Title: WIRELESS BATTERY CHARGING SYSTEM USING RECTENNA

Abstract: Disclosed is a wireless battery charging system using a rectenna, in which a sky wave relay (i.e., mobile base station, TV broadcasting relay station, artificial satellite, etc.) is used as a transmitting unit, while a mobile communicating appliance or an electronic equipment is used as a receiving unit. The system includes a transmitting section for outputting a high frequency power to a space, a DC power converting section for receiving the high frequency power outputted from the transmitting section through the rectenna and converting the high frequency power to a DC voltage of a given level, and a voltage stabilizing circuit for stabilizing the DC voltage to maintain a constant voltage.
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WIRELESS BATTERY CHARGING SYSTEM USING RECTENNA

Technical Field
The present invention relates to a wireless battery charging system using a rectenna for wirelessly charging a battery.

Background Art
Generally, appliances, such as a mobile wireless telephone, a personal digital assistant, a portable camcorder or the like, utilize electric energy charged in a battery as a power source. The battery used in these appliances is adapted to be recharged. Accordingly, the battery of the appliance is charged through a separate charging unit.

A battery charging system widely supplied up to now drops a common voltage (110-220 volts AC) to a desired level of voltage to implement full-wave rectification, and supplies the full-wave rectified power to the battery. This system is constructed in such a manner that an output terminal of the full-wave rectified DC is directly contacted with terminals of the battery, thereby charging the battery from the charging unit. The construction of this charging system will now be described with reference to Figs. 1 and 2.

In Figs. 1 and 2, reference numeral 12 denotes a power code for inputting the common electric power, and reference numeral 14 denotes a charger for dropping AC power inputted from the power code 12 to a desired level of voltage and rectifying the dropped AC power to generate DC voltage. The charger 14 includes electrode connectors 16 for contacting anode and cathode of the battery of the mobile terminal. Reference numeral 18 denotes the mobile terminal operated by the electricity supplied from the rechargeable battery. If the electrodes of the battery assembled to a rear of the mobile terminal are contacted with the electrode connectors 16 of the charger 14, the DC voltage is supplied to the battery from the charger 14, so as to charge the battery.

The conventional battery charging system can be used when the power code 12 of the charger 14 is connected to an electrical receptacle. Therefore, the system has a decisive problem in that it cannot charge the battery during a user moves. In addition,
when the battery of the mobile terminal is charged through the charger 14, there is a contact inferior between the electrode connectors 16 of the charger and the electrodes. This reason may cause the charger to be out of order.

In order to improve the contact inferior between the electrode connectors 16 of the charger 14 and the electrodes of the battery, some methods have been proposed: a magnetic-induction coupling method for charging the battery in state that the voltage terminals of the charging system are not contacted with the electrodes of the battery; and a non-contact charging system using non-radiative dielectric (NRD) waveguide technology. These methods will now be described with reference to Fig. 3.

The battery of the mobile terminal is wirelessly charged by means of the charger 14 according to the magnetic-induction coupling method or the NRD waveguide technology. However, the charging system employing the magnetic-induction coupling method is to charge the battery with the current through magnetic-induction coupling of transformers. There are some problems such as a limitation of induced coupling distance between a transmitter and a receiver, a bulky size, and high power dissipation.

The wireless charging system employing the NRD waveguide technology which electric property is changed in a high frequency band utilizes a high frequency of above 30 GHz. In the case of installing the system to a conventional sky wave relay, however, a financial burden is increased, and the power dissipation is resulted from a medium (rain, fog, steam, etc.) variation of a space. The system is limited to several conditions.

**Disclosure of the Invention**

Therefore, an object of the present invention is to solve the problems involved in the prior art, and to provide a wireless battery charging system capable of minimizing power transmitting interference according to a medium (rain, fog, steam, etc.) variation when electric power is transmitted via a space and receiving a radio wave radiated from a distance.

Another object of the present invention is to provide a wireless charging circuit capable of receiving a radio wave radiated from a distance using a rectenna to charge a
battery.

In order to accomplish the above and other objects, there is provided a wireless battery charging system using a rectenna, the system comprising a transmitting section for outputting a radio wave of a given power through an array of an antenna, a DC power converting section for receiving the radio wave through the rectenna and converting the radio wave to a DC voltage of a given level, and a voltage stabilizing circuit for stabilizing the DC voltage to maintain a constant voltage.

**Brief Description of the Drawings**

The above objects, other features and advantages of the present invention will become more apparent by describing the preferred embodiment thereof with reference to the accompanying drawings, in which:

Figs. 1 and 2 are perspective views of one conventional battery charging system.

Fig. 3 is a perspective view of another conventional battery charging system.

Fig. 4 is a block diagram illustrating one preferred embodiment of the present invention.

Fig. 5 is a block diagram illustrating a DC power converting section using an array rectenna in Fig. 4.

**Best Mode for Carrying Out the Invention**

Reference will now be made in detail to preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

In an embodiment of the present invention, a conventional transmitting system used in a sky wave relay may be employed as a transmitter for transmitting high frequency power, so that additional units are not required. In addition, use of separate demodulating unit or a quality of signal is matter little in the present invention, because of not transmitting data. Preferably, a transmitting antenna is constructed in type of an array antenna so as to improve efficiency of high frequency power to be transmitted.

A DC power converting section corresponding to a receiving section includes a
receiving array rectenna for receiving a high frequency power emitted from the array antenna of the transmitter, an RF rectifier for regulating the high frequency power received from the array rectenna, an RF blocking filter for suppressing ripple generated from a smoothing circuit and a load and interference of inductive electromagnetic wave, the smoothing circuit for converting the half-wave or full-wave rectified high frequency power by RF rectifier to DC voltage, and a voltage stabilizing circuit for converting the DC voltage to battery charging voltage.

The high frequency power transmitter may utilize the power of information and broadcasting signal for the sky wave relay.

According to the wireless charging system constructed as described above, the array rectenna receives the high frequency emitted from the array antenna of the transmitter, and the high frequency is rectified and filtered to maintain a constant voltage to be supplied to connectors of battery electrodes. Therefore, the system is not limited to a length of power code, and the problems due to the wireless charging mode according to the magnetic-induction coupling method or the NRD waveguide technology are solved.

Fig. 4 is a schematic view illustrating a construction of a wireless battery charging system using a rectenna according to a preferred embodiment of the present invention. Referring to Fig. 1, a high frequency power transmitting section 20 modulates digital information or analog information and emits the high frequency amplified from the modulated information to a space via the array antenna 22 connected to an output node. At that time, it is noted that the information outputted from the high frequency power transmitting section 20 may be unmodulated information.

The high frequency power transmitting section 20 may utilize a sky wave relay, for example, a relay of code division multiple access (CDMA) of cellular mobile radio system. Accordingly, the antenna is preferably assembled as the array antenna, as shown in Fig. 5, so as to increase the efficiency of the high frequency power emitted to the space.

The high frequency power emitted from the array antenna 22 of the high frequency power transmitting section 20 is received by a rectenna 24 connected to the receiver built in a mobile terminal distantly positioned in the space. The array rectenna 24 rectifies the
received high frequency power to convert it to DC voltage, and filters the converted DC voltage to remove a high frequency component and an unwanted wave component from the DC voltage and supply the filtered DC voltage to a voltage stabilizing circuit 26.

The voltage stabilizing circuit 26 stabilizes the rectified and smoothed DC voltage to maintain a constant voltage and supplies the DC voltage to the electrodes of a chargeable battery 28 connected to an output node. As described above, if the high frequency power transmitting section 20 composed of the sky wave relay emits the high frequency power to the space via the array antenna 22, the array antenna 24 built in the mobile terminal receives the high frequency power. Then, the array rectenna 24 rectifies and filters the high frequency to convert the high frequency to the DC voltage and supply it to the voltage stabilizing circuit 26, thereby charging the battery 28.

Fig. 4 does not depict a construction of preventing overcharge of the chargeable battery 28. However, it will be understood that the wireless charging system of the present invention may be provided with an overcharge preventing circuit which detects a voltage level of the chargeable battery and switches on/off an output of the voltage stabilizing circuit 26 to prevent the overcharge of the battery. The above operation will be more clearly understood with reference to Fig. 5 depicting the connecting construction of the array rectenna 24, the voltage stabilizing circuit 26 and the chargeable battery 28 which are built in the receiver, i.e., the mobile terminal.

Fig. 5 illustrates the construction of the DC power converting section using the array rectenna 24 of Fig. 4. Referring to Fig. 5, the array rectenna 24 consists of at least one rectenna arrayed and connected in a matrix type. The rectenna 24 includes a Schottky diode 30 with an anode and a cathode connected to antennas 231 and 33 spaced apart from each other, an RF blocking filter 32 for suppressing ripple and conductive electromagnetic wave interference, and a smoothing circuit 34 for converting the high frequency power half- or full-wave rectified by the Schottky diode. The RF blocking filter and the smoothing circuit are connected to the anode and cathode of the Schottky diode.

At that time, a plurality of rectennas are arranged in one or more than column and row directions to form the matrix array, the Schottky diodes arranged in the respective
columns are connected in parallel.

In the matrix-type array rectenna, anodes of a plurality of Schottky diodes of the rectenna positioned in the first column are connected to cathode electrodes of the voltage stabilizing circuit 26, while cathodes of a plurality of Schottky diodes of the rectenna positioned in the last column are connected to anode electrodes of the voltage stabilizing circuit. Anodes and cathodes of a plurality of Schottky diodes of the rectenna positioned in the remaining columns between the first and last columns are connected to anodes and cathodes of the Schottky diodes positioned the adjacent columns.

The array rectenna 24 consists of a plurality of rectennas connected to each other in the matrix array, so that wanted wattage of DC voltage may be obtained. In addition, connected position of the Schottky diode connected between the antennas 31 and 33 may be adjusted to obtain impedance matching between the antennas 31 and 33 and the Schottky diode.

Preferably, the array rectenna constructed as shown in Fig. 5 is formed in a microstrip line structure by properly designing a conductive board formed on a dielectric substrate. If the high frequency power outputted from the high frequency power transmitting section constructed as shown in Fig. 4 is transmitted by the array antenna 22 and is received by the array rectenna 24 constructed as shown in Fig. 5, the antennas 31 and 33 of the array rectenna 24 receive the high frequency power. At that time, parasitic capacity between the Schottky diodes connected between the antennas 31 and 33 is minimized and the Schottky diodes rectify the high frequency to the DC voltage. In other words, the Schottky diodes rectify the high frequency power received through the antennas 31 and 33.

The RF blocking filters and the smoothing circuits connected to the anodes and cathodes of the Schottky diodes suppress and remove the ripple component and the conductive electromagnetic wave interfering signal contained in the rectified voltage to supply the DC voltage dependant the level of the high frequency power to the voltage stabilizing circuit 26. The voltage stabilizing circuit 26 stabilizes a level of DC voltage outputted from the array rectenna 24 to supply the constant voltage clamped to a given
level to the anode and cathode of the battery 28 connected to the mobile terminal, thereby charging the battery cell.

As described above, the array rectenna receives the high frequency power emitted from the high frequency power transmitting section such as a sky wave relay, converts the received high frequency power to a given level of DC voltage, and removes the unwanted wave to supply the DC voltage to the battery as a charging voltage, thereby freely charging the battery of the mobile terminal.

While the present invention has been described and illustrated herein with reference to the preferred embodiments thereof, it will be apparent to those skilled in the art that various modifications and variations can be made therein without departing from the spirit and scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention that come within the scope of the appended claims and their equivalents.

**Industrial Applicability**

As apparent from the above description, the wireless charging system using the rectenna according to the present invention may solve the problems of the using limitation (usage of power code) and the power dissipation due to the contact inferior of connecting points in a conventional wire charging system, and also solve the problems caused by the non-contact charging system employing the magneto-induction coupling method and the NRD waveguide technology, thereby wirelessly charging the battery of the mobile terminal.
Claims

1. A wireless battery charging system using a rectenna, the system comprising:
   a transmitting section for outputting a high frequency power to a space;
   a DC power converting section for receiving the high frequency power outputted
   from the transmitting section through the rectenna and converting the high frequency power
   to a DC voltage of a given level; and
   a voltage stabilizing circuit for stabilizing the DC voltage to maintain a constant
   voltage.

2. The wireless battery charging system as claimed in claim 1, wherein the
   transmitting section outputs the high frequency power through an array antenna.

3. The wireless battery charging system as claimed in claim 1 or 2, wherein the DC
   power converting section and the voltage stabilizing circuit are built in a mobile terminal.

4. The wireless battery charging system as claimed in claim 3, wherein the DC power
   converting section includes an array rectenna receiving the high frequency power outputted
   from the array antenna of the transmitting section.

5. The wireless battery charging system as claimed in claim 4, wherein the array
   rectenna includes a plurality of rectennas arrayed in a matrix type, the rectenna having a
   Schottky diode with an anode and a cathode connected to antennas spaced apart from each
   other, an RF blocking filter for suppressing ripple generated from a smoothing circuit and a
   load and interference of inductive electromagnetic wave, and a smoothing circuit for
   converting the high frequency power rectified by the Schottky diode to DC voltage, in
   which the RF blocking filter and the smoothing circuit are connected to the anode and
   cathode of the Schottky diode.
6. The wireless battery charging system as claimed in claim 5, wherein the antennas of the rectenna are formed in a microstrip line structure on a dielectric substrate.
Fig 3
Fig 4
A. CLASSIFICATION OF SUBJECT MATTER
IPC7 H01L 21/68, H02J 7/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC7 H01L 21/68, H02J 7/00, H02J 13/00, H01M 10/48

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and applications for inventions since 1975
Korean 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)
KIPONET

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>KR 2002-63050 A (CHOI, DEOK-HYUN) 1 AUG 2002 claim 1-4</td>
<td>1-6</td>
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<tr>
<td>Y</td>
<td>KR 1999-18078 A (LEE, JONG-GU) 15 MAR 1999 claim 1, 6; Fig. 4; page 4, lines 2-12</td>
<td>1-6</td>
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<tr>
<td>A</td>
<td>T. YOO, J. MCSRADDEN, K. CHANG '35 GHz Rectenna Implemented With a Patch And a Microstrip Dipole Antenna' In : Microwave Symposium Digest, 1992 : IEEE MTT-S International, p.345-346 page 345 (see Introduction)</td>
<td>1-6</td>
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Further documents are listed in the continuation of Box C.
See patent family annex.

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26 NOVEMBER 2003 (26.11.2003)

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Authorized officer
SONG, Won Soon
Telephone No. 82-42-481-5735

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