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April 14, 2008

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APPLICATION NUMBER: 60/907,132

FILING DATE: March 22, 2007

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US60/907,132

**By Authority of the
Under Secretary of Commerce for Intellectual Property
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Certifying Officer**

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Patent and Trademark Office; US DEPARTMENT OF COMMERCE**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (b)(2).

Docket Number		34862		Type a plus sign (+) inside this box ->	+
INVENTOR(s) / APPLICANT(s)					
LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY)		
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TITLE OF THE INVENTION (280 characters max)					
LOCATION DETECTION OF A RECEIVER IN A TRANSMITTING SURFACE					
CORRESPONDENCE ADDRESS					
Martin D. Moynihan PRTSI, Inc. P.O. Box 16446 Arlington					
STATE	VIRGINIA	ZIP CODE	22215	COUNTRY	USA
ENCLOSED APPLICATION PARTS (check all that apply)					
☒ 7 pages of specification (including drawings)			☐ Assignment to:		
☐ - pages of sequence listing			☒ 5 Claims		
☐ - sheet of drawings			☒ Application Data Sheet		
☒ 7 total pages			☒ Applicant is entitled to Small Entity Status under 37 CFR 1.9 and 37 CFR 1.27		
THE FILING FEE HAS BEEN CALCULATED AS SHOWN BELOW:					
FOR:	SMALL ENTITY RATE FEE		OTHER THAN A SMALL ENTITY RATE FEE		
Provisional Application Filing Fee		\$ 100		\$ 200	
Provisional Application Size Fee (Per 50 Pages Over 100)	\$ 125	\$ 0	\$250		
	TOTAL	\$ 100.	TOTAL		
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT					
☒ The Commissioner is hereby authorized to charge \$100.00 filing fees to Deposit Account No. 50-1407. In the event additional fees are required, please charge these additional fees to Deposit Account No. 50-1407. In the event of overpayment, please credit Deposit Account No. 50-1407. A duplicate copy of this form is enclosed.					

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No ☐ Yes, the name of the US Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE Martin D. Moynihan

March 22, 2007

Date

40,338

REGISTRATION NO.
(if appropriate)TYPED or PRINTED NAME Martin D. Moynihan☐ Additional inventors are being named on separately numbered sheets attached hereto**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT**

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Application Data Sheet

Application Information

Application number::	Not Yet Assigned
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Title::	Location Detection Of A Receiver In A Transmitting Surface
Attorney Docket Number::	34862
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Request for Non-Publication?::	No
Suggested Drawing Figure::	
Total Drawing Sheets::	None
Small Entity?::	Yes
Secrecy Order in Parent Appl.?::	No

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APPLICATION FOR PATENT

Inventors: Nehemia NIV and Yossi AZANCOT

Title: LOCATION DETECTION OF A RECEIVER IN A TRANSMITTING SURFACE

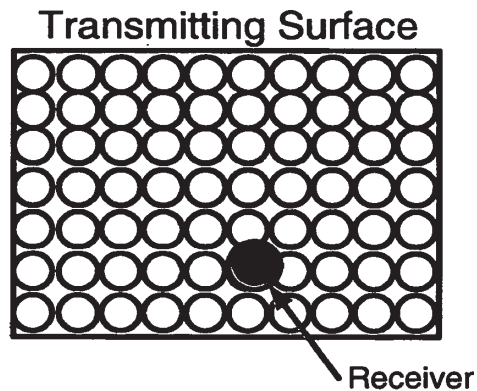
Figures

Figure 1: Surface made of transmitting coils with a receiver

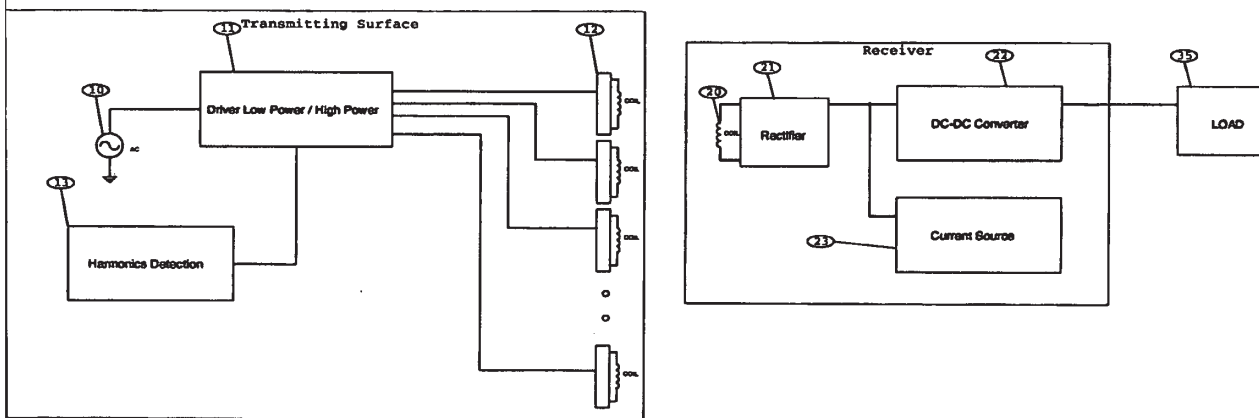


Figure 2: Block diagram of the transmitting surface and of the receiver

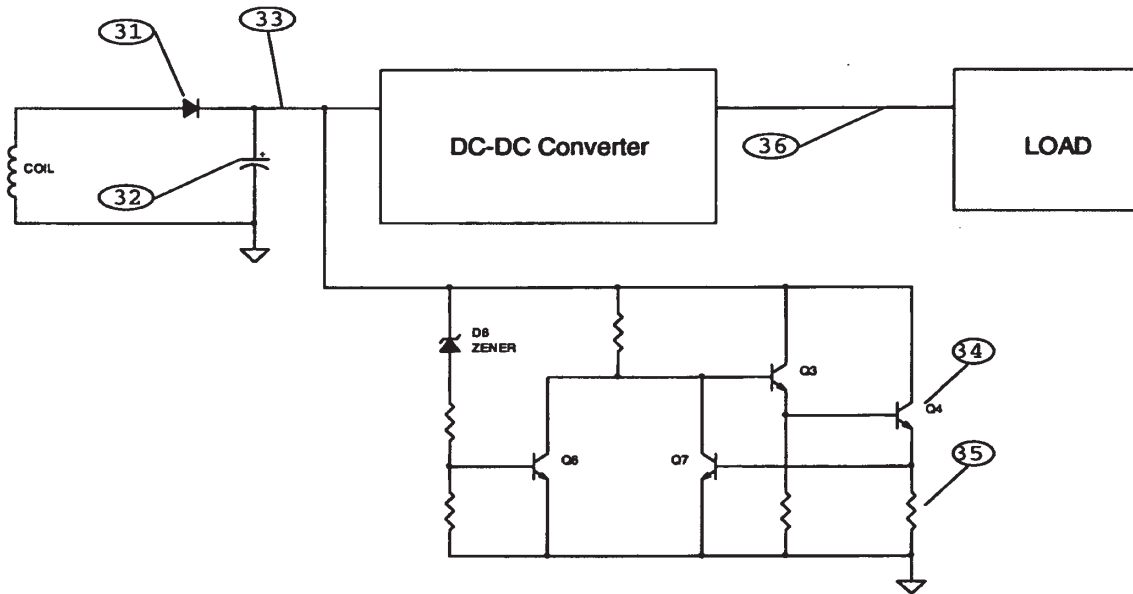


Figure 3: Receiver circuit

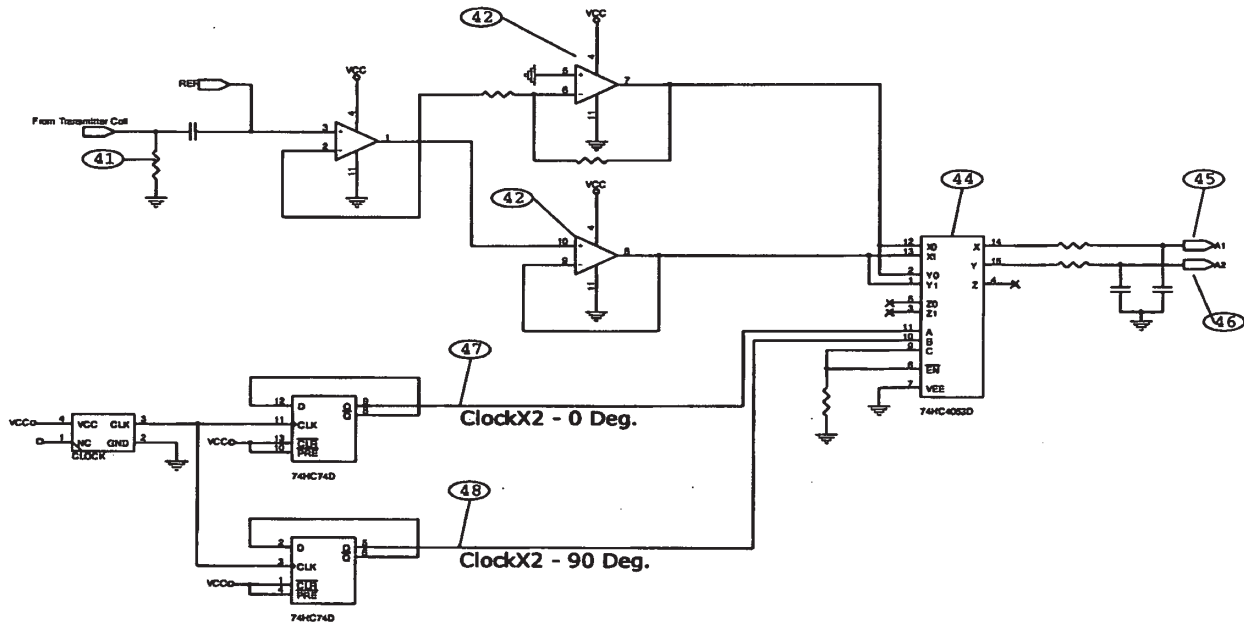


Figure 4: Harmonics detector

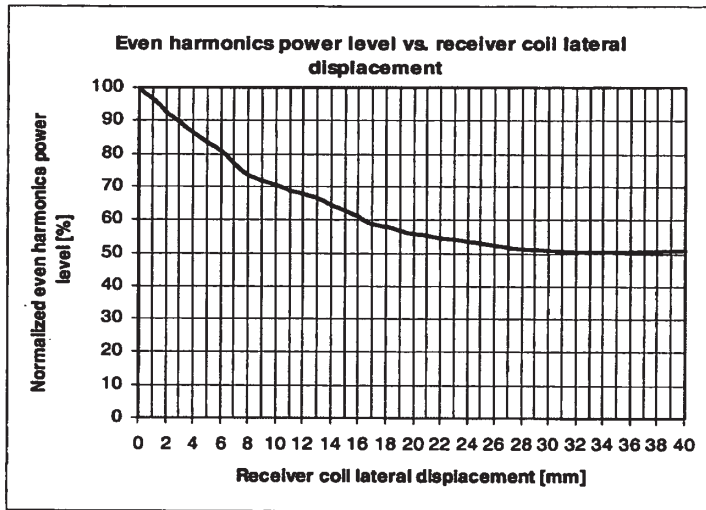


Figure 5: Test of Even harmonics power level vs. receiver coil lateral displacement

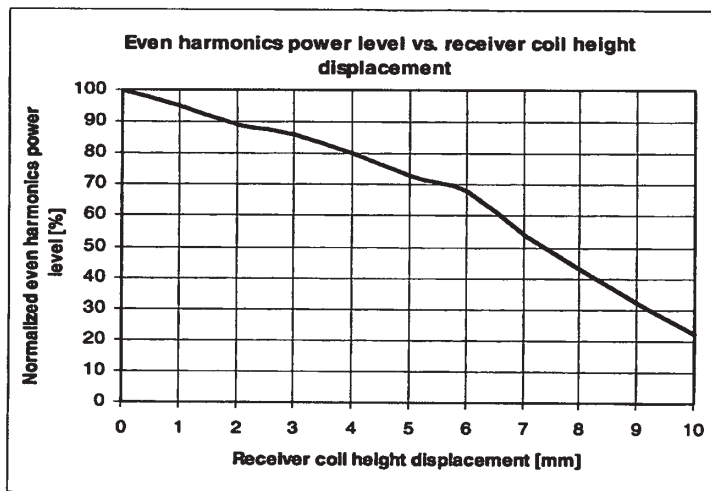


Figure 6: Test of Even harmonics power level vs. receiver coil height displacement

Field of the invention

The present invention relates to a mechanism of transmitting power between a transmitter to a receiver using inductive coupling. More specifically the transmitter is made of a large area, much larger than the receiver. This topology allows a freedom of location of the receiver on top of the surface.

Background of the invention

A conventional power transmission system using inductive coupling is made of a transmitting coil and a receiving coil. The transmitting coil and the receiving coil must be accurately coupled in order to transfer power efficiently. A small misalignment reduces the power transferred.

The present invention addresses this disadvantage and solves the problem by using a large surface made of multiple coils. Therefore the receiver does not have to be accurately placed on the surface. Additionally the surface is to be used on top of tables or desks in order to charge electronic devices. Generally speaking, energy transmission should be avoided from any of the transmitting coils if a receiving coil is not located on top of it. If such a transmission occurs, any metallic body, such as a ring or even a paper clip, would receive the above energy and convert it into heat. The present invention addresses this problem and solves it by an accurate detection of the receiver. Therefore the power transmission will be done only when a full juxtaposition between the receiving coil and the transmitting coil has been detected.

Summary of the invention

In a surface made of multiple coils, where every coil can be independently powered, an accurate location detection of the receiver should be performed.

The transmitter driver can operate every transmitting coil independently at two (or more) different power levels. Every power level determines the amount of energy that can be transferred. A low power mode is activated for the location detection of the receiver.

The receiver circuit is composed of a coil, half wave rectifier using a diode, capacitor, low power current source and a DC to DC converter. When the low power mode is activated on the transmitter, the transmitter activates the transmitting coil sequentially.

When a receiving coil receives this low power signal the receiver's current source is activated, and since the rectification is a half wave rectification it induces even harmonics off the transmitter clock.

The transmitter probes the current driven to the transmitting coil and can detect all the harmonics. Using a mathematical calculation called cross correlation, even harmonics can be detected. The power of the even harmonics determines if the receiver is accurately juxtaposed to the transmitting coil. Once the detection has been completed the transmitter goes into a high power mode, and the

receiver detects the new operating mode, deactivates the current source and activates the DC to DC converter in order to perform the desired power transfer to the external load connected to the receiver.

The odd and even harmonics are constantly monitored, and the harmonics power and phase determines if the power is transferred to the receiver. If the receiver has been displaced or removed, the transmitter will automatically detect it, and will go to a low power mode.

Detailed description of the invention

Figure 1 illustrates a transmitting surface made of multiple coils, and a receiver which has a receiving coil and an electronics circuit. The receiving coil diameter shown is similar to the diameter of the transmitting coil. The dimensions of the transmitting and receiving coils can be different.

Figure 2 shows a block diagram of the system. A generator 10 generates an AC clock. A driver 11 can operate in low power and high power modes. The driver 11 is connected to all the coils 12. A resonant R-L-C circuit activates the coil and produces a magnetic field transmitted by one of the coils 12. The receiving coil 20 receives the magnetic field and converts it into an AC current. The AC current is rectified on the rectifier 21. In the low power mode the DC-DC converter 22 is in a shutdown mode due to a low voltage in its input. The current source 23 operates when a low voltage is applied to it. The current source 23 consumes a constant low current. The transmitter performs the detection of the harmonics on 13.

Figure 3 shows the schematics of the receiver. Diode 31 and capacitor 32 performs half wave rectification. When the voltage in 33 is above a certain threshold (low voltage) the transistor 34 is open and fixed current flows on resistor 35. When the voltage in 33 is above a certain voltage, transistor 34 is closed since the current flows via the zener diode. The DC-DC converter is enabled when a high voltage is applied to it. This high voltage is high enough so that the DC-DC converter issues a fixed regulated voltage on 36 to the external load.

Figure 4 shows the schematics of the cross correlation detection circuit.

This technique is well known in the art and is used in many types of detectors.

The low value resistor in 41 is used as a current sense detector. The signal is inverted in 43.

The regular signal in 42 and the inverted signal in 43 are sequentially selected using the analog switch 44, according to a clock which equals to twice the clock used for the energy transfer. The detected signal is selected when the clock is in phase with signal 42. The result appears in 45. The detected signal is also selected with a clock which is in 90 degrees relatively to signal 42. The result appears on 46.

The even harmonics power level are calculated using the signals in 45 and 46.

Figure 5 and figure 6 shows the measured power levels of the even harmonics as a function of displacement in X axis and in Z axis respectively. The results have been normalized to the maximum value. Two identical planar coils were used. The planar coil internal diameter was 20mm and the external diameter of 80mm, with 15 turns.

The receiving coil was placed on top of the transmitting coil. As seen on figure 5 a lateral displacement of up to 20mm can be detected.

As seen of figure 6, up to 8 mm of height the receiver can still be detected.

Prior ART

1. Power Transmission of a Desk With a Cord-Free Power Supply

Koichi Hatanaka, Fumihiro Sato, Hidetoshi MatsukiShinki Kikuchi, Jun-ichi Murakami, Makoto Kawase, and Tadakuni Satoh

IEEE TRANSACTIONS ON MAGNETICS, VOL. 38, NO. 5, SEPTEMBER 2002

2. A large-area flexible wireless power transmission sheet using printed plastic MEMS switches and organic field-effect transistors

Tsuyoshi Sekitani¹, Makoto Takamiya², Yoshiaki Noguchi¹, Shintaro Nakano¹, Yusaku Kato¹, Kazuki Hizu¹, Hiroshi Kawaguchi³, Takayasu Sakurai³, and Takao Someya¹,

IEEE 2006.

Prior ART reference 1, describes a method of receiver detection based on a transmission of a 500Khz signal from the receiver to the transmitter. This requires that the receiver will be previously powered. Also the receiver coil diameter is about 3 times the transmitter coil diameter, and the number of transmitter coils is very high, and the overall required electronics on the transmitter coils is very high and complex. On the present invention the transmitter and receiver coil diameter is identical and therefore reduces the number of transmitting coil and the electronics associated to it.

Prior ART reference 2 describes a system manufactured using printed technology. The detection is based on a voltage increase on the transmitting coil resonant circuit when the receiving coil is in proximity. This technique may detect any coil, or any metallic body like a ring and will operate the system even if the receiver is not located on the transmitting surface. The detection criterion is not robust. On the present invention the detection of harmonics ensures that only a valid receiver will be detected.

What is claimed is:

1. Juxtaposition detector between a transmitter and a receiver in an inductive magnetic power transfer system between a surface and a receiver where the transmitting surface is made of multiple transmitting elements.
2. The system according to claim 1, wherein by activating the transmitting elements in an order and by performing a mathematical calculation, the receiver location on the transmitting surface can be detected.
3. The system according to claim 1, wherein the juxtaposition detection is achieved on the transmitting surface by means of measuring the impedance and the transmitting element and by searching the harmonics of the transmitting frequency detected on the surface due to the juxtaposition of the receiver.
4. The system according to claim 3, wherein the transmitting signal can contain multiple harmonics, and in this case, the detection will be performed by searching harmonics that have not been transmitted and have been created due to the juxtaposition of the receiver.
5. The transmission system according to all the above claims, wherein the surface is equipped with at least two sub-systems that allows transmission in different power levels, and the receiver is also equipped by at least two sub-systems that allows detection in a very wide range of power levels.