting means detects a falling time of the induced electromotive power pulse and transmits the battery charging status information together with detecting the falling time.

[40] In addition, the inducing means of the primary charging unit includes means for generating an AC voltage over a common frequency based on the DC voltage rectified from a common AC power; and means for generating a pulse width-modulated signal using the AC voltage over the common frequency.

[41] The primary charging unit may further include means for analyzing the battery charging status information to control the pulse width.

[42] The secondary charging unit may include means for detecting a falling time of the induced electromotive power pulse generated from the secondary coil; means for extracting the battery charging status information according to the detection of falling time and then generating a feedback response signal to be sent to the contact-less receiving module of the primary charging unit using the charging state information; means for rectifying the induced electromotive force generated from the secondary coil into DC; means for generating a constant voltage and a constant current to be supplied to the battery using the rectified DC voltage; means for detecting a charging voltage

and a charging current of the battery; and means for storing the charging voltage and the charging current.

[43] In a sixth aspect of the present invention, there is also provided a contact-less charging circuit module electrically connected to a battery cell to contact- less charging an electric energy thereto, the contact-less charging circuit comprising: a high frequency AC current inducing unit for inducing a high frequency AC current by a magnetic field generated by an external contact-less charging device; a rectifier for receiving the induced high frequency AC current and converting the induced high frequency AC current into a DC (Direct Current) current; a constant voltage/constant current supplier for receiving the DC current from the rectifier to supply a charging power to the battery cell in a constant voltage/constant current mode; and an overvoltage monitoring unit for monitoring voltages at both ends of the constant voltage/constant current supplier and transmitting a monitoring result to an external contact-less charging device by means of contact-less communication to induce a change of intensity of a magnetic field.

[44] In a seventh aspect of the present invention, there is also provide a contact-less charging device for transmitting a charging power to a contact-less charging battery that has a constant voltage/constant current supplier to allow charging in a constant voltage/constant current mode and contact- less transmits a monitoring result of voltages at both ends of the constant voltage/constant current supplier.

[45] The contact-less charging device includes a magnetic field generator for receiving an AC current to form a magnetic field in an outer space; a high frequency power driving unit for applying a high frequency AC current to the magnetic field generator; and a charging power control unit for receiving the monitoring result from the contact-less charging battery by means of contact-less communication to control the high frequency power driving unit such that power of the high frequency AC current applied to the magnetic field generator is adjusted to control a charging power transmitted to the battery.

[46] In an eighth aspect of the present invention, there is also provided a battery charging set having a contact-less charging battery and a contact-less charging device.

[47] The battery includes a high frequency AC current inducing unit to which a high frequency AC current is intermittently induced by means of a magnetic field intermittently generated from an external contact-less charging device; a rectifier for receiving the induced high frequency AC current to convert the induced high frequency AC current into a DC current; a constant voltage/constant current supplier for receiving the DC current from the rectifier to supply a charging power to a battery cell in a constant voltage/constant current mode; and an overvoltage monitoring unit for monitoring voltages at both ends of the constant voltage/constant current supplier

to transmit a monitoring result to an external contact-less charging device by means of contact-less communication while the induction of high frequency AC current does not occur.

[48] Also, the contact-less charging device includes a magnetic field generator for receiving an AC current to form a magnetic field in an outer space; a high frequency power driving unit for intermittently applying a high frequency AC current to the magnetic field generator; and a charging power control unit for receiving the monitoring result by means of contact- less communication to control the high frequency power driving unit such that power of the high frequency AC current applied to the magnetic field generator is adjusted to control a charging power transmitted to the battery, while a high frequency AC current is not applied to the magnetic field generator.

[49] In a ninth aspect of the present invention, there is also provided a charging control method for controlling charging of a contact- less charging battery by means of electromagnetic induction using a contact-less charging device.

[50] The charging control method includes (a) intermittently applying a high frequency AC current to a primary coil provided to the charging device to intermittently generate a magnetic field to an outside; (b) interlinking a magnetic flux of the generated magnetic field to a secondary coil provided to the battery to intermittently output an electromagnetically induced high frequency AC current; (c) rectifying the output high frequency AC current and converting the output high frequency AC current into a DC current; (d) applying the DC current to a battery cell through a constant voltage/ constant current element to charge the battery cell in a constant voltage/constant current mode; (e) monitoring voltages at both ends of the constant voltage/constant current element to transmit a monitoring result to the charging device by means of contact-less communication while a high frequency AC current is not induced to the secondary coil; and (f) controlling power of the high frequency AC current applied to the primary coil according to the transmitted monitoring result.

[51] In a tenth aspect of the present invention, there is also provided a contact- less charging device for charging a charging target having a secondary coil, the contact- less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil.

[52] The primary coil includes an outer coil arranged with a predetermined number of turns and a predetermined size; at least one inner coil arranged to be included inside the outer coil, wherein the outer and inner coil are arranged to have magnetic fluxes generated inside each coil in the same direction when a primary current is applied to the outer and inner coils.

[53] In an eleventh aspect of the present invention, there is also provided a contact-less

charging device for charging a charging target having a secondary coil, the contact-less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil.

[54] The primary coil is arranged with a predetermined number of turns and a predetermined size, and a density profile of a magnetic flux generated when a primary current is applied to the primary coil, seen along an intersecting line of the primary coil, has at least three maximum points within the primary coil.

[55] In a twelfth aspect of the present invention, there is also provided a contact-less charging device for charging a charging target having a secondary coil, the contact-less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil.

[56] The primary coil is arranged with a predetermined number of turns and a predetermined size, and a density of a magnetic flux formed when a primary current is applied to the primary coil is at least 50% of a maximum value of the magnetic flux density at any point within the primary coil.

[57] In a thirteenth aspect of the present invention, there is also provided a contact-less charging device magnetically coupled to a battery device having a receiving coil to contact-less charge the battery device.

[58] The contact-less charging device includes a sending coil array in which a plurality of sending coils are arranged to induce a charging power to the receiving coil; and means for detecting sending coils magnetically coupled to the receiving coil, and then selectively driving only the detected sending coils.

[59] In a fourteenth aspect of the present invention, there is provided a charging power supply device magnetically coupled to a battery device including a secondary coil for induced coupling, a contact-less sending module for contact-less sending data, a charging control circuit for controlling a charging status of a battery and a rechargeable battery.

[60] The charging power supply device includes a primary coil array in which a plurality of primary coils are arranged to induce a charging power to the secondary coil; a rectifying circuit for converting an external AC voltage into a DC voltage; a coil driving circuit for generating a driving power to drive the primary coil based on the DC voltage; a contact-less receiving module for receiving a feedback response signal from the contact-less sending module; and a driving control circuit for controlling the coil driving coil to preparatorily driving the primary coils, selecting only primary coils receiving a feedback response signal from the battery device according to the preparatory driving of the primary coils, and driving only the selected primary coils to charge the battery.

[61] In a fifteenth aspect of the present invention, there is also provided a battery

charging method using a contact-less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery.

[62] The battery charging method includes (A) selecting any one of the primary coils and then preparatorily driving the selected primary coil within a relatively short time; (B) standing by a feedback response from the battery device during a predetermined time; (C) in case the feedback response exists, temporarily storing identification information of the corresponding primary coil in a memory; (D) selecting another primary coil from the primary coil array and repeatedly executing the steps (A) to (C); (E) executing the step (D) to all primary coils of the primary coil array subsequently; and (F) reading the identification information of the primary coil from the memory and selectively supplying a charging power only to the corresponding primary coil.

[63] In a sixteenth aspect of the present invention, there is also provided a battery charging method using a contact-less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery.

[64] The battery charging method includes (A) preparatorily driving the primary coils subsequently within a relatively short time; (B) standing by a feedback response from the battery device during a predetermined time; (C) selecting at least one primary coil having the feedback response; and (D) applying a charging power to the selected primary coil to charge the battery device.

[65] In a seventeenth aspect of the present invention, there is also provided a battery charging method using a contact-less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery.

[66] The battery charging method includes (A) preparatorily driving all of the primary coils of the primary coil array subsequently within a relatively short time; (B) standing by a feedback response from the battery device during a predetermined time; (C) selecting at least one primary coil having the feedback response; and (D) applying a charging power to the selected primary coil to charge the battery device.

[67] In an eighteenth aspect of the present invention, there is also provided a contact-less charger system including a primary charging unit having a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, a secondary charging module having a secondary coil magnetically coupled to the primary coils and a contact-less sending module, and a battery for receiving a charging

power from the secondary charging unit

[68] The primary charging unit includes a primary coil array in which a plurality of primary coils are arranged to induce a charging power to the secondary coil; and means for selecting a primary coil having a feedback response from the secondary charging unit after the primary coils are driven in a standby mode, and then driving only the selected primary coil in a charging mode.

[69] Also, the secondary charging unit includes means for generating a feedback signal informing start of charging in case a voltage sufficient for driving an internal circuit of the secondary coil is induced, and then transmitting the feedback signal to the primary charging unit.

[70] Thus, among the primary coils of the primary coil array, only a primary coil forming positional conformation with the secondary coil is selectively driven.

[71] In a nineteenth aspect of the present invention, there is also provided a contact- less charging device including a charging circuit unit having a rectifier, and a coil unit having a primary coil for forming a magnetic field to contact- less charge a battery using a current supplied from the charging circuit unit.

[72] The charging circuit unit and the coil unit are separated, and the charging circuit unit and the coil unit are electrically connected with each other using a cable of a pre-determined length.

[73] In a twelfth aspect of the present invention, there is also provided a contact-less charging device for contact- less charging a battery, which includes a contact-type charging unit included in a frame of the contact- less charging device to charge the battery in a contact-type manner.

[74] In a twenty first aspect of the present invention, there is also provided a contact-less charging device, which includes a power supply for supplying a power required for driving the contact-less charging device using a common power; a primary coil for inducing a charging power; a power driving unit for converting the power input from the power supply to apply a high frequency AC current to the primary coil; and a current monitoring unit for controlling operation of the power driving unit with reference to a current value applied to the primary coil.

Brief Description of the Drawings

[75] Other objects and aspects of the present invention will become apparent from the following description of embodiments with reference to the accompanying drawing in which:

[76] FIG. 1 is a schematic perspective view showing a contact-less charger system according to a first embodiment of the present invention;

[77] FIG. 2 is a block diagram showing internal functions of the contact-less charger

system according to the first embodiment of the present invention;

[78] FIG. 3 is a timing chart illustrating a time-divisional arrangement of a power signal and a communication signal from a charging start point to a full-charged point;

[79] FIG. 4 is a flowchart illustrating a procedure of a contact-less charging method according to the first embodiment of the present invention;

[80] FIG. 5 is a functional block diagram showing a primary charging unit according to a second embodiment of the present invention;

[81] FIG. 6 is a functional block diagram showing a secondary charging unit according to the second embodiment of the present invention;

[82] FIG. 7 is a graph showing that a charging power is intermittently output from a secondary coil of the secondary charging unit;

[83] FIG. 8 shows the contact-less charger system according to the second embodiment of the present invention while being used;

[84] FIG. 9 is a perspective view showing that a battery of a portable electronic device is charged using a contact-less charging device according to a third embodiment of the present invention;

[85] FIG. 10 is a schematic plane view showing a primary coil of the contact-less charging device according to the third embodiment of the present invention;

[86] FIG. 11 is a schematic view showing a magnetic flux density profile of a magnetic field generated by the primary coil of the contact-less charging device according to the third embodiment of the present invention;

[87] FIG. 12 is a schematic plane view showing a modification of the primary coil of the contact-less charging device according to the third embodiment of the present invention;

[88] FIG. 13 illustrates an experiment for measuring an induced power while configuring a primary coil according to the third embodiment of the present invention as a contact-less charging device of a battery of a mobile phone, and then changing a position of a secondary coil of the battery of the mobile phone;

[89] FIG. 14 is a graph showing an induced power profile obtained from the experiment results of FIG. 13;

[90] FIG. 15 shows a contact-less charging device according to a fourth embodiment of the present invention in a used state;

[91] FIG. 16 shows the contact-less charging device according to the fourth embodiment of the present invention in another used state;

[92] FIG. 17 is a block diagram showing internal functions of the contact-less charger system according to the fourth embodiment of the present invention;

[93] FIG. 18 is a timing chart illustrating correlation between subsequent operation of a sending coil and a feedback response signal according to the fourth embodiment of the

present invention;

[94] FIG. 19 is a flowchart illustrating a procedure of the contact-less charging method according to the fourth embodiment of the present invention;

[95] FIG. 20 is a timing chart illustrating correlation between simultaneous operation of the sending coil and a feedback response signal according to a modification of the fourth embodiment of the present invention;

[96] FIG. 21 is a flowchart illustrating a procedure of the contact-less charging method according to a modification of the fourth embodiment of the present invention;

[97] FIG. 22 is an exploded perspective view showing a contact-less charging device according to a fifth embodiment of the present invention;

[98] FIG. 23 is a block diagram showing internal functions of the contact-less charging device according to the fifth embodiment of the present invention;

[99] FIG. 24 is a block diagram showing internal functions of the contact-less charging device according to a modification of the fifth embodiment of the present invention;

[100] FIG. 25 is a perspective view showing a contact-less charging device according to a sixth embodiment of the present invention;

[101] FIG. 26 is a perspective view showing the contact-less charging device of FIG. 25, in which a connector is drawn out;

[102] FIGs 27 to 29 are block diagrams showing internal functions of the contact-less charging device of FIG. 25, respectively; and

[103] FIG. 30 is a block diagram showing internal functions of a contact-less charging device according to a seventh embodiment of the present invention.

[104] < Reference Numerals of Essential Parts in the Drawings >

[105] 100: charging part 200: battery device

[106] 150: charging power supply device 250: charging device

[107] 110: primary coil 210: secondary coil

[108] 120: contact-less receiving module

[109] 220: contact-less sending module

[110] 151: common AC power 153: driving circuit

[111] 261: protecting circuit (PCM) 262: battery

Best Mode for Carrying Out the Invention

[112] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. Prior to the description, it should be understood that the terms used in the specification and the appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present invention on the basis of the principle that the inventor is allowed to define terms ap-

propriately for the best explanation. Therefore, the description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the invention, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the invention.

[113]

[114] **Embodiment 1**

[115] FIG. 1 is a schematic perspective view showing a contact-less charger system according to a first embodiment of the present invention.

[116] As shown in FIG. 1, the contact-less charger system according to the first embodiment of the present invention includes a charging part 100 for generating a charging power supplied to a battery using an external power, and a battery device 200 for contact-less receiving the charging power from the charging part 100 and charging an interior battery (not shown) using the charging power.

[117] The battery device 200 may be a battery pack including a battery or a portable electronic device including a battery. Preferably, the portable electronic device may be a cellular phone, PDA, MP3 player, and so on. The battery included in the battery device 200 may be a rechargeable battery cell, including a lithium ion battery and a lithium polymer battery.

[118] The charging part 100 is a device for receiving an electric energy from an external power and generating a charging power to be supplied to the battery device 200, and the charging part 100 is preferably configured in a pad shape such that the battery device 200 may be easily placed thereon. Also, the external power supplied to the charging part 100 is most preferably a home common AC power (60 Hz, 220V/100V), but other DC powers may also be used.

[119] The charging part 100 and the battery device 200 have a primary coil 110 and a secondary coil 210, corresponding to each other, and antennas 120, 220.

[120] The primary and secondary coils 110, 210 are magnetically coupled to each other by means of induced coupling. Thus, the secondary coil is juxtaposed on the primary coil such that a magnetic field generated by the primary coil leads an induced current in the secondary coil. Also, the primary and secondary coils 110, 210 are respectively surrounded by the antennas 120, 220.

[121] In addition, the charging part 100 includes a charging power supply circuit 150 (see FIG. 2) for driving the primary coil 110 to generate a magnetic field, and the battery device 200 includes a charging circuit 250 (see FIG. 2) for charging a battery using an induced electromotive force lead by the secondary coil 210.

[122] Hereinafter, the charging power supply circuit 150 and the charging circuit 250 will be explained in detail with reference to FIG. 2.

[123] The charging power supply circuit 150 included in the charging part 100 includes a

primary coil 110, a rectifier 152, a driving circuit 153, a controller 155, and a contact-less receiving module 120, 156.

[124] The rectifier 152 rectifies AC voltage from a common AC power 151 into DC, and then transfers it to the driving circuit 153. The driving circuit 153 generates a high frequency AC voltage pulse over a common frequency using the DC voltage rectified by the rectifier 152, and applies it to the primary coil 110 to generate a magnetic field.

[125] The driving circuit 153 is composed of a PWM signal generator 154b and a power driving unit 154a. The power driving unit 154a includes a high frequency oscillating circuit for converting a DC voltage of a predetermined level to oscillate a high frequency AC voltage over a common frequency, and a drive circuit for driving the primary coil 110 by applying a pulse width-modulated AC voltage pulse to the primary coil 110. The PWM signal generator 154b conducts PMW (Pulse Width Modulation) for the high frequency AC voltage. Thus, an output signal output from an output terminal of the power driving unit 154a becomes a high frequency AC voltage pulse. This high frequency AC voltage pulse is a pulse train as shown in FIG. 3. This pulse train has a pulse width controlled by the controller 155. The driving circuit 153 according to the present invention may adopt SMPS (Switching Mode Power Supply), and other equivalent means may also be used if they may give the same functions and roles.

[126] The controller 155 controls a pulse width of the pulse width-modulated high frequency AC voltage pulse based on a charging status information of a battery fed back via contact-less sending/receiving modules 156, 120, 220, 256. In particular, in case a response signal fed back from the charging circuit 250 is a charging start signal, the controller 155 switches a driving mode of the primary coil 110 from a standby mode to a charging mode, as shown in FIG. 3. In addition, as a result of determining the charging status information fed back from the charging circuit 250, if it is determined that the battery is fully charged, the controller 155 switches the driving mode of the primary coil from the charging mode to the full-charged mode. In case there is no response signal fed back from the charging circuit 250, the controller 155 keeps the driving mode of the primary coil 110 in the standby mode.

[127] As mentioned above, the controller 155 of the charging power supply circuit 150 switches the driving mode of the primary coil 110 to a standby mode, a charging mode or a full-charged mode depending on the presence and contents of the response signal from the battery device 200.

[128] The contact-less receiving module 120, 156 includes an antenna 120 for receiving a feedback response signal transmitted from a contact-less sending module 220, 256 of the charging circuit 250, and a receiver 156 acting like a modulator for modulating the feedback response signal to restore a charging status information of a battery.

[129] The charging power supply circuit 150 of the present invention may further include an overvoltage filter circuit for protecting the circuit against overvoltage, or a constant voltage circuit for keeping the DC voltage rectified by the rectifier as a voltage of a predetermined level. The overvoltage filter circuit is preferably disposed between the common AC power 151 and the rectifier 152, and the constant voltage circuit is preferably disposed between the rectifier 152 and the driving circuit 153.

[130] Now, the charging circuit 250 for receiving power from the charging power supply circuit 150 to charge a battery 262 will be explained. This charging circuit 250 is included in the battery device 200 together with the battery 262.

[131] The charging circuit 250 includes a secondary coil 210, a rectifier 251, a constant voltage/constant current circuit 252, a falling detector 253, a controller 255 and a contact-less sending module 220, 256.

[132] The secondary coil 210 is magnetically coupled to the primary coil 110 to generate an induced electromotive force. As mentioned above, the power signal applied to the primary coil 110 is a pulse width-modulated signal, so the induced electromotive force led to the secondary coil 210 is also AC voltage pulse train. Also, according to the driving mode of the primary coil 110, the AC voltage pulse led to the secondary coil 210 also conforms to any one of standby mode, charging mode and full-charged mode as shown in FIG. 3.

[133] The rectifier 251 is connected to an output terminal of the secondary coil 210 to smooth the AC voltage pulse induced by the secondary coil 210 into DC of a predetermined level.

[134] The constant voltage/constant current circuit 252 generates a constant voltage and a constant current to be charged to a battery using DC voltage of a predetermined level. That is to say, while a constant current mode is kept at an initial charging point of the battery, if a charging voltage of the battery becomes full, the constant current mode is switched into a constant voltage mode.

[135] The falling detector 253 detects a time when the AC voltage pulse induced by the secondary coil falls, namely a falling time. This falling detection signal is input to the controller 255.

[136] The controller 255 is a kind of microprocessor, which receives monitoring signals such as a falling detection signal, a charging current signal and a charging voltage signal, and then controls the constant voltage/constant current circuit 252 and the contact-less sending module 220, 256 based on the monitoring signals.

[137] That is to say, the controller 255 checks a falling time of pulse based on the falling detection signal input from the falling detector 253, and synchronizes a sending time of a feedback response signal to be sent to the charging power supply circuit 150 with the pulse falling time.

[138] The controller 255 always monitors a charging current and a charging voltage of a battery, and then temporarily stores the monitoring values in an internal memory (not shown). The memory, not shown, stores the battery charging status information such as monitored charging current and voltage, and battery specification information (product code, rating and so on) together.

[139] In addition, the controller 255 suitably selects or switches a constant voltage mode and a constant current mode according to the charging status of the battery, monitors whether an excessive voltage is applied to both ends of the constant voltage/ constant current circuit 252, and generates an adjustment request signal for the charging power if an excessive voltage is applied. This adjustment request signal is fed back to the charging power supply circuit 150 of the primary part via the contact-less sending module 220, 256.

[140] Preferably, the monitoring operation to both end voltages of the constant voltage/ constant current circuit 252 is conducted in a way of measuring a front end voltage Vpp and a rear end voltage Vch of the constant voltage/constant current circuit 252 and then checking whether a difference between them exceeds a criterion.

[141] The contact-less sending module includes an antenna 220 for sending a feedback response signal (for example, a charging start signal, a charging status signal, and an adjustment request signal) to be transmitted to the charging power supply circuit 150, and a sender 256 for modulating a baseband signal such as the charging status information to generate a feedback response signal.

[142] The protecting circuit (PCM) 261 is disposed between the constant voltage/constant current circuit 252 and the battery 262 to prevent an overvoltage or overcurrent from being applied to the battery. The protecting circuit 261 and the battery 262 compose a single battery unit 260.

[143] Now, the charging status of a battery will be explained in each mode with reference to FIG. 3. Here, for convenience, the charging power supply circuit or the charging part is defined as a primary charging unit, and the charging circuit or the battery device is defined as a secondary charging unit.

[144] If an external power such as the common AC power 151 is applied to the primary charging unit, the controller 155 of the primary charging unit wakes up and controls the driving circuit 153 to drive the primary coil 110.

[145] That is to say, in case no response is received from the secondary charging unit, the controller 155 determines it as a standby mode and then controls the driving circuit 153 to apply a standby mode power pulse train with a width of w_1 and a period of t_1 to the primary coil 110, as shown in FIG. 3. Accordingly, the primary coil 110 generates a magnetic field corresponding to the standby mode power pulse train, and emits it outside. This emission of magnetic field is continued until the charging start signal

shown in FIG. 3 is received to the contact-less receiving module 120, 156 of the primary charging unit.

[146] If the primary coil 110 and the secondary coil 210 are magnetically coupled (T point in FIG. 3) as the battery device 200 is placed on the charging part 100 as shown in FIG. 1, a standby mode power pulse train with a width of w_1 and a period of t_1 is induced at an output terminal of the secondary coil 210 by means of the magnetic field generated from the primary coil 110. This power pulse train has so weak power not to charge a battery, so it is used as a driving power of an interior circuit of the secondary charging unit (particularly, a driving power of a microprocessor). That is to say, the power pulse in the standby mode is emitted out and consumed until the primary and secondary coils are coupled, and it is used as a driving power for waking up the microprocessor if the primary and secondary coils are coupled.

[147] If an induced electromotive power is induced to the secondary part as mentioned above, the falling detector 253 of the secondary charging unit checks a falling point (or, a falling time) of the induced pulse. At this time, if the falling detector 253 detects a falling point of pulse, the falling detection signal is input to the controller 255 of the secondary charging unit, and the controller 255 sends a charging start signal shown in FIG. 3 to the primary charging unit as a feedback response via the contact-less sending module 220, 256. That is to say, in more detail, as the falling detection signal is input, the controller inquires an internal memory to determine whether a charging status information is present. At this time, if the charging status information is not present in the memory, the controller determines that a current status is a standby mode and then sends a charging start signal as a response to instruct the primary charging unit to switch into a charging mode.

[148] The controller 155 of the primary charging unit that receives a feedback charging start signal from the secondary charging unit switches the standby mode into the charging mode as shown in FIG. 3. That is to say, the controller 155 controls the driving circuit 153 to drive a charging mode power pulse train with a width of w_2 and a period of t_2 to the primary coil. Here, w_2 is at least greater than w_1.

[149] Accordingly, a charging mode power pulse train with a width of w_2 and a period of t_2 is induced at the output terminal of the secondary coil 210, and this power pulse train is rectified and then used for charging the battery 262. The battery is charged using a constant current mode and a constant voltage mode, as well known in the art.

[150] Meanwhile, as the charging mode power pulse train with a width of w_2 and a period of t_2 is induced at the output terminal of the secondary coil 210, the falling detector 253 checks a falling time of each pulse. At this time, if the falling point of pulse is detected, the controller reads the charging status information (for example, a charging voltage and a charging current) already monitored and stored in the memory. The read

charging status information is fed back to the primary charging unit via the contact-less sending module.

[151] The controller 155 of the primary charging unit to which the charging status information is fed back from the secondary charging unit analyzes the charging status information, and then controls the driving circuit 153 based on the analysis result to control a pulse width of the power pulse applied to the primary coil 110.

[152] At this time, if it is determined that the battery is already fully charged as an analysis result of the charging status information, the controller 155 of the primary charging unit switches the charging mode into a fully-charged mode as shown in FIG. 3.

[153] That is to say, the controller 155 controls the driving circuit to drive a fully-charged mode power pulse train with a width of w_3 and a period of t_3 to the primary coil. Here, w_3 is preferably smaller than w_2 but equal to or greater than w_1.

[154] Even in the fully-charged mode, the charging status information is fed back from the secondary charging unit to the primary charging unit at a falling time of pulse, and the controller of the primary charging unit analyzes this charging status information to determine whether to keep the fully-charged mode or to return to the charging mode.

[155] As explained above, a power signal (or, a power pulse train) transmitted between the primary and secondary coils and a communication signal (or, a feedback response signal) transmitted between the contact-less sending module and the contact-less receiving module are time-divided such that they are not overlapped in aspect of time. That is to say, the communication signal is synchronized and transmitted at the falling time of the power signal. Thus, it is possible to prevent any interference phenomenon or any distortion or dilution phenomenon of signals (particularly the communication signal) that may occur when a power signal and a communication signal are transmitted at the same time.

[156] In addition, in the present invention, a standby mode and a fully-charged mode are provided separately from the charging mode. Thus, energy emitted out by the primary coil and thus consumed is minimized, thereby capable of reducing power consumption in comparison with conventional contact-less charging devices.

[157] Hereinafter, operations of the contact-less charger system according to the first embodiment of the present invention will be explained with reference to FIGs. 3 and 4.

[158] If an external power such as the common AC power 151 is applied to the primary charging unit (Sl 1), the controller 155 of the primary charging unit wakes up and drives the primary coil 110. That is to say, the standby mode power pulse (or, the pulse width-modulated high frequency AC voltage) is applied to the primary coil 110, and the primary coil forms a magnetic field corresponding thereto and then emits it outside (S 12).

[159] Due to the magnetic field, an induced electromotive power pulse corresponding to the standby mode power pulse is generated at the output terminal of the secondary coil 210 (S30). This induced electromotive power pulse is so weak not to charge a battery, so it is just used as a driving power for driving a circuit in the secondary charging unit (particularly a microprocessor). Also, the falling detector 253 of the secondary charging unit checks a falling point of the power pulse to detect a falling time (S31).

[160] At this time, if the falling time is detected (YES of S32), the controller 255 of the secondary charging unit searches an internal memory to read status information (particularly, the charging status information) (S33). The status information includes charging status information such as charging voltage and charging current, and battery specification information such as product code or rating.

[161] In the step S33, if there is no charging status information in the memory (NO of S34), the controller 255 determines a current operating state as a standby mode and generates a charging start signal (S36), and transmits it to the primary charging unit via the contact-less sending module 220, 256 (S37).

[162] However, if the status information is present in the memory in the step S33 (YES of S34), the controller 255 reads the status information from the memory, generates a status feedback signal (or, a feedback response signal) based on the status information (S36), and then transmits it to the primary charging unit via the contact-less sending module 220, 256 (S37).

[163] Meanwhile, the controller 155 of the primary charging unit determines whether a response fed back from the secondary charging unit is present (S13), and then if there is no response, the controller 155 determines that the primary and secondary coils are not coupled and then keeps the existing standby mode as it is (S14).

[164] However, if there exists a response fed back from the secondary charging unit, the controller 155 analyzes the corresponding response and determines whether the response is a charging start signal (S15, S16).

[165] At this time, if the response is determined as a charging start signal, the controller 155 switches the driving mode of the system from the standby mode to the charging mode (S17). However, if the response is not a charging start signal, the controller 155 analyzes the status information more precisely (S18).

[166] As a result of the analysis of the status information in the step S18, if it is determined that the battery is fully charged (S19), the controller 155 switches the driving mode of the system from the charging mode to the fully-charged mode (S20).

[167] However, if the battery is not fully charged, the controller 155 controls a magnitude of the charging power based on the charging status information included in the status information. That is to say, the controller 155 controls a pulse width of the high frequency AC voltage pulse applied to the primary coil (S21).

[168]

[169] **Embodiment 2**

[170] Hereinafter, a contact-less charger system according to a second embodiment of the present invention will be explained with reference to FIGs. 5 to 8.

[171] FIG. 5 is a block diagram showing the primary charging unit (or, the charging part) according to the second embodiment of the present invention in more detail.

[172] Referring to FIG. 5, a power supply 157 includes an overvoltage filter 157a for intercepting an overvoltage applied from the common AC power 151, a rectifier 157b for converting the AC current passing through the overvoltage filter 157a into DC current, and a constant voltage supplier 157c for receiving the rectified DC current and supply a constant voltage DC current to the controller 155 and the driving circuit 153.

[173] The driving circuit 153 includes a pulse signal generator (PWM: Pulse Width Modulation) 154b for receiving a pulse driving signal from the controller 155 to generate a pulse signal, and a power driving unit 154a for rapidly switching the constant voltage DC current input from the constant voltage supplier 157c using the pulse signal output from the pulse signal generator 154b to generate a high frequency AC current and apply it to the primary coil 110.

[174] FIG. 6 is a block diagram showing the secondary charging unit (or, the battery pack) according to the second embodiment of the present invention in more detail.

[175] Referring to FIG. 6, the secondary charging unit (or, the battery pack) according to the second embodiment of the present invention includes first and second voltage detectors 272, 273 respectively provided to front and rear ends of the constant voltage/constant current circuit 252 to monitor whether an overvoltage is applied to both ends of the constant voltage/constant current circuit 252, and a voltage comparator 274 for inputting a comparison result of a first voltage V_{pp} and a second voltage V_{ch} respectively measured by the first and second voltage detectors 272, 273 to the controller 255.

[176] The voltage comparison result shows a difference value of the first and second voltages or a voltage status of both ends (overvoltage state: 1, common voltage state: 0) that indicate whether an overvoltage is applied. In the later case, the voltage comparator 274 compares the voltage difference acting as a basis of overvoltage state with a difference of the first and second voltages.

[177] Meanwhile, as a result of monitoring voltages of both ends of the constant voltage/constant current circuit 252, if it is determined that an overvoltage is applied, the controller 255 contact-less transmits an adjustment request signal for the charging power to the primary charging unit 150 using the sender 256.

[178] However, if the adjustment request signal is contact-less propagated while the charging power is transmitted from the primary coil 110 of the primary charging unit

150 to the secondary coil 210 of the secondary charging unit 200, the adjustment request signal may be interfered due to the magnetic field generated by the primary coil 110.

[179] Thus, in order to solve this problem, when the charging power is transmitted from the primary charging unit 150 to the secondary charging unit 200, the transmission of the charging power is temporarily interrupted at regular intervals.

[180] That is to say, as shown in FIG. 7, a charging region Δt_A in which high frequency AC current is induced to the secondary coil 210 by means of electromagnetic induction to allow charging and a ceasing region Δt_B in which the application of high frequency AC current to the primary coil 110 is intentionally stopped temporarily to cease charging are periodically repeated. In addition, while the induction of high frequency AC current at the secondary coil 210 is stopped to cease charging, the adjustment request signal for the charging power is transmitted to the primary charging unit 150.

[181] For this purpose, the secondary charging unit 200 according to the second embodiment of the present invention includes a charging cessation detector 270 for receiving the high frequency AC current induced at the secondary coil 210 to detect a time when the charging region ends (see t_s in FIG. 7).

[182] The charging cessation detector 270 detects the end point (see t_s in FIG. 7) of the charging region and then inputs it to the controller 255. Then, the controller 255 contact-less transmits the adjustment request signal for adjusting the charging power to the primary charging unit 150 via the sender 256 while the charging power is not transmitted. Thus, it is possible to prevent the adjustment request signal for the charging power from being interfered by the magnetic field generated by the primary coil 110.

[183] If the adjustment request signal for the charging power is contact-less transmitted to the primary charging unit 150, power of the high frequency AC current applied to the primary coil 110 is adjusted by means of the aforementioned feedback control, so voltages at both ends of the constant voltage/constant current circuit 252 may be kept at suitable levels.

[184] The contact-less charger system according to the second embodiment of the present invention as explained above may decrease a charging power in real time by means of feedback control though an overvoltage is applied to both ends of the constant voltage/constant current circuit 252, thereby capable of solving an overvoltage state instantly.

[185] Thus, the contact-less charger system of this embodiment does not need to fix relative positions as in the prior art so as to keep a magnitude of flux interlinking with the secondary coil 210. In addition, as shown in FIG. 8, the charging part (or, the primary charging unit) C is made in a pad shape, so a charger and battery set may be manufactured to allow each charging if a user places a charging object (or, the

secondary charging unit) B such as cellular phone combined with a battery on a predetermined position of the pad.

[186] Now, a contact-less charging control method according to this embodiment will be explained in detail with reference to FIGs. 5 and 6.

[187] First, in case of non-charging mode, the high frequency power driving unit 153 of the primary charging unit 150 applies a high frequency AC current to the primary coil 110 during a short period at regular time intervals under the control of the controller 155. For example, high frequency AC current of 80 KHz is applied for 50 ms at 1-second intervals. Then, the primary coil 110 forms a magnetic field around it whenever the high frequency AC current is applied thereto.

[188] The user positions the secondary charging unit 200 on the primary charging unit 150 for charging the battery 262. After the secondary charging unit 200 is positioned, if high frequency AC current is applied to the primary coil 110 of the primary charging unit 150 for a predetermined time, a magnetic field is generated on the primary coil 110, and as a result a magnetic flux is interlinked to the secondary coil 210 of the secondary charging unit 200. Accordingly, if high frequency AC current is induced to the primary coil 110 and then not applied thereto, induction of high frequency AC current at the secondary coil 210 is temporarily intercepted due to the disappearance of the magnetic field.

[189] Meanwhile, the charging cessation detector 270 detects a point when the induction of high frequency AC current is temporarily intercepted, and then inputs it to the controller 255. As a response, the controller 255 outputs a response signal to the sender 256. Here, the response signal is used for informing the controller 155 of the primary charging unit 150 that the secondary coil 210 provided to the secondary charging unit 200 is combined to the magnetic field generated from the primary coil 110 of the primary charging unit 150. If the response signal is output to the sender 256, the sender 256 modulates the response signal and then contact-less transmits it to the primary charging unit 150 via the antenna 220.

[190] If the response signal is contact-less transmitted, the receiver 156 of the primary charging unit 150 modulates the response signal and inputs it to the controller 155. Then, the controller 155 starts transmitting the charging power to the secondary charging unit 200. That is to say, the controller 255 controls the high frequency power driving unit 153 to repeat applying high frequency AC current to the primary coil 110 for a predetermined time and ceasing application of high frequency AC current for a predetermined time. For example, the high frequency power driving unit 153 applies high frequency AC current of 80 KHz for 3 seconds and then ceases for 50 ms.

[191] While high frequency AC current is applied to the primary coil 110, high frequency AC current is also induced at the secondary coil 210 of the secondary charging unit

200 due to the electromagnetic induction. The time for keeping induction of high frequency AC current as mentioned above is substantially identical to the time during which the application of high frequency AC current to the primary coil 110 is kept.

[192] The high frequency AC current induced to the secondary coil 210 is converted into DC current by the rectifier 251 and then applied to the battery 262 via the constant voltage/constant current circuit 252. Then, the battery 262 is gradually charged, and voltages at both ends of the battery 262 are increased until a fully-charged status.

[193] The controller 255 controls the constant voltage/constant current circuit 252 such that the battery 262 is charged in a constant current mode until a charging voltage of the battery 262 is increased to some extend and then the battery 262 is charged in a constant voltage mode if the voltage of the battery 262 is increased over a predetermined level.

[194] Meanwhile, if the application of high frequency AC current to the primary coil 110 is ceased, the induction of high frequency AC current at the secondary coil 210 is also temporarily intercepted, thereby temporarily stopping the charging work. Then, the charging cessation detector 280 detects a time when the induction of high frequency AC current is intercepted, and then inputs it to the controller 255. This operation is repeatedly conducted whenever the induction of high frequency AC current is temporarily intercepted.

[195] Separately from the charging process of the battery 262 as mentioned above, the controller 255 monitors whether an overvoltage is applied to both ends of the constant voltage/constant current circuit 252.

[196] For this purpose, the voltage comparator 274 periodically receives voltages measured by the first and second voltage detectors 272, 273 respectively provided to the front and rear ends of the constant voltage/constant current circuit 252, compares the voltages, and then inputs a voltage comparison result to the controller 255. Here, the voltage comparison result is a voltage status signal indicating a difference value between two measured voltages or indicating whether in an overvoltage state.

[197] After receiving the voltage comparison result from the voltage comparator 274, the controller 255 determines whether an overvoltage is applied to both ends of the const ant voltage/constant current circuit 252.

[198] As a result, if it is determined that an overvoltage is applied to both ends of the constant voltage/constant current circuit 252, the controller 255 determines whether the present time is a ceasing period in which high frequency induced current is not applied to the primary coil 110, with reference to the time at which the induction of high frequency AC current is temporarily intercepted, input by the charging cessation detector 270.

[199] As a result, if it is determined as a ceasing period, the controller 255 outputs an

adjustment request signal for the charging power to the sender 256. Then, the sender 256 modulates the adjustment request signal for the charging power and contact-less transmits it to the primary charging unit 150 via the antenna 220.

[200] As a response, the receiver 156 provided to the primary charging unit 150 receives and modulates the adjustment request signal for the charging power via the antenna 120, and then inputs it to the controller 155. Then, the controller 155 controls the high frequency power driving unit 153 to lower the high frequency AC current applied to the primary coil 110 as much as a predetermined level.

[201] If the power of high frequency AC current applied to the primary coil 110 is reduced, the power of high frequency AC current induced to the secondary coil 210 by means of electromagnetic induction is also decreased together.

[202] Meanwhile, separately from the feedback control for the power of high frequency AC current, the monitoring operation of the controller 255 for monitoring an overvoltage state at both ends of the constant voltage/constant current circuit 252 is periodically repeated. As a result, if it is determined by means of a first feedback control that the overvoltage status at both ends of the constant voltage/constant current circuit 252 is still not solved, the controller 255 contact-less transmits the adjustment request signal for the charging power to the primary charging unit 150 again so as to lower the power of high frequency AC current applied to the primary coil 110 by a predetermined level again. This process is continued until an overvoltage is not applied to both ends of the constant voltage/constant current circuit 252 by means of feedback control.

[203] Since a voltage difference between both ends of the constant voltage/constant current circuit 252 is kept in a suitable level by means of the above feedback control, it is possible to prevent the constant voltage/constant current circuit 252 from being damaged due to overvoltage while the battery 262 is charged in a contact- less way.

[204] In this embodiment as explained above, the controller 255 of the battery device (or, the secondary charging unit) 200 directly checks an overvoltage status by monitoring voltages measured at both ends of the constant voltage/constant current circuit 252 so as to prevent an overvoltage from being applied to both ends of the constant voltage/ constant current circuit 252 of the contact- less charging battery 262. In addition, in case of an overvoltage state, the controller 255 of the battery device 200 transmits an adjustment request signal for the charging power to the controller 155 of the charging part (or, the primary charging unit) 150 by means of contact- less communication. Then, the controller 155 of the charging part 150 adjusts the power of high frequency AC current applied to the primary coil 110 under the condition of receiving the charging power adjustment request signal.

[205] However, there may be other alternatives. In more detail, with reference to FIGs. 5

and 6, the controller 255 of the battery device 200 periodically monitors both ends of the constant voltage/constant current circuit 252 to obtain a voltage status.

[206] Here, the voltage status is voltage at both ends of the constant voltage/constant current circuit 252 or a difference between the voltages at both ends. This voltage status may be received from the voltage comparator 274, and it is also possible that voltages V_{pp}, V_{ch} measured by the first and second voltage detectors 272, 273 and then calculated to obtain the voltage status.

[207] The controller 255 of the battery device 200 refers to a time that the charging cessation detector 270 inputs whenever the voltage status is obtained, and then transmits the voltage status of both ends of the constant voltage/constant current circuit 252 to the controller 155 of the charging part 140 by means of contact-less commun ication while high frequency AC current is not induced to the secondary coil 210.

[208] Then, the controller 155 of the charging part 150 checks whether the voltage status is an overvoltage status, whenever receiving the voltage status. This checking process is conducted in a way of checking whether the different of voltages at both ends of the constant voltage/constant current circuit 252 exceeds a predetermined criterion.

[209] As a result, if the voltage status of both ends of the constant voltage/constant current circuit 252 is corresponding to an overvoltage status, the controller 155 controls the high frequency power driving unit 153 to adjust the power of high frequency AC current applied to the primary coil 110, thereby adjusting the charging power transmitted to the battery device 200.

[210] If the adjusting process for the charging current as mentioned above is repeated as required, though an overvoltage is applied to both ends of the constant voltage/constant current circuit 252, the overvoltage status is solved within a short time, thereby preventing the constant voltage/constant current circuit 252 from being damaged.

[211]

[212] **Embodiment 3**

[213] Now, a contact-less charger system whose deviation of charging efficiency is improved according to a third embodiment of the present invention will be explained with reference to FIGs. 9 to 14.

[214] In case of a contact-less charger system using induced coupling, there is a problem that deviation of charging efficiency is increased depending on a position where a battery device is placed. That is to say, to be compatible with portable electronic devices with various shapes and sizes (for example, even cellular phones with a fixed rated voltage of a battery have vary various shapes and sizes), a charging part may not have shape and structure matching with only a specific charging object, and it should be designed a little greater than a size of the charging object. Further, when considering a structure capable of charging at least two portable electronic devices or

batteries at the same time, the charging part should have a greater size, and accordingly there is serious deviation in a position of a portable electronic device or a battery device to be charged with respect to the charging part. However, an intensity of the magnetic field (or, a magnetic flux density) generated by the primary circuit of the charging part, namely the primary coil, is greatly decreased as it becomes more distant from the coil. Thus, a charging efficiency that is in proportion to the induction-coupled magnetic flux density has serious deviation according to a position of a charging target with respect to the primary coil, and, in case the charging target is placed at a bad position, the time taken for fully charging a battery is greatly increased, and in a worst case, the battery may be substantially not charged.

[215] In particular, a portable electronic device such as a cellular phone, PDA and MP3 player should be charged within a relatively short time such as a bedtime, differently from an electric toothbrush or an electric shaver that is used for a very short time but placed on a contact-less charger nearly all day, so the deviation of charging efficiency becomes a more serious issue.

[216] Thus, to make the contact- less charger more available to portable electronic devices such as cellular phones, it is urgently needed to improve the deviation of charging efficiency according to a position where a charging target is placed.

[217] Thus, this embodiment is directed to improving deviation of charging efficiency according to a position of a charging target with respect to a contact-less charger.

[218] FIG. 9 is a perspective view showing that a battery of a portable electronic device is charged using a contact-less charger according to a third embodiment of the present invention.

[219] As shown in FIG. 9, the contact-less charger 310 of this embodiment includes a pad unit 311 on which a portable electronic device 320 or its battery that is a charging target is placed, a circuit unit 312 in which various primary circuits required for the contact-less charger are accumulated on a substrate, and a status indicator 313 for displaying a charging status.

[220] The pad unit 311 having an approximately disk shape has a primary coil 330 (see FIG. 10) arranged thereon to generate a magnetic field when a high frequency primary current is applied thereto. The circuit unit 312 includes a rectifier for generating a desired high frequency current of a primary side from a common AC power, SMPS (Switching Mode Power Supply), a contact-less communication module for communicating with a battery of a secondary side, and a control circuit for controlling them. The status indicator 313 is used for displaying a charger status to indicate whether a power is connected, where the battery is in charging, whether the battery is fully charged, and so on, and the status indicator 313 is composed of LEDs of suitable number and color.

[221] However, this invention is characterized in shape and arrangement of the primary coil, explained later, and the configuration, arrangement and shape of the pad unit 311, the circuit unit 312, the status indicator 313 and so on may be changed in various ways.

[222] For example, the contact-less charger 310 including the pad unit 311 and the circuit unit 312 may have a polygonal shape such as rectangle or hexagon in addition to a disk shape, and the circuit unit 312 may not have a protruded structure. Further, in FIG. 9, the contact- less charger 310 is illustrated as being placed flat on the ground, but it may have a well-hanging structure such that the pad unit is configured as a pocket or drawer for receiving a portable electronic device 320.

[223] In addition, circuits included in the circuit unit 312 may also be not provided with a rectifier or the like in case it uses a DC power such as a power from a cigar jack, not a common AC power of 110V or 220V.

[224] Further, the status indicator 313 having LED may also be substituted wit a speaker giving a voice or an alarm.

[225] A battery (for example, a lithium ion battery or a lithium polymer battery) is mounted to a surface of the cellular phone 320 facing the pad unit 311 when the cellular phone 320 is placed on the pad unit 311, and the battery includes a secondary coil (not shown) induction-coupled with the primary coil 330 arranged on the pad unit 311 to generate an induction current.

[226] Meanwhile, though the portable electronic device is illustrated in FIG. 9 as a cellular phone 320 as an example, the present invention is not limited thereto, but the present invention may be applied to various portable electronic devices such as PDA, portable MP3 player, CD player and so on. Also, though it is illustrated that the entire cellular phone 320 is placed on the contact- less charger 310 for charging, it is also possible that only a battery cell of the cellular phone is placed thereon for charging.

[227] Now, configuration and arrangement of the primary coil 330 of this embodiment will be explained with reference to FIG. 10.

[228] As shown in FIG. 10, the primary coil 330 formed on the pad unit 311 is composed of an outer coil 331 and an inner coil 332. The outer coil 331 is arranged with a pre-determined number of turns and a predetermined radius r_o, and the inner coil 332 is arranged with a predetermined number of turns and a predetermined radius r_1 to be completely included in the outer coil 331. Meanwhile, in FIG. 10, the number of turns and the radius of each coil 331, 332 are not exactly illustrated but simplified for convenient explanation. In FIG. 10, S_1 and S_0 are respectively concentric areas of the inner coil 332 and the outer coil 331, which have relations of $S_1=\pi r_1^2$ and $S_o=\pi r_o^2$, respectively. Here, the number of turns, radius and concentric area of each coil are determined in consideration of a rating of a battery to be charged, rating and frequency of a charging power, impedance of the coil, and shape and size of a secondary coil, and

also in consideration of a magnetic flux density profile, explained later with reference to FIG. 11.

[229] Meanwhile, both of the outer coil 331 and the inner coil 332 are configured in a planar spiral shape in FIG. 10, but the coil may have polygonal shapes such as rectangle and hexagon according to the shape of the pad unit 311 or the secondary coil. Further, the outer coil 331 may have a different shape from the inner coil 332. Also, though it is illustrated in FIG. 10 that the outer coil 331 and the inner coil 332 are arranged concentrically with the same center, it is also possible that their centers are not coincided. Further, though it is illustrated in FIG. 10 that the inner coil 332 is used single, it is also possible that at least two inner coils 332a, 332b are subsequently included therein as shown in FIG. 12.

[230] In addition, each coil 331, 332 generally employ a copper wire coated with insulating material on its surface, but any material with excellent conductivity such as gold, silver and aluminum may also be used without any special limitation. Further, each coil 331, 332 may be configured such that a single wire is wound, but it is preferred in case of charging using high frequency current that a Litz wire in which a plurality of thin wires are aggregated is used.

[231] Also, each coil 331, 332 may be a conductor pattern, not using a wound conductive wire. That is to say, each coil 331, 332 may be a conductor pattern prepared by laminating a metal thin film with excellent conductivity such as copper and aluminum on a PCB or a flexible insulating film (or, a substrate film) made of such as polyimide, and then etching the metal thin film into a pattern as shown in FIG. 10 or 12. Further, though this embodiment relates to the primary coil, the secondary coil of the portable electronic device may have a wound wire or a conductor pattern of copper like the primary coil 331, 332 of this embodiment. Thus, the term 'coil' used in the specification has a broad meaning, including all kinds of coil made by winding a conductor wire, etching a metal thin film, or forming a pattern.

[232] The outer coil 311 and the inner coil 332 may be connected in series as shown in FIG. 10 to apply current to the primary side, but they may also be arranged separately to apply separate primary currents respectively. Here, it should be noted that, when a primary side current is applied to the primary coil 330, a magnetic field formed in each coil should be arranged in the same direction. The reason will be explained later.

[233] Now, the principle of this embodiment will be explained in more detail with reference to FIG. 11. FIG. 1 is a schematic view showing an intensity (or, magnetic flux density) profile of a magnetic field seen along a line (III-III line in FIG. 10) intersecting the outer coil 331 and the inner coil 332 when a primary side current is applied to the primary coil 330. Here, (a) of FIG. 11 shows the case of a conventional general primary coil without an inner coil, and (b) of FIG. 11 shows the case of a

primary coil having the outer coil 331 and the inner coil 332 according to the embodiment of the present invention as shown in FIG. 10.

[234] First, in case that there is no inner coil as shown in (a) of FIG. 11, if a primary side current is applied to the primary coil (or, the outer coil) 331, a magnetic field is generated in a direction based on the right handed screw rule (or, the Ampere's law), and an intensity (or, a magnetic flux density) of the magnetic field at any point near the coil 331 is in reverse proportion to the cube of a distance from the coil 331. Thus, as indicated by arrows 341, the magnetic flux density 341 is rapidly decreased as becoming more distant from the coil 331, and the magnetic flux density within the coil 331 has a profile as indicated by a dotted line 340. As understood from the magnetic flux density profile 340, the magnetic flux density formed within the coil 331 has a maximum value at a position nearest to the coil 331, and a minimum value at a center inside the coil. Thus, though being related to a radius of the coil 331 and an intensity of the primary side current, a charging efficiency may be greatly lowered and a time taken till full charging may be greatly increased according to a position that the cellular phone 320 or the battery is placed.

[235] Meanwhile, in case of (b) of FIG. 11 in which the inner coil 332 is present, a magnetic field is formed by the inner coil 332, and its magnetic flux density is decreased in reverse proportion to the cubic of a distance from the inner coil 332, as indicated by arrows 342. Thus, the total magnetic flux density by the outer coil 331 and the inner coil 332 becomes a sum of magnetic fluxes by both coils 331, 332, which shows a profile as indicated by a solid line 350. This total magnetic flux density profile 350 is compensated slightly by the magnetic flux of the outer coil 331 at an outer region out of the inner coil 332, so it is slightly decreased in the region rather than the profile 340 obtained by only the outer coil, but the profile 350 is reinforced inside the inner coil 332 to have another maximum point near the center of the primary coil. In addition, the total magnetic flux density profile 350 is minimal near an outer side of the inner coil 332, but this minimum value is greater than the minimum value of the magnetic flux density profile 340 obtained by only the outer coil 331. Thus, the total magnetic flux density profile 350 becomes flat as a whole rather than the magnetic flux density profile 340 obtained by only the outer coil. Thus, the deviation of magnetic flux density inside the primary coil (or, the outer coil) 331 is greatly reduced, so the deviations of induction power and charging efficiency are also greatly decreased accordingly, and as a result the deviation of time taken for fully charging is also greatly decreased.

[236] Here, the outer coil 331 and the inner coil 332 should be arranged to have magnetic fields in the same direction when a primary side current is applied thereto because the magnetic flux densities 341, 342 of the coils 331, 332 should be compensated near the

center of the coils 331, 332 to increase a minimum value of the magnetic flux density.

[237] Meanwhile, the total magnetic flux density profile 350 is changed depending on radius and turning number of the outer coil 331 and the inner coil 332, impedance, and intensity and frequency of the primary side current, but the basic shape shown in FIG. 11 is maintained, but detailed position and value of the minimum value may be adjusted by suitably controlling radius and turning number of coils, impedance, intensity and frequency of the primary side current, and so on. By controlling the total magnetic flux density profile 350, the minimum value of the magnetic flux density inside the primary coil 330 may be set to a desired level. Preferably, if the minimum value of the total magnetic flux density is set over 50% of the maximum value, the deviation of charging efficiency is decreased to reduce deviation of time taken for full charging. In addition, more preferably, if the minimum value of the total magnetic flux density is set over 70% of the maximum value, the deviation of charging efficiency is decreased to reduce deviation of time taken for full charging at the worst case.

[238] Now, a preferable example of configuration and arrangement of the primary coil is proposed based on the case of charging a battery of a cellular phone. However, this example is just for illustration only, and the present invention is not limited thereto. Further, in case a charging target of the secondary side is not a battery of a cellular phone but a battery of another kind of portable electronic device such as a battery of PDA or notebook computer, the following example may be changed as desired.

[239]

[240] Input power: AC 220V

[241] Frequency of the charging current: 80 kHz

[242] Intensity of the charging current: 110 to 160A

[243] DC resistance of the inner coil: 0.1 to 0.5 Ω

[244] DC resistance of the outer coil: 1.0 to 3.0 Ω

[245] Ratio of radii of coils (r_1/r_o): 0.1 to 0.9

[246] Ratio of concentric areas of coils (S_1/S_o): 0.01 to 0.81

[247] Number of turns of the inner coil: 5 to 15

[248] Number of turns of the outer coil: 40 to 60

[249] AC (IkHz to IMHz) resistance of the inner coil: 0.1 to 0.4 Ω

[250] AC (IkHz to IMHz) resistance of the outer coil: 2.0 to 20 Ω

[251] Inductance of the inner coil: 4.7 to 5.0 μH

[252] Inductance of the outer coil: 240 to 250 μH

[253]

[254] Meanwhile, a primary coil and a secondary coil are configured as in FIG. 13 and the following table 1 using an input power of AC 220V and a frequency of charging current of 80 kHz, and then an induction power profile proportional to its magnetic

flux density and maximum and minimum values of the induction power were measured. Here, the primary coil 331, 332 is prepared as a multi coil by connecting outer and inner coils made of Litz-type copper material in series, and the secondary coil 321 is also prepared as a circular single coil made of Litz-type copper material.

[255]

[256] Table 1

Coil parameters	Primary coil (331, 332)	Secondary coil (321)	Note
DC resistance (Ω)	Inner coil: 0.1Outer coil: 2.0	1.3	
Inductance (μH)	373.3 (1 kHz)	38 (80 kHz)	
Number of turns	Inner coil: 12Outer coil: 50	25	
Diameter of coil wire (mm)	0.15	0.08	Diameter of unit hairline of Ritz wire
Thickness of coil (mm)	2.5	0.3 to 0.4	Thickness perpendicular to the plane of FIG. 13
Inner radius (mm)	Inner coil (r_1): 18Outer coil (r_o): 35	r': 15	
Outer radius (mm)	Inner coil (Ri): 19Outer coil (Ro): 37	R': 20	
Interval between coils d (mm)	16	-	

[257]

[258] In addition, in order to compare effects of this embodiment with convention ones, a primary coil identical to this embodiment except that the inner coil is excluded was configured as a comparative example, and its induction power profile and maximum and minimum values of the induction power were measured.

[259] Voltage, current and power induced to the secondary coils of this embodiment and the comparative example were measured as in the following table 2 in the above experiments, and a profile of induction power is shown in FIG. 14.

[260]

[261] Table 2

Interval between centers D (mm)	Embodiment (double coil)			Comparative example (single coil)		
	Voltage (V)	Current (mA)	Power (W)	Voltage (V)	Current (mA)	Power (W)
25	5.07	366	1.9	5.07	366	1.86
22	4.84	366	1.8	4.71	366	1.72
20	4.01	366	1.5	4.11	366	1.50
18	3.83	366	1.4	3.92	366	1.43
15	3.28	366	1.2	5.80	200	1.16
13	3.19	366	1.2	5.31	200	1.06
11	3.00	366	1.1	4.98	200	1.00
8	3.17	366	1.2	4.52	200	0.90
6	3.43	366	1.3	4.26	200	0.85
4	3.95	366	1.4	4.12	200	0.82
2	4.18	366	1.5	4.00	200	0.80
0	4.08	366	1.5	3.98	200	0.80

[262]

[263] As understood from the table 2 and FIG. 14, maximum and minimum values of the secondary side induction power according to this embodiment are respectively 1.9W and 1.IW, so the minimum value reaches about 58% of the maximum value. Meanwhile, maximum and minimum values of the secondary side induction power according to the comparative example are respectively 1.86W and 0.8W, so the minimum value reaches about 43% of the maximum value.

[264] As seen from the experiments, it would be understood that the deviation of charging efficiency is greatly reduced in the contact-less charger having the primary coil according to the present invention.

[265] As explained above, by configuring the primary coil into a multi structure having outer and inner coils, the contact-less charger according to the third embodiment of the present invention compensates a magnetic flux density greatly decreased near the inner center of the outer coil with a magnetic flux of the inner coil. Thus, the deviation of magnetic flux density is greatly decreased inside the primary coil, and accordingly the deviation of charging efficiency depending on a position where the battery to be charged is placed is also greatly reduced.

[266]

[267] Embodiment 4

[268] Now, a contact-less charging device, a contact-less charger system and a charging method using a coil array according to a fourth embodiment of the present invention will be explained with reference to FIGs. 15 to 21.

[269] In case of a common contact-less charger system, a charging efficiency is varied depending on positional relationship between a primary coil and a secondary coil, disadvantageously. That is to say, if there exists a positional offset between the primary and secondary coils, an induced electromotive force is not sufficiently led to the secondary coil, so the charging efficiency is very deteriorated in comparison to a contact-type charger system. Thus, a user should make an effort to place a portable electronic device or a battery pack including a secondary coil at an optimal position on a charging part.

[270] To solve this problem, there have been made many attempts to change an arrangement pattern of the primary coil so as to ensure high charging efficiency regardless of position or direction of the secondary coil.

[271] Korean Patent Registration No. 524,254 discloses a contact-less charger system in which a core block having a coil of a predetermined pattern is arranged on a flat plate core where a plurality of small cores made of cobalt or ferrite are attached on a contact-less charging pad (or, a primary charging part).

[272] If a plurality of coils are arranged alternately or in parallel on the same plane of a charging part as in the above document to compensate positional offset between primary and secondary coils, energy is excessively consumed in comparison to the case that a single coil is used.

[273] Therefore, the fourth embodiment of the present invention provides a contact-less charging device capable of efficiently transferring an induced electromotive force to a secondary part regardless of a relative position between the primary and secondary coils, and also capable of minimizing energy consumption together with ensuring high charging efficiency.

[274] In addition, the fourth embodiment of the present invention provides a contact-less charging device capable of charging a plurality of portable electronic devices together.

[275] FIG. 15 is a schematic view showing a charging device according to the fourth embodiment of the present invention in a used state.

[276] Referring to (a) of FIG. 15, the charging device 400 of this embodiment is characterized in that a single coil is not included in a charging pad, but a plurality of coils 410 are included to configure a coil array, differently from the charging device 100 of FIG. 1. In addition, the coil array 410 is surrounded by an antenna coil 420. The antenna coil 420 may be installed in single to surround the coil array, or a plurality of antenna coils may be installed to surround each primary coil or several primary coils,

for example 4 to 6 primary coils.

[277] In case the plurality of coils 410 configure a coil array as mentioned above, it is easier to ensure positional conformation between the primary and secondary coils, rather than the case that a single coil is used. Thus, though a battery device 450 is placed with a slant on the charging device 400 as shown in (a) of FIG. 15, positional offset between the primary and secondary coils does not occur. That is to say, though the battery device 450 is placed at any position on the charging device 400, there exists at least one primary coil conforming to the secondary coil arranged on the battery device 400.

[278] Thus, if the charging device of this embodiment is used, a user need not be worried about positional relationship between the primary and secondary coils, thereby enhancing convenience of the user. In addition, the coil array 410 of this embodiment may be configured to arrange a plurality of coils in a matrix pattern as shown in (a) of FIG. 15 and also to arrange them in a zigzag pattern as shown in (b) of FIG. 15.

[279] FIG. 16 shows the charging device of this embodiment in another used state.

[280] Referring to FIG. 16, at least one battery device 450a, 450b, 450c are placed on the charging device 400 provided with the coil array 410. Thus, the charging device 400 of this embodiment may advantageously charge several battery devices 450a, 450b, 450c together.

[281] However, the charging device 400 shown in FIGs. 15 and 16 has a drawback of consuming much energy, in spite of advantages of ensuring stable charging efficiency regardless of positional relationship between the primary and secondary coils and capable of charging many battery devices together.

[282] Thus, the energy consumption may be greatly decreased in a way of driving only primary coils at least partially coupled with the secondary coils of the battery device, among the plurality of primary coils in the coil array, as explained in detail below.

[283] First, FIG. 17 is a functional block diagram showing a contact-less charger system according to this embodiment.

[284] Referring to FIG. 17, the contact-less charger system of this embodiment includes a charging device 400 and a battery device 450.

[285] The charging device 400 includes a sending coil array 410, a rectifier 402, a power distribution circuit 403, a coil driving circuit 404, a control circuit 405, a charging mode control circuit 406, and a contact-less receiving module 407, 408. The sending coil array 410 includes at least one sending coil (TC_1, TC_2 ~ TC_n), and the sending coil (TC_1, TC_2 ~ TC_n) is preferably arranged in a matrix pattern as shown in FIG. 15 or 16.

[286] The rectifier 402 rectifies AC voltage from a common AC power (60 Hz, 220V) 401 into DC, and then transfers it to the power distribution circuit 403.

[287] The power distribution circuit 403 transmits the DC voltage rectified by the rectifier

402 to a selected coil driving circuit 404. That is to say, the power distribution circuit 403 receives a selection instruction from the control circuit 405, and then transmits the rectified DC voltage to a coil driving circuit 404 indicated by the selection instruction. For example, the power distribution circuit 403 acts as a kind of switching circuit positioned between the rectifier 402 and the coil driving circuit 404 to electrically connect the rectifier 402 and a coil driving circuit 404 selected by the control circuit 405.

[288] The charging mode control circuit 406 controls a driving mode of the corresponding sending coil 410 by controlling the coil driving circuit 404 selected by the control circuit 405. For example, the driving mode may be a standby mode, a charging mode and a fully-charged mode.

[289] Referring to FIG. 18, the standby mode is for checking a coupling state of the primary and secondary coils, and for example the operation is conducted for 50 msec (w_1) and intercepted for 1 sec (t_1) in this mode. The charging mode is for charging the battery device by operating the primary coil for a time (w_2) longer than the standby mode with respect to the primary coil position-conforming to the secondary coil. In addition, the fully-charged mode is for reducing an operating time (w_3) of the primary coil to reduce energy consumption when the battery device is fully charged.

[290] In this embodiment, the driving mode of the sending coil is illustrated to have the standby mode, the charging mode and the fully-charged mode as in FIG. 18, but this embodiment is not limited thereto.

[291] The coil driving circuit 404 oscillates DC voltage from the rectifier as alternative voltages with predetermined level and frequency (e.g., 80 kHz) to drive each of the plurality of sending coils. In particular, the coil driving circuit 404 of this embodiment generates AC pulse voltage predetermined for each mode (for example, the standby mode, the charging mode and the fully-charged mode) as shown in FIG. 18 under the control of the charging mode control circuit 406.

[292] The contact- less receiving module 407, 408 is composed of an antenna coil 408, and a receiving circuit 407. The contact- less receiving module 407, 408 contact- less receives a charging start signal FR_1, FR_2 and a charging status signal CS_1, CS_2 fed back from the battery device 450, and then modulates it and transmits to the control circuit 405.

[293] The control circuit 405 receives the feedback signal of the battery device 450 from the receiving circuit 407, and analyzes the feedback signal to control the power distribution circuit 403 and the charging mode control circuit 406. In particular, the control circuit 405 is preferably connected to a pulse generator (not shown) and a timer (not shown). That is to say, the timer counts pulses transmitted from the pulse generator, and transmits the counted value to the control circuit 405. Accordingly, the

control circuit 405 controls the power distribution circuit 403 according to a predetermined period ($T = w_1 + t_1$) to subsequently oscillate the coil driving circuits 404.

[294] That is to say, the control circuit 405 subsequently drives the coil driving circuits 404 according to a predetermined time w_1, t_1, and receives the feedback signal from the battery device 450 to select a sending coil TC_1, TC_2 ~ TC_n to be switched to the charging mode.

[295] The battery device 450 includes a secondary coil 451, a rectifier 453, a constant voltage/constant current circuit 454, a charging status detecting circuit 458, a control circuit 457, and a contact-less sending module 452, 456.

[296] The secondary coil 451 is a receiving coil magnetically coupled to the primary coil (or, the sending coil) 410 to generate an inducted electromagnetic force. Since a power signal applied to the primary coil 410 is a pulse train signal (or, a pulse with a width of w_1) as shown in FIG. 18, the inducted electromotive force led to the secondary coil 451 is also an AC voltage pulse train. In addition, according to the driving mode of the primary coil 410, the AC voltage pulse induced to the secondary coil 451 also conforms any one of the standby mode, the charging mode and the fully-charged mode as in FIG. 18.

[297] The rectifier 453 is connected to an output terminal of the secondary coil 451 to smooth the AC voltage pulse induced by the secondary coil 451 into DC of a predetermined level.

[298] The constant voltage/constant current circuit 454 generates constant voltage and constant current to be charged to a battery using DC voltage of a predetermined level. That is to say, if a constant current mode is maintained at an initial charging stage of the battery and then a charging voltage of the battery becomes saturated, the mode is switched into a constant voltage mode.

[299] The charging status detecting circuit 458 detects a charging state such as an electric state induced to an output terminal of the secondary coil, an electric state of an output terminal of the rectifier, or voltages at both ends of the constant voltage/constant current circuit. The charging status detection signal detected as above is input to the control circuit 457.

[300] The control circuit 457 is a kind of microprocessor, which receives a monitoring signal such as te charging status detection signal and controls the constant voltage/constant current circuit 454 and the contact-less sending module 452, 456 based on the monitoring signal.

[301] That is to say, the control circuit 457 checks based on the charging status detection signal input from the charging status detecting circuit 458 whether the primary and secondary coils are coupled, positional relationship between the primary and secondary coils, charging status of the battery (for example, a constant current mode, a constant

voltage mode, a charging degree, and so on), and voltage state at both ends of the constant voltage/constant current circuit. In particular, the control circuit 457 checks a falling time of the AC voltage pulse induced to the secondary coil, and synchronizes a transmitting point of a feedback response signal to be sent to the charging device 400 with the falling time of pulse.

[302] In addition, the control circuit 457 feeds back a charging start signal FR_1, FR_2 (see FIG. 18) to the charging device 400 at the primary side from the outer terminal of the secondary coil 451, in case a minimum level current capable of driving the control circuit 457 is present. Accordingly the control circuit 405 of the charging device 400 determines that the sending coil 410 currently operating is at least partially coupled with the secondary coil 451, and then temporarily stores this information in an internal memory (not shown).

[303] Also, the control circuit 457 at the secondary side monitors a charging current and a charging voltage of the battery 459b at ordinary times, and temporarily stores the monitoring value to an internal memory (not shown). The memory, not shown, stores battery specification information (product code, rating, and so on) in addition to the battery charging status information such as monitored charging current and voltage.

[304] In addition, the control circuit 457 suitably selects and switches the constant voltage mode and the constant current mode according to the charging status of a battery.

[305] The contact-less sending module 452, 456 includes an antenna 452 for sending a feedback response signal (a charging start signal or a charging status signal) to be transmitted to the charging device 400 at the primary side, and a sending circuit 456 for modulating a baseband signal such as the charging status information to generate a feedback response signal.

[306] A protection circuit (PCM) 459a is arranged between the constant voltage/constant current circuit 454 and the battery 459b so as to prevent an overvoltage or overcurrent from being applied thereto. The protection circuit 459a and the battery 459b configures a single battery unit 459.

[307] The functional configuration of the contact-less charger system shown in FIG. 17 is just an example for illustrating the principle of this embodiment, so there may be various modifications within the scope not departing from the technical principle of this embodiment.

[308] Now, operations of the contact-less charger system according to this embodiment will be explained with reference to FIGs. 18 and 19.

[309] First, for the convenience, it is assumed that the charging device 400 of this embodiment has a coil array structure (15 primary coils are arranged in an antenna coil in a matrix pattern) as shown in FIG. 15, and a battery device (for example, a cellular phone) is placed on the charging device 400 as shown in FIG. 15. That is to say, it is

assumed that the battery device 450 is placed over sending coils #7, #8, #9, #12, #13, #14 of the charging device 400.

[310] If an external power such as the common AC power 401 is applied to the charging device 400, the control circuit 405 of the charging device wakes up and controls the power distribution circuit 403 and the coil driving circuit 404 to subsequently drive the sending coils 410 (SlO). At this time, the timer counts predetermined pulses input from a pulse generator, not shown, and the count information is input to the control circuit 405 (S15).

[311] First, the control circuit 405 controls the power distribution circuit 403 to apply DC current rectified by the rectifier to a 1st coil driving circuit 404 for a predetermined time w_1. That is to say, the 1st coil driving circuit 404 is oscillated as shown in FIG. 18 to drive a sending coil TC_1 for w_1 time (for example, 50 msec) and stands by for t_1 time (for example 1 sec) (S20). At this time, the control circuit 405 determines whether a feedback response signal (or, a charging start signal) from the battery device 450 at the secondary side exists within the t_1 time (S25).

[312] At this time, if no response is received from the battery device 450 at the secondary side, the control circuit 405 determines that there is no secondary coil coupled to the sending coil TC_1, and then controls the power distribution circuit 403 to oscillate a 2nd coil driving circuit 404. That is to say, the control circuit 405 determines whether the sequence n of the sending coil (or, the coil driving circuit) reaches 15 (S35), and then increases n by 1 if not reaching 15 (S40). Accordingly, the selection signal output from the control circuit 405 indicates the 2nd coil driving circuit 404, and the 2nd coil driving circuit 404 is oscillated as in the step S20.

[313] Meanwhile, in case there exists a feedback response signal from the battery device 450 at the secondary side in the step S25, the control circuit 405 determines that there exists a secondary coil 451 at least partially coupled with the sending coil TC_1, and then temporarily stores the sequence (#1) of the corresponding sending coil in an internal memory (S30), and then proceeds to the step S35.

[314] In this embodiment, the sending coils TC_1 to TC_6 are not magnetically coupled with the secondary coil as shown in FIG. 15. Thus, while the sending coils TC_1 to TC_6 are driven as shown in FIG. 18, any feedback response signal is received to the antenna coil 408. Meanwhile, in case of sending coils TC_7, TC_8, TC_{12}, TC_{13}, the battery device 450 is magnetically coupled to the secondary coil 451. Thus, an induced electromotive force is generated to the secondary coil 451 of the battery device, and the control circuit 457 of the battery device is driven using the induced electromotive force. Meanwhile, an induced electromotive force generated at the output terminal of the sec ondary coil 451 also becomes AC pulse as shown in FIG. 18, and the charging status detecting circuit 458 detects a falling time of the AC pulse and then reports it to the

control circuit 457. Accordingly, the control circuit 457 transmits the feedback response signal FR_1, FR_2, FR_3, or the like to the contact-less receiving module 407, 408 of the charging device 400 via the contact-less sending module 452, 456. FIG. 18 shows that feedback response signals FR_1, FR_2, FR_3 are respectively received to the antenna coil 408 of the charging device during the standby time (t_1) of the sending coils TC_7, TC_8, TC_{13}.

[315] In case of the sending coil TC_{14}, it is physically coupled to the battery device but it is not magnetically coupled to the secondary coil 451 of the battery device. Thus, though the sending coil TC_{14} is driven in the standby state, a feedback response signal is not received to the antenna coil. In addition, the sending coil TC_{12} is magnetically partially coupled to the secondary coil 451, but a voltage induced to the secondary coil is very low due to positional offset. Thus, though an induced electromotive force is generated, a feedback response signal is yet not received to the antenna coil since it cannot drive the control circuit 457 of the battery device.

[316] As mentioned above, the control circuit 457 stands by a feedback response signal from the battery device 450 while subsequently driving the sending coil TC_1 to the sending coil TC_{14}. At this time, if a feedback response signal is received when driving a specific sending coil, the sequence (#) of the corresponding sending coil is temporarily stored in an internal memory.

[317] Meanwhile, if n reaches 15 in the step S35, the process is forwarded to the step S45 to stand by a feedback response signal. At this time, if there exists a feedback response signal, the sequence #15 of the corresponding sending coil is temporarily stored in the internal memory as in the step S30 (S50). However, if there exists no feedback response signal, the standby mode is intercepted and switched into the charging mode.

[318] That is to say, the control circuit 405 inquires the internal memory to read sequence (#7, #8, #13) of sending coils temporarily stored therein, and then controls the power distribution circuit 403 and the charging mode control circuit 406 based on the read results to switch the sending coils TC_7, TC_8, TC_{13} and intercept operation of the other sending coils (S55, S60).

[319] Accordingly, a driving pulse with a width of w_2 is applied to the sending coil TC_7, TC_8, TC_{13}, and a corresponding charging power pulse is induced to the secondary coil 451 magnetically coupled to the sending coils. The charging power induced as above is converted into DC via the rectifier, and then charged to the battery 259b via the constant voltage/constant current circuit 454. At this time, the charging status detecting circuit 458 detects a charging current and a charging voltage applied to the battery 259b and transmits them to the control circuit 457. The control circuit 457 feeds back the charging status signals CS_1, CS_2, or the like as shown in FIG. 18 to the charging device 400 at the falling time of the charging power pulse.

[320] The control circuit 405 of the charging device that receives the feedback charging status signals CS_1, CS_2 from the battery device 450 controls a driving level of the sending coil TC_7, TC_8, TC_{13} suitably for the charging status of the battery. In addition, if the battery is fully charged while progressing the charging mode, the control circuit 405 controls the charging mode control circuit 406 to switch the driving mode of the sending coil TC_7, TC_8, TC_{13} into the fully-charged mode as shown in FIG. 18. A driving pulse w_3 of the fully-charged mode has a pulse width greatly smaller than a driving pulse w_2 of the charging mode but similar to a driving pulse w_1 of the standby mode.

[321] As explained above, the contact-less charger system of this embodiment does not drive all sending coils composing the sending coil array but drives only sending coils magnetically coupled to the receiving coil of the battery device, so it may greatly lower energy consumption in comparison to conventional systems. In addition, the contact-less charger system of this embodiment operates a preparatory standby mode having a relatively lower energy consumption in comparison to the charging mode in order to detect sending coils magnetically coupled to the sending coil of the battery device. Also, since a plurality of sending coils are included in the sending coil array, the contact-less charger system of this embodiment may charge several battery devices together.

[322] In the fourth embodiment of the present invention as explained above, the power distribution circuit 403 is arranged between the rectifier 402 and the coil driving circuits 404, but it is also possible that the power distribution circuit is arranged between a single coil driving circuit and a plurality of sending coils.

[323] In addition, in case of the fourth embodiment of the present invention, pulse width modulation is used for controlling a driving level of a sending coil, but other method such as frequency modulation may also used.

[324] In case of the embodiment shown in FIG. 17, a single antenna coil 408 surrounds the coil array 410 as a whole, but it is also possible that an antenna coil is separately arranged with respect to each sending coil TC_1, TC_2 ~ TC_n.

[325] If a sending coil and an antenna coil is grouped to form a coil block as mentioned above, there is no need to find a sending coil coupled to a secondary coil one by one while subsequently driving sending coils as shown in FIG. 18. That is to say, it is possible to drive all sending coils at the same time and then receive a feedback response signal only from sending coils magnetically coupled to the secondary coil as shown in FIG. 20. In this case, for distinguishing feedback signals received to different antenna coils, the coil blocks may use frequencies or codes different from each other.

[326] Another modification of this embodiment will be explained in brief with reference to FIGs. 20 and 21.

[327] If the external power 401 is applied to the charging device 400 (S200), the control circuit 405 controls the power distribution circuit 403 and the charging mode control circuit 406 to drive all sending coils TC_1 ~ TC_{15} composing the sending coil array 410 in the standby mode (S202).

[328] The magnetic field generated from the sending coils TC_1 ~ TC_{15} is emitted outward, and an induced electromotive force is formed at the outer terminal of the secondary coil 451 by means of a magnetic field generated from sending coils (for example, TC_2, TC_8) magnetically coupled to the secondary coil 451. At this time, signals output from the sending coils sending coils TC_1 ~ TC_{15} should have frequencies or codes different from each other such that the battery device 450 at the secondary part may distinguish the sending coils TC_1 ~ TC_{15}.

[329] The battery device 450 at the secondary part analyzes a standby mode power pulse induced to the output terminal of the secondary coil 451 to determine a sequence (#) of a sending coil that generates the induced electromotive force, and then transmits information about the sequence to the charging device 400 at the primary part as a feedback response signal.

[330] At this time, the control circuit 405 of the primary charging device oscillates the sending coils TC_1 ~ TC_{15} in the standby mode, and then determines whether a predetermined time (for example, 50 msec) passes while standing by a feedback response signal (S204, S206).

[331] At this time, if a feedback response signal is received from the secondary battery device 450 within the predetermined time, the control circuit 405 analyzes the response signal to select a sending coil (for example, TC_2, TC_8) magnetically coupled to the secondary coil 451 (S208).

[332] The control circuit 405 controls the power distribution circuit 403 and the charging mode control circuit 406 to switch a driving mode of the selected sending coil (for example, TC_2, TC_8) from the standby mode to the charging mode (S210).

[333] If all sending coils configuring the sending coil array are driven at the same time, a time operated in the standby mode is shortened to reduce unnecessary power consumption.

[334] As mentioned above, since a plurality of sending coils are arranged on the charging pad in a matrix pattern in the fourth embodiment of the present invention, it is possible to prevent positional offset from the secondary coil in advance and to contact-less charge several portable electronic devices together.

[335] In addition, since only primary coils position-conforming to the secondary coil of the portable electronic device may be selectively driven, it is possible to greatly reduce energy consumption.

[336]

[337] Embodiment 5

[338] Now, a contact-less charging device having a coil unit and a charging circuit unit separately according to a fifth embodiment of the present invention will be explained with reference to FIGs. 22 to 24.

[339] The charging pat 100 of the contact-less charging device shown in FIG. 1 includes a rectifier for converting AC to DC, a receiver for receiving data sent from a battery pack, and a driver for generating a pulse width-modulated signal applied to a primary coil according to the received data.

[340] This charging device 100 has a drawback in that its design may be not freely changed since the rectifier, the receiver and the driver are installed therein. In addition, if a defect occurs in any one of the rectifier, the receiver and the driver, the charging part should be entirely exchanged.

[341] Thus, the fifth embodiment of the present invention provides a contact-less charging device in which a coil unit may change its design freely and any one of the charging circuit unit and the coil unit may be selectively exchanged.

[342] FIG. 22 is an exploded perspective view showing a contact-less charging device in which a charging circuit unit and a coil unit are separated according to the fifth embodiment of the present invention, and FIG. 23 is a block diagram showing inner functions of the contact-less charging device.

[343] Referring to FIGs. 22 and 23, the contact-less charging device 500 includes a coil unit 510 and a charging circuit unit 550, which may be separated from each other and selectively connected.

[344] The coil unit 510 includes a primary coil 511, an receiving antenna 512 for receiving data from a contact-less sending module 620, 656, and a connection member 515 for connection with the charging circuit unit 550. The coil unit 510 preferably has a pad shape such that a battery device 600 may be easily placed thereon.

[345] The primary coil 511 is magnetically coupled to a secondary coil 610, explained later, by means of induction coupling. Thus, a magnetic field generated when the secondary coil 610 is juxtaposed on the primary coil 511 leads an induced current in the secondary coil 610. In addition, the primary and secondary coils 511, 610 are respectively surrounded by antennas 512, 620.

[346] The receiving antenna 512 receives a feedback response signal transmitted from the contact-less sending module 620, 656 and transmits it to a receiver 556, as explained later in detail.

[347] A connection terminal 551 installed to an end of a cable 559 is inserted into the connection member 515. The cable 559 connects the coil unit 510 and the charging circuit unit 550 with each other. The connection member 515 and the connection terminal 551 are widely used in general contact-type chargers.

[348] Since the coil unit 510 and the charging circuit unit 550 are selectively connected using the connection member 515 and the connection terminal 551, if a defect occurs in any one of the coil unit 510 and the charging circuit unit 550, only the defected component may be exchanged.

[349] As mentioned above, since a rectifier 552, a driving means 553, 555 and a receiver 556 required for charging a battery 662 are not installed to the coil unit 510 but to the charging circuit unit 550, the contact-less charging device 500 of this embodiment has an advantage that size and design of the coil unit 510 may be freely changed.

[350] The charging circuit unit 550 includes a driving means 553, 555 for controlling a width of a power pulse for driving the primary coil 511, and a connection terminal 551 installed at the end of the cable 559. The driving means includes a driving circuit 553 and a controller 555 for controlling operation of the driving circuit 553. Meanwhile, the connection terminal 551 is already explained above.

[351] The rectifier 552 rectifies AC supplied from a common AC power 501 into DC and then transfers it to the driving circuit 553. The driving circuit 553 generates a high frequency AC voltage pulse over a common frequency (60 Hz) using the DC voltage rectified by the rectifier 552, and applies it to the primary coil 511 to generate a magnetic field. The external power supplied to the rectifier 552 is most preferably a common AC power (60 Hz, 220V/100V) for home, but other DC powers may be also used.

[352] The driving circuit 553 includes a PWM signal generator 554b and a power driving unit 554a.

[353] The power driving unit 554a includes a high frequency oscillating circuit for converting DC voltage of a predetermined level to oscillate high frequency AC voltage over a common frequency, and a drive circuit for applying the pulse width-modulated high frequency AC voltage pulse to the primary coil 511 to drive the primary coil 511.

[354] The PWM signal generator 554b modulates pulse width (PWM) of the high frequency AC voltage. Thus, an output signal output through an output terminal of the power driving unit 554a becomes a high frequency AC voltage pulse. The high frequency AC voltage pulse is a pulse train as shown in FIG. 3. This pulse train has a pulse width controlled by the controller 555. The driving circuit 553 according to this embodiment may adopt SMPS (Switching Mode Power Supply), and other equivalent means may also be used if they may give the same functions and roles.

[355] The controller 555 controls a pulse width of the pulse width-modulated high frequency AC voltage pulse based on charging status information of a battery fed back via contact-less sending/receiving modules 556, 512, 620, 656. In particular, in case a response signal fed back from the charging circuit unit 550 is a charging start signal, the controller 555 switches a driving mode of the primary coil 511 from a standby

mode to a charging mode, as shown in FIG. 3. In addition, as a result of determining the charging status information fed back from the charging circuit unit 550, if it is determined that the battery is fully charged, the controller 555 switches the driving mode of the primary coil from the charging mode to the full-charged mode. In case there is no response signal fed back from the charging circuit unit 550, the controller 555 keeps the driving mode of the primary coil 511 in the standby mode.

[356] As mentioned above, the controller 555 of the charging circuit unit 550 switches the driving mode of the primary coil 511 to a standby mode, a charging mode or a full-charged mode depending on the presence and contents of the response signal from the battery device 600.

[357] The receiver 556 modulates the feedback response signal transmitted from the contact-less sending module 620, 656 to restore the charging status information of the battery 662.

[358] The charging circuit unit 550 of this embodiment may further include an overvoltage filter circuit for protecting the circuit against overvoltage, or a constant voltage circuit for keeping the DC voltage rectified by the rectifier as a voltage of a predetermined level. The overvoltage filter circuit is preferably disposed between the common AC power 501 and the rectifier 552, and the constant voltage circuit is preferably disposed between the rectifier 552 and the driving circuit 553.

[359] Now, the battery device 600 for receiving power from the coil unit 510 to charge a battery 662 is explained. The battery device 600 includes a battery 662, and a charging unit 650 for charging the battery 662.

[360] The battery device 600 is a battery pack including a battery, or a portable electronic device including a battery. Preferably, the portable electronic device may be a cellular phone, PDA, MP3 player, and so on. The battery 662 included in the battery device 600 may be a rechargeable battery cell, including a lithium ion battery and a lithium polymer battery.

[361] The charging circuit 650 includes a secondary coil 610, a rectifier 651, a constant voltage/constant current circuit 652, a falling detector 653, a controller 655 and a contact-less sending module 620, 656.

[362] The secondary coil 610 is magnetically coupled to the primary coil 511 to generate an induced electromotive force. As mentioned above, the power signal applied to the primary coil 511 is a pulse width-modulated signal, so the induced electromotive force led to the secondary coil 610 is also AC voltage pulse train. Also, according to the driving mode of the primary coil 511, the AC voltage pulse led to the secondary coil 610 also conforms to any one of standby mode, charging mode and full-charged mode as shown in FIG. 3.

[363] The rectifier 651 is connected to an output terminal of the secondary coil 610 to

smooth the AC voltage pulse induced by the secondary coil 610 into DC of a predetermined level.

[364] The constant voltage/constant current circuit 652 generates a constant voltage and a constant current to be charged to a battery using DC voltage of a predetermined level. That is to say, while a constant current mode is kept at an initial charging point of the battery, if a charging voltage of the battery becomes full, the constant current mode is switched into a constant voltage mode.

[365] The falling detector 653 detects a time when the AC voltage pulse induced by the secondary coil falls, namely a falling time. This falling detection signal is input to the controller 655.

[366] The controller 655 is a kind of microprocessor, which receives monitoring signals such as a falling detection signal, a charging current and a charging voltage, and then controls the constant voltage/constant current circuit 652 and the contact-less sending module 620, 656 based on the monitoring signals.

[367] That is to say, the controller 655 checks a falling time of pulse based on the falling detection signal input from the falling detector 653, and synchronizes a sending time of a feedback response signal to be sent to the receiving antenna 512 with the pulse falling time.

[368] In addition, the controller 655 always monitors a charging current and a charging voltage of the battery 662, and then temporarily stores the monitoring values in an internal memory (not shown). The memory, not shown, stores the battery charging status information such as monitored charging current and voltage, and battery specification information (product code, rating and so on) together.

[369] In addition, the controller 655 suitably selects or switches a constant voltage mode and a constant current mode according to the charging status of the battery.

[370] The contact-less sending module 620, 656 includes a sending antenna 620 for sending a feedback response signal (a charging start signal or a charging status signal) to be transmitted to the receiving antenna 512, and a sender 656 for modulating a baseband signal such as the charging status information to generate a feedback response signal.

[371] A protecting circuit (PCM) 661 is disposed between the constant voltage/constant current circuit 652 and the battery 662 to prevent an overvoltage or overcurrent from being applied to the battery 662. The protecting circuit 661 and the battery 662 compose a single battery unit 660.

[372] Now, the charging status of a battery will be explained in each mode with reference to FIG. 3. Here, for convenience, the charging circuit unit 550 and the coil unit 510 are defined as a primary charging unit, and the battery device 600 is defined as a secondary charging unit.

[373] If an external power such as the common AC power 501 is applied to the primary charging unit, the controller 555 of the primary charging unit wakes up and controls the driving circuit 553 to drive the primary coil 511.

[374] That is to say, in case no response is received from the secondary charging unit, the controller 555 determines it as a standby mode and then controls the driving circuit 553 to apply a standby mode power pulse train with a width of w_1 and a period of t_1 to the primary coil 511, as shown in FIG. 3. Accordingly, the primary coil 511 generates a magnetic field corresponding to the standby mode power pulse train, and emits it outside. This emission of magnetic field is continued until the charging start signal shown in FIG. 3 is received to the contact-less receiving module 512, 556 of the primary charging unit.

[375] If the primary coil 511 and the secondary coil 610 are magnetically coupled (T point in FIG. 3) as the battery device 600 is placed on the coil unit 550, a standby mode power pulse train with a width of w_1 and a period of t_1 is induced at an output terminal of the secondary coil 610 by means of the magnetic field generated from the primary coil 511. This power pulse train has so weak power not to charge a battery, so it is used as a driving power of an interior circuit of the secondary charging unit (particularly, a driving power of a microprocessor). That is to say, the power pulse in the standby mode is emitted out and consumed until the primary and secondary coils 511, 610 are coupled, and it is used as a driving power for waking up the microprocessor if the primary and secondary coils 511, 610 are coupled.

[376] If an induced electromotive power is induced to the secondary part as mentioned above, the falling detector 653 of the secondary charging unit checks a falling point (or, a falling time) of the induced pulse. At this time, if the falling detector 653 detects a falling point of pulse, the falling detection signal is input to the controller 655 of the secondary charging unit, and the controller 655 sends a charging start signal shown in FIG. 3 to the primary charging unit as a feedback response via the contact-less sending module 620, 656. That is to say, in more detail, as the falling detection signal is input, the controller 655 inquires an internal memory to determine whether charging status information is present. At this time, if the charging status information is not present in the memory, the controller 655 determines that a current status is a standby mode, and then sends a charging start signal as a response to instruct the primary charging unit to switch into a charging mode.

[377] The controller 555 of the primary charging unit that receives the feedback charging start signal from the secondary charging unit switches the standby mode into the charging mode as shown in FIG. 3. That is to say, the controller 555 controls the driving circuit 553 to drive a charging mode power pulse train with a width of w_2 and a period of t_2 to the primary coil. Here, w_2 is at least greater than w_1.

[378] Accordingly, a charging mode power pulse train with a width of w_2 and a period of t_2 is induced at the output terminal of the secondary coil 610, and this power pulse train is rectified and then used for charging the battery 662. The battery is charged using a constant current mode and a constant voltage mode, as well known in the art.

[379] Meanwhile, as the charging mode power pulse train with a width of w_2 and a period of t_2 is induced at the output terminal of the secondary coil 610, the falling detector 653 checks a falling time of each pulse. At this time, if the falling point of pulse is detected, the controller 655 reads the charging status information (for example, a charging voltage and a charging current) already monitored and stored in the memory. The read charging status information is fed back to the primary charging unit via the contact-less sending module 656, 620.

[380] The controller 555 of the primary charging unit to which the charging status information is fed back from the secondary charging unit analyzes the charging status information, and then controls the driving circuit 553 based on the analysis result to control a pulse width of the power pulse applied to the primary coil 511.

[381] At this time, if it is determined that the battery is already fully charged as an analysis result of the charging status information, the controller 555 of the primary charging unit switches the charging mode into a fully-charged mode as shown in FIG. 3.

[382] That is to say, the controller 555 controls the driving circuit to drive a fully-charged mode power pulse train with a width of w_3 and a period of t_3 to the primary coil. Here, w_3 is preferably smaller than w_2 but equal to or greater than w_1.

[383] Even in the fully-charged mode, the charging status information is fed back from the secondary charging unit to the primary charging unit at a falling time of pulse, and the controller of the primary charging unit analyzes this charging status information to determine whether to keep the fully-charged mode or to return to the charging mode.

[384] As explained above, a power signal (or, a power pulse train) transmitted between the primary and secondary coils 511, 610 and a communication signal (or, a feedback response signal) transmitted between the contact-less sending module 656, 620 and the contact-less receiving module 512, 556 are time-divided such that they are not overlapped in aspect of time. That is to say, the communication signal is synchronized and transmitted at the falling time of the power signal. Thus, it is possible to prevent any interference phenomenon or any distortion or dilution phenomenon of signals (particularly the communication signal) that may occur when a power signal and a communication signal are transmitted at the same time.

[385] In addition, in the present invention, a standby mode and a fully-charged mode are provided separately from the charging mode. Thus, energy emitted out by the primary coil and thus consumed is minimized, thereby capable of reducing power consumption

in comparison with conventional contact-less charging devices.

[386] Meanwhile, FIG. 24 is a block diagram showing internal functions of a contact-less charging device 500 according to another modification of the fifth embodiment of the present invention. The charging device 500' includes a coil unit 510' and a charging circuit unit 550', which are separated and selectively connected. In the charging device 500', a driving means 553, 555 and a receiver 556 are included in the coil unit 510'. In FIG. 24, any component with the same reference numeral as in FIG. 23 indicates the same component with the same function.

[387] That is to say, the coil unit 510' includes a primary coil 511, a contact- less receiving module 512, 556 for receiving data from a contact- less sending module 656, 620 of a battery device 600, and a driving means 553, 555 for controlling a width of a power pulse used for driving the primary coil 511. The charging circuit unit 550' includes a rectifier 552 for converting AC supplied from an AC power 501 into DC.

[388] As explained above, the contact-less charging device having the charging circuit unit and the coil unit separately according to the fifth embodiment of the present invention may freely change a design of the coil unit and also allow to selectively exchange any one of the charging circuit unit and the coil unit.

[389]

[390] Embodiment 6

[391] Now, a contact-less charging device having a contact- type charging unit according to a sixth embodiment of the present invention will be explained with reference to FIGs. 25 to 29.

[392] A general contact- less charging device has a problem that an electronic device may not be used together with charging a battery.

[393] Thus, the sixth embodiment of the present invention provides a charging device capable of charging contact-type charging and contact- less charging together such that an electronic device may be used together with charging a battery.

[394] FIG. 25 is a perspective view showing a contact- less charging device having a contact-type charging unit according to the sixth embodiment of the present invention, FIG. 26 shows that a connector of the contact-type charging device of FIG. 25 is drawn out, and FIG. 27 is a block diagram showing internal functions of the contact-less charging device.

[395] Referring to FIGs. 25 to 27, the contact-less charging device 700 includes a contact-type charging unit 740 and a contact-less charging unit 750. The contact-type charging unit 740 and the contact-less charging unit 750 are included together in a pre-determined frame 751.

[396] The contact-type charging unit 740 includes a rectifier 744 for rectifying AC from an AC power 701 into DC, a power driving unit 745 having a high frequency os-

dilating circuit and a drive circuit, a transformer 746, a rectifier 747 for smoothing AC voltage pulse induced to a secondary coil into DC of a predetermined level, a constant voltage/constant current circuit 748 for generating a constant voltage and a constant current used for charging a battery, and a connector 743 for connection with the battery 862.

[397] The rectifier 744 rectifies AC from the common AC power 701 into DC and then transmits it to the power driving unit 745.

[398] The power driving unit 745 includes a high frequency oscillating circuit for converting a DC voltage of a predetermined level to oscillate a high frequency AC voltage over a common frequency, and a drive circuit for applying the pulse width-modulated high frequency AC voltage pulse to a primary coil of the transformer 746 to drive the primary coil.

[399] The transformer 746 includes a primary coil and a secondary coil. The rectifier 747 is connected to an output terminal of the secondary coil to smooth the AC voltage pulse induced by the secondary coil into DC of a predetermined level.

[400] The constant voltage/constant current circuit 748 generates a constant voltage and a constant current for charging a battery using a DC voltage of a predetermined level. That is to say, if a constant current mode is kept at the initial charging stage of the battery and then a charging voltage of the battery becomes full, the mode is switched into a constant voltage mode.

[401] The connector 743 is installed to an end of a cable 742 for connecting the contact-type charging unit 740 and the battery 862. The connector 743 is widely used for charging a cellular phone.

[402] Preferably, the frame 751 has a through groove engaged with the connector 743, and the connector 743 is stored with being inserted into the through groove and drawn out of the through groove when the contact-type charging unit 740 is used.

[403] Meanwhile, the power driving unit 745 receives DC current from the rectifier 744, and the current of the rectifier 747 is supplied to the constant voltage/constant current circuit 748. However, it is also possible that the power driving unit 745 receives DC current from a rectifier 752 of the contact-less charging unit 750, and the rectifier 747 is connected to the constant voltage/constant current circuit 852 of the charging circuit 850 to supply current thereto, as shown in FIG. 28.

[404] Also, as shown in FIG. 29, the transformer 746 may receive current from a power driving unit 754a of the contact-less charging unit 750, and the current of the transformer 746 may be supplied to a rectifier 851 of the charging circuit 850.

[405] The contact-less charging unit 750 includes a primary coil 710, a rectifier 752, a driving circuit 753, a controller 755 and a contact-less receiving module 720, 756.

[406] The rectifier 752 rectifies AC voltage from the common AC power 701 into DC and

then transmits it to the driving circuit 753. The driving circuit 753 generates high frequency AC power pulse over a common frequency using the DC voltage rectified by the rectifier 752, and then applies it to the primary coil 710 to generate a magnetic field.

[407] The driving circuit 753 includes a PWM signal generator 754b and a power driving unit 754a.

[408] The power driving unit 754a includes a high frequency oscillating circuit for converting DC voltage of a predetermined level to oscillate high frequency AC voltage over a common frequency, and a drive circuit for applying the pulse width-modulated high frequency AC voltage pulse to the primary coil 710 to drive the primary coil 710.

[409] The PWM signal generator 754b modulates pulse width (PWM) of the high frequency AC voltage. Thus, an output signal output through an output terminal of the power driving unit 753 becomes a high frequency AC voltage pulse. The high frequency AC voltage pulse is a pulse train as shown in FIG. 3. This pulse train has a pulse width controlled by the controller 755. The driving circuit 753 according to this embodiment may adopt SMPS (Switching Mode Power Supply), and other equivalent means may also be used if they may give the same functions and roles.

[410] The controller 755 controls a pulse width of the pulse width-modulated high frequency AC voltage pulse based on charging status information of a battery 862 fed back via contact-less sending/receiving modules 756, 720, 820, 856. In particular, in case a response signal fed back from the charging circuit unit 850 is a charging start signal, a controller 855 switches a driving mode of the primary coil 710 from a standby mode to a charging mode, as shown in FIG. 3. In addition, as a result of determining the charging status information fed back from the charging circuit unit 850, if it is determined that the battery is fully charged, the controller 755 switches the driving mode of the primary coil from the charging mode to the full-charged mode. In case there is no response signal fed back from the charging circuit unit 850, the controller 755 keeps the driving mode of the primary coil 710 in the standby mode.

[411] As mentioned above, the controller 755 switches the driving mode of the primary coil 710 to a standby mode, a charging mode or a full-charged mode depending on the presence and contents of the response signal from the battery device 800.

[412] The contact-less receiving module 720, 756 includes an antenna 720 for receiving a feedback response signal transmitted from a contact-less sending module 820, 856 of the charging circuit 850, and a receiver 756 acting like a modulator for modulating the feedback response signal to restore a charging status information of the battery 862.

[413] The contact-less charging unit 750 of this embodiment may further include an overvoltage filter circuit for protecting the circuit against overvoltage, or a constant voltage circuit for keeping the DC voltage rectified by the rectifier as a voltage of a

predetermined level. The overvoltage filter circuit is preferably disposed between the common AC power 701 and the rectifier 752, and the constant voltage circuit is preferably disposed between the rectifier 752 and the driving circuit 753.

[414] Now, the charging circuit 850 for receiving power from the contact-less charging unit 750 to charge the battery 862 will be explained. This charging circuit 850 is included in the battery device 800 together with the battery 862.

[415] The charging circuit 850 includes a secondary coil 810, a rectifier 851, a constant voltage/constant current circuit 852, a falling detector 853, a controller 855 and a contact-less sending module 820, 856.

[416] The secondary coil 810 is magnetically coupled to the primary coil 710 to generate an induced electromotive force. As mentioned above, the power signal applied to the primary coil 710 is a pulse width-modulated signal, so the induced electromotive force led to the secondary coil 810 is also AC voltage pulse train. Also, according to the driving mode of the primary coil 710, the AC voltage pulse led to the secondary coil 810 also conforms to any one of standby mode, charging mode and full-charged mode as shown in FIG. 3.

[417] The rectifier 851 is connected to an output terminal of the secondary coil 810 to smooth the AC voltage pulse induced by the secondary coil 810 into DC of a pre-determined level.

[418] The constant voltage/constant current circuit 852 generates a constant voltage and a constant current to be charged to a battery using DC voltage of a predetermined level. That is to say, while a constant current mode is kept at an initial charging point of the battery, if a charging voltage of the battery becomes full, the constant current mode is switched into a constant voltage mode.

[419] The falling detector 853 detects a time when the AC voltage pulse induced by the secondary coil falls, namely a falling time. This falling detection signal is input to the controller 855.

[420] The controller 855 is a kind of microprocessor, which receives monitoring signals such as a falling detection signal, a charging current signal and a charging voltage signal, and then controls the constant voltage/constant current circuit 852 and the contact-less sending module 820, 856 based on the monitoring signals.

[421] That is to say, the controller 855 checks a falling time of pulse based on the falling detection signal input from the falling detector 853, and synchronizes a sending time of a feedback response signal to be sent to the charging power supply circuit 750 with the pulse falling time.

[422] Also, the controller 855 always monitors a charging current and a charging voltage of a battery, and then temporarily stores the monitoring values in an internal memory (not shown). The memory, not shown, stores the battery charging status information

such as monitored charging current and voltage, and battery specification information (product code, rating and so on) together.

[423] In addition, the controller 855 suitably selects or switches a constant voltage mode and a constant current mode according to the charging status of the battery.

[424] The contact-less sending module 820, 856 includes an antenna 820 for sending a feedback response signal (for example, a charging start signal, a charging status signal, and an adjustment request signal) to be transmitted to the charging power supply circuit 750, and a sender 856 for modulating a baseband signal such as the charging status information to generate a feedback response signal.

[425] A protecting circuit (PCM) 861 is disposed between the constant voltage/constant current circuit 852 and the battery 862 to prevent an overvoltage or overcurrent from being applied to the battery. The protecting circuit 861 and the battery 862 compose a single battery unit 860.

[426] Now, the charging status of a battery will be explained in each mode with reference to FIG. 3. Here, for convenience, the contact-less charging unit 750 is defined as a primary charging unit, and the battery device 800 is defined as a secondary charging unit.

[427] If an external power such as the common AC power 701 is applied to the primary charging unit, the controller 755 of the primary charging unit wakes up and controls the driving circuit 753 to drive the primary coil 710.

[428] That is to say, in case no response is received from the secondary charging unit, the controller 755 determines it as a standby mode and then controls the driving circuit 753 to apply a standby mode power pulse train with a width of w_1 and a period of t_1 to the primary coil 710, as shown in FIG. 3. Accordingly, the primary coil 710 generates a magnetic field corresponding to the standby mode power pulse train, and emits it outside. This emission of magnetic field is continued until the charging start signal shown in FIG. 3 is received to the contact-less receiving module 720, 756 of the primary charging unit.

[429] If the primary coil 710 and the secondary coil 810 are magnetically coupled (T point in FIG. 3) as the battery device 800 is placed on the charging part 700, a standby mode power pulse train with a width of w_1 and a period of t_1 is also induced to an output terminal of the secondary coil 810 by means of the magnetic field generated from the primary coil 710. This power pulse train has so weak power not to charge a battery, so it is used as a driving power of an interior circuit of the secondary charging unit (particularly, a driving power of a microprocessor). That is to say, the power pulse in the standby mode is emitted out and consumed until the primary and secondary coils are coupled, and it is used as a driving power for waking up the microprocessor if the primary and secondary coils are coupled.

[430] If an induced electromotive power is induced to the secondary part as mentioned above, the falling detector 853 of the secondary charging unit checks a falling point (or, a falling time) of the induced pulse. At this time, if the falling detector 853 detects a falling point of pulse, the falling detection signal is input to the controller 855 of the secondary charging unit, and the controller 855 sends a charging start signal shown in FIG. 3 to the primary charging unit as a feedback response via the contact-less sending module 820, 856. That is to say, in more detail, as the falling detection signal is input, the controller inquires an internal memory to determine whether charging status information is present. At this time, if the charging status information is not present in the memory, the controller determines that a current status is a standby mode and then sends a charging start signal as a response to instruct the primary charging unit to switch into a charging mode.

[431] The controller 755 of the primary charging unit that receives a feedback charging start signal from the secondary charging unit switches the standby mode into the charging mode as shown in FIG. 3. That is to say, the controller 755 controls the driving circuit 753 to drive a charging mode power pulse train with a width of w_2 and a period of t_2 to the primary coil. Here, w_2 is at least greater than w_1.

[432] Accordingly, a charging mode power pulse train with a width of w_2 and a period of t_2 is induced at the output terminal of the secondary coil 810, and this power pulse train is rectified and then used for charging the battery 862. The battery is charged using a constant current mode and a constant voltage mode, as well known in the art.

[433] Meanwhile, as the charging mode power pulse train with a width of w_2 and a period of t_2 is induced to the output terminal of the secondary coil 810, the falling detector 853 checks a falling time of each pulse. At this time, if the falling point of pulse is detected, the controller reads the charging status information (for example, a charging voltage and a charging current) already monitored and stored in the memory. The read charging status information is fed back to the primary charging unit via the contact-less sending module.

[434] The controller 755 of the primary charging unit to which the charging status information is fed back from the secondary charging unit analyzes the charging status information, and then controls the driving circuit 753 based on the analysis result to control a pulse width of the power pulse applied to the primary coil 710.

[435] At this time, if it is determined that the battery is already fully charged as an analysis result of the charging status information, the controller 755 of the primary charging unit switches the charging mode into a fully-charged mode as shown in FIG. 3.

[436] That is to say, the controller 755 controls the driving circuit to drive a fully-charged mode power pulse train with a width of w_3 and a period of t_3 to the primary coil. Here,

w_3 is preferably smaller than w_2 but equal to or greater than w_1.

[437] Even in the fully-charged mode, the charging status information is fed back from the secondary charging unit to the primary charging unit at a falling time of pulse, and the controller of the primary charging unit analyzes this charging status information to determine whether to keep the fully-charged mode or to return to the charging mode.

[438] As explained above, a power signal (or, a power pulse train) transmitted between the primary and secondary coils and a communication signal (or, a feedback response signal) transmitted between the contact-less sending module and the contact-less receiving module are time-divided such that they are not overlapped in aspect of time. That is to say, the communication signal is synchronized and transmitted at the falling time of the power signal. Thus, it is possible to prevent any interference phenomenon or any distortion or dilution phenomenon of signals (particularly the communication signal) that may occur when a power signal and a communication signal are transmitted at the same time.

[439] In addition, in this embodiment, a standby mode and a fully-charged mode are provided separately from the charging mode. Thus, energy emitted out by the primary coil and thus consumed is minimized, thereby capable of reducing power consumption in comparison with conventional contact-less charging devices.

[440] As explained above, the contact-less charging device having a contact-type charging unit according to the sixth embodiment of the present invention allows both contact-type charging and contact-less charging, so an electronic device may used together with charging a battery.

[441]

[442] Embodiment 7

[443] Now, a contact-less charging device having an overcurrent detecting means according to a seventh embodiment of the present invention will be explained with reference to FIG. 30.

[444] If a metallic impurity exists in a region where a magnetic field M of the contact-less charging device is formed, load impedance seen from a primary coil is reduced to greatly deteriorate a charging efficiency of the contact-less charging device. In addition, an overcurrent is generated to keep the charging power constantly, which may break down the contact-less charging device. Also, the metallic impurity is heated due to induced heating, which consumes the charging power due to heat loss.

[445] Thus, the seventh embodiment of the present invention provides a contact-less charging device capable of detecting occurrence of overcurrent due to a metallic impurity existing in a charging region of a charging part in advance to keep an optimum charging state, and thus capable of improving a charging efficiency.

[446] FIG. 30 shows the contact-less charging device 900 according to the seventh

embodiment of the present invention. Referring to FIG. 30, the contact-less charging device of this embodiment includes a power supply 901, a power driving unit 920, a primary coil 930, a current measuring means 940, and a controller 950.

[447] The power supply 910 converts AC voltage applied from a common AC power (220V/60Hz) into DC current, smoothes it to a predetermined level, and transmits it to the power driving unit 920.

[448] The power driving unit 920 generates a high frequency AC voltage pulse over a common frequency (60 Hz) using the DC voltage supplied from the power supply 910, and applies it to the primary coil 930 to generate a magnetic field.

[449] Preferably, the power driving unit 920 may include a high frequency oscillating circuit for converting a DC voltage of a predetermined level to oscillate a high frequency AC voltage over a common frequency, and a drive circuit for applying a pulse width-modulated (PMW) AC voltage pulse to the primary coil 930.

[450] The current measuring means 940 is used for measuring a current applied to the primary coil 930. Preferably, the current measuring means 940 may adopt a circuit using a hall element or a shunt circuit. In more detail, the hall element is installed on a power transmission path connecting the power driving unit 920 and the primary coil 930, and transmits a hall electromotive force generated from a current flowing on the power transmission path to a circuit for converting it into current. The converting circuit transmits the converted current value to the controller 950. The shunt circuit connects resistances with a small resistivity to the power transmission path in parallel, and then connects capacitors to the resistances in parallel. Voltage and impedance values reinforced in the shunt circuit are transmitted to a current operating circuit, and a calculated current value is transmitted to the controller 950.

[451] The controller 950 compares the current value input from the current measuring means 940 with a criterion value, and then, in case the input current value exceeds the criterion value, the controller 950 intercepts operation of the power driving unit 920.

[452] When setting the criterion value, while only a battery having a secondary coil is positioned in a magnetic field generated by the primary coil 930, a maximum current value applied to the primary coil 930 is set as the criterion value. For example, assuming that a rated current induced to a battery by the secondary coil is 500 mA, a current required to the primary coil 930 for inducing the rated current is calculated, and the calculated current value is set as the criterion value.

[453] In more detail, in case a metallic impurity is positioned in the magnetic field generated by the primary coil 930, load impedance seen from the primary coil 930 is decreased. While the charging power is kept constantly, if the impedance by load is decreased, a current applied to the primary coil 930 is rapidly increased.

[454] However, since the current measuring means 940 continuously measures a current

applied to the primary coil 930 and then inputs it to the controller 950, in case the current value measured by the current measuring means 940 exceeds the criterion value, the controller 950 of this embodiment detects that a metallic impurity is positioned within the magnetic field, and then intercepts operation of the power driving unit 920.

[455] In addition, the contact-less charging device 900 of this embodiment may further i nclude an alarming means 960 such as an indicator, an alarm or a voice guidance.

[456] The alarming means 960 is operated by the controller 950, and the controller 950 operates the alarming means 960 when it is determined that a metallic impurity is placed based on the current change, thereby informing a user that the impurity is placed on the contact-less charging device 900.

[457] Now, operations of the contact-less charging device according to this embodiment will be explained with reference to the components described above.

[458] First, if the contact-less charging device 900 is connected to a common power (220V/60Hz), the common power is converted into a DC voltage of a predetermined level and then output through the power supply 910. The DC voltage output from the power supply 910 is input to the power driving unit 920, and then output with being converted into a high frequency AC voltage over a common frequency. At this time, the high frequency AC voltage is pulse width-modulated and then applied to the primary coil 930, and the primary coil 930 forms a magnetic field corresponding thereto and emits it outward.

[459] Meanwhile, the current measuring means 940 monitors a current applied to the primary coil 930 in the unit of several to several ten μsec and transmits it to the controller 950. The controller 950 compares the input current value with the criterion value to determine whether or not to operate the power driving unit 920, and transmits a control signal corresponding thereto.

[460] If an impurity is positioned in the magnetic field generated by the primary coil 930, the current applied to the primary coil 930 is increased over the criterion value. The controller 950 detecting it (excess over the criterion current value) through the current measuring means 940 intercepts operation of the power driving unit 920 and operates the alarming means 960.

[461] As mentioned above, according to the seventh embodiment of the present invention, a current applied to the primary coil is sensed to detect a metallic impurity placed in the magnetic field formed by the primary coil, thereby capable of enhancing stability of a charging region and a charging efficiency of the contact-less charging device.

[462] The present invention has been described in detail. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since

various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Industrial Applicability

[463] As described above, the present invention allows to supply more suitable power to a secondary part since status information of a battery is fed back to control a charging power.

[464] In addition, since a power signal and a communication signal transmitted between the primary and second parts are synchronized not to overlap with each other, problems caused by signal interference, distortion or dilution may be easily solved.

[465] Also, since a driving mode of the system is designed to freely switch not only to a charging mode but also to power-saving standby full-charged modes, the power consumption may be reduced up to 95% in comparison to conventional systems.

Claims

[1] A charging power supply device contact-less coupled to a battery device including a secondary coil for induced coupling, a contact-less sending module for contact-less transmission of data, a charging control circuit for controlling a charging status of a battery, and a rechargeable battery, the charging power supply device comprising:
a primary coil for inducing a charging power to the secondary coil;
a contact-less receiving module for receiving charging status information from the contact-less sending module; and
means for driving the primary coil such that a power signal between the primary and secondary coils and a communication signal between the contact-less sending and receiving modules are not overlapped in aspect of time.

[2] A charging device for contact-less receiving a power from a charging power supply device that generates an AC (Alternating Current) voltage pulse over a common frequency, and charging a rechargeable battery using the power, the charging device comprising:
a secondary coil magnetically coupled to a primary coil of the charging power supply device to generate an induced electromotive power pulse corresponding to the AC voltage pulse;
a charging control circuit for generating a constant voltage and a constant current used for charging a battery based on the induced electromotive power pulse; and
a feedback control means for checking a falling time of the induced electromotive power pulse, and then contact-less feeding back a feedback response signal including charging status information of the battery to the charging power supply device in case the falling is detected.

[3] A battery device for contact-less receiving a charging power from a charging power supply device that generates a pulse width-modulated signal over a common frequency using a common AC power, the battery device comprising:
a rechargeable battery;
a secondary coil magnetically coupled to a primary coil of the charging power supply device to generate an induced electromotive power pulse corresponding to the pulse width-modulated signal;
a charging control circuit for generating a constant voltage and a constant current used for charging a battery based on the induced electromotive force, and charging the battery using the constant voltage and the constant current;
a falling detector for detecting a falling time of the induced electromotive power pulse;

a memory for storing charging status information and specification information of the battery;
a monitoring circuit for monitoring a charging status of the battery to generate charging status information and storing the charging status information into the memory;
a contact-less sending module for modulating the charging status information to generate a feedback response signal and contact-less transmitting the feedback response signal to the charging power supply device; and
a feedback controller for reading the charging status information from the memory in case the falling time is detected, and then transmitting the charging status information to the contact-less sending module.

[4] A contact-less charging method for charging a battery using a contact-less charger system that includes a primary charging unit having a primary coil and a contact-less receiving module, a secondary charging unit having a secondary coil magnetically coupled to the primary coil and a contact-less sending module, and a battery for receiving a charging voltage from the secondary charging unit, the contact-less charging method comprising:
(A) applying a power pulse train with a width of W_1 to the primary coil to emit a corresponding magnetic field outward;
(B) contact-less receiving a charging start signal informing that the primary coil and the secondary coil are magnetically coupled, from the secondary charging unit;
(C) generating a charging power pulse train with a pulse width W_2 at least greater than W_1 according to the charging start signal, and applying the charging power pulse train to the primary coil to generate an induced electromotive power pulse corresponding to the secondary coil;
(D) charging the battery using the induced electromotive power pulse;
(E) receiving charging status information of the battery from the secondary charging unit as a feedback signal; and
(F)controlling a pulse width of the charging power pulse based on the charging status information,
wherein the contact-less feedback signal from the secondary charging unit is synchronized with a falling time of the induced electromotive power pulse.

[5] A contact-less charger system including a primary charging unit having a primary coil and a contact-less receiving module, a secondary charging module having a secondary coil magnetically coupled to the primary coil and a contact-less sending module, and a battery for receiving a charging power from the secondary charging unit,

wherein the primary charging unit includes means for generating an AC power pulse over a common frequency as a common AC power is applied thereto, and applying the AC power pulse to the primary coil to induce a high frequency AC voltage pulse to the secondary coil, and

wherein the secondary charging unit includes means for transmitting charging status information of the battery to the primary charging unit using a cessation time between AC voltage pulses induced by the secondary coil,

whereby a power signal between the primary and secondary coils and a communication signal between the contact-less sending and receiving modules are not overlapped in aspect of time.

[6] A contact-less charging circuit module electrically connected to a battery cell to contact-less charging an electric energy thereto, the contact-less charging circuit comprising:

a high frequency AC current inducing unit for inducing a high frequency AC current by a magnetic field generated by an external contact-less charging device;

a rectifier for receiving the induced high frequency AC current and converting the induced high frequency AC current into a DC (Direct Current) current;

a constant voltage/constant current supplier for receiving the DC current from the rectifier to supply a charging power to the battery cell in a constant voltage/constant current mode; and

an overvoltage monitoring unit for monitoring voltages at both ends of the constant voltage/constant current supplier and transmitting a monitoring result to an external contact-less charging device by means of contact-less communication to induce a change of intensity of a magnetic field.

[7] A contact-less charging device for transmitting a charging power to a contact-less charging battery that has a constant voltage/constant current supplier to allow charging in a constant voltage/constant current mode and contact-less transmits a monitoring result of voltages at both ends of the constant voltage/constant current supplier, the contact-less charging device comprising:

a magnetic field generator for receiving an AC current to form a magnetic field in an outer space;

a high frequency power driving unit for applying a high frequency AC current to the magnetic field generator; and

a charging power control unit for receiving the monitoring result from the contact-less charging battery by means of contact-less communication to control the high frequency power driving unit such that power of the high frequency AC current applied to the magnetic field generator is adjusted to control a charging power transmitted to the battery.

[8] A battery charging set having a contact-less charging battery and a contact-less charging device,

wherein the battery includes:

a high frequency AC current inducing unit to which a high frequency AC current is intermittently induced by means of a magnetic field intermittently generated from an external contact-less charging device;

a rectifier for receiving the induced high frequency AC current to convert the induced high frequency AC current into a DC current;

a constant voltage/constant current supplier for receiving the DC current from the rectifier to supply a charging power to a battery cell in a constant voltage/ constant current mode; and

an overvoltage monitoring unit for monitoring voltages at both ends of the constant voltage/constant current supplier to transmit a monitoring result to an external contact-less charging device by means of contact-less communication while the induction of high frequency AC current does not occur, and

wherein the contact-less charging device includes:

a magnetic field generator for receiving an AC current to form a magnetic field in an outer space;

a high frequency power driving unit for intermittently applying a high frequency AC current to the magnetic field generator; and

a charging power control unit for receiving the monitoring result by means of contact-less communication to control the high frequency power driving unit such that power of the high frequency AC current applied to the magnetic field generator is adjusted to control a charging power transmitted to the battery, while a high frequency AC current is not applied to the magnetic field generator.

[9] A charging control method for controlling charging of a contact-less charging battery by means of electromagnetic induction using a contact-less charging device, the charging control method comprising:

(a) intermittently applying a high frequency AC current to a primary coil provided to the charging device to intermittently generate a magnetic field to an outside;

(b) interlinking a magnetic flux of the generated magnetic field to a secondary coil provided to the battery to intermittently output an electromagnetically induced high frequency AC current;

(c) rectifying the output high frequency AC current and converting the output high frequency AC current into a DC current;

(d) applying the DC current to a battery cell through a constant voltage/constant current element to charge the battery cell in a constant voltage/constant current mode;

(e) monitoring voltages at both ends of the constant voltage/constant current element to transmit a monitoring result to the charging device by means of contact-less communication while a high frequency AC current is not induced to the secondary coil; and

(f) controlling power of the high frequency AC current applied to the primary coil according to the transmitted monitoring result.

[10] A contact-less charging device for charging a charging target having a secondary coil, the contact-less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil,

wherein the primary coil includes:

an outer coil arranged with a predetermined number of turns and a predetermined size;

at least one inner coil arranged to be included inside the outer coil,

wherein the outer and inner coil are arranged to have magnetic fluxes generated inside each coil in the same direction when a primary current is applied to the outer and inner coils.

[11] A contact-less charging device for charging a charging target having a secondary coil, the contact-less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil,

wherein the primary coil is arranged with a predetermined number of turns and a predetermined size, and

wherein a density profile of a magnetic flux generated when a primary current is applied to the primary coil, seen along an intersecting line of the primary coil, has at least three maximum points within the primary coil.

[12] A contact-less charging device for charging a charging target having a secondary coil, the contact-less charging device having a primary coil for generating a magnetic field such that charging is conducted by means of induced coupling with the secondary coil,

wherein the primary coil is arranged with a predetermined number of turns and a predetermined size, and

wherein a density of a magnetic flux formed when a primary current is applied to the primary coil is at least 50% of a maximum value of the magnetic flux density at any point within the primary coil.

[13] A contact-less charging device magnetically coupled to a battery device having a

receiving coil to contact-less charge the battery device, the contact-less charging device comprising:
a sending coil array in which a plurality of sending coils are arranged to induce a charging power to the receiving coil; and
means for detecting sending coils magnetically coupled to the receiving coil, and then selectively driving only the detected sending coils.

[14] A charging power supply device magnetically coupled to a battery device including a secondary coil for induced coupling, a contact-less sending module for contact-less sending data, a charging control circuit for controlling a charging status of a battery and a rechargeable battery, the charging power supply device comprising:
a primary coil array in which a plurality of primary coils are arranged to induce a charging power to the secondary coil;
a rectifying circuit for converting an external AC voltage into a DC voltage;
a coil driving circuit for generating a driving power to drive the primary coil based on the DC voltage;
a contact- less receiving module for receiving a feedback response signal from the contact-less sending module; and
a driving control circuit for controlling the coil driving coil to preparatorily driving the primary coils, selecting only primary coils receiving a feedback response signal from the battery device according to the preparatory driving of the primary coils, and driving only the selected primary coils to charge the battery.

[15] A battery charging method using a contact- less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery, the battery charging method comprising:
(A) selecting any one of the primary coils and then preparatorily driving the selected primary coil within a relatively short time;
(B) standing by a feedback response from the battery device during a pre-determined time;
(C) in case the feedback response exists, temporarily storing identification in-formation of the corresponding primary coil in a memory;
(D) selecting another primary coil from the primary coil array and repeatedly executing the steps (A) to (C);
(E) executing the step (D) to all primary coils of the primary coil array sub-sequently; and

(F) reading the identification information of the primary coil from the memory and selectively supplying a charging power only to the corresponding primary coil.

[16] A battery charging method using a contact- less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery, the battery charging method comprising:

(A) preparatorily driving the primary coils subsequently within a relatively short time;

(B) standing by a feedback response from the battery device during a pre-determined time;

(C) selecting at least one primary coil having the feedback response; and

(D) applying a charging power to the selected primary coil to charge the battery device.

[17] A battery charging method using a contact- less charger system that includes a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, and a secondary battery device having a secondary coil magnetically coupled to the primary coils, a contact-less sending module and a battery, the battery charging method comprising:

(A) preparatorily driving all of the primary coils of the primary coil array sub-sequently within a relatively short time;

(B) standing by a feedback response from the battery device during a pre-determined time;

(C) selecting at least one primary coil having the feedback response; and

(D) applying a charging power to the selected primary coil to charge the battery device.

[18] A contact- less charger system including a primary charging unit having a contact-less receiving module and a primary coil array in which a plurality of primary coils are arranged, a secondary charging module having a secondary coil magnetically coupled to the primary coils and a contact-less sending module, and a battery for receiving a charging power from the secondary charging unit, wherein the primary charging unit includes:

a primary coil array in which a plurality of primary coils are arranged to induce a charging power to the secondary coil; and

means for selecting a primary coil having a feedback response from the secondary charging unit after the primary coils are driven in a standby mode, and then driving only the selected primary coil in a charging mode, wherein the secondary charging unit includes:

means for generating a feedback signal informing start of charging in case a voltage sufficient for driving an internal circuit of the secondary coil is induced, and then transmitting the feedback signal to the primary charging unit,

whereby, among the primary coils of the primary coil array, only a primary coil forming positional conformation with the secondary coil is selectively driven.

[19] A contact-less charging device including a charging circuit unit having a rectifier, and a coil unit having a primary coil for forming a magnetic field to contact-less charge a battery using a current supplied from the charging circuit unit,

wherein the charging circuit unit and the coil unit are separated, and the charging circuit unit and the coil unit are electrically connected with each other using a cable of a predetermined length.

[20] A contact-less charging device for contact-less charging a battery, the contact-less charging device comprising:

a contact-type charging unit included in a frame of the contact-less charging device to charge the battery in a contact-type manner.

[21] A contact-less charging device, comprising:

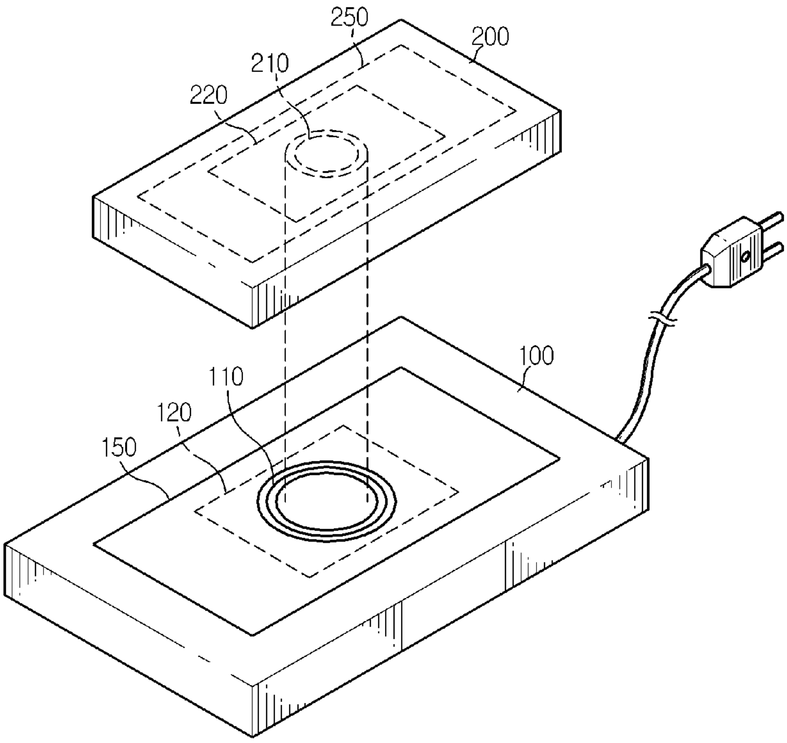
a power supply for supplying a power required for driving the contact-less charging device using a common power;

a primary coil for inducing a charging power;

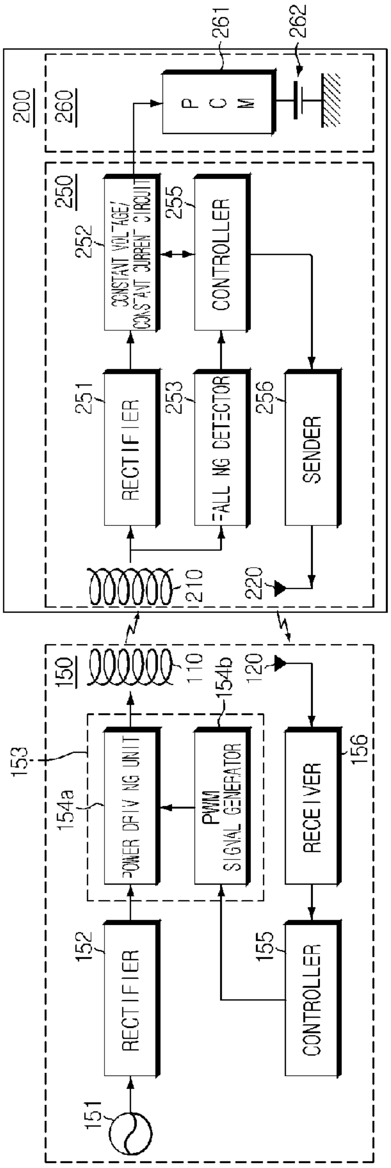
a power driving unit for converting the power input from the power supply to apply a high frequency AC current to the primary coil; and

a current monitoring unit for controlling operation of the power driving unit with reference to a current value applied to the primary coil.

[Fig. 1]



[Fig. 2]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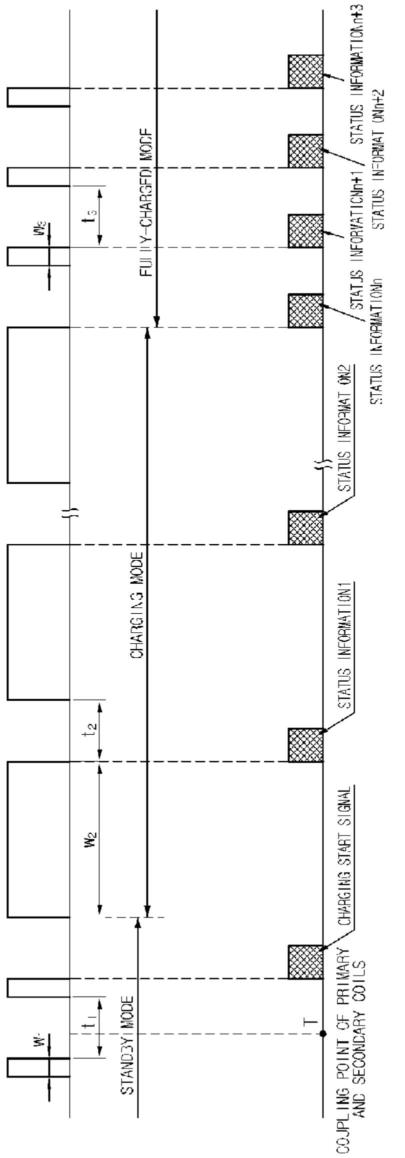
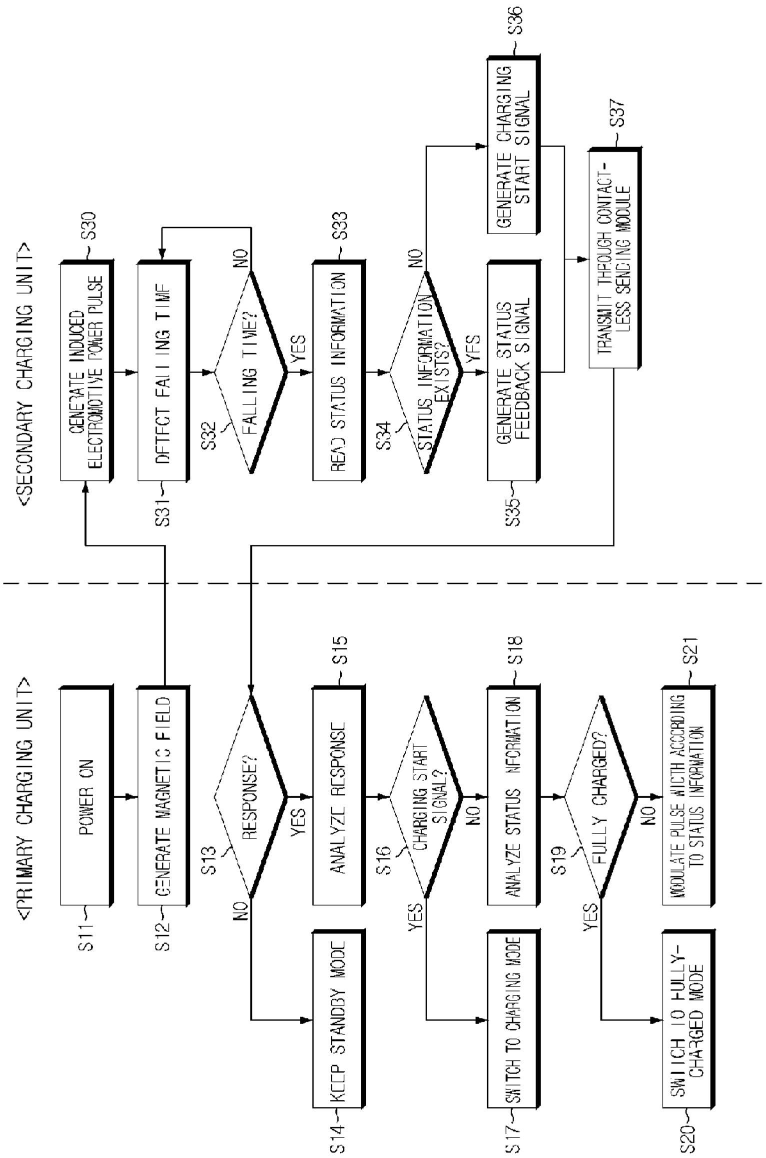
260
261
262
P
C
M
250
252
CONSTANT VOLTAGE/
CONSTANT CURRENT CIRCUIT
255
CONTROLLER
251
RECTIFIER
253
FALLING DETECTOR
256
SENDER
210
220
150
110
120
154b
153
154a
POWER DRIVING UNIT
PWM
SIGNAL GENERATOR
156
RECEIVER
152
RECTIFIER
155
CONTROLLER
151

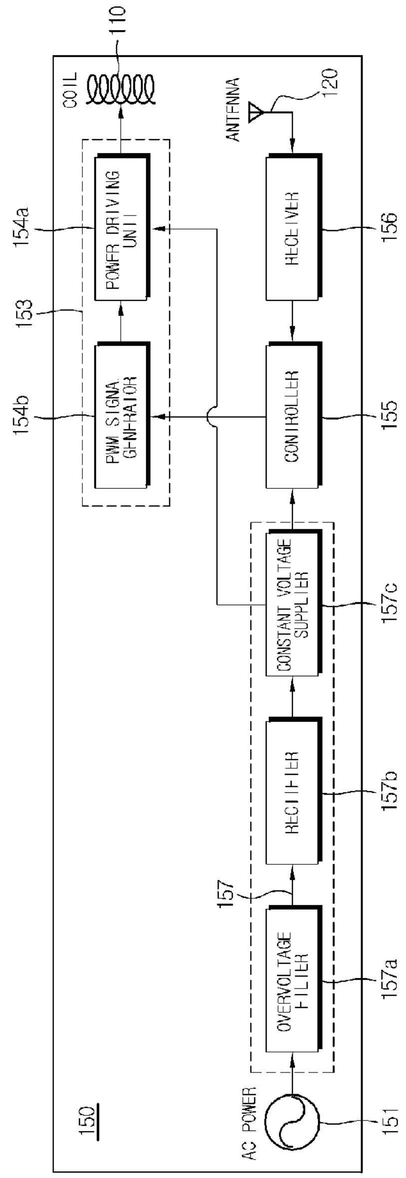
[Fig. 3]


CHARGING MODE
STATUS INFORMATION1
CHARGING START SIGNAL
T

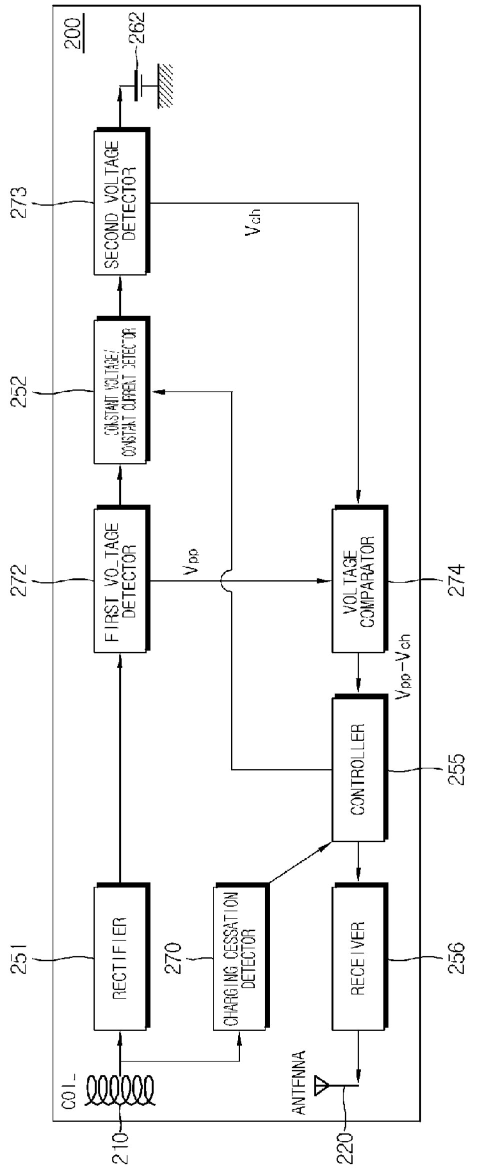
[Fig. 4]


<PRIMARY CHARGING UNIT>
POWER ON
S11
GENERATE MAGNETIC FIELD
S12
RESPONSE?
S13
YES
NO
KEEP STANDBY MODE
S14
ANALYZE RESPONSE
S15
CHARGING START SIGNAL?
S16
YES
NO
SWITCH TO CHARGING MODE
S17
ANALYZE STATUS INFORMATION
S18
FULLY CHARGED?
S19
YES
NO
SWITCH TO FULLY-CHARGED MODE
S20
MODULATE PULSE WIDTH ACCORDING TO STATUS INFORMATION
S21
<SECONDARY CHARGING UNIT>
GENERATE INDUCED ELECTROMOTIVE POWER PULSE
S30
DETECT FALLING TIME
S31
FALLING TIME?
S32
YES
NO
READ STATUS INFORMATION
S33
STATUS INFORMATION EXISTS?
S34
YES
NO
GENERATE STATUS FEEDBACK SIGNAL
S35
GENERATE CHARGING START SIGNAL
S36
TRANSMIT THROUGH CONTACT-LESS SENDING MODULE
S37

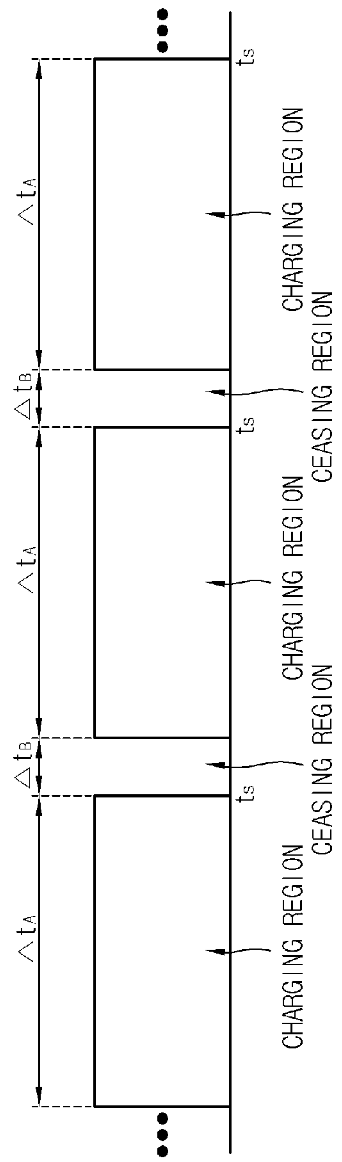
[Fig. 5]


110
COIL
ANTENNA
120
154a
POWER DRIVING UNIT
153
RECEIVER
156
154b
PWM SIGNAL GENERATOR
CONTROLLER
155
CONSTANT VOLTAGE SUPPLIER
157c
RECTIFIER
157b
157
OVERVOLTAGE FILTER
157a
150
AC POWER
151

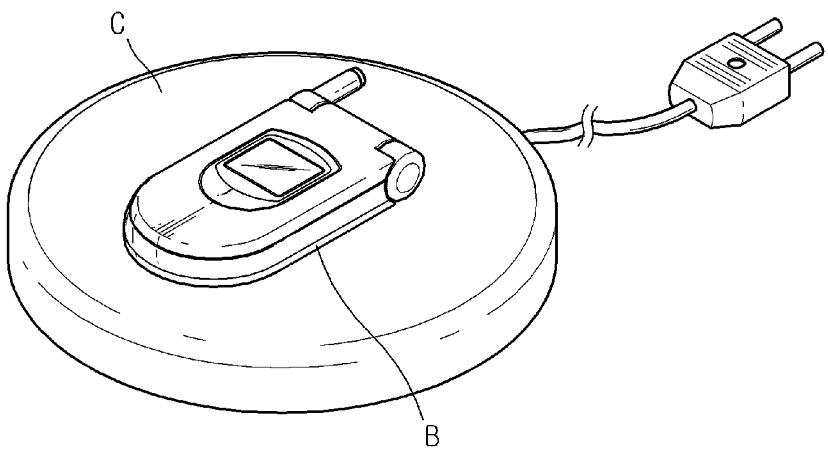
[Fig. 6]


200
262
273
SECOND VOLTAGE DETECTOR
Vch
252
CONSTANT VOLTAGE/ CONSTANT CURRENT DETECTOR
272
FIRST VOLTAGE DETECTOR
Vpp
VOLTAGE COMPARATOR
274
Vpp-Vch
CONTROLLER
255
251
RECTIFIER
270
CHARGING CESSATION DETECTOR
RECEIVER
256
COIL
ANTENNA
210
220

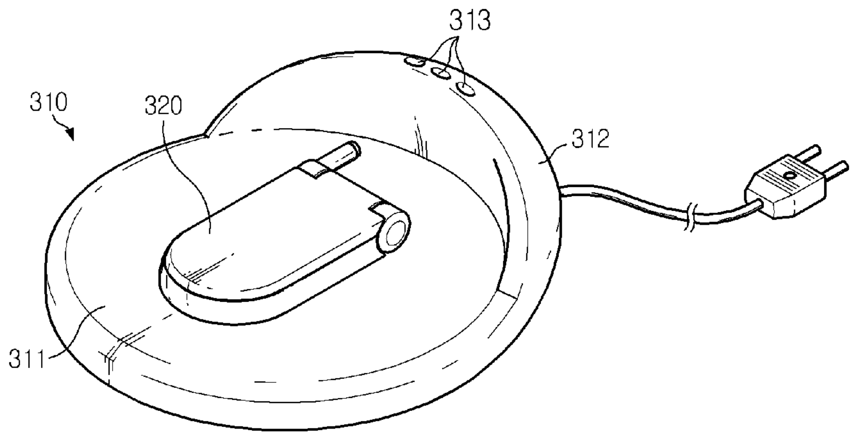
[Fig. 7]


ts
CHARGING REGION
CEASING REGION
ts
CHARGING REGION
CEASING REGION
ts
CHARGING REGION
Δt_A
Δt_B
Δt_A
Δt_B
Δt_A

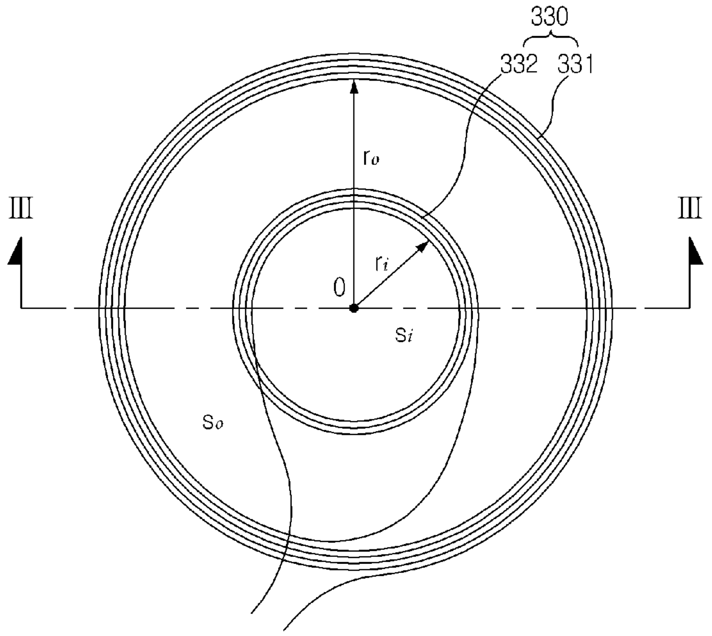
[Fig. 8]


C
B

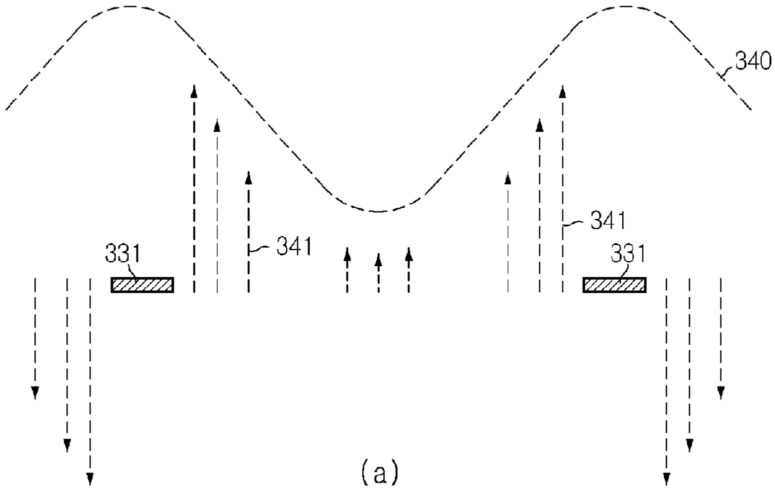
[Fig. 9]

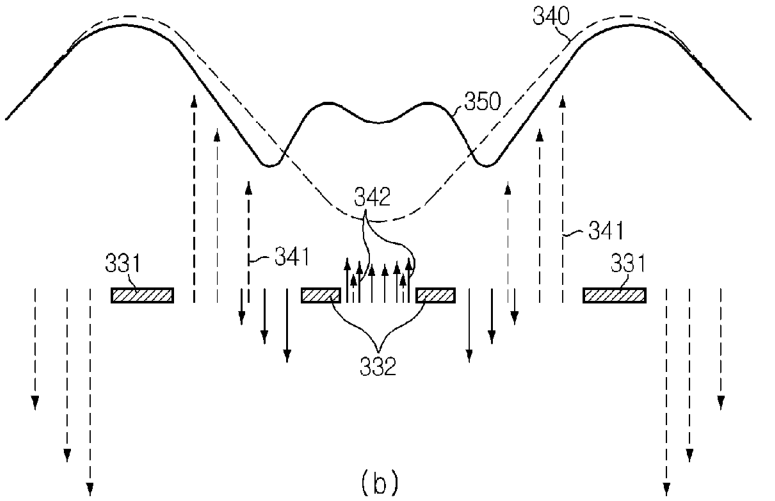


[Fig. 10]

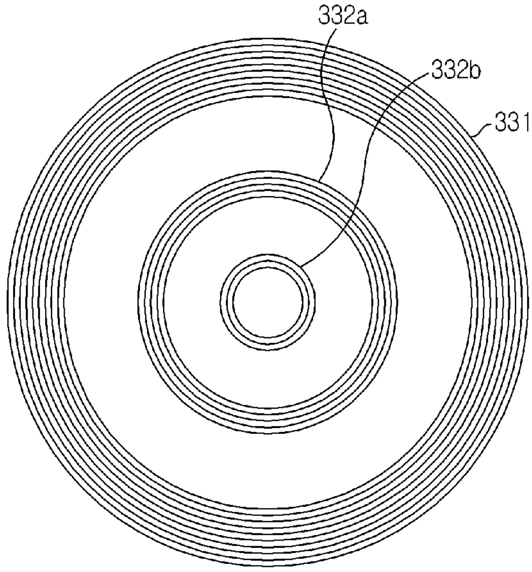


[Fig. 11]

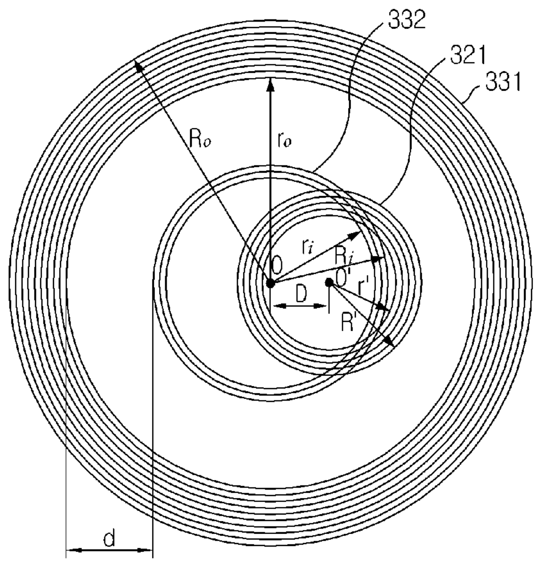

340
341
341
331
331
(a)


340
350
342
341
341
331
331
332
(b)

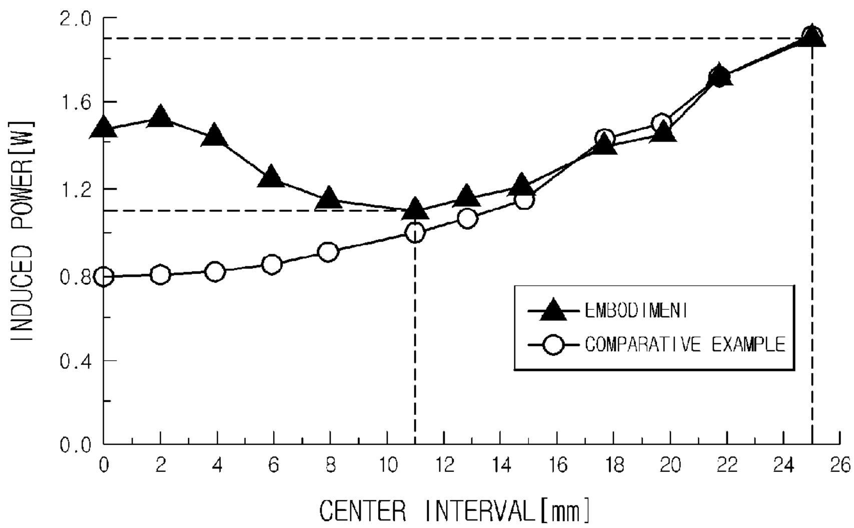
[Fig. 12]


332a
332b
331

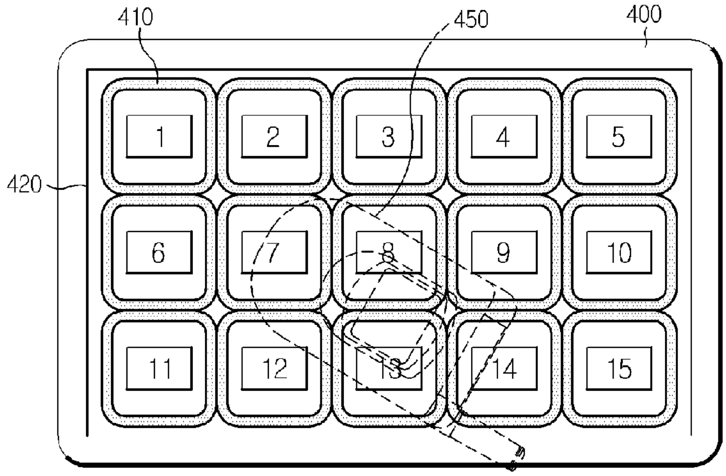
[Fig. 13]


332
321
331
Ro
ro
ri
Ri
O
O'
D
r'
R'
d

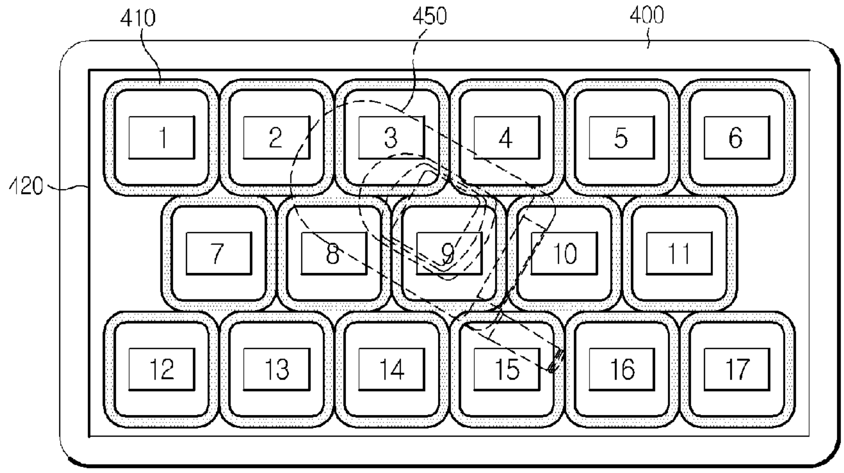
[Fig. 14]


INDUCED POWER[W]
2.0
1.6
1.2
0.8
0.4
0.0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
CENTER INTERVAL[mm]
EMBODIMENT
COMPARATIVE EXAMPLE

[Fig. 15]

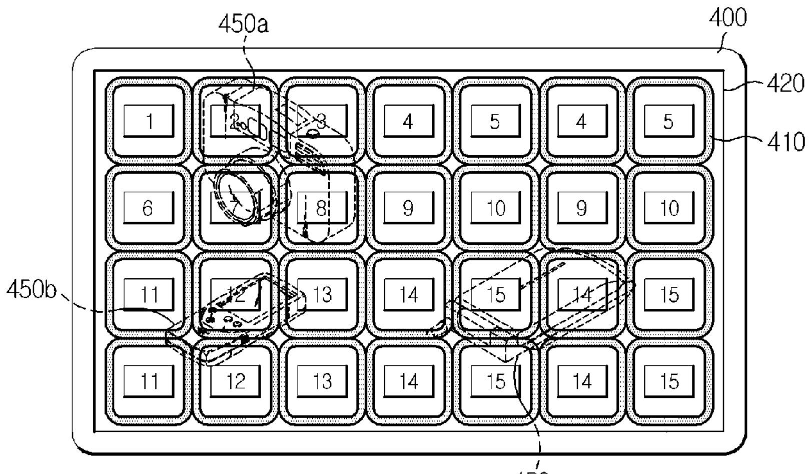


(a)

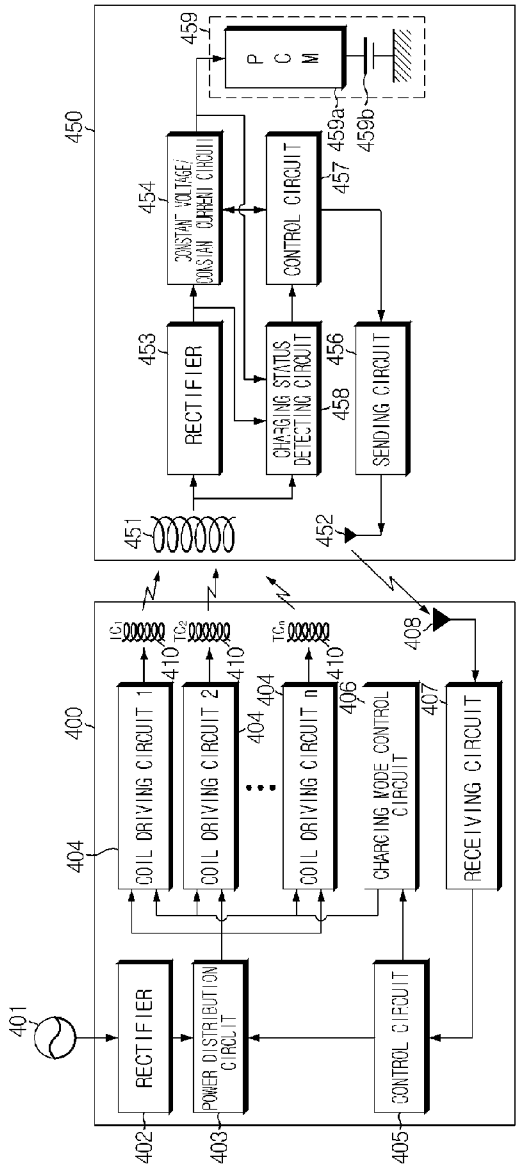


(b)

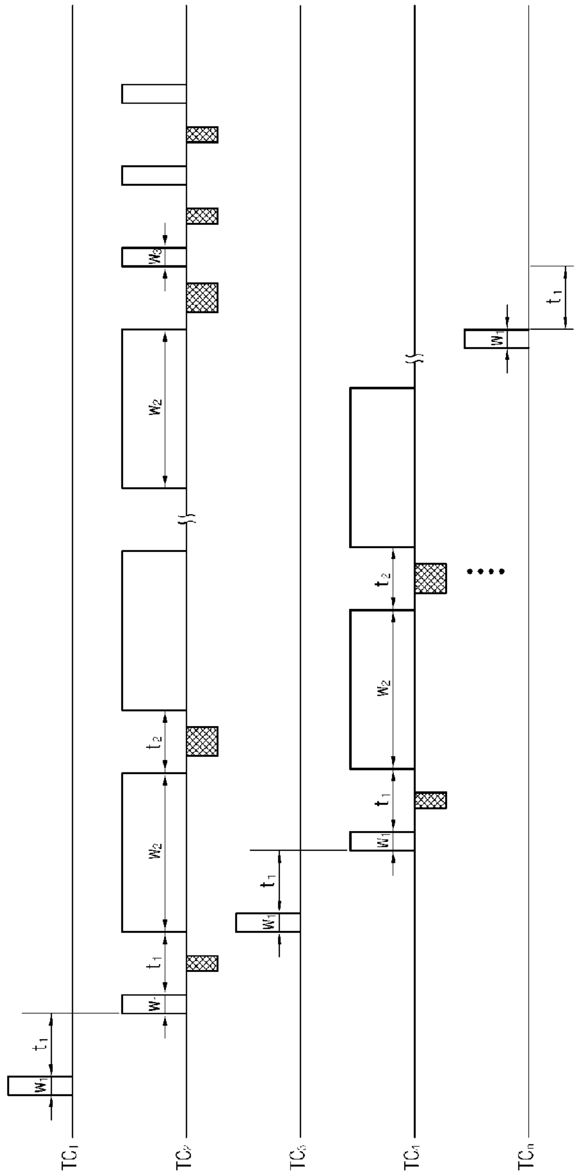
[Fig. 16]



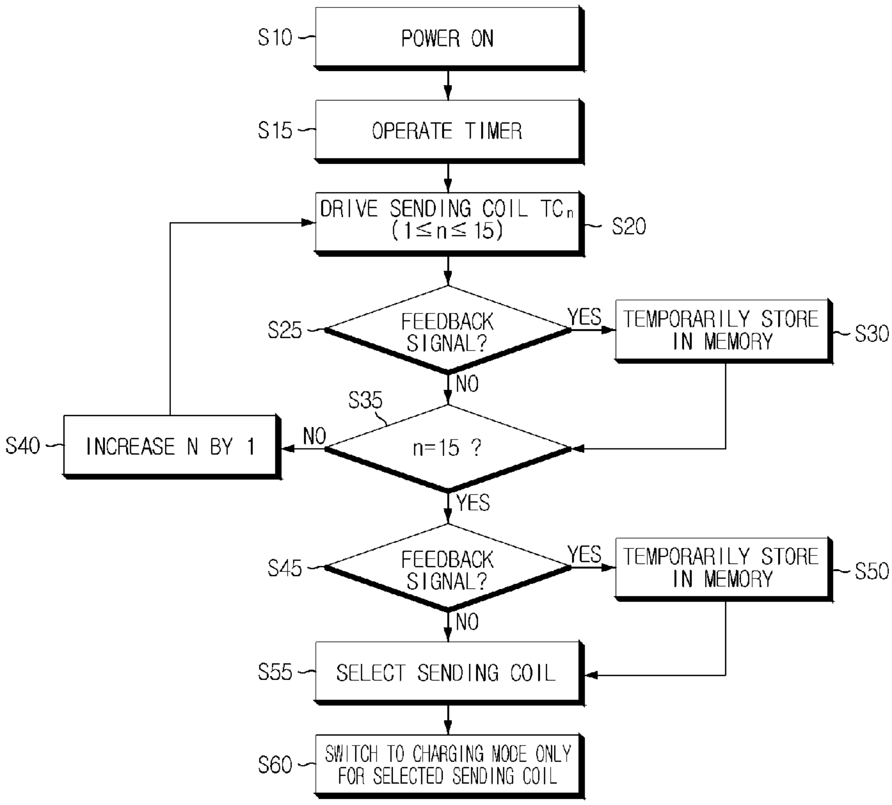
[Fig. 17]


450
459
P
C
M
459a
459b
454
CONSTANT VOLTAGE/
CONSTANT CURRENT CIRCUIT
457
CONTROL CIRCUIT
453
RECTIFIER
456
SENDING CIRCUIT
458
CHARGING STATUS
DETECTING CIRCUIT
451
452
400
404
COIL DRIVING CIRCUIT 1
COIL DRIVING CIRCUIT 2
COIL DRIVING CIRCUIT n
410
406
CHARGING MODE CONTROL
CIRCUIT
407
RECEIVING CIRCUIT
408
401
RECTIFIER
POWER DISTRIBUTION
CIRCUIT
CONTROL CIRCUIT
402
403
405

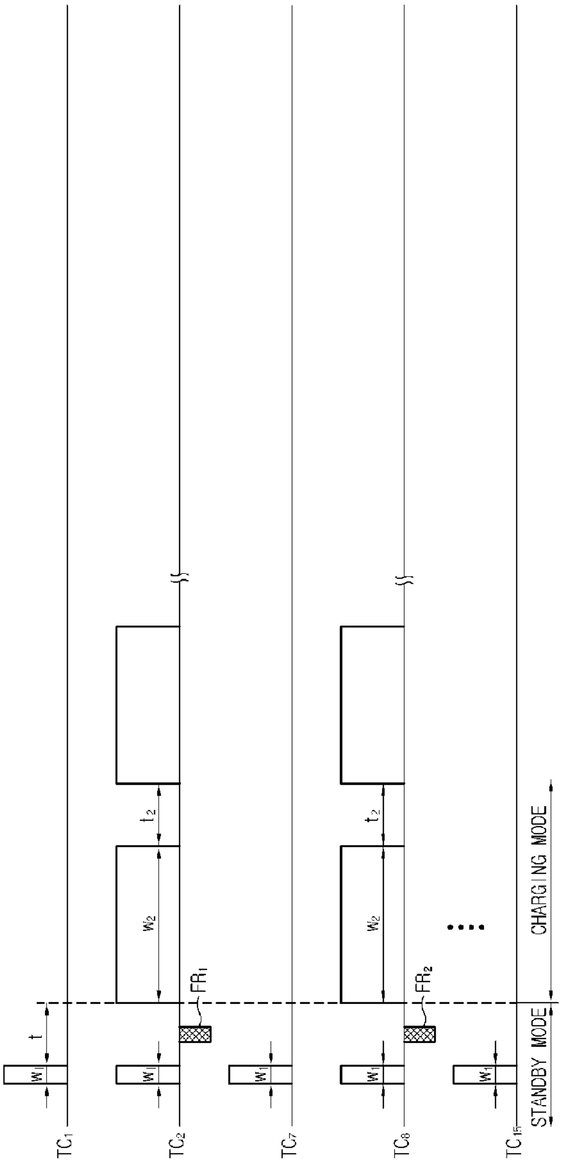
[Fig. 18]



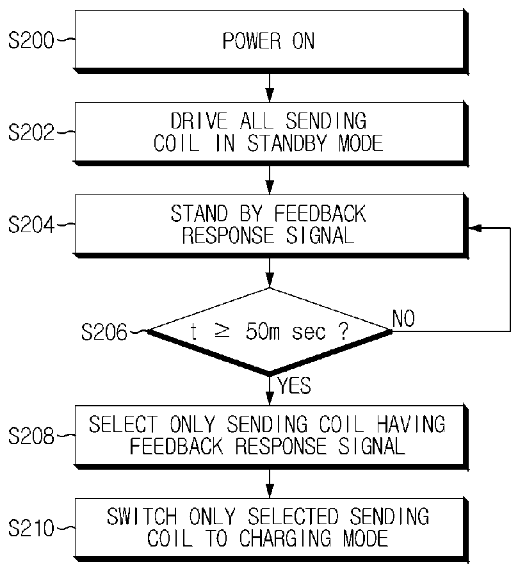
[Fig. 19]


S10
POWER ON
S15
OPERATE TIMER
DRIVE SENDING COIL TCn
(1≤n≤15)
S20
S25
FEEDBACK SIGNAL?
YES
TEMPORARILY STORE IN MEMORY
S30
NO
S35
n=15 ?
NO
S40
INCREASE N BY 1
YES
S45
FEEDBACK SIGNAL?
YES
TEMPORARILY STORE IN MEMORY
S50
NO
S55
SELECT SENDING COIL
S60
SWITCH TO CHARGING MODE ONLY FOR SELECTED SENDING COIL

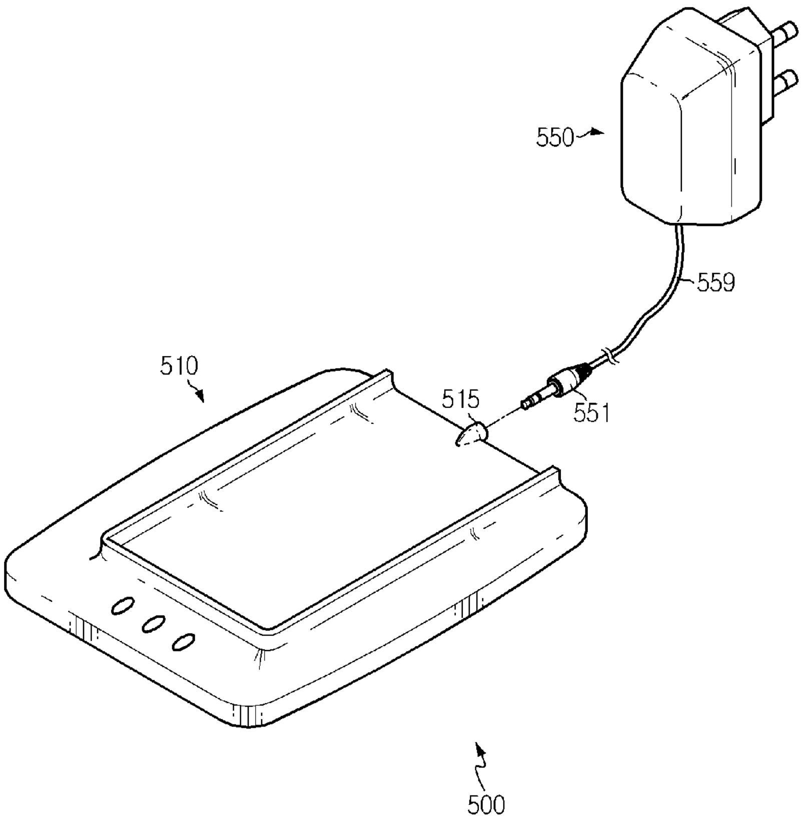
[Fig. 20]


TC1
TC2
TC7
TC8
TC15
w1
w2
t
t2
FR1
FR2
CHARGING MODE
STANDBY MODE

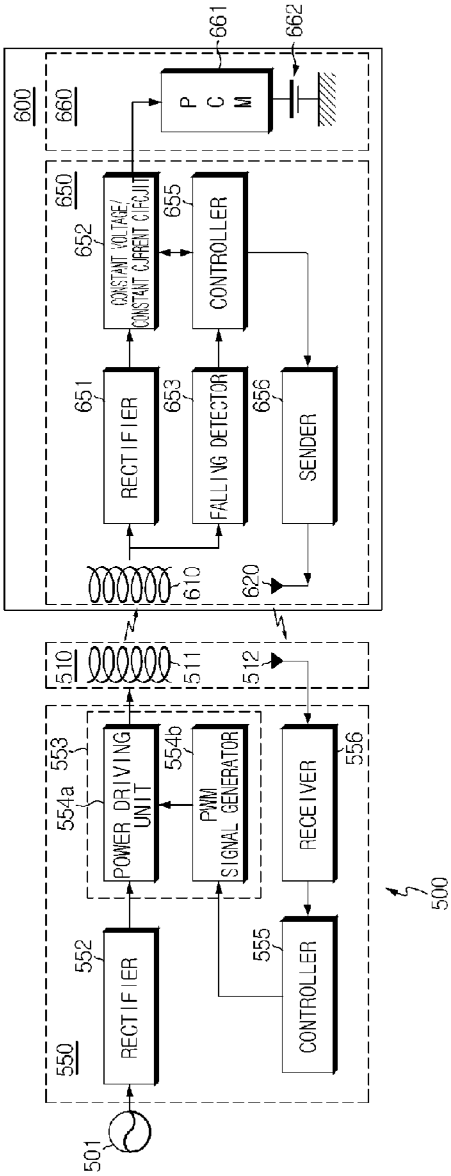
[Fig. 21]


S200
POWER ON
S202
DRIVE ALL SENDING COIL IN STANDBY MODE
S204
STAND BY FEEDBACK RESPONSE SIGNAL
S206
t ≥ 50m sec ?
NO
YES
S208
SELECT ONLY SENDING COIL HAVING FEEDBACK RESPONSE SIGNAL
S210
SWITCH ONLY SELECTED SENDING COIL TO CHARGING MODE

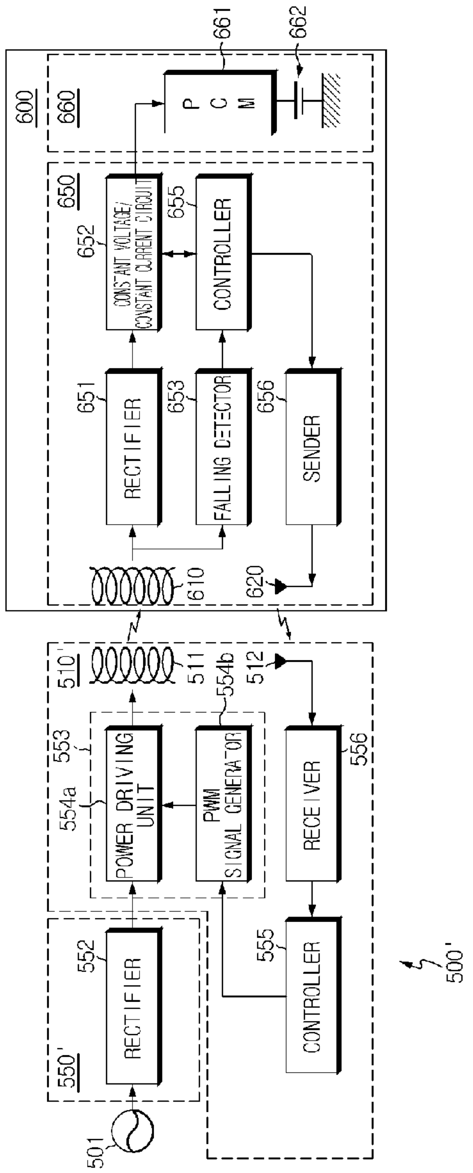
[Fig. 22]



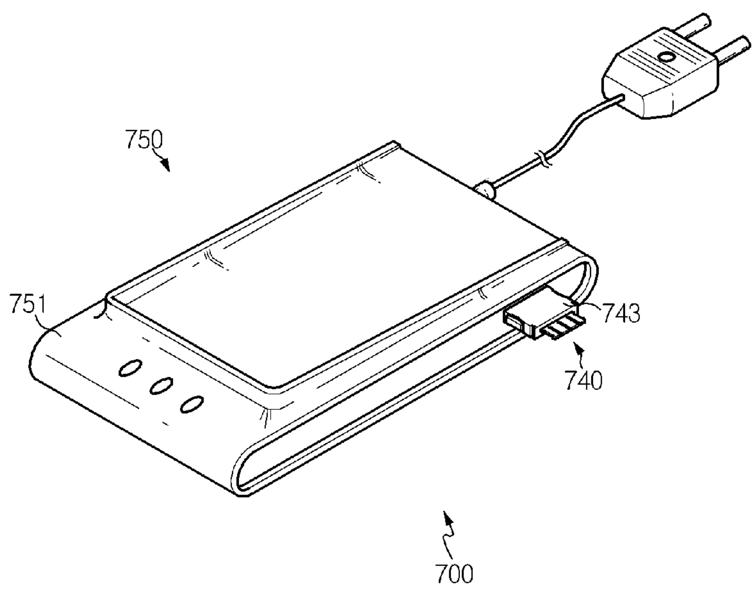
[Fig. 23]


600
660
661
662
P C M
650
652
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
655
CONTROLLER
651
RECTIFIER
653
FALLING DETECTOR
656
SENDER
610
620
510
511
512
550
552
RECTIFIER
553
554a
POWER DRIVING UNIT
554b
PWM SIGNAL GENERATOR
556
RECEIVER
555
CONTROLLER
501
500

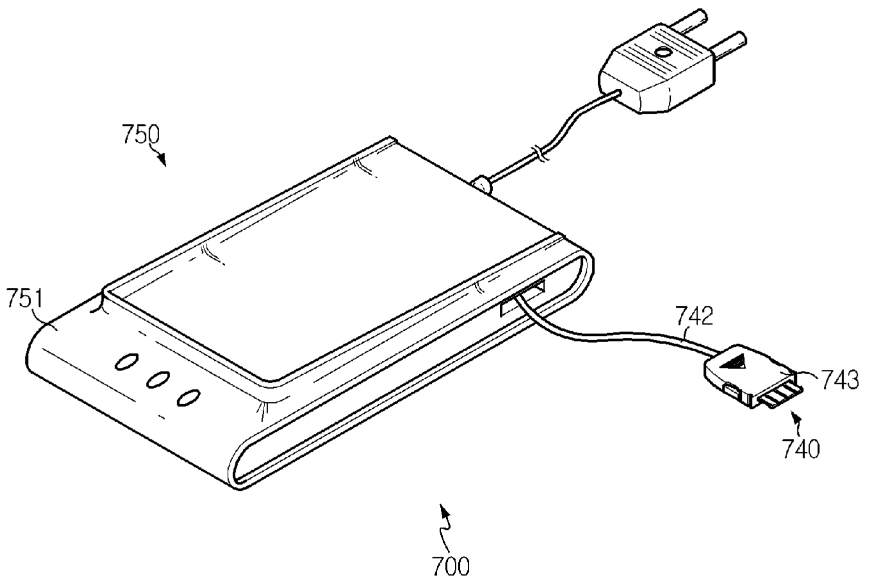
[Fig. 24]


600
660
661
662
P
C
M
650
652
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
655
CONTROLLER
651
RECTIFIER
653
FALLING DETECTOR
656
SENDER
610
620
510'
511
512
554b
553
554a
POWER DRIVING UNIT
PWM SIGNAL GENERATOR
556
RECEIVER
552
RECTIFIER
555
CONTROLLER
550'
501
500'

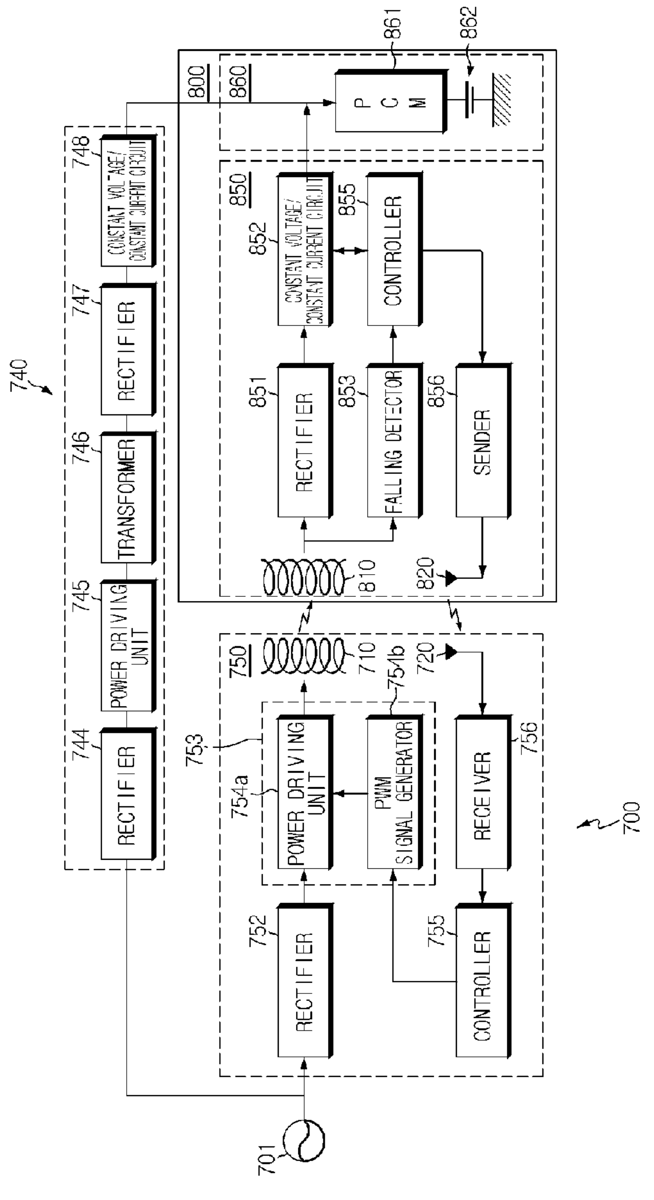
[Fig. 25]


750
751
743
740
700

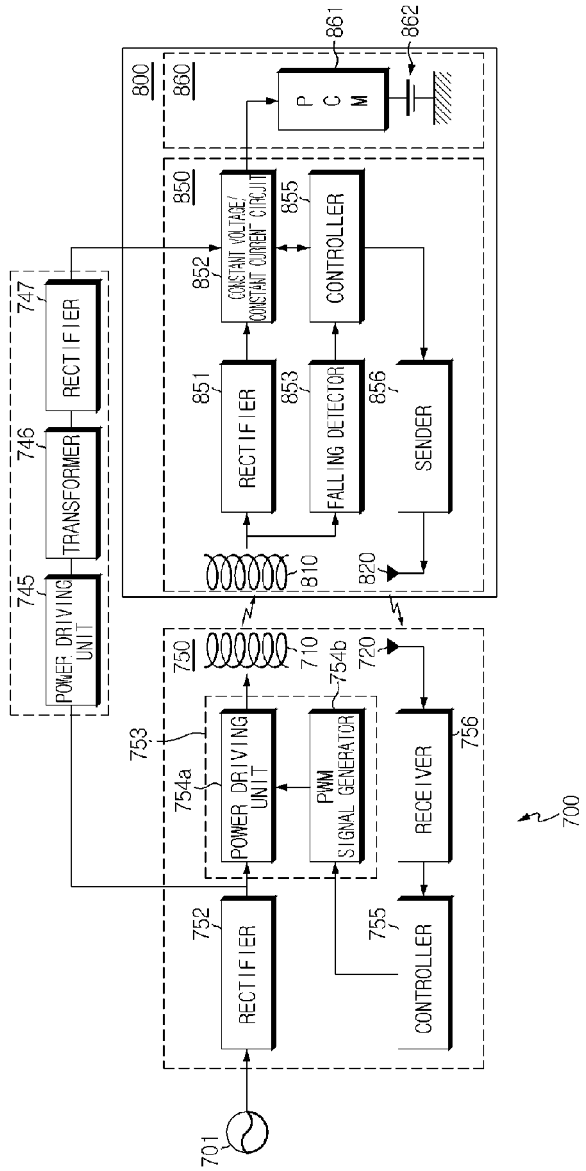
[Fig. 26]


750
751
742
743
740
700

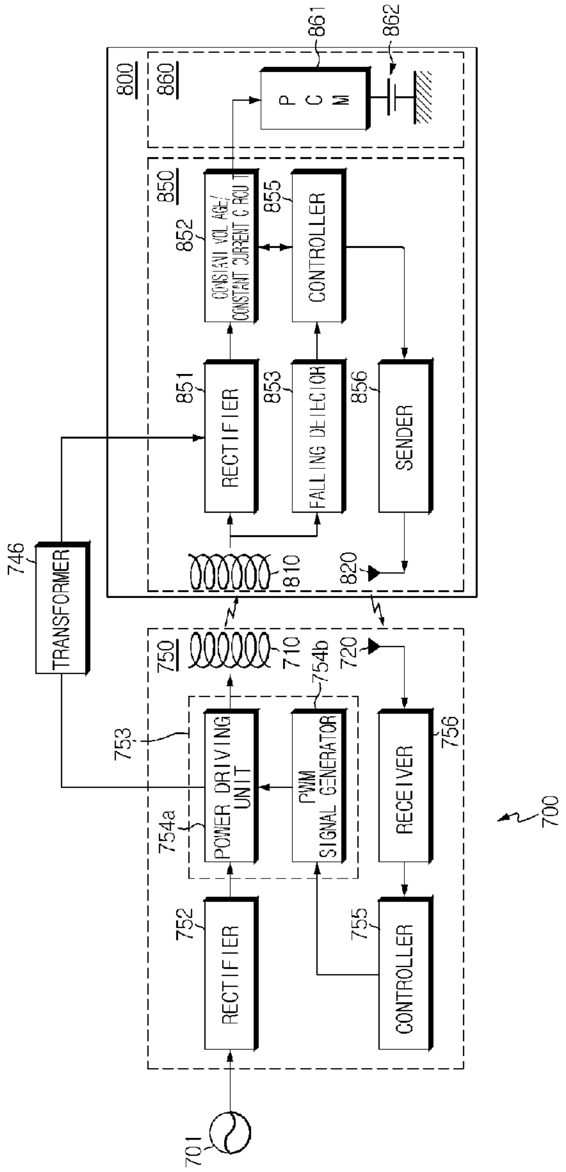
[Fig. 27]


800
860
861
862
P C M
850
852
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
855
CONTROLLER
851
RECTIFIER
853
FALLING DETECTOR
856
SENDER
810
820
740
748
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
747
RECTIFIER
746
TRANSFORMER
745
POWER DRIVING UNIT
744
RECTIFIER
750
710
720
753
754a
754b
POWER DRIVING UNIT
PWM SIGNAL GENERATOR
756
RECEIVER
752
RECTIFIER
755
CONTROLLER
700
701

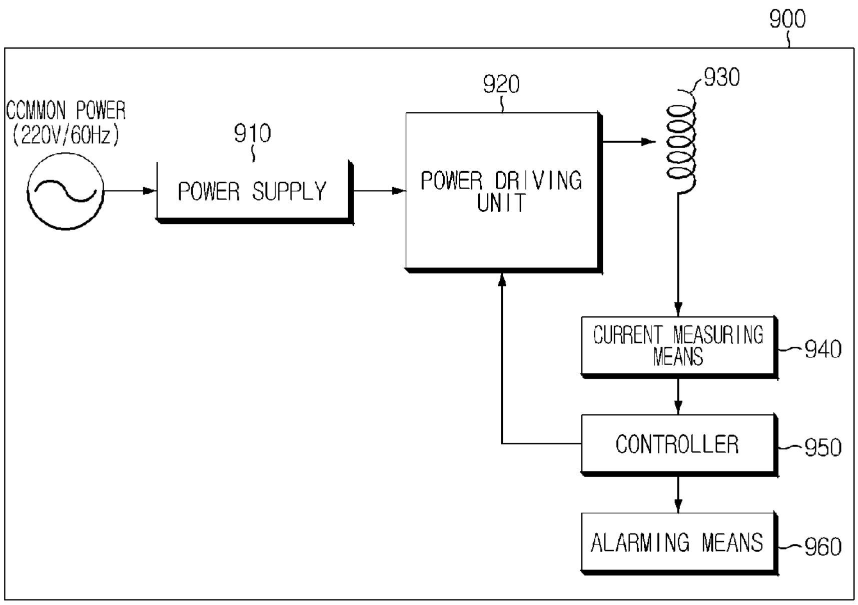
[Fig. 28]


800
860
861
862
PCM
850
852
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
855
CONTROLLER
851
RECTIFIER
853
FALLING DETECTOR
856
SENDER
810
820
747
RECTIFIER
746
TRANSFORMER
745
POWER DRIVING UNIT
750
710
720
753
754a
POWER DRIVING UNIT
754b
PWM SIGNAL GENERATOR
756
RECEIVER
752
RECTIFIER
755
CONTROLLER
701
700

[Fig. 29]


800
860
PCM
861
862
850
852
CONSTANT VOLTAGE/ CONSTANT CURRENT CIRCUIT
855
CONTROLLER
851
RECTIFIER
853
FALLING DETECTOR
856
SENDER
810
820
746
TRANSFORMER
750
710
720
753
754a
POWER DRIVING UNIT
754b
PWM SIGNAL GENERATOR
756
RECEIVER
752
RECTIFIER
755
CONTROLLER
700
701

[Fig. 30]


900
COMMON POWER (220V/60Hz)
910
POWER SUPPLY
920
POWER DRIVING UNIT
930
CURRENT MEASURING MEANS
940
CONTROLLER
950
ALARMING MEANS
960

INTERNATIONAL SEARCH REPORT

International application No
PCT/KR2007/004949

A. CLASSIFICATION OF SUBJECT MATTER

H02J 17/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 H02J 7/00, 7/02, 7/04, 7/12, 17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility Models since 1975

Japanese Utility models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) "non-contact", "charge", "battery"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
A	KR 10-2004-0087037 A (HANRIM POSTECH CO , LTD) 13 October 2004 See the abstract, figure 1	1-21
A	KR 10-2006-0005537 A (HANRIM POSTECH CO , LTD) 18 January 2006 See the abstract, figure 2	1-21
A	KR 10-2002-0057468 A (SAMSUNG ELECTRONICS CO , LTD) 11 July 2002 See the abstract, figure 2	1-21
A	KR 10-2003-0072999 A (LEE, KANG YONG et al) 19 September 2003 See the abstract, figures 2-4	1-21

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

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"O" document referring to an oral disclosure use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"X" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Si" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 JANUARY 2008 (21 01 2008)	22 JANUARY 2008 (22.01.2008)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
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Facsimile No 82-42-472-7140

Authorized officer

HAN, SANG IL

Telephone No 82-42-481-8185

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No
PPIT/RTR2007 /OfJ-I*)49

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR1020040087037A	13 10 2004	AU2003304023A 1	25.10.2004
		AU2003304023AA	25.10.2004
		KR2004087037A	13.10.2004
		W02004088816A1	14.10.2004
KR1020060005537A	18 01 2006	None	
KR1020020057468A	11 07 2002	KR2002057468A	11.07.2002
		US06683438	27.01.2004
		US20020089305A 1	11.07.2002
		US2002089305A 1	11.07.2002
		US2002089305AA	11.07.2002
		US20030045817A1	06.03.2003
		US6683438BB	27 01 2004
KR1020030072999A	19 09 2003	None	