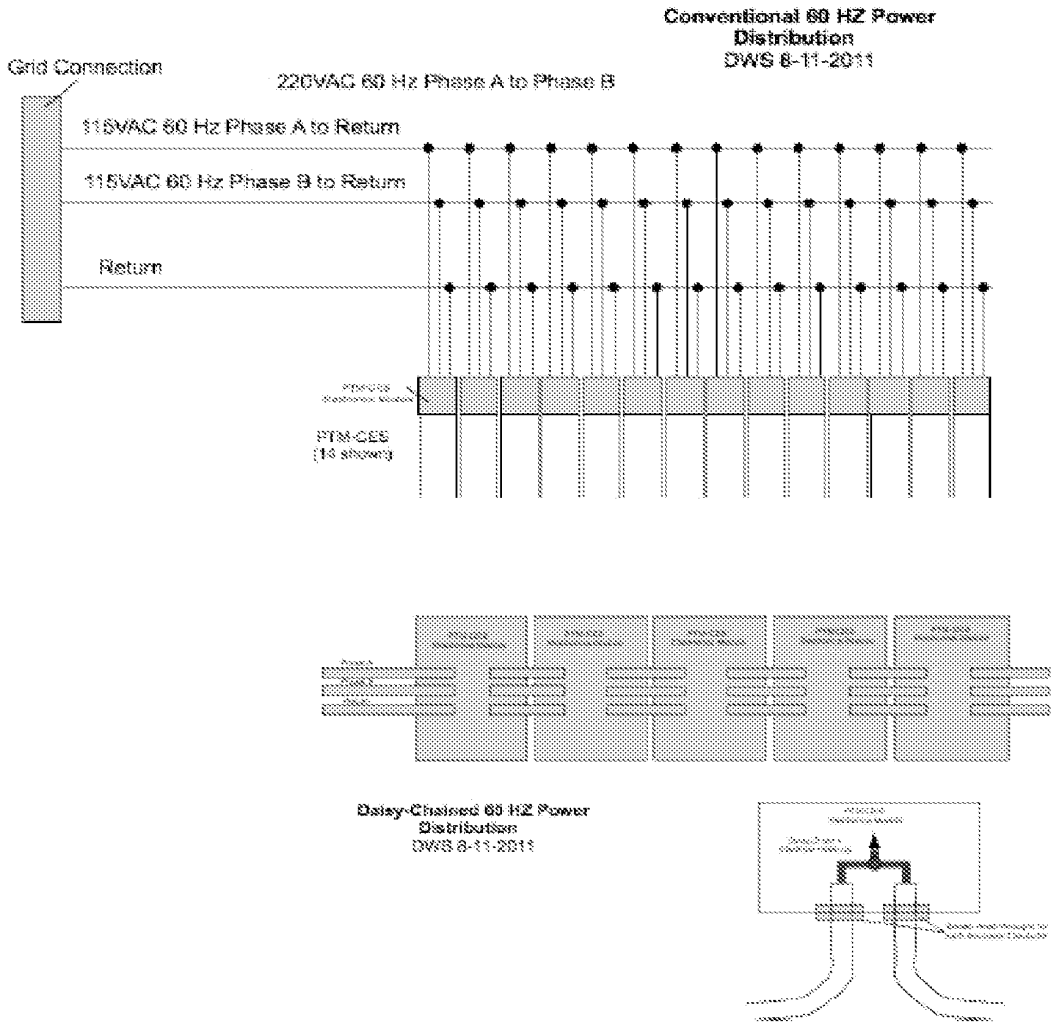

Conventional 60 HZ Power Distribution
DWS 8-11-2011
Grid Connection
220VAC 60 Hz Phase A to Phase B
115VAC 60 Hz Phase A to Return
115VAC 60 Hz Phase B to Return
Return
PTM-CES
Daisy-Chained 60 HZ Power Distribution
DWS 8-11-2011

FIGURE 15

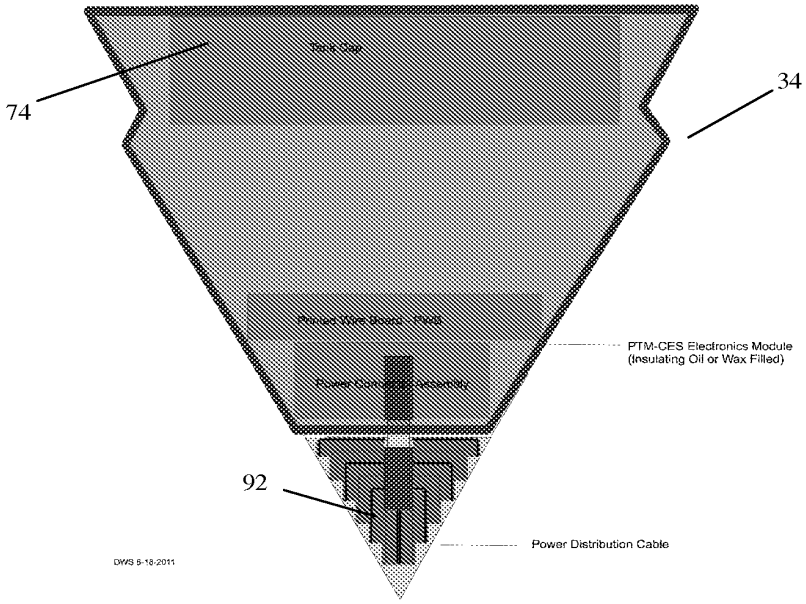


FIGURE 16

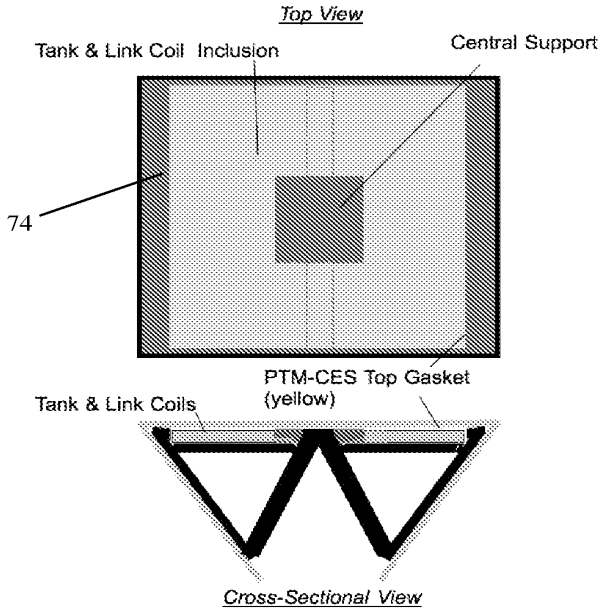


FIGURE 17

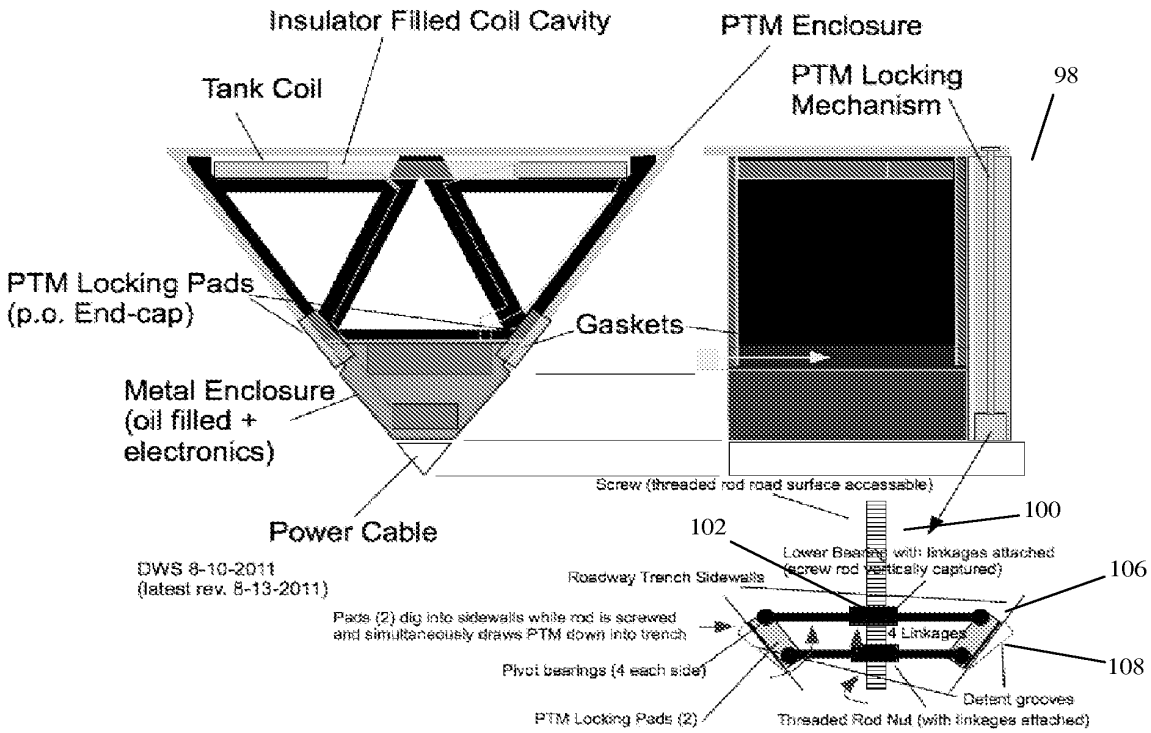


FIGURE 18

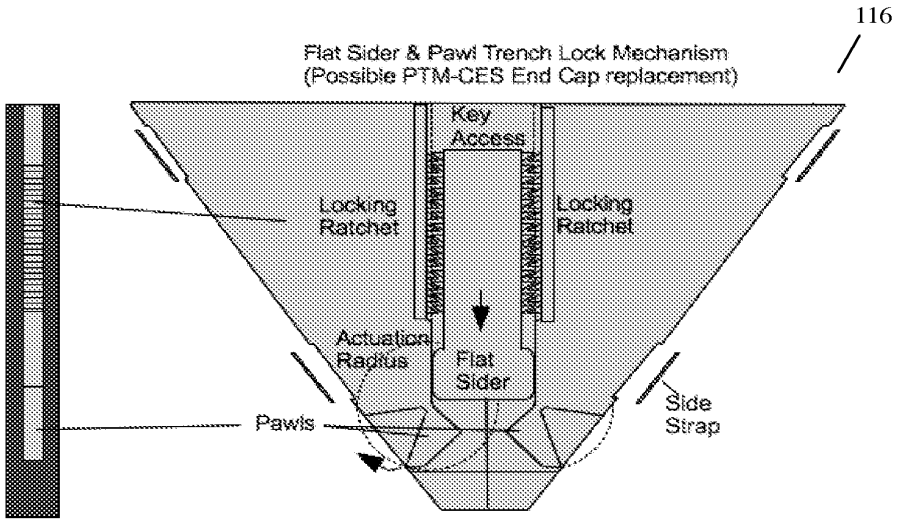


FIGURE 19

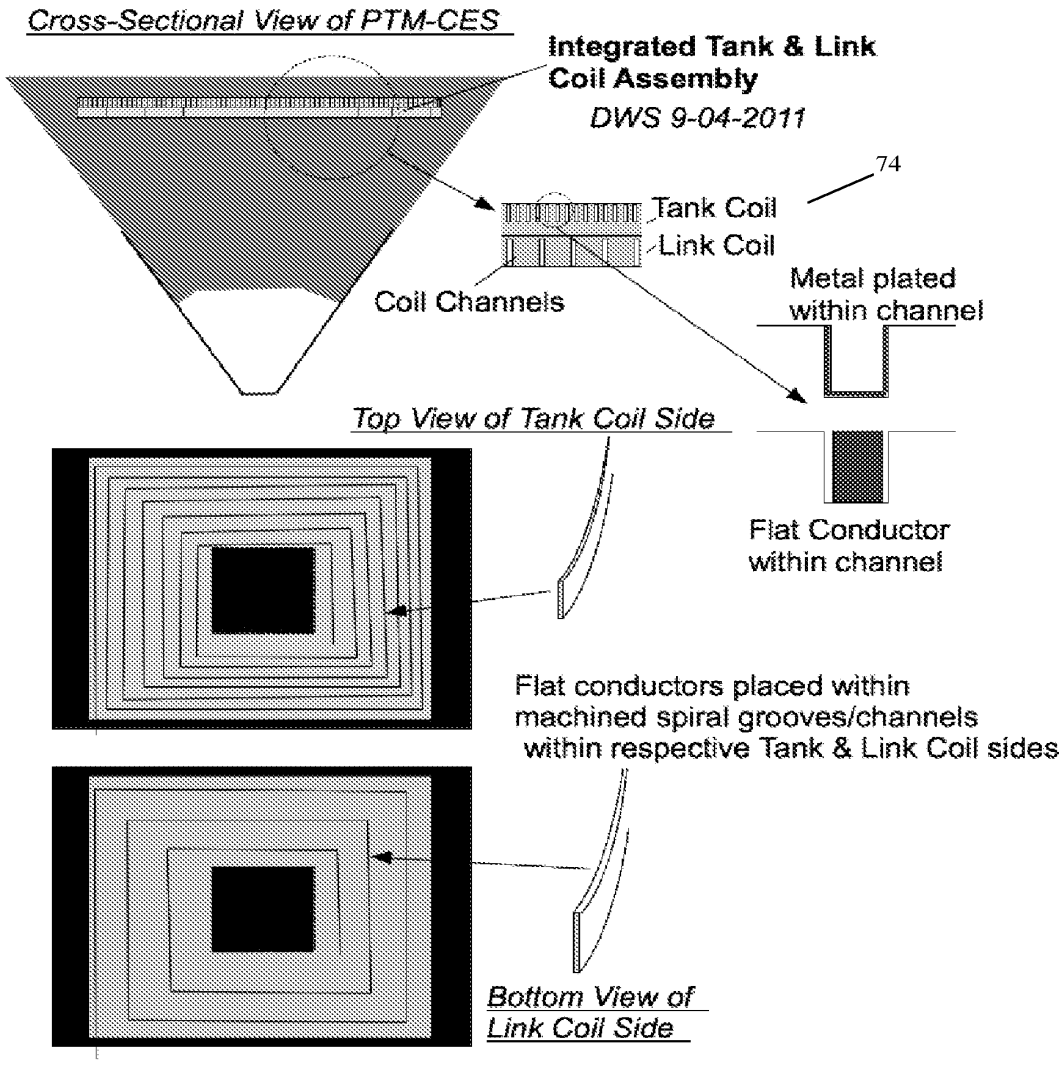

Cross-Sectional View of PTM-CES
Integrated Tank & Link Coil Assembly
DWS 9-04-2011
74
Tank Coil
Link Coil
Coil Channels
Metal plated within channel
Top View of Tank Coil Side
Flat Conductor within channel
Flat conductors placed within machined spiral grooves/channels within respective Tank & Link Coil sides
Bottom View of Link Coil Side

FIGURE 20

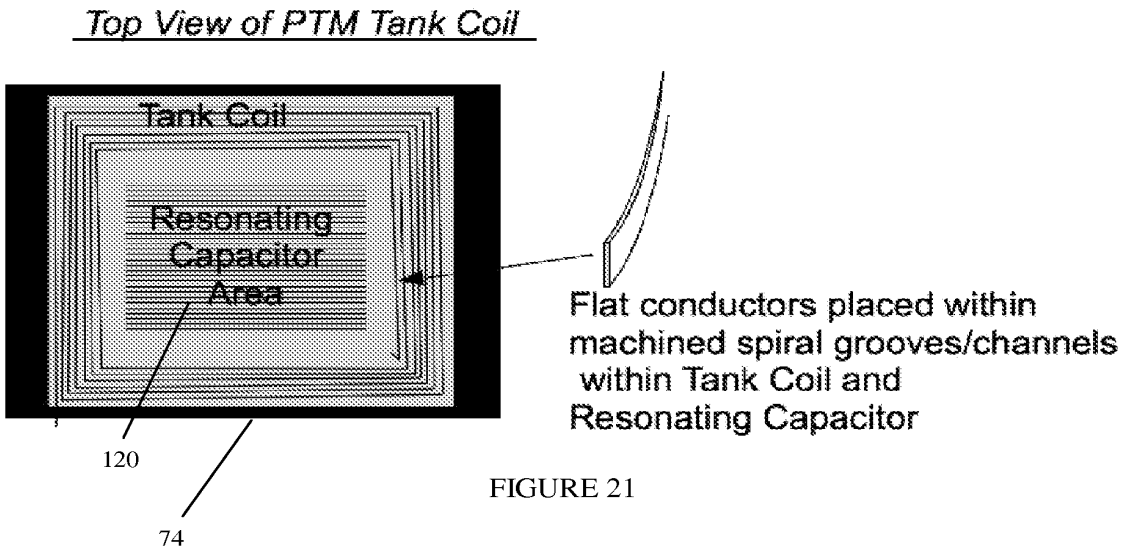


FIGURE 21

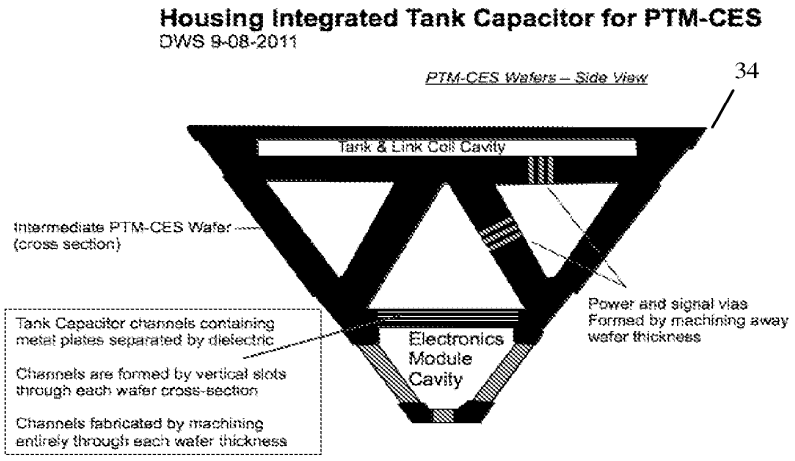
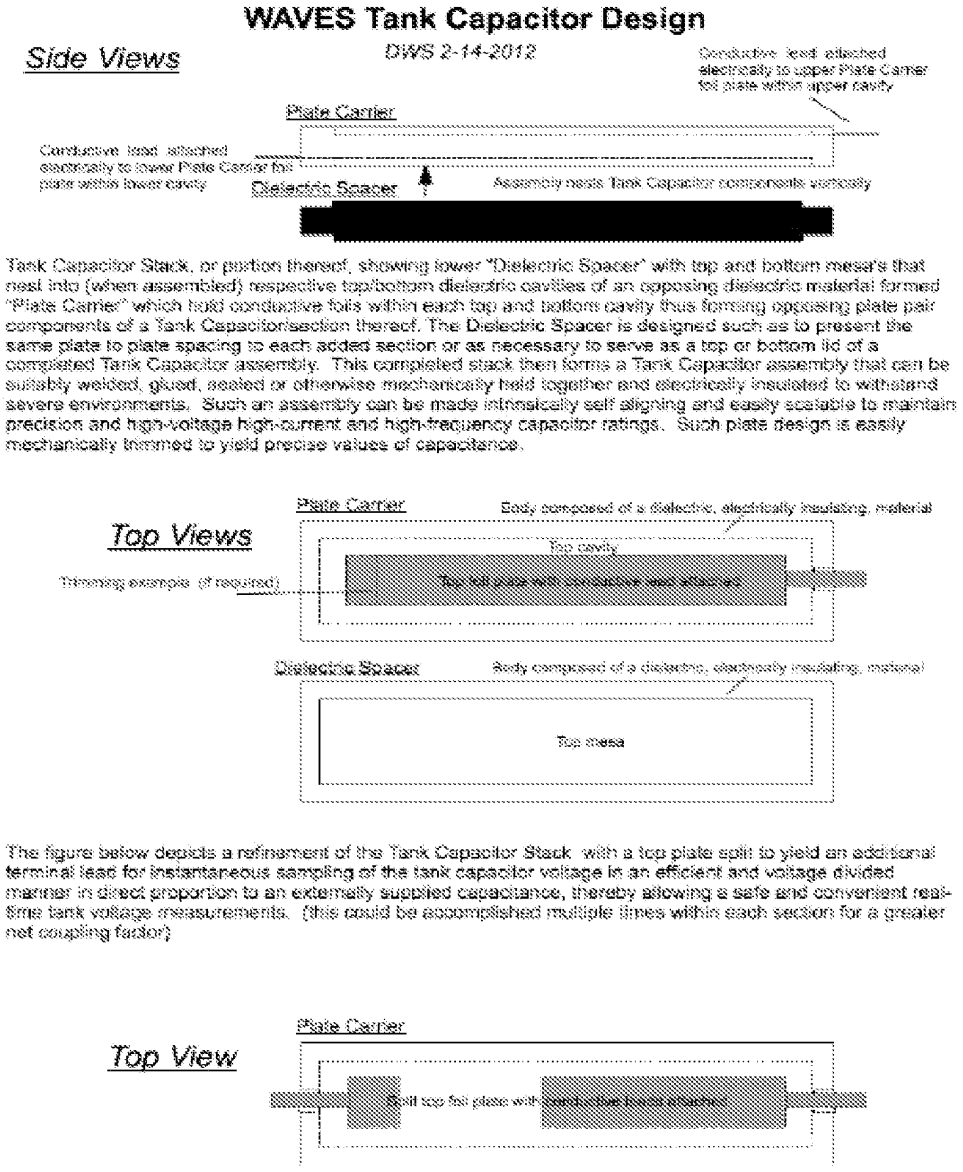


FIGURE 22



Tank Capacitor Stack, or portion thereof, showing lower "Dielectric Spacer" with top and bottom mesa's that nest into (when assembled) respective top/bottom dielectric cavities of an opposing dielectric material formed "Plate Carrier" which hold conductive foils within each top and bottom cavity thus forming opposing plate pair components of a Tank Capacitor/section thereof. The Dielectric Spacer is designed such as to present the same plate to plate spacing to each added section or as necessary to serve as a top or bottom lid of a completed Tank Capacitor assembly. This completed stack then forms a Tank Capacitor assembly that can be suitably welded, glued, sealed or otherwise mechanically held together and electrically insulated to withstand severe environments. Such an assembly can be made intrinsically self aligning and easily scalable to maintain precision and high-voltage high-current and high-frequency capacitor ratings. Such plate design is easily mechanically trimmed to yield precise values of capacitance.

The figure below depicts a refinement of the Tank Capacitor Stack with a top plate split to yield an additional terminal lead for instantaneous sampling of the tank capacitor voltage in an efficient and voltage divided manner in direct proportion to an externally supplied capacitance, thereby allowing a safe and convenient real-time tank voltage measurements. (this could be accomplished multiple times within each section for a greater net coupling factor)

FIGURE 23

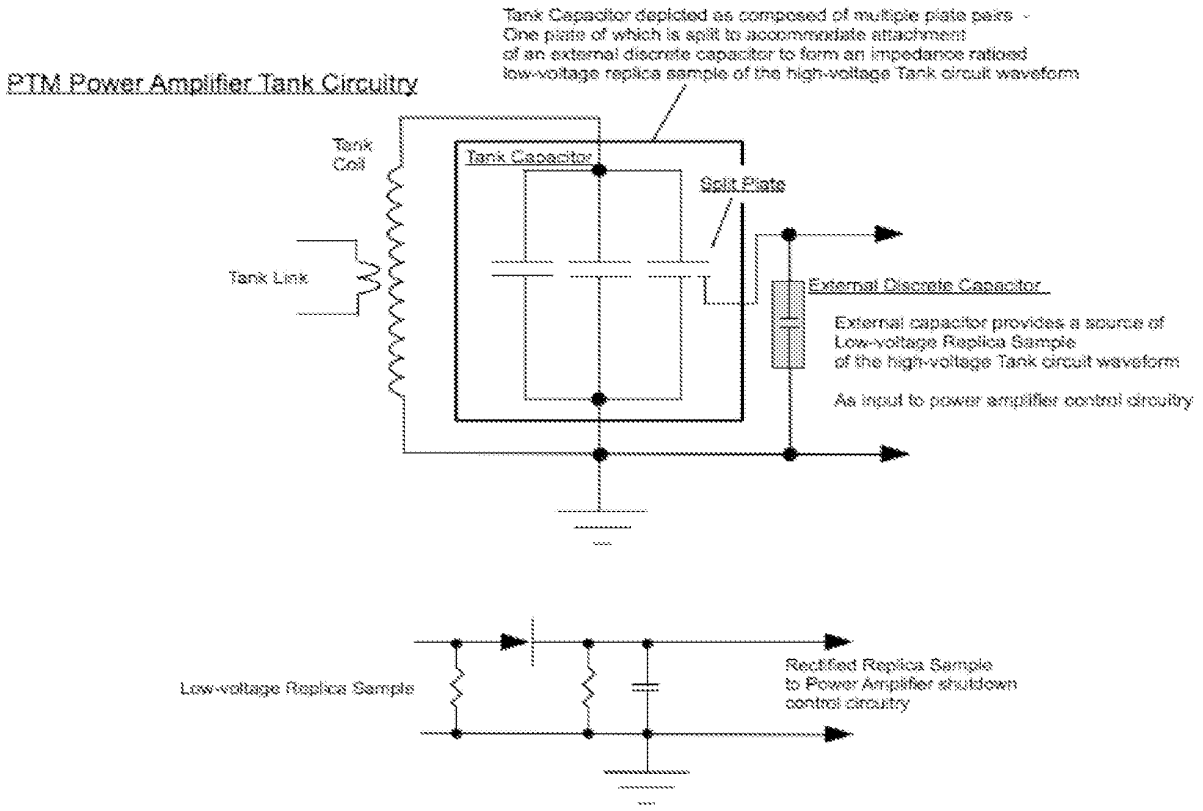

PTM Power Amplifier Tank Circuitry
Tank Capacitor depicted as composed of multiple plate pairs - One plate of which is split to accommodate attachment of an external discrete capacitor to form an impedance ratioed low-voltage replica sample of the high-voltage Tank circuit waveform
Tank Coil
Tank Capacitor
Split Plate
Tank Link
External Discrete Capacitor
External capacitor provides a source of Low-voltage Replica Sample of the high-voltage Tank circuit waveform
As input to power amplifier control circuitry
Low-voltage Replica Sample
Rectified Replica Sample to Power Amplifier shutdown control circuitry

FIGURE 24A

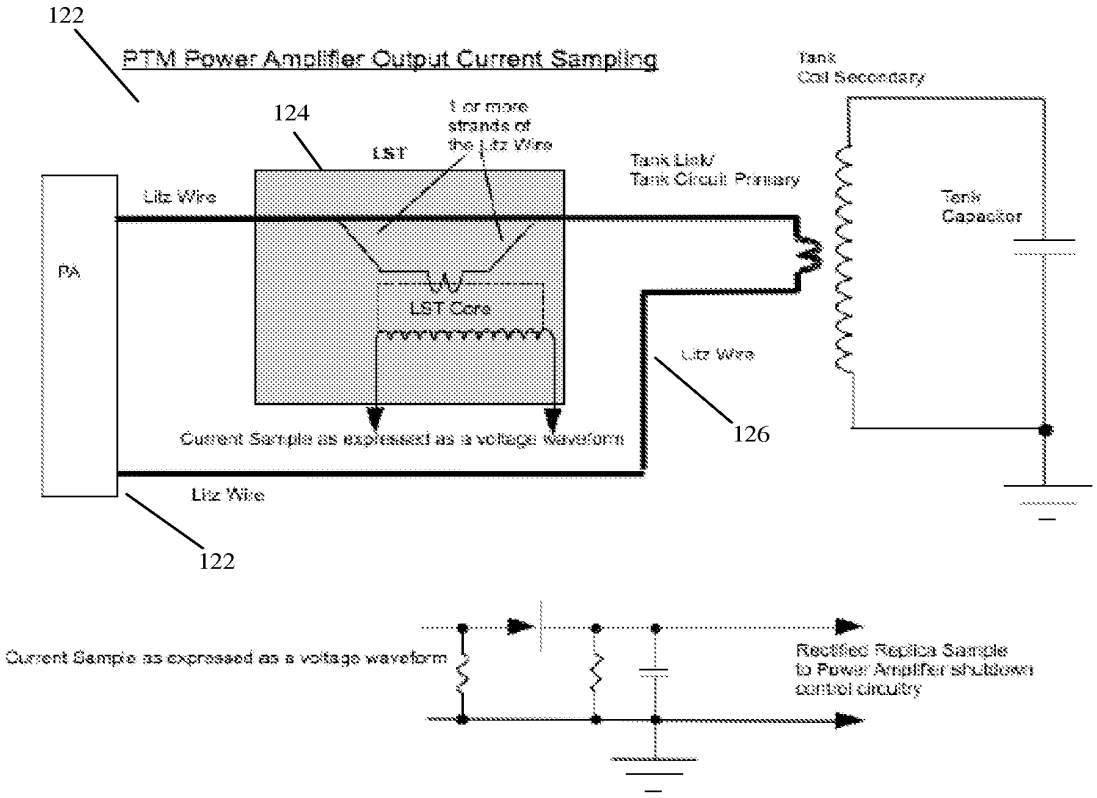

122
PTM Power Amplifier Output Current Sampling
124
1 or more strands of the Litz Wire
LST
Litz Wire
PA
LST Core
Tank Link/ Tank Circuit Primary
Tank Coil Secondary
Tank Capacitor
Litz Wire
126
Current Sample as expressed as a voltage waveform
Litz Wire
122
Current Sample as expressed as a voltage waveform
Rectified Replica Sample to Power Amplifier shutdown control circuitry

FIGURE 24B

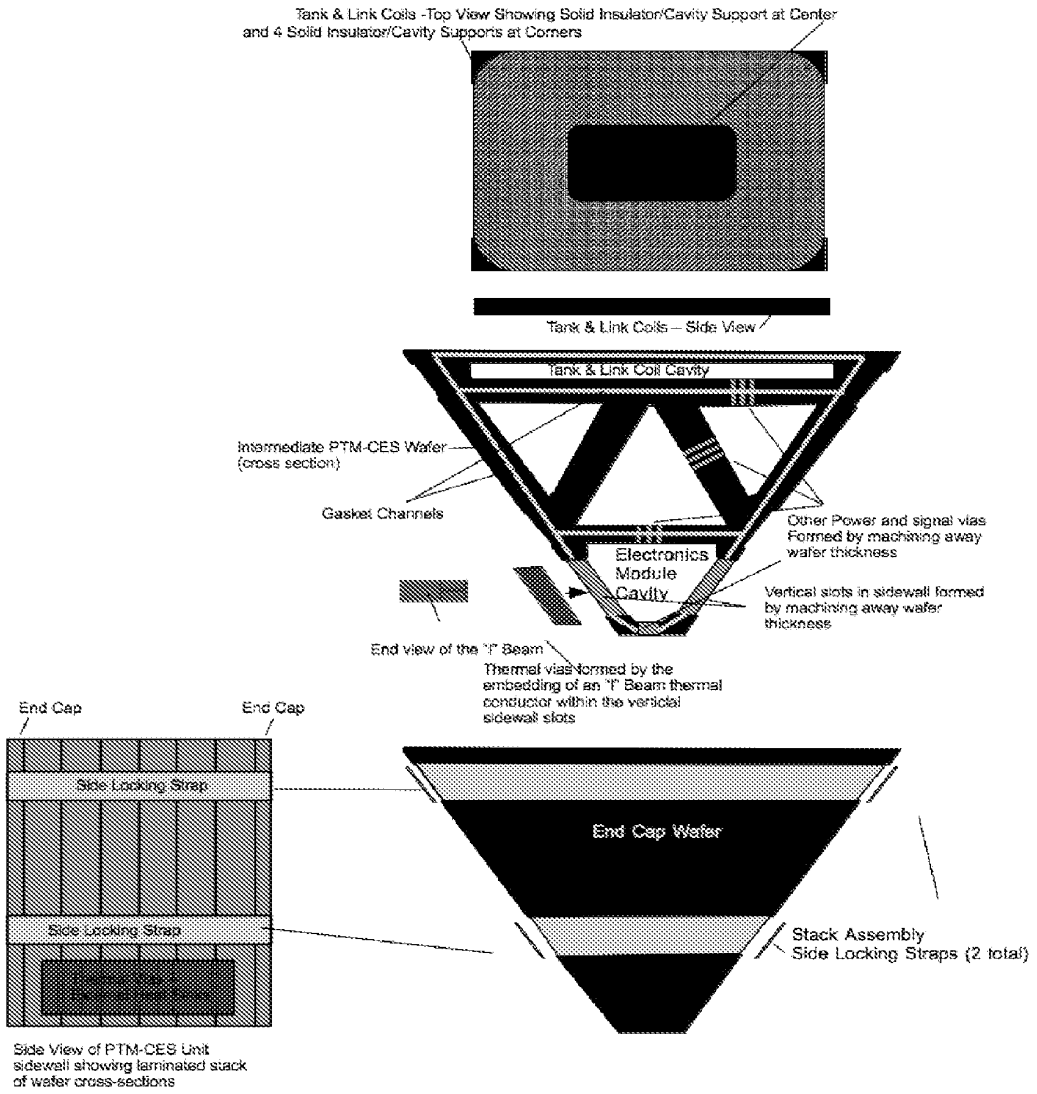

Laminant Construction for PTM-CES
DWS 9-02-2011 (latest rev. 9-03-2011)
Tank & Link Coils -Top View Showing Solid Insulator/Cavity Support at Center and 4 Solid Insulator/Cavity Supports at Corners
Tank & Link Coils – Side View
Tank & Link Coil Cavity
Intermediate PTM-CES Wafer (cross section)
Gasket Channels
Other Power and signal vias Formed by machining away wafer thickness
Electronics Module Cavity
Vertical slots in sidewall formed by machining away wafer thickness
End view of the "I" Beam
Thermal vias formed by the embedding of an "I" Beam thermal conductor within the vertical sidewall slots
End Cap
End Cap
Side Locking Strap
Side Locking Strap
End Cap Wafer
Stack Assembly
Side Locking Straps (2 total)
Side View of PTM-CES Unit sidewall showing laminated stack of wafer cross-sections

FIGURE 25

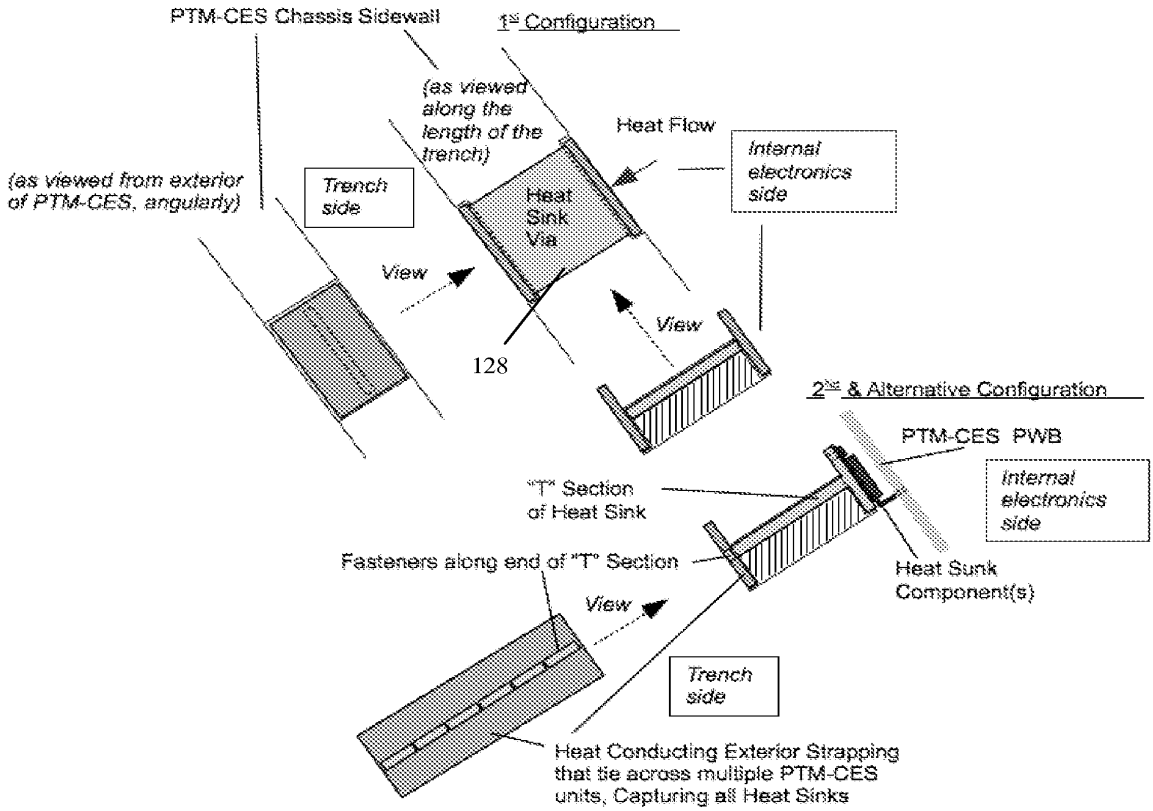

PTM-CES Chassis Sidewall
1st Configuration
(as viewed along the length of the trench)
Heat Flow
Internal electronics side
(as viewed from exterior of PTM-CES, angularly)
Trench side
Heat Sink Via
View
View
128
2nd & Alternative Configuration
PTM-CES PWB
"T" Section of Heat Sink
Internal electronics side
Fasteners along end of "T" Section
Heat Sunk Component(s)
View
Trench side
Heat Conducting Exterior Strapping that tie across multiple PTM-CES units, Capturing all Heat Sinks

FIGURE 26

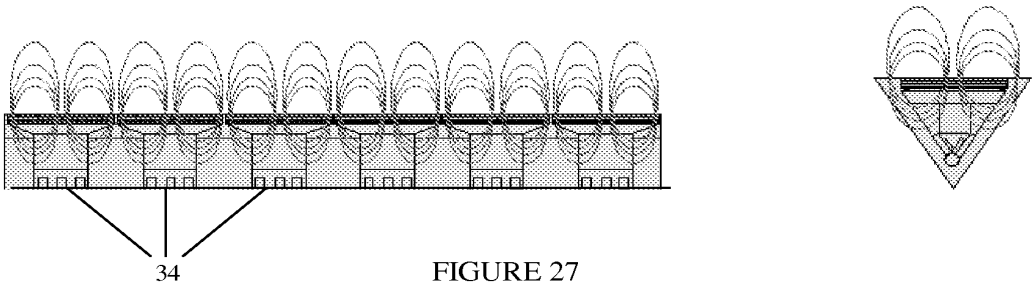


FIGURE 27

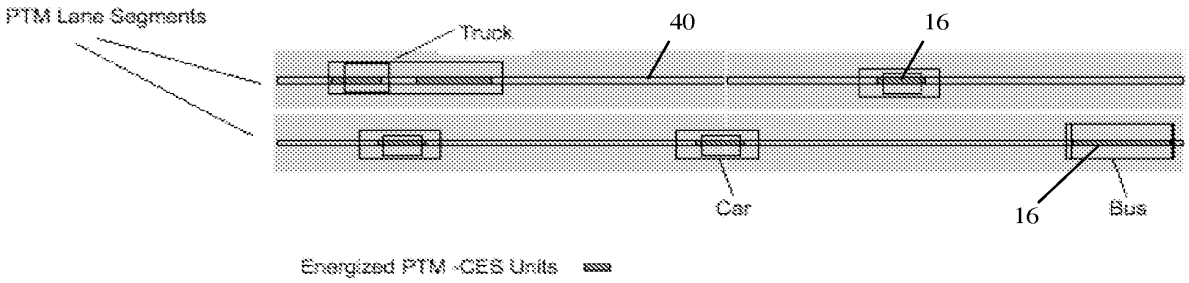


FIGURE 28

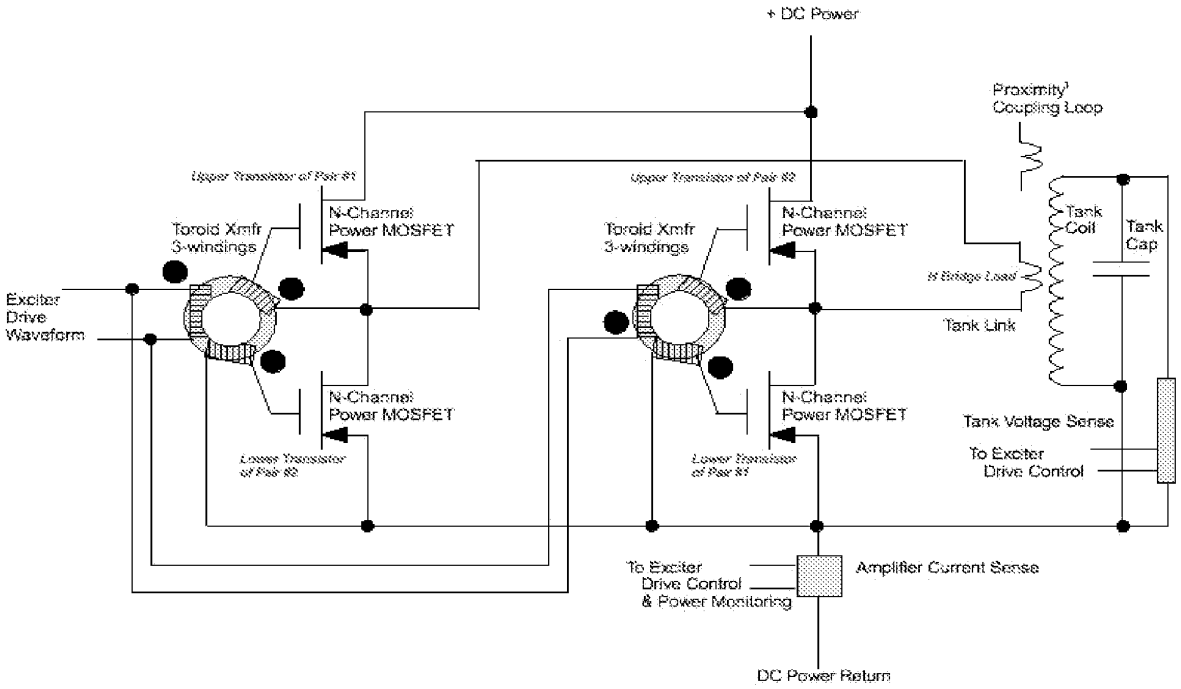


FIGURE 29

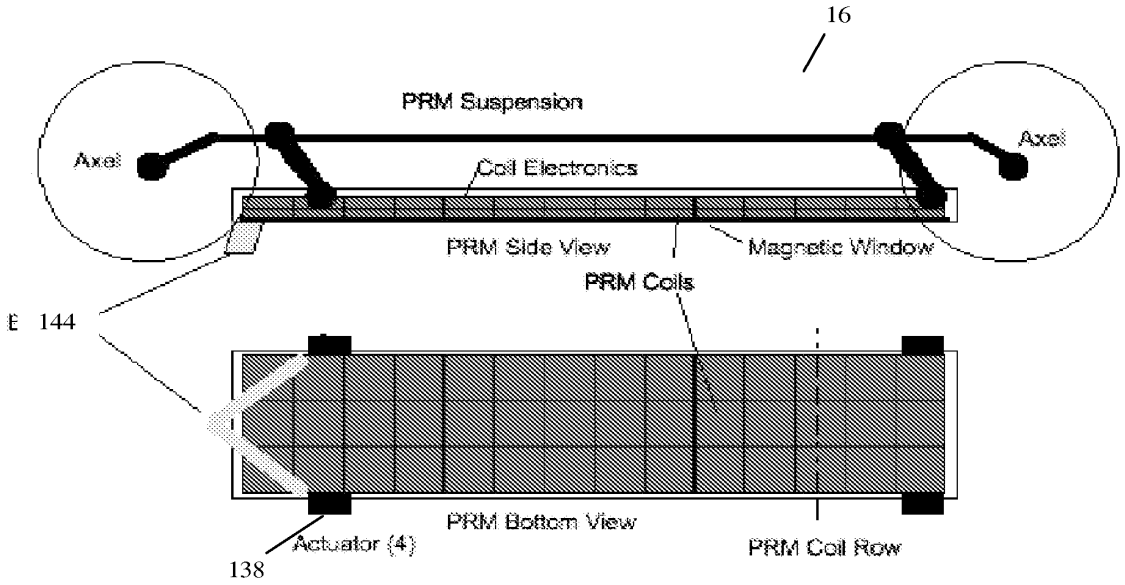


FIGURE 30

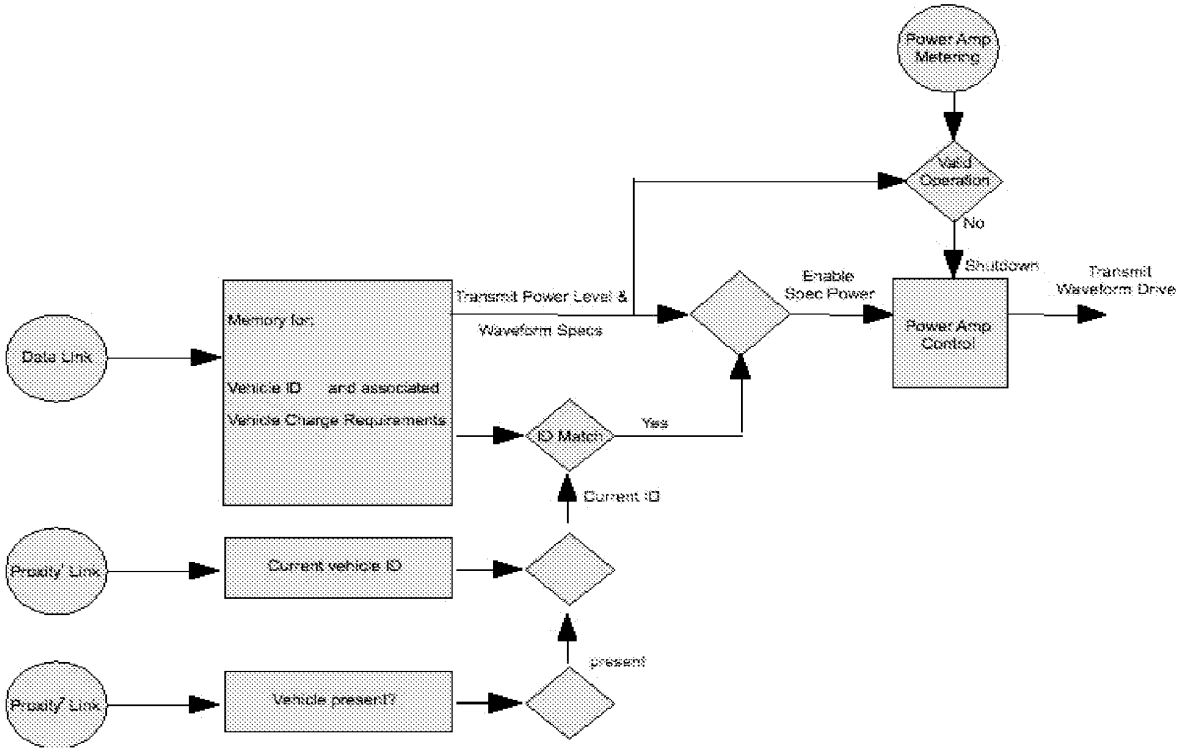

Power Amp Metering
Valid Operation
No
Shutdown
Transmit Waveform Drive
Enable Spec Power
Power Amp Control
Transmit Power Level & Waveform Specs
Data Link
Memory for:
Vehicle ID and associated
Vehicle Charge Requirements
ID Match
Yes
Current ID
Proxity Link
Current vehicle ID
present
Proxity Link
Vehicle present?

FIGURE 31

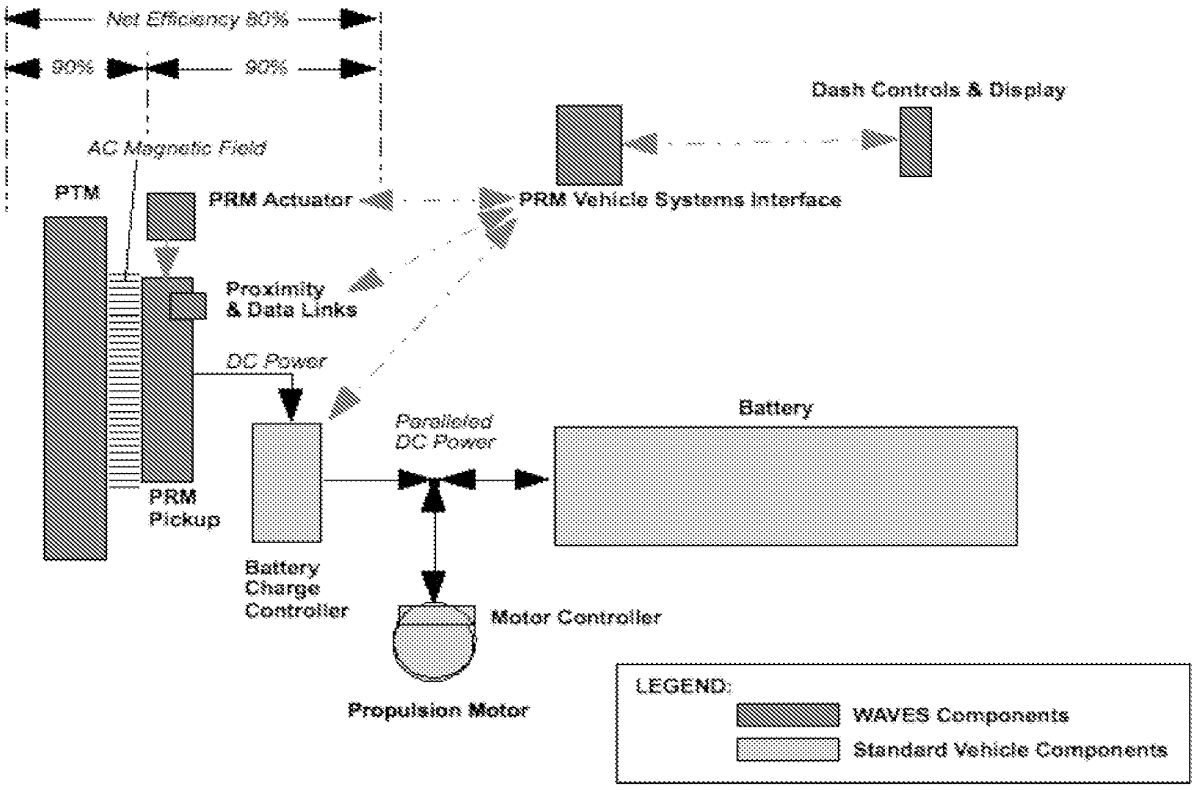

Net Efficiency 80%
90%
90%
AC Magnetic Field
PTM
PRM Actuator
Dash Controls & Display
PRM Vehicle Systems Interface
Proximity
& Data Links
DC Power
Paralleled
DC Power
Battery
PRM
Pickup
Battery
Charge
Controller
Motor Controller
Propulsion Motor
LEGEND:
WAVES Components
Standard Vehicle Components

FIGURE 32

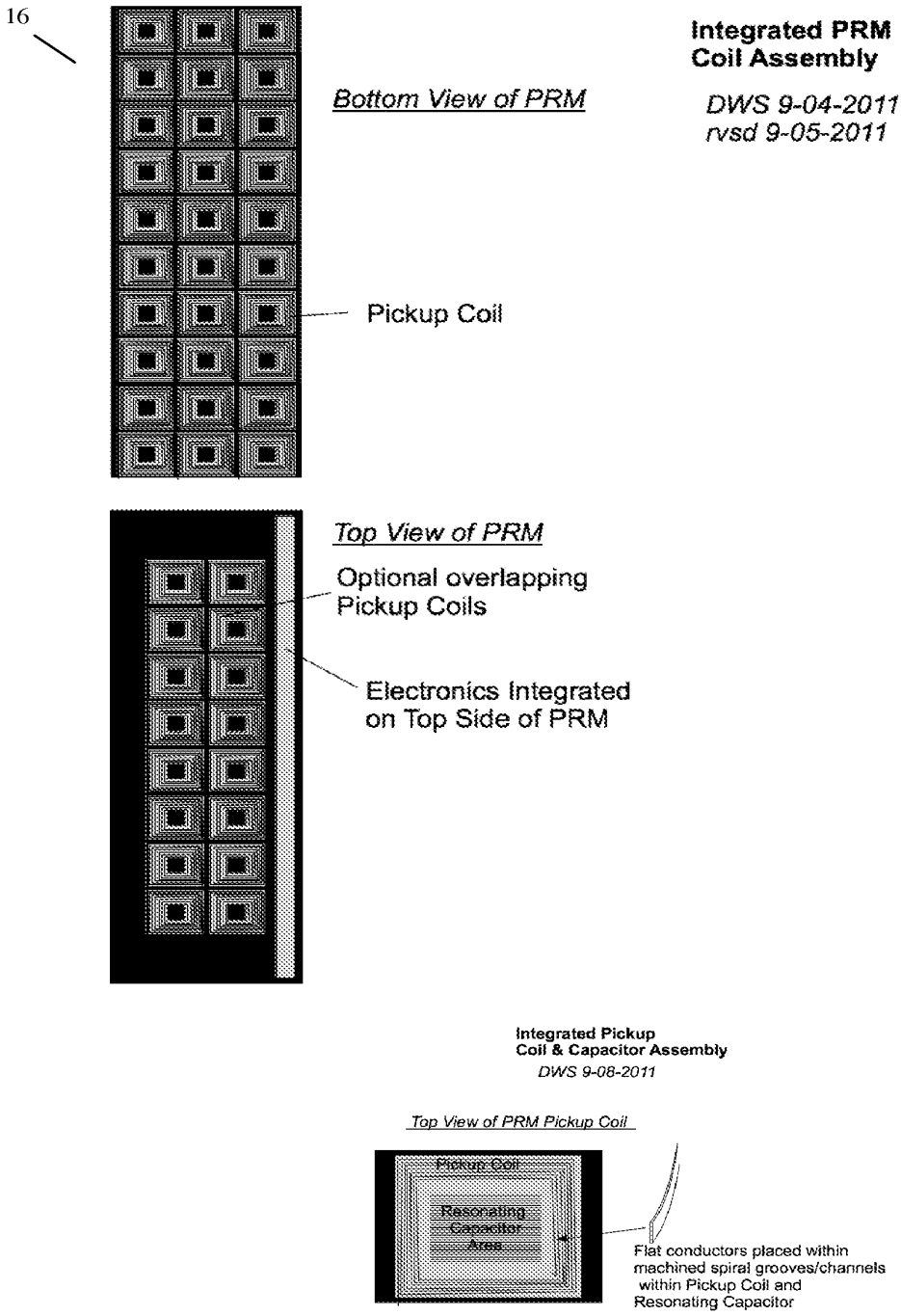

16
Integrated PRM
Coil Assembly
DWS 9-04-2011
rvsd 9-05-2011
Bottom View of PRM
Pickup Coil
Top View of PRM
Optional overlapping
Pickup Coils
Electronics Integrated
on Top Side of PRM
Integrated Pickup
Coil & Capacitor Assembly
DWS 9-08-2011
Top View of PRM Pickup Coil
Pickup Coil
Resonating
Capacitor
Area
Flat conductors placed within
machined spiral grooves/channels
within Pickup Coil and
Resonating Capacitor

FIGURE 33

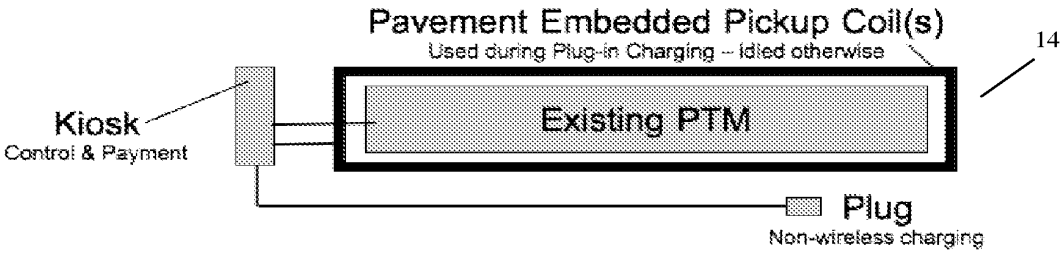


FIGURE 34

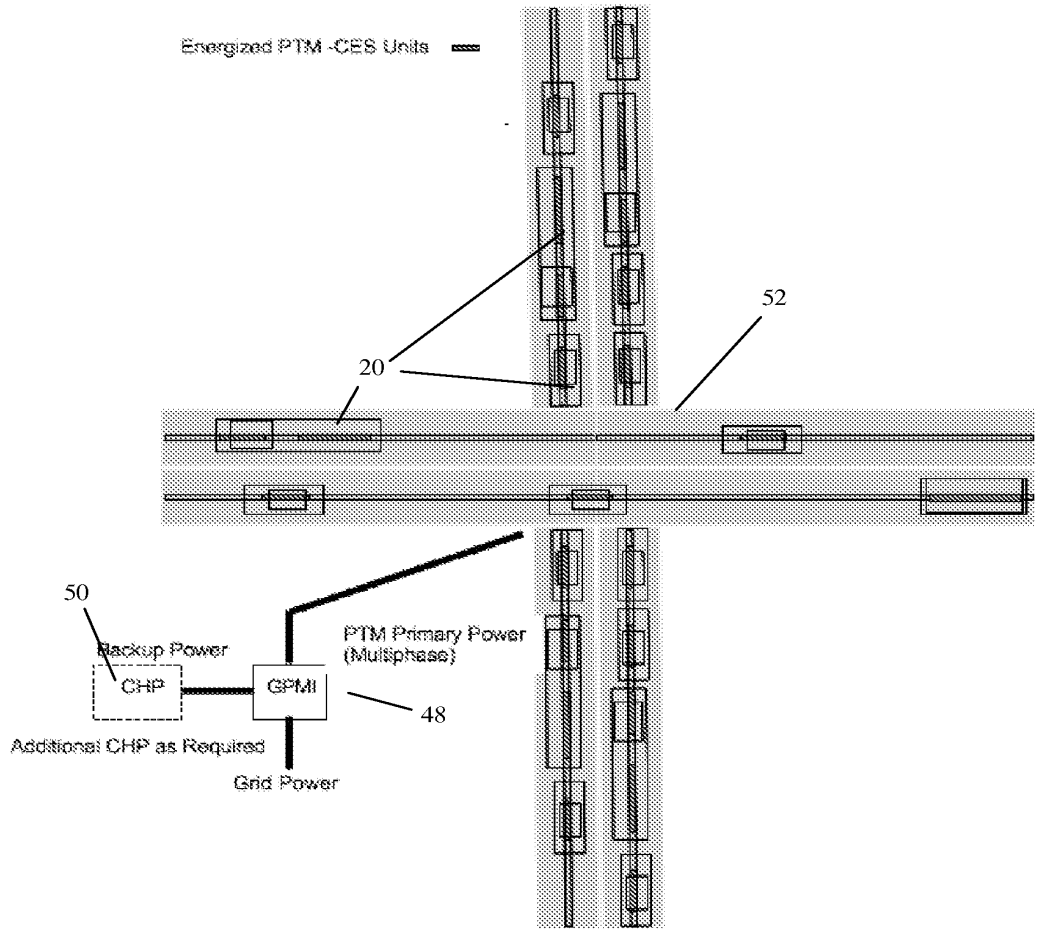


FIGURE 35

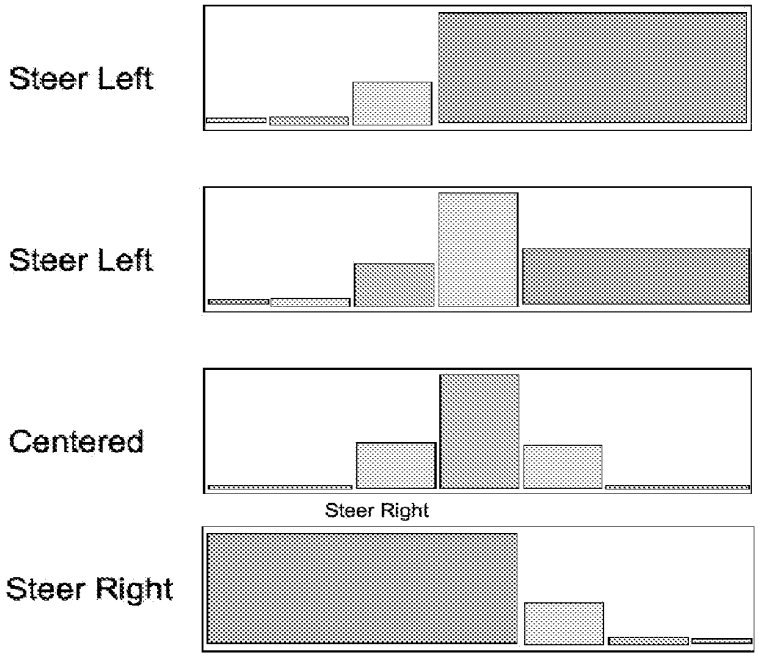


FIGURE 36

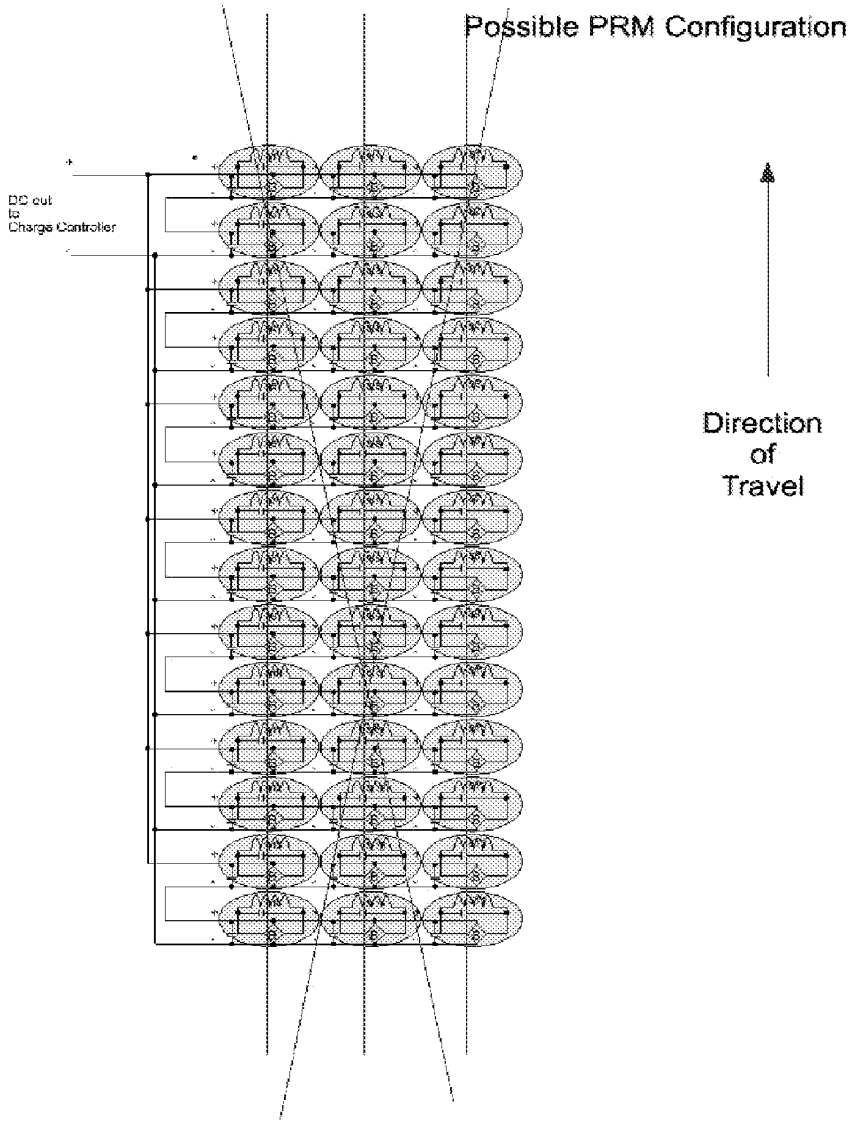

Possible PRM Configuration
DC out
to
Charge Controller
Direction
of
Travel

FIGURE 37

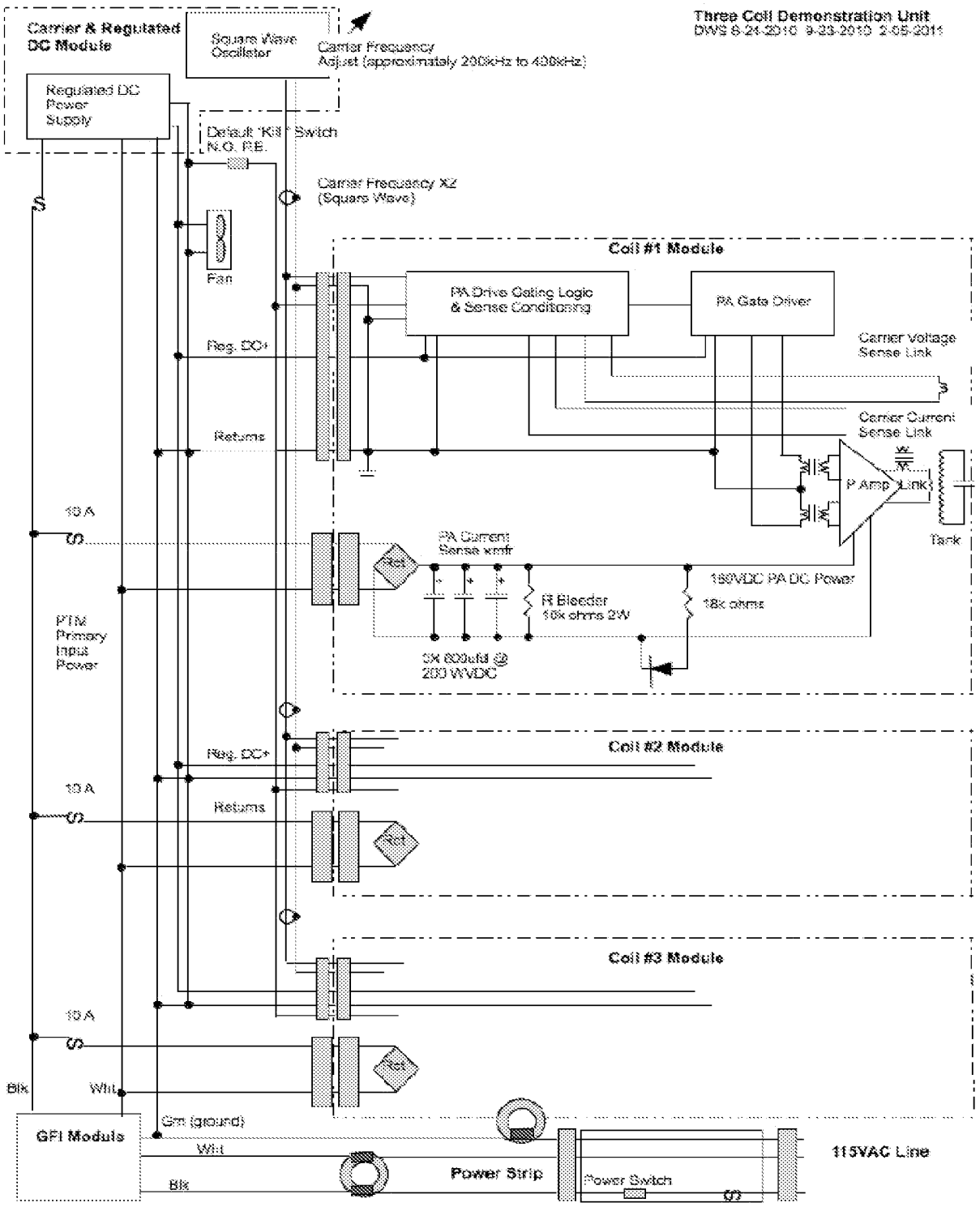

Three Coil Demonstration Unit
DWG 8-24-2010 9-23-2010 2-05-2011
Carrier & Regulated DC Module
Square Wave Oscillator
Carrier Frequency Adjust (approximately 200kHz to 400kHz)
Regulated DC Power Supply
Default "Kill" Switch N.O. P.B.
Carrier Frequency X2 (Square Wave)
Fan
Coil #1 Module
PA Drive Gating Logic & Sense Conditioning
PA Gate Driver
Reg. DC+
Carrier Voltage Sense Link
Returns
Carrier Current Sense Link
P Amp
Link
Tank
10 A
PA Current Sense xmfr
Rect
150VDC PA DC Power
R Bleeder 18k ohms 2W
18k ohms
PTM Primary Input Power
3X 820ufd @ 200 WVDC
Coil #2 Module
Reg. DC+
10 A
Returns
Rect
Coil #3 Module
10 A
Rect
Blk
Wht
Grn (ground)
GFI Module
Wht
Blk
Power Strip
Power Switch
115VAC Line

FIGURE 38

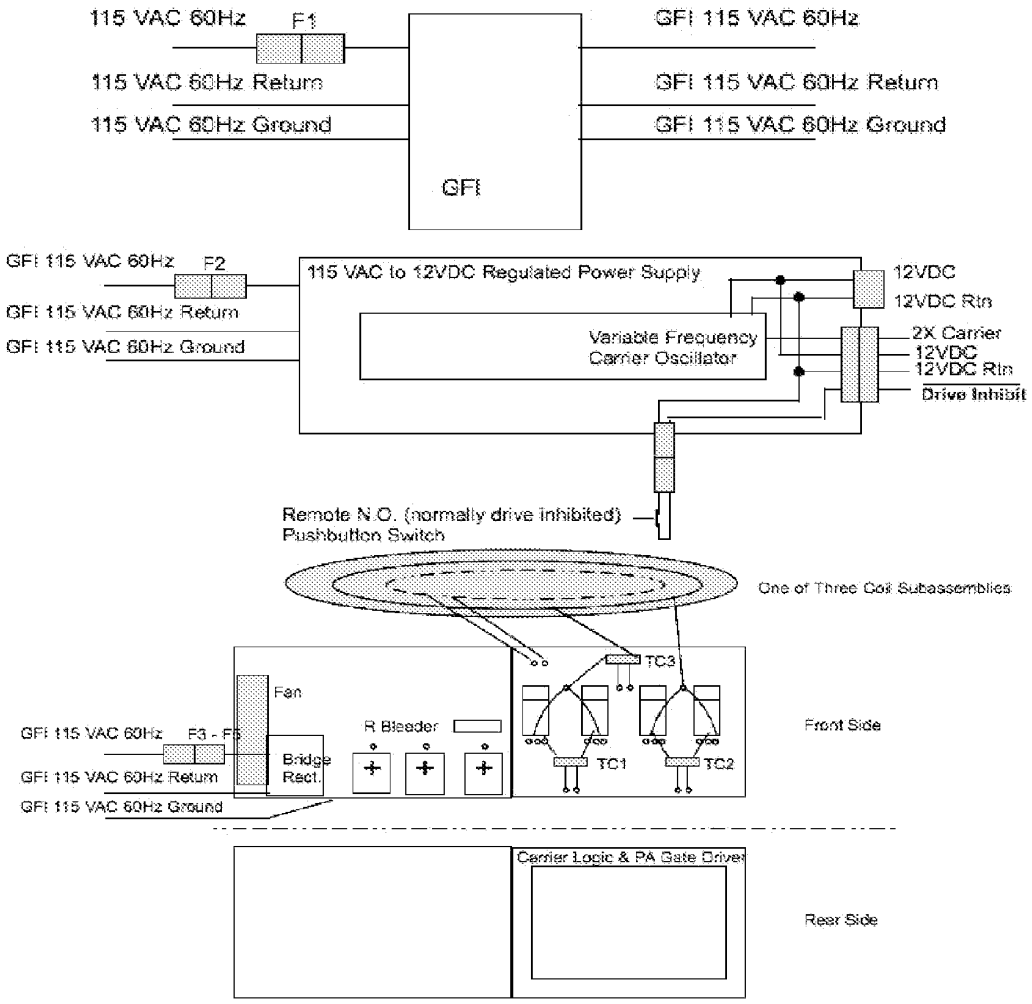

115 VAC 60Hz
F1
115 VAC 60Hz Return
115 VAC 60Hz Ground
GFI
GFI 115 VAC 60Hz
GFI 115 VAC 60Hz Return
GFI 115 VAC 60Hz Ground
GFI 115 VAC 60Hz
F2
GFI 115 VAC 60Hz Return
GFI 115 VAC 60Hz Ground
115 VAC to 12VDC Regulated Power Supply
Variable Frequency Carrier Oscillator
12VDC
12VDC Rtn
2X Carrier
12VDC
12VDC Rtn
Drive Inhibit
Remote N.O. (normally drive inhibited) Pushbutton Switch
One of Three Coil Subassemblies
TC3
Fan
R Bleeder
GFI 115 VAC 60Hz
F3 - F5
GFI 115 VAC 60Hz Return
GFI 115 VAC 60Hz Ground
Bridge Rect.
TC1
TC2
Front Side
Carrier Logic & PA Gate Driver
Rear Side

FIGURE 39

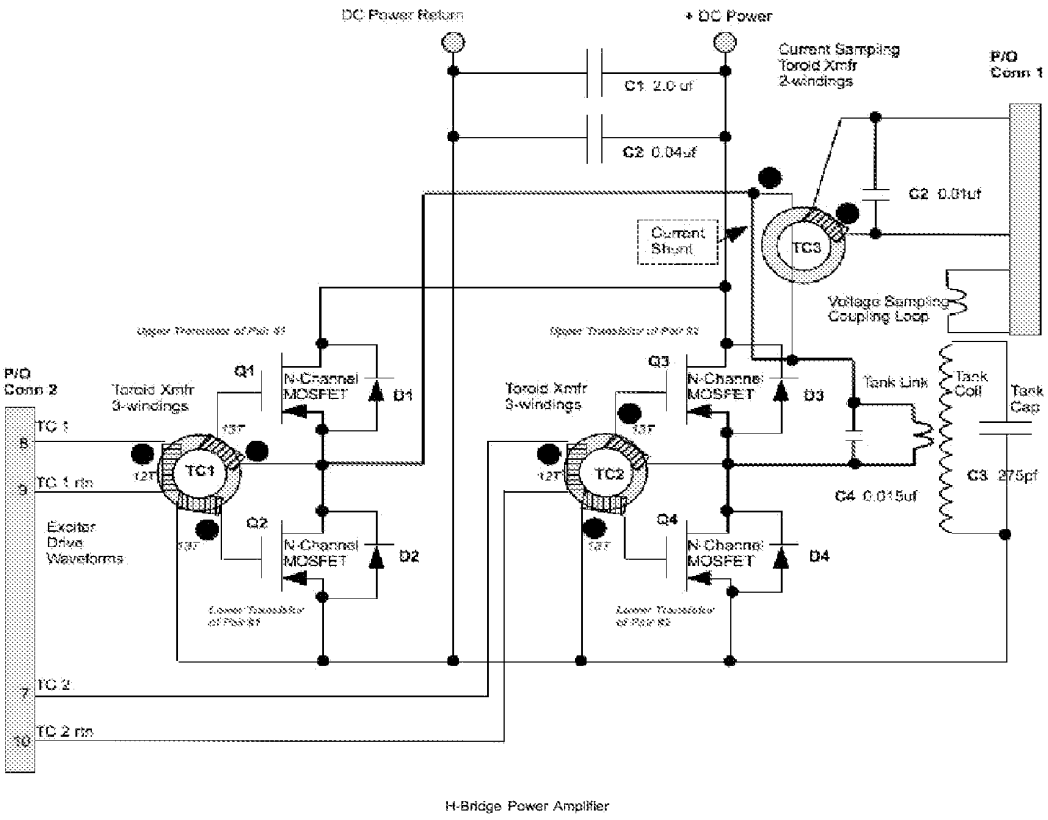

DC Power Return
+ DC Power
C1 2.0 uf
C2 0.04uf
Current Sampling Toroid Xmfr 2-windings
P/O Conn 1
C2 0.01uf
Current Shunt
TC3
Voltage Sampling Coupling Loop
P/O Conn 2
Toroid Xmfr 3-windings
Q1
N-Channel MOSFET
D1
TC 1
TC 1 rtn
TC1
12T
13T
Exciter Drive Waveforms
Q2
N-Channel MOSFET
D2
Toroid Xmfr 3-windings
Q3
N-Channel MOSFET
D3
Tank Link
Tank Coil
Tank Cap
TC2
C4 0.015uf
C3 275pf
Q4
N-Channel MOSFET
D4
TC 2
TC 2 rtn
H-Bridge Power Amplifier

FIGURE 40

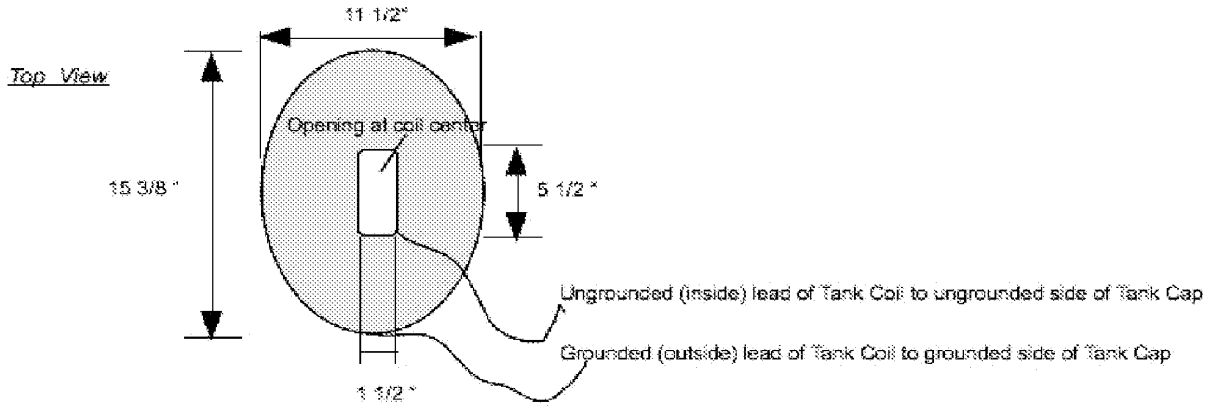

11 1/2"
Top View
Opening at coil center
15 3/8 "
5 1/2 "
Ungrounded (inside) lead of Tank Coil to ungrounded side of Tank Cap
Grounded (outside) lead of Tank Coil to grounded side of Tank Cap
1 1/2 "

FIGURE 41

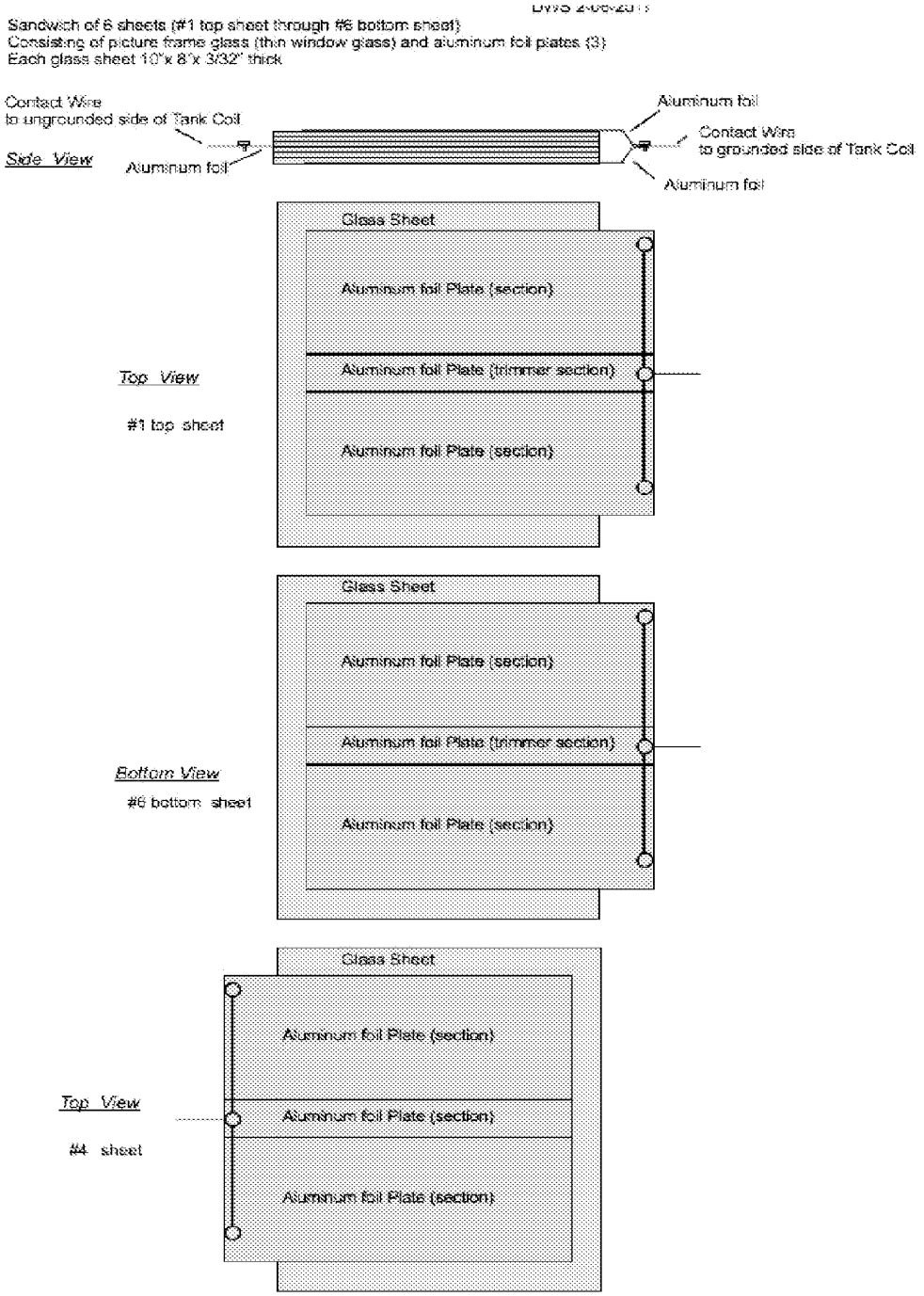

Sandwich of 6 sheets (#1 top sheet through #6 bottom sheet)
Consisting of picture frame glass (thin window glass) and aluminum foil plates (3)
Each glass sheet 10"x 8"x 3/32" thick
Contact Wire
to ungrounded side of Tank Coil
Side View
Aluminum foil
Aluminum foil
Contact Wire
to grounded side of Tank Coil
Aluminum foil
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (trimmer section)
Aluminum foil Plate (section)
Top View
#1 top sheet
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (trimmer section)
Aluminum foil Plate (section)
Bottom View
#6 bottom sheet
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (section)
Aluminum foil Plate (section)
Top View
#4 sheet

FIGURE 42

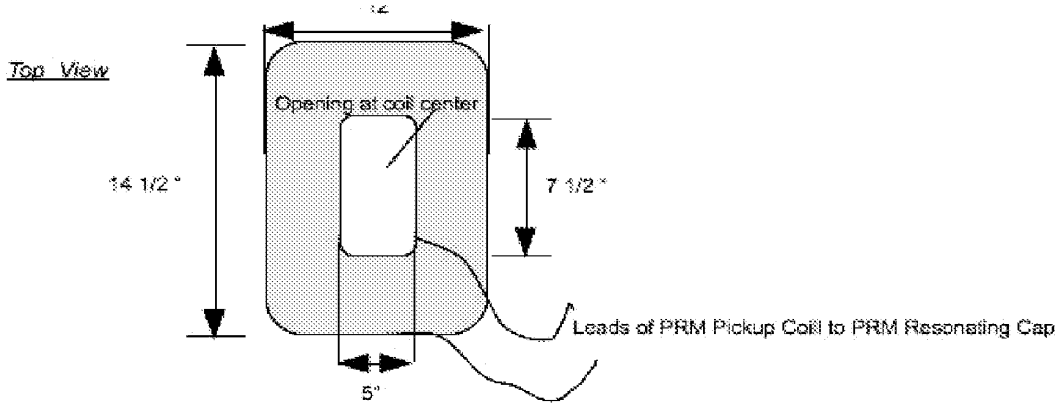

Top View
Opening at coil center
14 1/2 "
7 1/2 "
Leads of PRM Pickup Coil to PRM Resonating Cap
5"

FIGURE 43

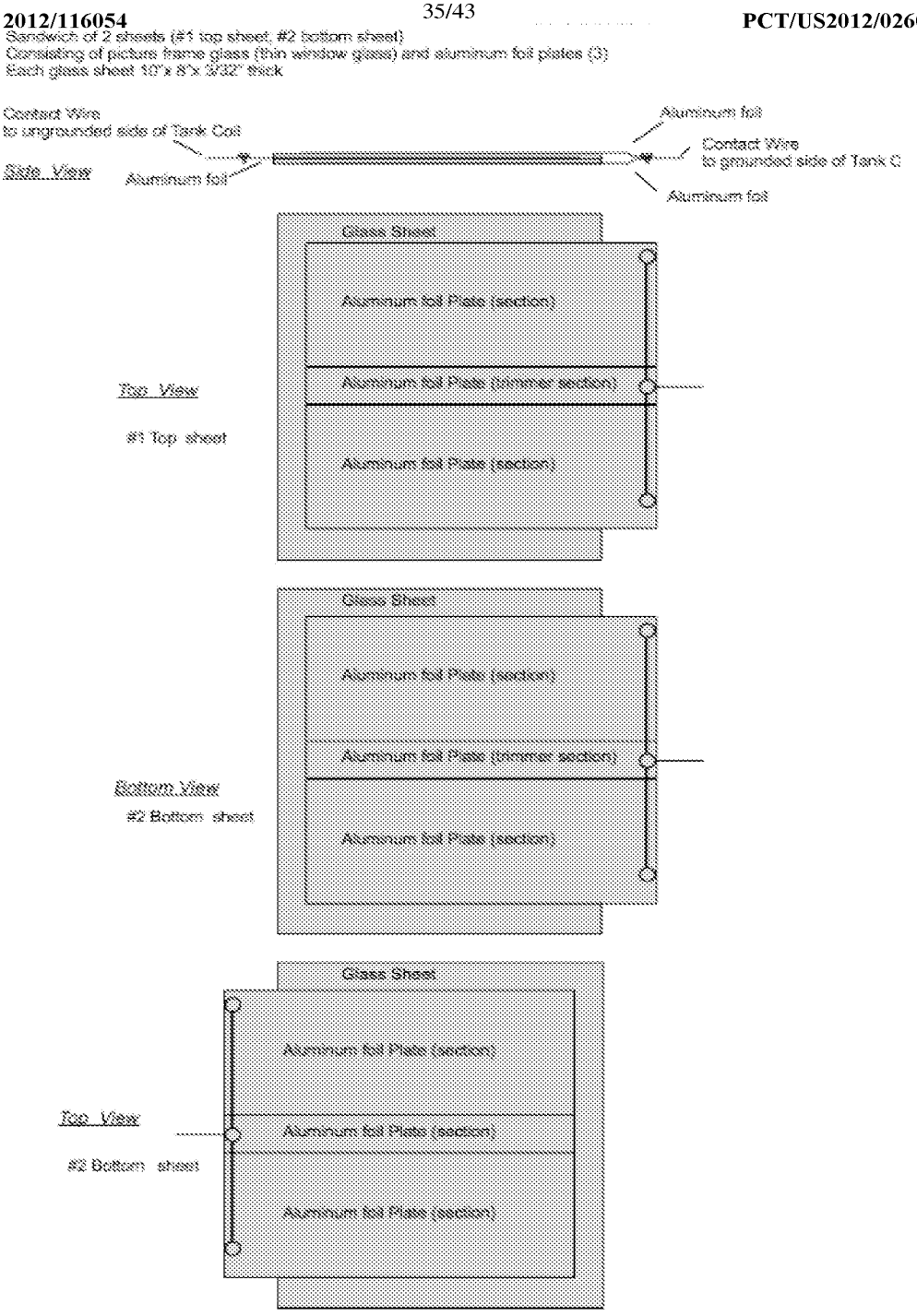

Sandwich of 2 sheets (#1 top sheet, #2 bottom sheet)
Consisting of picture frame glass (thin window glass) and aluminum foil plates (3)
Each glass sheet 10"x 8"x 3/32" thick
Contact Wire
to ungrounded side of Tank Coil
Side View
Aluminum foil
Aluminum foil
Contact Wire
to grounded side of Tank C
Aluminum foil
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (trimmer section)
Aluminum foil Plate (section)
Top View
#1 Top sheet
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (trimmer section)
Aluminum foil Plate (section)
Bottom View
#2 Bottom sheet
Glass Sheet
Aluminum foil Plate (section)
Aluminum foil Plate (section)
Aluminum foil Plate (section)
Top View
#2 Bottom sheet

FIGURE 44

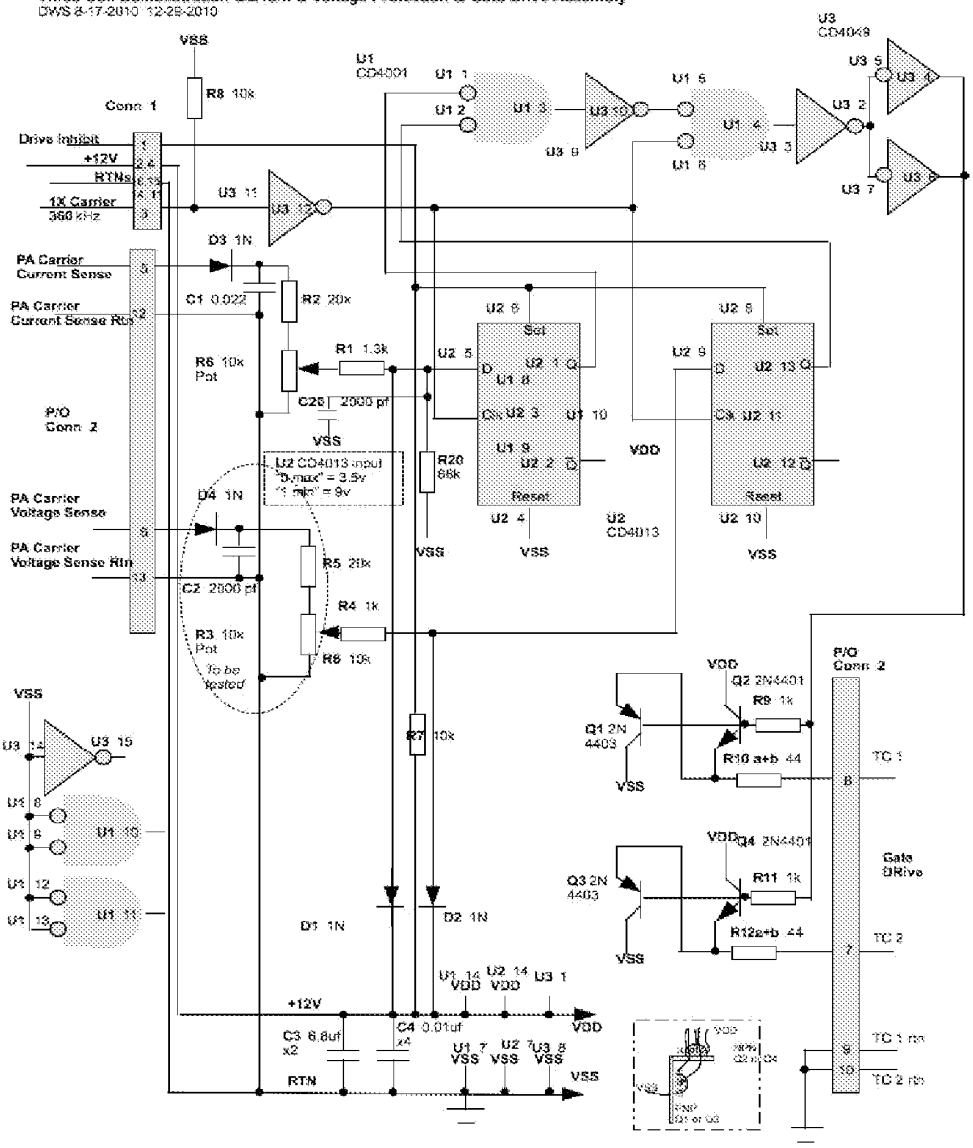

Three Coil Demonstration Current & Voltage Protection & Gate Drive Assembly
DWS 8-17-2010 12-28-2010
VSS
R8 10k
Conn 1
Drive Inhibit
+12V
RTNs
1X Carrier
360 kHz
U1
CD4001
U3
CD4049
U3 11
D3 1N
PA Carrier
Current Sense
PA Carrier
Current Sense Rtn
C1 0.022
R2 20k
R1 1.3k
R6 10k
Pot
C25 2000 pf
P/O
Conn 2
U2 CD4013 input
"0 max" = 3.5v
"1 min" = 9v
R20
66k
U2
CD4013
VDD
D4 1N
PA Carrier
Voltage Sense
PA Carrier
Voltage Sense Rtn
C2 2000 pf
R5 2k
R4 1k
R3 10k
Pot
To be
tested
R6 10k
R7 10k
D1 1N
D2 1N
+12V
C3 6.8uf
x2
C4 0.01uf
x4
RTN
VDD
Q2 2N4401
R9 1k
Q1 2N
4403
R10 a+b 44
TC 1
Q4 2N4401
R11 1k
Q3 2N
4403
R12a+b 44
TC 2
Gate
DRive
P/O
Conn 2
TC 1 rtn
TC 2 rtn

FIGURE 45

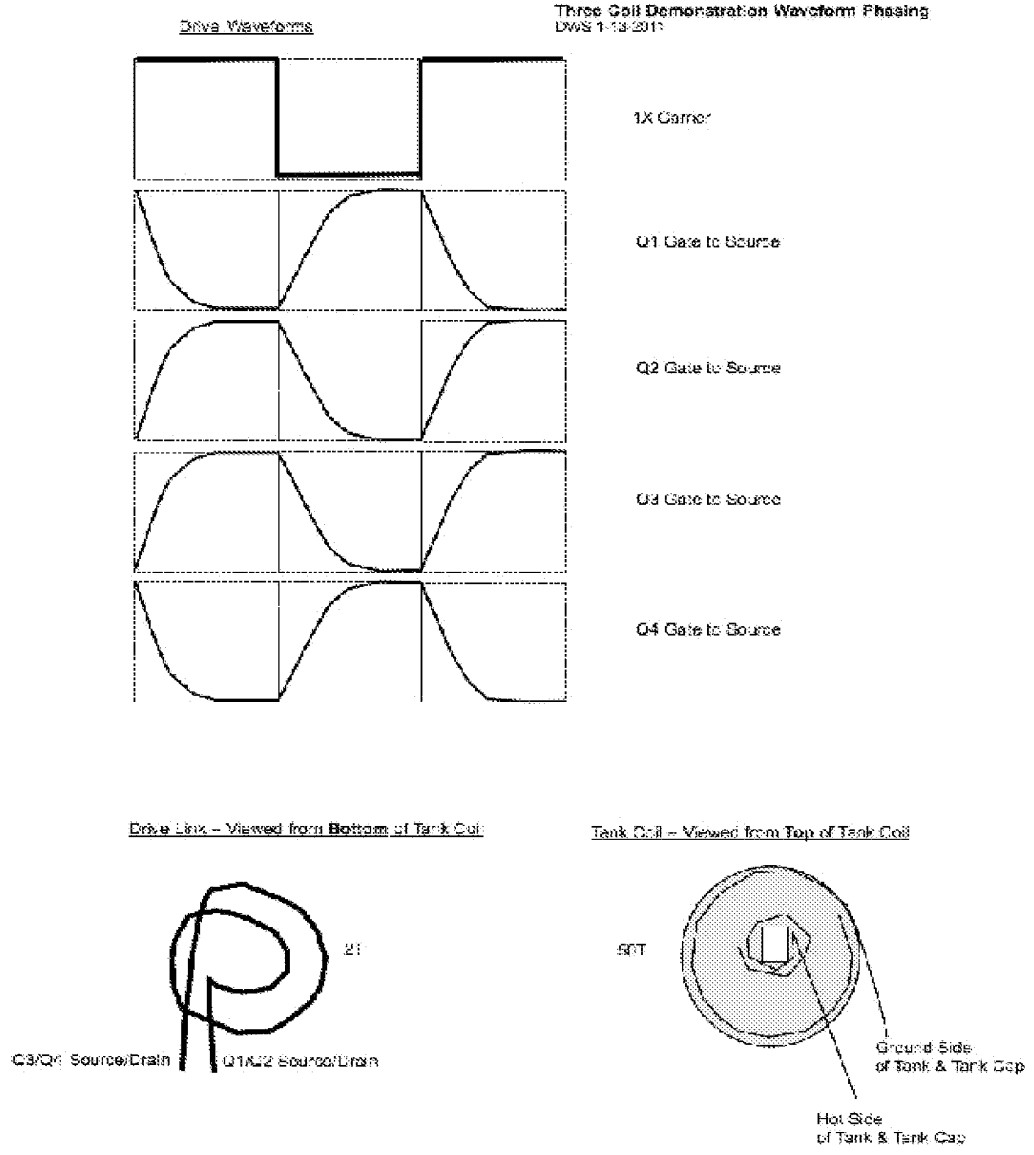

Drive Waveforms
Three Coil Demonstration Waveform Phasing
1X Carrier
Q1 Gate to Source
Q2 Gate to Source
Q3 Gate to Source
Q4 Gate to Source
Drive Link – Viewed from Bottom of Tank Coil
Q3/Q4 Source/Drain
Q1/Q2 Source/Drain
Tank Coil – Viewed from Top of Tank Coil
SMT
Ground Side of Tank & Tank Cap
Hot Side of Tank & Tank Cap

FIGURE 46

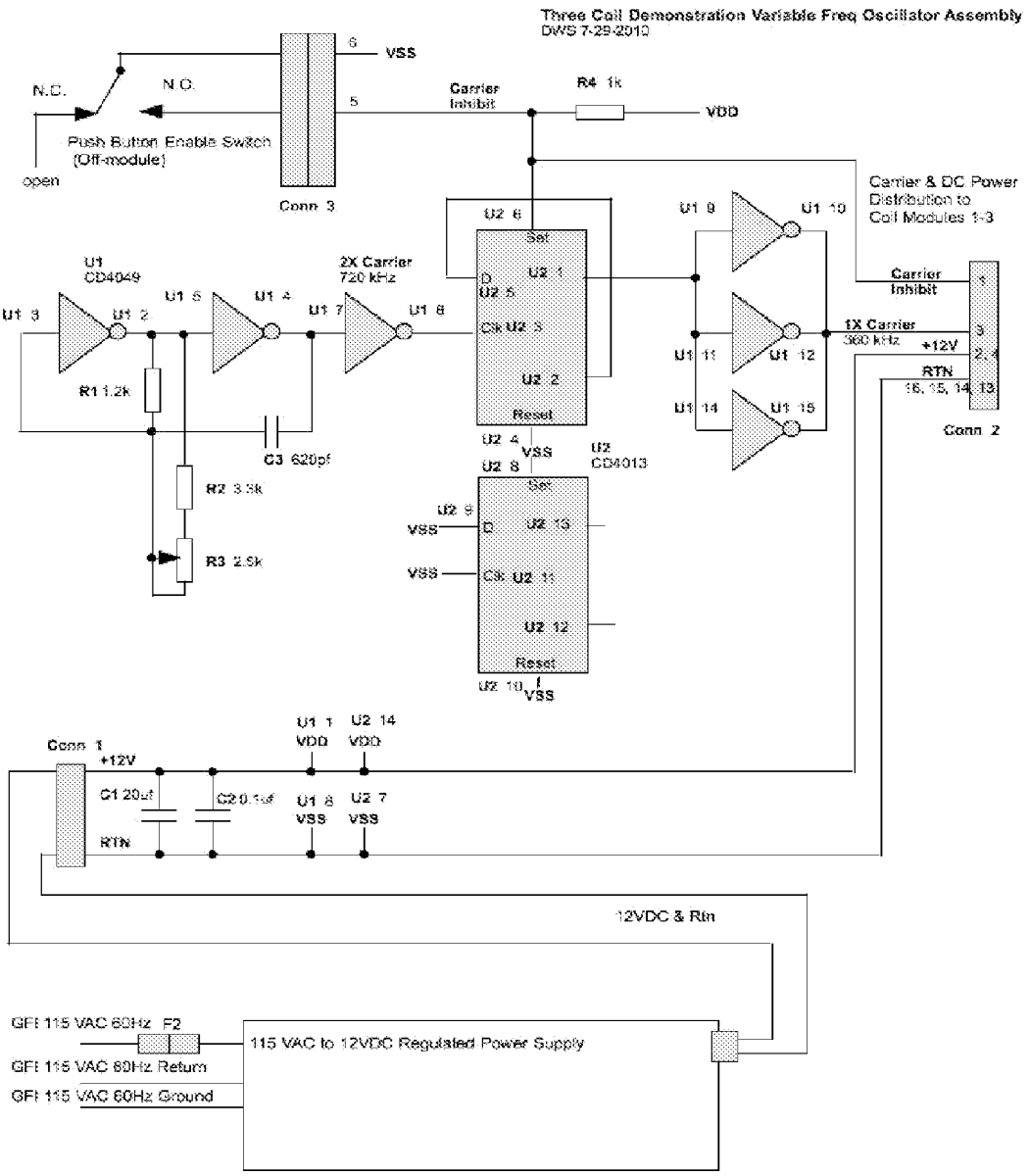

Three Coil Demonstration Variable Freq Oscillator Assembly
DWS 7-29-2010
N.C.
N.O.
Push Button Enable Switch
(Off-module)
open
Conn 3
6
VSS
5
Carrier
Inhibit
R4 1k
VDD
Carrier & DC Power
Distribution to
Coil Modules 1-3
U1
CD4049
U1 3
U1 2
U1 5
U1 4
U1 7
U1 6
2X Carrier
720 kHz
R1 1.2k
C3 620pf
R2 3.3k
R3 2.5k
U2 6
Set
U2 1
D
U2 5
Clk U2 3
U2 2
Reset
U2 4
VSS
U2
CD4013
U2 8
Set
U2 9
VSS
D
U2 13
VSS
Clk U2 11
U2 12
Reset
U2 10
VSS
U1 9
U1 10
U1 11
U1 12
U1 14
U1 15
Carrier
Inhibit
1X Carrier
360 kHz
+12V
RTN
16, 15, 14, 13
Conn 2
Conn 1
+12V
RTN
C1 20uf
C2 0.1uf
U1 1
VDD
U2 14
VDD
U1 8
VSS
U2 7
VSS
12VDC & Rtn
GFI 115 VAC 60Hz F2
GFI 115 VAC 60Hz Return
GFI 115 VAC 60Hz Ground
115 VAC to 12VDC Regulated Power Supply

FIGURE 47

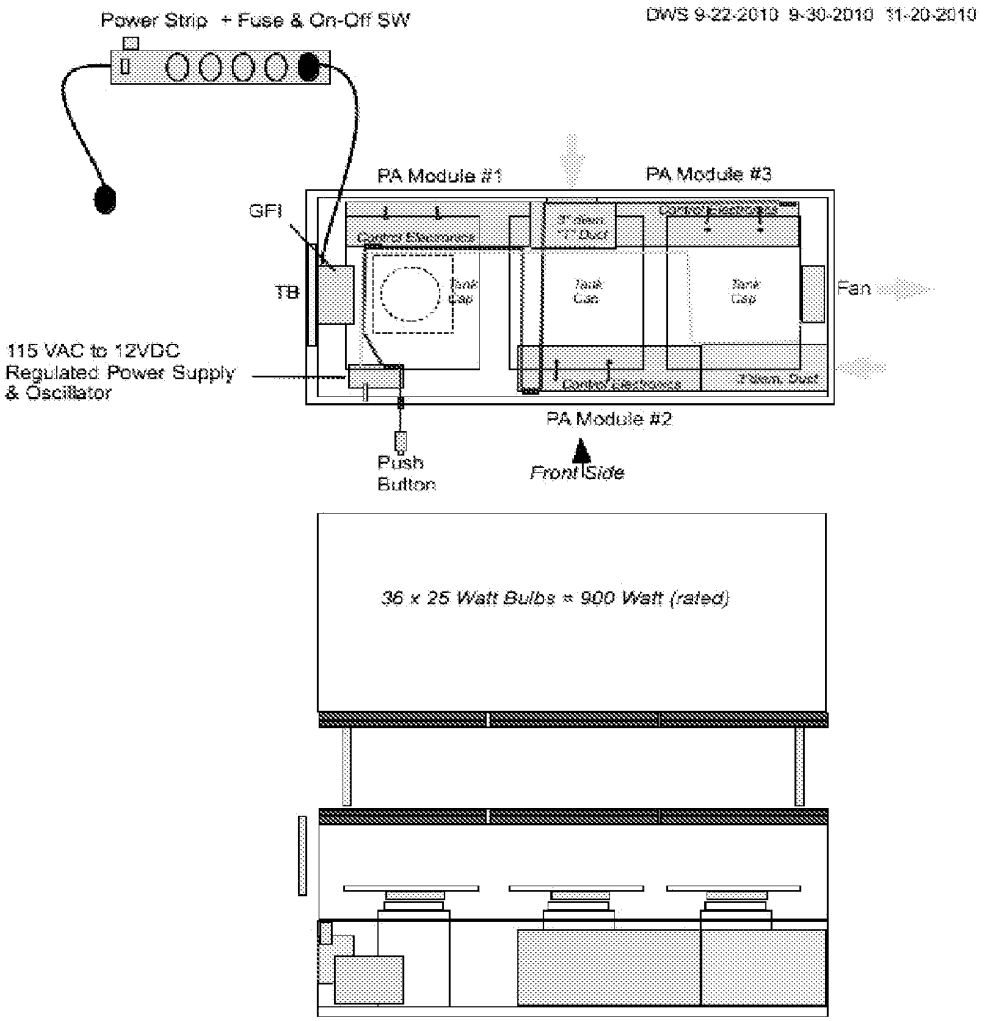

Power Strip + Fuse & On-Off SW
DWS 9-22-2010 9-30-2010 11-20-2010
PA Module #1
PA Module #3
GFI
TB
Fan
115 VAC to 12VDC
Regulated Power Supply
& Oscillator
PA Module #2
Push
Button
Front Side
36 x 25 Watt Bulbs = 900 Watt (rated)

FIGURE 48

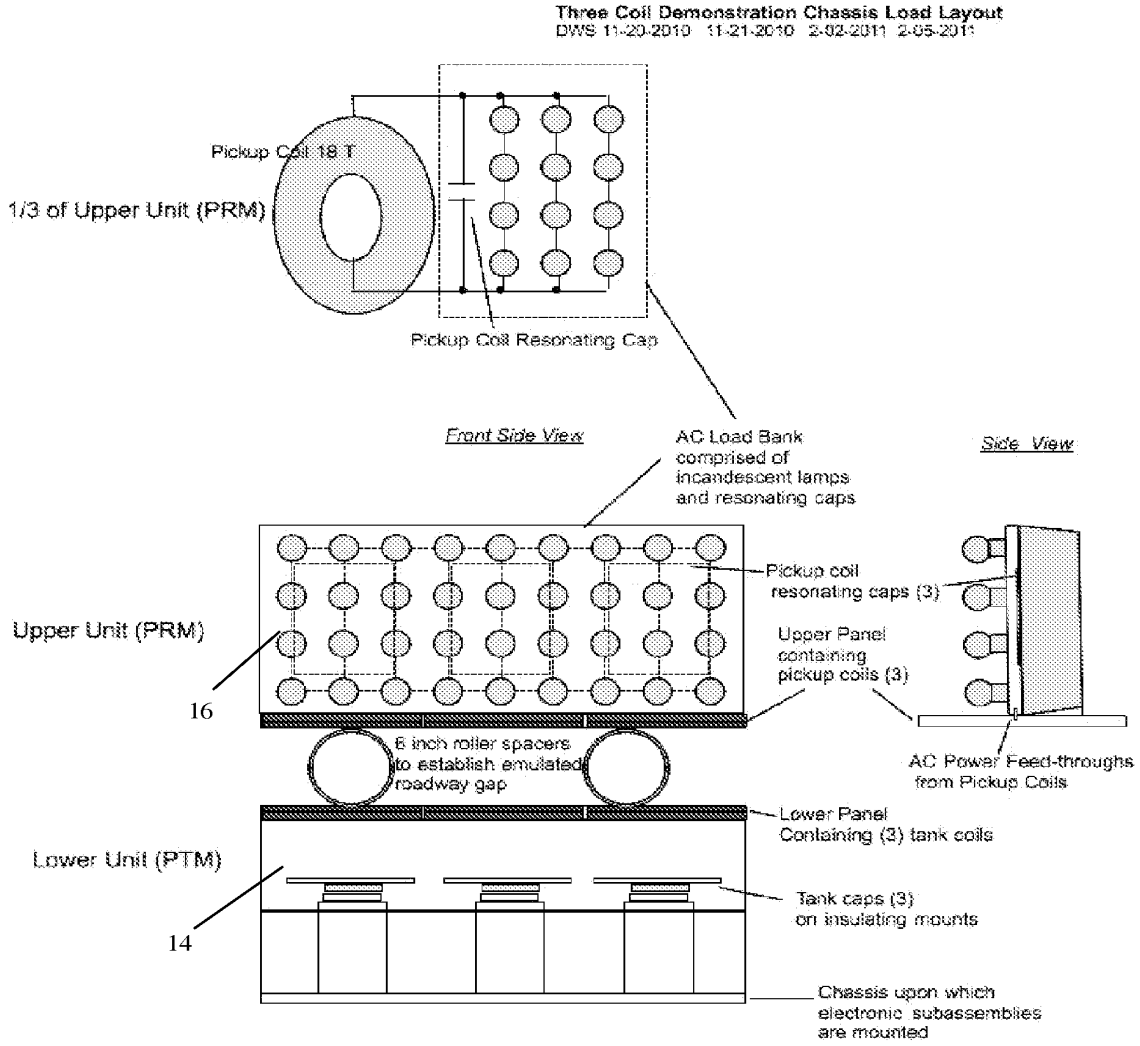

Three Coil Demonstration Chassis Load Layout
DWS 11-20-2010 11-21-2010 2-02-2011 2-05-2011
Pickup Coil 18 T
1/3 of Upper Unit (PRM)
Pickup Coil Resonating Cap
Front Side View
AC Load Bank comprised of incandescent lamps and resonating caps
Side View
Pickup coil resonating caps (3)
Upper Unit (PRM)
16
Upper Panel containing pickup coils (3)
6 inch roller spacers to establish emulated roadway gap
AC Power Feed-throughs from Pickup Coils
Lower Panel Containing (3) tank coils
Lower Unit (PTM)
Tank caps (3) on insulating mounts
14
Chassis upon which electronic subassemblies are mounted

FIGURE 49

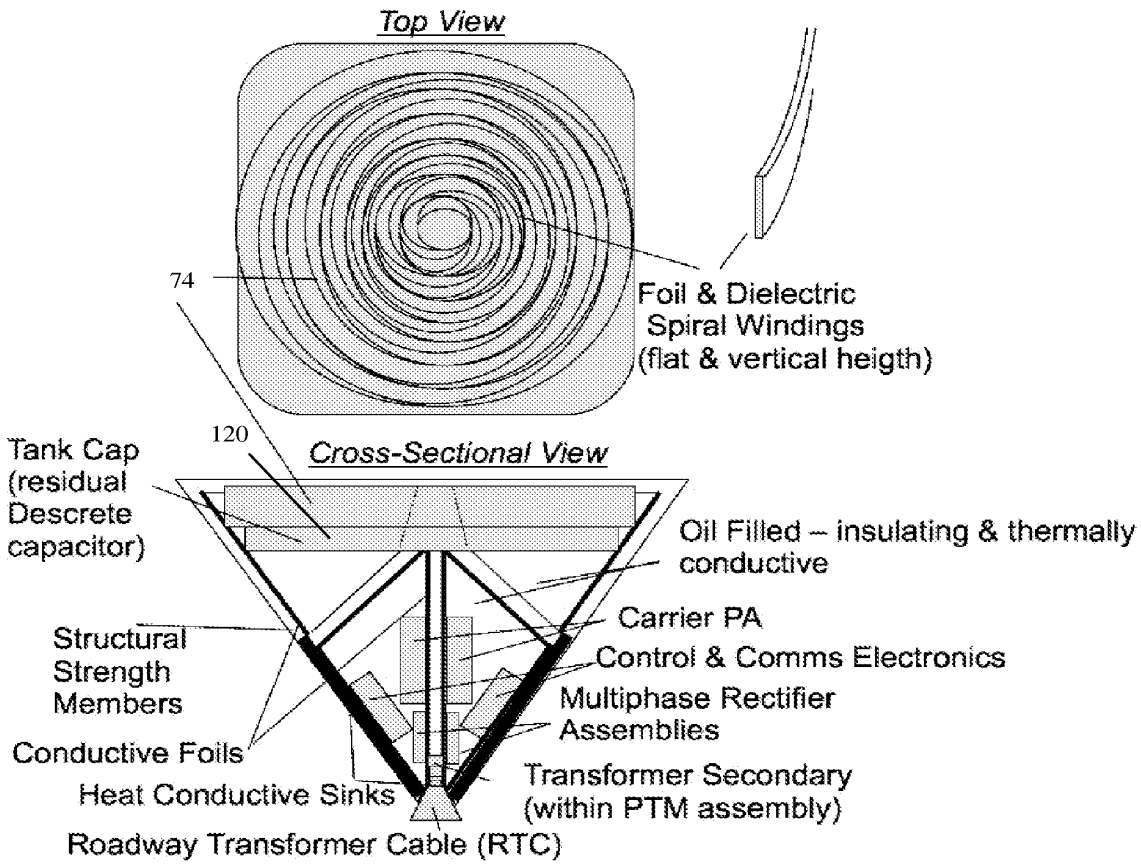

Top View
74
Foil & Dielectric
Spiral Windings
(flat & vertical heigth)
120
Cross-Sectional View
Tank Cap
(residual
Descrete
capacitor)
Oil Filled – insulating & thermally
conductive
Carrier PA
Control & Comms Electronics
Multiphase Rectifier
Assemblies
Structural
Strength
Members
Conductive Foils
Heat Conductive Sinks
Transformer Secondary
(within PTM assembly)
Roadway Transformer Cable (RTC)

FIGURE 50

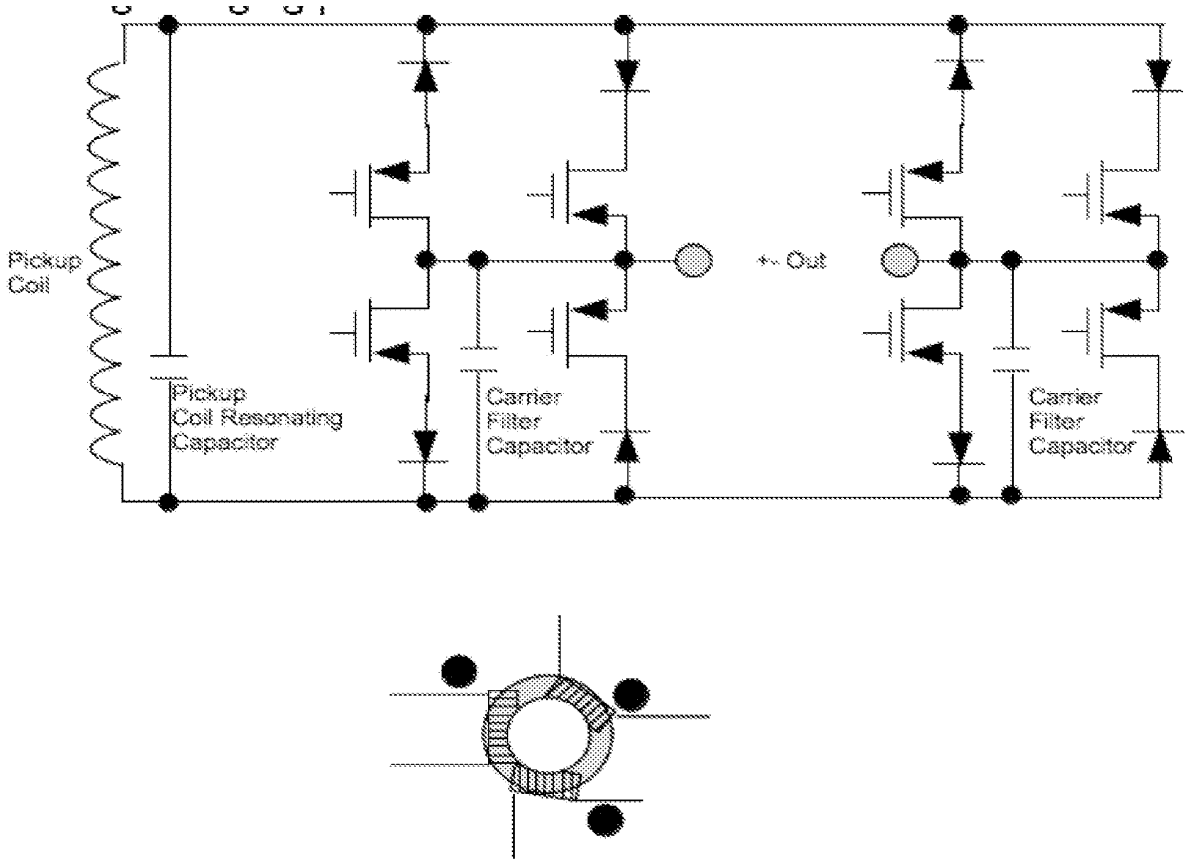

Pickup
Coil
Pickup
Coil Resonating
Capacitor
Carrier
Filter
Capacitor
+- Out
Carrier
Filter
Capacitor

FIGURE 51

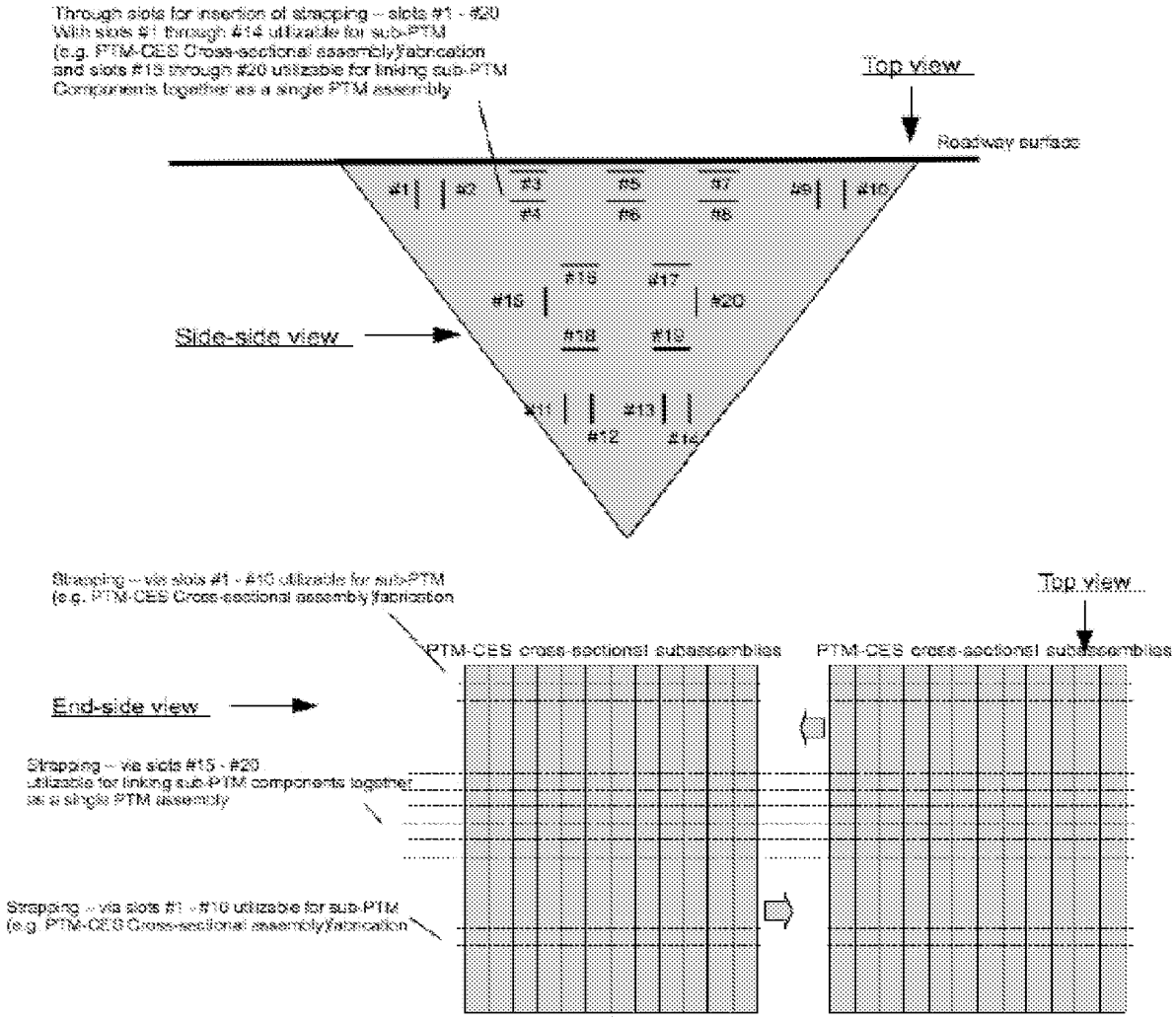

Through slots for insertion of strapping – slots #1 - #20
With slots #1 through #14 utilizable for sub-PTM
(e.g. PTM-CES Cross-sectional assembly/fabrication
and slots #15 through #20 utilizable for linking sub-PTM
Components together as a single PTM assembly
Top view
Roadway surface
#1
#2
#3
#4
#5
#6
#7
#8
#9
#10
#15
#16
#17
#18
#19
#20
Side-side view
#11
#12
#13
#14
Strapping – via slots #1 - #10 utilizable for sub-PTM
(e.g. PTM-CES Cross-sectional assembly fabrication
Top view
PTM-CES cross-sectional subassemblies
PTM-CES cross-sectional subassemblies
End-side view
Strapping – via slots #15 - #20
utilizable for linking sub-PTM components together
as a single PTM assembly
Strapping – via slots #1 - #10 utilizable for sub-PTM
(e.g. PTM-CES Cross-sectional assembly/fabrication

FIGURE 52

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/115,811	Filing Date 05/25/2011	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **06/17/2014**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 28	Minus	** 36	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DORIS ISAAC/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/115,811	05/25/2011	Afshin Partovi	AFPA-01007US1	4181

23910 7590 03/04/2014

MEYER IP LAW GROUP
410 PACIFIC AVENUE
SAN FRANCISCO, CA 94133

EXAMINER	
BERHANU, SAMUEL	
ART UNIT	**PAPER NUMBER**
2859	

NOTIFICATION DATE	DELIVERY MODE
03/04/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

officeactions@meyerip.com
pctoa@meyerip.com

Office Action Summary	Application No. 13/115,811	Applicant(s) PARTOVI ET AL.	
	Examiner SAMUEL BERHANU	Art Unit 2859	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/13/2013*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-36* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-36* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *5/25/2011* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *11/26/2013 and 10/29/2013*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

Terminal Disclaimer

1. The terminal disclaimer filed on 11/13/2013 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of US # . 7,952,322 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Claim Rejections - 35 USC § 102

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

3. Claims 3-5 are rejected under pre-AIA 35 U.S.C. 102 (a) as being anticipated by Hui (US 2005/0189910).

As to claim 3, a mobile device charger [see figure 4c] or power supply comprising see figure : a plurality of coils or wires [see coils 4], wherein the coils or wires are placed in one or more layers and are used to inductively charge a mobile device [mobile device see figure 10b] in proximity to the mobile device charger [see Abstract].

As to claim 4, Hui discloses in figures 1-10 wherein one or more of the coils are manufactured by one of printed circuit boards or by etching or stamping or forming copper or other material and are manufactured to have a low resistance.

As to claim 5, Hui discloses in figure 45, wherein two or more coils or wires are activated to charge or power a mobile device [see page 17, lines 19-21].

Claim Rejections - 35 USC § 103

4. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

5. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-8, 10-12, 22, 30-31 and 36 rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Jung et. al. (WO 2006/001557) (hereinafter Jung) in view of Lyon (US 2004/0145342).

As to Claims 1 and 11, Jung discloses in Figures 1-6, a mobile device and/or battery capable of being inductively powered or charged comprising:

a battery; [see figure 1, element 100 $ page 9, lines 1-2] , wherein one or both of a mobile device and the battery have particular charging characteristics associated therewith;

a receiver [charging receiver module, 110; see page 9 lines 14]] for one of inductively powering the device or charging the battery in the mobile device, wherein the receiver is one of attached to or incorporated into the battery or the mobile device:

a regulator [the controller 240; controls and regulates charging], that

determines characteristics of the mobile device or the battery [see page 6, lines 23-26, including one or more of a charming capacity, present charge, required voltage, or current temperature [determining charge status of the battery, see page 7, lines 1-3 & 18-21], wherein different mobile devices and batteries can have different charging characteristics associated therewith [see page 9, lines 14-17]; and

wherein the receiver communicates with a base unit to one or more detect, identify and authenticate the receiver with the base unit [see page 9, lines 14-17] verify the continued presence of the receiver near the base unit, and communicate information to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics [page 18, lines 2-15; see also figure 7, steps S100-S140].

Jung does not disclose explicitly, regulator senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery.

Lyon discloses in figures 1-2, regulator [controller 214] senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery [see paragraphs 019-0020].

It would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify controller of Jung and allow to regulate the charging current or voltage as taught by Lyon in order to improve magnetic coupling between the charger and the device necessary for charging.

As to Claim 2, Jung discloses in Figure 2, wherein the receiver [110] is attached to the shell of the mobile device or battery.

As to claim 3, Jung discloses in figure 3, plurality of coils or wires [Poil 1 & Pcoil2] , wherein the coils or wires are placed in one or more layers and are used to inductively charge a mobile device in proximity to the mobile device charger.

As to Claims 4 and 12, Jung discloses in figure 3, wherein one or more of the coils are manufactured by one of printed circuit boards or by etching or stamping or forming copper or other material and are manufactured to have a low resistance.

As to claim 5, Jung discloses in figure 3, wherein two or more coils or wires are activated to charge or power a mobile device [see page 17, lines 19-21].

As to Claim 6, Lyon discloses in Figures 1-6, wherein the base unit and the mobile device and/or battery communicate with each other to transfer data (220).

As to Claim 7, Lyon discloses in Figures 1-6, wherein the base unit includes a first set of coils (210) or wires for inductively charging or supplying power to the mobile

device and/or battery, and a separate antenna or second set of coils or wires for data transfer or verification or communication for regulation of power or voltage (243-, 242).

As to claim 8, Lyon discloses in figures 1-6, wherein the charger or power supply includes coils or wires for inductively charging or supplying power to the mobile device, and wherein the coils or wires also function as an antenna for data transfer [see figures 1-2].

As to Claim 10, Lyon discloses in Figures 1-6, wherein the base unit stores charging or power requirements for mobile devices and/or batteries which can be charged or powered by the charger or power supply.

As to Claim 22, Lyon discloses in Figures 1-6, a data storage component for storage of data, for subsequent transmission of data to or from the mobile device.

As to Claim 30, Lyon discloses in Figures 1-6, wherein the charger or power supply is made in the shape of a cup, bowl, or other container and mobile devices and/or batteries placed inside would be are charged or powered inductively.

As to Claim 31, Lyon discloses in Figures 1-6, wherein a plurality of modular chargers or power supplies can be interconnected to form a single unit.

As to Claim 36, Lyon discloses in Figures 1-6, wherein, the mobile device includes an after-market or field-replaceable battery pack compatible with an original battery pack for the device, and wherein the matching secondary coil or coils within the mobile device are incorporated into the after-market or field-replaceable battery pack.

Claim Rejections - 35 USC § 103

7. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 9, 13,15- 16 and 34-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in views of Lyon and Van Lerberghe (US 5,925,814) (hereinafter Van)

As to Claims 9 and 13, neither Jung nor Lyon discloses, wherein the base unit includes a primary circuit having a switch means for switching the primary coil on and off whenever the mobile device and/or battery is placed close to the primary coil of the base unit or the presence of the mobile device and/or battery is to be detected.

Van discloses in Figures 1-5, wherein the base unit includes a primary circuit having a switch (28) means for switching the primary coil on and off whenever the mobile device and/or battery is placed close to the primary coil of the base unit or the presence of the mobile device and/or battery is to be detected

It would have been obvious to a person having ordinary skill in the art at the time of the invention to add a switching means in Jung's charger as taught by Van in order to avoid unnecessary power lose due to charging

As to Claim 15, Jung in combination with Lyon and Van discloses wherein the alternating switching is periodically started and stopped to automatically detect a

presence of a mobile device and/or battery placed close to or aligned with the primary coil of the base unit.

As to Claim 16, Jung in combination with Lyon and Van, wherein the presence of the mobile device and/or battery placed close to or aligned with the primary coil of the base reunit is detected by monitoring the current passing through the primary coil or the switching means.

As to Claim 34, Jung in combination with Lyon and Van discloses, charging circuit having a Zener diode, wherein the Zener diode clamps the voltage to the mobile device to a predetermined maximum voltage.

As to Claim 35, Jung in combination with Lyon and Van discloses, wherein the switch means is a MOSFET and the circuit includes a capacitor connected in parallel to the source to drain terminals of the MOSFET, and wherein the alternating switching in the primary coil is automatically started by the MOSFET when the base unit detects a mobile device and/or battery placed close to or aligned with the primary coil.

9. Claims 14, 17-18, 23-29 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in views of Lyon and Hui (US 2005/0189910)

As to Claim 14, neither Jung nor Lyon discloses , wherein the base unit includes multiple primary coils that can be used to simultaneously charge multiple mobile devices and/or batteries.

Hui discloses in Figure 4(a), wherein the base unit includes multiple primary coils that can be used to simultaneously charge multiple mobile devices and/or batteries.

It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Jung's apparatus in order to charge different devices simultaneously to minimize the time it takes to charge a plurality of electronic devices.

As to Claim 17, Hui discloses in Figure 4a, wherein the base unit is in the shape generally of a pad and wherein the multiple primary coils are distributed within layers of the pad.

As to Claim 18, Hui discloses in Figure 4a, wherein the multiple primary coils can move within their plane to more closely align with the secondary coil of a mobile device and/or battery

As to Claim 23, Hui discloses wherein the cover surface of the base unit or pad includes a decorative or non-slip surface.

As to Claim 24, Hui discloses wherein the base unit can be integrated into any of briefcases, bags, carriers, or clothing.

As to Claim 25, Hui discloses wherein the base unit is integrated into a charging kiosk for occasional charging of mobile devices.

As to Claim 26, Jung in combination with Lyon and Hui discloses, wherein one or more of the primary coils are stacked to improve transfer efficiency.

As to Claim 27, Jung in combination with Lyon and Hui discloses, further comprising a plurality of coils or wires, wherein the charger or power supply senses the location of the mobile device and/or battery and activates a coil or wire near the mobile device and/or battery to charge or provide power the mobile device and/or battery.

As to Claim 28, Lyon in combination with Hui discloses, wherein the charger or power supply senses the location of the mobile device and/or battery by sensing a change in a resonant circuit in the charger or power supply when the mobile device and/or battery is nearby.

As to Claim 29, Lyon in combination with Hui discloses, wherein the mobile device includes an inductively charged battery where a receiver for the inductive power is made of flexible PCB material and can be shaped into a curve to fit the battery, an application or a device.

9. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in vies of Lyon and Chen et. al. (US 6,331,744) (hereinafter Chen)

As to Claim 19, neither Jung nor Lyon discloses, wherein a magnet is placed at the center of each primary, wherein the magnet at the center of each primary has a magnetic axis that is perpendicular to the plane of the coil, and wherein one or more of the devices to be charged include a magnet at the center of their receiver coil, so that the magnets in the devices and the magnets in the base are oriented to attract each other when a coil in a mobile device and/or battery_ is placed directly on top of a coil in the base.

Chen discloses in Figure 2, wherein a magnet is placed at the center of each primary, wherein the magnet at the center of each primary has a magnetic axis that is perpendicular to the plane of the coil, and wherein one or more of the devices to be charged include a magnet at the center of their receiver coil, so that the magnets in the

devices and the magnets in the base are oriented to attract each other when a coil in a mobile device and/or battery is placed directly on top of a coil in the base.

It would have been obvious to a person having ordinary skill in the art at the time of the invention to add Magnetic material in Jung's charger as taught by Chen in order to strength the inductive charging energy.

11. Claims 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in views of Lyon and Fukuda et. al. (US 4,311,953) (hereinafter Fukuda).

As to claims 20 and 21, Fukuda discloses in Column 1, lines 59-67, a charger unit including solar and secondary battery.

It would have been obvious to a person having ordinary skill in the art at the time of the invention to add Magnetic material in Jung's charger as taught by Chen in order to strength the inductive charging energy.

12. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in vies of Lyon and SUDO (US JP408000838)

As to Claim 32, Sudo discloses in the Abstract, wherein the mobile device is one of a kitchen appliance or dish, or a toy that can receive power inductively from the charger or power supply.

It would have been obvious to a person having ordinary skill in the art at the time of the invention to use inductive charging of Jung for vehicle toy as taught by Sudo to extend battery life.

13. Claim 33 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jung in views of Lyon and Charych (US 6,798,716)

As to Claim 33, Charych discloses charging RFID tag battery, wherein the mobile device is a charger for inductively charging active RFID batteries, including an active RFID tag which includes a battery such that the battery can be charged inductively with the system.

It would have been obvious to a person having ordinary skill in the art at the time of the invention to use inductive charging of Jung for RFID batteries as taught by Charych to extend battery life.

Response to Arguments

10. Applicant's arguments with respect to claims have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

11. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMUEL BERHANU whose telephone number is (571)272-8430. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Drew A. Dunn can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAMUEL BERHANU/
Primary Examiner
Art Unit 2859

Notice of References Cited	Application/Control No. 13/115,811	Applicant(s)/Patent Under Reexamination PARTOVI ET AL.	
	Examiner SAMUEL BERHANU	Art Unit 2859	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	WO 2006115368				
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	WO 2006115368: JUNG et. al. Method for Transmitting/Receiving Data In A communication System; November 2, 2006
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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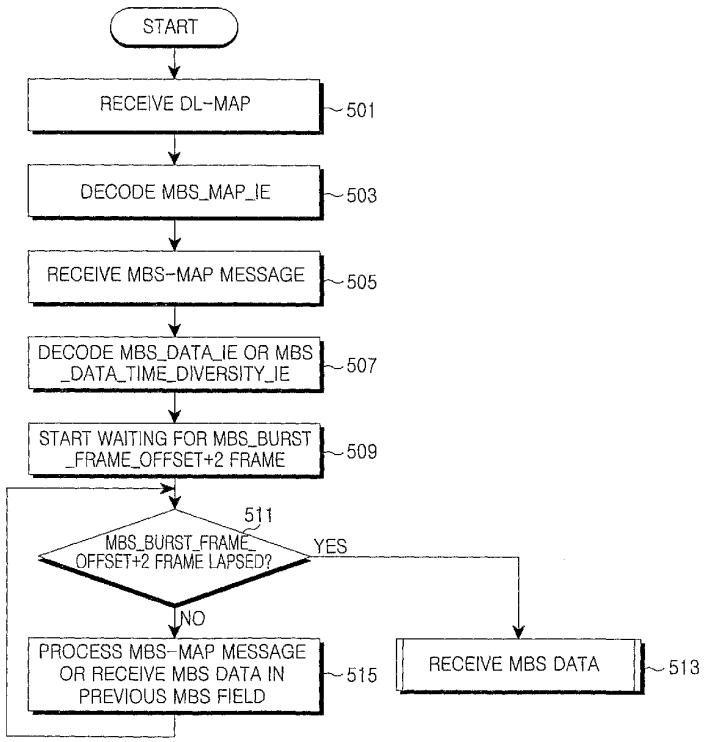
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[Continued on next page]

(54) Title: METHOD FOR TRANSMITTING/RECEIVING DATA IN A COMMUNICATION SYSTEM



(57) Abstract: Provided is a method for transmitting/receiving data in a communication system providing Multicast/Broadcast Service (MBS). The method includes, generating transmission data to be transmitted to a receiver; allocating the transmission data to a frame; setting a MAP message that includes information on a frame offset related to the frame; and transmitting to the receiver the MAP message.

WO 2006/115368 A1

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD FOR TRANSMITTING/RECEIVING DATA IN A COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a communication system, and in particular, to a method for transmitting/receiving data in a communication system providing Multicast and Broadcast Service (MBS).

2. Description of the Related Art

In the next generation communication system, active research is being conducted to provide users with services varying in Quality-of-Service (QoS) and at a high data rate. Particularly, in the current next generation communication system, studies are being carried out to support high-speed services capable of guaranteeing mobility and QoS in a Broadband Wireless Access (BWA) communication system such as a wireless Local Area Network (LAN) communication system and a wireless Metropolitan Area Network (MAN) communication system. The Institute of Electrical and Electronics Engineers (IEEE) 802.16 communication system is a typical BWA, LAN and MAN communication system.

The IEEE 802.16 communication system employs an Orthogonal Frequency Division Multiplexing (OFDM)/Orthogonal Frequency Division Multiple Access (OFDMA) scheme to support a broadband transmission network for physical channels of the wireless MAN system. The IEEE 802.16 communication system currently takes into account not only fixed elements of a system but also mobile a subscriber stations (SS). An SS having both fixed elements and mobile elements will be referred to as a mobile station (MS).

The BWA communication system provides user with high-speed multimedia communication service, for example, MBS, beyond the voice and packet data communication services provided in the existing communication system. That is, in a communication system providing MBS, a transmitter, for example, a base station (BS), provides broadcast contents to a plurality of

receivers, for example, MSs, using a multicast scheme. The multicast scheme refers to a transmission scheme in which one transmitter transmits transmission data to a plurality of receivers. The communication system providing MBS divides its full broadcast service area into a plurality of service areas, and in each of the divided service areas, one or more transmitters transmit MBS data to all receivers located in their service area using the multicast scheme. The receivers located in each service area simultaneously receive the MBS data from their transmitter(s). In the communication system providing a MBS, one transmitter may manage more than one service areas and simultaneously provide the MBS to receivers located in the multiply service areas.

In the communication system providing the MBS, particularly in the IEEE 802.16 communication system, a transmitter transmits MBS data to receivers at the same frame number and the same MBS symbol position at the same time using the same coding scheme. In order to allow a receiver located in a boundary area of each service area to obtain a macro diversity effect through radio frequency combining, the transmitter should define an MBS field (or MBS zone) in a downlink frame and transmit the MBS data through the MBS field. The receiver receives an MBS-MAP message including information on an MBS field that it should receive in the downlink frame, to detect the MBS field, thereby receiving the MBS data transmitted through the MBS field. Herein, the MAP message transmitting downlink resource allocation information is referred to as a downlink-MAP (DL-MAP) message, and the MAP message transmitting uplink resource allocation information is referred to as an uplink-MAP (UL-MAP) message.

If the transmitter transmits downlink resource allocation information and uplink resource allocation information through the DL-MAP message and the UL-MAP message in this way, the receivers decode the DL-MAP message and UL-MAP message transmitted by the transmitter to detect the allocation position of resources allocated thereto and the control information of the data they should receive. The MSs can transmit/receive data through the downlink and the uplink by detecting the resource allocation position and control information.

FIG. 1 is a diagram illustrating a structure of a downlink frame in a

general communication system providing MBS. In FIG. 1, a downlink frame is represented by subchannels and symbols in a time domain and a frequency domain.

Referring to FIG. 1, a downlink frame includes a preamble field 101, DL-MAP fields 103 and 105, an MBS-MAP message field 109, and a plurality of MBS data burst fields, i.e., an MBS data burst 1 field 113, an MBS data burst 2 field 115, and an MBS data burst 3 field 117. Further, the DL-MAP field 103 includes an MBS_MAP_Information Element (MBS_MAP_IE) field 107, and the MBS-MAP message field 109 includes an MBS_Data_Information Element (MBS_Data_IE) field 111.

The preamble field 101 transmits a synchronization signal, i.e., a preamble sequence, for synchronization acquisition between a transmitter and a receiver. The DL-MAP fields 103 and 105, fields for transmitting DL-MAP information, include the MBS_MAP_IE field 107 to provide MBS, and an MBS_MAP_IE included in the MBS_MAP_IE field 107 provides information for decoding the MBS-MAP message field 109. A format of the MBS_MAP_IE included in the MBS_MAP_IE field 107 is shown in Table 1 below.

Table 1

Syntax	Size (bits)	Notes
MBS_MAP_IE() {		
Extended DIUC	4	MBS_MAP=0x0A
Length	4	
MBS Zone Identifier	7	MBS Zone identifier corresponds to the identifier provided by the BS at connection initiation
Macro diversity enhanced	1	0=Non Macro diversity enhanced zone 1=Macro diversity enhanced zone
If(Macro diversity enhanced=1) {		
Permutation	2	0b00=PUSC permutation 0b01=FUSC permutation 0b10=Optional FUSC permutation 0b11=Adjacent subcarrier permutation

IDcell	6	
}		
OFDMA symbol offset	7	OFDMA symbol offset with respect to start of the MBS region
DIUC change indication	1	Used to indicate DIUC change is included
If(DIUC change indication=1) {		
Reserved	1	
Boosting	3	
DIUC	4	
No. subchannels	6	
No. OFDMA symbols	2	
Repetition coding indication	2	0b00=No repetition coding 0b01=repetition coding of 2 used 0b10=repetition coding of 4 used 0b11=repetition coding of 6 used
} else {		
DIUC	4	
CID	12	12 LSB of CID
OFDMA symbol offset	8	The offset of the OFDMA symbol in which the burst starts, measured in OFDMA symbols from beginning of the downlink frame in which the DL-MAP is transmitted.
Subchannel offset	6	The lowest index OFDMA subchannel used for carrying the burst, starting from subchannel 0.
Boosting	3	
SLC_3_Indication	1	Used to notify sleep mode class 3 is used for single BS MBS service
No. OFDMA symbols	6	
No. subchannels	6	
Repetition coding indication	2	0b00=No repetition coding 0b01=Repetition coding of 2 used 0b10=Repetition coding of 4 used 0b11=Repetition coding of 6 used
If(SLC_3_Indication=0) {		

Next MBS frame offset	8	The Next MBS frame offset value is lower 8bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA symbol offset	8	The offset of the OFDMA symbol in which the next MBS zone starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.
}		
}		
If!(byte boundary) {		
Padding nibble	Variable	Padding to reach byte boundary
}		
}		

Table 1 shows Information Elements (IEs) of the MBS_MAP_IE included in the MBS_MAP_IE field 107. In Table 1, 'Extended Downlink Interval Usage Code (Extended DIUC)' indicates that the MBS_MAP_IE includes MBS-MAP information, and is set to have a value of '0x0A'. 'MBS Zone Identifier' indicates an identifier of the MBS field, 'Macro Diversity Enhanced' indicates whether macro diversity is applied to the MBS field, and 'Permutation' and 'IDcell' indicate information necessary when the macro diversity is applied to the MBS zone. Herein, the MBS field includes the MBS-MAP message field 109 having the MBS_Data_IE field 111, and a plurality of MBS data burst fields 113, 115 and 117.

In addition, 'OFDMA symbol offset' indicates a start offset of an MBS-MAP message in the MBS field, 'DIUC change indication' indicates a change in DIUC to be used for receiving the MBS-MAP message, and 'No. Subchannels' indicates the number of allocated subchannels. Further, 'No. OFDMA Symbols' indicates the number of allocated OFDMA symbols, and 'Repetition coding indication' indicates coding information to be used for decoding the MBS-MAP message. The IEs not mentioned in Table 1 are not directly related to the present invention, so a detailed description thereof will be omitted herein.

As shown in Table 1, the MBS_MAP_IE field 107 includes information on the MBS-MAP message field 109, and receivers receive the MBS-MAP message transmitted with the MBS-MAP message field 109 through the MBS_MAP_IE. With reference to Table 2, a detailed description will now be made of the MBS-MAP message. Table 2 below shows a format of the MBS-MAP message.

Table 2

Syntax	Size(bits)	Notes
MBS-MAP Message format () {		
MAC Generic Header	48	6bytes
Management message type=62	4	
Frame number	4	The frame number is identical to the frame number in the DL-MAP
MBS_DIUC_Change_Count	8	
# MBS_DATA_IE	4	Number of included MBS_DATA_IE
For(i=0;i<n; i++) {		N= #MBS_DATA_IE
MBS_DATA_IE	Variable	
}		
#MBS_DATA_Time_Diversity_IE	4	Number of included MBS_DATA_Time_Diversity_IE
For(i=0;i<m; i++) {		m= #MBS_DATA_ Time_Diversity_IE
MBS_DATA_Time_Diversity_IE	Variable	
}		
If(!byte boundary) {		
Padding nibble	8	
}		
TLV encoding element		
}		

Table 2 shows a format of the MBS-MAP message transmitted through the MBS-MAP message field 109. The MBS-MAP message includes a 6-byte or 48-bit Medium Access Control (MAC) Generic Header, and a plurality of IEs. Of the IEs, 'Management Message Type' indicates a type of a management message,

'Frame number' indicates the same frame number as a frame number of the DL-MAP, and 'MBS DIUC Change Count' indicates whether the MBS data burst profile is identical to a previous MBS data burst profile.

If a value of the 'MBS DIUC Change Count' is changed, the receiver that received the MBS-MAP message should receive downlink burst profile information included as Time/Length/Value (TLV) information of the MBS-MAP message. However, if the downlink burst profile information is not included in the MBS-MAP message, the receiver receives the downlink burst profile information through a next Downlink Channel Descriptor (DCD) message. In addition, 'MBS_Data_IE' and 'MBS_Data_Time_Diversity_Information Element' (MBS_Data_Time_Diversity_IE) indicate field information of MBS data bursts that the receiver will receive. The 'MBS_Data_Time_Diversity_IE' includes information on MBS data bursts allocated when there is only the MBS burst data for a receiver supporting a Hybrid Automatic Repeat reQuest (HARQ) scheme. The IEs not mentioned in Table 2 are not directly related to the present invention, so a detailed description thereof will be omitted herein.

With reference to Table 3, a description will now be made of the MBS_Data_IE including information on the MBS data burst fields 113, 115 and 117 over which MBS data is transmitted.

Table 3

Syntax	Size (bits)	Notes
MBS_DATA_IE {		
MBS_MAP_Type=0	4	MBS_DATA_IE
Next MBS MAP change indication	1	This indicates whether the size of MBS MAP message of next MBS frame for these multicast CIDs included this IE will be different from the size of this MBS MAP message.
No. of Multicast CID	3	
For(i=0;i<No. of Multicast CIDs; i++) {		
Multicast CID	12	12 LSBs of CID for multicast

}		
MBS DIUC	4	
OFDMA symbol offset	8	OFDMA symbol offset with respect to start of the MBS portion
Subchannel offset	6	OFDMA subchannel offset with respect to start of the MBS portion
Boosting	3	
No. OFDMA symbols	7	The size of MBS data
No. subchannels	6	
Repetition coding indication	2	0b00=No repetition coding 0b01=Repetition coding of 2 used 0b10=Repetition coding of 4 used 0b11=Repetition coding of 6 used
Next MBS frame offset	8	The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA symbol offset	8	The offset of the OFDMA symbol in which the next MBS portion starts, measured in OFDMA symbols from beginning of the downlink frame in which the MBS-MAP is transmitted.
If(Next MBS MAP change indication=1) {		
Next MBS No. OFDMA symbols	2	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
Next MBS No. OFDMA symbols	6	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
}		
}		

Table 3 shows IEs of the MBS_Data_IE transmitted through the MBS_Data_IE field 111. In Table 3, 'MBS_MAP_Type' indicates that the IEs of Table 3 are MBS_Data_IE, and 'Next MBS MAP change indication' indicates a

change in size of an MBS-MAP message that will come in the next MBS frame, wherein the MBS frame means the frame that includes information of the MBS data or the data burst of the MBS. In addition, 'Multicast Connection Identifier (CID)' indicates multicast identifier information mapped to the MBS_Data_IE, 'OFDMA Symbol Offset' and 'Subchannel Offset' indicate start offsets of the MBS data burst fields 113, 115 and 117, and 'No. Subchannels' indicates the number of subchannels of the MBS data burst fields 113, 115 and 117 allocated to the MBS frame. Further, 'No. OFDMA Symbols' indicates the number of OFDMA symbols of the allocated MBS data burst fields 113, 115 and 117, and 'Repetition coding indication' indicates the number of repetitions (or iterations) needed for decoding the MBS data transmitted through the MBS data burst fields 113, 115 and 117.

In addition, 'Next MBS frame offset' indicates an offset of the next MBS frame, and 'Next MBS OFDMA symbol offset' indicates an offset of a downlink frame OFDMA symbol for receiving the next MBS-MAP message. Herein, if the 'Next MBS MAP change indication' is set to '1', it means that the 'Next MBS OFDMA symbol offset' includes 'Next MBS No. OFDMA symbols' indicating a size of an MBS-MAP message that will come in the next MBS frame, and 'Next MBS No. OFDMA subchannels'. After receiving the 'Next MBS frame offset' and the 'Next MBS OFDMA symbol offset', the receiver can obtain the MBS service information without receiving the MBS_MAP_IE of the DL-MAP. The IEs not mentioned in Table 3 are not directly related to the present invention, so a detailed description thereof will be omitted herein.

The foregoing MBS-MAP message serves as a MAC control message including information so that the receiver can decode the MBS data burst fields and the corresponding MBS data in MBS data transmitted through the fields. As a result, the MBS-MAP message shown in Table 2 provides information on the MBS data burst fields to the receivers, along with 48-bit MAC Generic Header, as described above. If the amount of information on the MBS data burst fields in which the MBS-MAP message is to be included is large, the MBS-MAP message may not include information on many MBS data burst fields that should be included in one MBS frame, because of the 48-bit MAC Generic Header. Accordingly, the MBS-MAP message is not fully transmitted in one MBS frame,

and is transmitted in the next MBS frame, along with the MAC Generic Header.

As the MBS-MAP message is transmitted over two MBS frames together with the MAC Generic Header, the MAC Generic Header becomes an overhead. In addition, the transmitter transmits the MBS-MAP message over two MBS frames due to the 48-bit MAC Generic Header even for the information on the MBS data burst fields that can be transmitted in one MBS frame, thereby causing a waste of frequency bands. In order to prevent the waste of the frequency bands, it is also possible to allocate information on some of the MBS data burst fields to the current MBS frame before transmission, and transmit information on the other MBS data burst fields in the next MBS frame. In this case, there is a need for a scheme for additionally transmitting information indicating to which MBS frame the information on the MBS data burst fields included in the MBS-MAP message transmitted in the current MBS frame is allocated before being transmitted.

FIG. 2 is a diagram schematically illustrating a structure of an MBS frame in a general communication system providing MBS. In FIG. 2, an MBS-MAP message and information on MBS data burst fields included in the MBS-MAP message are transmitted over two frames of a particular frame n and the next frame (n+1). For convenience, FIG. 2 illustrates only the MBS field in the downlink MBS frame of FIG. 1.

Referring to FIG. 2, an MBS frame n 200 includes an MBS-MAP message field 201, and a plurality of MBS data burst fields that include an MBS data burst 1 field 211, an MBS data burst 2 field 213 and an MBS data burst 3 field 215. The MBS-MAP message field 201 includes a plurality of an MBS_Data_IE fields 203, 205, 207 and 209 each including MBS data burst field information. In addition, an MBS frame (n+1) 250, the next frame of the MBS frame n 200, includes an MBS-MAP message field 251, and a plurality of MBS data burst fields that include an MBS data burst 4 field 255 and an MBS data burst 5 field 257. The MBS-MAP message field 251 includes an MBS_Data_IE 253 including the MBS data burst field information. The MBS_Data_IEs transmitted through the MBS_Data_IE fields 203, 205, 207 and 209 included in the MBS-MAP message field 201 of the MBS frame n 200 include information on the MBS data burst fields 211, 213, 215 and 255. In addition, the

MBS_Data_IE transmitted through the MBS_Data_IE field 253 included in the MBS-MAP message field 251 of the MBS frame (n+1) 250 includes information on the MBS data burst fields 257.

Because the MBS data burst fields 211, 213, 215 and 255 mapped to the MBS_Data_IE transmitted through the MBS_Data_IE fields 203, 205, 207 and 209 included in the MBS-MAP message field 201 of the MBS frame n 200 cannot be wholly allocated to one MBS frame, i.e., the MBS frame n 200, the receiver cannot fully receive the MBS data transmitted through the MBS data burst fields 211, 213, 215 and 255. Accordingly, the MBS data burst 1 field 211, the MBS data burst 2 field 213 and the MBS data burst 3 field 215 among the MBS data burst fields 211, 213, 215 and 255 are allocated to the MBS frame n 200, so that the receiver receives MBS data transmitted through the MBS data burst 1 field 211, the MBS data burst 2 field 213 and the MBS data burst 3 field 215 in the MBS frame n 200. In addition, the MBS data burst 4 field 255 among the MBS data burst fields 211, 213, 215 and 255 is allocated to the MBS frame (n+1) 250, so that the receiver receives MBS data transmitted through the MBS data burst 4 field 255 in the MBS frame (n+1) 250.

At this moment, the receiver cannot determine whether the transmitter has allocated the MBS data bursts 211, 213, 215 and 255 mapped to the MBS-MAP message field 201 of the MBS frame n 200 in the current MBS frame, i.e., the MBS frame n 200, or in the next MBS frame, i.e., the MBS frame (n+1) 250. Therefore, upon receiving the MBS frame n 200, the receiver decodes the MBS data of the MBS data burst 1 field 211, MBS data of the MBS data burst 2 field 213, and MBS data of the MBS data burst 3 field 215 received in the MBS frame n 200, using the MBS_Data_IE included in the MBS_Data_IE fields 203, 205 and 207 of the MBS-MAP message field 201. In addition, upon receiving the next MBS frame, i.e., the MBS frame (n+1) 250, the receiver decodes the MBS data of the MBS data burst 5 field 257 received in the MBS frame (n+1) 250 using the MBS_Data_IE included in the MBS_Data_IE field 253 of the MBS-MAP message field 251.

FIG. 2 illustrates operations 221, 223, 255 and 271 of decoding the MBS data transmitted through the MBS data burst fields 211, 213, 215 and 257, using the

MBS_Data_IE in each frame. As described with reference to FIG. 2, in the MBS frame n 200, information on the MBS data burst fields included in the MBS-MAP message field 201 is information on the MBS data burst 1 field 211, the MBS data burst 2 field 213, the MBS data burst 3 field 215 and the MBS data burst 4 field 255. Although the information on the MBS data burst fields 211, 213, 215 and 255 is allocated to the MBS frame n 200 in this manner, the MBS data burst 4 field 255 is actually allocated to the MBS frame (n+1) 250.

However, the receiver receiving the MBS frame n 200 cannot determine that the transmitter has allocated the MBS data burst fields 211, 213, 215 and 255 as described above, using the MBS-MAP message and the MBS_Data_IE having the structures of Table 2 and Table 3, transmitted through the MBS-MAP message field 201 and the MBS_Data_IE fields 203, 205, 207 and 209 of the MBS frame n 200. Therefore, upon receiving the MBS frame n 200, i.e., the current MBS frame, the receiver performs an operation 227 of decoding the MBS data transmitted through the MBS data burst 4 field 255, considering that the MBS data burst 4 field 255 is allocated to the current MBS frame. However, because the MBS data burst 4 field 255 is not allocated to the MBS frame n 200, an error may occur in the receiver.

In addition, the receiver, receiving the MBS-MAP message with the MBS_Data_IE in a particular MBS frame, may not decode the MBS data transmitted through the MBS data burst fields mapped to the MBS_Data_IE in the particular MBS frame in a real time. That is, even though the transmitter has transmitted the MBS data through the MBS_Data_IE and the MBS data burst fields including allocation and decoding information of the MBS data burst fields in the particular MBS frame, the receiver may fail to decode the MBS data transmitted through the MBS data burst fields due to its processing delay.

Therefore, because the MBS data burst fields individually mapped to the MBS data burst fields included in the MBS_Data_IE of the MBS-MAP message should be allocated to the same MBS frame as the MBS-MAP message field through which the MBS-MAP message is transmitted, there is a need for a scheme for reducing a size of the MBS-MAP message. In addition, there is a demand for a scheme for reducing a processing error which may occur when the

receiver recognizes an MBS frame to which the MBS data burst fields are allocated, and decodes the MBS data transmitted through the MBS data burst fields. Further, there is a need for a scheme in which the transmitter provides the receiver with information used for previously decoding the MBS data before a transmission time of the MBS data through the MBS data burst fields, and an allocation time of the MBS data burst fields through which the MBS data is transmitted, i.e., a transmission time of the MBS data, thereby preventing the processing delay of the receiver.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a method for transmitting/receiving data in a communication system.

It is another object of the present invention to provide a data transmission/reception method for preventing processing delay and misoperation of the system by previously transmitting/receiving data transmission information before a data transmission time in a communication system.

It is further another object of the present invention to provide a data transmission/reception method in a communication system providing MBS.

According to one aspect of the present invention, there is provided a method for transmitting data in a communication system. The method includes, generating transmission data to be transmitted to a receiver; allocating the transmission data to a frame; setting a MAP message that includes information on a frame offset related to the frame; and transmitting to the receiver the MAP message.

According to another aspect of the present invention, there is provided a method for transmitting data in a communication system. The method includes, upon generation of data to be transmitted to a receiver, determining a transmission field of the generated data, and allocating the determined transmission field to a frame; setting in transmission field information location information of the transmission field allocated to the frame and frame offset information defining an

offset between the frame to which the transmission field is allocated and a reference frame; and transmitting to the receiver a MAP message including the set transmission field information.

According to another aspect of the present invention, there is provided a method for transmitting data in a communication system. The method includes, upon generation of data to be transmitted to a receiver, determining a transmission field of the generated data; determining offset of frame including the transmission field; setting in data information offset information defining the offset of frame and location information of the transmission field according to the offset information; and transmitting to the receiver a MAP message including the set data information.

According to another aspect of the present invention, there is provided a method for transmitting multicast broadcast service (MBS) data of a base station (BS) in a broadband wireless access (BWA) communication system. The method includes, determining a frame offset of MBS data burst, a frame comprising the MBS data burst is the n-th frame following the current frame comprising the frame offset; determining a position of the MBS data burst within the n-th frame; setting information of the frame offset and the position in a message; and transmitting the message to a mobile station.

According to further another aspect of the present invention, there is provided a method for receiving data in a communication system. The method includesreceiving a MAP message that includes information on a frame offset related to a data burst before receiving the data burst from a transmitter; analyzing the information on the frame offset; and receiving from the transmitter the data burst within the n-th frame flowing a frame comprising the MAP message according to the analysis of the information.

According to yet another aspect of the present invention, there is provided a method for receiving data in a communication system. The method includesupon receiving a MAP message before receiving data from a transmitter, analyzing location information of a data burst included in the MAP message and frame offset information defining an offset between a frame to which the data

burst is allocated and a current frame; and receiving the data burst within the frame according to the analyzed location information and the frame offset information.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a diagram illustrating a structure of a downlink frame in a general communication system providing MBS;

FIG. 2 is a diagram illustrating a structure of an MBS frame in a general communication system providing MBS;

FIG. 3 is a diagram illustrating a structure of an MBS frame in a communication system providing MBS according to the present invention;

FIG. 4 is a flowchart schematically illustrating an operation of a receiver in a communication system providing MBS according to the present invention;

FIG. 5 is a flowchart illustrating an operation of a receiver in a communication system providing MBS according to another embodiment of the present invention; and

FIG. 6 is a flowchart illustrating an operation of a transmitter in a communication system providing MBS according to the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail with reference to the annexed drawings. In the following description, a detailed description of known functions and configurations incorporated herein has been omitted for clarity and conciseness.

The present invention proposes a method for transmitting/receiving data in an communication system, for example, Institute of Electrical and Electronics Engineers (IEEE) 802.16 communication system which is a typical Broadband Wireless Access (BWA) communication system. Although the present invention will be described below with reference to an IEEE 802.16 communication system

employing an Orthogonal Frequency Division Multiplexing (OFDM)/Orthogonal Frequency Division Multiple Access (OFDMA) scheme, the data transmission method proposed in the present invention can also be applied to other communication systems.

In addition, the present invention proposes a data transmission/reception method between a transmitter, for example, a base station (BS), for managing a service area and a receiver, for example, a mobile station (MS), for receiving communication service from the transmitter in a communication system, wherein the MS is both fixed and mobile. The present invention proposes a method in which a transmitter transmits Multicast and Broadcast Service (MBS) data to a plurality of receivers located in its coverage area and the receivers receive the transmitted MBS data in a communication system providing MBS.

Further, the present invention proposes a method in which a transmitter previously transmits information related to transmission data to a receiver before a data transmission time before transmitting data in a communication system. Herein, the "information related to transmission data" can include information about a frame in which the data is transmitted, information about a data transmission field allocated for data transmission in the frame, and decoding information for the data. The present invention will be described herein based on the communication system providing the MBS. In the communication system providing the MBS, a downlink MBS frame can be represented with subchannels and symbols in a time domain and a frequency domain as described with reference to FIG. 1, wherein the MBS frame means the frame that includes information of the MBS data or the data burst of the MBS. In addition, the downlink MBS frame includes a preamble field, a DL-MAP field, an MBS-MAP message field, and a plurality of MBS data burst fields. Further, the DL-MAP field includes an MBS_MAP_Information Element (MBS_MAP_IE) field, and the MBS-MAP message field includes an MBS_Data_Information Element (MBS_Data_IE) field.

The preamble field transmits a synchronization signal, i.e., a preamble sequence, for synchronization acquisition between a transmitter and a receiver. The DL-MAP field, a field for transmitting DL-MAP information, includes the

MBS_MAP_IE field to provide MBS, and an MBS_MAP_IE included in the MBS_MAP_IE field provides information for decoding the MBS-MAP message field. A format of the MBS_MAP_IE included in the MBS_MAP_IE field is shown in Table 1. As shown in Table 1, 'Extended Downlink Interval Usage Code (Extended DIUC)' of the MBS_MAP_IE indicates that the MBS_MAP_IE includes MBS-MAP information, and is set to have a value of '0x0A'. 'MBS Zone Identifier' indicates an identifier of the MBS field, 'Macro Diversity Enhanced' indicates whether macro diversity is applied to the MBS field (or MBS zone), and 'Permutation' and 'IDcell' indicate information necessary when the macro diversity is applied to the MBS zone. Herein, the MBS field includes the MBS-MAP message field having the MBS_Data_IE field, and a plurality of MBS data burst fields in FIG. 1.

In addition, 'OFDMA symbol offset' indicates a start offset of an MBS-MAP message in the MBS field, 'DIUC change indication' indicates a change in DIUC to be used for receiving the MBS-MAP message, and 'No. Subchannels' indicates the number of allocated subchannels. Further, 'No. OFDMA Symbols' indicates the number of allocated OFDMA symbols, and 'Repetition coding indication' indicates coding information to be used for decoding the MBS-MAP message.

The present invention reduces an overhead due to the MBS-MAP message that a receiver desiring to receive MBS data from a transmitter receives in a communication system providing MBS, allowing the receiver to transmit the MBS-MAP message within one MBS frame. The present invention proposes a method in which when decoding MBS data using information on MBS data burst fields in which MBS data included in the MBS-MAP message is transmitted, a receiver receives MBS data using either information on the MBS-MAP message transmitted over the current MBS frame, or information on the MBS-MAP message transmitted over a previous MBS frame. In this method, the receiver receives MBS data actually transmitted through the MBS data burst fields, and recognizes a processing time of the MBS data, i.e., a decoding time of the MBS data, using the 'MBS_Burst_Frame_Offset' included in the MBS_Data_IE and the MBS_Data_Time_Diversity_Information Element (MBS_Data_Time_Diversity_IE) of the MBS-MAP message. Herein, the

MBS_Data_IE and the MBS_Data_Time_Diversity_IE indicate field information of the MBS data bursts the receiver will receive. The receiver receives the MBS data transmitted through the MBS data burst fields allocated to the MBS frame at the recognized time according to the recognized information, and processes the received MBS data.

A detailed description will now be made of an MBS-MAP message transmitted through the MBS-MAP message field of the MBS frame and a MBS_Data_IE transmitted through a MBS_Data_IE field included in the MBS-MAP message field in the communication system providing MBS according to the present invention.

Table 4 below shows the format of the MBS-MAP message transmitted through the MBS-MAP message field of the MBS frame in the communication system providing MBS according to the present invention.

Table 4

Syntax	Size(bits)	Notes
MBS-MAP Message format () {		
MBS MAP indicator	5	Shall be set to 11101
Reserved	3	Shall be set to 0
Frame number	4	The frame number is identical to the frame number in the DL-MAP
MBS_DIUC_Change_Count	8	
#MBS_DATA_IE	4	Number of included MBS_DATA_IE
For(i=0;i<n; i++) {		n= #MBS_DATA_IE
MBS_DATA_IE	variable	
}		
#MBS_DATA_Time_Diversity_IE	4	Number of included MBS_DATA_Time_Diversity_IE
For(i=0;i<m; i++) {		m= #MBS_DATA_Time_Diversity_IE
MBS_DATA_Time_Diversity_IE	variable	
}		
If(!byte boundary) {		

Padding nibble	8	
}		
TLV encoding element		
}		

Although Table 4, showing the format of the MBS-MAP message transmitted through the MBS-MAP message field of the MBS frame, provides the information similar to that of the MBS-MAP message of Table 2, the MBS-MAP message of Table 4 does not include the 48-bit Medium Access Control (MAC) Generic Header of Table 2. That is, in the communication system providing MBS according to the present invention, the MBS-MAP message uses a format of an independently provided MAC header without transmitting the 48-bit MAC Generic Header to the receiver.

With reference to Table 4, a detailed description will now be made of the MBS-MAP message in the communication system providing MBS according to the present invention. The MBS-MAP message includes an MBS MAP indicator. The MBS MAP indicator has a value '11101', and two Most Significant Bit (MSB) bits, i.e., first and second MSB bits, of the MBS MAP indicator, indicate information mapped to a Header Type (HT) field and an Encryption (EC) field of the MAC header. A value of the HT field, the first MSB bit of the MBS MAP indicator, indicates whether the MBS-MAP message transmits a general MAC PDU or a bandwidth request message, and the EC field, the second MSB bit of the MBS MAP indicator, indicates whether encryption is applied to the currently transmitted frame. A third MSB bit of the MBS MAP indicator indicates whether the corresponding MAP is a compressed MAP, and the third MSB bit of the MBS MAP indicator being set to '0' indicates a compressed MAP. The last two bits, i.e., fourth and fifth MSB bits, of the MBS MAP indicator indicate that the corresponding MAP is a Sub DownLink UpLink MAP (Sub-DL-UL-MAP). Herein, the fourth and fifth MSB bits of the MBS MAP indicator being set to '00' indicates that the next information is a Sub-DL-UL-MAP, and if the fourth and fifth MSB bits of the MBS MAP indicator are set to '01', it indicates that the next information is a MBS-MAP message. The compressed MAP and the Sub-DL-UL-MAP are not related to the present invention, so a detailed description thereof will

be omitted herein.

That is, a transmitter desiring to transmit the MBS-MAP message to the receiver sets the first and second MSB bits of the MBS MAP indicator to '11', and sets the third MSB bit to '1' to indicate a non-compressed MAP. Further, the transmitter sets the fourth and fifth MSB bits of the MBS MAP indicator to '01' to indicate an MBS-MAP message. As a result, the transmitter sets the MBS MAP indicator of the MBS-MAP message to '11101'. Thereafter, the transmitter transmits the MBS MAP indicator to the receiver through the MBS-MAP message field of the MBS frame, and the receiver, receiving the set MBS MAP indicator of the MBS-MAP message through the MBS-MAP message field of the MBS frame, recognizes that the received information is an MBS-MAP message if the five bits of the MBS MAP indicator are set to '11101'.

Thereafter, the receiver performs decoding on the recognized MBS-MAP message, and decodes MBS data transmitted through MBS data burst fields of the MBS frame using information on the MBS data burst fields included in the MBS-MAP message. In addition, 'Frame number' of the MBS-MAP message indicates the same frame number as a frame number of the DL-MAP, and 'MBS DIUC Change Count' indicates whether the MBS data burst profile is identical to a previous MBS data burst profile.

If a value of the 'MBS DIUC Change Count' is changed, the receiver receiving the MBS-MAP message should receive downlink burst profile information included as Time/Length/Value (TLV) information of the MBS-MAP message. However, if the downlink burst profile information is not included in the MBS-MAP message, the receiver receives the downlink burst profile information through a next Downlink Channel Descriptor (DCD) message. In addition, 'MBS_Data_IE' and 'MBS_Data_Time_Diversity_Information Element' (MBS_Data_Time_Diversity_IE) indicate field information of MBS data bursts the receiver will receive. The MBS_Data_Time_Diversity_IE includes information on MBS data bursts allocated when there is only the MBS burst data for a receiver supporting a Hybrid Automatic Repeat reQuest (HARQ) scheme. The IEs not mentioned in Table 4 are not directly related to the present invention, so a detailed description thereof will be omitted herein.

With reference to Table 5, a description will now be made of the MBS_Data_IE including information on the MBS data burst fields in which MBS data is transmitted.

Table 5

Syntax	Size (bits)	Notes
MBS_DATA_IE {		
MBS_MAP_Type=0	3	MBS_DATA_IE
Next MBS frame indicator	1	0=MBS data burst of the current MBS frame 1=MBS data burst of the next MBS frame
Next MBS MAP change indication	1	This indicates whether the size of MBS MAP message of next MBS frame for these multicast CIDs included this IE will be different from the size of this MBS MAP message.
No. of Multicast CID	3	
For(i=o; i<No. of Multicast CIDs; i++) {		
Multicast CID	12	12 LSBs of CID for multicast
}		
MBS DIUC	4	
OFDMA symbol offset	8	OFDMA symbol offset with respect to start of the MBS portion
Subchannel offset	6	OFDMA subchannel offset with respect to start of the MBS portion
Boosting	3	
No. OFDMA symbols	7	The size of MBS data
No. subchannels	6	
Repetition coding indication	2	0b00=No repetition coding 0b01=Repetition coding of 2 used 0b10=Repetition coding of 4 used 0b11=Repetition coding of 6 used
Next MBS frame offset	8	The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA symbol offset	8	The offset of the OFDMA symbol in which the

		next MBS portion starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.
If(Next MBS MAP change indication=1) {		
Next MBS No. OFDMA symbols	2	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
Next MBS No. OFDMA subchannels	6	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
}		
}		

Table 5 shows IEs of the MBS_Data_IE transmitted through the MBS_Data_IE field. The MBS_Data_IE is included in the MBS-MAP message, and includes information on the MBS data transmitted from the transmitter to the receiver through the MBS data burst fields of the MBS frame. 'MBS_MAP_Type' of the MBS_Data_IE indicates that the IEs of Table 5 are MBS_Data_IE, and 'Next MBS MAP change indication' indicates a change in size of an MBS-MAP message that will come in the next MBS frame. In addition, the MBS_Data_IE transmits information indicating whether the MBS data corresponds to the same MBS frame as the MBS frame in which an MBS-MAP message is currently received, or corresponds to an MBS frame in which the next MBS-MAP will be received, using a Next MBS frame indicator.

In other words, if the Next MBS frame indicator of the MBS_Data_IE is set to '0', the receiver processes, or decodes the MBS data transmitted through the MBS data burst fields in the current MBS frame, recognizing that the information included in the MBS_Data_IE transmitted through the current MBS frame is MBS data will be processed in the current MBS frame. However, if the Next MBS frame indicator is set to '1', the receiver processes, or decodes the

MBS data transmitted through the MBS data burst fields in the next MBS frame, recognizing that the information included in the MBS_Data_IE transmitted through the current MBS frame will be processed in the next MBS frame. In this manner, the receiver receives the MBS data. If the Next MBS frame indicator is set to '1', i.e., if the receiver recognizes that the information included in the MBS_Data_IE transmitted through the current MBS frame is MBS data will be processed in the next MBS frame, the receiver buffers the information on the MBS data burst fields included in the MBS_Data_IE using a specific buffer, and then processes the MBS data transmitted through the MBS data burst files in the next MBS frame.

In addition, 'Next MBS MAP change indication' of the MBS_Data_IE indicates a change in size of an MBS-MAP message that will come in the next MBS frame. 'Multicast Connection Identifier (CID)' indicates multicast identifier information mapped to the MBS_Data_IE, 'OFDMA Symbol Offset' and 'Subchannel Offset' indicate start offsets of the MBS data burst fields, and 'No. Subchannels' indicates the number of subchannels of the MBS data burst fields allocated to the MBS frame. 'No. OFDMA Symbols' indicates the number of OFDMA symbols of the allocated MBS data burst fields, and 'Repetition coding indication' indicates the number of repetitions needed for decoding the MBS data transmitted through the MBS data burst fields.

'Next MBS frame offset' indicates an offset of the next MBS frame, and 'Next MBS OFDMA symbol offset' indicates an offset of a downlink frame OFDMA symbol for receiving the next MBS-MAP message. Herein, the 'Next MBS MAP change indication' being set to '1' means that the 'Next MBS OFDMA symbol offset' includes 'Next MBS No. OFDMA symbols' indicating a size of an MBS-MAP message that will come in the next MBS frame, and 'Next MBS No. OFDMA subchannels'. After receiving the 'Next MBS frame offset' and the 'Next MBS OFDMA symbol offset', the receiver can obtain MBS service information without receiving the MBS_MAP_IE of the DL-MAP. The IEs not mentioned in Table 5 are not directly related to the present invention, so a detailed description thereof will be omitted herein.

A description will now be made of a method for transmitting/receiving

data using the MBS-MAP message and information on the MBS_Data_IE included in the MBS-MAP message in the communication system providing MBS according to the present invention.

FIG. 3 is a diagram illustrating a structure of an MBS frame in a communication system providing MBS according to the present invention. For convenience, in FIG. 3, an MBS-MAP message and information on MBS data burst fields included in the MBS-MAP message are transmitted over two frames of a particular frame n and the next frame (n+1). In other words, FIG. 3 illustrates a structure of an MBS frame for the case where the Next MBS frame indicator of the MBS_Data_IE shown in Table 5 is set to '1', wherein the receiver receives MBS data by processing, or decoding the MBS data transmitted through the MBS data burst fields in the next MBS frame, recognizing that the information included in the MBS_Data_IE transmitted through the current MBS frame, i.e., the MBS frame n, is MBS data will be processed in the next MBS frame, i.e., the MBS frame (n+1). The process for the Next MBS frame indicator='1' has been described, so a description thereof will be omitted herein. Similarly, FIG. 3 illustrates only the MBS field in the downlink MBS frame of FIG. 1, for convenience.

Referring to FIG. 3, an MBS frame n 300 includes an MBS-MAP message field 301, and a plurality of MBS data burst fields of an MBS data burst 1 field 311, an MBS data burst 2 field 313 and an MBS data burst 3 field 315. The MBS-MAP message field 301 includes MBS_Data_IE fields 303, 305, 307 and 309 for processing the MBS data burst fields. In addition, an MBS frame (n+1) 350, the next frame of the MBS frame n 300, includes an MBS-MAP message field 351, and a plurality of MBS data burst fields of an MBS data burst 4 field 355 and an MBS data burst 5 field 357. The MBS-MAP message field 351 includes an MBS_Data_IE 353. The MBS_Data_IE transmitted through the MBS_Data_IE fields 303, 305, 307 and 309 included in the MBS-MAP message field 301 of the MBS frame n 300 includes information on the MBS data burst fields 311, 313, 315 and 355. In addition, the MBS_Data_IE transmitted through the MBS_Data_IE field 353 included in the MBS-MAP message field 351 of the MBS frame (n+1) 350 includes information on the MBS data burst fields 357.

Because the MBS data burst fields 311, 313, 315 and 355 mapped to the MBS_Data_IE transmitted through the MBS_Data_IE fields 303, 305, 307 and 309 included in the MBS-MAP message field 301 of the MBS frame n 300 cannot be wholly allocated to one MBS frame, i.e., the MBS frame n 300, the MBS data burst fields 311, 313, 315 and 355 are allocated to the current MBS frame, i.e., MBS frame n 300, and the next frame, i.e., MBS frame (n+1) 350. At this time, the receiver determines whether the MBS data burst fields 311, 313, 315 and 355 are allocated to the MBS frame n 300 and the MBS frame (n+1) 350, using the Next MBS frame indicator of the MBS_Data_IE transmitted through the MBS_Data_IE fields 303, 305, 307 and 309 included in the MBS-MAP message field 301.

That is, upon receiving the MBS frame n 300, the receiver checks the allocation information of the MBS data burst 1 field 311, the MBS data burst 2 field 313, the MBS data burst 3 field 315 received in the current MBS frame, i.e., MBS frame n 300, using the MBS_Data_IE transmitted through the MBS_Data_IE fields 303, 305 and 307 included in the MBS-MAP message field 301 of the MBS frame #n 300, and decodes the MBS data transmitted through each of the allocated MBS data burst fields 311, 313 and 315. In addition, the receiver checks the allocation information of the MBS data burst #4 field 355 in the MBS frame (n+1) 350 using the MBS_Data_IE transmitted through the MBS_Data_IE field 309 included in the MBS-MAP message field 301 of the MBS frame n 300, and decodes MBS data transmitted through the allocated MBS data burst 4 field 355 in the MBS frame (n+1) frame 350.

More specifically, the MBS data burst 4 field 355 is allocated to the MBS frame (n+1) 350, and a value of the Next MBS frame indicator in the MBS_Data_IE 309 of the MBS frame n 300 having information on the MBS data burst 4 field 355 is set to '1'. The receiver receiving the MBS frame n 300 processes, or decodes, the MBS data transmitted through the MBS data burst 4 field 355 allocated to the MBS frame (n+1) 350 upon receipt of the MBS frame (n+1) 350, recognizing that the MBS data burst 4 field 355 is allocated to the next MBS frame, i.e., the MBS frame (n+1) 350.

In addition, the receiver receiving the MBS frame (n+1) 350 checks the

allocation information of the MBS data burst 5 field 357 received in the current MBS frame, i.e., the MBS frame (n+1) 350, using the MBS_Data_IE transmitted through the MBS_Data_IE field 353 included in the MBS-MAP message field 351 of the MBS frame (n+1) 350, and decodes the MBS data transmitted through the allocated MBS data burst 5 field 357. FIG. 3 illustrates operations 321, 323, 325, 327 and 371 of decoding the MBS data transmitted through the MBS data burst fields 311, 313, 315, 355 and 357, using the MBS_Data_IE in each frame.

FIG. 4 is a flowchart illustrating an operation of a receiver in a communication system providing MBS according to the present invention.

Referring to FIG. 4, in step 401, a receiver receives a DL-MAP message transmitted from a transmitter through a DL-MAP message field allocated to an MBS frame. In step 403, if a DIUC value of the received DL-MAP message shown in Table 4 is set to '0x0A', the receiver decodes an MBS_MAP_IE transmitted through an MBS_MAP_IE field included in the DL-MAP message. Thereafter, in step 405, the receiver acquires location information and decoding information of an MBS-MAP message from the received MBS_MAP_IE, and receives an MBS-MAP message transmitted from the transmitter through an MBS-MAP message field allocated to the MBS frame. A format of the received MBS-MAP message is shown in Table 4.

Next, in step 407, the receiver decodes an MBS_Data_IE including the information on the MBS data burst fields in the MBS frame. That is, the receiver receives an MBS_Data_IE transmitted through the MBS_Data_IE field included in the MBS-MAP message field. In step 409, the receiver determines whether a Next MBS frame indicator of the received MBS_Data_IE shown in Table 5 is set to '1'. If it is determined in step 409 that the Next MBS frame indicator is set to '1', the receiver proceeds to step 411. However, if the Next MBS frame indicator is set to '0', the receiver proceeds to step 413.

In step 411, after waiting from an MBS frame, i.e., the current MBS frame, received at the present time until the time that the next MBS frame is received, the receiver processes, or decodes the MBS data transmitted through the MBS data burst fields allocated to the current MBS frame and the next MBS

frame using information included in the MBS_Data_IE transmitted through an MBS_Data_IE field included in each MBS-MAP message of the current MBS frame and the next MBS frame. The method of processing, or decoding, data transmitted through the MBS data burst fields allocated to the two frames has been described above, so a detailed description will be omitted herein.

Meanwhile, in step 413, the receiver processes, or decodes, MBS data transmitted through MBS data burst fields allocated to the current MBS frame using information included in an MBS_Data_IE in the current MBS frame. The method of processing, or decoding data transmitted through the MBS data burst fields allocated to the one frame has also been described above, so a detailed description will be omitted herein. After processing the MBS data transmitted through the MBS data burst fields allocated to each MBS frame in steps 411 and 413, if the receiver continues to receive the MBS provided from the transmitter, the process returns to step 405 and repeats the operation of step 405 and its succeeding steps.

In FIG. 4, the receiver determines whether the information on the MBS data burst fields included in the MBS_Data_IE of the MBS-MAP message corresponds to the current MBS frame or both of the current MBS frame and the next MBS frame, i.e., whether MBS data burst fields are allocated to two consecutive MBS frames, and then processes, or decodes, the MBS data transmitted through the allocated MBS data burst fields according to the determination results. After receiving the MBS-MAP message in the current MBS frame, the receiver receiving MBS provided from the transmitter may receive MBS data transmitted through MBS data burst fields allocated to an MBS frame following more than two MBS frames including the current MBS frame.

That is, the information on the MBS data burst fields included in the MBS_Data_IE of the MBS-MAP message in the current MBS frame may not only be the current MBS frame or both of the current frame and the next frame but also be the information on the MBS data burst fields allocated to the frame transmitted after the next frame. In this case, the receiver should process, or decode, the data transmitted through the MBS data burst fields in real time.

A description will now be made of a method for decoding received MBS data by a receiver in the case where the information on the MBS data burst fields included in the MBS_Data_IE of the MBS-MAP message in the current MBS frame is not only the current MBS frame or both of the current MBS frame and the next frame but also the information on the MBS data burst fields allocated to the frame transmitted after the next frame in the communication system providing MBS according to the present invention.

In the above case, in the communication system according to the present invention, the receiver previously receives information on the MBS data burst fields to be allocated to the frame following at least two frames through the MBS-MAP message transmitted in the current MBS frame. Thereafter, the receiver decodes the MBS data transmitted through the MBS data burst fields allocated to the frame following the at least two frames using the previously received information. Therefore, the MBS-MAP message transmitted through the MBS-MAP message field allocated to the MBS frame includes information indicating how many frames later from the current MBS frame the frame in which MBS data transmitted through the MBS data burst fields is decoded is located. A format of the MBS_Data_IE including such information is shown in Table 6 below.

Table 6

Syntax	Size (bits)	Notes
MBS_DATA_IE {		
MBS-MAP-Type=0	2	MBS_DATA_IE
MBS_Burst_Frame_Offset	2	This indicates the burst indicated by this IE will be shown after MBS_Burst_Frame_offset + 2 frames.
Next MBS MAP change indication	1	This indicates whether the size of MBS MAP message of next MBS frame for these multicast CIDs included this IE will be different from the size of this MBS MAP message.
No. of Multicast CID	3	
For(i=o; i<No. of Multicast CIDs; i++) {		

Multicast CID	12	12 LSBs of CID for multicast
}		
MBS DIUC	4	
OFDMA symbol offset	8	OFDMA symbol offset with respect to start of the next (MBS_Burst_Frame_offset +2)th frame
Subchannel offset	6	OFDMA subchannel offset with respect to start of the next (MBS_Burst_Frame_offset +2)th frame
Boosting	3	
No. OFDMA symbols	7	The size of MBS data
No. subchannels	6	
Repetition coding indication	2	0b00=No repetition coding 0b01=Repetition coding of 2 used 0b10=Repetition coding of 4 used 0b11=Repetition coding of 6 used
Next MBS frame offset	8	The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA symbol offset	8	The offset of the OFDMA symbol in which the next MBS portion starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.
If(Next MBS MAP change indication=1) {		
Next MBS No. OFDMA symbols	2	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
Next MBS No. OFDMA subchannels	6	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.

}		
}		

Table 6 shows IEs of the MBS_Data_IE transmitted through the MBS_Data_IE field. The MBS_Data_IE is included in the MBS-MAP message, and includes information on the MBS data transmitted from the transmitter to the receiver through the MBS data burst fields of the MBS frame. Herein, MBS_MAP Type='0' means that the MBS_Data_IE is transmitted through the MBS_Data_IE field, MBS_MAP Type='1' means that MBS_Data_Time_Diversity_IE is transmitted through the MBS_Data_IE field, and MBS_MAP Type='2' means that an Extended MBS_MAP_Information Element (Extended MBS_MAP_IE) is transmitted through the MBS_Data_IE field. For both MBS_MAP Type='0' and '2', because the MBS_Data_IE is transmitted through the MBS_Data_IE field and IEs for both cases are identical to each other, the following description will be given for the MBS_MAP Type='0', for convenience.

A detailed description of the MBS_MAP Type='1' in which the MBS_Data_Time_Diversity_IE is transmitted through the MBS_Data_IE field will be made later with reference to Table 7 below.

The MBS_Data_IE includes MBS_Burst_Frame_Offset indicating how many frames later from the frame where the current MBS-MAP message is received the MBS data burst field is allocated, i.e., indicating how many frames later from the current MBS frame the MBS data the MBS data will be received at the receiver. After decoding the MBS_Data_IE, the receiver recognizes the possibility of processing, or decoding the MBS data transmitted through MBS data burst fields allocated to an frame received more than two frames later from the MBS frame where the MBS_Data_IE is received.

In other words, for MBS_Burst_Frame_Offset='0', the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame received the two frames later, recognizing the possibility of receiving MBS data through MBS data burst fields allocated to an frame following two frames later

from the MBS frame where the MBS_Data_IE is received. For MBS_Burst_Frame_Offset='1', the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame received the three frames later, recognizing the possibility of receiving MBS data through MBS data burst fields allocated to an frame following three frames later from the MBS frame where the MBS_Data_IE is received.

Similarly, for MBS_Burst_Frame_Offset='2' or '3', the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame received four or five frames later.

Table 6 shows an exemplary case where the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame corresponding to each MBS_Burst_Frame_Offset value, wherein the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame following two frames. However, it is also possible to extend the two frames to four frames, six frames, eight frames, and so on. The frame corresponding to the MBS_Burst_Frame_Offset value is a factor that varies according to the system situations or characteristics. The IEs not mentioned in Table 6 have been described in detail with reference to Table 5.

In the case where receivers supporting an HARQ scheme receive MBS service from a transmitter, the transmitter transmits an MBS_Data_Time_Diversity_IE instead of the MBS_Data_IE to the receivers along with the MBS-MAP message. A format of the MBS_Data_Time_Diversity_IE included in the MBS-MAP message is shown in Table 7 below.

Table 7

Syntax	Size (bits)	Notes
MBS_DATA_Time_Diversity_IE() {		
MBS_MAP_Type=1	2	MBS_DATA_Time_Diversity_IE
MBS_Burst_Frame_Offset	2	This indicates the burst indicated by this IE will be shown after MBS_Burst_Frame_Offset +2

		frames.
Multicast CID	12	
OFDMA symbol offset	8	This indicates starting position of the region of MBS Bursts with respect to start of the next (MBS_Burst_Frame_Offset +2)th frame
N_EP code	4	
N_SCH code	4	
AI_SN	1	
SPID	2	
ACID	4	
Next MBS MAP change indication	1	This indicates whether the size of MBS MAP message of next MBS frame for these multicast CIDs included this IE will be different from the size of this MBS MAP message.
Next MBS frame offset	8	
Next MBS OFDMA symbol offset	8	
If(Next MBS MAP change indication=1) {		
Next MBS No. OFDMA symbols	2	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
Nest MBS No. OFDMA subchannels	6	It is to indicate the size of MBS_MAP message in Next MBS portion where the BS shall transmit the next MBS frame for multicast CIDs in this IE.
}		
}		

Table 7 shows IEs of the MBS_Data_Time_Diversity_IE transmitted instead of the MBS_Data_IE transmitted through the MBS_Data_IE field included in the MBS-MAP message field of the MBS frame, and the MBS_Data_Time_Diversity_IE is transmitted through the MBS_Data_IE field included in the MBS-MAP message field in which MBS_Data_IE is transmitted.

In the MBS_Data_Time_Diversity_IE, MBS_MAP_Type indicates that IEs of Table 7 are MBS_Data_Time_Diversity_IE. Further, MBS_Burst_Frame_Offset indicates an MBS_Burst_Frame_Offset indicating how many frames later from the frame where the current MBS-MAP message is received, i.e., from the current MBS frame, the MBS data burst fields will be allocated. 'Multicast CID' indicates information on a multicast identifier mapped to the MBS_Data_Time_Diversity_IE, and 'OFDMA symbol offset' indicates a start offset of MBS data burst fields allocated to the frame.

'N_EP code', 'N_SCH code', 'ARQ Identifier_Sequence Number (AI_SN)', 'Sub_Packet IDentifier (SPID)' and 'Hybrid ARQ Channel IDentifier (ACID)' indicate information used for decoding the HARQ data. 'Next MBS MAP change indication' indicates any change in MBS-MAP message to be transmitted through an MBS-MAP message field in the next MBS frame, and 'Next MBS frame offset' indicates an offset of the next MBS frame. 'Next MBS OFDMA symbol offset' indicates an offset of a downlink frame OFDMA symbol for receiving an MBS-MAP message transmitted through the next MBS frame. Next MBS MAP change indication='1' indicates that it includes 'Next MBS No. OFDMA symbols' indicating a size of an MBS-MAP message that will be transmitted through the next MBS frame, and 'Next MBS No. OFDMA subchannels'.

Moreover, after receiving the Next MBS frame offset and the Next MBS OFDMA symbol offset, the receiver can obtain MBS information without receiving the MBS_MAP_IE of the DL-MAP message. Further, after decoding the MBS_Data_Time_Diversity_IE, the receiver recognizes the possibility of receiving MBS data transmitted through MBS data burst fields allocated to an frame received more than two frames later from the MBS frame where the MBS_Data_Time_Diversity_IE is received.

In other words, for MBS_Burst_Frame_Offset='0', the receiver processes, or decodes MBS data transmitted through MBS data burst fields allocated to an frame received the two frames later, recognizing the possibility of receiving the MBS data transmitted through MBS data burst frames allocated to an frame following two frames. For MBS_Burst_Frame_Offset='1', the receiver processes,

or decodes, MBS data transmitted through MBS data burst fields allocated to an frame received the three frames later, recognizing the possibility of receiving the MBS data transmitted through MBS data burst frames allocated to an frame following three frames.

Similarly, for MBS_Burst_Frame_Offset='2' or '3', the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame received four or five frames later. As mentioned above, Table 6 shows an exemplary case where the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame corresponding to each MBS_Burst_Frame_Offset value, wherein the receiver receives the MBS data transmitted through MBS data burst fields allocated to an frame following two frames. However, it is also possible to extend the two frames to four frames, six frames, eight frames, and so on. The frame corresponding to the MBS_Burst_Frame_Offset value is a factor that varies according to the system situations or characteristics. The IEs not mentioned in Table 6 have been described in detail with reference to Table 5.

FIG. 5 is a flowchart illustrating an operation of a receiver in a communication system providing MBS according to the present invention.

Referring to FIG. 5, in step 501, a receiver receives a DL-MAP message transmitted from a transmitter through a DL-MAP message field allocated to an MBS frame. In step 503, if a DIUC value of the received DL-MAP message shown in Table 4, Table 5 and Table 6 is set to '0x0A', the receiver decodes an MBS_MAP_IE transmitted through an MBS_MAP_IE field included in the DL-MAP message. Thereafter, in step 505, the receiver acquires location information and decoding information of an MBS-MAP message from the received MBS_MAP_IE, and receives an MBS-MAP message transmitted from the transmitter through an MBS-MAP message field allocated to the MBS frame. A format of the received MBS-MAP message is shown in Table 2, Table 4.

Next, in step 507, the receiver decodes an MBS_Data_IE or an MBS_Data_Time_Diversity_IE that include information on MBS data burst fields in the MBS frame. That is, the receiver receives the MBS_Data_IE or the MBS_Data_Time_Diversity_IE transmitted through an MBS_Data_IE field

included in an MBS-MAP message field. A format of the MBS_Data_IE is shown in Table 6, and a format of the MBS_Data_Time_Diversity_IE is shown in Table 7.

Thereafter, in step 509, the receiver recognizes an expected reception time of MBS data transmitted through the MBS data burst fields allocated to the frame using MBS_Burst_Frame_Offset information included in the MBS_Data_IE or the MBS_Data_Time_Diversity_IE received in step 507. That is, the receiver recognizes the possibility of receiving the MBS data transmitted through MBS data burst fields allocated to an frame following MBS_Burst_Frame_Offset+2 frames, for example, an frame following two or three frames, and waits for the frame where the MBS data is transmitted through MBS data burst fields actually allocated to the corresponding frame.

In step 511, the receiver determines whether the MBS_Burst_Frame_Offset+2 frames have elapsed. If it is determined in step 511 that MBS_Burst_Frame_Offset+2 frames have elapsed, the receiver proceeds to step 513. In step 513, the receiver processes, or decodes, MBS data transmitted through MBS data burst fields actually allocated to an frame following the MBS_Burst_Frame_Offset+2 frames. However, if it is determined in step 511 that the MBS_Burst_Frame_Offset+2 frames have not elapsed, the receiver proceeds to step 515.

In step 515, the receiver processes an MBS-MAP message transmitted through the next MBS frame, or processes MBS data transmitted through MBS data burst fields of the previous frame, i.e., MBS data transmitted through MBS data burst fields allocated in the current frame corresponding to the information on the MBS data burst fields previously received before the current frame is transmitted. As a result, the receiver can perform an operation in the next MBS frame according to a Next MBS Frame offset included in the MBS_Data_IE or the MBS_Data_Time_Diversity_IE decoded in step 507. This corresponds to the case where a value of the MBS Burst Frame Offset+2 frames is greater than the Next MBS Frame offset.

Alternatively, in step 515, if MBS data burst fields where MBS data is

transmitted are allocated within MBS Burst Frame Offset+2 frames from the current MBS frame based on the MBS Burst Frame Offset provided from the MBS_Data_IE or the MBS_Data_Time_Diversity_IE included in the MBS-MAP message of the previous MBS frame, the receiver receives MBS data transmitted through the MBS data burst fields. As a result, the receiver receives MBS data transmitted through MBS data burst fields allocated to an frame following a predetermined frame using the MBS_Burst_Frame_Offset in the MBS_Data_IE and the MBS_Data_Time_Diversity_IE shown in Table 6 and Table 7.

FIG. 6 is a flowchart illustrating an operation of a transmitter in a communication system providing MBS according to the present invention.

Referring to FIG. 6, in step 601, a transmitter determines an MBS Burst Frame Offset value according to the MBS data to be transmitted to a receiver, in order to allocate the MBS data burst fields, in which the MBS data is transmitted, to an frame. Thereafter, in step 603, the transmitter generates an MBS_Data_IE or an MBS_Data_Time_Diversity_IE of an MBS-MAP message including the determined MBS Burst Frame Offset value as shown in Table 6 or Table 7.

In step 605, the transmitter transmits a DL-MAP message including location information of an MBS-MAP message with the generated MBS_Data_IE or MBS_Data_Time_Diversity_IE. Herein, the location information of the MBS-MAP message includes location information of an MBS-MAP message field and an MBS_Data_IE field included the MBS-MAP message field in the downlink MBS frame, and a plurality of MBS data burst fields. That is, in step 605, the transmitter transmits all information for the MBS data transmission/reception to the receiver so that the receiver may process, or decode, the MBS data that the transmitter itself provides to the receiver. Thereafter, in step 607, the transmitter transmits MBS data to the receiver through the corresponding MBS data burst fields in MBS Burst Frame Offset+2 frames according to the MBS_Data_IE or the MBS_Data_Time_Diversity_IE included in the MBS-MAP message.

As can be understood from the foregoing description, the present invention newly defines a service MAP message and a service data information element according to the service data to be transmitted to a receiver receiving

communication service in a communication system. This contributes to an increase in resource efficiency during the transmission of the service MAP message and a reduction in overhead due to the service MAP message. The receiver recognizes the frame where the service data is transmitted by receiving the newly defined service MAP message and service data information elements. As a result, the receiver can decode the service data without error. In addition, a transmitter transmits the newly defined service MAP message and service data information elements to the receiver, to inform the receiver of a decoding time of the service data, thereby enabling real-time service data processing between the transmitter and the receiver and thus reducing the required transmission/reception load.

While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A method for transmitting data in a communication system, comprising the steps of:

generating transmission data to be transmitted to a receiver;

allocating the transmission data to a frame;

setting a MAP message that includes information on a frame offset related to the frame; and

transmitting to the receiver the MAP message.

2. The method of claim 1, wherein the frame offset indicates that the frame will be shown after a plurality of frames from the current frame comprising the frame offset.

3. The method of claim 2, wherein a number of the plurality of frames is equal to the sum of the frame offset and a predetermined number of frames.

4. The method of claim 1, wherein the MAP message includes information on a position of the transmission data within the frame.

5. The method of claim 4, wherein the information on the position includes information relating to a symbol offset within the frame.

6. The method of claim 4, wherein the information on the position includes information relating to a subchannel offset within the frame.

7. The method of claim 1, wherein the MAP message includes data time diversity information when the receiver supports a hybrid automatic repeat request scheme.

8. The method of claim 1, wherein the MAP message includes a MAP indicator of a number of bits indicating a MAP message, and the MAP indicator includes type information of a medium access control header, encryption field information, compressed MAP information, and sub downlink-uplink MAP information.

9. The method of claim 1, further comprising the step of:

buffering the allocated transmission data for a plurality of frames and transmitting the buffered transmission data within the frame to the receiver.

10. A method for receiving data in a communication system, comprising the steps of:

receiving a MAP message that includes information on a frame offset related to a data burst before receiving the data burst from a transmitter;

analyzing the information on the frame offset; and

receiving from the transmitter the data burst within the n-th frame flowing a frame comprising the MAP message according to the analysis of the information.

11. The method of claim 10, wherein the n is equal to the sum of the frame offset and a predetermined minimum frame offset.

12. The method of claim 10, wherein the MAP message includes information on a position of the data burst within the n-th frame.

13. The method of claim 12, wherein the information on the position includes information relating to a symbol offset of the data burst within the n-th frame.

14. The method of claim 12, wherein the information on the position includes information relating to a subchannel offset of the data burst within the n-th frame.

15. The method of claim 10, wherein the MAP message includes data time diversity information when the receiver supports a hybrid automatic repeat request scheme.

16. The method of claim 10, wherein the MAP message includes a MAP indicator of a number of bits indicating a MAP message, and the MAP indicator includes type information of a medium access control header, encryption

field information, compressed MAP information, and sub downlink-uplink MAP information.

17. A method for transmitting data in a communication system, comprising the steps of:

upon generation of data to be transmitted to a receiver, determining a transmission field of the generated data, and allocating the determined transmission field to a frame;

setting in transmission field information location information of the transmission field allocated to the frame and frame offset information defining an offset between the frame to which the transmission field is allocated and a reference frame; and

transmitting to the receiver a MAP message including the set transmission field information.

18. The method of claim 17, wherein the reference frame includes the MAP message.

19. The method of claim 17, wherein the offset between the frame to which the transmission field is allocated and the reference frame is equal to the sum of the frame offset information and a predetermined number of frames.

20. The method of claim 17, wherein the location information includes information on a position of the transmission data within the frame to which the transmission field is allocated.

21. The method of claim 20, wherein the information on the position includes information relating to a symbol offset and a subchannel offset within the frame.

22. The method of claim 17, wherein the MAP message includes data time diversity information when the receiver supports a hybrid automatic repeat request scheme.

23. The method of claim 17, further comprising the step of:

buffering the generated data for the offset and transmitting the buffered data within the frame to the receiver.

24. The method of claim 17, wherein the MAP message includes a MAP indicator of a number of bits indicating a MAP message, and the MAP indicator includes type information of a medium access control header, encryption field information, compressed MAP information, and sub downlink-uplink MAP information.

25. A method for receiving data in a communication system, comprising the steps of:

upon receiving a MAP message before receiving data from a transmitter, analyzing location information of a data burst included in the MAP message and frame offset information defining an offset between a frame to which the data burst is allocated and a current frame; and

receiving the data burst within the frame according to the analyzed location information and the frame offset information.

26. The method of claim 25, wherein the current frame includes the MAP message.

27. The method of claim 25, wherein the offset between the frame to which the data burst is allocated and the current frame is equal to the sum of the frame offset information and a predetermined number of frames.

28. The method of claim 25, wherein the location information includes symbol offset information and subchannel offset information of the data burst within the frame to which the data burst is allocated.

29. The method of claim 25, wherein the MAP message includes data time diversity information when the receiver supports a hybrid automatic repeat request scheme, and the data time diversity information includes the location information and the offset information.

30. The method of claim 25, wherein the MAP message includes a MAP indicator of a number of bits indicating a MAP message, and the MAP

indicator includes type information of a medium access control header, encryption field information, compressed MAP information, and sub downlink-uplink MAP information.

31. A method for transmitting data in a communication system, comprising the steps of:

upon generation of data to be transmitted to a receiver, determining a transmission field of the generated data;

determining offset of frame including the transmission field;

setting in data information offset information defining the offset of frame and location information of the transmission field according to the offset information; and

transmitting to the receiver a MAP message including the set data information.

32. The method of claim 31, wherein the offset information is used to inform the receiver that the data will be transmitted through a transmission field included to a frame following a number of frames from the frame including the MAP message.

33. The method of claim 31, wherein the location information includes symbol offset information and subchannel offset information which indicate start offset of the transmission field included to the frame.

34. The method of claim 31, wherein the MAP message includes data time diversity information when the receiver supports a hybrid automatic repeat request scheme, and the data time diversity information includes the information on the transmission field.

35. The method of claim 34, wherein the generated data is transmitted to the receiver through a transmission field for the frame according to the transmission field information.

36. The method of claim 31, wherein the MAP message includes a MAP indicator of a number of bits indicating a MAP message, and the MAP

indicator includes type information of a medium access control header, encryption field information, compressed MAP information, and sub downlink-uplink MAP information.

37. A method for transmitting multicast broadcast service (MBS) data of a base station (BS) in a broadband wireless access (BWA) communication system, the method comprising the steps of:

determining a frame offset of MBS data burst, a frame comprising the MBS data burst is the n-th frame following the current frame comprising the frame offset;

determining a position of the MBS data burst within the n-th frame;

setting information of the frame offset and the position in a message; and

transmitting the message to a mobile station.

38. The method of claim 37, wherein the 'n' is equal to the sum of the frame offset and a predetermined minimum frame offset value.

39. The method of claim 37, wherein the information of the frame offset and the position comprises information relating to a symbol offset within the n-th frame.

40. The method of claim 37, wherein the information of the frame offset and the position comprises information relating to a subchannel offset within the n-th frame.

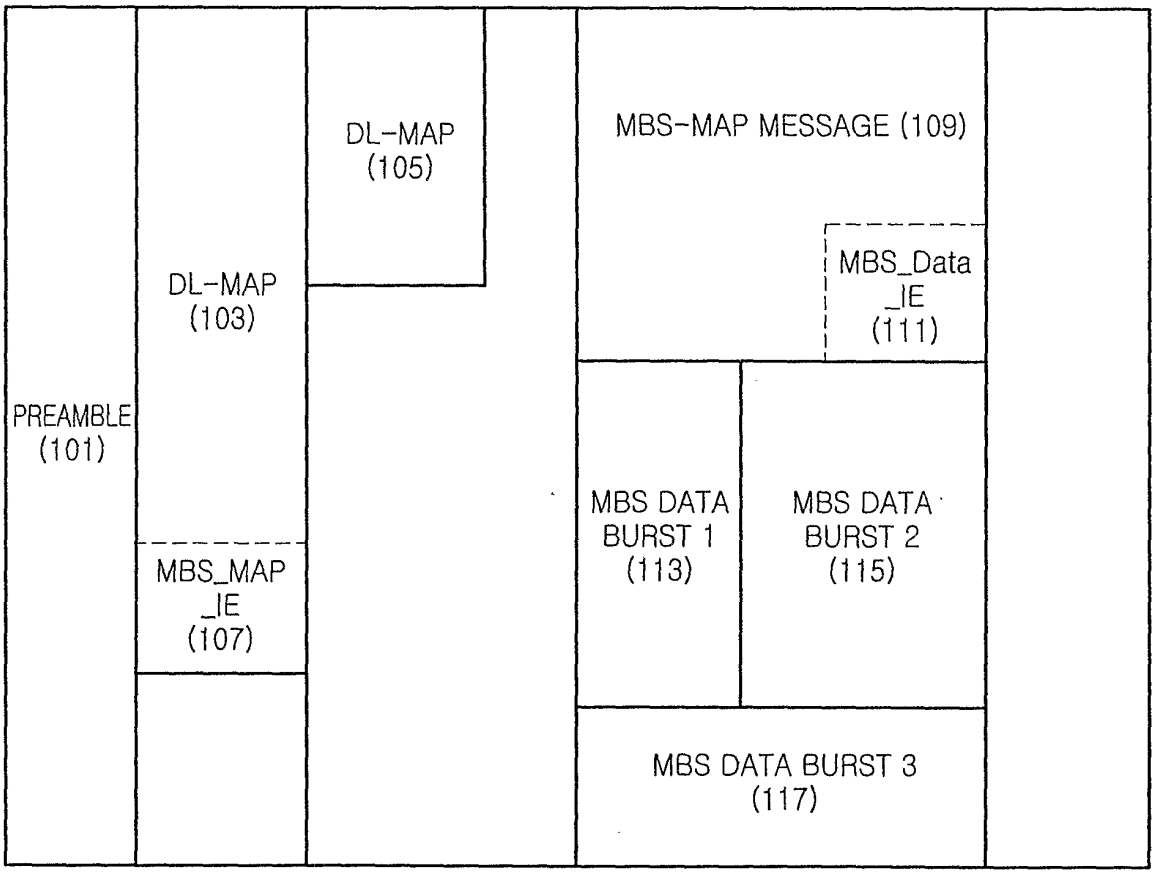

PREAMBLE
(101)
DL-MAP
(103)
MBS_MAP
_IE
(107)
DL-MAP
(105)
MBS-MAP MESSAGE (109)
MBS_Data
_IE
(111)
MBS DATA
BURST 1
(113)
MBS DATA
BURST 2
(115)
MBS DATA BURST 3
(117)

FIG.1

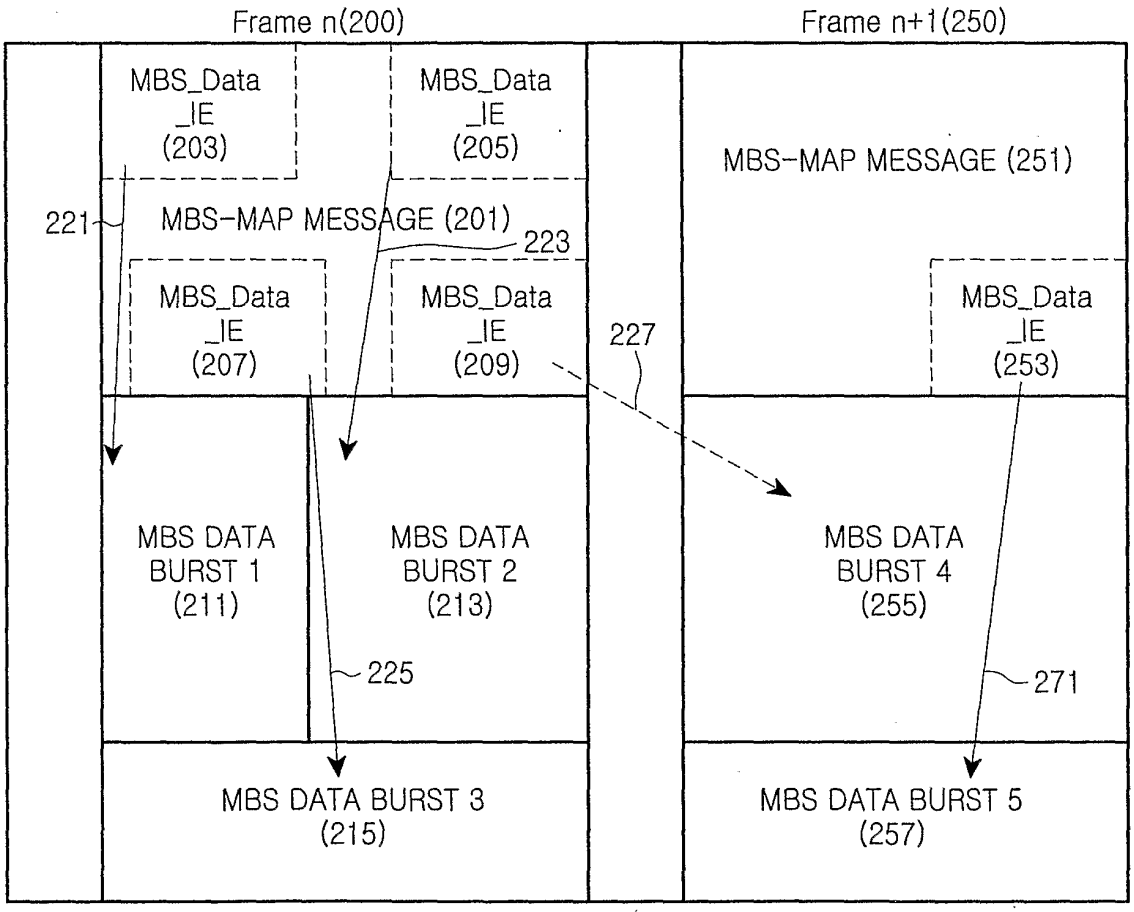

Frame n(200)
Frame n+1(250)
MBS_Data _IE (203)
MBS_Data _IE (205)
MBS-MAP MESSAGE (251)
221
MBS-MAP MESSAGE (201)
223
MBS_Data _IE (207)
MBS_Data _IE (209)
227
MBS_Data _IE (253)
MBS DATA BURST 1 (211)
MBS DATA BURST 2 (213)
MBS DATA BURST 4 (255)
225
271
MBS DATA BURST 3 (215)
MBS DATA BURST 5 (257)

FIG.2

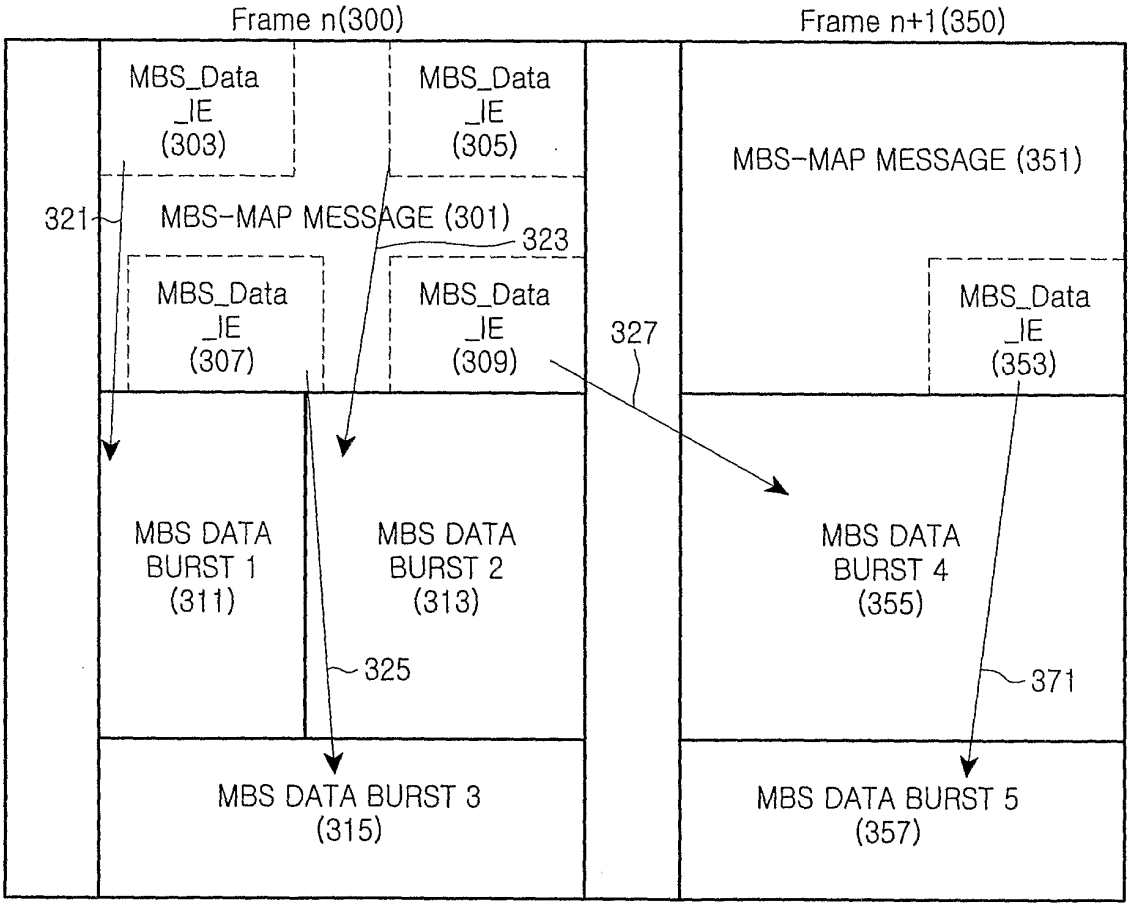

Frame n(300)
Frame n+1(350)
MBS_Data _IE (303)
MBS_Data _IE (305)
MBS-MAP MESSAGE (351)
321
MBS-MAP MESSAGE (301)
323
MBS_Data _IE (307)
MBS_Data _IE (309)
327
MBS_Data _IE (353)
MBS DATA BURST 1 (311)
MBS DATA BURST 2 (313)
MBS DATA BURST 4 (355)
325
371
MBS DATA BURST 3 (315)
MBS DATA BURST 5 (357)

FIG.3

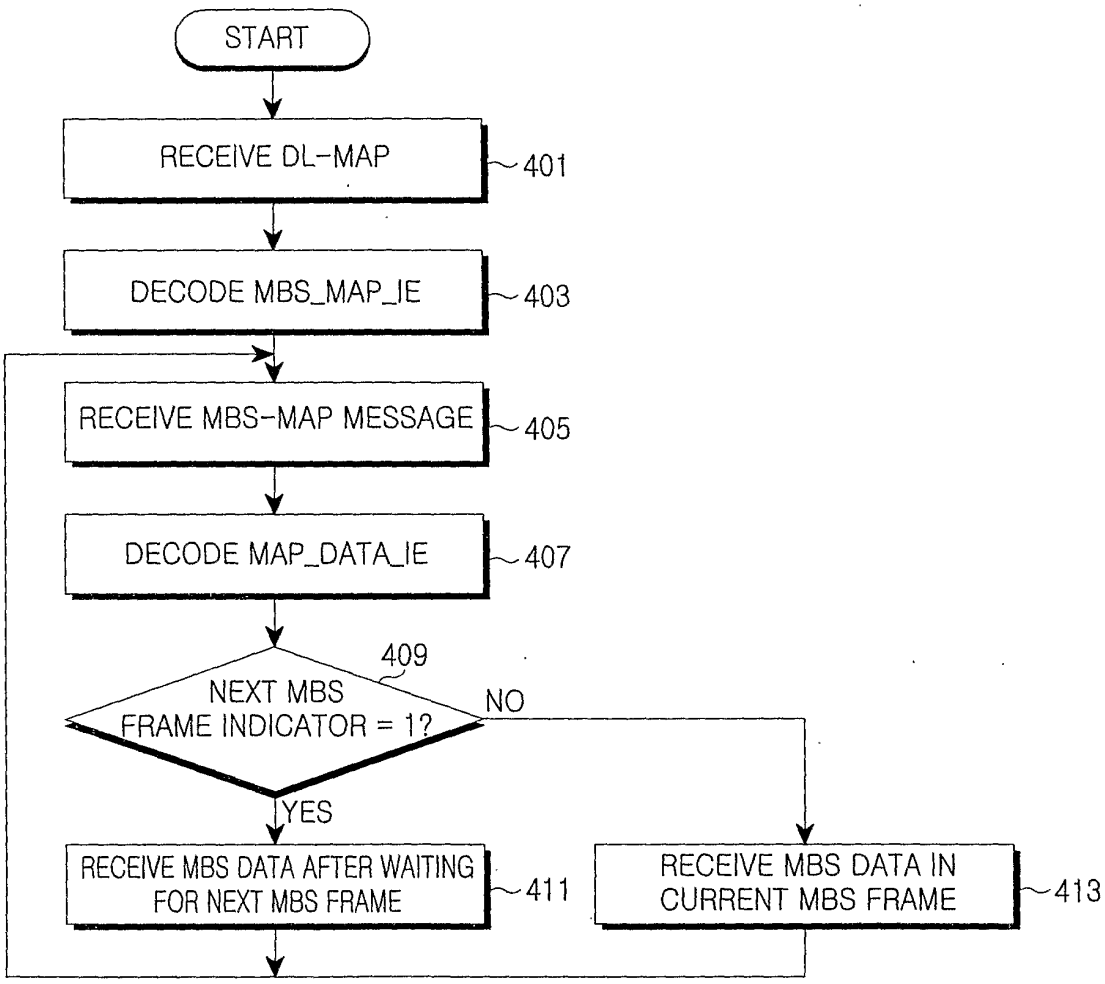

START
RECEIVE DL-MAP
401
DECODE MBS_MAP_IE
403
RECEIVE MBS-MAP MESSAGE
405
DECODE MAP_DATA_IE
407
409
NEXT MBS FRAME INDICATOR = 1?
NO
YES
RECEIVE MBS DATA AFTER WAITING FOR NEXT MBS FRAME
411
RECEIVE MBS DATA IN CURRENT MBS FRAME
413

FIG.4

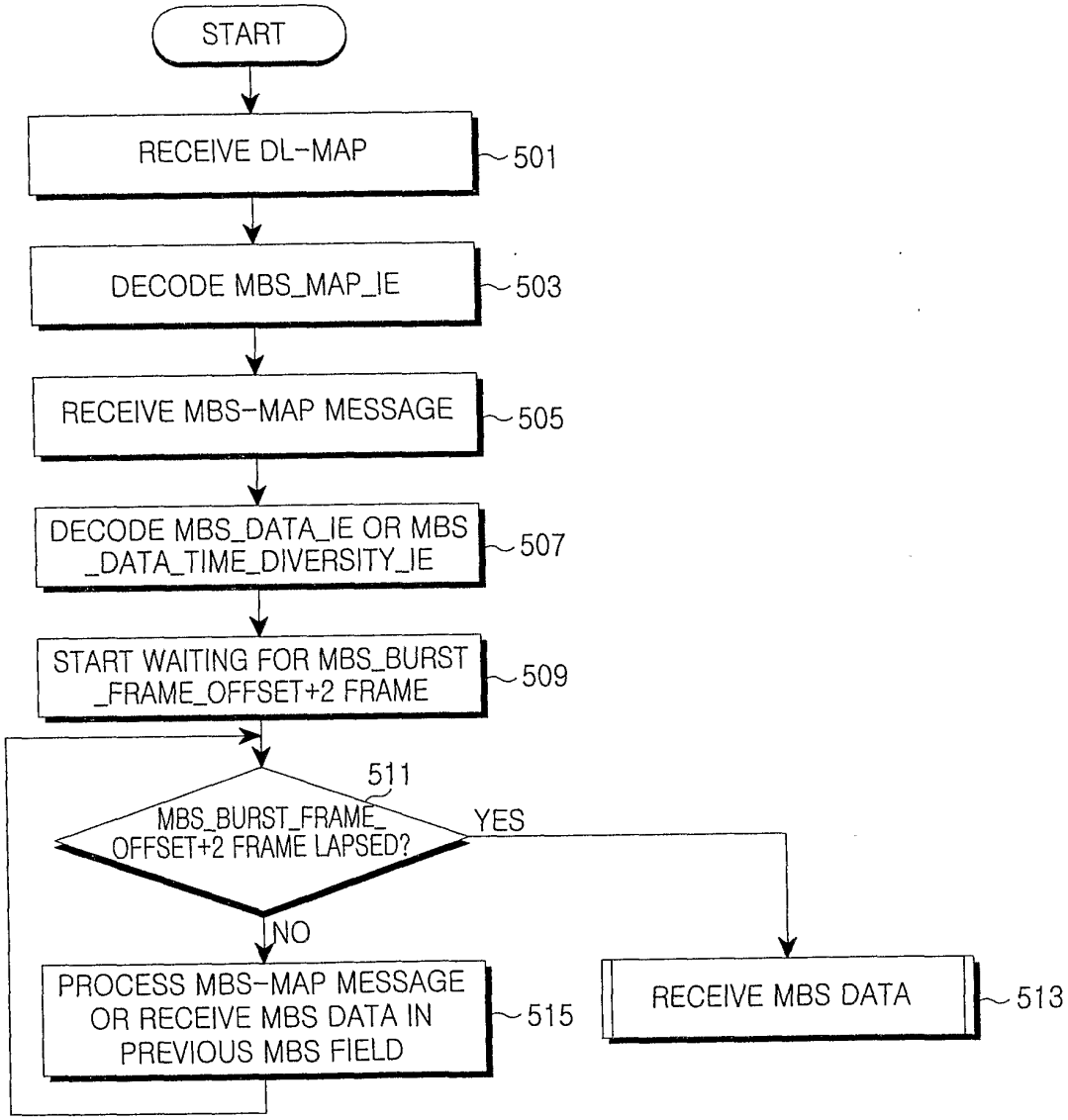

START
RECEIVE DL-MAP
501
DECODE MBS_MAP_IE
503
RECEIVE MBS-MAP MESSAGE
505
DECODE MBS_DATA_IE OR MBS _DATA_TIME_DIVERSITY_IE
507
START WAITING FOR MBS_BURST _FRAME_OFFSET+2 FRAME
509
511
MBS_BURST_FRAME_ OFFSET+2 FRAME LAPSED?
YES
NO
PROCESS MBS-MAP MESSAGE OR RECEIVE MBS DATA IN PREVIOUS MBS FIELD
515
RECEIVE MBS DATA
513

FIG.5

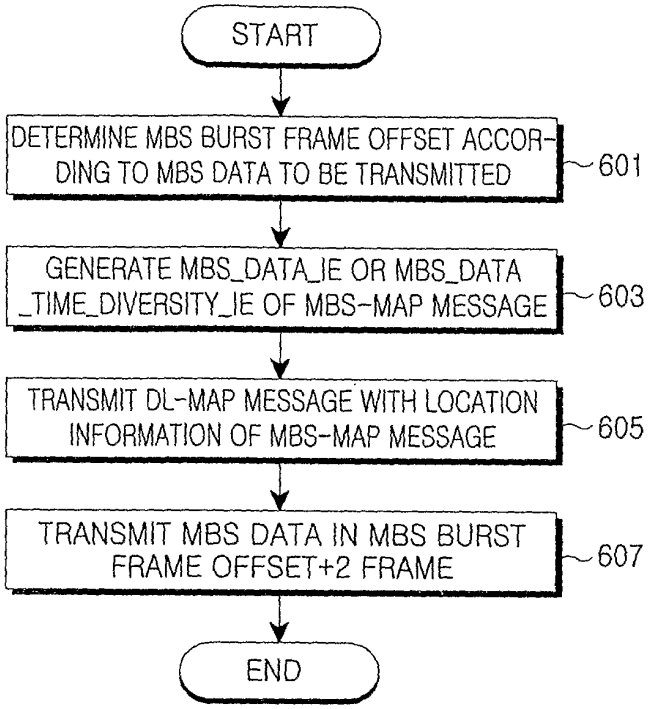

START
DETERMINE MBS BURST FRAME OFFSET ACCORDING TO MBS DATA TO BE TRANSMITTED
601
GENERATE MBS_DATA_IE OR MBS_DATA_TIME_DIVERSITY_IE OF MBS-MAP MESSAGE
603
TRANSMIT DL-MAP MESSAGE WITH LOCATION INFORMATION OF MBS-MAP MESSAGE
605
TRANSMIT MBS DATA IN MBS BURST FRAME OFFSET+2 FRAME
607
END

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/001557

A. CLASSIFICATION OF SUBJECT MATTER

H04H 1/00(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: H04J H04B H04L

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

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
PAJ, FPD, USPAT, eKIPASS, IEEE "MULTICAST""MBS""MAP""NEXT""OFDM"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	IEEE C802/16e-05/111 (SAMSUNG ELECTRONICS) 09 MARCH 2005 see the whole document	1-40
Y	IEEE C802.16e-04/444r2 (SAMSUNG ELECTRONICS) 15 NOVEMBER 2004 see the whole document	1-40

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"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
"T" 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 JUNE 2006 (29.06.2006)	**29 JUNE 2006 (29.06.2006)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer CHEKAL Hyun Telephone No. 82-42-481-5667

Form PCT/ISA/210 (second sheet) (April 2005)

PUB-NO: WO2006115368A1
DOCUMENT-IDENTIFIER: WO 2006115368 A1
TITLE: METHOD FOR TRANSMITTING/RECEIVING DATA IN A COMMUNICATION SYSTEM
PUBN-DATE: November 2, 2006
PATENT-FAMILY-ID: 36699210

INVENTOR-INFORMATION:

NAME	COUNTRY
LEE GEUN-HO	KR
JOO PAN-YUH	KR
KOO CHANG-HOI	KR
LEE SUNG-JIN	KR
SON YEONG-MOON	KR
LIM HYOUNG-KYU	KR
SON JUNG-JE	KR
KANG HYUN-JEONG	KR

APPLICANT:

NAME	COUNTRY
SAMSUNG ELECTRONICS CO LTD	KR

APPL-NO: KR 2006001557 W
APPL-DATE: April 25, 2006

PRIORITY-DATA:

PRIORITY-NO	PRIORITY-APPL-DATE
KR 20050036436 A	20050429
KR 20050034254 A	20050425

CPC-CURRENT:

TYPE	CPC/DATE
CPCI	H04L5/0007 20130101
CPCI	H04L5/0053 20130101
CPCI	H04L5/0091 20130101
CPCI	H04L5/0094 20130101

CPCA	H04W72/005 20130101
CPCA	H04W72/042 20130101

INT-CL-CURRENT:

TYPE	**IPC/DATE**
IPCP	H04H1/00 20060101
IPCS	H04W72/12 20090101
IPCS	H04L29/08 20060101
IPCS	H04L12/70 20130101
IPCN	H04W28/06 20090101
IPCN	H04W28/04 20090101

REF-CITED:

PHASE-COUNTRY/NUMBER/KIND/DATE-NPL-INFO

SER 'Editorial corrections to chapter 11' IEEEC802.16E/444 15 November 2004, pages 1 - 4, XP003003147

SER 'MBS Correction' IEEE C802/16E-05/111 09 March 2005, pages 1 - 5, XP003003146

ABSTRACT:

Provided is a method for transmitting/receiving data in a communication system providing Multicast/Broadcast Service (MBS). The method includes, generating transmission data to be transmitted to a receiver; allocating the transmission data to a frame; setting a MAP message that includes information on a frame offset related to the frame; and transmitting to the receiver the MAP message.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13115811	PARTOVI ET AL.
	Examiner	Art Unit
	SAMUEL BERHANU	2859

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
320	108	3/22/2013	SB
320	150	3/22/2013	SB
	Updated	2/24/2014	SB

SEARCH NOTES		
Search Notes	Date	Examiner
EAST inventor and PLUS search conducted----------see printout	3/22/2013	SB

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13115811
Filing Date	2011-05-25
First Named Inventor	Partovi, Afshin
Art Unit	2859
Examiner Name	Berhanu, Samuel
Attorney Docket Number	AFPA-01007US1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6803774		2004-10-12	Park	
	2	8169185		2012-05-01	Partovi et al.	
	3	5744933		1998-04-28	Inoue et al.	
	4	4800328		1989-01-24	Bolger et al.	
	5	7151357		2006-12-19	Xian et al.	
	6	5889384		1999-05-30	Hayes et al.	
	7	5434493		1995-07-18	Woody et al.	

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(Not for submission under 37 CFR 1.99)	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100007307		2010-01-14	Barrman et al.	
	2	20080272889		2008-11-06	Symons et al.	
	3	20100277121		2010-11-04	Hall et al.	
	4	20110012556		2011-01-20	Lai	
	5	20020089305		2002-11-07	Park et al.	
	6	20020093309		2002-07-18	Peele et al.	
	7	20070279002		2007-12-07	Partovi et al.	
	8	20090096413		2009-04-16	Partovi et al.	
	9	20110187318		2011-08-04	Hui et al.	
	10	20110221387		2011-09-15	Steigerwald et al.	

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	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

	11	20110221391		2011-09-15	Won et al.		
	12	20100201313		2010-08-12	Vorenkamp et al.		
	13	20100213895		2010-08-26	Keating et al.		
	14	20100327804		2010-12-30	Takahashi et al.		
	15	20110057606		2011-03-10	Saunamaki et al.		
	16	20070139000		2007-06-21	Kozuma		
	17	20110050164		2011-03-03	Partovi et al.		

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	JP/2006-246633A	JP		2006-09-14	Kamitsuma Yosuke et al.		☐
	2	JP/2006-500894A	JP		2006-01-05	Beart et al.		☐

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	Attorney Docket Number	AFPA-01007US1

	3	2011/156768 A2	WO		2011-12-15	Partovi		☐

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report dated June 14, 2013, International Application No. PCT/US2013/033352 filed March 21, 2013, 3 pages	☐

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EXAMINER SIGNATURE

Examiner Signature	/Samuel Berhanu/	Date Considered	02/24/2014

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	First Named Inventor	Partovi, Afshin	
	Art Unit	2859	
	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☒ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Karl Kenna/	Date (YYYY-MM-DD)	2013-10-29
Name/Print	Karl Kenna	Registration Number	45,445

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
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Application Number	13115811
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First Named Inventor	Partovi, Afshin
Art Unit	2859
Examiner Name	Berhanu, Samuel
Attorney Docket Number	AFPA-01007US1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7804054		2010-09-28	Shalom	
	2	4873677		1989-10-10	Sakamoto	
	3	6301128		2001-10-09	Jang	
	4	5600225		1997-02-04	Goto	
	5	5963012		1999-10-05	Garcia	
	6	6870089		2005-03-02	Gray	
	7	3938018		1976-02-10	Dahl	
	8	5991170		1999-11-23	Nagai	

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	Art Unit	2859	
	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

	9	5550452		1996-08-27	Shirai	
	10	6310465		2001-10-30	Najima	
	11	7026789		2006-04-11	Bozzone	
	12	7399202		2008-07-15	Dayan	
	13	6184654		2001-02-06	Bachner	
	14	7355150		2008-04-08	Baarman	
	15	7855529		2010-12-21	Xun Liu	
	16	7872445		2011-01-18	Shu-Yuen Ron Hui	
	17	6888438		2005-05-03	Shu-Yuen Ron Hui	
	18	6501364		2002-12-31	Shu-Yuen Ron Hui	
	19	6913477		2005-07-05	Dayan	

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	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

	20	4415959		1983-11-15	Vinciarelli	
	21	7311526		2007-12-25	Rohrbach	
	22	7645143		2010-01-12	Rohrbach	
	23	7554316		2009-06-30	Stevens et al.	
	24	7605496		2009-10-20	Stevens et al.	
	25	7164245		2007-01-16	Chen	
	26	8035255		2011-10-11	Kurs et al.	
	27	7825543		2010-11-02	Karalis et al.	
	28	7741734		2010-06-22	Joannopoulos et al.	
	29	8049370		2011-11-01	Azancot et al.	
	30	7906936		2011-03-15	Azancot et al.	

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	31	8040103		2011-10-18	Hui et al.	
	32	7495414		2009-02-24	Hui	
	33	5642087		1997-06-24	Crow	
	34	4731585		1988-03-15	Fox	
	35	7781916		2010-08-24	Boys	
	36	8050068		2011-11-01	Hussmann et al.	
	37	D639734		2011-06-14	Ferber et al.	
	38	D625721		2010-10-19	Ferber et al.	
	39	D624316		2010-09-28	Ferber et al.	
	40	D611408		2010-03-09	Ferber et al.	
	41	D611407		2010-03-09	Webb	

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	42	D607879		2010-01-12	Ferber et al.	
	43	D603603		2009-11-10	Laine et al.	
	44	D636333		2011-04-19	Kulikowski	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100259401		2010-10-14	Azancot	
	2	20100257382		2010-10-07	Azancot	
	3	20100253282		2010-10-07	Azancot	
	4	20100244584		2010-09-30	Azancot	
	5	20100219698		2010-09-02	Azancot	
	6	20100219697		2010-09-02	Azancot	

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	7	20100219693		2010-09-02	Azancot	
	8	20100219183		2010-09-02	Azancot	
	9	20100194336		2010-08-05	Azancot	
	10	20100181841		2010-07-22	Azancot	
	11	20100073177		2010-03-25	Azancot	
	12	20100072825		2010-03-25	Azancot	
	13	20100070219		2010-03-18	Azancot	
	14	20100066176		2010-03-18	Azancot	
	15	20090257259		2009-10-15	Leibovitz	
	16	20060021926		2006-02-02	Woodard	
	17	20080067874		2008-03-20	Tseng	

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	18	20080164839		2008-07-10	Kato	
	19	20090015075		2009-01-15	Cook	
	20	20090033564		2009-02-05	Cook	
	21	20110217927		2011-09-08	Ben-Shalom et al.	
	22	20110157137		2011-06-30	Ben-Shalom	
	23	20110121660		2011-05-26	Azancot et al.	
	24	20110062793		2011-03-17	Azancot et al.	
	25	20100181845		2010-07-22	Fiorello et al.	
	26	20100181843		2010-07-22	Schatz et al.	
	27	20100187911		2010-07-29	Joannopoulos et al.	
	28	20100171368		2010-07-08	Schatz et al.	

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	29	20100164298		2010-07-01	Karalis et al.	
	30	20100164297		2010-07-01	Kurs et al.	
	31	20100164296		2010-07-01	Kurs et al.	
	32	20100148589		2010-06-17	Hamam et al.	
	33	20100141042		2010-06-10	Kesler et al.	
	34	20100133920		2010-06-03	Joannopoulos et al.	
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	Art Unit	2859	
	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

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☒ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Karl F. Kenna/	Date (YYYY-MM-DD)	2013-10-29
Name/Print	Karl F. Kenna	Registration Number	45445

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	European Search Report and Search Opinion in connection with Europe Application 08747863.2 (European National Stage application of PCT/US2008/063084) dated April 2, 2013, 7 pages.	☐
	2	Office Action in connection with Chinese Application 200880023854.4 (Chinese National Stage application of PCT/US2008/063084) dated August 28, 2012, 18 pages.	☐

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Receipt date: 10/29/2013	Application Number	13115811 13115811 - GAU: 2859
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2011-05-25
	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	3	Office Action in connection with Application No. 12/769,586 dated August 27, 2013, 15 pages.	☐
	4	Office Action in connection with Application No. 13/352,096 dated September 11, 2013, 12 pages.	☐
	5	Office Action in connection with Application No. 13/709,937 dated September 12, 2013, 7 pages.	☐
	6	Office Action in connection with Application No. 12/769,586 dated December 13, 2012, 19 pages.	☐
	7	Office Action in connection with Application No. 13/708,827 dated June 26, 2013, 22 pages.	☐
	8	Office Action in connection with Application No. 13/708,838 dated June 24, 2013, 27 pages.	☐
	9	PCT International Search Report in connection with PCT Application No. PCT/US2011/040062 dated February 17, 2012, 9 pages.	☐
	10	Office Action in connection with Application No. 13/708,548 dated June 7, 2013, 5 pages.	☐
	11	Office Action in connection with Application No. 13/115,811 dated March 28, 2013, 13 pages.	☐
	12	Office Action in connection with Application No. 13/708,520 dated May 24, 2013, 7 pages.	☐
	13	Office Action in connection with Application No. 13/158,134 dated June 12, 2013, 15 pages.	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2011-05-25
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	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	14	Office Action in connection with Application No. 13/709,983 dated June 7, 2013, 7 pages.	☐
	15	Office Action in connection with Application No. 13/710,017 dated June 11, 2013, 7 pages.	☐
	16	Office Action in connection with Application No. 13/710,062 dated June 7, 2013, 7 pages.	☐
	17	Office Action in connection with Japanese Application JP/2010-507666 (Japanese National Stage application of PCT/US2008/063084) dated December 3, 2012, 4 pages.	☐
	18	Office Action in connection with Application No. 12/769,586 dated December 13, 2012, 19 pages.	☐
	19	International Search Report and Written Opinion of the International Searching Authority, Korean Intellectual Property Office, in re International Application No. PCT/US2010/032845 dated December 13, 2010, 10 pages.	☐
	20	WildCharge Life unplugged!, http://www.wildcharg.com/4/17/2009, 2 pages	☐
	21	Powermat "the Future of Wireless Power has Arrived", http://www.pwrmat.com,4/15/2009, 2 pages	☐
	22	eCoupled Wireless Power Technology Fulton Innovation, http://www.ecoupled.com, 4/15/2009, 5 pages	☐
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	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	25	Office Action in connection with Application No. 11/757,067 dated October 19, 2009, 14 pages.	☐
	26	Office Action in connection with Application No. 11/757,067 dated May 10, 2010, 15 pages.	☐
	27	Office Action in connection with Application No. 13/113,977 dated November 9, 2012, 9 pages	☐
	28	Office Action in connection with Application No. 11/669,113 dated October 29, 2008, 11 pages.	☐
	29	Office Action in connection with Application No. 11/669,113 dated August 25, 2009, 17 pages.	☐
	30	Office Action in connection with Application No. 11/669,113 dated May 13, 2010, 20 pages	☐
	31	Office Action in connection with Application No. 12/116,876 dated May 2, 2011, 5 pages.	☐
	32	Office Action in connection with Application No. 13/442,698 dated September 13, 2012, 6 pages.	☐
	33	PCT International Search Report in connection with PCT application No. PCT/US2008/63084, 8 pages, dated August 8, 2008.	☐
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	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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	Art Unit	2859	
	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☒ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Karl Kenna/	Date (YYYY-MM-DD)	2013-10-29
Name/Print	Karl Kenna	Registration Number	45,445

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Afshin Partovi
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6844702		2005-01-18	Giannopoulos	

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	1	20060238930		2006-10-26	Baarman	

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	1	2004030176	WO		2004-04-08	Splashpower Limited		☐

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	First Named Inventor	Afshin Partovi
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	1	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/708, 548, November 20, 2013, 5 pages.	☐
	2	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/115, 811, September 23, 2013, 17 pages.	☐
	3	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/708,584, September 13, 2013, 16 pages.	☐
	4	UNKNOWN AUTHOR, System Description Wireless Power Transfer, Volume I: Low Power Part 1: Interface Definition, Version 1.0, July 2010, 83 pages.	☐
	5	THE PATENT OFFICE OF THE PEOPLE'S REPUBLIC OF CHINA, 2nd Office Action for Chinese Patent Application No. 200880023854.4, April 15, 2013, 4 pages.	☐
	6	INTERNATIONAL SEARCHING AUTHORITY, International Search Report and Written Opinion for PCT/ US2012/021729, August 31, 2012, 9 pages.	☐

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☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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	1	6906495		2005-06-14	Cheng	
	2	5959433		1999-09-28	Rohde	
	3	6208115		2001-03-27	Binder	
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	5	6489745		2002-12-03	Koreis	
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	7	5734254		1998-03-31	Stephens	
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	Attorney Docket Number	AFPA-01007US1

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	Attorney Docket Number	AFPA-01007US1	

	20	6008622		1999-12-28	Nakawatase	
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	31	6975198		2005-12-13	Baarman	
	32	7031662		2006-04-18	Suzuki	
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	41	7221919		2007-05-22	Takagi	

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	42	7305258		2007-12-04	Rydgren	
	43	7324051		2008-01-29	Hayes	
	44	7342539		2008-03-11	Rosenberg	
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Receipt date: 10/29/2013	Application Number	13115811	13115811 - GAU: 2859
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2011-05-25	
	First Named Inventor	Partovi, Afshin	
	Art Unit	2859	
	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

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	Examiner Name	Berhanu, Samuel	
	Attorney Docket Number	AFPA-01007US1	

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Receipt date: 10/29/2013	Application Number	13115811 13115811 - GAU: 2859
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Receipt date: 10/29/2013	Application Number	13115811	13115811 - GAU: 2859
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	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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	Attorney Docket Number	AFPA-01007US1

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2011-05-25
	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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Signature	/Karl F. Kenna/	Date (YYYY-MM-DD)	2013-10-29
Name/Print	Karl F. Kenna	Registration Number	45445

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Application Number	13115811
Filing Date	2011-05-25
First Named Inventor	Afshin Partovi
Art Unit	2859
Examiner Name	Berhanu, Samuel
Attorney Docket Number	AFPA-01007US1

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Signature	/Karl F. Kenna/	Date (YYYY-MM-DD)	2014-02-27
Name/Print	Karl F. Kenna	Registration Number	45445

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		PATENT APPLICATION	
Inventor(s):	Partovi, Afshin		
Appl. No.:	13/115,811	Art Unit:	2859
Confirm. No.:	4181	Examiner:	Berhanu, Samuel
Filed:	May 25, 2011		
Title:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM	**Customer No. 23910**	

TRANSMITTAL LETTER RE INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. §1.56

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

It is requested that the information identified in this statement be considered by the Examiner and made of record in the above-identified application. This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56. If this is a continuation, divisional or continuation-in-part application, it is understood that the Examiner will consider all information which was considered by the Office in a parent application. MPEP §609. Such information therefore is not listed herein unless it is desired that the information be printed on a patent issuing from the subject application.

Enclosed with this statement are the following:

✓ Form PTO/SB/08a. The Examiner is requested to initial the form and return it to the undersigned in accordance with M.P.E.P. §609.

✓ As allowed under 37 C.F.R § 1.98(a)(2)(ii), no copies of the U.S. patents and U.S. patent application publications are enclosed, unless required by the office.

This statement should be considered because:

___ **37 C.F.R. §1.97(b)**. This statement qualifies under 37 C.F.R. §1.97, subsection (b) because:

(1) It is being filed within three months of the filing date of an application other than a continued prosecution application under § 1.53(d);

-- OR --

(2) It is being filed within 3 months of entry of a national stage;

-- OR --

(3) It is being filed before the mailing date of the first Office Action on the merits,

-- OR --

(4) It is being filed before the mailing date of the first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. §1.114.

✓ **37 C.F.R. §1.97(c)**. Although it may not qualify under subsection (b), this statement qualifies under 37 C.F.R. §1.97, subsection (c) because:

(1) It is being filed before the mailing date of a FINAL Office Action, a Notice of Allowance, or an action that otherwise closes prosecution in the subject application, whichever occurs first.

-- AND *(check at least one of the following)* --

__ (a) It is accompanied by a STATEMENT as set forth in 37 C.F.R. §1.97(e).

-- OR –

✓ (b) It is accompanied by the fee set forth in 37 C.F.R. §1.17(p).

✓ ***Fee Authorization.*** The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account No. 06-1325.

Respectfully submitted,

MEYER IP LAW GROUP

Date: February 27, 2014

By: /Karl F. Kenna/
Karl F. Kenna
Reg. No. 45,445

Customer No. 23910
MEYER IP LAW GROUP
410 Pacific Avenue
San Francisco, California 94133
Telephone: (415) 362-3800

Electronic Patent Application Fee Transmittal	
Application Number:	13115811
Filing Date:	25-May-2011
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Filer:	Karl Kenna/Christopher Burnharte
Attorney Docket Number:	AFPA-01007US1
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	18319561
Application Number:	13115811
International Application Number:	
Confirmation Number:	4181
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Customer Number:	23910
Filer:	Karl Kenna/Christopher Burnharte
Filer Authorized By:	Karl Kenna
Attorney Docket Number:	AFPA-01007US1
Receipt Date:	27-FEB-2014
Filing Date:	25-MAY-2011
Time Stamp:	14:03:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	278
Deposit Account	061325
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Other Reference-Patent/App/Search documents	afpa_1013cn0_2nd_OA.pdf	262095 f673dbfef695a8f5e6fc70ec6968a01b36692ba7	no	4
Warnings:					
Information:					
2	Non Patent Literature	41_UnknownAuthor_WirelessPowerSpecificationPart1.pdf	2657502 78189ec3c3b07cf8e3fdba60b0fc9045f161d59e	no	83
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	33_Office_Action_13708548_112013.pdf	166335 25ff229bc3e22aff05c3aade198200b54f67872f	no	5
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	34_Office_Action_13115811_092313.pdf	636644 35296e72678a5b0255672996fa32515dcea116a4	no	17
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	35_Office_Action_13708584_091313.pdf	536292 6a1c98a0c706b4d2003f4eaefe109d1b679ccac0	no	16
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	Office_Action_13158134_012214.pdf	1746422 959da351a32eb8b5d8e46eb86c092e0d23adb001	no	43
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	Office_Action_13708827_020514.pdf	1143153 fdc54c1be2791f718e7216323de8d7cbd1d254c4	no	28
Warnings:					
Information:					
8	Other Reference-Patent/App/Search documents	Office_Action_13708520_020514.pdf	297034 ae82aed12a88ab6f9cb60ba83c470601a3819a9e	no	8

Warnings:					
Information:					
9	Information Disclosure Statement (IDS) Form (SB08)	afpa_1007us1.pdf	946020 83a90ba088d460ce6226e1381666347afaae39b3	no	6
Warnings:					
Information:					
10	Transmittal Letter	afpa_1007us1_IDS_Trans_022714.pdf	120521 d9fa317978bbd142a80a69fdcb69ff681c010125	no	2
Warnings:					
Information:					
11	Fee Worksheet (SB06)	fee-info.pdf	30593 7b0fd32aee67a532a92a57dae8a495b5f99231ae	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	8542611		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	13/115,811	PARTOVI ET AL.	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 11/13/13	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:

Lawana Hixon

U.S. Patent and Trademark Office

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Afshin Partovi
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6844702		2005-01-18	Giannopoulos	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20060238930		2006-10-26	Baarman	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2004030176	WO		2004-04-08	Splashpower Limited		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Afshin Partovi
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	1	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/708, 548, November 20, 2013, 5 pages.	☐
	2	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/115, 811, September 23, 2013, 17 pages.	☐
	3	UNITED STATES PATENT AND TRADEMARK OFFICE, Office Action for U.S. Patent Application No. 13/708,584, September 13, 2013, 16 pages.	☐
	4	UNKNOWN AUTHOR, System Description Wireless Power Transfer, Volume I: Low Power Part 1: Interface Definition, Version 1.0, July 2010, 83 pages.	☐
	5	THE PATENT OFFICE OF THE PEOPLE'S REPUBLIC OF CHINA, 2nd Office Action for Chinese Patent Application No. 200880023854.4, April 15, 2013, 4 pages.	☐
	6	INTERNATIONAL SEARCHING AUTHORITY, International Search Report and Written Opinion for PCT/ US2012/021729, August 31, 2012, 9 pages.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Afshin Partovi
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Karl F. Kenna/	Date (YYYY-MM-DD)	2013-11-26
Name/Print	Karl F. Kenna	Registration Number	45,445

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal	
Application Number:	13115811
Filing Date:	25-May-2011
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Filer:	Karl Kenna/Christopher Burnharte
Attorney Docket Number:	AFPA-01007US1
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	17510556
Application Number:	13115811
International Application Number:	
Confirmation Number:	4181
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Customer Number:	23910
Filer:	Karl Kenna/Christopher Burnharte
Filer Authorized By:	Karl Kenna
Attorney Docket Number:	AFPA-01007US1
Receipt Date:	26-NOV-2013
Filing Date:	25-MAY-2011
Time Stamp:	17:39:14
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	6005
Deposit Account	061325
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Other Reference-Patent/App/Search documents	33_Office_Action_13708548_112013.pdf	166335 25ff229bc3e22aff05c3aade198200b54f67872f	no	5
Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	34_Office_Action_13115811_092313.pdf	636644 35296e72678a5b0255672996fa32515dcea116a4	no	17
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	35_Office_Action_13708584_091313.pdf	536292 6a1c98a0c706b4d2003f4eaefe109d1b679ccac0	no	16
Warnings:					
Information:					
4	Non Patent Literature	41_UnknownAuthor_WirelessPowerSpecificationPart1.pdf	2657502 78189ec3c3b07cf8e3fdba60b0fc9045f161d59e	no	83
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	afpa_1013cn0_2nd_OA.pdf	262095 f673dbfef695a8f5e6fc70ec6968a01b36692ba7	no	4
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	afpa_1032wo0_ISR.pdf	486296 bdabb6c08a91d049f2fc86d8d50bc4f3f84c84fc	no	9
Warnings:					
Information:					
7	Foreign Reference	WO2004030176.pdf	698113 b365b0d2e6fdd0f49fb516a937fbb33b3bea99ae	no	17
Warnings:					
Information:					
8	Transmittal Letter	afpa_1007us1_IDS_Trans_112613.pdf	121080 9fe2fc0bc218a17a72f658963fc95a7284f9c849	no	2

Warnings:					
Information:					
9	Information Disclosure Statement (IDS) Form (SB08)	afpa_1007us1_IDS_1113.pdf	788949 a14a774d650ae70bc4fb39c5c80dda19d72df77c	no	4
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	30593 d2cc5a044a2ac06a17d2d45277496e282d9c7c8f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	6383899		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:

KENNA KARL F.

FLIESLER MEYER LLP 650 CALIFORNIA STREET, FOURTEENTH FLOOR SAN FRANCISCO CA 94108 USA

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 31 AUGUST 2012 (31.08.2012)
Applicant's or agent's file reference AFPA01032WO0	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. **PCT/US2012/021729**	International filing date *(day/month/year)* **18 JANUARY 2012 (18.01.2012)**
Applicant **PARTOVI AFSHIN**	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:

   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 . 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the PCT Applicant's Guide, National Chapters.

Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer COMMISSIONER Telephone No. 82-42-481-8753

Form PCT/ISA/220 (July 2010)

* Attention

Copies of the documents cited in the international search report can be searched in the following Korean Intellectual Property Office English website for three months from the date of mailing of the international search report.

http://www.kipo.go.kr/en/ => PCT Services => PCT Services

ID : PCT international application number
PW : **XV5WWV8S**

Inquiries related to PCT International Search Report or Written Opinion prepared by KIPO as an International Searching Authority can be answered not only by KIPO but also through IPKC (Intellectual Property Korea Center), located in Vienna, VA, which functions as a PCT Help Desk for PCT applicants.

Homepage: http://www.ipkcenter.com
Email: ipkc@ipkcenter.com
Phone: +1 703 388 1066
Fax: +1 703 388 1084

Notes to Form PCT/ISA/220 (July 2010)

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PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
AFPA01032WO0		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2012/021729	**18 JANUARY 2012 (18.01.2012)**	18 JANUARY 2011 (18.01.2011)

Applicant

PARTOVI AFSHIN

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   ✓ ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 23
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/021729

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)

H02J 17/00; H01F 38/14

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
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: wireless power, magnet, modify, magnitude, phase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2000-341885 A (MATSUSHITA ELECTRIC WORKS LTD) 08 December 2000 See the abstract; paragraph [0020]; figure 7.	1-18,20-24,26-39 19,25
Y A	US 2010-0244584 A1 (AZANCOT YOSSI et al.) 30 September 2010 See the abstract; claims 1,11; figures 11,12a,12b.	19,25 1-18,20-24,26-39
A	JP 2003-045731 A (NEC TOKIN CORP) 14 February 2003 See the abstract; paragraphs [0002]-[0010]; claim 1; figures 1,2.	1-39
A	JP 2009-200174 A (PANASONIC ELECTRIC WORKS CO LTD) 03 September 2009 See the abstract; claim 1; figure 1.	1-39

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"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
"T" 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 AUGUST 2012 (30.08.2012)	**31 AUGUST 2012 (31.08.2012)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	WEE Jae Woo Telephone No. 82-42-481-8540

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2012/021729

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2000-341885 A	08.12.2000	None	
US 2010-0244584 A1	30.09.2010	AU 2008-309154 A1	16.04.2009
		CA 2702164 A1	16.04.2009
		CN 102017031 A	13.04.2011
		EP 2206129 A2	14.07.2010
		JP 2011-030418 A	10.02.2011
		JP 2011-501633 A	06.01.2011
		KR 10-2010-0082008 A	15.07.2010
		KR 10-2010-0087712 A	05.08.2010
		US 2009-0179424 A1	16.07.2009
		US 2010-0219183 A1	02.09.2010
		US 2010-0219693 A1	02.09.2010
		US 2010-0259401 A1	14.10.2010
		WO 2009-047768 A2	16.04.2009
		WO 2009-047768 A3	16.04.2009
JP 2003-045731 A	14.02.2003	None	
JP 2009-200174 A	03.09.2009	EP 2246864 A1	03.11.2010
		KR 10-2010-0121644 A	18.11.2010
		TW 200937466 A	01.09.2009
		US 2010-0320843 A1	23.12.2010
		WO 2009-104474 A1	27.08.2009

Form PCT/ISA/210 (patent family annex) (July 2009)

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
KENNA KARL F.

FLIESLER MEYER LLP 650 CALIFORNIA STREET,
FOURTEENTH FLOOR SAN FRANCISCO CA 94108 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**31 AUGUST 2012 (31.08.2012)**
Applicant's or agent's file reference AFPA01032WO0	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/021729	**18 JANUARY 2012 (18.01.2012)**	18 JANUARY 2011 (18.01.2011)

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

H02J 17/00(2006.01)i

Applicant

PARTOVI AFSHIN

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	30 AUGUST 2012 (30.08.2012)	WEE Jae Woo Telephone No.82-42-481-8540

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/021729

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/021729

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	19,25	YES
	Claims	1-18,20-24,26-39	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-39	NO
Industrial applicability (IA)	Claims	1-39	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following document:

D1: JP 2000-341885 A (MATSUSHITA ELECTRIC WORKS LTD) 08 December 2000
D2: US 2010-0244584 A1 (AZANCOT YOSSI et al.) 30 September 2010

1. Novelty and Inventive step

1.1. Claims 1-28

1.1.1. Claims 1-18, 20-24, 26-28

D1, which is considered to be the closest prior art to the subject matter of claims 1-18, 20-24, 26-28, discloses a magnetic part(7) gathering magnetic flux(B) in order to increase the power transmitted from the primary coil to the secondary coil (See paragraph [0020], figure 7). As all of the features of claims 1-18, 20-24, 26-28 are disclosed in D1, claims 1-18, 20-24, 26-28 are anticipated by D1. Therefore, claims 1-18, 20-24, 26-28 lack novelty under PCT Article 33(2).

1.1.2. Claims 19, 25

Claim 19 differs from D1 in including the presence of the one or more receivers which are detected by the one or more chargers and/or power supplies and/or cause a change in the operating behavior or characteristics of the chargers and/or power supplies. Therefore, the subject matter of claim 19 is considered to be novel under PCT Article 33(2). However D2 describes the features of communicating a signal from the primary inductor to a controller and detecting a radiation emanating from the primary inductor(See claim 11). Accordingly, claim 19 would have been obvious over D2 in view of D1. Thus, the subject matter of claim 19 does not involve an inventive step under PCT Article 33(3).

(Continued on the Supplemental box.)

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of :

Box No. V

Claim 25 differs from D1 in including the wireless charger or power supply that may be a stand-alone part, device, or product, or may be incorporated into another electric or electronics device, table, desk chair, TV stand or mount or furniture or vehicle or airplane or marine vehicle or boat. Therefore, the subject matter of claim 25 is considered to be novel under PCT Article 33(2). However D2 describes the wireless charger or power supply used in a standing lamp(1320a), a photocopier(1320b), a reading lamp(1340a), a laptop computer(1340b), a novelty coffee mug(1340c) (See figures 11, 12a, 12b). Accordingly, claim 25 would have been obvious over D2 in view of D1. Thus, the subject matter of claim 25 does not involve an inventive step under PCT Article 33(3).

1.2. Claims 29-37

Claims 29-37 are the same as claims 1-4, 6-10 in the aspect of a technical concept. Therefore, claims 29-37 lack novelty under PCT Article 33(2).

1.3. Claims 38-39

Claims 38-39 are the same as claims 1, 23 in the aspect of a technical concept. Therefore, claims 38-39 lack novelty under PCT Article 33(2).

2. Industrial Applicability

Claims 1-39 are considered to be industrially applicable under PCT Article 33(4).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 April 2004 (08.04.2004)

PCT

(10) International Publication Number
WO 2004/030176 A2

(51) International Patent Classification[7]: H02J 7/00

(21) International Application Number:
PCT/GB2003/004150

(22) International Filing Date:
26 September 2003 (26.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0222436.8 27 September 2002 (27.09.2002) GB

(71) Applicant *(for all designated States except US)*: **SPLASHPOWER LIMITED** [GB/GB]; St. John's Innovation Centre, Cowley Road, Cambridge CB4 0WS (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BEART, Pilgrim, Giles, William** [GB/GB]; 35 Royston Road, Harston, Cambridge CB2 5NH (GB). **CHENG, Lily, Ka, Lai** [CA/GB]; 53 College Fields, Woodhead Drive, Cambridge CB4 1YZ (GB).

(74) Agent: **HASELTINE LAKE**; Imperial House, 15-19 Kingsway, London WC2B 6UD (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

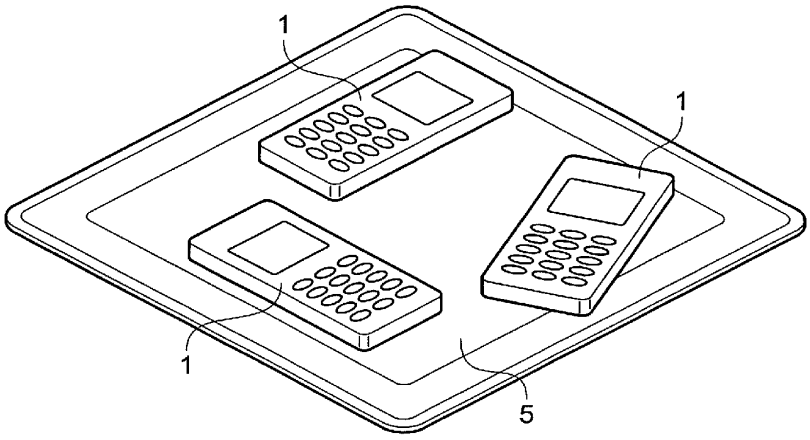
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVEMENTS RELATING TO RETENTION OF RECHARGEABLE DEVICES



(57) Abstract: There is disclosed a system and method for retaining portable rechargeable devices to recharging stations wherein one or other or both of the recharging station and the portable device are provided with connecting means adapted for temporary releasable connection of the two. This is particularly advantageous when used with recharging stations, which permit the device to be recharged in multiple places on the recharging station, providing a positive means of retaining the device. This is particularly advantageous if the recharging station is to be used in a mobile environment such as a car, or on a wall or ceiling.

WO 2004/030176 A2

IMPROVEMENTS RELATING TO RETENTION OF RECHARGEABLE DEVICES

This invention relates to a new system for temporary attachment of portable rechargeable devices to recharging stations, and a method of temporarily attaching portable rechargeable devices to their charging units.

Today's portable rechargeable devices are typically recharged by temporarily connecting them to a recharger via a mating plug-in or clip-on connection. An example is the typical "floating wire" connection between a mains charger and a mobile phone (see Figure 1).

The connection serves two purposes:

1) It electrically connects the device to its recharger, allowing transfer of power.
2) It mechanically connects the device to its recharger, in a way which retains it securely against forces from accidental knocks and the like, but is easily removable by the user. This mechanical connection thus allows recharging to continue reliably until the user physically breaks the connection, and in some cases may also keep the device conveniently available to the user. Examples of the latter include the recharging "cradle" for the Palm Pilot® and the drop-in "hands-free" car socket for a mobile phone.

Some of today's portable rechargeable devices are charged by a non-contact means, for example by inductive power transfer. An example is the Braun® electric toothbrush, where the toothbrush must be accurately located onto a spigot on the recharger, which retains it. However, the spigot serves only as a positioning means and no additional force is required to separate the toothbrush from the charger other than that required to lift the toothbrush against gravity.

But some of these non-contact charging means do not require the device and the recharger to be so precisely aligned. Such solutions may offer significant freedoms for the designer and for the user. For example the recharging means may be a

laminar surface upon which a device can conveniently be placed, in any position and any orientation, as disclosed, for example, in the present applicant's UK patent application no. 01283175 of 27 November 2001. This avoids the limitations of the positive mechanical connection (e.g. cradles, connectors, clips) required by other charging solutions, and so is more convenient to the user because it is easier to place a device casually anywhere on a surface than precisely to align it with a mechanical socket. Dispensing with the need for mechanical location may also allow other benefits, such as the ability simultaneously to recharge multiple units, and/or to recharge devices of different types on the same recharger.

However in some situations, the lack of positive mechanical retention of such a surface may be a disadvantage for users. For example:

- A flat recharging surface must be kept substantially horizontal to prevent devices from sliding off the surface. But this requirement may be inconvenient to the user – for example putting the surface on a desk may occupy otherwise-useful space. Freeing-up the surface so that it can be placed in any orientation would give the user much more flexibility to use otherwise-useless space – for example to mount the surface vertically on a wall, or even on the inside of a car roof.
- If a mobile recharging surface is likely to be subject to movement (e.g. a tabletop that may get knocked, or in a car, aeroplane or spacecraft), the devices may fall off.

Clearly, it would be convenient to remove these potential disadvantages whilst preserving the benefits of freedom of design and use of such surface-based charging systems.

According to a first aspect of the present invention there is provided a system for wireless powering or recharging of rechargeable devices, the system comprising a charging unit and a power receiving device, wherein one or other or both of the charging unit and the power receiving device is provided with connecting means

adapted for temporary releasable connection of the power receiving device to the charging unit, the connecting means not being an electrical connection.

According to a second aspect of the invention, there is provided a system for wireless powering or recharging of rechargeable devices, the system comprising a charging unit and a power receiving device, wherein one or other or both of the charging unit and the power receiving device is provided with connecting means adapted for temporary releasable connection of the power receiving device to the charging unit in at least two positions and/or rotations of the device relative to the charging unit.

According to a third aspect of the invention, there is provided a charging unit adapted for wireless powering or recharging of a power receiving device, wherein the charging unit is provided with connecting means for temporary releasable connection of a power receiving device thereto, the connecting means not being an electrical connection.

According to a fourth aspect of the present invention, there is provided a power receiving device adapted for wireless powering or recharging by a charging unit, wherein the power receiving device is provided with connecting means for temporary releasable connection of a charging unit thereto, the connecting means not being an electrical connection.

According to a fifth aspect of the present invention, there is provided a method of wireless powering or recharging of a power-receiving device which comprises temporarily attaching the device to a charging unit, said method further comprising utilising a releasable temporary connecting means attached to the charging unit and/or the device, wherein said connecting means is adapted to enable the charging unit and the device to be attached in one or more positions and/or orientations relative to each other, the connecting means not being an electrical connection.

Accordingly, embodiments of the present invention provides a system for powering or recharging rechargeable devices which has several advantages over the prior art.

Such a system is advantageous because it provides convenient retention of the device to the charging unit while still preserving the convenience of being able to simple drop or press the device against the charging unit, thus greatly expanding the number of usable places for the user to locate the charging unit.

It is to be appreciated that embodiments of the present invention are distinguished over existing systems and methods in that there is provided a combination of wireless power transfer and a temporary releasable connection. Ordinary wired power transfer systems generally incorporate a releasable physical connection such as a plug and socket with physical mating means, but these are provided in order to secure a good electrical connection. Ordinary wireless power transfer systems, on the other hand, do not incorporate physical, temporary releasable physical connections, since these have hitherto been seen as disadvantageous in a wireless system. For the avoidance of doubt, it is hereby stated that the expression "temporary releasable connection" is intended to cover connections that require a predetermined degree of force for separation. In other words, a simple location spigot such as found in wireless electric toothbrush chargers is not intended to be covered by the term "temporary releasable connection", since no particular force is required to separate the toothbrush from the charger. Embodiments of the present invention therefore combine a releasable physical connection with a wireless power transfer system in a counterintuitive way that is not suggested by the prior art.

Preferably, the power receiving device is portable. Examples of portable power receiving devices include mobile telephones, lap-top computers, and personal digital assistants (PDA).

Examples of relative positions and/or orientations in which the charging unit and device may be attached include:

- Any position in one translational dimension.
- Any position in an orthogonal translational dimension.
- Any rotation about one plane.
- Any rotation about a plane orthogonal to the first.

- Any combination of the above.

It will be understood that the term "recharging" may also be taken to mean "powering" for devices which do not have substantial rechargeable batteries, and therefore can only operate while in proximity to the recharger, for example lightbulbs, fans etc.

Preferably, the charging unit is capable of charging multiple types of device.

Preferably, the charging unit is capable of charging multiple devices simultaneously.

Preferably, the device is capable of being charged by multiple types of charging unit.

Advantageously, the connecting means comprises a means added to the surface of the device and/or the charging unit. Examples of this type of connecting means include hook-and-eye fasteners (such as Velcro™), suckers, reusable, self-adhesive glue (as used in, for example, Post-It™ notes) or high stiction/friction surfaces such as a rubbery or rough surface. The means may cover only a small portion of the surface, or for example a complete face, or the entire device and/or charging unit.

Alternatively or in addition, the connecting means may comprise a shaping of the surface of the device and/or the charging unit. Examples of the connecting means used in this embodiment of the invention include bumps, ridges or grooves on the surface of either the charging unit or the device. For example, the connecting means may comprise a plurality of projections on one surface and a plurality of corresponding holes on another surface, for example as used in Lego® building blocks. Alternatively, spiked systems such as those exemplified by Stickle-Bricks(R) or spikes with corresponding holes can be used as connecting means. Hook-and-eye shapings may also be used as connecting means.

Alternatively or in addition, the connecting means may comprise means added beneath the surface of the device and/or the charging unit, said means being capable

of acting at a distance. Examples of the connecting means in this embodiment of the invention may include permanent magnets, and arrays of such, electromagnets, and arrays of such or possibly electrostatically-charged terminals.

Alternatively or in addition, only the charging unit, and not the device comprises a connecting means. In this embodiment, examples of the connecting means include pockets. For example, the charging unit may be positioned so that it hangs vertically on a wall and the connecting means of the charging unit may be multiple pockets to receive one or more devices. Further examples of the connecting means of the charging unit may include elastic bands to strap down the device(s), or indentations or contours on the charging unit. Examples of such indentations or contours on the charging unit include a ridge designed to hold standard AA cells for example or a bowl shape indentation to retain a variety of differently-shaped devices.

In one embodiment, the connecting means may be adapted to enable the charging unit and the device to be mated in a large number of different relative orientations, for example, such that the possible relative location and rotation of the device and charging unit are quantised into so many possibilities that there is no limitation visible to the user. For example, the connecting means could be Velcro®, which would enable mating between the charging unit and the device to occur in almost any position and rotation relative to each another. Alternatively, the connecting means may be adapted to enable the charging unit and the device to be mated in a limited number of relative orientations only. For example, the connecting means may comprise a plurality of projections on one surface and a plurality of corresponding holes on another surface, such as Lego® building blocks, which may only allow mating between the charging unit and the device in a maximum of four possible rotations and at a finite number of discrete locations).

In particular, there may only be one possible relative orientation in which the device and charging unit may be mated together. For example, a manufacturer selling a device capable of being recharged by relatively large recharging surfaces may nevertheless choose to include with the device a small, low-cost recharging surface

which precisely fits the device, and is retained to it, for example by 4 holes in the device and 4 corresponding bumps in the surface. Thus the user can "clip" the surface of the charging unit to the device in a manner similar to today's wired charging connections, but the device is capable of being used more flexibly with larger charging unit surfaces. In this case, the surface may be incorporated directly into a mains-powered charging unit, providing a low-cost "no wires" easy-travel solution onto which a device can be conveniently pressed.

The connecting means of the device may correspond to the connecting means of the charging unit, such that devices will attach to charging units, but not devices to devices nor charging units to charging units. An example of a connecting means of this embodiment is Velcro® which comes in "male" and "female" types which stick to each other but not to themselves. Thus, the connecting means of the device may be Velcro® of the male type, and the connecting means of the charging unit may be Velcro® of the female type.

Alternatively, the connecting means of the charging unit may be identical to the connecting means of the device. This embodiment will be capable of attaching to itself and may be used on all devices and charging units. An example is a reusable tacky adhesive such as the glue used in Post-It® notes. A potential advantage of this is in the case where a device is capable of performing the function of a charging unit to another device.

In a yet further embodiment, there may be several different classes of pairs of types of connecting means, with each pair class attaching only to the other of the pair. A potential advantage of this is in the case that not all charging units are capable of recharging all devices – a user can then immediately feel that a device is not "sticking" to a (or part of a) charging unit and will not be recharged by it.

In addition to the embodiments described above, the connecting means may in addition possess aesthetic or visual qualities to conveniently inform users that a device is capable of being recharged, or a charging unit is available to recharge, or if

a certain (part of the) charging unit is more appropriate for charging a particular class of device in the manner described above.

Examples of these qualities include giving the connecting means:

- A specific reflective colour (e.g. Pantone® 123)
- A specific emissive colour (e.g. a bright red light)
- A fluorescent or luminous colour
- A specific "sheen" (e.g. glittering metallic silver)
- A specific repeated pattern (e.g. triangles)
- A specific logo design or text (e.g. "Zap™")
- An outline of the area in which a device may receive power
- A texture, which may optionally be recognisable by touch alone (e.g. fuzzy)
- A material

or combinations of the above.

These aesthetic qualities may even by used to inform users of the presence of devices or charging units in places where they would not otherwise suspect them, for example a charging unit embedded within part of a tabletop.

The aesthetic qualities may change their appearance or touch depending on the state of the device and/or the charging unit. For example the surface of a device and/or charging unit may change colour when it is powered-on, or the device is in need of recharging, or is recharging, or is recharged, or is in need of attention (for example a mobile phone device receiving an incoming call).

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

For a better understanding of the present invention and to show it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawings, in which:

FIGURE 1 shows an example of a prior art recharging connection;

FIGURE 2 shows an embodiment of the present invention; and

FIGURE 3 shows an alternative embodiment of the present invention.

Referring to Figure 3, there is shown a power receiving device 1, in this embodiment the device is a mobile phone. The mobile phone 1 has a connecting means 3 attached to the back of the phone. In this embodiment the connecting means 3 of the device 1 is a patch of self-adhesive Velcro® of the "male" type. This is black and slightly prickly, informing the user that the phone may be charged on a charging surface. Figure 3 also shows a charging unit 5. In this embodiment the charging unit 5 is an inductive recharging pad. On the surface 7 of the pad 5 is attached a patch of self-adhesive Velcro® of the "female" type 9, which acts as the connecting means of the charging unit. This is black and slightly fuzzy, informing the user that the pad may charge devices.

To mate the phone 1 and the pad 5 temporarily, the user simply presses the phone 1 onto the pad 5 (or drops it, if the pad is below the phone) and the Velcro® 3, 9 holds the phone in place on the pad . The phone can be placed onto the pad in any orientation and in any position, and is held securely by the Velcro®. Once the phone and the pad are attached in this way, the phone can receive power from the pad and so can be recharged. When the phone 1 has been recharged fully, or before if desired, it can be removed from the pad 5 easily by the user at any time, simply by pulling it away. This disengages the Velcro® 3 from the Velcro® 9.

Figure 2 shows an alternative embodiment wherein a plurality of devices 1, (in this

embodiment, mobile phones) are attached to a charging unit 5 (in this embodiment, a pad). Figure 2 shows that, in this embodiment, the mobile phone 1 and the pad 5 can be mated at various different orientations to the each other and also the mobile phones can be positioned at different orientations relative to the other mobile phones 1.

CLAIMS:

1. A system for wireless powering or recharging of rechargeable devices, the system comprising a charging unit and a power receiving device, wherein one or other or both of the charging unit and the power receiving device is provided with connecting means adapted for temporary releasable connection of the power receiving device to the charging unit, the connecting means not being an electrical connection.

2. A system as claimed in claim 1, wherein the connecting means is adapted for temporary releasable connection of the power receiving device to the charging unit in at least two positions and/or rotations of the device relative to the charging unit.

3. A system as claimed in claim 1 or 2, wherein the connecting means is selected from a group comprising: hook-and-eye fasteners, suckers, reusable self-adhesive glue, high stiction/friction surfaces, a shaped recess or projection or plurality thereof, a permanent magnet or array of permanent magnets, an electromagnet or array of electromagnets, and electrostatically-charged terminals.

4. A charging unit adapted for wireless powering or recharging of a power receiving device, wherein the charging unit is provided with connecting means for temporary releasable connection of a power receiving device thereto, the connecting means not being an electrical connection.

5. A charging unit as claimed in claim 4, wherein the connecting means is adapted for temporary releasable connection of the power receiving device to the charging unit in at least two positions and/or rotations of the device relative to the charging unit.

6. A charging unit as claimed in claim 4 or 5, wherein the connecting means is selected from a group comprising: hook-and-eye fasteners, suckers, reusable self-adhesive glue, high stiction/friction surfaces, a shaped recess or projection or

plurality thereof, a permanent magnet or array of permanent magnets, an electromagnet or array of electromagnets, and electrostatically-charged terminals.

7. A power receiving device adapted for wireless powering or recharging by a charging unit, wherein the power receiving device is provided with connecting means for temporary releasable connection of a charging unit thereto, the connecting means not being an electrical connection.

8. A power receiving device as claimed in claim 7, wherein the connecting means is adapted for temporary releasable connection of the power receiving device to the charging unit in at least two positions and/or rotations of the device relative to the charging unit.

9. A power receiving device as claimed in claim 7 or 8, wherein the connecting means is selected from a group comprising: hook-and-eye fasteners, suckers, reusable self-adhesive glue, high stiction/friction surfaces, a shaped recess or projection or plurality thereof, a permanent magnet or array of permanent magnets, an electromagnet or array of electromagnets, and electrostatically-charged terminals.

10. A method of wireless powering or recharging of a power-receiving device which comprises temporarily attaching the device to a charging unit, said method further comprising utilising a releasable temporary connecting means attached to the charging unit and/or the device, wherein said connecting means is adapted to enable the charging unit and the device to be attached in one or more positions and/or orientations relative to each other, the connecting means not being an electrical connection.

11. A method according to claim 10, wherein the connecting means is adapted for temporary releasable connection of the power receiving device to the charging unit in at least two positions and/or rotations of the device relative to the charging unit.

12. A method according to claim 10 or 11, wherein the connecting means is selected from a group comprising: hook-and-eye fasteners, suckers, reusable self-adhesive glue, high stiction/friction surfaces, a shaped recess or projection or plurality thereof, a permanent magnet or array of permanent magnets, an electromagnet or array of electromagnets, and electrostatically-charged terminals.

13. A system for wireless powering or recharging of rechargeable devices, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

14. A charging unit adapted for wireless powering or recharging of a power receiving device, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

15. A power receiving device adapted for wireless powering or recharging by a charging unit, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

16. A method of wireless powering or recharging of a power-receiving device, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

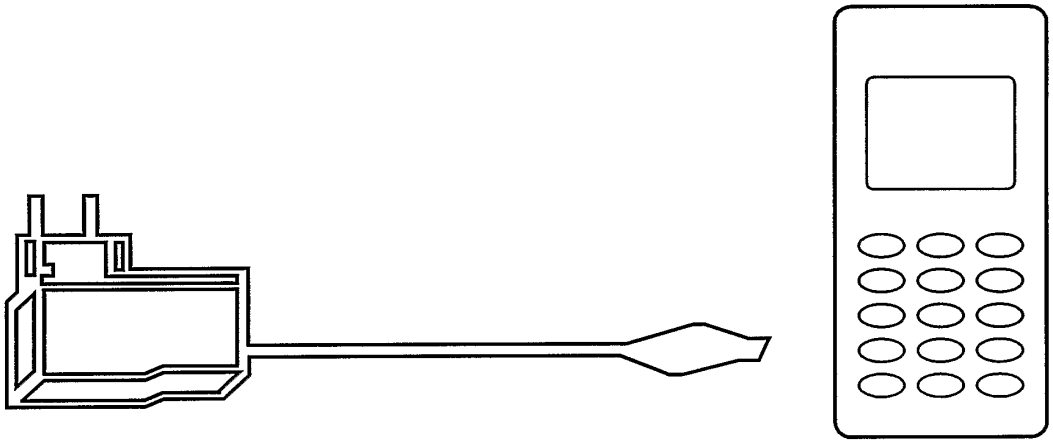


Fig. 1

2/3

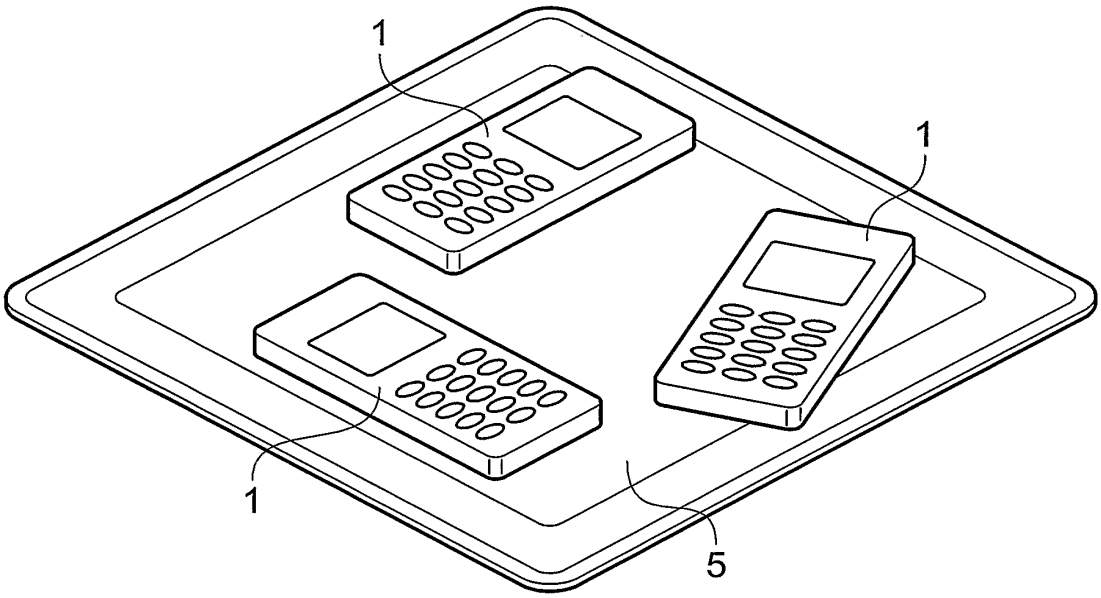


Fig. 2

3/3

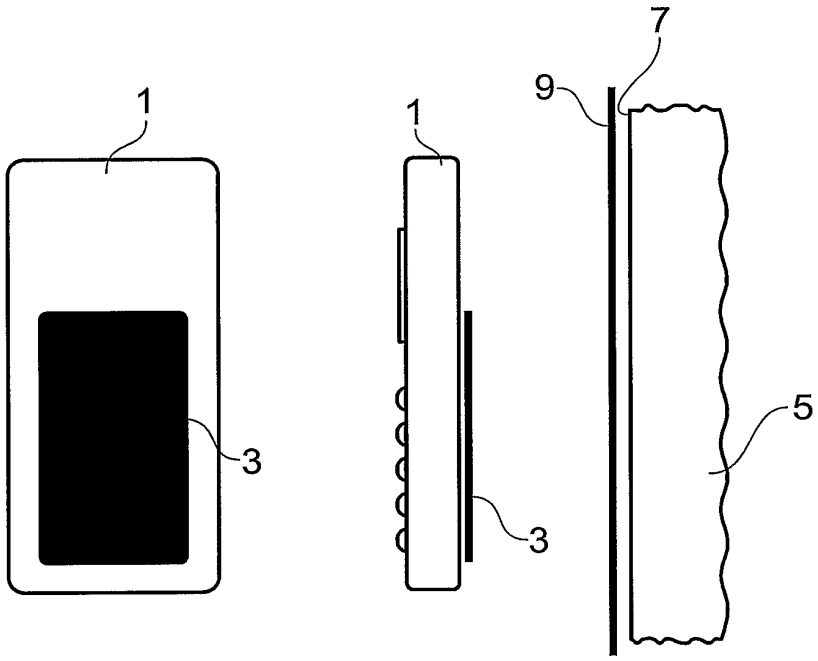


Fig. 3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		PATENT APPLICATION	
Inventor(s):	Partovi, Afshin		
Appl. No.:	13/115,811	Art Unit:	2859
Confirm. No.:	4181	Examiner:	Berhanu, Samuel
Filed:	May 25, 2011		
Title:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM	**Customer No. 23910**	

TRANSMITTAL LETTER RE INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. §1.56

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

It is requested that the information identified in this statement be considered by the Examiner and made of record in the above-identified application. This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56. If this is a continuation, divisional or continuation-in-part application, it is understood that the Examiner will consider all information which was considered by the Office in a parent application. MPEP §609. Such information therefore is not listed herein unless it is desired that the information be printed on a patent issuing from the subject application.

Enclosed with this statement are the following:

✓ Form PTO/SB/08a. The Examiner is requested to initial the form and return it to the undersigned in accordance with M.P.E.P. §609.

✓ As allowed under 37 C.F.R § 1.98(a)(2)(ii), no copies of the U.S. patents and U.S. patent application publications are enclosed, unless required by the office.

___ As allowed under 37 CFR §1.98(d), copies of cited documents noted with an asterisk are not enclosed because they were previously submitted in U.S. Patent Application No. _____, which is relied on for an earlier effective filing date under 35 USC §120, and which included an Information Disclosure Statement that complies with 37 CFR §1.98(a) through (c).

✓ A copy of an International Search Report and Written Opinion dated August 31, 2012 for PCT International Patent Application No. PCT/US2012/021729.

This statement should be considered because:

___ **37 C.F.R. §1.97(b)**. This statement qualifies under 37 C.F.R. §1.97, subsection (b) because:

(1) It is being filed within three months of the filing date of an application other than a continued prosecution application under § 1.53(d);

-- OR --

(2) It is being filed within 3 months of entry of a national stage;

-- OR --

(3) It is being filed before the mailing date of the first Office Action on the merits,

-- OR --

(4) It is being filed before the mailing date of the first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. §1.114.

_✓_ **37 C.F.R. §1.97(c)**. Although it may not qualify under subsection (b), this statement qualifies under 37 C.F.R. §1.97, subsection (c) because:

(1) It is being filed before the mailing date of a FINAL Office Action, a Notice of Allowance, or an action that otherwise closes prosecution in the subject application, whichever occurs first.

-- AND *(check at least one of the following)* --

__ (a) It is accompanied by a STATEMENT as set forth in 37 C.F.R. §1.97(e).

-- OR –

_✓_ (b) It is accompanied by the fee set forth in 37 C.F.R. §1.17(p).

_✓_ ***Fee Authorization.*** The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account No. 06-1325.

Respectfully submitted,

FLIESLER MEYER LLP

Date: November 26, 2013

By: /Karl F. Kenna/
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Inventor(s):	Afshin Partovi, et al.
Appln. No.:	13/115,811
Confirm. No.:	4181
Filed:	May 25, 2011
Title:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM

PATENT APPLICATION

Art Unit: 2859
Examiner: Berhanu, Samuel

Customer No. 23910

REPLY TO OFFICE ACTION UNDER 37 C.F.R. §1.111

Mail Stop AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This REPLY is in response to the Office Action mailed September 23, 2013.

Amendments

Please amend the above-identified application as follows:

Amendments to the Claims begin on Page 2.

Remarks begin on Page 8.

In the Claims:

Please amend Claims 1 and 11, as shown below. Applicant respectfully reserves the right to prosecute any originally presented or canceled claims in a continuing or future application.

1. (Currently Amended) A mobile device capable of inductive powering or charging comprising:

a battery, wherein one or both of a mobile device and the battery have particular charging characteristics associated therewith; [[and]]

a receiver for one of inductively powering the device or charging the battery in the mobile device, [[and]] wherein the receiver is one of attached to or incorporated into the battery or the mobile device;

a regulator that

determines characteristics of the mobile device or the battery, including one or more of a charging capacity, present charge, required voltage, or current temperature,

senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery, and

regulates one or more of the current drawn or the output voltage or output current to be within a range of one of predefined or appropriate power parameters for the mobile or the battery;

wherein different mobile devices and batteries can have different charging characteristics associated therewith; and

wherein the receiver communicates with a base unit to one or more detect, identify and authenticate the receiver with the base unit, verify the continued presence of the receiver near the base unit, and communicate information to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

2. (Original) The mobile device of claim 1 further comprising a shell, wherein the receiver is attached to the shell.

3. (Original) A mobile device charger or power supply comprising:

a plurality of coils or wires, wherein the coils or wires are placed in one or more layers and are used to inductively charge a mobile device in proximity to the mobile device charger.

4. (Original) The mobile device charger or power supply of claim 3, wherein the coils or wires are formed within a printed circuit board PCB layer of at least two different sizes or shapes.

5. (Original) The mobile device charger or power supply of claim 3, wherein two or more coils or wires are activated to charge or power a mobile device.

6. (Original) The mobile device charger or power supply of claim 3, wherein the charger or the power supply, and the mobile device, communicate with each other to transfer data.

7. (Original) The mobile device charger or power supply of claim 3, wherein the charger or power supply includes coils or wires for inductively charging or supplying power to the mobile device, and a separate antenna or wires for data transfer or verification.

8. (Original) The mobile device charger or power supply of claim 7, wherein the charger or power supply includes coils or wires for inductively charging or supplying power to the mobile device, and wherein the coils or wires also function as an antenna for data transfer.

9. (Original) The mobile device charger or power supply of claim 8, wherein the data transfer includes information about the presence of the mobile device adjacent to the charger or power supply.

10. (Original) The mobile device charger or power supply of claim 3, wherein the charger or power supply stores charging or power requirements for mobile devices which can be charged or powered by the charger or power supply.

11. (Currently Amended) A system for use with a mobile device for charging or powering the mobile device inductively, comprising:

a base unit including one or more primary coils therein, the primary coil having a generally planar shape so that when a current is passed through the primary coil a magnetic field is generated in a direction substantially perpendicular to the plane of the primary coil; [[and]]

wherein the perpendicular magnetic field inductively generates a current in a matching secondary coil or coils within a mobile device placed close to and aligned with the base unit, to

charge or power the mobile device;

wherein one or both of the mobile device and a battery have a receiver and particular charging characteristics associated therewith, and a regulator that

determines characteristics of the mobile device or the battery, including one or more of a charging capacity, present charge, required voltage, or current temperature,

senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery, and

regulates one or more of the current drawn or the output voltage or output current to be within a range of one of predefined or appropriate power parameters for the mobile or the battery;

wherein different mobile devices and batteries can have different charging characteristics associated therewith; and

wherein the receiver communicates with the base unit to one or more detect, identify and authenticate the receiver with the base unit, verify the continued presence of the receiver near the base unit, and communicate information to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

12. (Original) The system of claim 11 wherein one or more of the coils are manufactured on printed circuit boards and are manufactured to have a low resistance.

13. (Original) The system of claim 11 wherein the base unit includes a primary circuit having a switch means for switching the primary coil on and off whenever the mobile device is placed close to the primary coil of the base unit or the presence of the mobile device is to be detected.

14. (Original) The system of claim 11 wherein the base unit includes multiple primary coils that can be used to simultaneously charge multiple mobile devices.

15. (Original) The system of claim 14 wherein the alternating switching is periodically started and stopped to automatically detect a presence of a mobile device placed close to or aligned with the primary coil of the base unit.

16. (Original) The system of claim 15 wherein the presence of the mobile device placed close to or aligned with the primary coil of the base unit is detected by monitoring the current passing through the primary coil or the switching means.

17. (Original) The system of claim 11 wherein the base unit is in the shape generally of a pad and wherein the multiple primary coils are distributed within layers of the pad.

18. (Original) The system of claim 17 wherein the multiple primary coils can move within their plane to more closely align with the secondary coil of a mobile device.

19. (Original) The system of claim 11 wherein a magnet is placed at the center of each primary, wherein the magnet at the center of each primary has a magnetic axis that is perpendicular to the plane of the coil, and wherein one or more of the devices to be charged include a magnet at the center of their receiver coil, so that the magnets in the devices and the magnets in the base are oriented to attract each other when a coil in a device is placed directly on top of a coil in the base.

20. (Original) The system of claim 11 further comprising a battery coupled to and powering the base unit, and wherein the battery can be occasionally charged by an external power supply to maintain a charge sufficient to power the inductive device for a period of time.

21. (Original) The system of claim 20 further comprising a solar cell coupled to the battery for charging the battery in the base unit.

22. (Original) The system of claim 11, further comprising a data storage component for storage of data, for subsequent transmission of data to or from the mobile device.

23. (Original) The system of claim 11 wherein the cover surface of the base unit or pad includes a decorative or non-slip surface.

24. (Original) The system of claim 11 wherein the base unit can be integrated into any of briefcases, bags, or clothing.

25. (Original) The system of claim 11 wherein the base unit is integrated into a charging kiosk for occasional charging of mobile devices.

26. (Original) The system of claim 11 wherein one or more of the primary coils are stacked

to improve transfer efficiency.

27. (Original) The system of claim 11, further comprising a plurality of coils or wires, wherein the charger or power supply senses the location of the mobile device and activates a coil or wire near the mobile device to charge or provide power the mobile device.

28. (Original) The system of claim 27, wherein the charger or power supply senses the location of the mobile device by sensing a change in a resonant circuit in the charger or power supply when the mobile device is nearby.

29. (Original) The system of claim 11, wherein the mobile device includes an inductively charged battery where a receiver for the inductive power is made of flexible PCB material and can be shaped into a curve to fit the battery, an application or a device.

30. (Original) The system of claim 11, wherein the charger or power supply is made in the shape of a cup, bowl, or other container and mobile devices placed inside would be charged or powered inductively.

31. (Original) The system of claim 11, wherein a plurality of modular chargers or power supplies can be interconnected to form a single unit.

32. (Original) The system of claim 11, wherein the mobile device is one of a kitchen appliance or dish, or a toy that can receive power inductively from the charger or power supply.

33. (Original) The system of claim 11, wherein the mobile device is a charger for inductively charging active RFID batteries, including an active RFID tag which includes a battery such that the battery can be charged inductively with the system.

34. (Original) The system of claim 11, wherein the mobile device to be charged or powered includes a charging circuit having a Zener diode, wherein the Zener diode clamps the voltage to the mobile device to a predetermined maximum voltage.

35. (Original) The system of claim 13, wherein the switch means is a MOSFET and the circuit includes a capacitor connected in parallel to the source to drain terminals of the

MOSFET, and wherein the alternating switching in the primary coil is automatically started by the MOSFET when the base unit detects a mobile device placed close to or aligned with the primary coil.

36. (Original) The system of claim 11, wherein, the mobile device includes an after-market or field-replaceable battery pack compatible with an original battery pack for the device, and wherein the matching secondary coil or coils within the mobile device are incorporated into the after-market or field-replaceable battery pack.

Remarks

This REPLY is in response to the Office Action mailed September 23, 2013.

I. Applicant's Interview Summary

Applicant thanks Examiner Samuel Berhanu for the courtesy of a telephone interview with Karl Kenna on September 12, 2013, during the course of which interview it was noted that the previous Office Action did not address Claims 1-10, and that a new Office Action would be mailed, as set forth in the Applicant-Initiated Interview Summary mailed by the Examiner on September 23, 2013.

II. Request for Interview

In the event the amendments and remarks provided herein fail to place the application in condition for allowance, Applicant respectfully requests the opportunity to interview with the Examiner, at the Examiner's convenience, and prior to issuance of a subsequent Office Action, to assist in expediting prosecution.

III. Summary of Examiner's Rejections

Prior to the Office Action mailed September 23, 2013, Claims 1-36 were pending in the Office Action. In the Office Action, Claims 1-36 were rejected under the doctrine of obviousness-type double patenting as being unpatentable over Claims 1-54 of U.S. Patent No. 7,952,322 (hereinafter Partovi). Claims 1-8, 10-12, 22, 30-31, 36, 38-41 and 43-44 were rejected under 35 U.S.C. 102(b) as being anticipated by Lyon (U.S. Publication No. 2004/0145342). Claims 9, 13, 15-16 and 34-35 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Van Lerberghe (U.S. Patent No. 5,952,814, hereinafter Van). Claims 14, 17-18, 23-29, 37 and 42 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Hui (U.S. Publication No. 2005/0189910). Claim 19 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Chen (U.S. Patent No. 6,331,744). Claims 20-21 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Fukuda et al. (U.S. Patent No. 4,311,953, hereinafter Fukuda). Claim 32 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Sudo (Japanese Patent No. JP408000838). Claim 33 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Charych (U.S. Patent No. 6,798,716).

IV. Summary of Applicant's Amendment

The present Reply amends Claims 1 and 11, leaving for the Examiner's present consideration Claims 1-36.

V. Claim Rejections under Double Patenting

In the Office Action, Claims 1-36 were rejected under the doctrine of obviousness-type double patenting as being unpatentable over Claims 1-54 of U.S. Patent No. 7,952,322. Accordingly, filed together with this Reply is an appropriate Terminal Disclaimer in compliance with 37 CFR 1.321. Applicant respectfully submits that the filing of a Terminal Disclaimer renders moot the rejection of the claims under the doctrine of obviousness-type double patenting. Reconsideration thereof is respectfully requested.

VI. Claim Rejections under 35 U.S.C. §102(b)

In the Office Action, Claims 1-8, 10-12, 22, 30-31, 36, 38-41 and 43-44 were rejected under 35 U.S.C. 102(b) as being anticipated by Lyon (U.S. Publication No. 2004/0145342).

Claim 1

Claim 1 has been amended to recite:

1. (Currently Amended) A mobile device capable of inductive powering or charging comprising:

a battery, wherein one or both of a mobile device and the battery have particular charging characteristics associated therewith;

a receiver for one of inductively powering the device or charging the battery in the mobile device, wherein the receiver is one of attached to or incorporated into the battery or the mobile device;

a regulator that

determines characteristics of the mobile device or the battery, including one or more of a charging capacity, present charge, required voltage, or current temperature,

senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery, and

regulates one or more of the current drawn or the output voltage or output current to be within a range of one of predefined or appropriate power parameters for the mobile or the battery;

wherein different mobile devices and batteries can have different charging characteristics associated therewith; and

wherein the receiver communicates with a base unit to one or more detect, identify and authenticate the receiver with the base unit, verify the continued presence of the receiver near the base unit, and communicate information to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

Lyon discloses a method and apparatus is used for adaptive inductive charging of a device. Charging includes detecting the presence of a device capable of receiving an inductive charge, determining a set of parameters for inductively charging the device, and transmitting an inductive charge corresponding to the set of parameters for charging the device. (Abstract). Charge logic component 226 includes logic for charging multiple devices and determines the profiles to be used for charging each of the devices placed on inductive charger 106. In addition, charge logic component 226 processes information to determine when a particular device is fully charged or having difficulties being charged and notifies an operator or user of the same. For example, charge logic component 226 may receive signal from a device being charged indicating the charging status of the device (e.g., fully charged, no charge, or battery failure). (Paragraph [0022]). Device 204 includes a controlled rectifier 230, a secondary coil 232, a battery/load 234, an output voltage control 236, a memory 238, a processor (RFID) 240, and communication port 242 for communicating over data communication channel 220. Alternatively, communication port 242 can communicate charge information and status over secondary inductor 232 and through inductors 210 to 212 rather than a separate data communication channel 220. Controlled rectifier 230 receives charge over secondary coil 232 and regulates the output in view of any load changes that may occur. To a lesser extent, controlled rectifier 230 may also regulate input voltage changes from the one or more inductors 210 through 212. (Paragraphs [0023]-[0024]).

In the Office Action, it was asserted that Lyon discloses a mobile device and/or battery capable of being inductively powered or charged, comprising a battery; a receiver for one of inductively powering the device directly and/or charging the battery in the mobile device, wherein the receiver includes a receiver coil having generally planar shape, so that when a magnetic field is applied in a direction generally perpendicularly to the receiver coil using induction from a primary coil in a base unit, an electrical current is generated within the receiver coil and is used to power or charge the mobile device and/or battery, a regulator circuit that senses the current drawn from the receiver coil and regulates it to match one of either a

predefined value of voltage or current, or an appropriate power parameter of the mobile device and/or battery as sensed by the regulator circuit; and wherein the receiver is one of attached to or incorporated into or on the battery or the mobile device.

However, Applicant respectfully submits that, although Lyon appears to describe that a charge logic component at a charger includes logic for charging multiple devices and determines profiles to be used for charging each of the devices placed on the charger, Lyon does not appear to describe a mobile device having a regulator that determines characteristics of the mobile device or the battery, including one or more of a charging capacity, present charge, required voltage, or current temperature, senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery, and regulates one or more of the current drawn or the output voltage or output current to be within a range of one of predefined or appropriate power parameters for the mobile or the battery.

To more clearly recite the embodiment therein, Claim 1 has been amended to recite that, in accordance with an embodiment, the mobile device comprises a battery, wherein one or both of a mobile device and the battery have particular charging characteristics associated therewith; a receiver for one of inductively powering the device or charging the battery in the mobile device, wherein the receiver is one of attached to or incorporated into the battery or the mobile device; and a regulator that determines characteristics of the mobile device or the battery, including one or more of a charging capacity, present charge, required voltage, or current temperature, senses one or more of a current drawn from the receiver, or an output voltage or output current provided to the mobile device or the battery, and regulates one or more of the current drawn or the output voltage or output current to be within a range of one of predefined or appropriate power parameters for the mobile or the battery.

Claim 1 has been amended to recite that, in accordance with an embodiment, different mobile devices and batteries can have different charging characteristics associated therewith; and wherein the receiver communicates with a base unit to one or more detect, identify and authenticate the receiver with the base unit, verify the continued presence of the receiver near the base unit, and communicate information to provide power transfer to the receiver and to the mobile device and the battery according to their particular charging characteristics.

In view of the above remarks, Applicant respectfully submits that Claim 1, as currently amended, is neither anticipated by, nor obvious in view of the cited references, when considered alone or in combination. Reconsideration thereof is respectfully requested.

Claim 11

The remarks provided above with regard to Claim 1 are herein incorporated by reference. Claim 11 has been amended similarly to Claim 1 to more clearly recite the embodiment therein. For similar reasons as provided above, Applicant respectfully submits that Claim 11, as currently amended, is likewise neither anticipated by, nor obvious in view of the cited references, when considered alone or in combination. Reconsideration thereof is respectfully requested.

Claims 2-8, 10, 12, 22, 30-31, 36, 38-41 and 43-44

Claims 2-8, 10, 12, 22, 30-31, 36, 38-41 and 43-44 depend from and include all of the features of one of Claims 1 or 11. Claims 2-8, 10, 12, 22, 30-31, 36, 38-41 and 43-44 are not addressed separately herein. However, Applicant respectfully submits that these claims are allowable at least as depending from an allowable independent claim, and further in view of the amendments to the independent claims, and the remarks provided above. Reconsideration thereof is respectfully requested.

VII. Claim Rejections under 35 U.S.C. §103(a)

In the Office Action, Claims 9, 13, 15-16 and 34-35 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon (U.S. Publication No. 2004/0145342) in view of Van (U.S. Patent No. 5,952,814). Claims 14, 17-18, 23-29, 37 and 42 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Hui (U.S. Publication No. 2005/0189910). Claim 19 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Chen (U.S. Patent No. 6,331,744). Claims 20-21 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Fukuda (U.S. Patent No. 4,311,953). Claim 32 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Sudo (Japanese Patent No. JP408000838). Claim 33 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lyon in view of Charych (U.S. Patent No. 6,798,716).

Claims 2, 9, 12, 22, 30-31, 36, 38-41 and 43-44 depend from and include all of the features of one of Claims 1 or 11. Claims 2, 12, 22, 30-31, 36, 38-41 and 43-44 are not addressed separately herein. However, Applicant respectfully submits that these claims are allowable at least as depending from an allowable independent claim, and further in view of the amendments to the independent claims, and the remarks provided above. Reconsideration thereof is respectfully requested.

VIII. Conclusion

In view of the above amendments and remarks, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and reconsideration thereof is respectfully requested. The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: November 13, 2013

By: /Karl F. Kenna /
Karl F. Kenna
Reg. No. 45445

Customer No.: 23910
FLIESLER MEYER LLP
410 Pacific Avenue
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Electronic Patent Application Fee Transmittal

Application Number:	13115811
Filing Date:	25-May-2011
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Filer:	Karl Kenna/Christopher Burnharte
Attorney Docket Number:	AFPA-01007US1

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Statutory or Terminal Disclaimer	1814	1	160	160
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**160**

Electronic Acknowledgement Receipt	
EFS ID:	17395073
Application Number:	13115811
International Application Number:	
Confirmation Number:	4181
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Customer Number:	23910
Filer:	Karl Kenna/Christopher Burnharte
Filer Authorized By:	Karl Kenna
Attorney Docket Number:	AFPA-01007US1
Receipt Date:	13-NOV-2013
Filing Date:	25-MAY-2011
Time Stamp:	18:01:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$160
RAM confirmation Number	5517
Deposit Account	061325
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer Filed	afpa_1007us0_Terminal_Disclaimer.pdf	377872 2d74065e69918b1f4c66e023bd44f2b506707590	no	2
Warnings:					
Information:					
2		afpa_1007us1_ROA_092313.pdf	111935 f2bb574151477975287 5abc5d9722c62d76f242a	yes	13

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	7
Applicant Arguments/Remarks Made in an Amendment	8	13

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30390 0e688eeee26bbf53dea5568d5ef3d19288226f5b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	520197		

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) AFPA-01007US1

In re Application of: Afshin Partovi, et al.

Application No.: 13/115,811

Filed: May 25, 2011

For: INDUCTIVE POWER SOURCE AND CHARGING SYSTEM

The owner*, Mojo Mobility, Inc., of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 7,952,322 as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
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is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 45,445

/Karl F. Kenna/ — Signature

November 13, 2013 — Date

Karl F. Kenna — Typed or printed name

415.362.3800 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) included.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/115,811	Filing Date 05/25/2011	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	11/13/2013	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $40 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/ROSALIND BALL/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13115811
Filing Date	2011-05-25
First Named Inventor	Partovi, Afshin
Art Unit	2859
Examiner Name	Berhanu, Samuel
Attorney Docket Number	AFPA-01007US1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7952322		2011-05-31	Partovi et al.	
	2	7948208		2011-05-24	Partovi et al.	
	3	7443135		2008-10-28	Cho	
	4	5367242		1994-11-22	Hulman	
	5	7915858		2011-03-29	Liu et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20070029965		2007-02-08	Hui	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	2	20100207771		2010-08-19	Trigiani, Antonio	
	3	20060202665		2011-03-10	Hsu Feng-Hsiung	
	4	20060108977		2006-05-25	Kagermeier et al.	
	5	20100081473		2010-04-01	Chatterjee et al.	

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	1	European Search Report and Search Opinion in connection with Europe Application 08747863.2 (European National Stage application of PCT/US2008/063084) dated April 2, 2013, 7 pages.	☐
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13115811
	Filing Date	2011-05-25
	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

	3	Office Action in connection with Application No. 12/769,586 dated August 27, 2013, 15 pages.	☐
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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☐ None

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Karl Kenna/	Date (YYYY-MM-DD)	2013-10-29
Name/Print	Karl Kenna	Registration Number	45,445

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	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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	First Named Inventor	Partovi, Afshin
	Art Unit	2859
	Examiner Name	Berhanu, Samuel
	Attorney Docket Number	AFPA-01007US1

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	1	WO03096512A2	WO		2003-11-20	Splashpower Limited		☐
	2	WO03105308A1	WO		2003-12-18	City University of Hong Kong		☐
	3	WO2005109598A1	WO		2005-11-17	Splashpower Limited		☐

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Name/Print	Karl F. Kenna	Registration Number	45445

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Art Unit	2859
Examiner Name	Berhanu, Samuel
Attorney Docket Number	AFPA-01007US1

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	2	8169185		2012-05-01	Partovi et al.	
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	1	20100007307		2010-01-14	Barrman et al.	
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	1	JP/2006-246633A	JP		2006-09-14	Kamitsuma Yosuke et al.		☐
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal	
Application Number:	13115811
Filing Date:	25-May-2011
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Filer:	Karl Kenna/Nancy McElrath
Attorney Docket Number:	AFPA-01007US1
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	17258883
Application Number:	13115811
International Application Number:	
Confirmation Number:	4181
Title of Invention:	INDUCTIVE POWER SOURCE AND CHARGING SYSTEM
First Named Inventor/Applicant Name:	Afshin Partovi
Customer Number:	23910
Filer:	Karl Kenna/Nancy McElrath
Filer Authorized By:	Karl Kenna
Attorney Docket Number:	AFPA-01007US1
Receipt Date:	29-OCT-2013
Filing Date:	25-MAY-2011
Time Stamp:	19:13:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	6418
Deposit Account	061325
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Transmittal Letter	afpa_1007us1_IDS_Trans_1013.pdf	260126 a0ef86e242ad1e324b0ef2a3acb5ecf419fad143	no	3
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Information:					
2	Non Patent Literature	1_ESR_EP_08747863_AFPA1013EP0.pdf	400970 8e8f06fa72f1dcee67ccc5d43efb1e971cb8165e	no	7
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Information:					
3	Non Patent Literature	2_CN_200880023854_4_Office_Action_0828121.pdf	1268011 157808bd2b5e1870f334456f3011d18669565678	no	13
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4	Non Patent Literature	3_Office_Action_12769586_082713.pdf	533946 b17927d3043db4f76b042239bdfdb997b9f33f65	no	15
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5	Non Patent Literature	4_Office_Action_13352096_091113.pdf	457556 1842d9ac13f1bc82eeeae4a8436532d25eec2b25	no	13
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6	Non Patent Literature	5_Office_Action_13709937_091213.pdf	282709 ff9858a04f85f606bfac10d6a45cf6a9c8910260	no	8
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7	Non Patent Literature	6_Office_Action_12769586_121312.pdf	674087 3f64a91f3eb9adc95ef5c98b2566d441ed55379d	no	20
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8	Non Patent Literature	7_Office_Action_13708827_062613.pdf	935558 a369d35d4f1532d63a4ae9f2eba78b03f3e477c1	no	23
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Information:					

10	Non Patent Literature	9_ISR_PCTUS_2011_040062_021712_AFPA1030WO0.pdf	188627 7f80556445930489a03d9388729f2513f055eb59	no	3
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11	Non Patent Literature	10_Office_Action_13708548_060713.pdf	191576 cf4fe12f7d54c9659d0845309fe8cb05b6d25de9	no	6
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12	Non Patent Literature	11_Office_Action_13115811_032813.pdf	483004 dcf30b4639e988ed56f9f9093f01d4cf70c65e30	no	14
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13	Non Patent Literature	12_Office_Action_13708520_052413.pdf	265794 b1f13d0cf0f2c47aa7f4658a59cd6305822e77a7	no	8
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16	Non Patent Literature	15_Office_Action_13710017_061113.pdf	277602 c8eb516531e9e06935694a22764d5ca20de59db4	no	8
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17	Non Patent Literature	16_Office_Action_13710062_060713.pdf	294457 7338c982bdf48522a75220eb12742401f21ddb4e	no	9
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Information:					
18	Non Patent Literature	17_JP_2010_507666_Office_Action_120312.pdf	874439 706c19775c08d4efcf2b66d695b246095e9fb2cb	no	4
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19	Non Patent Literature	18_Office_Action_12769586_121312.pdf	677013 7cbba64be271c2d2fcc32d913f6bb8a3bea9183d	no	20
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20	Non Patent Literature	19_ISR_PCTUS_2010_032845_121310_AFPA1026WO0.pdf	172327 8d03eb55834a8109e2d64a5ce993f3afa7bdd65c	no	3
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21	Non Patent Literature	20_WildChargeLifeUnplugged.pdf	1002831 4e1957c7e8c17e016f43b345b99388a24942603c	no	2
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22	Non Patent Literature	21_Powermat_TheFutureHasArrived.pdf	299825 b55fdffd59e83ed6bdaa141828d594bad28edf95	no	2
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23	Non Patent Literature	22_eCoupledWirelessPowerTechnolgy_FultonInnovation.pdf	634788 e955627f357472928e5f5f9091e0e5c75f1cc484	no	5
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26	Non Patent Literature	25_Office_Action_11757067_101909.pdf	884661 98799a74a558720b0ca6487a4af64aaf0515daba	no	23
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Information:					

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Information:					
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30	Non Patent Literature	29_Office_Action_11669113_082509.pdf	738419 aa2ee5aa1ea543d3dba61a04d1f9746bf8d6a3e1	no	22
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Information:					
32	Non Patent Literature	31_Office_Action_12116876_050211.pdf	223670 ea4165c2251ef547d309315b1c29ed9e36e2882c	no	8
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34	Non Patent Literature	33_ISR_PCTUS_2008_063084_080808_AFPA1013WO0.pdf	314268 acb8ecb765c5e2eb9a5e40f98ce3a69c21c1e26d	no	8
Warnings:					
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35	Non Patent Literature	34_ISR_PCTUS_2007_061406_021408_AFPA1007WO0.pdf	2821910 7ac71ee6bf24c4599790258c92315d1277a3aa17	no	8
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36	Foreign Reference	1_WO_2005_109597.pdf	540555 15b67f97c4366f229472f0006aead4f9304e2d70	no	62
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37	Foreign Reference	2_WO_2005_024865.pdf	1047987 c026f5c6fec3539f08ed68dca6c3b13d1fc8199a	no	25
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38	Foreign Reference	3_WO_2004_055654.pdf	1373366 7c496b41ec6da6e6e18dd8c6e59037936908c097	no	32
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39	Foreign Reference	4_WO_2004_038887.pdf	723992 89a8472663b5cb4c7a059d555ffb0cb252fcc081	no	21
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41	Foreign Reference	6_JP_2009200174.pdf	305507 67f885c38adade85944247a9e882a821425061ea	no	8
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42	Foreign Reference	7_WO_03_105311.pdf	630647 aab9f8af5f51bf3d136c43944a6c83deb0c57920	no	17
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43	Foreign Reference	8_WO_03_096361.pdf	1232016 f156ecb378441f15d7e3621e22ac1e40377219d8	no	36
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44	Foreign Reference	9_JP_408000838.pdf	377128 fb948003d7f3e74f329d6d512b6bd4bcf70facd9	no	8
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45	Foreign Reference	10_WO_2008_137996.pdf	2813559 f04a5585756ebb862495fae2ed8f47a04092de52	no	148
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46	Foreign Reference	11_KR_100836634.pdf	9642147 b52a7292dcb6839aff6a78eddae906e446c739af	no	22
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47	Foreign Reference	12_JP_2000341885.pdf	347233 1c930a38c3fa326a31b78dc09054991f664f2dad	no	7
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Information:					
48	Foreign Reference	13_JP_2003045731.pdf	147755 497728240cb7945d7518debf3623df5b03a42a7a	no	3
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49	Non Patent Literature	1_Sakamoto_ANovelCircuit.pdf	1950013 f9d17e304dcfe99ca40349e179800451d0adf9d7	no	7
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50	Non Patent Literature	2_Abe_ANonContactCharger.pdf	254237 128f6f4129c167a809a0f39e17a7c4ae0dfe7aa4	no	8
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51	Non Patent Literature	3_Sakamoto_LargeAirGap_A.pdf	913943 886af41807820996d7ef52d0ea39e2820789c395	no	3
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52	Non Patent Literature	4_Sakamoto_ANovelConverter_A.pdf	726622 4aebe5f49b9171712f7e2947c83713463723ef6f	no	3
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53	Non Patent Literature	5_Kim_DesignOfAContactless.pdf	284826 989646c90cab64df5221845f280aee9f82f88007	no	10
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Information:					
54	Non Patent Literature	6_Hui_CorelessPrintedCircuitBoardTransf_1052_1054.pdf	1329296 c21028fd672b3f835aef7dd2bf9eb40ef86b26d9	no	3
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55	Non Patent Literature	7_Hui_OptimalOperationofCoreless.pdf	249949 b6699d23bed635d2b33b532ab9f8d32ab2702893	no	9
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56	Non Patent Literature	8_Tang_CharacterizationOfCoreless.pdf	224514 37252bc19f175611e4aa721e4350565c0eb31cfd	no	8
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57	Information Disclosure Statement (IDS) Form (SB08)	afpa_1007us1_IDS_1013_1.pdf	1076536 8ac16d92c32096b1a77b088e1cdebe910f88a75b	no	8
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58	Information Disclosure Statement (IDS) Form (SB08)	afpa_1007us1_IDS_1013_2.pdf	1996710 048a1d367f6b4f512bbfc665ad7aef41b591d271	no	16
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61	Fee Worksheet (SB06)	fee-info.pdf	30373 37eaf517b4c66484308a7c9f9e36a0d56e3d2692	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	55517145		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		PATENT APPLICATION	
Inventor(s):	Partovi, Afshin		
Appl. No.:	13/115,811	Art Unit:	2859
Confirm. No.:	4181	Examiner:	Berhanu, Samuel
Filed:	05-25-2011		
Title:	Inductive Power Source and Charging System	**Customer No. 23910**	

CERTIFICATE OF TRANSMISSION / MAILING UNDER 37 C.F.R. §1.8
I hereby certify that this correspondence is being electronically transmitted to the USPTO or deposited in the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**, on the date shown below.

/Karl F. Kenna/ (Attorney Signature)
Karl F. Kenna, Reg. No. 45,445
Signature Date: Oct. 29, 2013

TRANSMITTAL LETTER RE INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. §1.56

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

It is requested that the information identified in this statement be considered by the Examiner and made of record in the above-identified application. This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56. If this is a continuation, divisional or continuation-in-part application, it is understood that the Examiner will consider all information which was considered by the Office in a parent application. MPEP §609. Such information therefore is not listed herein unless it is desired that the information be printed on a patent issuing from the subject application.

Enclosed with this statement are the following:

✓ Form PTO/SB/08a. The Examiner is requested to initial the form and return it to the undersigned in accordance with M.P.E.P. §609.

✓ As allowed under 37 C.F.R § 1.98(a)(2)(ii), no copies of the U.S. patents and U.S. patent application publications are enclosed, unless required by the office.

__ As allowed under 37 CFR §1.98(d), copies of cited documents noted with an asterisk are not enclosed because they were previously submitted in U.S. Patent Application No. , which is relied on for an earlier effective filing date under 35 USC §120, and which included an Information Disclosure Statement that complies with 37 CFR §1.98(a) through (c).

___ A copy of an International Search Report dated _____ for International Patent Application No. _____.

___ A copy of a Supplementary European Search Report dated _____ for European Patent Application No. _____.

___ A copy of an International Preliminary Examination Report dated _____ for Application No. _____.

___ If any of the cited/submitted documents is in a foreign language, a concise explanation of relevance is provided pursuant to 37 C.F.R. §1.98(a)(3)(I). For foreign language documents cited in a search report by a foreign patent office, the requirement for a concise explanation of relevance is satisfied by the submission herewith of an English language version of the search report. MPEP §609A(3). If a written English-language translation of a non-English language document, or portion thereof, is within the possession, custody or control of, or is readily available to any individual designated in §1.56(c), a copy of the translation accompanies this statement, 37 C.F.R. §1.98(a)(3)(ii), and satisfies the requirement for a concise explanation of relevance, MPEP §609A(3).

This statement should be considered because:

___ **37 C.F.R. §1.97(b)**. This statement qualifies under 37 C.F.R. §1.97, subsection (b) because:

(1) It is being filed within three months of the filing date of an application other than a continued prosecution application under § 1.53(d);

-- OR --

(2) It is being filed within 3 months of entry of a national stage;

-- OR --

(3) It is being filed before the mailing date of the first Office Action on the merits,

-- OR --

(4) It is being filed before the mailing date of the first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. §1.114.

✓ **37 C.F.R. §1.97(c)**. Although it may not qualify under subsection (b), this statement qualifies under 37 C.F.R. §1.97, subsection (c) because:

(1) It is being filed before the mailing date of a FINAL Office Action, a Notice of Allowance, or an action that otherwise closes prosecution in the subject application, whichever occurs first.

-- AND *(check at least one of the following)* --

___ (a) It is accompanied by a STATEMENT as set forth in 37 C.F.R. §1.97(e).

-- OR –

✓ (b) It is accompanied by the fee set forth in 37 C.F.R. §1.17(p).

__ **37 C.F.R. §1.97(d)**. Although it may not qualify under subsection (b) or (c), this statement qualifies under 37 C.F.R. §1.97, subsection (d) because:

(1) It is being filed on or before payment of the Issue Fee;
-- AND --
(2) It is accompanied by a STATEMENT as set forth in 37 C.F.R. §1.97(e);
-- AND --
(3) It is accompanied by the fee set forth in 37 C.F.R. §1.17(p).

___ ***PTA Statement under 37 C.F.R. §1.704(d).*** Each item of information contained in the *Information Disclosure Statement* was cited in a communication from a foreign patent office in a counterpart application and this communication was not received by any individual designated in §1.56(c) more than thirty days prior to the filing of the *Information Disclosure Statement.*

__ *37 C.F.R. §1.97(e)(1).* THE UNDERSIGNED ATTORNEY HEREBY STATES THAT each item of information contained in this *Information Disclosure Statement* was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this *Information Disclosure Statement*; or

__ *37 C.F.R. §1.97(e)(2).* THE UNDERSIGNED ATTORNEY HEREBY STATES THAT no item of information contained in this *Information Disclosure Statement* was cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of the person signing this statement after making reasonable inquiry, no item of information contained in this *Information Disclosure Statement* was known to any individual designated in §1.56(c) more than three months prior to the filing of this statement.

__✓__ ***Fee Authorization.*** The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account No. 06-1325.

Respectfully submitted,

FLIESLER MEYER LLP

Date: Oct. 29, 2013

By: /Karl F. Kenna/
Karl F. Kenna
Reg. No. 45,445

Customer No. 23910
FLIESLER MEYER LLP
410 Pacific Avenue
San Francisco, California 94133
Telephone: (415) 362-3800

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
AFPA1030WO0		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2011/040062	**10 JUNE 2011 (10.06.2011)**	11 JUNE 2010 (11.06.2010)
Applicant		
MOJO MOBILITY, INC. et al		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 2
      ☐ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☒ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/040062

A. CLASSIFICATION OF SUBJECT MATTER

H02J 17/00(2006.01)i, H02J 7/00(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)

H02J 17/00; H01F 38/00, H01F 7/02; H02J 700; H02J 7/00; H01F 7/20

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

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: "Converter", "Inverter", "Half-bridge", "Charger", "Coil", "Battery ", "Microcontroller", "Wireless power", "Magnetic", "Multi-pole"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6844702 B2 (Koninklijke Philips Electronics) 18 Jan. 2005 see the abstract, claims 1-19, column 2 line 34 - column 6 line 20, figures 1-5	1-6
X	US 2009-0243397 A1 (Nigel Power LLC) 1 Oct. 2009 see the abstract, claims 1-40, paragraph [0162]-[0268], figures 1-23	1-6
X	US 2009-0127937 A1 (Nigel Power LLC) 21 May. 2009 see the abstract, claims 1-28, paragraph [0022]-[0064], figures 1-6	1-6
A	US 2007-0182367 A1 (Afshin Partovi) 9 Aug. 2007 see the abstract, claims 1-36, figures 1-22	1-15
A	US 6094119 A (Eastman Kodak Comp) 25 Jul. 2000 see the abstract, claims 1-8, figures 1-7	1-15
A	US 6573817 B2 (STI Optronics Inc) 3 Jun. 2003 see the abstract, claims 1-55, figures 1-9	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"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

"T" 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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 FEBRUARY 2012 (10.02.2012)	**17 FEBRUARY 2012 (17.02.2012)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer BAE, Jin Yong Telephone No. 82-42-481-8503

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2011/040062

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6844702 B2	18.01.2005	AU 2003-230103 A1	02.12.2003
		CN 1653670 A	10.08.2005
		CN 1653670 C	10.08.2005
		EP 1506606 A1	16.02.2005
		JP 2005-526474 A	02.09.2005
		KR 10-2005-0005480 A	13.01.2005
		US 2003-0214821 A1	20.11.2003
		WO 03-098773 A1	27.11.2003
US 2009-0243397 A1	01.10.2009	CN 101978746 A	16.02.2011
		EP 2269408 A2	05.01.2011
		JP 2011-514781 A	06.05.2011
		KR 10-2010-0130618 A	13.12.2010
		WO 2009-111597 A2	11.09.2009
		WO 2009-111597 A3	11.09.2009
US 2009-0127937 A1	21.05.2009	CN 101911029 A	08.12.2010
		EP 2223222 A2	01.09.2010
		JP 2011-508578 A	10.03.2011
		KR 10-2010-0083846 A	22.07.2010
		WO 2009-065099 A2	22.05.2009
		WO 2009-065099 A3	22.05.2009
US 2007-0182367 A1	09.08.2007	US 2007-0279002 A1	06.12.2007
		US 7948208 B2	24.05.2011
		US 7952322 B2	31.05.2011
		WO 2007-090168 A2	09.08.2007
		WO 2007-090168 A3	09.08.2007
US 6094119 A	25.07.2000	JP 2000-182829 A	30.06.2000
US 6573817 B2	03.06.2003	DE 60229686 D1	18.12.2008
		EP 1246513 A2	02.10.2002
		EP 1246513 A3	29.06.2005
		EP 1246513 B1	05.11.2008
		JP 2003-007500 A	10.01.2003
		US 2002-0158736 A1	31.10.2002

Form PCT/ISA/210 (patent family annex) (July 2009)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
AFPA1026WO0		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2010/032845	**28 APRIL 2010 (28.04.2010)**	28 APRIL 2009 (28.04.2009)

Applicant

MOJO MOBILITY, INC. et al

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/032845

A. CLASSIFICATION OF SUBJECT MATTER

H02J 7/00(2006.01)i, H02J 17/00(2006.01)i, H01F 38/14(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)

H02J 7/00; G06F 15/16; H04J 3/22; H04B 7/02

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
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: wireless charging, contactless, communication, coil, magnet, induce, battery, charger.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2008-137996 A1 (MOJO MOBILITY, INC. et al.) 13 November 2008 See abstract; pages 2-91; claims 1-20; figures 1-75.	15 1-14,16-60
Y A	US 2008-0258679 A1 (MANICO JOSEPH A. et al.) 23 October 2008 See abstract; claims 1-20; figures 1-9.	1-14,16-60 15
A	US 7211986 B1 (PLANTRONICS, INC.) 01 May 2007 See abstract; claims 1-14; figures 1-12B.	1-60
A	KR 10-0836634 B1 (HANRIM POSTECH CO., LTD.) 10 June 2008 See abstract; claims 2-6; figure 1-14.	1-60

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents.
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"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
"T" 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 DECEMBER 2010 (10.12.2010)	**13 DECEMBER 2010 (13.12.2010)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer KOO, Young Hoi Telephone No. 0424818376

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2010/032845

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008-137996 A1	13.11.2008	EP 2151037 A1	10.02.2010
		JP 2010-527226 A	05.08.2010
		US 2009-0096413 A1	16.04.2009
		WO 2008-137996 A1	13.11.2008
US 2008-0258679 A1	23.10.2008	CN 101669265 A	10.03.2010
		EP 2140538 A1	06.01.2010
		JP 2010-525785 A	22.07.2010
		KR 10-2010-0015828 A	12.02.2010
		KR20100015828A	12.02.2010
		US 7772802 B2	10.08.2010
		WO 2008-133806 A1	06.11.2008
US 7211986 B1	01.05.2007	None	
KR 10-0836634 B1	10.06.2008	CN 100589304 C	10.02.2010
		CN 101147308 A0	19.03.2008
		EP 1946426 A1	23.07.2008
		JP 2009-501000 A	08.01.2009
		US 2009-0261778 A1	22.10.2009
		US 2010-0289450 A1	18.11.2010
		US 7791312 B2	07.09.2010
		WO 2008-050917 A1	02.05.2008

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AUG 1 1 2008

FLIESLER MEYER LLP

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
KARL F. KENNA
FLIESLER MEYER LLP
650 CALIFORNIA STREET, FOURTEENTH FLOOR
SAN FRANCISCO, CA 94108

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 0 8 AUG 2008
Applicant's or agent's file reference AFPA01013WO0	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 08/63084	International filing date *(day/month/year)* 08 May 2008 (08.05.2008)
Applicant MOJO MOBILITY, INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 1435

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004)

Fliesler Meyer LLP
File: AFPA-01001US1
Action Item: Int'l Search Report-IDS?
Date Due: September 10, 2008
Critical Date: November 8, 2008
Attorney Path: KFK

(See notes on accompanying sheet)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference AFPA01013WO0	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 08/63084	International filing date *(day/month/year)* 08 May 2008 (08.05.2008)	(Earliest) Priority Date *(day/month/year)* 08 May 2007 (08.05.2007)
Applicant MOJO MOBILITY, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 16

   ☒ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☐ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/63084

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02J 7/00 (2008.04)
USPC - 320/108
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)
USPC: 320/108

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 320/108 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(USPT,PGPB,EPAB,JPAB); Google
Search Terms: inductive, base, receiver, coil, zener, mosfet, single unit, spiral, non-ferrite, charge, primary coil

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X – Y	US 7,211,986 B1 (FLOWERDEW et al.) 01 May 2007 (01.05.2007), entire document especially the Abstract; Fig 2; col 4, lns 44-60; col 7, lns 52-61; col 6, lns 14-27	9-14 --- 1-8 and 15-20
Y	US 2004/0113589 A1 (CRISP et al.) 17 June 2004 (17.06.2004), entire document especially paras [0088], [0136], [0154]	15-16 and 18
Y	US 2003/0094921 A1 (LAU et al.) 22 May 2003 (22.05.2003), entire document especially the Abstract	17
Y	US 2003/0103039 A1 (BURR et al.) 05 June 2003 (05.06.2003), entire document especially paras [0019], [0023], and [0029]	1-8 and 19-20
Y	US 2005/0127867 A1 (CALHOON et al.) 16 June 2005 (16.06.2005), entire document especially para [0050]	2 and 7
Y	US 2005/0189910 A1 (HUI) 01 September 2005 (01.09.2005), entire document especially paras [0014], [0085]	6 and 8

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"T" 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 August 2008 (06.08.2008)	08 AUG 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
KARL F. KENNA
FLIESLER MEYER LLP
650 CALIFORNIA STREET, FOURTEENTH FLOOR
SAN FRANCISCO, CA 94108

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	0 8 AUG 2008
Applicant's or agent's file reference: AFPA01013WO0	FOR FURTHER ACTION: See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 08/63084	08 May 2008 (08.05.2008)	08 May 2007 (08.05.2007)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H02J 7/00 (2008.04)
USPC - 320/108

Applicant MOJO MOBILITY, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	06 August 2008 (06.08.2008)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 08/63084

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing

      ☐ contained in the international application as filed

      ☐ filed together with the international application in electronic form

      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (April 2007)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 08/63084

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-8 and 15-20	YES
	Claims	9-14	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 9-14 lack novelty under PCT Article 33(2) as being anticipated by US 7,211,986 B1 to FLOWERDEW et al. (hereinafter Flowerdew).

Claim 9; Flowerdew discloses a mobile device capable of being inductively powered or charged (Abstract) comprising:
a battery (320); and
a receiver (304) for one of inductively powering the device or charging the battery in the mobile device, and wherein the receiver is one of attached to or incorporated into the battery or the mobile device (Fig 2).

Claim 13; Flowerdew discloses a system for use with a mobile device or battery for charging or powering the mobile device or battery inductively (Abstract), comprising:
a base unit (302) including one or more primary coils (312, 314) therein, the primary coil having a generally planar shape (pancake coil) so that when a current is passed through the primary coil a magnetic field is generated in a direction substantially perpendicular to the plane of the primary coil (col 7, lns 52-61); and
wherein the perpendicular magnetic field inductively generates a current in a matching receiver coil or coils (316) within a mobile device or battery (320) placed close to and aligned with the base unit, to charge or power the mobile device or battery (Fig 2).

Claim 10; Flowerdew discloses that the coils or wires are formed within a printed circuit board PCB layer of at least two different sizes or shapes (Fig 7).

Claim 11; Flowerdew discloses that the charger or the power supply, and the mobile device, communicate with each other to transfer data (col 15, lns 1-6).

Claim 12; Flowerdew discloses that the data transfer includes information about the presence of the mobile device adjacent to the charger or power supply and/or wherein the charger or power supply stores charging or power requirements for mobile devices which can be charged or powered by the charger or power supply (col 14, lns 29-52).

Claim 14; Flowerdew discloses that one or more of the coils are manufactured on printed circuit boards and are manufactured to have a low resistance (Fig 7 (coils inherently have low resistance)).

Claims 15-16 and 18 lack an inventive step under PCT Article 33(3) as being obvious over Flowerdew in view of US 2004/0113589 A1 to CRISP et al. (hereinafter Crisp).
Claim 15; Flowerdew discloses the system of Claim 13.
Crisp discloses a battery coupled to and powering the base unit, and wherein the battery can be occasionally charged by an external power supply to maintain a charge sufficient to power the inductive charger or power supply device for a period of time (para [0154]).
A skilled practitioner would have been motivated to modify the system of Flowerdew in accordance with the teachings of Crisp to include a battery coupled to and powering the base unit, and wherein the battery can be occasionally charged by an external power supply to maintain a charge sufficient to power the inductive charger or power supply device for a period of time, since it would allow recharging devices at remote locations.

Claim 16; Flowerdew discloses the system of Claim 13.
Crisp discloses a solar cell coupled to a battery in the base unit, for charging the battery in the base unit; a data storage component for storage of data, for subsequent transmission of data to or from the mobile device; or a cover surface
of the base unit or pad includes a decorative or non-slip surface (para [0136]-[0137]).
A skilled practitioner would have been motivated to modify the system of Flowerdew in accordance with the teachings of Crisp to include a solar cell coupled to a battery in the base unit, for charging the battery in the base unit; a data storage component for storage of data, for subsequent transmission of data to or from the mobile device; or a cover surface of the base unit or pad includes a decorative or non-slip surface, since it would minimize greenhouse gas emissions.

-- See Continuation Sheet --

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 08/63084

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box V. 2. Citations and explanations:

Claim 18; Flowerdew discloses the system of Claim 13.
Crisp discloses a charging circuit having a Zener diode, wherein the Zener diode clamps the voltage to the mobile device or battery to a predetermined maximum voltage, and a switch means that includes a MOSFET and the circuit includes a capacitor connected in parallel to the source to drain terminals of the MOSFET, and wherein the alternating switching in the primary coil is automatically started by the MOSFET when the base unit detects a mobile device or battery placed close to or aligned with the primary coil (para [0088]).
A skilled practitioner would have been motivated to modify the system of Flowerdew in accordance with the teachings of Crisp to include a zener diode and mosfet as claimed, since it would allow control of the battery charging process.

Claim 17 lacks an inventive step under PCT Article 33(3) as being obvious over Flowerdew in view of US 2003/0094921 A1 to LAU et al. (hereinafter Lau).
Claim 17; Flowdrew discloses the system of Claim 13.
Lau discloses a plurality of modular chargers or power supplies that can be interconnected to form a single unit (Abstract).
A skilled practitioner would have been motivated to modify the system of Flowerdew in accordance with the teachings of Lau to include a plurality of modular chargers or power supplies that can be interconnected to form a single unit, since it would allow for scaling the system to provide charging to a large number of devices.

Claims 1, 3-5, and 19-20 lack an inventive step under PCT Article 33(3) as being obvious over Flowerdew in view of US 2003/0103039 A1 to BURR et al. (hereinafter Burr).

Claim 1; Flowerdew discloses a system for inductive powering and charging of portable devices or batteries (Abstract), comprising:
a base unit (302), including one or more primary coils (312, 314) and shaped as planar spiral coils (pancake coil) (col 6, lns 14-27), which are capable of generating an inductive energy for use in powering or charging multiple devices or batteries simultaneously (col 7, lns 52-61);
a receiver unit (304), including a receiver coil (316) which is coupled to or incorporated into a portable device or battery (320), wherein the secondary coil receives energy inductively from the primary coil and uses it to charge or power the portable device or battery (col 4, lns 44-60);
means within the base unit for allowing a degree of position independence of the
devices or batteries on the base unit and selectively activating the one or more primary coils (col 5, lns 32-50); and
wherein the base unit can simultaneously charge or power additional portable devices or batteries with additional secondary coils (col 5, lns 52-61).
However, Flowerdew does not specifically disclose that the coils are comprised of non-ferrite material or that the receiver coil is shaped as a planar spiral coil.
Burr discloses a system for inductive powering and charging of portable devices or batteries wherein the coils are non-ferrite and wherein both coils are planar spiral coils (paras [0019], [0023], and [0029]).
A skilled practitioner would have been motivated to modify the system of Flowerdew to use non-ferrite spiral coils as taught by Burr, since it would provide a lightweight effective charging system.

Claim 3; Flowerdew discloses that the charger and a receiver in the device or battery both include microcontroller units (col 16, lns 1-6), wherein the microcontroller unit in the charger monitors current flow (Abstract), and wherein the microcontroller unit in the portable device or battery provides communication between the charger and the receiver for use in controlling charging (col 16, lns 1-6).

Claim 4; Flowerdew discloses that the charger or power supply includes an additional verification step prior to activating charging, to verify the identity or permissions of a device or battery (col 15, lns 5-6 (Bluetooth links provide for such verification)).

Claim 5; Flowerdew discloses a plurality of coils are integrated into a pad-like charger or power supply and wherein the coils are used to form a coil mosaic and an effective area of charging or power that does not cover more than approximately 90% of pad surface (Fig 7).

Claim 19; Flowerdew discloses the system of Claim 13.
Burr discloses means within the base unit for providing control regulation, and/or verification of the power charging and/or powering, including a switch means for adjusting and/or controlling the power into the coils under different load conditions, to maintain high efficiency during different load conditions or charging stages (para [0031]).
A skilled practitioner would have been motivated to further modify the system of Flowerdew to include the claimed switch means, since it provide an effective means of controlling the power usage.

Claim 20; Burr discloses that the switch means is a zero voltage crossing or zero current crossing switch geometry, and wherein the controlling of output power is be achieved by changing the frequency of the operation (para [0031] (PWM power control necessarily comprises a zero voltage crossing or zero current crossing switch geometry, wherein the controlling of output power is be achieved by changing the frequency of the operation)).

-- See Continuation Sheet --

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 08/63084

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:
Box V. 2. Citations and explanations:

Claims 2 and 7 lack an inventive step under PCT Article 33(3) as being obvious over Flowerdew in view of Burr and further in view of US 2005/0127867 A1 to CALHOON et al. (hereinafter Calhoon).

Claim 2; Flowerdew in view of Burr discloses the system of Claim 1.
Flowerdew further discloses that the charger or power supply includes a plurality of coils (312, 314), but doe not specifically disclose that the means for selective charging or powering is used to control the on off operation of the coils in the vicinity of the portable device or battery.
Calhoon discloses that the means for selective charging or powering is used to control the on off operation of the coils in the vicinity of the portable device or battery (para [0050]).
A skilled practitioner would have been motivated to further modify the system of Flowerdew in accordance with the teachings of Calhoon such that the means for selective charging or powering is used to control the on off operation of the coils in the vicinity of the portable device or battery, since it would provide an effective means to use power only when a chargeable device is present.

Claim 7; Flowerdew in view of Burr discloses the system of Claim 1.
Calhoon discloses that the one or more coils includes a switch component, and wherein the microcontroller unit periodically starts the switch components, monitors the current therein, and uses the current to sense the proximity of a receiver and device or battery to that coil, and activate charging in that coil, or a selection of coils in that region (para [0050]).
A skilled practitioner would have been motivated to further modify the system of Flowerdew in accordance with the teachings of Calhoon such that that the one or more coils includes a switch component, and wherein the microcontroller unit periodically starts the switch components, monitors the current therein, and uses the current to sense the proximity of a receiver and device or battery to that coil, and activate charging in that coil, or a selection of coils in that region, since it would provide an effective means to use power only when a chargeable device is present.

Claims 6 and 8 lack an inventive step under PCT Article 33(3) as being obvious over Flowerdew in view of Burr and further in view of US 2005/0189910 A1 (HUI).

Claim 6; Flowerdew in view of Burr discloses the system of Claim 1.
Hui discloses that each of the plurality of coils are driven by an individual drive circuit to provide power to each coil and to selectively activate one or more coils (para [0014]).
A skilled practitioner would have been motivated to further modify the device of Flowerdew in accordance with the teachings of Hui such that each of the plurality of coils are driven by an individual drive circuit to provide power to each coil and to selectively activate one or more coils, since it would increase efficiency by not unnecessarily powering coils.

Claim 8; Flowerdew in view of Burr discloses the system of Claim 1.
Hui discloses a plurality of layers of coils that are layered upon one another to create an effective area, and so that powering anyone or a selection of the coils allows a receiver whose center is within the effective area to be charged (para [0085]).
A skilled practitioner would have been motivated to further modify the device of Flowerdew in accordance with the teachings of Hui to use a plurality of layers of coils, since it would provide means of controlling the intensity of the oscillating magnetic field.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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FLIESLER MEYER LLP

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: Karl F. Kenna
Fliesler Meyer LLP
650 California Street, Fourteenth Floor
San Francisco, California 94108

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference AFPA01007WO0	Date of mailing *(day/month/year)* 14 FEB 2008 **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No PCT/US 07/61406	International filing date *(day/month/year)* 31 January 2007 (31.01.2007)
Applicant PARTOVI, Alshin	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46).

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes, 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 28 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

Ref: AFPA-01007US01
Action Item: Int'l Search Report - ISR
Date Due: March 20, 2008
Critical Date: May 14, 2008
Attorney Path: KFK
Docketed By: JAS
Verified By:

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference AFPAG1007WO0	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 07/61406	International filing date *(day/month/year)* 31 January 2007 (31.01.2007)	(Earliest) Priority Date *(day/month/year)* 31 January 2006 (31.01.2006)
Applicant PARTGVI, Alshin		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1 **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3 ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the drawings to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (April 2007)

International application No
PCT/US 07/61408

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) H02J 7/00 (2007.01)
USPC 320/108
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
USPC 320/108, 112

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

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

USPTO WEST - Databases: PGPB,USPT,USOC,EPAB,JPAB - Terms: portable, mobile, charge, charger, battery, induction, inductive, non-contact, coil, printed circuit board, data, transfer, communicate, antenna, align, orient, position, magnet, size, shape, simultaneous, plurality, multiple, mosfet, zener diode, capacitor, parallel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	US 2002/0094167 A1 (JENSON et al.) 10 January 2002 (10.01.2002) para [0005]; para [0319]	1, 2
X ... Y	US 6,008,622 A (NAKAWATASE) 28 December 1999 (28.12.1999) Col. 1, ln 10-14; Col. 2, ln 5-20; Col. 3, ln 11-28, Col. 3, ln 59-67; Col 4, ln 1-36	3, 11, 26 ..... 4-10, 12-25, 27-36
Y	US 2002/0067238 A1 (LEU) 06 June 2002 (06.06.2002) abstract; para [0045]	4,5,12
Y	US 2005/0127869 A1 (CALHOON et al.) 16 June 2005 (16.06.2005) abstract, para [0042]; [0044]; [0043]; [0045]; [0051]-[0053]; [0047]; claim 7; para [0022]; [0030]; [0060]	6-10, 13-18, 20-25, 27, 28, 30-32, 36
Y	US 2005/0075696 A1 (FORSBERG et al.) 07 April 2005 (07.04.2005) para [0064]-[0065]	18, 19, 29
Y	US 2005/0063488 A1 (TROYK et al.) 24 March 2005 (24.03.2005) para [0006]-[0007]	33-35

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"T" 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 July 2007 (23.07.2007)	14 FEB 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

From the
INTERNATIONAL SEARCHING AUTHORITY

To: Karl F. Kenna
Fliesler Meyer LLP
650 California Street, Fourteenth Floor
San Francisco, California 94108

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	14 FEB 2008

Applicant's or agent's file reference	FOR FURTHER ACTION
AFPA01007WO0	See paragraph 2 below

International application No.	International filing date *(day month year)*	Priority date *(day month year)*
PCT/US 07/61406	31 January 2007 (31.01.2007)	31 January 2006 (31.01.2006)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H02J 7/00 (2007.01)
USPC - 320/108

Applicant PARTOVI, Afshin

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	23 July 2007 (23.07.2007)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 07/61406

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ on paper

☐ in electronic form

c. time of filing/furnishing

☐ contained in the international application as filed.

☐ filed together with the international application in electronic form.

☐ furnished subsequently to this Authority for the purposes of search.

4 ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No
PCT/US 07/81406

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	4-10, 12-36	YES
	Claims	1-3, 11	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-36	NO
Industrial applicability (IA)	Claims	1-36	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1 and 2 lack novelty under PCT Article 33(2) as being anticipated by US 2002/0004187 A1 to Jenson et al. (hereinafter 'Jenson').

As to claims 1 and 2 Jenson teaches an electrically powered portable device (para [0005]) which includes a shell, and a battery integrated with the shell (abstract), wherein an RF antenna 3014 is also placed within the cap so that the battery 1110 imbedded within the cap 3012 can be recharged by passing radio frequency into the cap or inductively coupling the required energy into the cap. (para [0319]).

Claims 3 and 11 lack novelty under PCT Article 33(2) as being anticipated by US 6,008,622 A (Nakawatase).

As to claim 3, Nakawatase teaches a mobile device charger (Col. 1, ln 10-14) comprising: a plurality of coils or wire, wherein the coils or wires are placed in one or more layers and are used to inductively charge a mobile device in proximity to the mobile device charger (Col 2, ln 9-20).

As to claim 11, Nakawatase teaches a mobile device charger (Col. 1, ln 10-14) comprising: a unit comprising a plurality of primary coils of wire, wherein the coils have a generally planar shape so that when a current is passed through the primary coil a magnetic field is generated in a direction substantially perpendicular to the plane of the primary coil (Col. 3, ln 11-26) and wherein the perpendicular magnetic field inductively generates a current in a matching secondary coil or coils within a mobile device placed close to and aligned with the base unit, to charge or power the mobile device (Col. 3, ln 59-67; Col 4, ln 1-36).

Claim 26 lacks an inventive step under PCT Article 33(3) as being obvious over Nakawatase.

As to claim 26, although Nakawatase does not explicitly teach wherein one or more of the primary coils is stacked to improve transfer efficiency, Nakawatase teaches a a flat-faced spiral coil as well as a coil wound on a ferrite core (col 1, ln 41-42). It would have been obvious to a person skilled in the art that a coil wound on a core resembles a stack of connected coils, especially when transposed to a flat substrate, as taught by Nakawatase.

Claims 4, 5 and 12 lack an inventive step under PCT Article 33(3) as being obvious over Nakawatase in view of US 2002/0067238 A1 (Leu).

As to claim 4, Nakawatase teaches wherein coils are formed on a flat surface having two different sizes and shapes (Col. 3, ln 59-67). Although Nakawatase does not explicitly teach wherein said coils may be formed within a printed circuit board, Leu teaches the formation of inductive coils on a printed circuit board (abstract). It would have been obvious to a person skilled in the art to combine the teaching of Leu with that of Nakawatase since printed circuit boards are in common use in portable electronic devices and Leu teaches a method enabling the invention of Nakawatase using the circuit board as a flat substrate.

As to claim 5, Nakawatase teaches wherein two or more coils are activated to charge a mobile device (Col. 3, ln 59-67; Col 4, ln 1-36).

As to claim 12, Nakawatase teaches wherein coils are formed on a flat surface having two different sizes and shapes (Col. 3, ln 59-67) Although Nakawatase does not explicitly teach wherein said coils may be formed within a printed circuit board, Leu teaches the formation of inductive coils on a printed circuit board (abstract). Although Leu does not explicitly teach wherein the coils are low resistance, Leu teaches wherein the coils are formed of silver or gold (para [0045]). Silver and gold are known by those skilled in the art to be low resistance conductors. It would have been obvious to a person skilled in the art to combine the teaching of Leu with that of Nakawatase since printed circuit boards are in common use in portable electronic devices and Leu teaches a method enabling the invention of Nakawatase using the circuit board as a flat substrate.

Claims 6-10, 13-17, 20-25, 27, 28, 30-32, and 36 lack an inventive step under PCT Article 33(3) as being obvious over Nakawatase in view of US 2005/0127869 A1 to Calhoon et al. (hereinafter 'Calhoon').

As to claim 6, although Nakawatase does not explicitly teach wherein the mobile device charger or power supply and the mobile device communicate with each other to transfer data, Calhoon teaches an inductive power adapter (abstract) wherein both a power source and a power adapter may have a microprocessor controller (para [0042]), adapted for data communication between a power supply (320) and a host device (100) or a power adapter (304) and a host device (100) (para [0044]). It would have been obvious to a person skilled in the art to combine the teachings of Nakawatase and Calhoon, as both teach inductive battery charging for portable devices.

- Please see continuation sheet -

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No
PCT/US 07/61406

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:
Box V 2 - Citations and Explanations.

As to claim 7, Calhoon teaches separate wire for data transfer (a bus with a two-wire interface system; para [0043])

As to claim 8, Calhoon teaches wherein the coils also function as an antenna for data transfer (para [0045]).

As to claim 9, Calhoon teaches wherein the data transfer includes information about the presence of the mobile device adjacent to the charger or power supply (para [0051]-[0053])

As to claim 10, Calhoon teaches wherein the charger or power supply stores charging or power requirements for mobile devices which can be charged or powered by the charger or power supply (para [0047]).

As to claim 13, Calhoon teaches wherein the base unit includes a primary circuit having a switch means for switching the primary coil on and off whenever the mobile device is placed close to the primary coil of the base unit or the presence of the mobile device is to be detected (para [0051]-[0053])

As to claim 14, Calhoon teaches wherein the base unit includes multiple primary coils that can be used to charge devices (claim 7). Although Calhoon does not explicitly teach simultaneous charging, it would have been obvious to a person skilled in the art to suggest simultaneously charging more than one device, based on the teaching of Calhoon.

As to claim 15, Calhoon teaches periodically starting and stopping the alternating switching to automatically detect a presence of a mobile device placed close to or aligned with the primary coil of a base unit (para [0051]-[0053]).

As to claim 16, although Calhoon does not explicitly teach wherein the presence of the device close to or aligned with the primary coil of the base unit is detected by monitoring the current passing through the primary coil or switching means, Calhoon teaches wherein the power adapter 304, via controller 316, is configured to listen for a power source through the power pickup coil 324, then when the device is positioned proximate to the base, the transmission coil 312 and pickup coil 324 are in close enough proximity to establish communications and inductive coupling. (para [0052]). It would have been obvious to a person skilled in the art that the listening taught by Calhoon would have involved sensing the current through the coil. It further would have been obvious that a similar process could have been conducted using the power source, as opposed to the power adapter, as taught by Calhoon.

As to claim 17, Calhoon teaches a charge pad (para [0072]), wherein said pad may comprise a plurality of transmission elements (claim 7).

As to claim 20, although neither Nakawatase nor Calhoon explicitly teaches wherein the charging unit comprises a battery that can occasionally be charged by an external power supply to maintain a charge sufficient to power the inductive device for a period of time, heavy-duty external or internal batteries, such as uninterruptible power supplies, were well known to those skilled in the art, and it would have been obvious to a person skilled in the art to suggest using such a rechargeable power source as a means of maintaining a polling or communication scheme as taught by Calhoon for the sensing of a device to be charged, or for providing power to recharge a device in order to allow the charger, itself to be mobile, or in the event that an external power source failed while portable devices needed recharging.

As to claim 21, although neither Nakawatase nor Calhoon explicitly teaches wherein the charging unit comprises a solar cell for charging a battery in the base or charging unit, solar cells were well known to those skilled in the art. It would have been obvious to a person skilled in the art to suggest charging a storage or back-up battery in an inductive charger as taught by Nakawatase and modified in view of Calhoon, as long as conditions whereby the solar cell would have been able to operatively provide sufficient power to charge the battery on a periodic basis existed.

As to claim 22, Calhoon teaches a nonvolatile data storage component for the storage of data, for subsequent transmission of data to or from the mobile device (para [0030]).

As to claim 23, although neither Nakawatase nor Calhoon explicitly teaches wherein the cover surface of the base unit or pad includes a decorative or non-slip surface, Calhoon teaches wherein the charging unit is built into a work surface or table (para [0060]). It would have been obvious to a person skilled in the art that an electronic consumer product would have been expected to have a housing that was appropriately decorative, stylish, or labeled so as to integrate well with the devices with which it would have been expected to be utilized.

As to claims 24 and 25, although neither Nakawatase nor Calhoon explicitly teaches a charging kiosk, briefcase, bag or clothing, Calhoon teaches wherein the charger may be usefully incorporated into lecterns, desks, vehicles, and the like (para [0060]). It would have been obvious to a person skilled in the art to suggest alternative embodiments of a charger, depending upon the size and type of the device which would have been expected to be used in conjunction with said charger. For smaller devices, a person skilled in the art would have anticipated smaller, more portable applications or embodiments, as claimed.

As to claim 27, Calhoon teaches wherein a charger or power supply senses the location of a mobile device and activates a coil or wire near the device to charge or provide power to the mobile device (para [0051]-[0053]).

As to claim 28, although Calhoon does not explicitly teach a resonant circuit in the charger or power supply for the sensing of the location of a mobile device, Calhoon does teach wherein the power adapter 304, via controller 316, is configured to listen for a power source through the power pickup coil 324, then when the device is positioned proximate to the base, the transmission coil 312 and pickup coil 324 are in close enough proximity to establish communications and inductive coupling. (para [0052]). It would have been obvious to a person skilled in the art that the listening taught by Calhoon could have involved sensing the current through the coil, potentially by a resonant circuit.

- Please see next continuation sheet -

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of

Box V.2 - Citations and Explanations:

As to claim 30, although Calhoon does not explicitly teach wherein the charger or power supply is made in the shape of a bowl, cup or other container, Calhoon describes power systems for computing devices wherein embodiments include work surfaces, lecterns, desks, vehicles, and the like (para [0060]), as well as a seatback tray of a commercial aircraft (para [0006]). It would have been obvious to a person skilled in the art that an inductive charger could be used in nearly any shape or form appropriate for the devices to be inductively charged.

As to claim 31, although Calhoon does not explicitly teach a plurality of modular devices, Calhoon teaches wherein the charger may be usefully incorporated into lecterns, desks, vehicles, and the like (para [0060]). It would have been obvious to a person skilled in the art to suggest modularly linking desks or other small work surfaces into a larger work surface incorporating a plurality of chargers, as taught by Calhoon.

As to claim 32, although neither Nakawatase nor Calhoon explicitly teaches wherein the mobile device to be powered is a kitchen appliance, dish, or a toy, it would have been obvious to a person skilled in the art to use an inductive battery charger to power a toy, particularly toys used by smaller children, as battery consumption by such devices is high, while children do not possess the capacity to safely handle and change batteries.

As to claim 36, Calhoon teaches wherein the adapter 304 housing may be provided in any appropriate shape and may fit into a battery port of typical portable electronic devices (para [0038]). It would have been obvious to a person skilled in the art to design a form-factored replacement for an existing battery design or pack as an aftermarket replacement, based on the teaching of Calhoon.

Claims 19 and 29 lack an inventive step under PCT Article 33(3) as being obvious over Nakawatase in view of US 2005/0075696 A1 to Forsberg et al. (hereinafter 'Forsberg').

As to claim 19, although Nakawatase does not explicitly teach wherein a magnet is place at the center of a primary coil, wherein the magnet at the center has a magnetic axis that is perpendicular to the plane of the coil, and wherein one or more of the devices to be charged include a magnet at the center of the receiver (secondary) coil, so that the magnets in the devices and the magnets in the charger are oriented to attract each other when a coil in a device is placed directly on top of a coil in the base, Fosberg teaches a magnetic core positioned in a primary coil in order to position the primary coil properly for maximizing the magnetic flux received by the secondary coil (para [0064]-[0065]). Although Fosberg does not explicitly teach wherein a magnet is also present in the secondary coil for the purpose of alignment, it would have been obvious to a person skilled in the art that it would have been possible to also include a magnetic core in the secondary coil in such a manner as to attract the magnetic core in the center of the primary coil, as taught by Fosberg.

As to claim 29, although Nakawatase does not explicitly teach a flexible PCB material as a substrate for a receiver of inductive power, Forsberg teaches a flexible material as a shield for a primary coil (para [0010]). It would have been obvious to a person skilled in the art that the substrate could similarly be constructed of a flexible polymer material.

Claim 18 lacks an inventive step under PCT Article 33(3) as being obvious over Nakawatase and Calhoon, further in view of Fosberg.

As to claim 18, although neither Nakawatase nor Calhoon explicitly teaches wherein the primary coils can move within their plane to more closely align with the secondary coil or mobile device, Forsberg teaches a repositionable magnetic core 58 can help to focus electromagnetic energy from primary coil 46 to more closely be aligned with secondary coil 34 (para [0052]) for an inductively rechargeable, implantable medical device (abstract). It would have been obvious to a person skilled in the art to combine the teaching of Forsberg regarding a repositionable primary coil to a charging base as taught by Nakawatase, modified as taught by Calhoon because all three references teach inductive charging of portable or mobile devices.

Claims 33-35 lacks an inventive step under PCT Article 33(3) as being obvious over Nakawatase and Calhoon, further in view of US 2009/0063488 A1 to Troyk et al. (hereinafter 'Troyk').

As to claim 33, Troyk teaches a magnetically coupled data and power transmission system (para [0004]) that may also be effectively applied to other applications, such as some RFID transponders (para [0001]). It would have been obvious to a person skilled in the art that an active RFID transponder, which also incorporates a power-storing device, would have been enabled by the teachings of Troyk.

As to claim 34, although Nakawatase does not explicitly teach wherein a mobile device to be charged or powered includes a charging circuit having a Zener diode, wherein the Zener diode clamps the voltage to the mobile device to a predetermined maximum value, Troyk teaches a diode rectifying bridge in a circuit with the receiving coil (para [0034]). While Troyk does not explicitly teach wherein said diode is a Zener diode to clamp the voltage at a maximum value, Troyk teaches a resonant circuit comprised of inductor 8 (a coil), and capacitors 4 and 5, wherein capacitor 5 is chosen to be substantially larger than capacitor 4 results in a beneficial capacitive voltage division, thereby reducing the voltage stresses on MOSFET switch 3 (para [0029]). It would have been obvious to a person skilled in the art to suggest a different, well-known means of limiting the voltage in the inductive system, such as using a Zener diode.

As to claim 35, although neither Nakawatase nor Calhoon teaches wherein a mosfet and capacitor may be used in a switching circuit, Troyk teaches wherein, in the prior art, a mosfet switch is used to place a capacitor directly across an antenna coil, wherein the drain capacitance appears in parallel with the transmitter coil when the mosfet is off, lowering the resonant frequency of the system for modulation of the current in the transmitter coil. This allows communication with a device over the magnetic link (para [0006]-[0007]). It would have been obvious to a person skilled in the art to apply the teaching of Troyk to a charging system as taught by Calhoon, further specifying wherein the alternating switching described by Calhoon (para [0051]-[0053]) for the primary coil is started by the MOSFET.

Claims 1-36 have industrial applicability as defined by PCT Article 33(4), because the subject matter can be made or used in industry.

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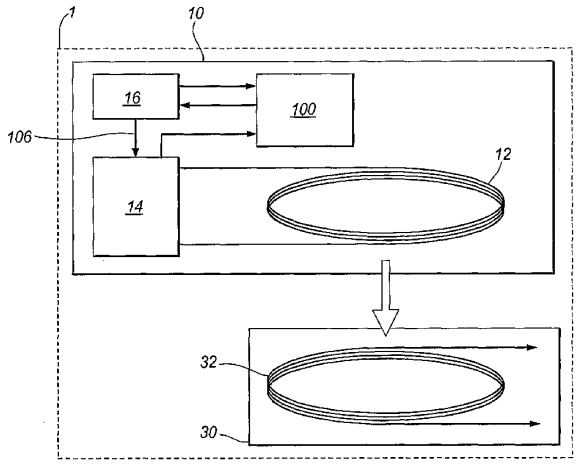
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(54) Title: CONTROLLING INDUCTIVE POWER TRANSFER SYSTEMS



(57) Abstract: An inductive power transfer system (1) comprises a primary unit (10) operable to generate an electromagnetic field and at least one secondary device (30), separable from the primary unit, and adapted to couple with the field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween. The system detects if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices. Following such detection, the system restricts or stops the inductive power supply from the primary unit. Such a system can detect the presence of unwanted parasitic loads in the vicinity of the primary unit reliably.

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CONTROLLING INDUCTIVE POWER TRANSFER SYSTEMS

The present invention relates to controlling inductive power transfer systems for use, for example, to power portable electrical or electronic devices.

This application claims priority from the applicant's copending applications GB 0410503.7 filed on 11th May 2004 and GB 0502775.0 filed on 10th February 2005, the entire content of each of which is incorporated herein by reference.

Inductive power transfer systems suitable for powering portable devices may consist of two parts:

- A primary unit having at least one primary coil, through which it drives an alternating current, creating a time-varying magnetic flux.
- A secondary device, separable from the primary unit, containing a secondary coil. When the secondary coil is placed in proximity to the time-varying flux created by the primary coil, the varying flux induces an alternating current in the secondary coil, and thus power may be transferred inductively from the primary unit to the secondary device.

Generally, the secondary device supplies the transferred power to an external load, and the secondary device may be carried in or by a host object which includes the load. For example the host object may be a portable electrical or electronic device having a rechargeable battery or cell. In this case the load may be a battery charger circuit for charging the battery or cell. Alternatively, the secondary device may be incorporated in such a rechargeable cell or battery, together with a suitable battery charger circuit.

A class of such an inductive power transfer systems is described in our United Kingdom patent publication GB-A-2388716. A notable characteristic of this class of systems is the physically "open" nature of the magnetic system of the primary unit – a significant part of the magnetic path is through air. This is necessary in order that the primary unit can supply power to different shapes and sizes of secondary device, and to multiple secondary devices simultaneously. Another example of such an "open" system is described in GB-A-2389720.

Such systems may suffer from some problems. A first problem is that the primary unit cannot be 100% efficient. For example, switching losses in the electronics and I^2R losses in the primary coil dissipate power even when there is no secondary device present, or when no secondary devices that are present require charge. This wastes energy. Preferably the primary unit should enter a low-power "standby mode" in this situation.

A second problem in such systems is that it is not possible to mechanically prevent foreign objects from being placed into proximity with the primary coil, coupling to the coil. Foreign objects made of metal will have eddy-currents induced therein. These eddy currents tend to act to exclude the flux, but because the material has resistance, the flowing eddy currents will suffer I^2R losses which will cause heating of the object. There are two particular cases where this heating may be significant:

- If the resistance of any metal is high, for example if it is impure or thin.
- If the material is ferromagnetic, for example steel. Such materials have high permeability, encouraging a high flux density within the material, causing large eddy currents and therefore large I^2R losses.

In the present application, such foreign objects that cause power drain are termed "parasitic loads". Preferably the primary unit should enter a "shutdown mode" when parasitic loads are present, to avoid heating them.

Various approaches to solve these two problems have been proposed in the prior art.

Solutions to the first problem, of not wasting power when no secondary device requires charge, include:

- In EP0533247 and US 6118249 the secondary device modulates its inductive load during charging, causing a corresponding variation in the power taken from the primary unit. This indicates to the primary unit that it should stay out of the standby state.
- In EP1022840 the primary unit varies the frequency of its drive, and thus the coupling factor to a tuned secondary unit. If the secondary unit is not taking power, there is no difference in the power taken as the frequency is swept and thus the primary unit goes into a standby state.
- In US5536979 the primary unit simply measures the power flowing in the primary coil, and enters a pulsing standby state if this is below a threshold.

- In US5896278 the primary unit contains detecting coils which have power coupled back into them according to the position of the secondary device. If the device is not present the primary unit enters a standby mode.
- In US5952814 the secondary device has a mechanical protrusion which fits a slot in the primary unit, activating it.
- In US6028413 the primary unit drives two coils, and there are a corresponding two power receiving secondary coils in the secondary unit. The primary unit measures the power delivered from each primary coil and enters standby mode if it is below a threshold.

Solutions to the second problem, of parasitic loads, include:

- As mentioned above, in EP1022840 the primary unit varies the frequency of its drive. In this system, the secondary device is tuned, so this frequency variation will result in a variation of the power taken from the primary unit. If the load is instead a piece of metal, then varying the frequency will not have as much effect and the primary unit will enter a shutdown state.
- As mentioned above, in US5952814 a key in the secondary device activates the primary unit. The assumption is that if a secondary device is present then this will physically exclude any foreign objects.
- As mentioned above, in US6028413 the primary unit supplies power to the secondary device by driving two primary coils. If the amount of power supplied by the two coils is different, the primary unit assumes that the load is not a valid secondary device and enters shutdown mode.

These approaches all assume a 1:1 relationship between the primary unit and the secondary device. Therefore they are not sufficient for systems such as those described in GB-A-2388716 where more than one secondary device at a time may be present. For example, they would not work when there are two secondary devices present, one requiring charge and the other not.

Some of these approaches also assume that the physical or electrical presence of a valid secondary device implies that all foreign objects are physically excluded by the secondary device. This is not necessarily the case, particularly when the secondary devices may be positioned arbitrarily in respect of the primary unit, as in those described in GB-A-2388716.

According to a first aspect of the present invention there is provided a method of controlling inductive power transfer in an inductive power transfer system comprising a primary unit operable to generate an electromagnetic field and at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween, which method comprises: setting the or each secondary device to a no-load state in which supply of any of the power received inductively by the secondary device to an actual load thereof is substantially prevented; and in the primary unit, measuring a power drawn from the primary unit when the or each secondary device is set into said no-load state, and restricting or stopping the inductive power supply from the primary unit in dependence upon the measured power.

Because the secondary device(s) are set into the no-load state during the power measurement, it can be detected easily from the measured power if there is a substantial parasitic load. If so, the primary unit can enter a shutdown mode. For example, the if the measured power is greater than a threshold value in the no-load state, then the power supply may be restricted or stopped.

This method is convenient because it is unnecessary for the secondary devices to communicate their power requirements to the primary unit or for the primary unit to carry out any summation of the power requirements: it is known that since the secondary devices are in the no-load state their combined power requirement is zero or at least a small value influenced by any parasitic load imposed on the primary unit by the secondary devices themselves.

According to a second aspect of the present invention there is provided a method of controlling inductive power transfer in an inductive power transfer system comprising a primary unit operable to generate an electromagnetic field and at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween, which method comprises: in the primary unit, receiving, from the or each secondary device that is in a power-requiring state, information relating to a power requirement of the secondary device concerned; and in the primary unit, measuring the power drawn from the primary unit when power is being

supplied to the or each secondary device having the power-requiring state, and restricting or stopping the inductive power transfer from the primary unit in dependence upon the measured power and the received power requirement information.

In this case, the inductive power supply from the primary unit may be restricted or stopped in dependence upon a difference between said measured power and a sum of the respective power requirements of the secondary devices having said power-requiring state. For example, the inductive power supply may be restricted or stopped in the event that the measured power exceeds said sum by more than a threshold value.

This method has the advantage over the method of the first aspect that it does not need to set the secondary devices into the no-load state during the power measurement. Thus, power can be supplied continuously to the actual loads of the secondary devices.

Of course, in the method of the first aspect, the power measurement period can be very short, so that any interruption to the power supply to the load may be unnoticeable. If interruption of the load is a problem, it is possible to provide an energy storage means such as a capacitor in the secondary device to maintain the power supply to the actual load during the power measurement period.

In the method of the second aspect, any suitable communication method may be used to transmit the power requirement information from each secondary device to the primary unit. One preferred method for the or each secondary device to transmit its power requirement information to the primary unit is an RFID method. Alternatively, the or each secondary device may transmit its power requirement information to the primary unit by varying a load imposed by the secondary device on the primary unit.

It will be appreciated that the methods embodying the first and second aspects of the invention provide different ways of detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices. Following such detection, the inductive power supply from the primary unit can be restricted or stopped.

In the methods of the first and second aspects it is possible to vary a load imposed by the secondary device on the primary unit to communicate a signal or information from the secondary device to the primary unit. For example, the power requirement information needed in the second aspect may be transmitted this way.

An advantage of communicating using load variation is that it can permit two or more, or possibly all, secondary devices to supply respective items of information simultaneously to the primary unit. For example, if any secondary device requires power it may vary its load. If the primary unit detects no or no substantial overall load variation it can conclude that no secondary device requires power and hence enter a standby mode. Similarly, the primary unit will detect the sum of any load variations. If the load variation from each individual secondary device is proportional to some analog quantity to be communicated to the primary unit, for example the power requirement or parasitic load of the secondary device, then the sum of the respective analog quantities will be detected by the primary unit in the power measurement. This means that the sum can be obtained directly without the need for additional processing in the primary unit which may be time-consuming and/or costly to implement.

It may also be desirable to detect a condition for entering a standby mode in addition to detecting when to enter the shutdown mode. For example, in the method of the first aspect it is possible to restrict or stop the inductive power supply in the event that the measured power is less than a standby threshold value (different from the shutdown threshold mentioned above). Another possibility is that the or each said secondary device reports to the primary unit state information indicating whether the secondary device is in a no-power-requiring state, in which an actual load of the secondary device currently requires no power from the primary unit, or a power-requiring state in which said active load does currently require power from the primary unit. The primary unit then restricts or stops the inductive power supply therefrom in dependence upon the state information reported by the or each secondary device. For example, the primary unit may restrict or stop the inductive power transfer unless the state information reported by at least one secondary device indicates that it has said power-requiring state. Preferably, for speed of response, two or more secondary devices report their respective state information simultaneously to the primary unit. One convenient possibility, as noted above, is for the or each said secondary device to report its said state information by varying a load imposed by it on the primary unit.

In general, it is possible to carry out two or more measurements of the power drawn from the primary unit in different measurement periods. If the secondary devices are synchronised with the primary unit, then they can behave differently in one measurement period from another, so that the primary unit can detect two or more different conditions under which power restriction or stopping is appropriate.

One preferred embodiment has three measurement periods. In the first period, each secondary device turns off a dummy load. In the second period, each secondary device that requires power turns on its dummy load. The other secondary devices turn their dummy loads off. In the third period, each secondary device turns on its dummy load. The primary unit can detect from a comparison of the power measurements in the three periods whether there is a substantial parasitic load requiring shutdown or no device requiring power so that standby is appropriate.

It is also possible to vary the load during a measurement period. For example, the amplitude of the load change may be fixed but the duration may be varied to supply information.

The primary unit may have registered therein a power requirement of at least one said secondary device. In this case the power requirement information transmitted from that secondary device may simply be information identifying the secondary device. The primary unit employs the identifying information to retrieve the registered power requirement for the device. The identifying information can be a code or a type, model or serial number assigned to the secondary device. This can reduce the amount of information to be transmitted to the primary unit and also improve speed of response and reliability.

Although each secondary device that is in the power-receiving state transmits power requirement information to the primary unit in the method of the second aspect, the or each said secondary device not having the power-requiring state may also transmit such power requirement information to the primary unit, if desired. One possibility is for the power requirement information transmitted by the or each said secondary device not in said power-requiring state to be representative of a parasitic load imposed on the primary unit by the secondary device. This can then be used to make the shutdown

detection more reliable. It is also possible for the power requirement information to be the sum of power requirement of the actual load and the parasitic load of the secondary device when in the power-requiring state and just the power requirement of the parasitic load when not in that state.

Generally, it is desirable for the detection of the conditions for restricting or stopping the inductive power supply to take account of any losses in the primary unit and the secondary devices. There are a number of ways of doing this.

One way is to employ, when carrying out said detection, first compensation information relating to losses in the primary unit itself so as compensate for said losses. It is possible to derive part or all of said first compensation information from measurements taken by the primary unit when it is effectively in electromagnetic isolation. The first compensation information may be stored in a calibration unit of the primary unit.

Another way is to employ, when carrying out said detection, second compensation information relating to a parasitic load imposed on the primary unit by the or each secondary device so as to compensate for said parasitic load of the or each secondary device. The or each said secondary device preferably communicates its said second compensation information directly to said primary unit or communicates to the primary unit other information from which the primary unit derives said second compensation information. The secondary device may communicate its said second compensation information or its said other information to the primary unit by varying a load imposed by it on the primary unit, as mentioned above.

A particularly convenient and efficient way is for the or each said secondary device to have a dummy load, representative of its said parasitic load, which it imposes on said primary unit to vary the load imposed by it on the primary unit.

Part or all of said first compensation information and/or part or all of said second compensation information may be information stored in the primary unit during manufacture and/or testing of the primary unit.

It may be advantageous to vary one or both of said first and second compensation information when one or more operating conditions (e.g. temperature) of the primary unit varies. A secondary device may be capable of being used either by itself or

combination with another object. For example, the secondary device may be removable from a host object. If it can be powered when removed or when installed in the host object, the parasitic load of the device alone is likely to be quite different from the parasitic load of the device and host object together. To deal with this situation, the second compensation information may be varied in dependence upon whether the device is used by itself or in combination with another object.

In many implementations, the secondary devices need to operate in synchronism with primary unit. It is therefore preferable to transmit a synchronising signal from the primary unit to the or each said secondary device, or from the or each said secondary device to the primary unit, to synchronise operation of the primary unit and the or each said secondary device. This is conveniently done by modulating a drive signal applied to a primary coil in the primary unit. Frequency, amplitude or phase modulation, or a combination thereof, may be used.

Many different techniques can be used to measure the power drawn from the primary unit by the secondary devices. In one technique, the electromagnetic field is generated by a primary coil driven by an electrical drive unit, and electrical power for the drive unit is supplied from a power supply of the primary unit to a power input of the drive unit. The power drawn from the primary unit is measured by temporarily disconnecting the power supply and detecting a change at said power input during the disconnection. The change may be a voltage decay. The advantage of this technique is that there is no series resistance through which the current for drive unit passes. Such a series resistance dissipates significant power.

It is preferable to store energy in an energy storage unit such as a capacitor connected to said power input so that power can continue to be supplied to said power input whilst said power supply is disconnected.

Another way to measure the power drawn may be available if the electrical drive unit has a feedback circuit to control the current or power of the drive to the primary coil. In this case, a feedback signal in the feedback circuit may provide a measure of the power being drawn without the need to add in a power measurement unit at all.

Another way to measure the power involves causing a circuit including said primary coil to operate, during a measurement period, in an undriven resonating condition in which

the application of drive signals to the primary coil is suspended so that energy stored in the circuit decays over the course of said period. One or more measures of such energy decay are then taken during said period and employed to measure said power drawn from the primary unit.

Two or more power measurements may be taken under the same conditions and the results averaged to improve accuracy.

In operation it may be desirable to set the field magnitude of the electromagnetic field to a value lower than the maximum value even in the operating mode. In the method of the second aspect the primary unit has the power requirement information from each secondary device and can therefore easily set the field magnitude in dependence upon the power required by the secondary device or, if there is more than one secondary device, the combined power required by the secondary devices. In this way a minimum power output for powering the secondary devices can be found. However, there are other ways to achieve a similar result. For example, a secondary device that is not getting enough power may modulate its load in some way. The primary unit may start operating at maximum power and reduce the power until the load modulation is detected from at least one secondary device. This enables minimum power to be determined in a simple and quick way.

According to a third aspect of the present invention there is provided an inductive power transfer system comprising: a primary unit operable to generate an electromagnetic field; at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween; means for detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices; and means operable, following such detection, to restrict or stop the inductive power supply from the primary unit.

According to a fourth aspect of the present invention there is provided a primary unit, for use in an inductive power transfer system that also has at least one secondary device separable from the primary unit, the primary unit comprising: means for

generating an electromagnetic field which couples with said at least one secondary device when it is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween; means for detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices; and means operable, following such detection, to restrict or stop the inductive power supply from the primary unit.

According to a fifth aspect of the present invention there is provided a secondary device, for use in an inductive power transfer system that comprises a primary unit which generates an electromagnetic field, the secondary device comprising: a secondary coil adapted to couple with said field generated by said primary unit when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween; load connection means, connected to said secondary coil and adapted to be connected when the secondary device is in use to a load requiring power from the primary unit, for supplying such inductively-received power to the load; detecting means for detecting a synchronisation signal transmitted by the primary unit; and control means, responsive to the detection of the synchronisation signal, to set the secondary device into a no-load state in which supply by the load connection means of any of the inductively-received power to said load is substantially prevented.

This can provide a secondary device adapted for use in the method embodying the first aspect of the invention described above.

According to a sixth aspect of the present invention there is provided a secondary device, for use in an inductive power transfer system that comprises a primary unit which generates an electromagnetic field, the secondary device comprising: a secondary coil adapted to couple with said field generated by said primary unit when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween; load connection means, connected to said secondary coil and adapted to be connected when the secondary device is in use to a

load requiring power from the primary unit, for supplying such inductively-received power to the load; and RFID communication means operable to supply to the primary unit, using an RFID communication method, information relating to a power requirement of the secondary device.

This can provide a secondary device adapted for use in the method embodying the second aspect of the invention described above. In this case the load connection means does not disconnect the actual load during the power measurement.

According to a seventh aspect of the present invention there is provided a method of controlling conductive power transfer in an inductive power transfer system comprising a primary unit operable to generate an electromagnetic field and at least one secondary device, separable from primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween, which method comprises: in an information supplying phase, permitting two or more secondary devices to supply simultaneously to the primary unit information relating respectively to the secondary devices concerned; and interpreting the simultaneously-supplied information at the primary unit and determining based on the interpreted information whether to restrict or stop the inductive power supply from the primary unit.

This method can permit rapid supply of information or signals from the secondary devices to enable restriction or stopping of the power supply to be achieved quickly.

In one embodiment, the information supplied from each secondary device indicates whether or not the secondary device concerned is in a power-requiring state in which an actual load of the secondary device requires power from the primary unit, and the primary unit determines that the inductive power supply therefrom should be restricted or stopped unless the information supplied in said information supplying phase by at least one of the secondary devices indicates that it has said power-receiving state.

The information supplied from each secondary device may represent an analog quantity of the secondary device concerned. In this case, the primary unit can derive directly from the simultaneously-supplied information a sum of the respective analog quantities of the secondary devices.

The analog quantity may be representative of a parasitic load imposed on the primary unit by the secondary device itself.

The analog quantity may be representative of a power requirement of an actual load of the secondary device.

The analog quantity may be representative of a total load imposed on the primary unit by the secondary device, said total load including an actual load of the secondary device and a parasitic load imposed on the primary unit by the secondary device itself.

In one embodiment, each said secondary device supplies its said information by varying a load imposed by it on the primary unit. For example, each said secondary device may have a dummy load which it imposes selectively on the primary unit during said information supplying phase. The dummy load is preferably representative of said analog quantity. Different dummy loads may be used to represent different analog quantities, for example a power requirement and a parasitic load.

In one embodiment each said secondary device has its said information supplying phase at a time determined by the primary unit.

According to an eighth aspect of the present invention there is provided a method of controlling inductive power transfer in an inductive power transfer system comprising a primary unit operable to generate an electromagnetic field and at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween, in which method: in a reporting phase the or each said secondary device reports to the primary unit information indicating whether the secondary device is in a no-power-requiring state, in which an actual load of the secondary device currently requires no power from the primary unit, or a power-requiring state in which said active load does currently require power from the primary unit; and the primary unit determines that the inductive power supply therefrom should be restricted or stopped in dependence upon the information reported by the or each secondary device in said reporting phase.

Preferably, the or each said secondary device has its said reporting phase at a time determined by the primary unit.

In one embodiment there are at least two secondary devices and each said secondary device has its said reporting phase at the same time.

The or each said secondary device may report its said information by varying a load imposed by it on the primary unit. For example, the or each said secondary device may have a dummy load which it imposes selectively on the primary unit during its said reporting phase.

In one embodiment, the or each said secondary device that has said power-requiring state imposes its said dummy load during said reporting phase and the or each said secondary device that has said non-power-requiring state does not impose its said dummy load during said reporting phase.

According to a ninth aspect of the present invention there is provided a secondary device, for use in an inductive power transfer system that comprises a primary unit which generates an electromagnetic field, the secondary device comprising: a secondary coil adapted to couple with said field generated by said primary unit when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween; load connection means, connected to said secondary coil and adapted to be connected when the secondary device is in use to a load requiring power from the primary unit, for supplying such inductively-received power to the load; and communication means operable to communicate to the primary unit information relating to a parasitic load imposed on the primary unit by the secondary device.

Such a secondary device can communicate its parasitic load to the primary unit for the primary unit to use to compensate for that load. For example, the communicated parasitic load can be used when detecting conditions for restricting or stopping inductive power transfer from the primary unit.

Any communication method can be used, and the method is not limited to load variation. For example, infrared or ultrasonic communication can be used. RFID can also be used.

In one embodiment, said communication means are operable to communicate said information by imposing a dummy load on said primary unit. The communication means may be operable to impose a first dummy load on the primary unit at a first time and a second dummy load, different from said first dummy load, at a second time, a difference between said first and second dummy loads being set in dependence upon said parasitic load. One of said first and second dummy loads may be zero.

According to a tenth aspect of the present invention there is provided a portable electrical or electronic device comprising: a load which at least at times requires power from said primary unit; and a secondary device embodying the aforesaid fifth, sixth or ninth aspect of the present invention, said load connection means of said secondary device being connected to said load for supplying such inductively-received power to the load at said times.

According to an eleventh aspect of the present invention there is provided a method of controlling inductive power transfer in an inductive power transfer system comprising a primary unit, having a primary coil to which electrical drive signals are applied to generate an electromagnetic field, and also comprising at least one secondary device, separable from the primary unit and having a secondary coil adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be transferred inductively from the primary unit to the secondary device without direct electrical conductive contacts therebetween, which method comprises: causing a circuit including said primary coil to operate, during a measurement period, in an undriven resonating condition in which the application of said drive signals to said primary coil is suspended so that energy stored in the circuit decays over the course of said period; taking one or more measures of such energy decay during said period; and restricting or stopping inductive power transfer from the primary unit in dependence upon said one or more energy decay measures.

Such a method can enable either or both of parasitic load and standby detection to be achieved in a robust and cost-effective manner. It is particularly advantageous in

systems which may have multiple secondary devices and/or whose open magnetic nature makes it easy for parasitic objects to couple to the primary coil.

Reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a block diagram showing parts of an inductive power transfer system embodying the present invention;

Figure 2 is a flowchart for use in explaining a first method of detecting a shutdown condition in accordance with the present invention;

Figure 3 is a flowchart for use in explaining a first method of detecting a standby condition in accordance with the present invention;

Figure 4 is a block diagram showing parts of an inductive power transfer system according to a first embodiment of the present invention;

Figure 5 shows waveform diagrams for use in explaining operation of the Figure 4 system;

Figures 6 show waveform diagrams showing the timing of the various signals within the Figure 4 system: Figure 6(a) shows a frequency of an AC voltage signal applied to a primary coil; Figure 6(b) shows a power drawn from the primary unit; Figure 6(c) shows a state of a switch in the primary unit; and Figure 6(d) shows the voltage across the switch in the primary unit;

Figure 7 is a diagram showing the load drawn during three different measurement operations;

Figure 8 is a diagram illustrating different modes of operation in the Figure 4 system;

Figure 9 is a block diagram showing parts of a primary unit in a power transfer system according to a second embodiment of the present invention;

Figure 10 is a flowchart for use in explaining a second method of detecting a shutdown condition in accordance with the present invention; and

Figure 12 is a block diagram showing parts of a power transfer system according to a third embodiment of the present invention.

Figure 1 illustrates parts of an inductive power transfer system embodying the present invention. The system 1 comprises a primary unit 10 and at least one secondary device 30. The primary unit 10 has a primary coil 12 and an electrical drive unit 14 connected to the primary coil 12 for applying electrical drive signals thereto so as to generate an electromagnetic field. A control unit 16 is connected to the electrical drive unit 14. This control unit generates an AC voltage signal 106. The electrical drive unit takes the AC voltage signal 106 and converts it to an AC current signal in the primary coil 12, so as to generate an induced electromagnetic field in the proximity of the primary coil 12.

The primary unit 10 may have any suitable form but one preferred form is a flat platform having a power transfer surface on or in proximity to which each secondary device 30 can be placed. In this case, the field may be distributed over a power transfer area of the surface, as described in GB-A-2388716.

The secondary device 30 is separable from the primary unit 10 and has a secondary coil 32 which couples with the electromagnetic field generated by the primary unit 10 when the secondary device 30 is in proximity to the primary unit 10. In this way, power can be transferred inductively from the primary unit 10 to the secondary device 30 without direct electrical conductive contacts therebetween.

The primary coil 12 and the secondary coils 32 can have any suitable forms, but may for example be copper wire wound around a high-permeability former such as ferrite or amorphous metal.

The secondary device 30 is usually connected to an external load (not shown - also referred to herein as the actual load of the secondary device) and supplies the inductively-received power to the external load. The secondary device 30 may be carried in or by an object requiring power such as a portable electrical or electronic device or a rechargeable battery or cell. Further information regarding designs of

secondary device 30 and the objects which can be powered using the secondary devices 30 can be found in GB-A-2388716.

The primary unit 10 in the Figure 1 system also comprises a power measurement unit 100 connected to the control unit 16. The power measurement unit 100 performs a measurement of the electrical power drawn by the electrical drive unit 14, on receipt of a signal provided by the control unit 16. The power measurement unit 100 provides an output representative of the electrical power drawn by the electrical drive unit 14 to the control unit 16. The power drawn by the electrical drive unit 14 is representative of the power drawn by the primary coil 12 and hence also the power drawn by all the secondary devices 30 plus other losses.

In the Figure 1 system it is desirable to detect certain conditions and restrict or stop the inductive power supply from the primary unit under those conditions.

One such condition is the presence of a substantial parasitic load in the vicinity of the primary unit. In this case, the control unit 16 may enter a shutdown mode in which the drive to the primary coil 12 is reduced or stopped, preventing heating of the parasitic load.

Another such condition is when no secondary device 30 of the system is present in the vicinity of the primary unit 10. Another such condition is when there is at least one secondary device 30 present but none of the devices has a load currently requiring power. A load does not require power, for example, when turned off or when, in the case of a rechargeable battery or cell, the battery or cell is fully charged. Under both these conditions the control unit 16 may enter a standby mode in which the drive to the primary coil 12 is reduced or stopped, preventing unnecessary power consumption in the primary unit 10.

Fig. 2 is a flowchart for use in explaining a first method for detecting the presence of a substantial parasitic load in the vicinity of the primary unit in accordance with the present invention.

In this first method, when the system of Fig. 1 is in use, from time to time all of the secondary devices in the vicinity of the primary unit are deliberately set to a no-load state. In this no-load state, supply of any of the power received inductively by the

secondary device to an actual load thereof (the external load mentioned above) is prevented.

In step S2, with all of the secondary devices in the no-load state, the power measurement unit 100 in the primary unit measures the power drawn by the secondary devices from the primary unit. In step S3, the control unit 16 in the primary unit determines, in dependence upon the power measured in step S2, whether to restrict or stop the inductive power supply from the primary unit.

In the simplest case, in step S3 the control unit 16 simply compares the measured power with a predetermined shutdown threshold. If the measured power exceeds the shutdown threshold value, the control unit 16 determines that the inductive power supply from the primary unit should be restricted or stopped. As described in more detail below, however, it is preferable to take into account losses which inevitably occur in the power transfer system. In particular, these losses include losses in the primary unit itself and/or any secondary devices/host objects present. These losses include inefficiencies in the primary coil itself and any other components associated with the primary coil such as the electrical drive unit, for example I^2R losses in the copper of the coil or effective series resistance of any resonating capacitor. The losses also include any magnetic losses in the primary unit and the secondary devices, for example magnetic is hysteretic loop losses in any coils associated with the primary unit and/or secondary devices. According, the control unit 16 may employ, in addition to the measured power, first compensation information relating to losses in the primary unit itself, so as to compensate for those losses in step S3. Alternatively, or in addition, the control unit 16 may employ, in addition to the measured power, second compensation information relating to a parasitic load imposed on the primary unit by the or each secondary device, so as to compensate for the parasitic load of the or each secondary device in step S3.

If it is determined in step S3 that the power supply should be restricted or stopped, then in step S4 the control unit 16 places the primary unit in a shutdown mode in which the inductive power supply from the primary unit is restricted or stopped.

The primary unit will remain in the shutdown mode until it is reset in some way. Such a reset could be manually initiated by a user of the primary unit, or alternatively the

control unit 16 could periodically start to supply inductive power again and repeat steps S1 to S3 to determine whether to remain in the shutdown mode or not.

In step S3, if the control unit 16 determines that the power supply does not need to be restricted or stopped, then in step S6 secondary devices requiring power resume receiving power from the primary unit. Processing then returns, for example after a predetermined interval, to step S1 again.

Next, a first method of detecting the conditions for entering the standby mode will be described with reference to Fig. 3.

In Fig. 3, as shown in step S11, from time to time each secondary device (if any) that is present in the vicinity of the primary unit 10 has a reporting phase. All of the secondary devices which are present may enter a reporting phase simultaneously. Alternatively, each of the secondary devices in turn may enter the reporting phase individually. In either case, in the reporting phase each secondary device reports to the primary unit state information indicating whether the secondary device is in a no-power-requiring state or a power-requiring state. In the no-power-requiring state, an actual load of the secondary device currently requires no power from the primary unit. In the power-requiring state, on the other hand, the actual load does currently require power from the primary unit.

In step S12 the control unit 16 in the primary unit determines if the inductive power supply therefrom should be restricted or stopped in dependence upon the state information reported in step S11. In particular, unless at least one secondary device reports in the reporting phase to the primary unit that it is in the power-requiring state the control unit 16 determines that the inductive power supply should be restricted or stopped and processing proceeds to step S13 in which the primary unit is set into the standby mode. Of course, if no secondary device is present in the vicinity of the primary unit at all, so that in step S11 no or no valid state information is received by the primary unit, then the control unit 16 also sets the primary unit into the standby mode.

As described above in relation to step S5 of the method of Fig. 2, once the primary unit has been set into the standby mode it may be reset into an operating mode again either by manual intervention from a user or automatically.

If in step S12 the control unit 16 determines that the inductive power supply should not be restricted or stopped based on the reported state information, then processing returns to step S11, for example after a predetermined interval. In this way, each secondary device present periodically has a reporting phase in which it reports its state information to the primary unit.

The methods of Figs. 2 and 3 may be carried out independently of one another. However, it is preferable for the control unit 16 of the primary unit to be able to detect both when to enter the shutdown mode and to enter the standby mode. This can be achieved by a combination of the methods of Figs. 2 and 3 as will now be described with reference to Fig. 4.

Figure 4 shows parts of an inductive power transfer system according to a first embodiment of the present invention. The system 1 has a primary unit 10 and a secondary device 30. Figure 4 also shows a parasitic load 500 on the primary unit, caused for example by a foreign object placed in the vicinity of the primary unit 10. The secondary device 30 in this case is assumed to be carried in or by a host object such as a portable electrical or electronic device. As explained hereinbefore the secondary device 30 and/or host object also inevitably impose a "friendly" parasitic load 501 on the primary unit 10.

As described earlier with reference to Figure 1, the primary unit 10 comprises a primary coil 12, an electrical drive unit 14, a control unit 16 and a power measurement unit 100. The electrical drive unit 14 has an input connected to an output of the control unit 16 supplying the AC voltage signal 106. The output nodes of the electrical drive unit 14 are connected to the primary coil 12. The electrical drive unit is connected to the power supply 105, via the power measurement unit 100. The power supply 105 supplies direct current to the electrical drive unit 14. The electrical drive unit 14 presents a high input impedance for the AC voltage signal 106, so that essentially all the load current is drawn from power supply 105.

The control unit 16 is a microprocessor in this embodiment. The microprocessor has an inbuilt digital-to-analogue converter (not shown) to drive the output supplying the AC voltage signal 106. Alternatively, an ASIC could be used to implement the control unit 16, as well as some or all of the other circuit elements of the primary unit.

The control unit 16 in this embodiment is adapted to modulate the AC voltage signal 106 for transmitting a synchronisation signal to a secondary device. The modulation is a frequency modulation of the AC voltage signal. Other modulation techniques such as amplitude or phase modulation may also be used. The control unit 16 is adapted to send a synchronisation signal to any secondary devices 30 present. The secondary devices 30 alter their load conditions in response to the synchronisation signal. This information is used to detect the conditions for entering the shutdown and standby modes.

It is desirable for the power measurement unit 100 to be operative without the need to disconnect the electrical supply to the primary coil 12, as this means that supply to the secondary device 30 is not interrupted and it reduces stray electromagnetic interference into the surrounding environment. This is challenging because there is a lot of noise and the measurement is required in a short time.

The power measurement unit 100 comprises a switch 102 between the 0V supply in the power supply 105 and the ground terminal of the electrical drive unit 14. The switch 102 is controlled by the control unit 16. The power measurement unit also comprises a capacitor 101 connected between the positive and ground terminals of the electrical drive unit 14. The capacitor functions as an energy storage unit. There is a differential amplifier 103 with inputs either side of the switch 102 which has an output coupled to an analogue-to-digital converter 104. The analogue-to-digital converter output is coupled to the control unit 16.

When the switch 102 is closed, the power measurement unit 100 is not operative and the power is directly coupled from the power supply 105 to the electrical drive unit 14. A power measurement is performed when the switch 102 is opened. The capacitor 101 is now disconnected from the 0V rail on the power supply 105, but still retains its charge. The electrical drive unit 14 meanwhile continues to draw current and therefore discharges the capacitor 101. In so doing the voltage across the capacitor 101 decays slightly and consequently the voltage at the point between the capacitor 101 and switch 102 rises slightly above 0V. The reservoir capacitor 107 ensures that the positive supply voltage remains constant. The differential amplifier 103 measures the voltage across the switch 102 and the resulting measurement is converted into a digital signal by the analogue-to-digital converter 104 and passed to the control unit 16. The small

temporary voltage drop across the electrical drive unit 14 does not have any noticeable effect on the power transfer to the secondary devices 30.

Whilst the switch 102 is open, two separate measurements are taken at time t_1 and t_2, giving measurements V_1 and V_2 respectively, shown in Figure 5. There is a delay t_1 after the switch is opened to allow transient effects to stabilise. The power, P is then given by

$$P = CV\frac{dV}{dt} = C\left(V^+ - \frac{(V_1+V_2)}{2}\right)\frac{(V_2-V_1)}{(t_2-t_1)} \approx CV^+\frac{(V_2-V_1)}{(t_2-t_1)}$$

where V^+ is the supply voltage, assuming V_1, $V_2 << V^+$. It is advantageous to sample the voltage level at the same point in the cycle, so that the periodic perturbation in voltage is removed (also shown in Figure 5). The switch 102 is then closed again to reconnect the power supply 105 to the electrical drive unit 14.

Incidentally, instead of the capacitor 101 an inductor could be used as an energy storage unit. In this case, the change measured by the circuitry during the disconnection of the power supply might be a change in current, for example measured as a voltage drop across a series resistor.

The primary unit 10 further comprises a calibration unit 29 in this embodiment. The calibration unit 29 stores compensation information about the losses in the primary unit (e.g. electrical or magnetic losses). By design, at manufacture, and/or periodically thereafter, the losses in the primary unit may be calibrated and stored within the calibration unit 29. The calibration unit 29 supplies the stored information to the control unit 16 to enable the control unit 16 to subtract the losses from the total measurement, thus calculating a number for the loss due to parasitic loads alone. This calibration unit 29 may vary the compensation information to cope with variable losses in the primary unit, for example losses which vary with temperature.

The secondary device 30 comprises a secondary coil 32, a rectifier 34, a secondary control unit 36, a dummy load switch 38, a dummy load 40, a load switch 42, a storage unit 44 and an actual load 46. The dummy load switch 38 and the load switch 42 may each be an FET, for example. The dummy load 40 is, for example, a resistor. The storage unit 44 is a capacitor in this embodiment but an inductor could be used instead.

The actual load 46 is external to the secondary device 30 in this embodiment and is part of the host object. It could be a battery charge controller for a Lithium-ion cell.

There is also a detection unit 200 for detecting a modulation imposed on the received AC signal. To detect a frequency modulated signal, the detection unit 200 may be a zero crossing detector which passes a signal to the control unit every time the AC signal crosses zero volts. The control unit 36 may then comprise an internal clock and counter circuit (not shown). The clock and counter circuit may be used to measure the time interval between successive zero crossings and hence derive the frequency of the AC signal 106 imposed by the primary unit control unit 16. Hence, the secondary unit may detect a change in frequency and respond by altering its load conditions by adjusting switches 42 and 38.

Other forms of load detection circuit 200 may comprise a threshold detector for digital amplitude modulation or an analogue-to-digital converter for multiple level amplitude modulation or a phase detector for phase modulation or any combination thereof.

Operation of the system will now be described.

In an "operating mode" of the system, the host object incorporating the secondary device 30 is placed on or in proximity to the primary unit 10. Switch 102 is closed. The control unit 16 applies an AC voltage signal 106 to the electrical drive unit 14. The electrical drive unit 14 takes DC power from the power supply 105 and amplifies the AC voltage signal 106 and applies it to the primary coil 12.

In the operating mode, the primary coil 12 generates an electromagnetic field in the vicinity of the primary unit 10. The secondary coil 32 couples with this field and an alternating current is induced in the coil by the field. The dummy load switch 38 is open and the load switch 42 is closed. The alternating current induced in the secondary coil 32 is rectified by the rectifier 34 and the rectified current is supplied via the load switch 42 to the storage unit 44 and the actual load 46. In this way, power is transferred inductively from the primary unit 10 to the secondary device 30 and from there to the load 46. The storage unit 44 stores energy in the operating mode.

Whilst in the operating mode, from time to time the control unit 16 in the primary unit 10 initiates a measurement. The measurement starts with the primary unit 10 sending a

synchronisation signal to the secondary unit 30 by applying a momentary frequency change to the AC drive voltage signal 106. The secondary devices 30 receive the AC voltage signal and in each receiving secondary device the detection unit 200 in conjunction with the control unit 36 determine when the synchronisation signal has occurred. In response to a synchronisation signal, the secondary units present alter their load conditions for a set time period and the primary unit 10 measures the total load (power drawn) within this time period.

The secondary device 30 uses the storage unit 44 to store energy from the primary unit 10 during normal operation. During the measurement, the actual load 46 is disconnected by opening switch 42. The energy stored in the storage unit 44 of the secondary device gradually decays as energy is delivered to the load. Provided that the storage unit has sufficient capacity, and is sufficiently well-charged before a measurement commences, the storage unit can deliver continuous power to the secondary device load throughout the measurement, so the actual load 46 is not interrupted.

In this embodiment the primary unit 10 initiates a series of three power measurements for the purposes of determining: 1) whether the there is a parasitic metal present requiring it to enter the shutdown mode to prevent overheating and 2) if there are no devices requiring any power, such that the unit can enter the standby mode. The behaviour of the primary unit 10 and the secondary device 30 is slightly different in each of the three measurements of the series.

During the first measurement, the secondary control unit 36 has the dummy load switch 38 open so that the dummy load 40 is not connected to the secondary coil 32. As a result, the first measurement is a measure of the power delivered to any parasitic loads 500 from foreign objects in the vicinity of the primary unit and any parasitic load 501 imposed by losses in the secondary device and/or its host object and any losses in the primary unit itself. Thus, operation during the first measurement corresponds to the steps S1 to S3 of Figure 2 above.

During the second measurement, the secondary control unit 36 selectively closes the dummy load switch 38. The secondary control unit 36 decides whether to have the dummy load switch 38 open or closed during the second measurement based on the power requirement of the actual load 46. If the load 46 does not require any power at

the present time, for example because it has a rechargeable battery which is presently fully charged, then the dummy load switch 38 is kept open during the second measurement. If, on the other hand, the load 46 does require power at the present time, then the dummy load switch 38 is closed so that the dummy load 40 is connected to the primary coil 32.

The control unit 16 produces another measure of the power load during the second measurement. If the second power measurement is substantially different from the first power measurement, the control unit 16 detects that a secondary device requiring power is present in the vicinity of the primary unit. Thus, operation during the second measurement corresponds to steps S11 and S12 of Figure 3 above.

During the third measurement, the secondary control unit 36 always closes the dummy load switch 38 so that the dummy load 40 is connected to the secondary coil 32.

Another power measure is taken by the control unit 16 in the primary unit. In this case, the measurement is the sum of the parasitic loads 500, the parasitic load 501 of the secondary device and/or host object, primary unit losses, and the dummy load 40. Based on the difference between the first and third power measurements, the control unit calculates the value of the total of the dummy loads 40 in all of the secondary devices present in the vicinity of the primary unit.

The timing of the various signals and measurements is illustrated diagrammatically in Figures 6 (not to scale). Figure 6(a) represents the frequency of the drive applied to the primary coil 12, Figure 6(b) represents the load presented by the secondary device 30, Figure 6(c) represents the state of the switch 102 in the primary unit 10 and Figure 6(d) represents the voltage across the switch 102.

At the start of each measurement, the primary unit 10 first momentarily changes the frequency of the drive to the primary coil 510, 511, 512, for the first, second and third measurements respectively. Then each secondary device 30 isolates its actual load 513, 514, 515 and depending on the circumstances introduces a dummy load 514, 515. Within this time frame, the switch 102 in the primary unit opens 516, 517, 518. Within the window of the switch opening, the voltage across the switch 106 ramps up 519, 520, 521. This voltage is sampled at several points within this window to measure the power. On the first measurement, there is no dummy load 513, on the second

measurement each device only connects the dummy load if its actual load requires power 514, on the third measurement the dummy load is always connected 515.

The secondary device 30 knows which measurement is which by the order in which they occur. If there has been a long gap of say a few ms since the last synchronisation signal then the secondary device knows that it must be the first measurement. The secondary device can count the number of periods in the received alternating current to determine this. The second and third measurement synchronisation signals naturally follow in that order within a set number of cycles. In order to get more accurate measurements, it is possible to average each measurement over a number of sequences.

Each dummy load 40 in a secondary device 30 in the system of this embodiment is set to a particular value (at manufacture or during calibration or testing) so that the value represents the parasitic load 501 imposed by the secondary device concerned and/or by its host object.

Thus, the total dummy load for all secondary devices present, as calculated by the control unit 16, can be used by the control unit 16 as second compensation information to compensate for the parasitic loads 501 of the secondary devices present. For example, if the control unit 16 detects that a substantial parasitic load 500 is present in the vicinity of the primary unit when the measured power exceeds some threshold, the threshold may be increased by an amount dependent on the total parasitic load 501 of all the secondary devices present, so that the detection of parasitic loads 500 from foreign objects is not influenced by the number of secondary devices present.

Figure 7 shows diagrammatically the load drawn for the three measurements. The load drawn is the sum of: the losses associated with the primary coil in the primary unit (pad) 543, the parasitic load associated with foreign metal objects 542, 'friendly parasitics' of metal associated with host object (portable device) to be powered 541 and the current load associated with all the secondary devices 540. The first measurement 530 has all of these components except the load 540. If no devices require power then the second measurement 531 will be the same as the first measurement 530, so the primary unit can be placed into the standby mode (step S4 in Figure 3). However, if at least one device requires power then the second measurement 531 will be greater than the first measurement 530, and power is

required. On the third measurement, each secondary device 30 connects its dummy load. The dummy load of each device 40 is made equal to that device's 'friendly parastics'. By subtracting the first measurement from the third measurement, the result is the 'friendly parasitics' 541. The primary unit loss 543 is known (and stored in the calibration unit 29). To produce a measure of the total parasitic load 542 present, the calculated 'friendly parasitics' 541 and the known primary unit loss 543 may be subtracted from the first measurement 530. If this figure is above a certain threshold then the unit can be placed into the shutdown mode (step S4 in Figure 2).

A system embodying the present invention is capable of measuring loads imposed on the primary unit sensitively, for example to within 50mW or so. With this degree of sensitivity, it is possible to ensure that very little power is coupled into parasitic loads 500 such as foreign objects.

Figure 8 is a diagram illustrating the different modes of operation in the Figure 4 system and the conditions for switching between these different modes. The three modes of operation are an operating mode, a shutdown mode and a standby mode.

In the operating mode, the primary unit is in the normal state (driven condition) most of the time, but periodically does a sequence of three measurements as described above. If the result of the measurement sequence is that no secondary device requires power, the primary unit goes into a standby mode. If the result of the measurement sequence is that a significant parasitic load 500 is present, the primary unit goes into a shutdown mode.

In the standby mode, the electrical drive unit 14 is stopped for most of the time, thus consuming little power. Periodically the primary unit enters the normal mode, then does a series of measurements in respective probing periods, to check whether it should enter either the operating mode or the shutdown mode. Otherwise it remains in the standby mode.

The shutdown mode is functionally identical to standby mode. However, the two modes may be distinguished by some user-interface feature such as an LED to prompt the user to remove any substantial parasitic load 500.

In addition to this first embodiment of the invention, there are many other possible embodiments and combinations of features that may be utilised to advantage.

There are other inductive power transfer systems, which rather than have a single primary coil 12 have a plurality of coils, for instance as described in GB-A-2398176. In such a system there may be two sets of coils which are arranged orthogonally to each other. They may each be driven with the same AC voltage signal, but driven in quadrature (i.e. separated in phase by 90°), such that the induced magnetic field rotates with time. This allows the secondary device 30 to be placed at any orientation and still be able to receive electrical power. The present invention may be used in such a configuration directly. The electrical drive unit 14 not only supplies the AC current drive to the first coil, but also to the second coil. The transmitted synchronisation signals will be present on both coils. Furthermore, since the current measurement is performed by determining the current drawn from the power supply, the power measurement will be the total sum of all the load drawn regardless of what proportion is drawn by each coil. In such a 2 channel rotating system, the orientation of the secondary device 30 is arbitrary. Therefore the secondary device 30 will see a +/- 180° phase difference relative to the primary unit. Therefore the secondary devices 30, must each lift their load for at least 1/2 cycle each side of the primary unit's measurement period.

In addition to the three measurements described, a fourth measurement may be made. This measure is initiated by the control unit 16 in the primary unit 10, and results in the power measurement unit 100 taking a power measurement, but without any synchronisation signal being sent to the primary coil 12. The secondary units 30 do not alter their load conditions and this is therefore a measurement of the power whilst in the operating state. This measurement can be performed at any time other than during a measurement sequence of the first three measurements. This fourth measurement is used to determine if the total load drawn is greater than the power specification of the device and hence put the primary unit into an 'overload state'. The 'overload' state is functionally identical to the 'shutdown state', but may be distinguished by some use-interface feature such as an LED.

Another possibility is for the electrical drive unit 14 to be adapted to modify the magnitude of its output current into the primary coil for the purpose of varying the field magnitude of the generated magnetic field. This would allow the field magnitude to be

reduced for small loads, thereby conserving electrical power. An implementation of this feature is to use the first and second measurements in a different way, not only to detect if devices require power, but also to set the required field magnitude. Instead of switching in the dummy load 40 during the second measurement if it needs power, a secondary device could switch in its dummy load if it is not getting sufficient power. The presence of a difference between the first and second measurements would then be taken by the primary unit as a "not enough power" signal. The primary unit 10 could periodically bring the field up to maximum magnitude and then gradually reduce it until the difference between the first and second measurements was greater than a certain threshold ("not enough power" signal). This way the primary unit would always be operating at the lowest possible field magnitude.

In another embodiment, the secondary devices are adapted for changing the magnitude of their dummy loads dynamically. This could be achieved for instance by incorporating a load which may be altered in value by a control means. A simple example might be a resistor ladder with an array of switches, which may be arranged with values in binary increments. The load may be adapted to have a continuously variable magnitude by use of a transistor circuit or by incorporation of some other nonlinear element. Another way of dynamically changing the load is to modulate the switch 40 which connects the load, such that when the power measurement is averaged over the measurement time interval, the effective load is altered. The pulse width or duty cycle could be altered to change the effective load magnitude.

The ability to change the dummy load dynamically is useful for devices whose 'friendly parasitic' load may change. For instance a self-charging battery may have a different 'friendly parasitic' load when charged alone, compared to when it is charged whilst connected to a mobile phone. The control unit 36 could detect whether the phone was attached and modify the dummy load accordingly. Alternatively, the phone could communicate its 'friendly parasitics' to the battery. Other removable attachments which contribute additional 'friendly parasitic' load could also be detected and the dummy load modified accordingly. These include for example, but are not limited to, removable camera attachments, cases and speakers.

In addition to giving information about the load requirements and parasitic information of the secondary device 30, this method could be used such that the primary unit 10 could deduce other information about the secondary device 30. For example the

primary unit 10 could receive information about the serial number, model number, power requirements or other information stored in the secondary device. The load could be altered dynamically either synchronously or asynchronously to achieve this. Amplitude modulation or pulse width modulation may be used. A number of 'bits' or 'symbols' may be used (where a 'symbol' represents a plurality of amplitude levels or pulse width durations and therefore more than one 'bit').

In another embodiment, the primary unit 10 could communicate information to the secondary device 30, other than synchronisation signals, by means of modulating the AC voltage signal 106 applied to the electrical drive unit. This information may include but is not limited to information about the primary unit 10, such as cost of a charge, power capability, codes; information about the location of the primary unit, such as nearby facilities; and other information such as advertising material. The secondary device 30 could receive such information by means of the detection element 200 and the control unit 36.

It will be apparent to those skilled in the art that it is not necessary to implement all these features simultaneously in order to gain advantage. For instance by only using the first and second measurements, the standby detect feature may be implemented. Similarly, by only using the first and third measurements, the parasitic detect feature may be implemented. By only using the fourth measurement, the overload detect feature may be implemented. Information about the secondary device 30 may be deduced by the primary unit, without implementing other features. Similarly, information may be sent from the primary unit to the secondary device without implementing other features. Further measurements may be used to implement additional features. It should be appreciated that the labelling of each measurement is purely for identification purposes and the measurements may be performed in any order.

In addition to the described method of sending a synchronisation signal before each measurement and identifying each measurement by the order in which they occur, there are other methods of identifying each measurement. These include but are not limited to: sending a different synchronisation signal before each measurement, whereby synchronisation signals may differ in frequency offset, amplitude or phase; or sending only a first synchronisation signal and deducing the timing of the other measurements may be means of either a counter to count cycles of the received signal or an internal clock within each secondary device. It is even possible to perform the

measurements back to back, with no substantial gap between them. Alternatively measurements are initiated by the secondary device rather than the primary unit. The secondary device could initiate a 'preamble' dynamic load modulation, which the primary unit would detect and then synchronise on, so that its power measurements coincided with the timing of the secondary device adapting its load conditions. For primary units capable of simultaneously supplying power to more than one secondary device, the 'preamble' could involve the use of some unique identifier, so that each secondary device may be interrogated independently. 'Preambles' could also be used in communication from the primary unit to the secondary device to address each device independently.

As described above, the dummy load may be used to represent the 'friendly parasitic' load of the host device. Of course, the ratio between the dummy load value and the friendly parasitic load to be communicated is not limited to any particular value. For instance the dummy load could be twice or three times the 'friendly parasitic' value or a noninteger multiple of the value. The primary unit can deduce the total 'friendly parasitic load' so long as it knows what the ratio is. Furthermore, if a device does not have any significant 'friendly parasitic' load, it may be desirable to 'assign' it a particular value, so that it may be used for indicating whether the device requires charge. It may be desirable to use more than one dummy load. A first dummy load may be used for the second measurement and a second dummy load may be used for the third measurement. The first dummy load would be used for standby detection and the second dummy load would be representative of the 'friendly parasitics'. This is particularly advantageous if the secondary devices have widely varying parasitic loads. The first dummy load could also be used for determining the power requirements of the secondary devices requiring charging, rather just making a standby decision. The dummy load value would be adapted to be representative of the power requirements of that particular device. The first and second dummy loads may be implemented by a single dynamically variable dummy load described above, or fixed loads may be used, or a combination of the two.

In addition to the power measurement method and apparatus described, it will be appreciated that there are many methods which can be used to detect the load on the primary coil or coils. The simplest power measurement may comprise inserting a series resistor on one supply rail. The voltage could be measured across that resistor and the power deduced from the observed voltage and the known resistor value. With such a

method it may be desirable to incorporate a switch across the resistor, so that during periods outside of the measurement time, the resistor may be short circuited, such that there is no unnecessary power dissipation in the resistor.

Another method of power measurement is to measure the power within the electrical drive unit. For instance, it is desirable for the electrical drive to the coil or coils to be regulated by means of a feedback circuit. The feedback signal may be used to derive a power measurement.

It is also possible to combine the functions of sending a synchronisation signal and power measurement within a single element as described for instance, in the applicant's copending application GB 0410503.7 filed on 11th May 2004, from which the present application claims priority. In that system, the power measurement involves disconnecting the power to the primary coils and detecting the decay in the undriven resonant circuit. The act of disconnecting the power to the primary coil 12 also has the effect of modulating the signal in the primary coil and as a result the signal received in the secondary device 30.

Figure 9 shows a second embodiment of a power transfer system according to the present invention. This embodiment differs from the first embodiment of Fig. 4 mainly in the way in which the power measurements are carried out. The primary unit 110 comprises a primary coil 112, an electrical drive unit 114, a control unit 116 and a decay measurement unit 118. The electrical drive unit 114 in this embodiment has a conventional half bridge configuration in which a first switch 120 is connected between a first power supply line of the primary unit and an output node of the electrical drive unit, and a second switch 121 is connected between the output node and a second power supply line of the primary unit. The first and second switches 120 and 121 may, for example, be field-effect transistors (FETs).

The electrical drive unit 114 also comprises a drive controller 119 which applies control signals to the switches 121 and 122 to turn them on and off. The drive controller 119 has a control input connected to an output of the control unit 116. The output node of the electrical drive unit 114 is connected via a capacitor 117 to one side of the primary coil 112.

The control unit 116 is a microprocessor in this embodiment. Alternatively, an ASIC could be used to implement the control unit 116, as well as some or all of the other circuit elements of the primary unit.

The decay measurement unit 118 comprises a resistor 125 which has a first node connected to one side of a switch 128 and a second node connected to the second power supply line. The resistor 125 is a low-value resistor. The decay measurement unit 118 further comprises an operational amplifier 126 having an input connected to the first node of the resistor 125. The decay measurement unit 118 also comprises an analog-to-digital converter (ADC) 127 connected to an output of the operational amplifier 126. An output of the ADC 127 is connected to a measurement input of the control unit 116.

The other side of the switch 128 is connected to the other side of the primary coil 112. A snubber unit 122 is connected in parallel with the switch 128. The snubber unit 122 comprises a capacitor 123 and a resistor 124 connected in series with one another. The calibration unit 129 is the same as the calibration unit 29 in Figure 4.

Each secondary device in this embodiment can be substantially the same as the secondary device 30 in Figure 4, and accordingly a description thereof is omitted here and no secondary device is illustrated in Figure 9.

Operation of the Figure 9 system will now be described with reference to Figure 10.

Initially, the system has a normal state in which the control unit 116 causes the electrical drive unit 114 to apply drive signals to the primary coil 112 to cause it to oscillate. It will be appreciated that in the operating mode, the system is in this state for almost all the time. The switch 128 is closed, and the circuit including the capacitor 117 and primary coil 112 forms a resonant tank.

The next state is a "snub" state. The application of drive signals to the primary coil 112 by the electrical drive unit 114 is suspended under the control of the control unit 116. The drive controller 119 closes the switch 121. The control unit 116 also opens the switch 128 at a time when most of the energy in the resonant tank resides in the capacitor 117. The opening of the switch 128 brings the snubber unit 122 in series with the resonant tank. The snubber unit 122 quickly dissipates any energy which remains

in the primary coil 112, stopping it from resonating within one cycle or so. Most of the energy stored in the resonant tank is left in the capacitor 117. The sudden cessation of cycles is detected by the detection unit 200 and the secondary control unit 36 in the secondary device 30. The secondary control unit 36 opens the load switch 42. Incidentally, it will be appreciated that he detection unit 200 in Figure 4 needs to be modified to detect the sudden cessation of cycles in the snub state in the present embodiment. A threshold detector (as mentioned above) may be used as the detection unit in the present embodiment.

In this embodiment, therefore, the snub state is used as the synchronisation signal to the secondary device, though the other forms (e.g. frequency or phase modulation) could also be used. It is not always necessary to have a synchronisation signal before every measurement as described above.

The system then enters the decay state from the snub state. The control unit 116 closes the switch 128, removing the snubber unit 122 from the resonant tank, and thus allowing the energy in capacitor 117 to flow again within the resonant tank. In the decay state, the resonant tank operates in an undriven resonating condition. Energy stored in the resonant tank decays over the course of time in the decay state. In this embodiment, the decay measurement unit 118 measures the energy decay in the resonant tank by measuring the current flowing through the primary coil 112. The same current flows through the resistor 125 and generates a voltage at the first node of that resistor. This voltage is buffered by the operational amplifier 126 and converted into a digital signal by the ADC 127. The resulting digital signal is applied to the measurement input of the control unit 116.

Figure 10 shows how the current flowing through the primary coil 12 varies in the normal, snub and decay states which occur during a power measurement. In this embodiment, the digital signals representing the current flowing in the primary coil within a measurement period are received and processed within the control unit 16 to calculate a measure of the rate of energy decay in the resonant tank.

An equation describing the energy stored in the resonant tank, at resonance, is:

$$E = \frac{1}{2} L\hat{I}^2 = \frac{1}{2} C\hat{V}^2.$$

where E is the energy, L the inductance, $\hat{I}$ is the peak current, C is the capacitance and $\hat{V}$ is the peak voltage.

Therefore the energy stored in the resonant tank of the primary unit at any given moment can be calculated if the inductance and peak current are known, or if the capacitance and peak voltage are known, or combinations thereof. Typically the capacitance is known by design, the peak current and voltage can be measured by suitable circuitry, and the inductance can be deduced by observing the natural resonant frequency during the measurement and applying the formula:

$$L = \frac{1}{4\pi^2 f^2 C}$$

The power measure, *P*, is given by the rate of decay of energy (and thus the loss) from the resonant tank and can be calculated by measuring E_1 at time T_1 and E_2 at another time T_2.

$$P = \frac{E_2 - E_1}{T_2 - T_1}$$

Since at resonance the voltage and current in the resonant tank will be 90 degrees out of phase with one another, a convenient method of reading the peak voltage of one is to trigger the measurement on the zero-crossing of the other.

A second method for detecting a shutdown condition in accordance with the present invention will be described with reference to Fig. 11. This method can be used in the Figure 1 system.

When the Fig. 1 system is in use, from time to time each secondary device which is in the power-requiring state supplies information to the primary unit relating to its own power requirement. The power requirement information may take many different forms. For example, the information may comprise a binary part used to indicate either "no power required" or "power required". In this case, in the event that a binary part is "power required", supplemental information may be provided by the secondary device to indicate the amount of power required. Alternatively the power requirement information may simply be representative of the amount of power required, and "0" may be transmitted if the device requires no power at all. It is also possible that the power requirement of the secondary device may already be known to the primary unit. For example, it may be known that all secondary devices of a certain type will have a

particular power requirement. In this case, the power requirement information may simply be a code (or some other identifying information) indicating the type of the secondary device.

All of the secondary devices may supply the power requirement information simultaneously to the primary unit. Alternatively, each secondary device supplies its power requirement information individually in turn to the primary unit.

The power requirement information supplied by each secondary device that has the power-requiring state is received by the primary unit.

In step S22, the control unit 16 in the primary unit causes the power measurement unit 100 to measure the power drawn by the secondary devices from the primary unit as described previously. In practice, the measured power will also reflect any losses in the system.

In step S23 the control unit 16 determines whether inductive power supply from the primary unit should be restricted or stopped in dependence upon the measured power in step S22 and the power requirement information received in step S21. For example, the control unit 16 calculates a sum of the respective power requirements of all of the secondary devices that are in the power-requiring state. This sum is compared with the measured power found in step S22. If the measured power exceeds the sum of the power requirements by more than a threshold value, then the control unit determines that a substantial parasitic load must be present in the vicinity of the primary unit. In that case, processing proceeds to step S24 in which the primary unit enters the shutdown mode and inductive power supply from the primary unit is restricted or stopped. As described previously in relation to the method of Fig. 2, the system may be reset manually or automatically in step S25.

If in step S23 the control unit 16 determines that the power supply need not be restricted or stopped, then processing returns to step S21, for example after a predetermined time interval.

To compensate for the losses in the primary unit and/or secondary devices, the shutdown threshold employed in step S23 may be adjusted. One way in which this can be done is for each secondary device (whether or not in the power-requiring state) to

also supply to the primary unit information relating to its "friendly parasitic" load. Similarly, losses as in the primary unit may be accounted for using a calibration unit as described with reference to Fig. 4.

Fig. 12 shows parts of a power transfer system according to a third embodiment of the present invention. This system implements the shutdown detection method of Fig. 11 using an RFID communication method.

The Fig. 12 system comprises a plurality of secondary devices 600_1, 600_2, ..., 600_n. The system of Fig. 12 also comprises a primary unit 700. The primary unit 700 comprises an RFID unit 710, a control unit 720 and a power measurement unit 730. The control unit 720 corresponds generally to the control unit 16 described previously with reference to Fig. 1, and the power measurement unit 730 corresponds generally to the power measurement unit 100 described in reference to Fig. 1.

The features of the secondary device 600 are generally the same as those of the secondary device 30 in Figure 4 except that the elements 38, 40, 42, 44 and 200 may be omitted. Instead of these elements, each secondary device 600 comprises its own load measuring unit 610 and an RFID unit 620. The load measuring unit 610 measures the power being supplied to the actual load (46 in Fig. 4) of that secondary device. For example, the load measuring unit 610 may measure the current and/or voltage being supplied to the actual load 46 and may possibly integrate these measures over time for averaging purposes. For example, the averaging period may be ten seconds.

The RFID unit 620 in each secondary device is capable of communicating with the RFID unit 710 in the primary unit 700 using an RFID link 630. The load measure produced by the load measuring unit 610 in each secondary device is supplied to the RFID unit 620 in the device and then transmitted via the relevant RFID link 630 to the RFID unit 710 in the primary unit. For example, the RFID unit 710 may poll the RFID unit 610 in each of the secondary devices from time to time. In response, the RFID unit 620 that has been polled transmits its load measure. This load measure corresponds to the power requirement information of step S21 in Fig. 11.

The power measurement unit 730 in the primary unit also measures the power being drawn by the secondary devices from the primary unit, as in step S22 in Fig. 11. Then, the control unit 720 determines, in dependence upon the measured power and the sum

of the received load measures from the secondary devices, whether or not the power supply to the secondary devices should be restricted or stopped. In particular, if the measured power from the power measurement unit 730 exceeds the sum of the load measures from the secondary devices by more than a shutdown threshold, then the control unit 720 concludes that a substantial parasitic load must be present and places the primary unit in the shutdown mode, as in step S24 in Fig. 11.

It is also possible for the load measure produced by each secondary device to represent a total load from the secondary device including the amount of power required by the actual load and any friendly parasitic load of the secondary device/host object. If the actual load requires no power the load measure may change to represent only the friendly parasitic load.

Some anti-collision or collision avoidance technique is necessary in the Fig. 12 embodiment. In one known collision avoidance technique, every RFID unit 620 has an unique code (or one which will be practically unique based on statistics). The RFID unit 710 in the primary unit would send out a signal requesting that all RFID units 620 within a certain range reply. The RFID units 620 send out their reply in code (e.g. Manchester code), so that the RFID unit 710 can tell if more than one device has replied. The primary unit gradually narrows down the range until it can uniquely identify the code of each device present. Typically, it may halve the range of codes in each iteration to home in quickly.

It will be appreciated that instead of RFID, any suitable communication link can be used to permit each secondary device to communicate its power requirement information to the primary unit. For example, infrared or ultrasound communication could be used. Alternatively, each secondary device could vary the load it imposes on the primary unit to communicate the power requirement information. For example, each secondary device could impose a dummy load representing the amount of power required by its actual load. In this technique, all the secondary devices in the power-requiring state can impose their respective dummy loads simultaneously, so that the primary unit can directly derive the sum of the power requirements of all the secondary devices in one measurement. Alternatively, the dummy load may represent a total load from the secondary device including the amount of power required by the actual load and any friendly parasitic load of the secondary device/host object.

CLAIMS:

1. A method of controlling inductive power transfer in an inductive power transfer system comprising a primary unit operable to generate an electromagnetic field and at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween, which method comprises:

detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices; and

following such detection, restricting or stopping the inductive power supply from the primary unit.

2. A method as claimed in claim 1, further comprising:

setting the or each secondary device to a no-load state in which supply of any of the power received inductively by the secondary device to an actual load thereof is substantially prevented; and

in the primary unit, measuring a power drawn from the primary unit when the or each secondary device is set into said no-load state, and restricting or stopping the inductive power supply from the primary unit in dependence upon the measured power.

3. A method as claimed in claim 2, wherein the inductive power supply is restricted or stopped in the event that the measured power is greater than a threshold value.

4. A method as claimed in claim 2 or 3, further comprising restricting or stopping the inductive power supply in the event that the measured power is less than a standby threshold value.

5. A method as claimed in claim 1, further comprising:

in the primary unit, receiving, from the or each secondary device that is in a power-requiring state, information relating to a power requirement of the secondary device concerned; and

in the primary unit, measuring the power drawn from the primary unit when power is being supplied to the or each secondary device having the power-requiring state, and restricting or stopping the inductive power transfer from the primary unit in dependence upon the measured power and the received power requirement information.

6. A method as claimed in claim 5, wherein the inductive power supply from the primary unit is restricted or stopped in dependence upon a difference between said measured power and a sum of the respective power requirements of the secondary devices having said power-requiring state.

7. A method as claimed in claim 6, wherein the inductive power supply is restricted or stopped in the event that the measured power exceeds said sum by more than a threshold value.

8. A method as claimed in any one of claims 5 to 7, wherein the or each secondary device transmits its power requirement information to the primary unit using an RFID method.

9. A method as claimed in any one of claims 5 to 7, wherein the or each secondary device transmits its power requirement information to the primary unit by varying a load imposed by the secondary device on the primary unit.

10. A method as claimed in any one of claims 5 to 9, wherein the primary unit has registered therein a power requirement of at least one said secondary device, and said power requirement information transmitted from that secondary device is information identifying the secondary device, and the primary unit employs said identifying information to retrieve the registered power requirement for the device.

11. A method as claimed in any one of claims 5 to 10, wherein the or each said secondary device not having the power-requiring state also transmits such power requirement information to the primary unit.

12. A method as claimed in claim 11, wherein the power requirement information transmitted by the or each said secondary device not in said power-requiring state is representative of a parasitic load imposed on the primary unit by the secondary device.

13. A method as claimed in any preceding claim, further comprising employing, when carrying out said detection, first compensation information relating to losses in the primary unit itself so as compensate for said losses.

14. A method as claimed in claim 13, further comprising deriving part or all of said first compensation information from measurements taken by the primary unit when it is effectively in electromagnetic isolation.

15. A method as claimed in any preceding claim, further comprising employing, when carrying out said detection, second compensation information relating to a parasitic load imposed on the primary unit by the or each secondary device so as to compensate for said parasitic load of the or each secondary device.

16. A method as claimed in claim 15, wherein the or each said secondary device communicates its said second compensation information directly to said primary unit or communicates to the primary unit other information from which the primary unit derives said second compensation information.

17. A method as claimed in claim 16, wherein the or each said secondary device communicates its said second compensation information or its said other information to the primary unit by varying a load imposed by it on the primary unit.

18. A method as claimed in claim 17, wherein the or each said secondary device has a dummy load, representative of its said parasitic load, which it imposes on said primary unit to vary the load imposed by it on the primary unit.

19. A method as claimed in any one of claims 13 to 18, wherein part or all of said first compensation information and/or part or all of said second compensation information is information stored in the primary unit during manufacture and/or testing of the primary unit.

20. A method as claimed in any one of claims 13 to 19, further comprising varying one or both of said first and second compensation information when one or more operating conditions of the primary unit varies.

21. A method as claimed in any one of claims 13 to 20, wherein the or one said secondary device is capable of being used either by itself or combination with another object, and said second compensation information is varied in dependence upon whether the device is used by itself or in said combination.

22. A method as claimed in any preceding claim, wherein:

the or each said secondary device reports to the primary unit state information indicating whether the secondary device is in a no-power-requiring state, in which an actual load of the secondary device currently requires no power from the primary unit, or a power-requiring state in which said active load does currently require power from the primary unit; and

the primary unit restricts or stops the inductive power supply therefrom in dependence upon the state information reported by the or each secondary device.

23. A method as claimed in claim 22, wherein the primary unit restricts or stops the inductive power transfer unless the state information reported by at least one secondary device indicates that it has said power-requiring state.

24. A method as claimed in claim 22 or 23, wherein two or more secondary devices report their respective state information simultaneously to the primary unit.

25. A method as claimed in claim 22, 23 or 24, wherein the or each said secondary device reports its said state information by varying a load imposed by it on the primary unit.

26. A method as claimed in any preceding claim, further comprising transmitting a synchronising signal from the primary unit to the or each said secondary device, or from the or each said secondary device to the primary unit, to synchronise operation of the primary unit and the or each said secondary device.

27. A method as claimed in claim 26, wherein said electromagnetic field is generated by a primary coil of the primary unit, and the synchronising signal is transmitted from the primary unit to the or each said secondary device by modulating a drive signal applied to said primary coil.

28. A method as claimed in any preceding claim, wherein the electromagnetic field is generated by a primary coil driven by an electrical drive unit, electrical power for the drive unit is supplied from a power supply of the primary unit to a power input of the drive unit, and the power drawn from the primary unit is measured by temporarily disconnecting the power supply and detecting a change at said power input during the disconnection.

29. A method as claimed in claim 28, further comprising storing energy in an energy storage unit connected to said power input so that power can continue to be supplied to said power input whilst said power supply is disconnected.

30. A method as claimed in any one of claims 1 to 27, wherein the electromagnetic field is generated by a primary coil, and the method further comprises:

causing a circuit including said primary coil to operate, during a measurement period, in an undriven resonating condition in which the application of drive signals to the primary coil is suspended so that energy stored in the circuit decays over the course of said period;

taking one or more measures of such energy decay during said period and employing said one or more measures to measure said power drawn from the primary unit.

31. A method as claimed in any preceding claim, further comprising varying a field strength of said field in dependence upon the power required by the secondary device or, if there is more than one secondary device, the combined power required by the secondary devices.

32. An inductive power transfer system comprising:

a primary unit operable to generate an electromagnetic field;

at least one secondary device, separable from the primary unit, and adapted to couple with said field when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween;

means for detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices; and

means operable, following such detection, to restrict or stop the inductive power supply from the primary unit.

33. A primary unit, for use in an inductive power transfer system that also has at least one secondary device separable from the primary unit, the primary unit comprising:

means for generating an electromagnetic field which couples with said at least one secondary device when it is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween;

means for detecting if there is a substantial difference between, on the one hand, a power drawn from the primary unit and, on the other hand, a power required by the secondary device or, if there is more than one secondary device, a combined power required by the secondary devices; and

means operable, following such detection, to restrict or stop the inductive power supply from the primary unit.

34. A secondary device, for use in an inductive power transfer system that comprises a primary unit which generates an electromagnetic field, the secondary device comprising:

a secondary coil adapted to couple with said field generated by said primary unit when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween;

load connection means, connected to said secondary coil and adapted to be connected when the secondary device is in use to a load requiring power from the primary unit, for supplying such inductively-received power to the load; and

detecting means for detecting a synchronisation signal transmitted by the primary unit; and

control means, responsive to the detection of the synchronisation signal, to set the secondary device into a no-load state in which supply by the load connection means of any of the inductively-received power to said load is substantially prevented.

35. A secondary device, for use in an inductive power transfer system that comprises a primary unit which generates an electromagnetic field, the secondary device comprising:

a secondary coil adapted to couple with said field generated by said primary unit when the secondary device is in proximity to the primary unit so that power can be received inductively by the secondary device from the primary unit without direct electrical conductive contacts therebetween;

load connection means, connected to said secondary coil and adapted to be connected when the secondary device is in use to a load requiring power from the primary unit, for supplying such inductively-received power to the load; and

RFID communication means operable to supply to the primary unit, using an RFID communication method, information relating to a power requirement of the secondary device.

1/11

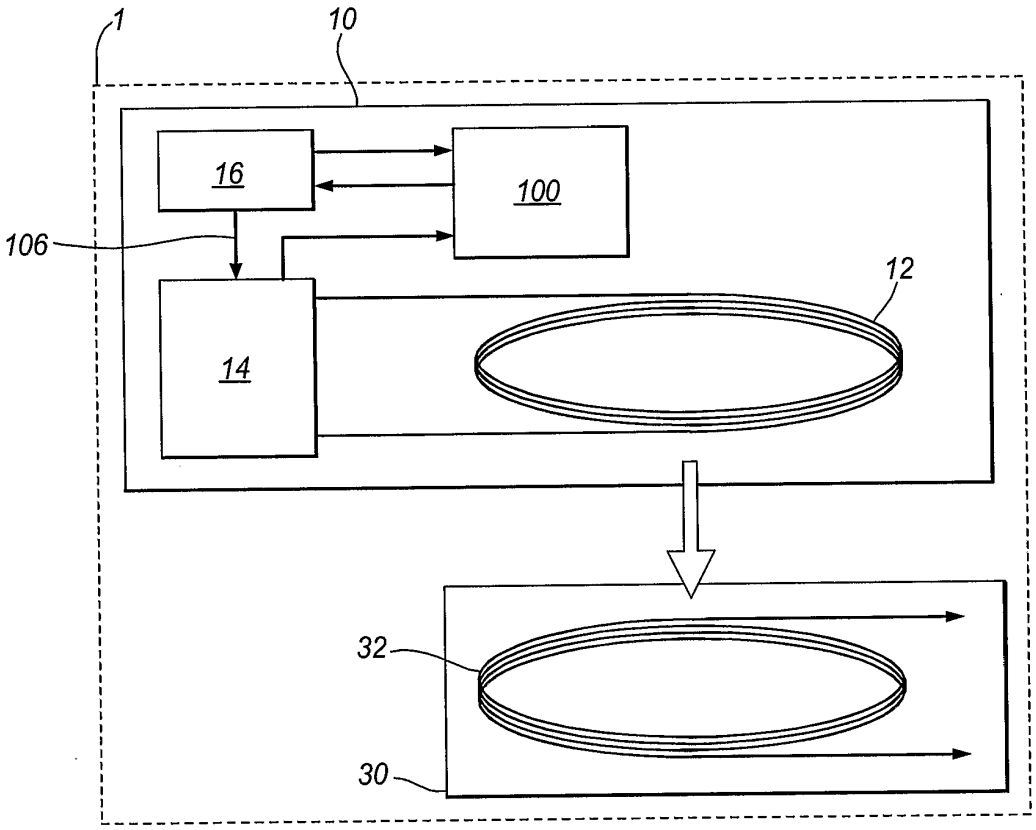


Fig.1

2/11

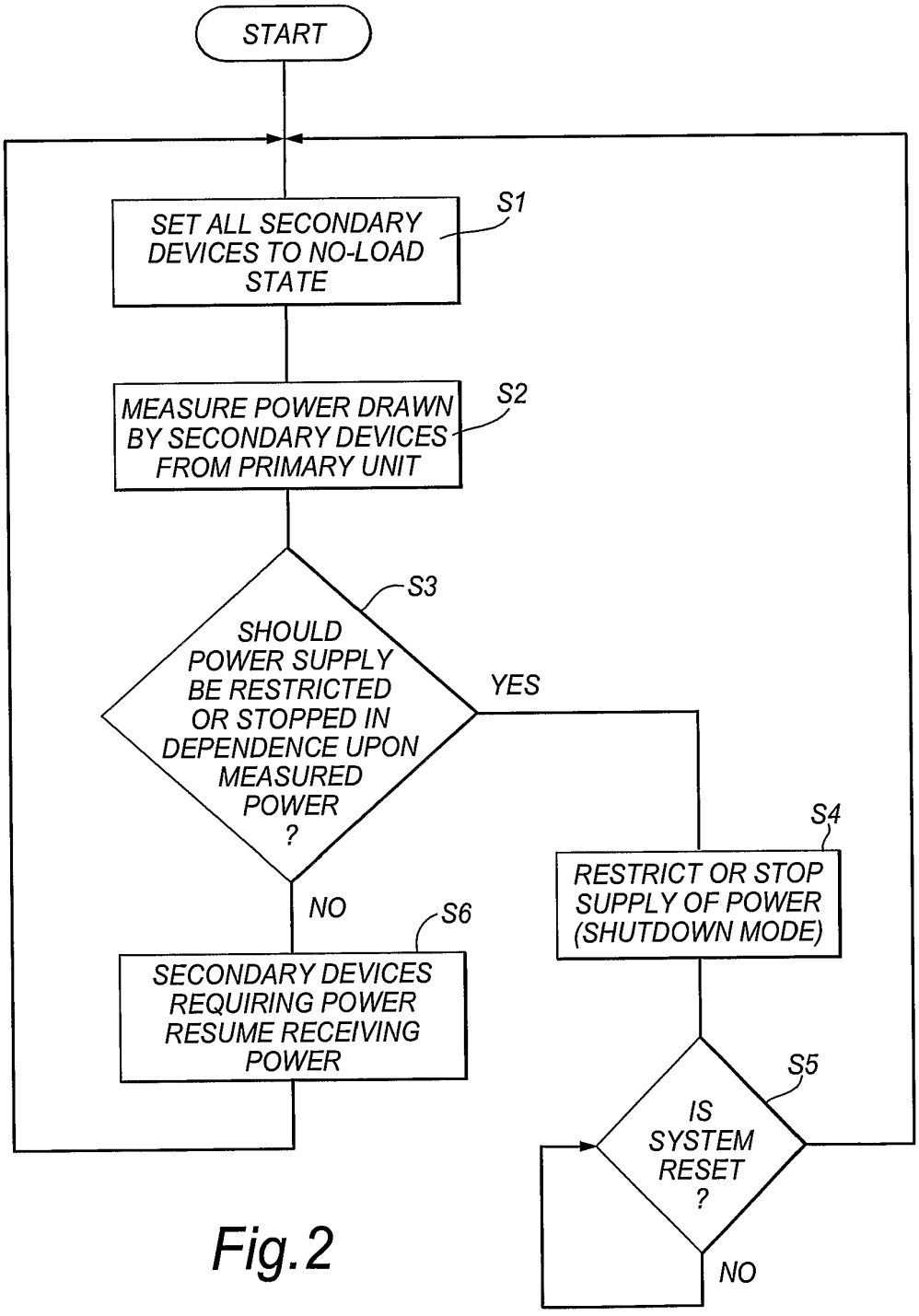

START
SET ALL SECONDARY DEVICES TO NO-LOAD STATE
S1
MEASURE POWER DRAWN BY SECONDARY DEVICES FROM PRIMARY UNIT
S2
SHOULD POWER SUPPLY BE RESTRICTED OR STOPPED IN DEPENDENCE UPON MEASURED POWER ?
S3
YES
NO
RESTRICT OR STOP SUPPLY OF POWER (SHUTDOWN MODE)
S4
SECONDARY DEVICES REQUIRING POWER RESUME RECEIVING POWER
S6
IS SYSTEM RESET ?
S5
NO

Fig.2

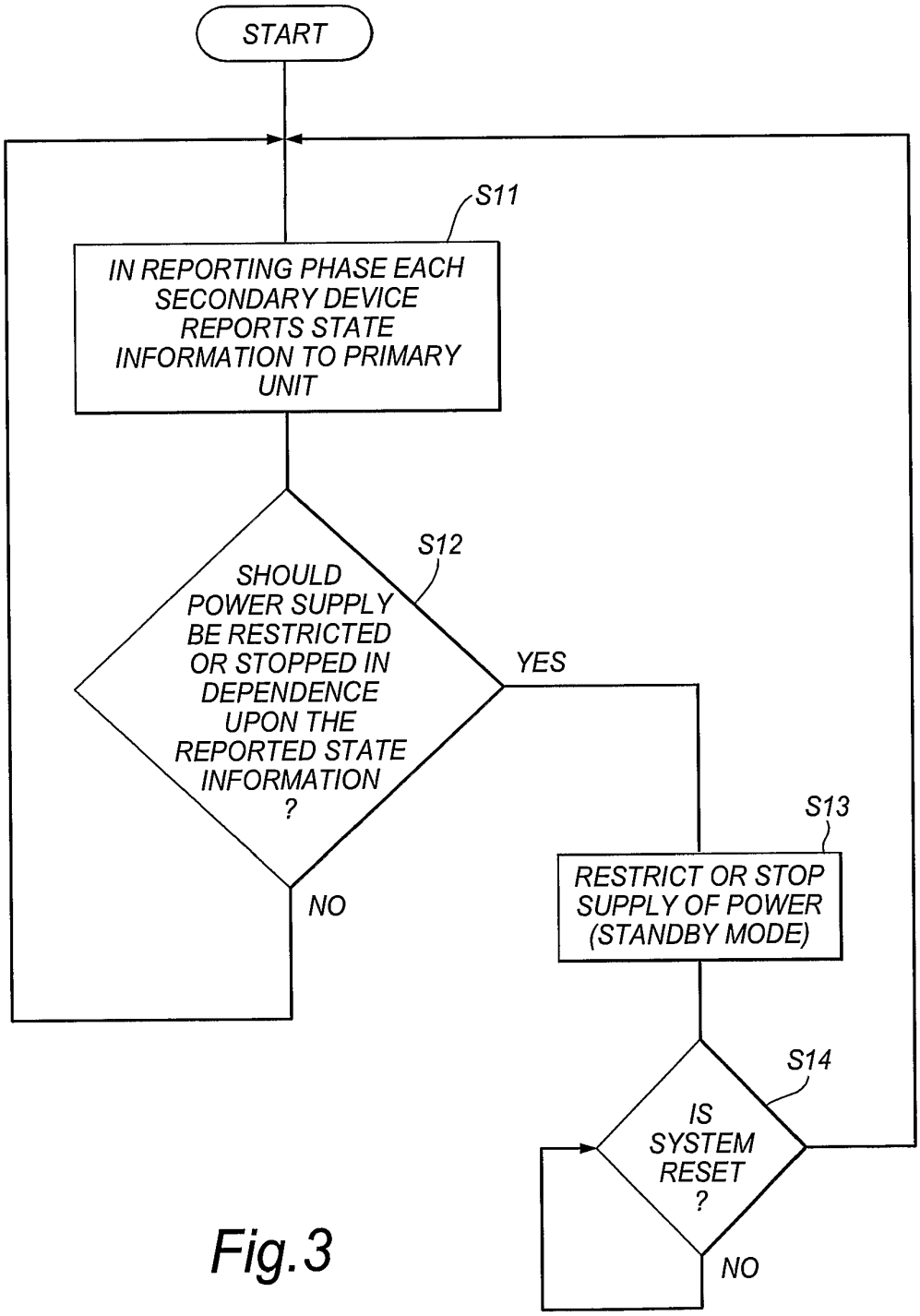

START
S11
IN REPORTING PHASE EACH SECONDARY DEVICE REPORTS STATE INFORMATION TO PRIMARY UNIT
S12
SHOULD POWER SUPPLY BE RESTRICTED OR STOPPED IN DEPENDENCE UPON THE REPORTED STATE INFORMATION ?
YES
NO
S13
RESTRICT OR STOP SUPPLY OF POWER (STANDBY MODE)
S14
IS SYSTEM RESET ?
NO

Fig.3

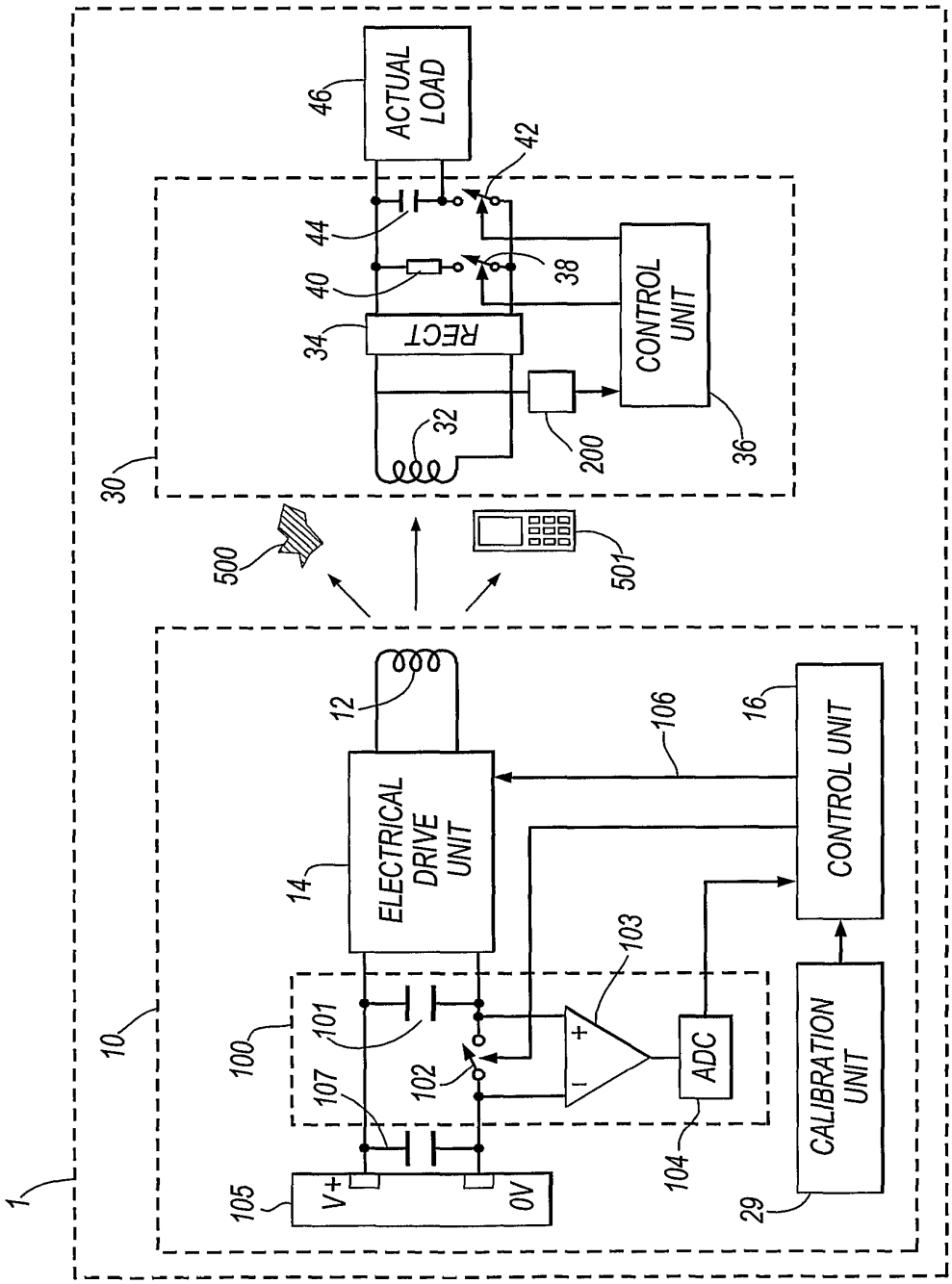

ACTUAL LOAD
46
42
44
40
38
CONTROL UNIT
REACT
34
32
200
36
30
500
501
12
106
16
CONTROL UNIT
ELECTRICAL DRIVE UNIT
14
103
101
100
10
107
102
ADC
CALIBRATION UNIT
104
29
105
V+
0V
1

Fig.4

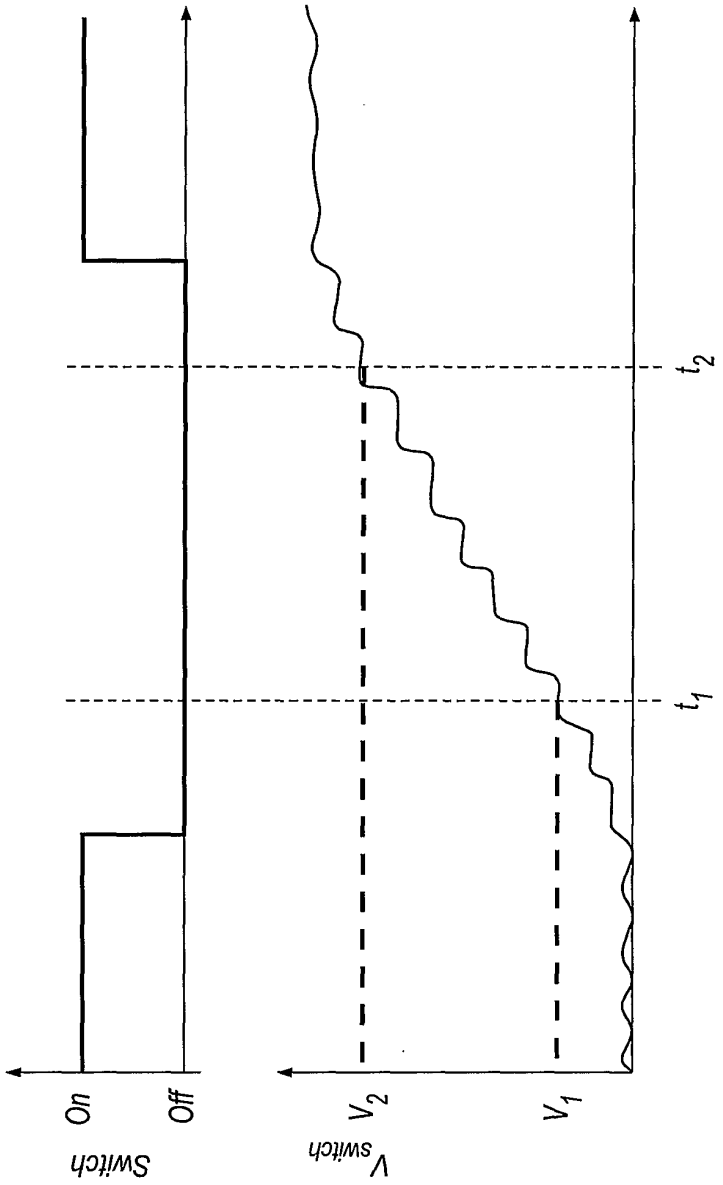
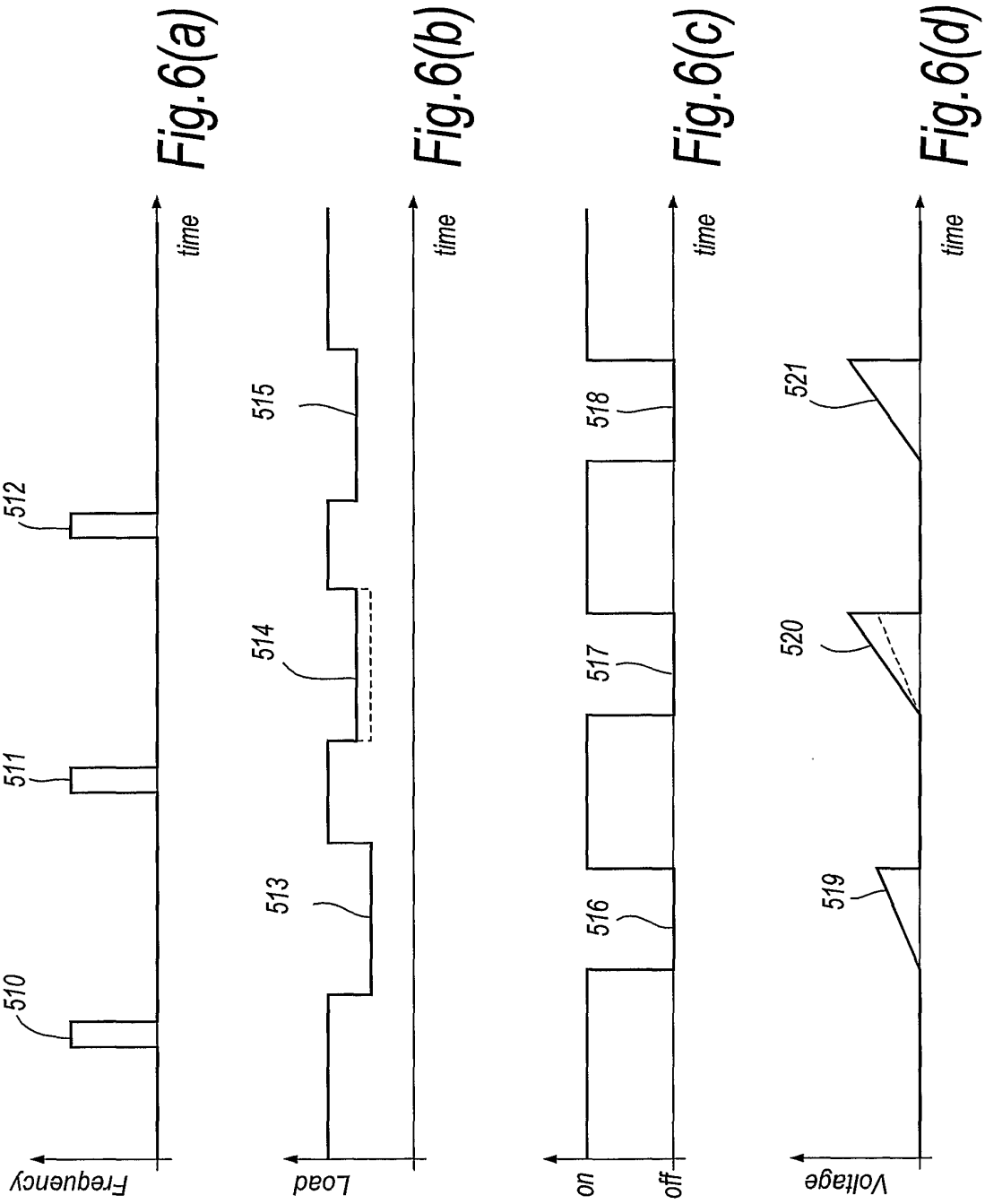


Fig.5


Fig.6(a)
time
Frequency
510
511
512
Fig.6(b)
time
Load
513
514
515
Fig.6(c)
time
on
off
516
517
518
Fig.6(d)
time
Voltage
519
520
521

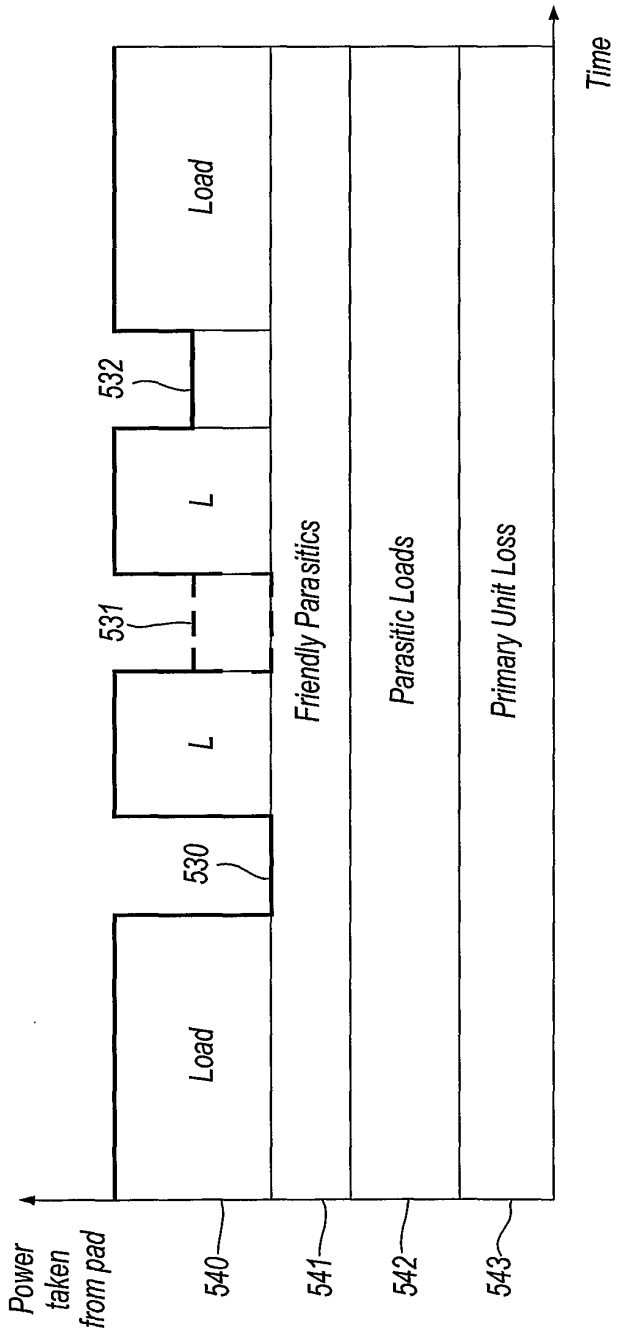

Time
Load
532
L
531
L
530
Load
Friendly Parasitics
Parasitic Loads
Primary Unit Loss
Power taken from pad
540
541
542
543

Fig.7

8/11

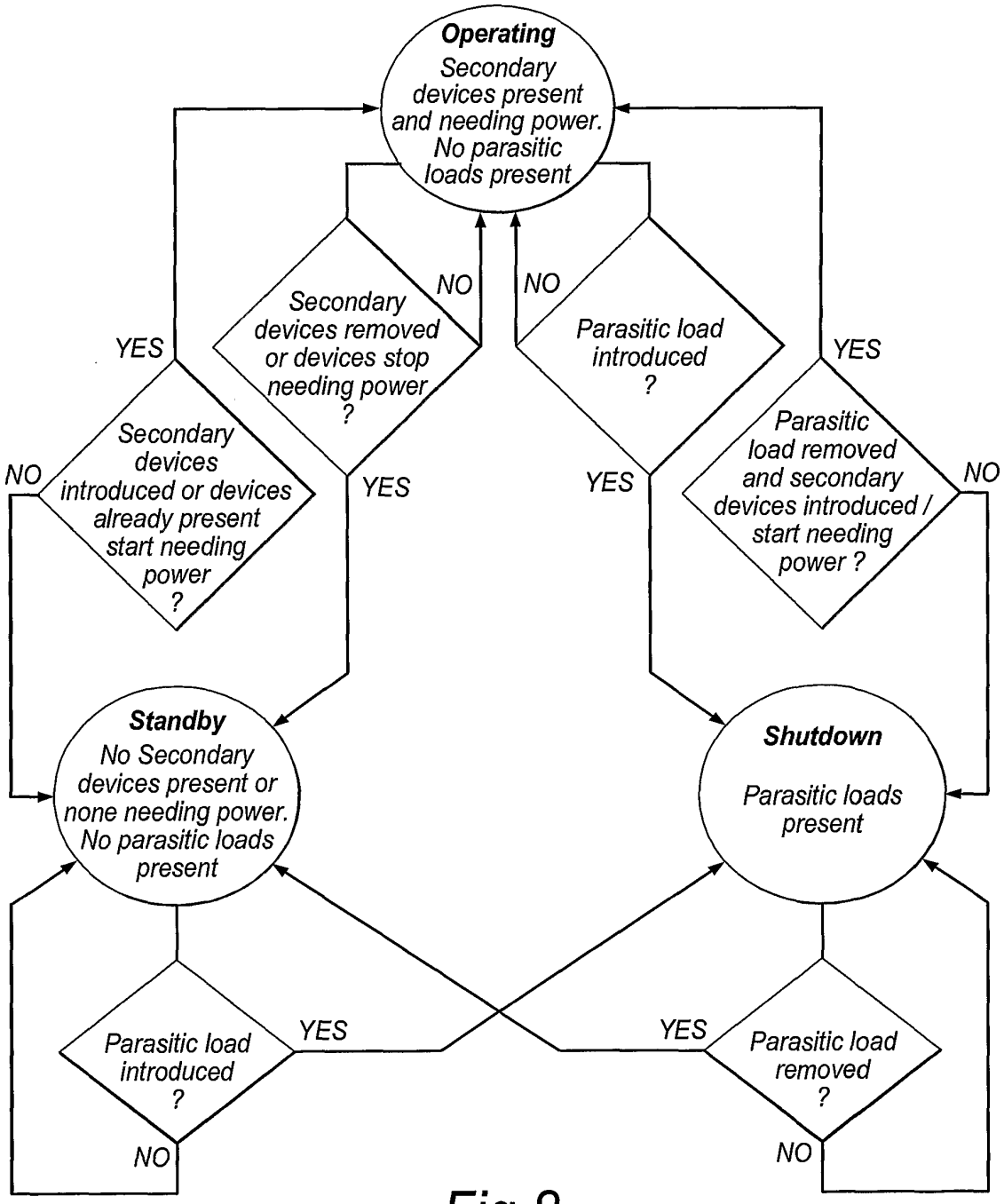

Operating
Secondary devices present and needing power. No parasitic loads present
Secondary devices removed or devices stop needing power ?
NO
YES
Parasitic load introduced ?
NO
YES
Secondary devices introduced or devices already present start needing power ?
NO
YES
Parasitic load removed and secondary devices introduced / start needing power ?
YES
NO
Standby
No Secondary devices present or none needing power. No parasitic loads present
Shutdown
Parasitic loads present
Parasitic load introduced ?
YES
NO
Parasitic load removed ?
YES
NO

Fig.8

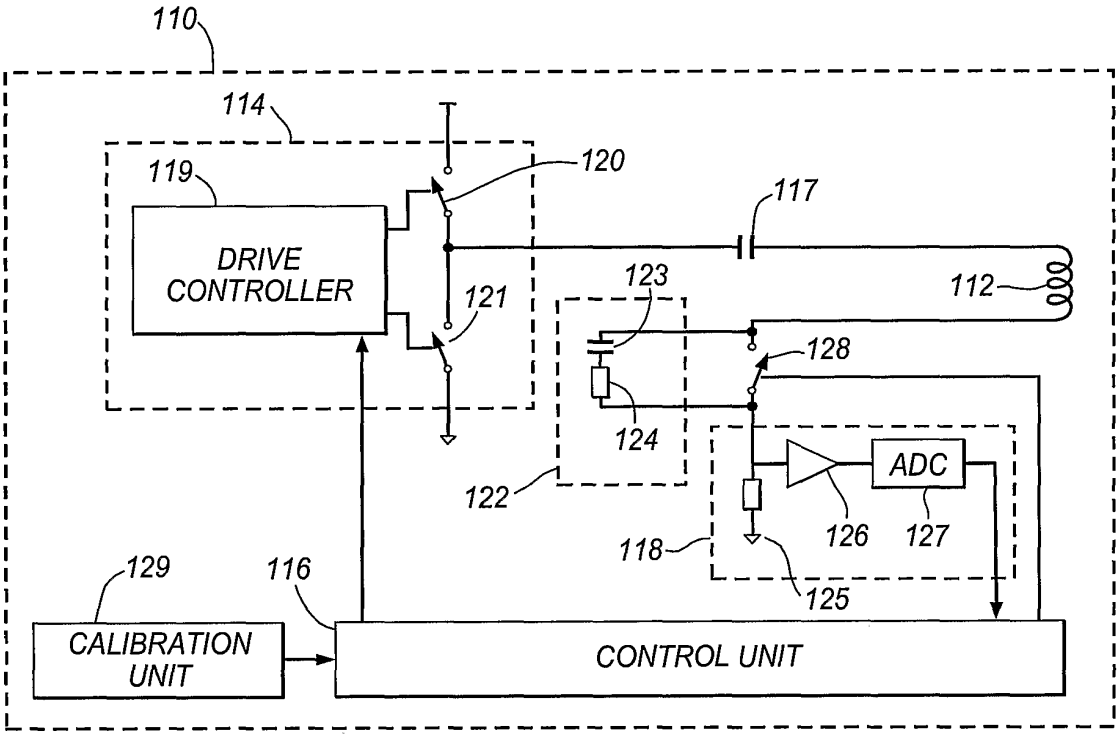

110
114
119
DRIVE CONTROLLER
120
121
117
112
123
124
128
122
ADC
126
127
118
125
129
116
CALIBRATION UNIT
CONTROL UNIT

Fig.9

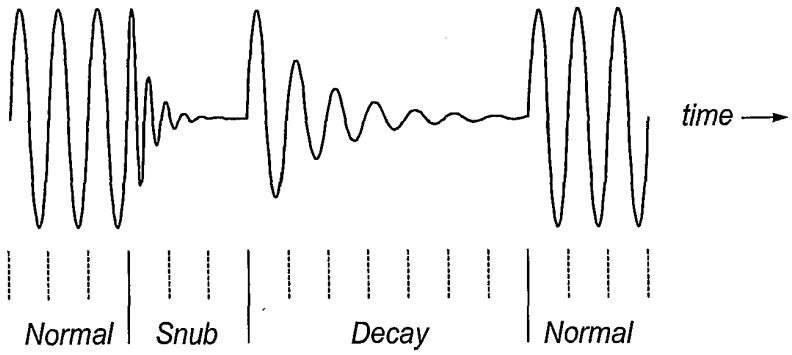

time
Normal
Snub
Decay
Normal

Fig.10

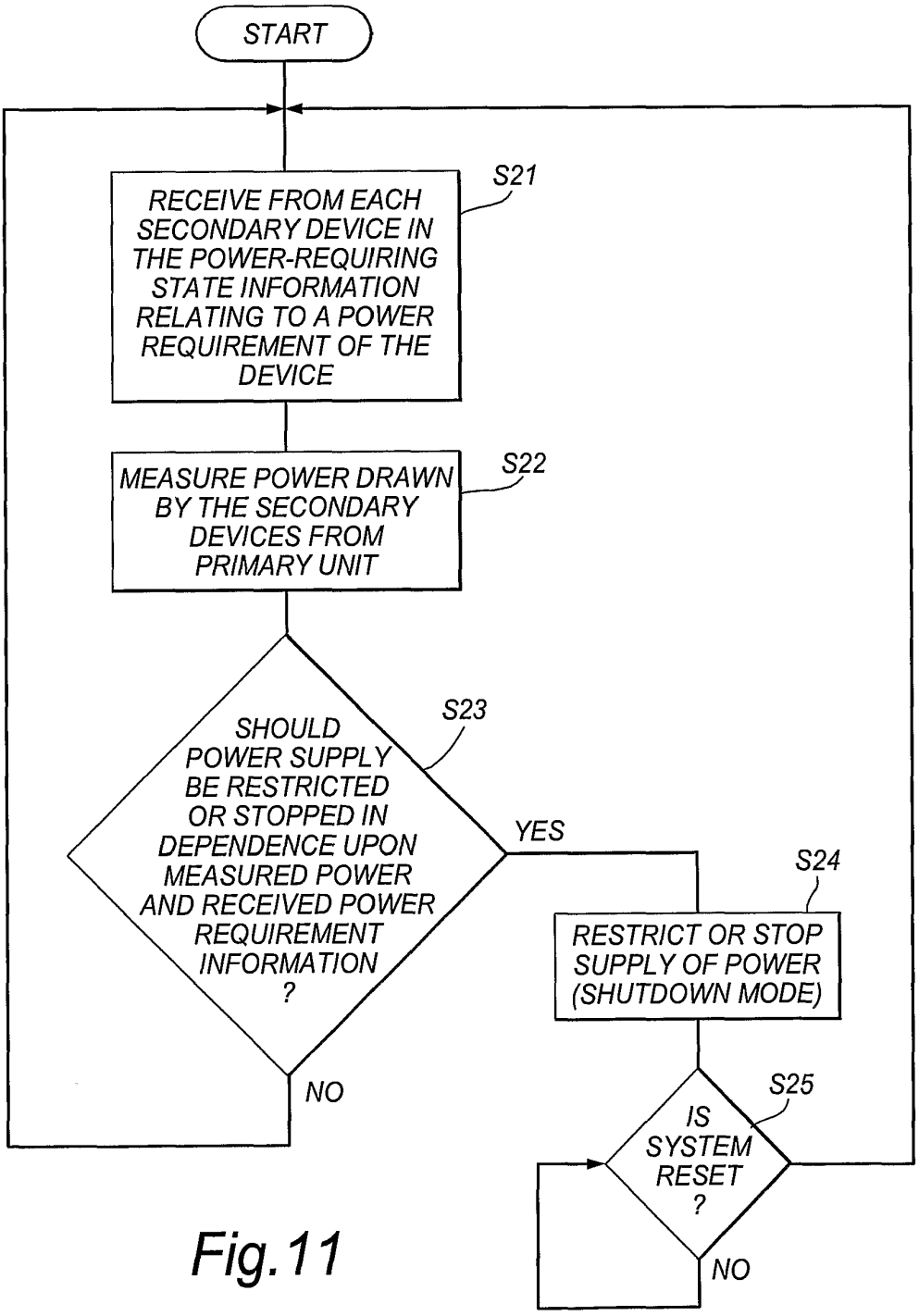

START
RECEIVE FROM EACH SECONDARY DEVICE IN THE POWER-REQUIRING STATE INFORMATION RELATING TO A POWER REQUIREMENT OF THE DEVICE
S21
MEASURE POWER DRAWN BY THE SECONDARY DEVICES FROM PRIMARY UNIT
S22
SHOULD POWER SUPPLY BE RESTRICTED OR STOPPED IN DEPENDENCE UPON MEASURED POWER AND RECEIVED POWER REQUIREMENT INFORMATION ?
S23
YES
NO
RESTRICT OR STOP SUPPLY OF POWER (SHUTDOWN MODE)
S24
IS SYSTEM RESET ?
S25
NO

Fig.11

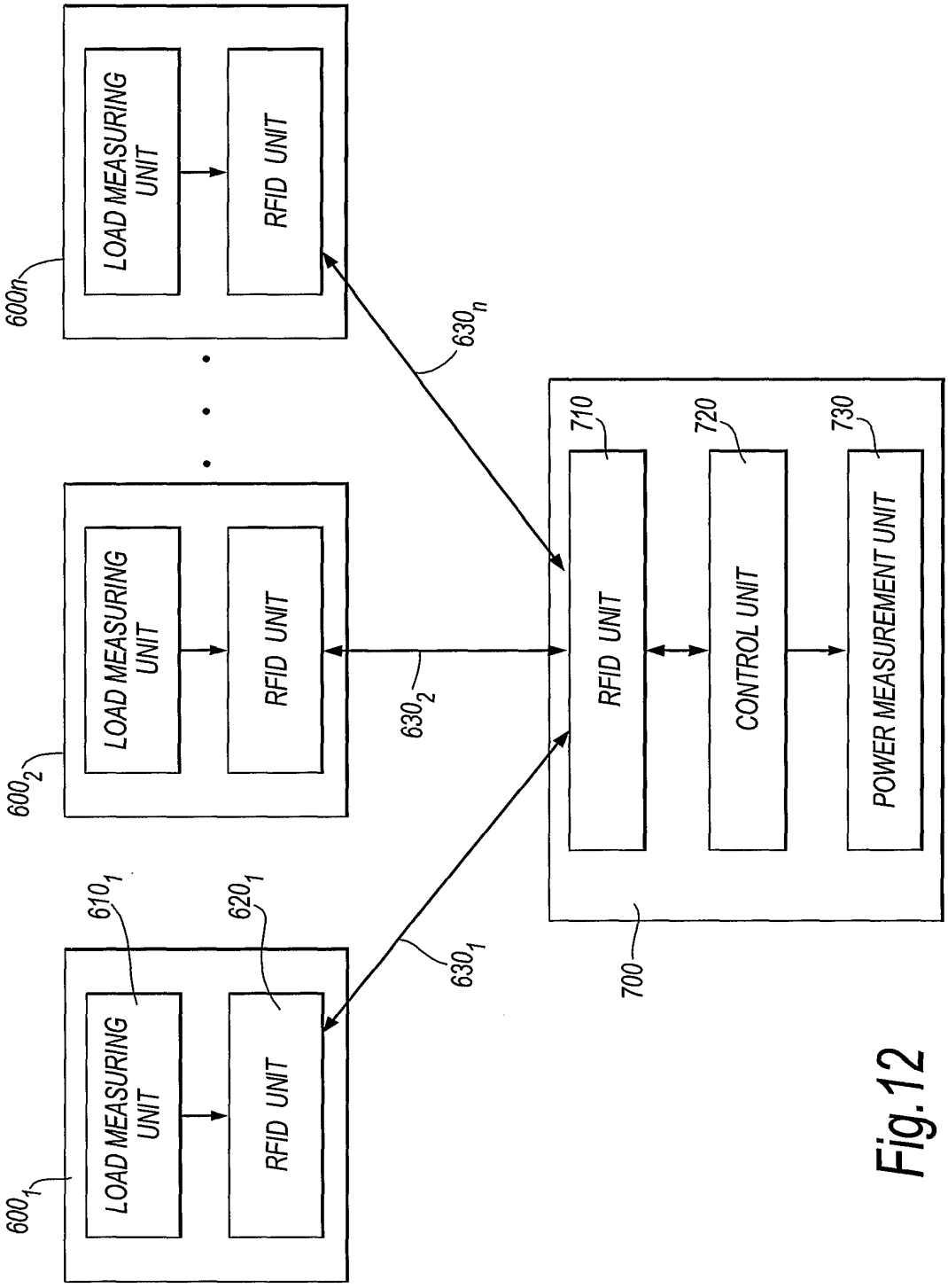

LOAD MEASURING UNIT
RFID UNIT
600n
630n
710
720
730
RFID UNIT
CONTROL UNIT
POWER MEASUREMENT UNIT
600 2
630 2
610 1
620 1
600 1
630 1
700

Fig.12

INTERNATIONAL SEARCH REPORT

Interi al Application No
PCT/GB2005/001824

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J5/00

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)
IPC 7 H02J

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 6 057 668 A (CHAO ET AL) 2 May 2000 (2000-05-02) column 3, paragraph 6; claim 1; figure 1	1,32,33 2-9,34, 35
Y	EP 0 533 247 A (ERICSSON RADIO SYSTEMS B.V) 24 March 1993 (1993-03-24) cited in the application claim 18	5-9,34
Y	US 2002/154518 A1 (ELFERICH REINHOLD ET AL) 24 October 2002 (2002-10-24) paragraph '0090!	8,9,35
Y A	WO 2004/015885 A (MOBILEWISE, INC; DAYAN, TAL; GOREN, OFER; KIKINIS, DAN; GOREN, YEHUDA) 19 February 2004 (2004-02-19) page 2 - page 5	5-7 12

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
3 August 2005	12/08/2005

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INTERNATIONAL SEARCH REPORT

Inter l Application No
PCI/GB2005/001824

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 118 249 A (BROCKMANN ET AL) 12 September 2000 (2000-09-12) cited in the application claims 1-4; figure 1	2-4

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INTERNATIONAL SEARCH REPORT

...rmation on patent family members

Inter ...al Application No
PCT/GB2005/001824

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EP 0533247 A	24-03-1993	NL 9101590 A	16-04-1993
		DE 69207313 D1	15-02-1996
		DE 69207313 T2	15-05-1996
		EP 0533247 A1	24-03-1993
		US 5367242 A	22-11-1994
US 2002154518 A1	24-10-2002	DE 10119283 A1	24-10-2002
		EP 1253695 A2	30-10-2002
		JP 2002369414 A	20-12-2002
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US 6118249 A	12-09-2000	DE 19837675 A1	24-02-2000
		EP 0982831 A2	01-03-2000

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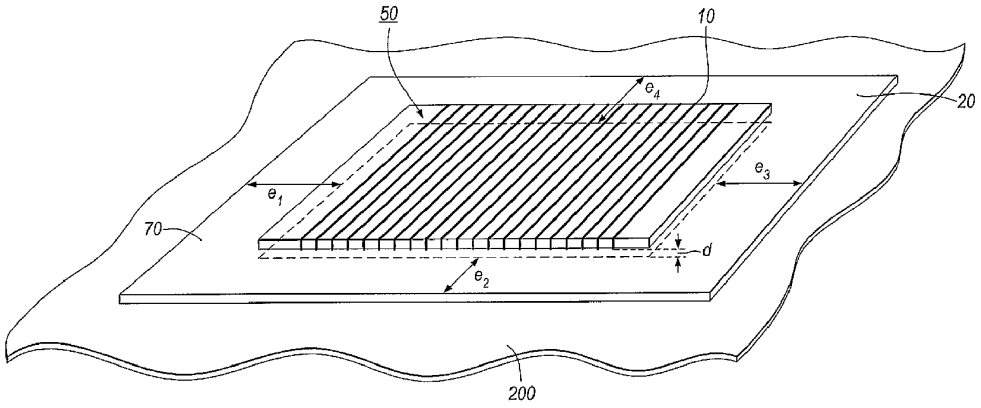
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Published:
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(54) Title: INDUCTIVE POWER TRANSFER UNITS HAVING FLUX SHIELDS



(57) Abstract: An inductive power transfer unit is adapted to be placed when in use on a support surface (200). A flux generating unit (50) extends in two dimensions over the support surface, and generates flux at or in proximity to a power transfer surface of the unit so that a secondary device placed on or in proximity to the power transfer surface can receive power inductively from the unit. A flux shield (70), made of electrically-conductive material, is interposed between the flux generating unit and the support surface, the shield extending outwardly (e_1 - e_4) beyond at least one edge of the flux generating unit. Alternatively, the flux shield may have one or more portions which extend over one or more side faces of the inductive power transfer unit or which extend between the side face(s) and the flux generating unit. The flux shield may be supplied as a removable accessory which attaches to the outside of the inductive power transfer unit.

WO 2005/024865 A2

INDUCTIVE POWER TRANSFER UNITS HAVING FLUX SHIELDS

This invention relates to inductive power transfer units having flux shields.

Inductive power transfer units, as described for example in the present applicant's published International patent publication no. WO-A-03/096512, the entire contents of which is hereby incorporated into the present application by reference, seek to provide a flat or curved power transfer surface over which a substantially horizontal alternating magnetic field flows. This field couples into any secondary devices placed upon the power transfer surface. In some variants this field may rotate in the plane of the surface to provide complete freedom of positioning for any secondary device placed on the surface to receive power. The secondary devices are, for example, built into portable electrical or electronic devices or rechargeable batteries which can be removed from the surface when not receiving power.

Depending on the design of the flux generating unit (magnetic assembly) of such power transfer units, they may also emit flux in directions other than desired horizontal surface field. For example a "squashed solenoid" design of flux generating unit emits flux symmetrically above and below it.

In Figure 1, a flux generating unit 50 comprises a coil 10 shaped into a flat solenoid wound around a former 20. The former 20 is in the form of a thin sheet of magnetic material. This results in a substantially horizontal field across the upper surface of the flux generating unit, but also an equal field across the lower surface. The field lines of both fields extend generally in parallel with one another over the respective surfaces, substantially perpendicularly to the coil windings. A secondary device 60 is shown in place over the upper surface.

Figure 2 shows a similar arrangement to that of Figure 1, but with an additional coil 11 wound, in an orthogonal direction to the winding direction of the coil 10, around the former 20. By driving the two coils 10 and 11 in a suitable manner, the flux generating unit may create a field which is substantially horizontal over the power

transfer surface (upper surface) and which rotates in the plane of that surface. In typical usage, the flux above the upper surface provides the functionality that the user desires (powering the secondary device 60), but the flux present at other surfaces may not be useful and can cause undesired effects.

Figure 3 shows a side view Finite Element analysis of the flux lines generated by the flux generating unit 50 in Figure 1 at an instant in time. The lines travel through the centre of the solenoid and then divide to return over and under it through the air. A secondary device 60 is shown placed on top of the unit 50.

One undesired effect occurs particularly when the primary unit is placed upon a ferrous metal surface, for example a mild steel desk or part of a vehicle chassis. The permeability of mild steel is sufficiently high that it provides a return path for the flux which is of considerably lower reluctance than the alternative path through air. Therefore the flux is "sucked" down into the metal desk. Figure 4 shows another Finite Element analysis view when a metal desk 200 is brought under the flux generating unit. The high permeability of the metal offers the flux lines a much lower-reluctance path than air to return from one end of the flux generating unit 50 to the other, and so they travel within the desk rather than through the air. This is undesirable for two reasons:

- A significant proportion of the flux generated by the inductive power transfer unit (primary unit) is flowing into the metal desk instead of flowing into any secondary devices on the upper surface of the unit, therefore the system becomes less efficient (consumes the more power) and the power received by the secondary device varies.
- The flux flowing through the metal desk causes core losses, for example via hysteresis and / or eddy current loss , which cause it to heat up.

It is known that when conductive materials, for example copper or aluminium, are placed into an alternating magnetic field, the field induces eddy-currents to circulate within them. The eddy currents then act to generate a second field which - in the limit of a perfect conductor - is equal and opposite to the imposed field, and cancels

it out at the surface of the conductor. Therefore these conductive materials can be seen as "flux-shields" – the lines of flux in any magnetic system are excluded from them. This may be used to shield one part of a system from a magnetic field and consequently concentrate the field in another part. GB-A-2389720, which is a document published after the priority date of the present application but having an earlier priority date, discloses a flux generating unit in the form of a printed circuit board having an array of spiral conductive tracks for generating flux above the upper surface of the unit. A ferrite sheet is placed under the board, and a conductive sheet is placed under the ferrite sheet, to provide a flux shield. The ferrite sheet and conductive sheet are of the same dimensions, parallel to the sheets, as the board.

According to a first aspect of the present invention there is provided an inductive power transfer unit, adapted to be placed when in use on a support surface, comprising: a flux generating means which, when the unit is placed on the support surface, extends in two dimensions over the support surface, said flux generating means being operable to generate flux at or in proximity to a power transfer surface of the unit so that a secondary device placed on or in proximity to the power transfer surface can receive power inductively from the unit; and a flux shield, made of electrically-conductive material, arranged so that when the unit is placed on the support surface, the shield is interposed between the flux generating means and the support surface, the shield extending outwardly beyond at least one edge of the flux generating means.

According to a second aspect of the present invention there is provided an inductive power transfer unit, adapted to be placed when in use on a support surface, comprising: a flux generating means which, when the unit is placed on the support surface, extends in two dimensions over the support surface, said flux generating means being operable to generate flux at or in proximity to a power transfer surface of the unit so that a secondary device placed on or in proximity to the power transfer surface can receive power inductively from the unit; and a flux shield, made of electrically-conductive material, having one or more portions which extend over one

or more side faces of the unit or which extend between said one or more side faces and said flux generating means.

In cases where the flux generating unit operates by creating a field which alternates back and forth in one linear dimension, the conductive shield will have induced in it an equal and opposite alternating linear field, which acts to cancel the field near the shield. In cases where the unit operates by creating a rotating field in the plane of its laminar surface, the conductive shield has induced in it a field which also rotates, again cancelling the field.

Such power transfer units are advantageous because they allow the flux to be concentrated in directions in which it is useful, improving the flux-efficiency of the unit, and to be shielded from directions where it can cause side-effects, for example by coupling into a metal desk under the unit.

In addition, the flux shield increases the coupling between the flux generating unit and the secondary device(s) by forcing most of the flux to go over the power transfer surface. Therefore less drive current is needed in the flux generating unit to create a given flux density in the secondary device(s). Accordingly, provided that losses in the flux shield are minimised, the system as a whole becomes more efficient.

To ensure that the apparatus runs cool and is power-efficient, I^2R losses (losses caused by circulating currents dissipating as heat) in the conductive shield must be kept small:

- The conductive shield is advantageously made of a highly conductive material, for example copper or aluminium sheet of sufficient thickness to ensure that the eddy-currents induced therein do not suffer from excessive resistance and therefore create heat. The flux density, and therefore the eddy currents, may vary across different parts of the apparatus, and therefore the necessary thickness, or material, may also vary.
- The spacing between the shield and the electrically-driven conductors of the flux generating unit can be optimised. The larger it is (i.e. the greater the

spacing between it and the electrically-driven conductors), the lower the current-density induced in the conductive shield, and therefore the lower the heating. However this must be traded-off against the larger the overall dimensions necessary, which may be less ergonomic.

In addition, the conductive shield must not itself be substantially ferrous, otherwise it may provide a low-reluctance path which "shorts" the intended flux path.

In one embodiment of the present invention, the conductive shield extends in a substantially continuous sheet substantially over all but one face of the flux generating unit, such that only the face substantially exposed is the laminar surface intended for power delivery to secondary devices. For example, if the generating unit is a substantially flat rectangular shape, the shield may extend to cover the bottom and four sides of the unit. As another example, if the flux generating unit is a substantially flat cylinder, the shield may extend to cover the bottom and cylindrical side of the unit. The advantage of such an arrangement is that it increases still further, compared to a flat sheet, the path that flux would have to travel in order to travel through a metal object underneath the flux generating unit.

In another embodiment of the present invention, the conductive shield may enclose all but a part of one or more faces of the flux generating unit. For example, if the flux generating unit is a substantially flat rectangular shape, the shield may cover the bottom, sides and outer part of the top of the flux generating unit. This may be advantageous in controlling the flux pattern at the edge of the top of the flux generating unit.

The conductive shield may form part of an enclosure of the inductive power transfer unit, for example a formed or cast aluminium or magnesium casing. This may be advantageous in reducing cost.

According to a third aspect of the present invention there is provided an inductive power transfer unit comprising: a power transfer surface on or in proximity to which

a secondary device can be placed to receive power inductively from the unit; flux generating means arranged to generate flux at or in proximity to said power transfer surface; and flux shield attachment means arranged for attaching a flux shield to the unit such that the attached shield is arranged at one or more external surfaces of the unit other than said power transfer surface, or is arranged between said one or more external surfaces and said flux generating means, so that the shield serves to shield objects outside the unit, adjacent to said one or more external surfaces, from flux generated by the flux generating means.

According to a fourth aspect of the present invention there is provided an accessory, adapted to be attached to the outside of an inductive power transfer unit, the unit having a power transfer surface on or in proximity to which a secondary device can be placed to receive power inductively from the unit and also having flux generating means arranged to generate flux at or in proximity to the power transfer surface, and the accessory comprising: means which co-operate with the unit to attach the accessory to the outside of the unit in a predetermined working disposition; and a flux shield, made of electrically-conductive material, which, when the accessory is in its said working disposition, extends at or in proximity to one or more external surfaces of the unit other than said power transfer surface so as to shield objects outside the unit, adjacent to said one or more external surfaces, from flux generated by the flux generating means.

In the third and fourth aspects of the invention the conductive shield is supplied to the user as a separate accessory to be placed under or around the power transfer unit. Optionally it may be provided as a retainable accessory, for example a clip-on cover. This is advantageous as it allows the bill of materials for the power transfer unit to be kept to an absolute minimum, yet allows users to purchase the accessory if the unit is to be used in a location where it may be necessary to constrain its field, for example on a ferrous metal desk.

In one embodiment the flux generating unit comprises at least one means for generating an electromagnetic field, the means being distributed in two dimensions

across a predetermined area in or parallel to the power transfer surface so as to define at least one power transfer area of the power transfer surface that is substantially coextensive with the predetermined area, the charging area having a width and a length on the power transfer surface. Preferably the means is configured such that, when a predetermined current is supplied thereto and the primary unit is effectively in electromagnetic isolation, an electromagnetic field generated by the means has electromagnetic field lines that, when averaged over any quarter length part of the power transfer area measured parallel to a direction of the field lines, subtend an angle of 45° or less to the power transfer surface in proximity thereto and are distributed in two dimensions thereover. Preferably the means has a height measured substantially perpendicular to the power transfer area that is less than either of the width or the length of the power transfer area. The height is more preferably less than one fifth, or less than one tenth, of either the width or height, so that the inductive power transfer unit as a whole is in the form of a flat bed or platform. When a secondary device, including at least one electrical conductor, is placed on or in proximity to a power transfer area of the inductive power transfer unit, the electromagnetic field lines couple with the at least one conductor of the secondary device and induce a current to flow therein. The conductive sheet or shield is arranged on or in the power transfer unit at a location other than the side on which the power transfer area is located.

In the context of the present application, the word "laminar" defines a geometry in the form of a thin sheet or lamina. The thin sheet or lamina may be substantially flat, or may be curved.

It is to be appreciated that the conductive sheet or shield may be generally laminar, or may include one or more edge portions that are directed towards the power transfer surface.

The conductive sheet or shield may be exposed on the side of the power transfer unit opposed to the power transfer surface, or may be covered with a layer of dielectric or other material, for example by part of a casing of the unit.

For a better understanding of the present invention and to show how it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawings, in which:

FIGURE 1 is a perspective view showing an example of a flux generating unit suitable for use in embodiments of the present invention.

FIGURE 2 is a perspective view showing another example of a flux generating unit suitable for use in embodiments of the present invention.

FIGURE 3 shows a side view of the flux generating unit of Figure 1 for illustrating flux lines generated thereby.

FIGURE 4 is a view corresponding to Figure 3 but illustrating flux lines generated when a metal desk is present under the arrangement.

FIGURE 5 is a perspective view showing parts of an inductive power transfer unit according to a first embodiment of the present invention.

FIGURE 6 shows a side view of the unit of Figure 5 for illustrating flux lines generated thereby when the unit is placed on a metal desk.

FIGURE 7 is a perspective view showing parts of an inductive power transfer unit according to a second embodiment of the present invention.

FIGURE 8 shows a side view of the unit of Figure 7 for illustrating flux lines generated thereby when the unit is placed on a metal desk.

FIGURE 9 is a side view of an inductive power transfer unit and an accessory therefor according to a third embodiment of the present invention.

Figure 5 shows parts of an inductive power transfer unit according to a first embodiment of the present invention. In this embodiment, a flux generating unit 50 has the same general construction as the flux generating unit described in the introduction with reference to Figure 1. Of course a flux generating unit 50' as shown in Figure 2 can be used in this (and other) embodiments of the invention, instead. Similarly, any of the flux generating units described in WO-A-03/096512 can be used in embodiments of the present invention.

The flux generating unit 50 comprises a coil 10 wound around a former 20. The former 20 is in the form of a thin sheet of magnetic material. When the inductive power transfer unit is placed on a support surface 200, the flux generating unit 50 extends in two dimensions over the support surface.

A flux shield 70, made of electrically-conductive material such as copper, is interposed between the flux generating unit 50 and the support surface 200. As shown in Figure 5, the shield 70 extends outwardly by distances e_1 to e_4 beyond each edge of the flux generating unit 50. The distance e_1 is for example 50mm. The distance e_2 is for example 50mm. The distance e_3 is for example 50mm. The distance e_4 is for example 50mm.

In this embodiment, the flux shield 70 is in the form of a flat sheet which extends generally in parallel with the support surface. There is a gap of size d between the sheet and the electrical conductors of the coil 10 extending over the lower surface of the former 20. d is 4mm, for example.

Figure 6 shows a Finite Element analysis view of the unit of Figure 5. The support surface 200 is assumed to be a metal desk. The shield 70 forces any flux lines flowing through the metal desk to travel around the shield, increasing the path length and thus the effective reluctance of the "desk" path. As a result, the presence of the desk has less effect, since more flux lines travel over the unit instead of going through the desk.

Although the flux shield 70 has extensions beyond all edges of the unit 50 in the Figure 5 example, it will be appreciated that a worthwhile flux-shielding effect can also be obtained even if the flux shield extends beyond one edge or only extends beyond a pair of opposite edges.

Figure 7 shows parts of an inductive power transfer unit according to a second embodiment of the present invention. In this embodiment a flux shield 80 having 5 sides (base 82 and side walls 84, 86, 88 and 90) is provided. The base 82 of the flux shield 80 extends between the lower surface of the flux generating unit 50 and the support surface 200. Because the flux shield 80 has side walls in this embodiment, the base 82 need not extend out beyond the edges of the flux generating unit 50 by as far as the distances e_1 to e_4 in the Figure 5 embodiment. For example, e_1 to e_4 may each be 4mm. This can enable the overall dimensions of the power transfer unit to be reduced while keeping the effective reluctance of the desk path high. The height of the side walls 84, 86, 88 and 90 is exaggerated in Figure 7 for clarity. In practice, the side walls need not extend above the upper surface of the flux generating unit 50.

The flux shield 80 may be formed from a flat sheet of conductive material which is cut and folded up at the edges to form a tray-form member.

Figure 8 shows a finite element analysis view of the unit of Figure 7.

Figure 9 shows parts of an inductive power transfer unit 400 according to a third embodiment of the present invention. In this embodiment a flux generating unit 50, similar to the flux generating units described with reference to the first and second embodiments, is contained in a casing 410 of the unit 400. An upper surface of the casing 410 provides the power transfer surface in this embodiment, and a secondary device 60 is placed directly on the surface to receive power inductively from the flux generating unit 50.

In each of the four side walls of the casing 410 a small circular recess 420 is formed.

In this embodiment the flux shield 90 is an accessory which is adapted to be attached to the outside of the inductive power transfer unit 400. The flux shield 90, which is similar in form to the flux shield 80 shown in Figure 7, has circular projections 95 formed on the inner surfaces of the upstanding side walls of the flux shield 90. The projections 95 engage respectively with the recesses 420 in the casing of the inductive power transfer unit 400. In this way, the unit 400 can be inserted into the flux shield 90 due to the resilience of the materials of the flux shield 90 and/or casing 410. The projections and recesses serve to hold the flux shield 90 on the outside of the unit 400 in such a way that the flux shield shields objects outside the unit, adjacent to the external surfaces of the unit, from flux generated by the flux generating unit 50.

The provision of a removable flux shield has several advantages. In some applications, the flux shield is unnecessary. For example, the shield is unnecessary if the support surface on which the unit will be placed is non-metallic. In this way, the unit can be made as small as possible and at the lowest possible cost. Any user who intends to use the unit on a metallic support surface can purchase the flux shield as an optional accessory.

When the flux shield is in the form of a removable accessory, it is not necessary for the flux shield to have the form of the first embodiment or second embodiment described above. For example, the flux shield need not extend outwardly beyond the edges of the flux generating unit 50; it could be coterminous with the planar area of the flux generating unit 50 or even smaller than the planar area thereof. For example, a flat sheet-form conductive shield could be built into the base of a tray-form plastics housing of the accessory.

Any suitable way of attaching the flux shield to the outside of the inductive power transfer unit may be used. Although snap-fitting is particularly convenient, the flux shield may be attached to the unit using screws or Velcro ®. Equally, there could simply be a tight fit between the flux shield and the casing of the unit.

By way of example only, there now follows a set of test results for embodiments of this invention. In the test set up the flux generating unit 50 measured approximately 175x125x9mm. The flux shield 70 or 80 was made from a 0.6mm thick sheet of copper. The metal desk 200 was a sheet of metal 500mm x 500mm x 0.6mm thick (magnetically, this is effectively an infinite plane).

The current through the flux generating unit 50 was adjusted so that the power delivered to a secondary device 60 was the same at the start of each test. A control loop then held the current constant during the rest of each test.

The power received by the secondary device was monitored and the extra power drawn from the charger was monitored.

The results were as follows:

Test Condition	Power seen by secondary device	Extra power needed from charger
1a. No flux shield	100%	0W
1b. As 1a with steel under	*123%*	*11W*
2a. Flux shield sheet (Figure 5) immediately under magnetic assembly	100%	1.5W
2b. Flux shield moved 4mm from assembly	100%	0.7W
2c. As 2b with steel under	*110%*	*4.6W*
3a. Flux shield box (Figure 7)around bottom and edges (4mm gap)	100%	1.5W
3b. As 3a with steel under	*108%*	*2.2W*

Test 1 shows the case without any flux shield. The flux lines will initially be approximately as shown in Figure 3. Introducing a metal sheet under the assembly causes the flux to travel down and through the sheet, in preference to travelling up and over the top, as shown in Figure 4. The control loop in the generator is forced to expend 11W to keep its coil current constant, which is not optimal since it is inefficient and will cause the metal to warm up. In addition, the secondary device sees a rise in the power it receives to 123%, because eddy currents in the metal desk do act as a poor flux excluder even as they consume large amounts of generator

power – and this is not optimal either.

Test 2 shows the case with a flat flux shielding sheet underneath as in the first embodiment. A large (190mm x 140mm x 0.6mm) copper sheet flux shield immediately under the magnetic assembly (test 2a) causes the generator to have to supply an additional 1.5W, presumably because it starts to short the coil turns in the assembly. Moving this 4mm away from the assembly (i.e. d = 4mm in Figure 5) reduces this drain to 0.7W (test 2b). Now introducing a metal sheet only causes the generator to have to supply 4.6W (i.e. an additional 3.9W), and the power into the secondary device now only changes to 110% (test 2c). This is shown in Figure 6. So the flux shield has reduced each of the two side-effects by more than half.

Test 3 shows the case where the edges of the flux shield are brought up around the edges of the magnetic assembly, as in the second embodiment shown in Figure 7. The shield is kept 4mm away from the magnetic assembly on all sides (test 3a) to avoid the phenomenon seen in Test 2a. The generator must supply an additional 1.5W to overcome the losses of the eddy currents in the shield. Now introducing a metal sheet (test 3b) only causes the generator to have to supply an extra 2.2W (i.e. an additional 0.7W), and the power seen by the secondary device now only changes to 108%.

In conclusion, these test results clearly demonstrate the two key advantages of a flux shield in reducing the side effects of metal objects: less power delivered into the steel by the generator, and less variation in the power seen by the secondary device.

A shield extending completely around the magnetic assembly, except over the desired power transfer surface, can reduce the effect of metal desks on the generator by more than an order of magnitude, and on the secondary device by more than half. In the example shown the price to pay for this advantage is an extra 1.54W of quiescent power delivered by the generator, to overcome losses in the eddy-currents in the flux shield.

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS

1. An inductive power transfer unit, adapted to be placed when in use on a support surface, comprising:

a flux generating means which, when the unit is placed on the support surface, extends in two dimensions over the support surface, said flux generating means being operable to generate flux at or in proximity to a power transfer surface of the unit so that a secondary device placed on or in proximity to the power transfer surface can receive power inductively from the unit; and

a flux shield, made of electrically-conductive material, arranged so that when the unit is placed on the support surface, the shield is interposed between the flux generating means and the support surface, the shield extending outwardly beyond at least one edge of the flux generating means.

2. A unit as claimed in claim 1, wherein said flux shield is in the form of a flat sheet which extends generally in parallel with the support surface.

3. A unit as claimed in claim 1 or 2; wherein said flux shield extends outwardly beyond each edge of the flux generating means.

4. An inductive power transfer unit, adapted to be placed when in use on a support surface, comprising:

a flux generating means which, when the unit is placed on the support surface, extends in two dimensions over the support surface, said flux generating means being operable to generate flux at or in proximity to a power transfer surface of the unit so that a secondary device placed on or in proximity to the power transfer surface can receive power inductively from the unit; and

a flux shield, made of electrically-conductive material, having one or more portions which extend over one or more side faces of the unit or which extend between said one or more side faces and said flux generating means.

5. A unit as claimed in any preceding claim, wherein said flux shield also extends over an outer peripheral portion of said power transfer surface or between said outer peripheral portion and said flux generating means.

6. A unit as claimed in any preceding claim, wherein said flux shield extends substantially continuously around said flux generating means except for a part thereof adjacent to said power transfer surface.

7. A unit as claimed in any preceding claim, wherein said flux shield provides at least part of a casing of the unit.

8. A unit as claimed in any preceding claim, wherein at least part of an outer surface of the flux shield is covered with a dielectric or other material.

9. A unit as claimed in any preceding claim, wherein a gap between said flux shield and electrical conductors of said flux generating means is set so that flux shielding is achieved without the flux shield unduly increasing power consumption of the flux generating means.

10. A unit as claimed in any preceding claim, wherein said flux shield varies in thickness from one part to another.

11. A unit as claimed in any preceding claim, wherein different parts of the flux shield are made from different respective materials.

12. A unit as claimed in any preceding claim, wherein the flux shield is attached removably to the unit.

13. An inductive power transfer unit comprising:

a power transfer surface on or in proximity to which a secondary device can be placed to receive power inductively from the unit;

flux generating means arranged to generate flux at or in proximity to said power transfer surface; and

flux shield attachment means arranged for attaching a flux shield to the unit such that the attached shield is arranged at one or more external surfaces of the unit other than said power transfer surface, or is arranged between said one or more external surfaces and said flux generating means, so that the shield serves to shield objects outside the unit, adjacent to said one or more external surfaces, from flux generated by the flux generating means.

14. An accessory, adapted to be attached to the outside of an inductive power transfer unit, the unit having a power transfer surface on or in proximity to which a secondary device can be placed to receive power inductively from the unit and also having flux generating means arranged to generate flux at or in proximity to the power transfer surface, and the accessory comprising:

means which co-operate with the unit to attach the accessory to the outside of the unit in a predetermined working disposition; and

a flux shield, made of electrically-conductive material, which, when the accessory is in its said working disposition, extends at or in proximity to one or more external surfaces of the unit other than said power transfer surface so as to shield objects outside the unit, adjacent to said one or more external surfaces, from flux generated by the flux generating means.

15. An accessory as claimed in claim 14, adapted to be attached removably to the outside of the unit.

16. An accessory as claimed in claim 14 or 15, being a clip-on cover for the unit.

17. An accessory as claimed in any one of claims 14 to 16, wherein, when the accessory is attached to the unit in its working disposition and the accessory is placed on a support surface, the flux generating means of the unit extend in two dimensions over the support surface with the flux shield of the accessory interposed between the

flux generating means and the support surface, and the flux shield extends outwardly beyond at least one edge of the flux generating means.

18. An accessory as claimed in claim 17, wherein said flux shield is in the form of a flat sheet which extends generally in parallel with the support surface.

19. An accessory as claimed in claim 17 or 18, wherein said flux shield extends outwardly beyond each edge of the flux generating means.

20. An accessory as claimed in any one of claims 14 to 19, wherein when said accessory is attached to the unit in its said working disposition said flux shield also extends over one or more side faces of the unit.

21. An accessory as claimed in any one of claims 14 to 20, wherein when said accessory is attached to the unit in its said working disposition said flux shield also extends over an outer peripheral portion of said power transfer surface of the unit.

1/6

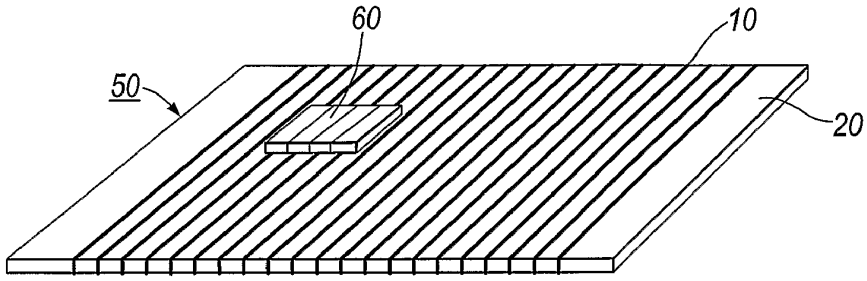


Fig.1

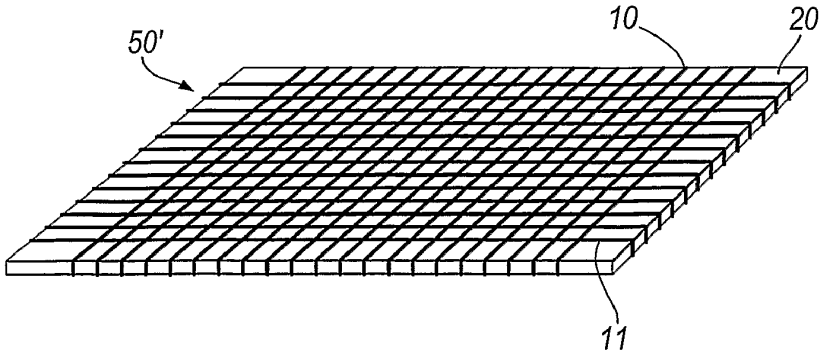


Fig.2

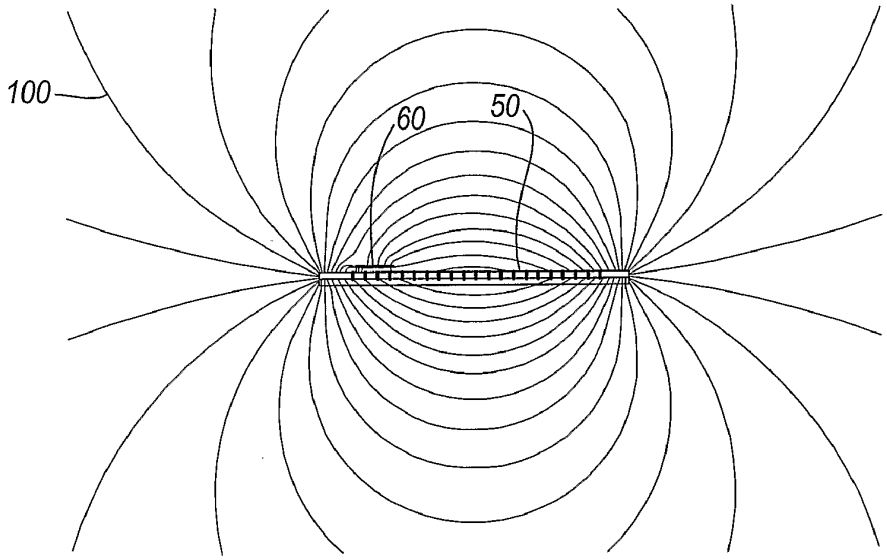


Fig.3

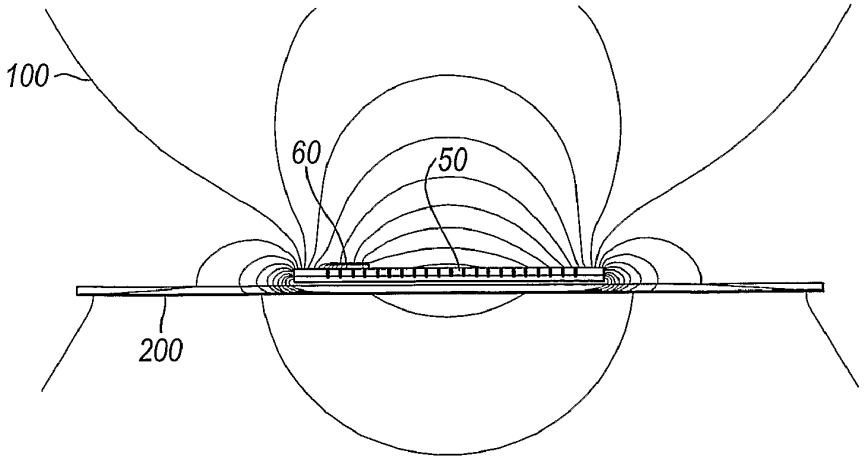


Fig.4

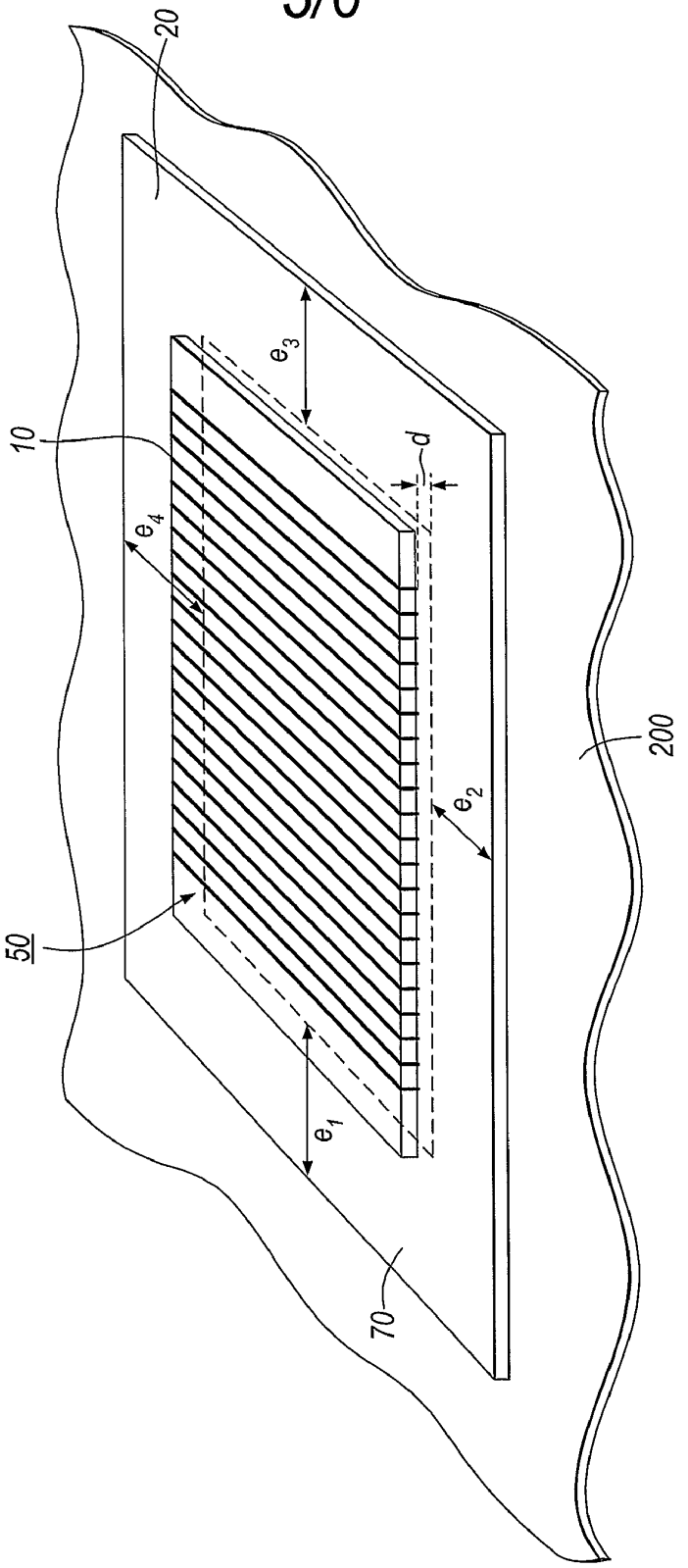


Fig.5

4/6

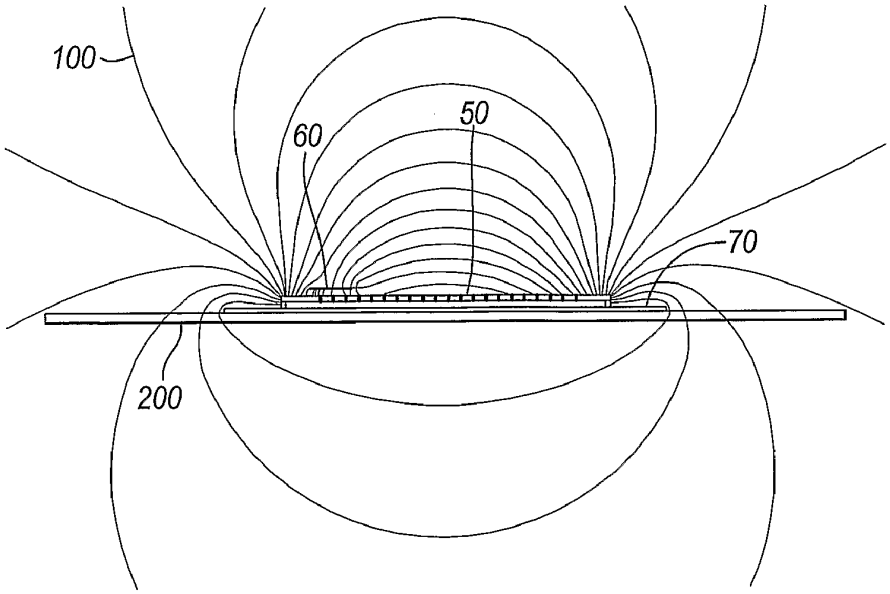


Fig.6

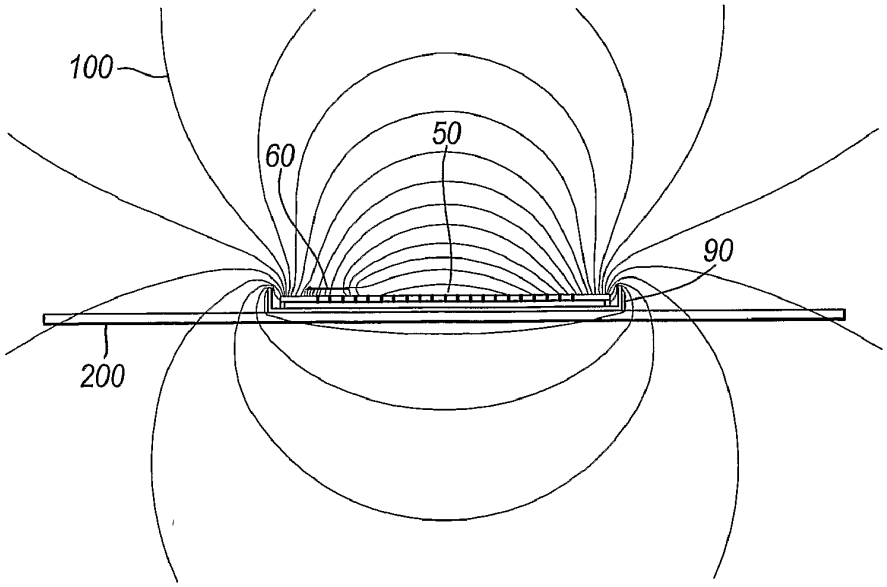


Fig.8

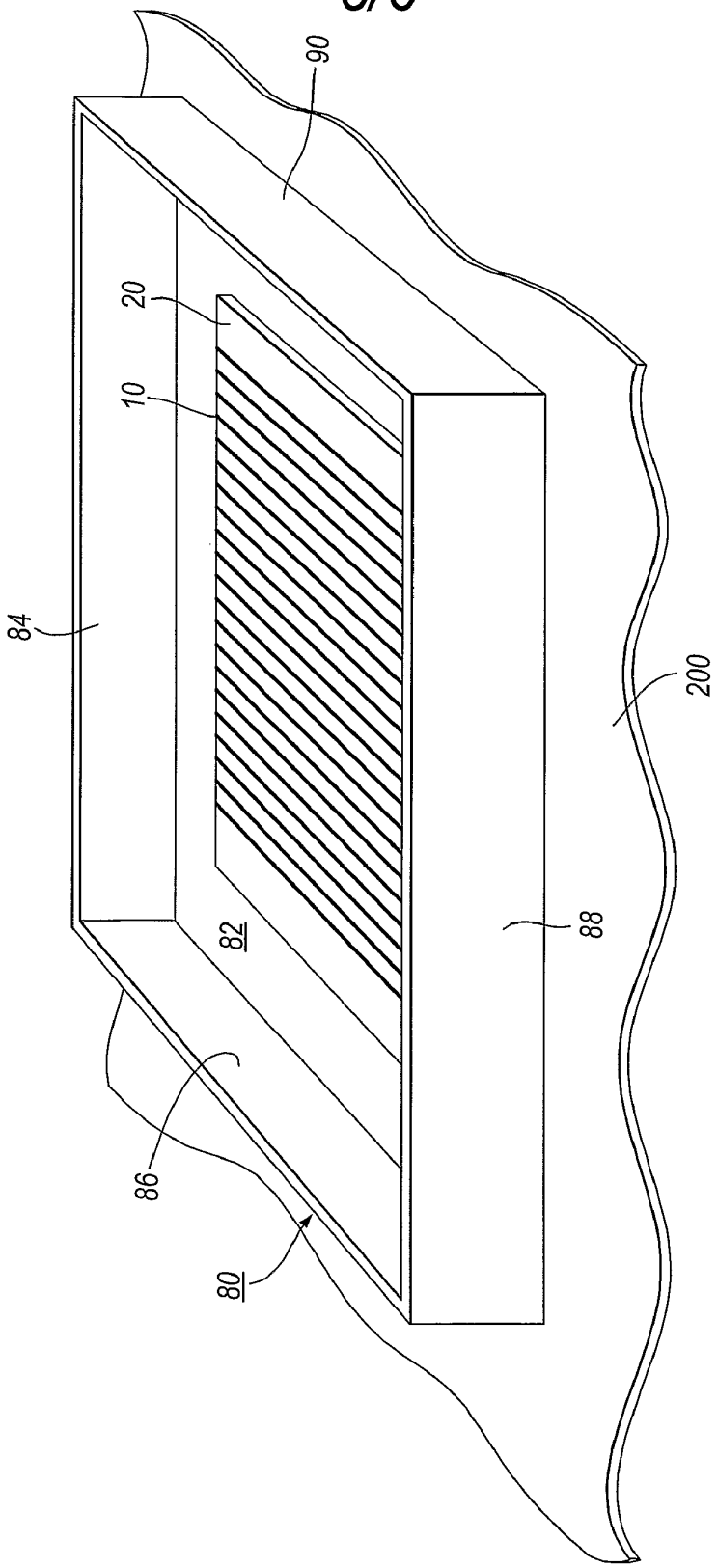


Fig.7

6/6

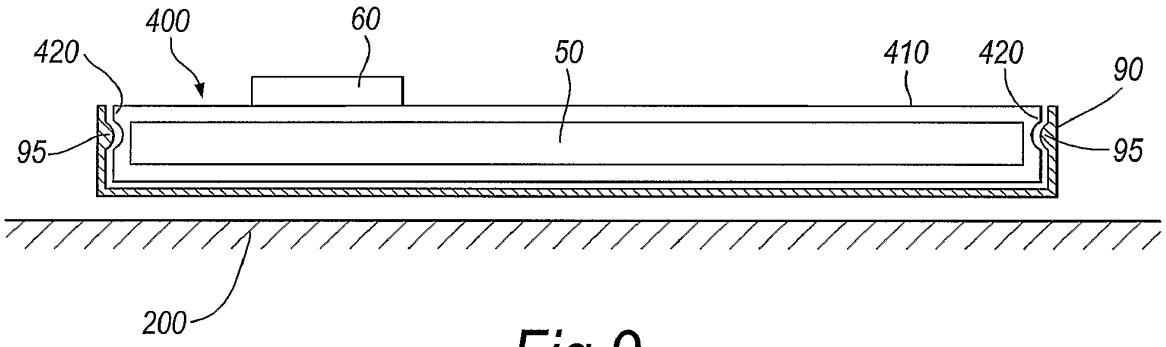


Fig.9

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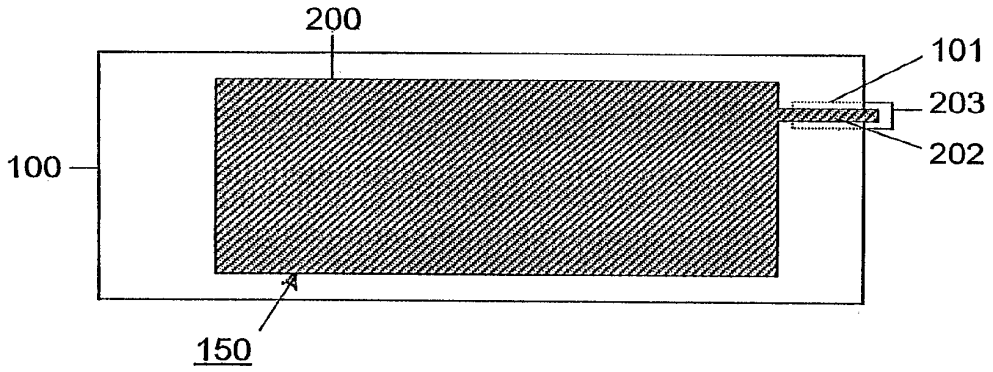
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[Continued on next page]

(54) Title: ADAPTING PORTABLE ELECTRICAL DEVICES TO RECEIVE POWER WIRELESSLY



(57) Abstract: Wireless power receiving apparatus (150) is retrofitted to a portable electrical device (100) to enable the device to receive power wirelessly. The apparatus comprises a power-receiving element (200) adapted to be attached to the device, e.g. by adhesive (201), and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another. One or more power connectors (203) are connected electrically to the power-receiving element and are adapted to be connected, when the apparatus is in use, to one or more corresponding power connectors (101) of the portable electrical device to deliver power received by the element to the device. The power-receiving element may be in the form of a sticker or may be carried by or incorporated in a replacement cover portion for the portable electrical device.

WO 2004/055654 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ADAPTING PORTABLE ELECTRICAL DEVICES TO RECEIVE POWER WIRELESSLY

The present invention relates to adapting portable electrical devices to receive power wirelessly.

Many of today's portable devices contain an internal secondary cell or battery which may be recharged by temporarily attaching an external adaptor to the power connector of the device. However this is something of a nuisance for users because it requires manual dexterity, requires both hands, and, especially, because different manufacturers use incompatible connectors, so the right adaptor must be located for each device.

Various means have been proposed for charging devices without the need to attach an external adaptor. These include:

- A surface providing power by presenting an array of contacts which then mate with receiving contacts on the device. Examples include:
  - In academia, the "Networked Surfaces" research conducted by James Scott and Frank Hoffman of the Laboratory for Communications Engineering, Engineering Department, University Of Cambridge, U.K.
  - In business, the wire-free electricity base proposed by MobileWise Inc., U.S.A.
- A surface providing power to devices by induction, without any contacts, for example as disclosed in patent publication no. WO-A-03/96512. In this system, the device incorporates a substantially flat element for receiving power inductively, conditioning it and then providing it to the device's battery and electronics.

These solutions typically require a device design to be modified, typically by the Original Equipment Manufacturer, in order to incorporate the power-receiving

element during manufacture. However there are a very large number of existing portable devices which are not already enabled. It would therefore be convenient to have a solution whereby the user could enable an existing device by simply retrofitting a power-receiving element to it.

According to a first aspect of the present invention, there is provided wireless power receiving apparatus for use with a portable electrical device to enable the device to receive power wirelessly, the apparatus comprising: a power-receiving element adapted to be attached to the device, and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and one or more power connectors which, when the apparatus is in use, are connected electrically to the power-receiving element and are adapted to be connected to one or more corresponding power connectors of the portable electrical device to deliver power received by the element to the device.

The benefit of the invention is that it enables users to add wireless power transfer capability to their existing portable devices easily.

In use, the user simply attaches the power-receiving element to the portable device and then connects the power connector(s) to the corresponding power connector(s) (power-input) of the portable device, thus enabling the device to receive power without wires from a transmitter of power (e.g. an external charger) for example by way of electromagnetic induction.

The means of attaching the power-receiving element to the device might be an adhesive, or might be some mechanical means such as a clip. The power receiving element could alternatively snap-fit on the device or slide on to it. The element may be removable or permanently attached once applied.

Yet another way of attaching the power-receiving element to the portable electrical device is to have a rigid connection between the power-receiving element and at least one of the power connectors. In this case, connection of that power connector or

those power connectors to the corresponding power connector(s) on the portable electrical device serves to attach the power-receiving element mechanically to the device without the need for any separate attaching means such as adhesive or a clip.

Another way of attaching the power-receiving element to the portable electrical device is to form the power-receiving element as part of a replacement cover portion of the portable electrical device. Some devices, such as mobile phones, have replaceable cover portions so that the user can change the appearance or "skin" of the device.

Optionally, the power-connector(s) may be attached to the power-receiving element by a flexible connecting member, allowing the power-connector(s) to be inserted and removed from the device's power-input while the power-receiving element remains attached for convenient future use. Preferably, the flexible connecting member also serves to connect the one or more power connectors electrically to the power-receiving element.

In one embodiment the electrical connections (e.g. wires) extending between the power-receiving element and power connectors are detachable from the power-receiving element and/or from the power connectors when the apparatus is not in use. This can enable the electrical connections and the power connectors to be removed to protect them from possible damage whilst still leaving the power-receiving element attached.

By having the electrical connections detachable it is also possible to offer a single design of power-receiving element but several different designs of power connector (or power connector plus electrical connection such as a flying lead) for use with different portable electrical devices.

Optionally, the power-connector may itself incorporate a contact means similar to the power-receiving input of the device, so that even when it is connected to the device,

the device may still be plugged in to a conventional adaptor in a "pass-through" fashion.

The portable electrical device may have first connector means adapted to connect to corresponding second connector means of external equipment. The first connector means provide the one or more corresponding power connectors of the portable electrical device, possibly together with one or more further connectors for other purposes such as signal or data input/output. In this case, the apparatus preferably further comprises: third connector means adapted to connect to the device's first connector means, the third connector means providing the power connector(s) of the apparatus; fourth connector means adapted to connect to the external equipment's second connector means; and a pass-through connection arrangement interconnecting at least one connector of the third connector means and a corresponding connector of said fourth connector means.

The third and fourth connector means may be on opposite faces of a power connector unit or block so that the unit or block can be sandwiched between the external equipment (e.g. a car hands-free cradle for a mobile phone) and the portable electrical device. It is not necessary for the pass-through connection arrangement to interconnect the power connectors of the third and fourth connector means, although this is preferable to enable power to be supplied from the external equipment when available. The pass-through connection arrangement could serve just to interconnect signal or data connectors of the third and fourth connector means.

If the power received by the power-receiving means must be power-conditioned before being passed to the device, the power-conditioning circuitry may optionally be incorporated into the power-receiving element or the power-connector.

Optionally, all parts of the invention, especially the adhesive, may be substantially waterproof.

Optionally, the power-receiving element may be coloured and textured such that, when adhered to the device, it appears to be a part of the device. Alternatively, or additionally, the power-receiving means may carry text or pictures, for example a logo or advertising.

Optionally, the power-receiving element may include a substantially transparent pocket into which pictures and the like may be slid.

In another embodiment, a part of the power-receiving element which must be placed in proximity with the transmitter is marked or coloured or labelled distinctively. In this way, the user can be informed of how to position or orient the power-receiving element (attached to the portable electrical device) relative to the transmitter so that power is transferred efficiently from the transmitter to the power-receiving element.

Optionally, a power indicator may be provided, optionally in the power-receiving element or the power-connector, to indicate when power is being received and/or being passed to the device. The indicator may produce light (perhaps an LED or electroluminescent panel), sound or vibration.

Optionally, the power-receiving element may be applied inside the device instead of outside, for example to the rear of the battery compartment.

Optionally, the power-connector may connect to internal power contacts within the device, possibly to its batteries and/or battery contacts.

Preferably, the power-receiving element is substantially flat. Alternatively, but preferably in addition, the power-receiving element is flexible. These features make it easy to attach the power-receiving element to the portable electrical device at a suitable internal or external surface portion thereof. When the surface portion is an internal one, having the power-receiving element substantially flat and/or flexible makes it possible to fit the element conveniently even in confined spaces such as battery compartments. When the surface portion is external, these features make it

possible to attach the power-receiving element without significantly affecting the overall shape and/or ergonomics of the portable electrical device.

According to a second aspect of the present invention, there is provided in combination a portable electrical device and wireless power receiving apparatus embodying the aforesaid first aspect of the present invention.

The following non-exhaustive list illustrates some examples of devices that can be enabled using the present invention. Possibilities are not limited to those described below:

- A mobile communication device, for example a radio, mobile telephone or walkie-talkie;
- A portable computing device, for example a personal digital assistant or palmtop or laptop computer;
- Portable entertainment devices, for example a music player, game console or toy;
- Personal care items, for example a toothbrush, shaver, hair curler, hair rollers;
- A portable imaging device, for example video recorder or camera;
- Containers of contents that may require heating, for example coffee mugs, plates, cooking pots, nail-polish and cosmetic containers;
- Consumer devices, for example torches, clocks and fans;
- A battery-pack for insertion into any of the above;
- A standard-sized battery cell;

In the case of unintelligent secondary devices such as a battery cell, some sophisticated charge-control means may also be necessary to meter inductive power to the cell and to deal with situations where multiple cells in a device have different charge states. Furthermore, it becomes more important for the transmitter of power to be able to indicate a "charged" condition, since the secondary cell or battery may not be easily visible when located inside another electrical device.

According to a third aspect of the present invention there is provided a power-receiving element in the form of a sticker adapted to be attached adhesively to a surface portion of a portable electrical device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

By providing the power-receiving element in the form of a sticker the user can readily retrofit the power-receiving element to the portable electrical device.

For convenience of delivery and attachment, the sticker preferably has a removable backing sheet on its adhesive side which is removed at the time of attaching the element to the device.

The side of the sticker opposite its adhesive side may conform in appearance to surface portions of the portable electrical device that will be adjacent to that opposite side when the sticker is attached to the device. This can enable the sticker-form power-receiving element to be attached unobtrusively or invisibly to the outside of the portable electrical device.

In another embodiment the sticker has, on its side opposite its adhesive side, a substantially transparent pocket for carrying an insert. The insert may carry text or pictures, for example a logo or advertising.

According to a fourth aspect of the present invention, there is provided a replacement cover portion for a portable electrical device, the cover portion carrying or incorporating a power-receiving element adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device. Preferably, the replacement cover portion has substantially the same size and shape as the cover portion which it replaces. Alternatively, the replacement cover portion may be thicker than that which it

replaces, or extend over the side of the portable electrical device which houses the power connector, to allow the connection means to connect to the power connector.

In one embodiment the replacement cover portion has a power connector part carrying one or more power connectors arranged to connect, when the replacement cover portion is in place on the device, to one or more corresponding power connectors of the portable electrical device. Preferably, the power connector part is connected rigidly or semi-rigidly (e.g. resiliently) to the remaining parts of the replacement cover portion so that fitting the replacement cover portion automatically brings the one or more power connectors of the replacement cover portion into electrical connection with the one or more corresponding power connectors of the portable electrical device.

In another embodiment, the replacement cover portion covers a battery compartment of the portable electrical device and has one or more battery connectors adapted to connect to one or more corresponding battery connectors of the device and/or to terminals of one or more batteries installed in the device. For example, the one or more battery connectors of the cover portion may be adapted to be interposed between the battery terminals and the corresponding battery connectors of the device.

In another embodiment, the replacement cover portion covers a battery compartment of the portable electrical device, and the cover portion further carries or incorporates at least one rechargeable battery. When the replacement cover portion is in place on the device the battery is installed operatively in the battery compartment. The power-receiving element is connected operatively to the battery for charging the battery when power is received wirelessly from the transmitter.

The replacement cover portion is, for example, a replacement cover portion for a handset of a mobile communications network.

According to a fifth aspect of the present invention, there is provided a method of adapting a portable electrical device having no wireless power receiving capability to

have such a capability, the method comprising: attaching a power-receiving element to the device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and connecting one or more power connectors, which are connected electrically to the element, to one or more corresponding power connectors of the device so that power received by the element can be delivered to the device.

According to a still further aspect of the present invention, there is provided an attachable means for receiving power, the means comprising:

i) a substantially flat power-receiving means of sufficiently small dimensions that it can attach to an existing portable device without significantly altering its ergonomics;

ii) a power connector capable of attaching to the power input of an existing portable device; and

iii) a means of attaching part or all of the above to a portable device.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:

Figure 1a shows a schematic side view of a portable electrical device and a first example of wireless power receiving apparatus embodying the present invention;

Figure 1b is a schematic end view corresponding to Figure 1a;

Figure 1c is a plan view corresponding to Figure 1a;

Figures 2a to 2c are respective schematic side, end and plan views of a portable electrical device and a second example of wireless power receiving apparatus embodying the present invention;

Figures 3a and 3b are respective schematic plan and side views of a power-receiving

element embodying the present invention;

Figure 4 shows a circuit diagram of parts of circuitry included in apparatus according to one embodiment of the present invention;

Figure 5 shows a schematic cross-sectional view of a power connector of apparatus according to one embodiment of the present invention;

Figure 6 shows a schematic perspective view of a power-receiving element in the form of a sticker according to one embodiment of the present invention;

Figure 7 shows a schematic perspective view of a power-receiving element according to another embodiment of the present invention.

Figure 8 shows a schematic perspective view of parts of a handset for use in a mobile communications network, a battery pack therefor and a replacement cover portion for the handset according to one embodiment of the present invention;

Figure 9 shows a schematic perspective view of the handset and battery pack of Figure 8 and a replacement cover portion for the handset according to another embodiment of the present invention; and

Figure 10 shows a schematic perspective view of the handset of Figure 8 and a replacement cover portion for the handset according to yet another embodiment of the present invention.

FIGURE 1 shows parts of apparatus 150 according to a first embodiment of the present invention, and an example portable electrical device (mobile handset) 100 with which the apparatus is used. As originally manufactured the device has no wireless power receiving capability.

As shown in side view in Figure 1a the device 100 has a power-connector 101 which in this case is a socket. The apparatus 150 comprises a substantially flat power-receiving element 200, a layer of adhesive 201, a flexible connecting member (flexible wiring) 202 and a power-connector 203 capable of being plugged-in to the device's power-connector 101.

Figures 1b and 1c show end and plan views of the arrangement of Figure 1a. The rear face (underside) of the mobile device 100 is uppermost in Figure 1a, and it is to this face that the element 200 is attached.

Figures 2a to 2c shows corresponding views to those of Figures 1a to 1c but for apparatus 160 according to the second embodiment of the present invention. In this case the device power connections (first connector means) 111a,b are contact strips instead of a socket. These device power connections 111a,b are adapted to connect to corresponding mating strips (second connector means – not shown) of external equipment (not shown) such as a charger. A power connector unit 213 of the apparatus has corresponding mating strips (third connector means) 215a,b on an inner face 214 thereof which make electrical contact with the device's power connections 111a,b. In addition, further connectors (fourth connector means) 217a,b are provided on an outer face 216 of the power connector unit 213 so that other equipment, for example an in-car hands-free unit or charger, having the second connector means may still be connected. These further connectors 217a,b are connected electrically to the corresponding contacts 215a,b by a pass-through connection arrangement incorporated into the power connector unit 213. The connectors 215a,b and 217a,b may include connectors used for purposes other than power delivery, for example input/output of signals and data.

Figures 3a and 3b show plan and side views respectively of one example of a substantially flat power-receiving element 200 for use in embodiments of the present invention. A magnetic core consists of six strips of amorphous metal 400 each measuring 50x30x0.02mm, stacked. Around these is wound a coil 300, which could be for example of copper wire, tape, or a stamped or pressed metal. In this case, the

coil passes around the core 30 times, with a centre-tap, providing current to three connections 202 which connect to further circuitry described later with reference to Figure 4. The entire element is readily flexible, which is useful in making it conform to any non-flat part of the device to which it is applied, and also makes it less fragile, since the entire element can be less than 0.2mm thick.

Further information regarding the power-receiving element of the example shown in Figures 3a and 3b, and regarding further examples of suitable power-receiving element is given in our patent publications WO-A-03/096361 and WO-A-03/096512, the entire contents of which are incorporated herein by reference. Various designs of a transmitter of wireless power suitable for use with the power-receiving element are also disclosed in these patent publications.

Figure 4 shows circuitry 450 capable of converting the alternating current delivered by the power receiving element into power suitable for use in a portable electronic device. A parallel-resonating capacitor 501 tunes the coil, which allows increased power transfer. A value of 100's of nF is typical, depending on the exact core materials and coil construction, and therefore inductance. The alternating current is full-wave rectified by diodes 500. Schottky diodes with a forward voltage drop of 0.3V provide best performance. Capacitor 502 provides smoothing of the DC. The voltage at this point is unregulated, which may be sufficient to send to subsequent electronics within the portable device, if it is capable of taking such. Optional voltage regulator 503 limits the voltage for devices which are not capable of taking an unregulated supply. This regulator may be a linear or switch mode type, and may optionally also contain other protection and system management circuitry. Optional indicator 504 indicates that power is being received.

An alternative configuration to that shown in Figures 3a, 3b and 4 would be to use a full bridge rectifier instead of diodes 500, removing the need for the centre-tap, but increasing the total power loss. With this configuration, the tuning capacitor may be parallel-resonant or series-resonant.

Figure 5 shows a detail view of one implementation of a power connector 600. A barrel-shaped protrusion carries two conducting rings 601 and 602 which mate with contacts within the power input socket of the portable device. The circuitry 450 of Figure 4 is contained within the power connector, and the optional power indicator 504 is visible externally. Optionally the connector 600 is removable from an end 603 of the flexible wiring 202, allowing different power connectors to be fitted to suit the particular device, each with the appropriate circuitry (power electronics) 450.

Alternatively, one end of the flexible wiring 202 could be removable from the power-receiving element 200 and the other end attached permanently to the power connector 600. This would allow the power connector 600 and flexible wiring 202 to be sold as one unit, and the power-receiving element to be sold as another unit. Again, this would make it possible to offer different versions of the power connector plus flexible wiring to work with different portable electrical devices, whilst offering only a single design of power-receiving element. The removable connections between the flexible wiring and the power connector and/or power-receiving element can be made by any suitable electrical connection arrangement such as a plug and socket.

A preferred implementation of the present invention is illustrated schematically in Figure 6. In this implementation, the power-receiving element is in the form of a "sticker" 700. The element 700 has a layer of adhesive 702 on one surface 701 thereof. The element is supplied with a removable backing sheet 703 which protects the adhesive 702 prior to attachment of the element to the portable electrical device. The backing sheet 703 is peeled off by a user to expose the layer of adhesive 702 on surface 701. After peeling off the backing sheet 703 the user simply presses the power-receiving element on its adhesive side 702 to the portable electrical device.

Figure 7 shows a schematic perspective view of a power-receiving element in another embodiment of the present invention. In this embodiment the power-receiving element 800 has, on its side 801 which will be visible to a user when the element is attached to the device, a transparent pocket 802. An insert 803, for

example a slip of paper or card, is carried within the pocket 802. The insert may bear text or pictures, for example a logo or advertising.

Another preferred implementation of apparatus embodying the present invention is in the form of a replacement cover portion of the portable electrical device itself. There are several types of portable electrical device commercially available which have replaceable cover portions. Handsets for use in mobile communications networks made by several major manufacturers are one example. Replacement cover portions for such devices can advantageously carry or incorporate at least the power-receiving element of apparatus embodying the present invention.

Figure 8 shows a schematic perspective view of such a handset 900. The handset 900 has a battery compartment 902 for holding a removable battery pack 904. The removable battery pack 904 is, for example, a rechargeable battery pack. The battery pack 904 has terminals (not shown) which connect to corresponding battery connectors 906 of the handset 900 within the battery compartment 902 when the battery pack 904 is installed in the battery compartment. The handset 900 also has a power connector 908 at a bottom end 910 thereof.

A replacement cover portion 950 according to an embodiment of the present invention is adapted to be fitted to the handset 900. The replacement cover portion in this embodiment is a rear cover portion and covers the battery compartment 902 of the handset 900 as well as other parts thereof. The cover portion 950 has on its inner face or incorporated within it a power-receiving element 952. The element 952 may, for example, be the same as the power-receiving element 200 described hereinbefore. The cover portion 950 is designed to extend at one end 954 beyond the bottom end 910 of the handset 900. At the end 954 the cover portion 950 has a power connector part 956 carrying one or more power connectors 958. The power connector(s) is/are connected in some suitable way (not shown) to the power-receiving element 952, either directly or via power conditioning circuitry such as the circuitry 450 of Figure 4. The power connector(s) 958 is/are adapted to connect to the corresponding power connector(s) of the handset power connector 908. This arrangement is convenient in

that installation of the cover portion 950 on the handset 900 automatically makes the required electrical connections between the power-receiving element 952 and the power connector 908 of the handset. If necessary, the power connector part 956 of the cover portion 950 may be connected semi-rigidly (e.g. resiliently) instead of rigidly to the remaining parts of the cover portion 950. This can make it easier for the power connector(s) 958 of the cover portion to be connected to the corresponding power connector(s) of the handset 900 when the cover portion is being fitted to the handset.

Figure 9 shows another embodiment in which the power-receiving element is carried by or incorporated in a replacement cover portion. In Figure 9, a replacement cover portion 1000 does not have the extended end 954 or the power connector part 956 of the replacement cover portion 950 of Figure 8. Instead, an internal power connector part 1002 is connected, preferably via power conditioning circuitry such as the circuitry 450 of Figure 4, to the power-receiving element 952. The connection may be made using flexible wiring 1004. The power connector part 1002 is sufficiently thin to enable it to be interposed between the battery terminals of the battery pack 904 and the power connectors 906 formed within the battery compartment 902 of the handset 900. In a similar way to that described previously with reference to Figure 2, the power connector part 1002 has a set of contacts on both its main faces. The two sets of contacts are connected together by a pass-through connection arrangement. This enables the power from the battery pack 904 to be supplied to the power connectors 906 when the power-receiving element is not receiving power wirelessly from a transmitter.

Figure 10 shows yet another embodiment in which a replacement cover portion 1050 carries or incorporates a rechargeable battery pack 1054 in addition to a power-receiving element 952. The electrical connections between the power receiving element 952 and the battery pack 1054 are made by suitable means (not shown) incorporated in or carried by the cover portion 1050. The fitting of the replacement cover portion 1050 to the handset 900 brings the battery terminals of the battery pack 1054 into contact with the power connectors 906 of the handset 900.

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. Wireless power receiving apparatus for use with a portable electrical device to enable the device to receive power wirelessly, the apparatus comprising:

a power-receiving element adapted to be attached to the device, and also being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and

one or more power connectors which, when the apparatus is in use, are connected electrically to the power-receiving element and are adapted to be connected to one or more corresponding power connectors of the portable electrical device to deliver power received by the element to the device.

2. Apparatus as claimed in claim 1, wherein said power-receiving element is adapted to be attached adhesively to the device when the apparatus is in use.

3. Apparatus as claimed in claim 1, further comprising mechanical attachment means adapted to attach the power-receiving element mechanically to the device when the apparatus is in use.

4. Apparatus as claimed in claim 1, wherein said power-receiving element forms part of a replacement cover portion of the portable electrical device.

5. Apparatus as claimed in claim 1, wherein said power-receiving element and at least one of said power connectors of the apparatus are connected rigidly together, whereby connection of said at least one power connector to its said corresponding power connector of the portable electrical device serves to attach the power-receiving element mechanically to the device.

6. Apparatus as claimed in any one of claims 1 to 4, further comprising a flexible connecting member connecting said one or more power connectors flexibly to said power-receiving element.

7. Apparatus as claimed in claim 6, wherein said flexible connecting member also serves to connect said one or more power connectors electrically to the power-receiving element.

8. Apparatus as claimed in any one of claims 1 to 5, having one or more electrical connections extending between said power-receiving element and said one or more power connectors, said one or more electrical connections being detachable

from said power-receiving element and/or from said one or more power connectors when the apparatus is not in use.

9. Apparatus as claimed in any preceding claim, wherein said portable electrical device has first connector means adapted to connect to corresponding second connector means of external equipment, said first connector means providing said one or more corresponding power connectors of the portable electrical device, and the apparatus further comprising:

third connector means adapted to connect to said first connector means of the portable electrical device, said third connector means providing said one or more power connectors of the apparatus;

fourth connector means adapted to connect to said second connector means of said external equipment; and

a pass-through connection arrangement interconnecting at least one connector of said third connector means and a corresponding connector of said fourth connector means.

10. Apparatus as claimed in claim 9, wherein said first to fourth connector means also provide connectors for purposes other than power delivery, and said pass-through connection arrangement serves to interconnect corresponding connectors of said third and fourth connector means used for said other purposes.

11. Apparatus as claimed in any preceding claim, further comprising:

power-conditioning circuitry operable to condition the power received by the power-receiving element prior to delivery to the portable electrical device.

12. Apparatus as claimed in any preceding claim, wherein said power-receiving element is small relative to said portable electrical device.

13. Apparatus as claimed in any preceding claim, wherein said power-receiving element is thin relative to said portable electrical device.

14. Apparatus as claimed in any preceding claim, wherein a volume occupied by said power-receiving element is small in comparison with a volume occupied by said portable electrical device.

15. Apparatus as claimed in any preceding claim, wherein said power-receiving element is of sufficiently small dimensions that, when attached to the portable electrical device, it does not substantially alter the ergonomics of the device.

16. Apparatus as claimed in any preceding claim, wherein parts of said power-receiving element that are visible to a user of the device when the element is attached to the device have an external appearance which conforms to an external appearance of adjacent parts of the device.

17. Apparatus as claimed in any preceding claim, wherein a part of said power-receiving element which must be placed in proximity with the transmitter is marked or coloured or labelled distinctively.

18. Apparatus as claimed in any preceding claim, wherein said power-receiving element has, at a surface thereof that is visible to a user of the portable electrical device when the element is attached to the device, a substantially transparent pocket for carrying an insert to be visible to the user.

19. Apparatus as claimed in any preceding claim further comprising an indicator which produces a predetermined indication of an operating state of the apparatus.

20. Apparatus as claimed in any preceding claim, wherein said power-receiving element is substantially flat.

21. Apparatus as claimed in any preceding claim, wherein said power-receiving element is flexible.

22. In combination a portable electrical device and wireless power receiving apparatus as claimed in any preceding claim.

23. The combination of claim 22, wherein said power-receiving element is attached to an external surface portion of the device.

24. The combination of claim 22, wherein said power-receiving element is attached to an internal surface portion of the device.

25. The combination of claim 24, wherein said internal surface portion is a surface portion of a battery compartment of the device.

26. The combination of any one of claims 22 to 25, wherein said one or more corresponding power connectors of the portable electrical device are internal power connectors.

27. The combination of any one of claims 22 to 26, wherein said one or more corresponding power connectors of the portable electrical device are battery connectors.

28. A power-receiving element in the form of a sticker adapted to be attached adhesively to a surface portion of a portable electrical device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

29. A power-receiving element as claimed in claim 28, wherein said sticker has a removable backing sheet on its adhesive side which is removed at the time of attaching the element to the device.

30. A power-receiving element as claimed in claim 28 or 29, wherein a side of said sticker opposite its adhesive side conforms in appearance to surface portions of the portable electrical device that will be adjacent to said opposite side when the sticker is attached to the device.

31. A power-receiving element as claimed in any one of claims 28 to 30, wherein said sticker has, on its side opposite its adhesive side, a substantially transparent pocket for carrying an insert.

32. A replacement cover portion for a portable electrical device, the cover portion carrying or incorporating a power-receiving element adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another, and having connection means from which an electrical connection can be made to a power connector of the device.

33. A replacement cover portion as claimed in claim 32, having a power connector part carrying one or more power connectors connected operatively to the power-receiving element and arranged to connect, when the replacement cover portion is in place on the device, to one or more corresponding power connectors of the portable electrical device.

34. A replacement cover portion as claimed in claim 32 or 33, adapted to cover a battery compartment of the portable electrical device, and having one or more battery connectors adapted to connect to one or more corresponding battery connectors of the device and/or to terminals of one or more batteries installed in the device.

35. A replacement cover portion as claimed in claim 34, wherein said one or more battery connectors of the cover portion are adapted to be interposed between said battery terminals and said corresponding battery connectors of the device.

36. A replacement cover portion as claimed in claim 32 or 33, adapted to cover a battery compartment of the portable electrical device, and further carrying or incorporating at least one rechargeable battery such that, when the replacement cover portion is in place on a device, the battery is installed operatively in the battery compartment, the power-receiving element being connected operatively to the battery for charging the battery for charging the battery when power is received wirelessly from the transmitter.

37. A replacement cover portion as claimed in any one of claims 32 to 36, being a replacement cover portion for a handset of a mobile communications network.

38. A method of adapting a portable electrical device having no wireless power receiving capability to have such a capability, the method comprising:

attaching a power-receiving element to the device, the element being adapted to receive power wirelessly from a transmitter of power when the element and transmitter are in proximity with one another; and

connecting one or more power connectors, which are connected electrically to the element, to one or more corresponding power connectors of the device so that power received by the element can be delivered to the device.

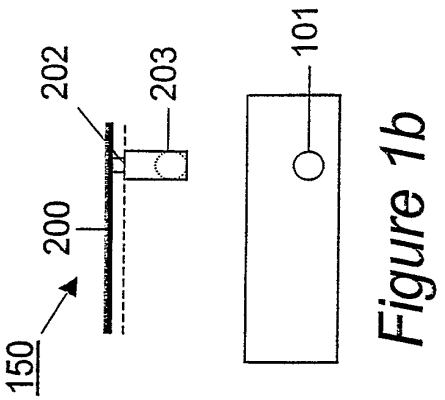


Figure 1b

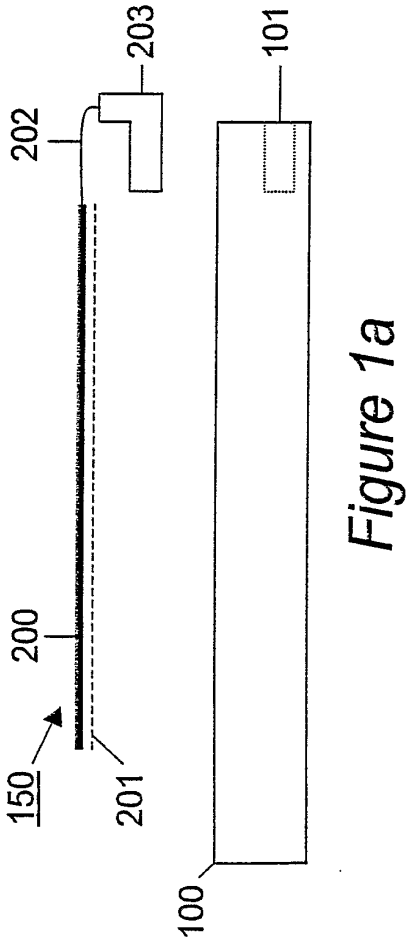


Figure 1a

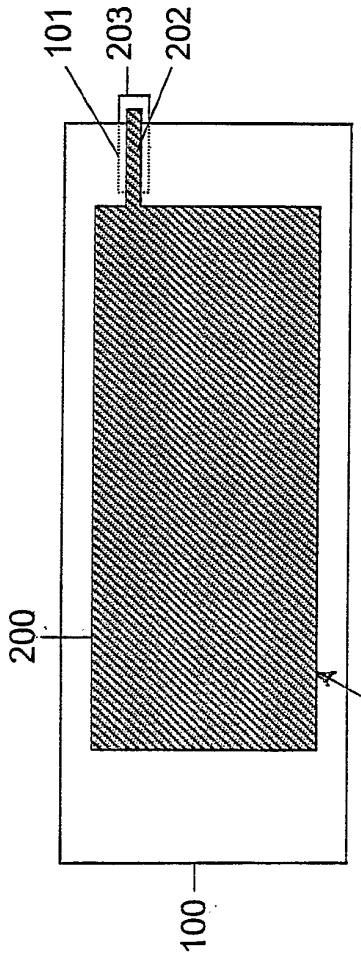


Figure 1c

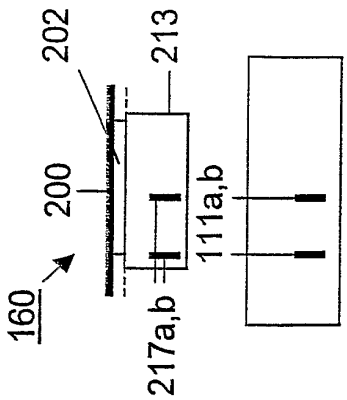


Figure 2b

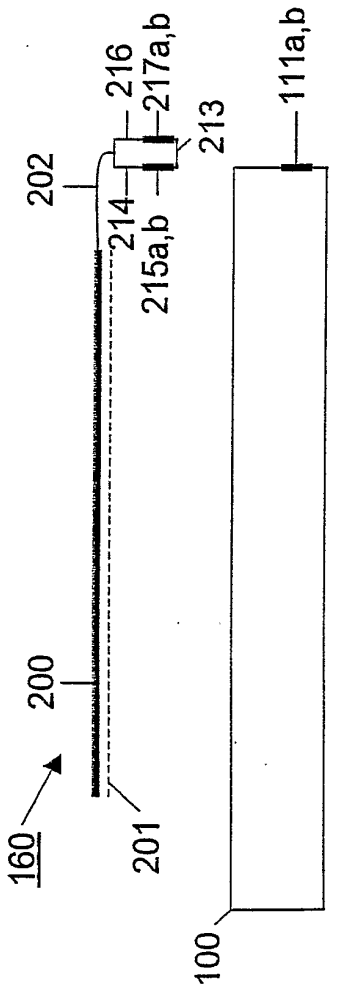


Figure 2a

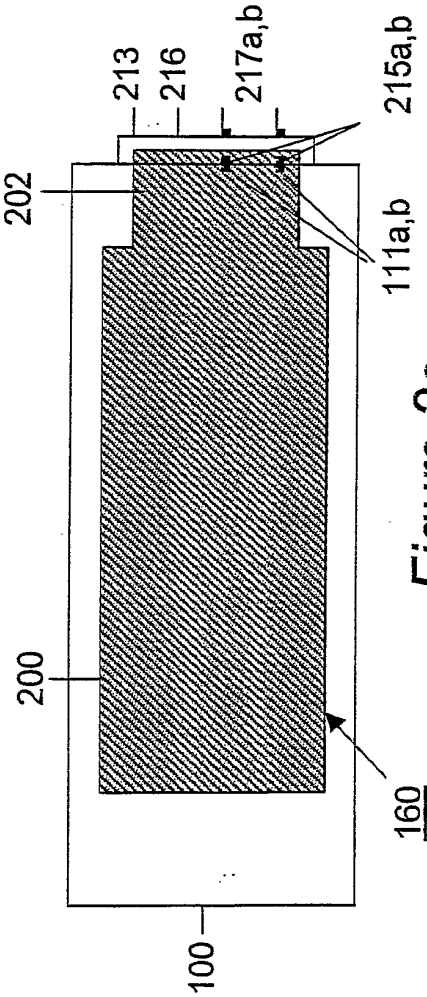


Figure 2c

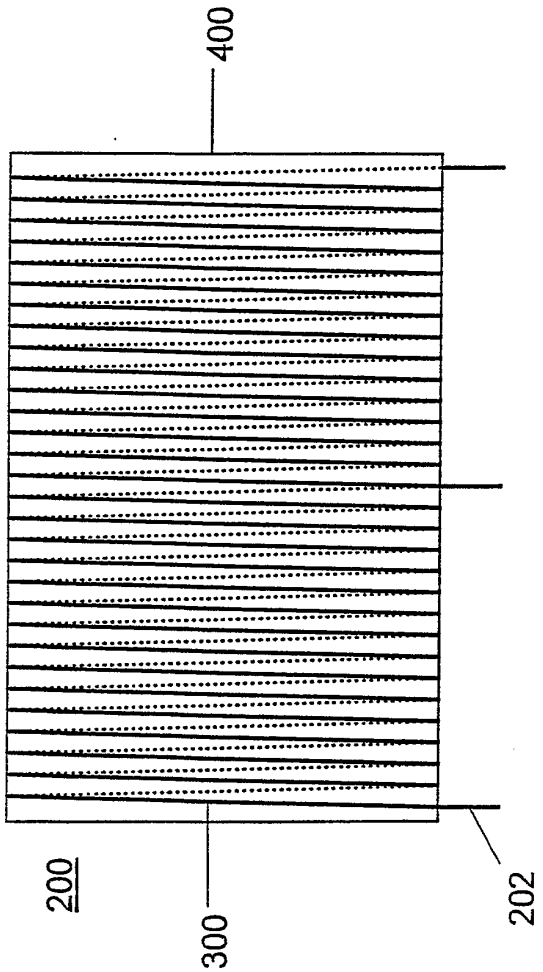


Figure 3a

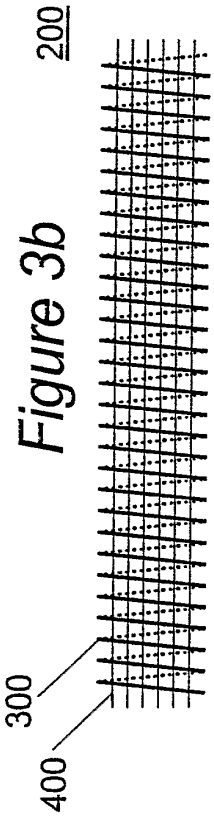
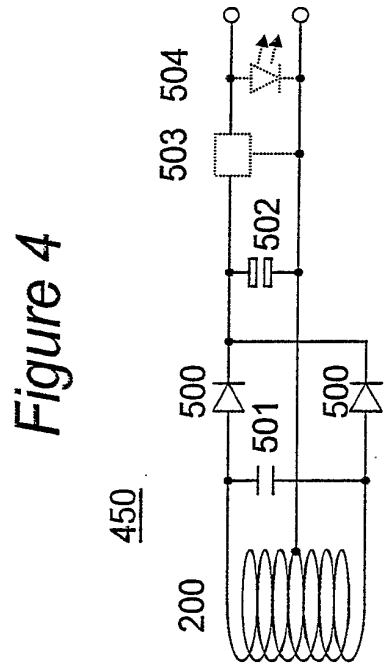


Figure 3b

Figure 4



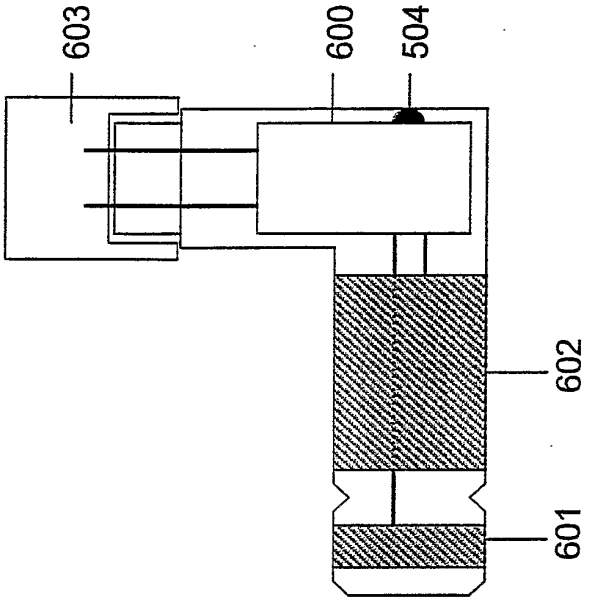


Figure 5

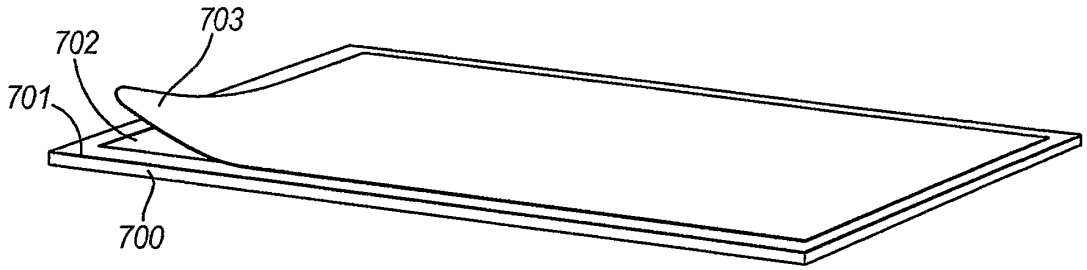


Fig.6

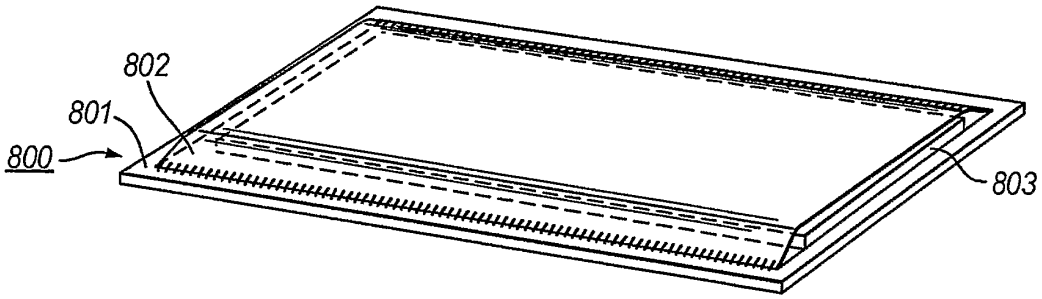


Fig.7

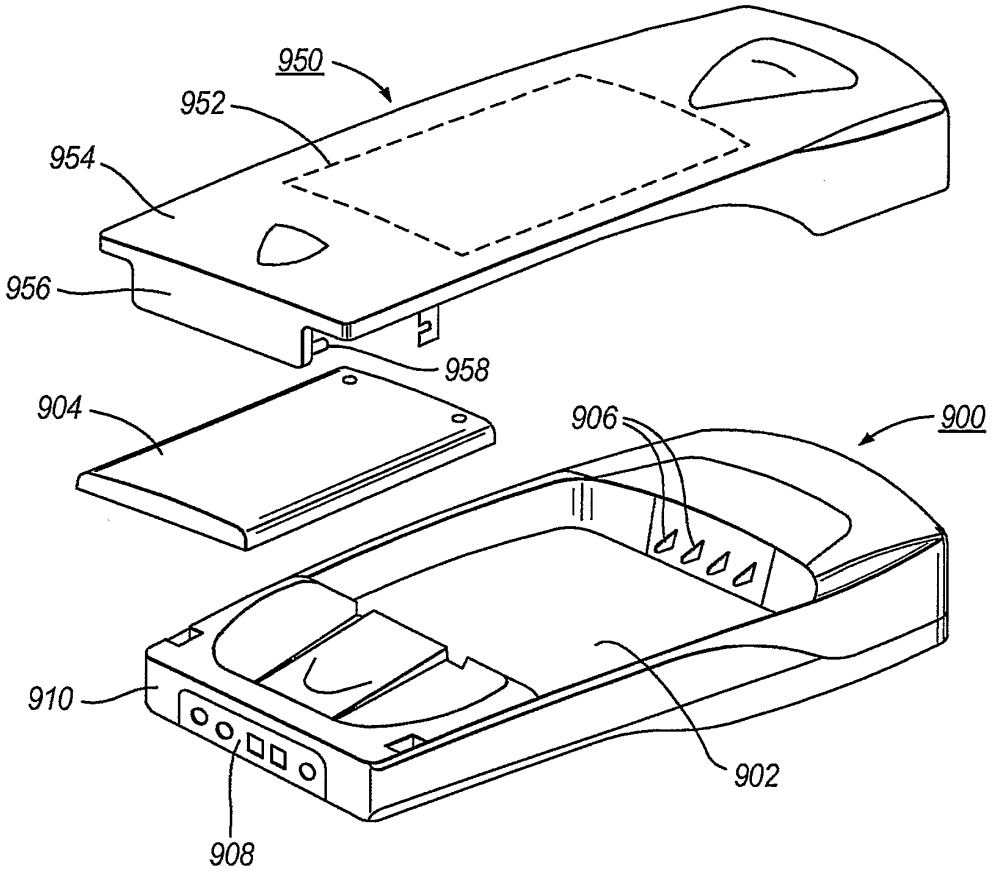


Fig.8

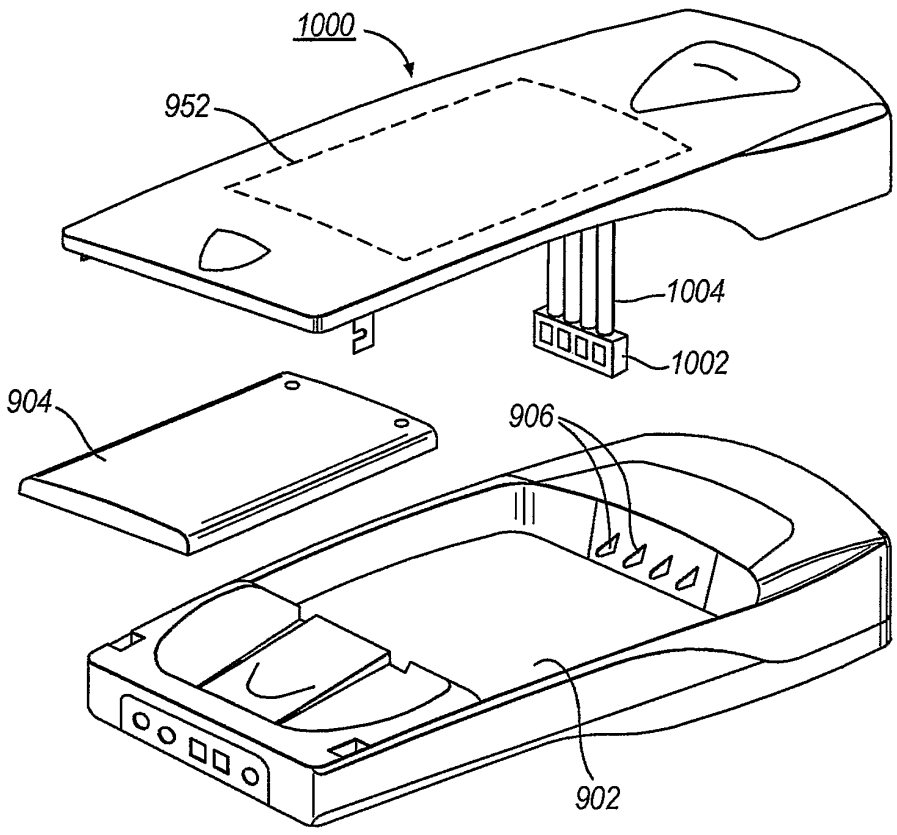


Fig.9

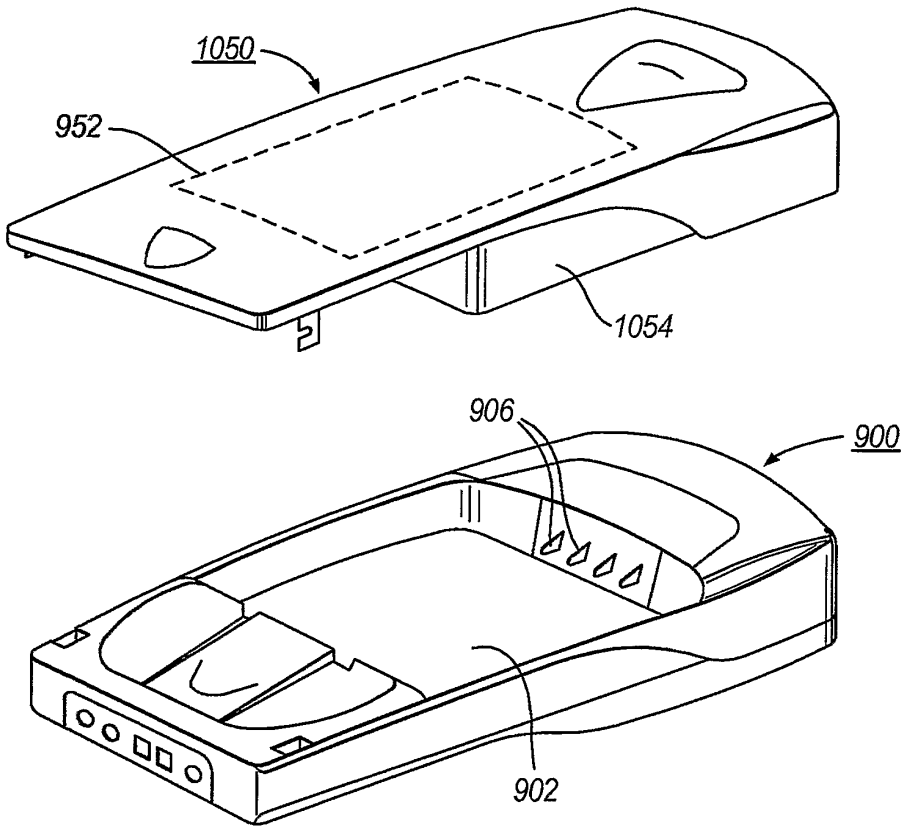


Fig.10

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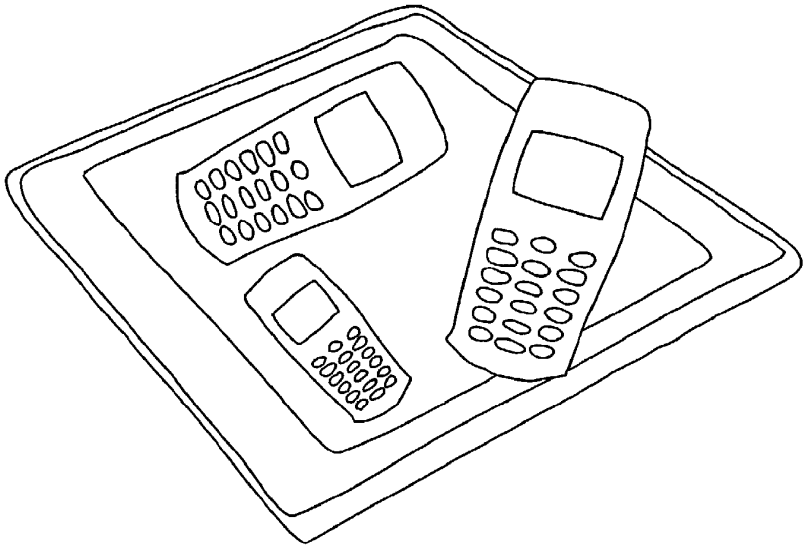
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— *of inventorship (Rule 4.17(iv)) for US only*
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[Continued on next page]

(54) Title: IMPROVEMENTS RELATING TO AUTOMATICALLY CONFIGURING RECHARGEABLE DEVICES



Wirelessly-rechargeable devices, recharged by being placed onto, or in proximity to, a recharging pad.

(57) Abstract: There is disclosed a system and method for causing portable electronic devices to take various actions or state changes when brought into proximity to a recharging station, and/or removed from proximity to a recharging station. Additionally, the actions or changes may vary depending on the relative position of the device on the recharging station.

WO 2004/038887 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

IMPROVEMENTS RELATING TO AUTOMATICALLY CONFIGURING RECHARGEABLE DEVICES

This invention relates to a new system of managing portable rechargeable devices in relation to their recharging stations, and a method of managing portable rechargeable devices in relation to their recharging stations.

Portable rechargeable devices (instances of which are hereinafter referred to simply as a "device") are usually charged either by:

- attaching a wire from a recharger (Figure 1), or
- by dropping the device into some kind of receptive cradle connected to a recharger, or
- by dropping the device onto a surface connected to a recharger (Figure 2)

Charging is either by via electrical contacts or a non-contact means, e.g. magnetic induction or light-power.

Examples include:

- The Palm Pilot™ series of Personal Digital Assistants (PDAs), which sit in a recharging cradle.
- Mobile phones, which can be dropped into a cradle in a car for recharging and hands-free operation.

In some cases, devices charged by non-contact means may not need to be physically touching their rechargers – just placing a device close to a recharger may be sufficient to enable charging to take place. So hereinafter in this patent application, when the word "on" is used in the context of recharging a device on a recharger, it should be understood to mean that it may either touch its recharger, or be near enough to permit recharging to take place. Likewise the word "off" used in such a context should be understood to mean that it is being taken out of contact with its recharger, or far enough away that recharging is no longer possible.

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In some instances, today's wire-recharged devices are able to perform certain useful automatic actions when they:

- are removed from the recharging station and/or
- are replaced on the recharging station and/or
- remain on the recharging station

Examples include:

- Hagenuk™ DECT wireless cordless home phones, which if removed from the cradle while ringing automatically go "off-hook" (answer), and if off-hook automatically go "on-hook", terminating the call, as they are replaced onto the cradle.
- The Palm Pilot™, which is also able to synchronise data with a connected PC via its recharging cradle, on command from a manual pushbutton.
- Various mobile phones (e.g. Ericsson™ T68) which can detect when an external hands-free set is plugged in to them, and alter their "profile" setting accordingly. The "profile" is a collection of settings which affect the phone's behaviour, for example the volume setting and the answer mode. If the hands-free set functionality is incorporated in an in-car charging cradle, the combined unit has the functionality of automatically changing its profile when dropped into the cradle, and of automatically reverting to a previous profile when removed from the cradle.

Unrelated to the above, but of relevance to the present invention, there exist devices powered by an external inductive field, and capable of simultaneously exchanging data to and from the remote device generating that field. An example of such data modulation combined with an inductive power source is the passive "RFID" devices and smart labels, for example the Philips MIFARE™ smart tags, which are both powered and interrogated by an inductive field from a nearby reader.

Today more and more devices are capable of obtaining their data communications (e.g. voice data or computer data) wirelessly, for example by DECT or Bluetooth or 802.11 WiFi.

If such devices are also made capable of being recharged without wires (e.g. by induction-charging) then the devices become entirely wire-free, with obvious benefits of convenience for the user.

However in this case the mechanical contact connection which today serves to indicate to the device that it is in a cradle is not present in such inductively-charged devices. This removes a useful means of triggering automatic actions such as those described above.

According to a first aspect of the present invention there is provided:

- a recharging station ("recharger") and
- a portable rechargeable device ("device"),
- the device incorporating a means for receiving power from such a recharger without direct electrical contact ("receiver"),
- the receiver having a means for detecting when it is in proximity to the recharger, and signalling this information to the rest of the device ("control means"),
- the control means using this information to change the state of the device, or to take some predetermined action.

Such a system is advantageous because it provides the device with a means of altering its behaviour in some useful fashion as it is removed from and/or replaced on the recharger.

According to a second aspect of the present invention, there is provided a method of altering the settings, and/or triggering certain behaviour of a portable rechargeable device by means of a receiver capable of detecting that it is in proximity to a recharging station and informing the control software or electronics of the device electronics of this fact.

The receiver may receive power for example via an inductive loop or a photovoltaic cell. Typically it may incorporate some kind of power-conditioning circuit, for example a rectifier and a smoothing capacitor, and possibly a voltage regulator, which will then typically be connected both to the power-supply input of the device and to a rechargeable battery. There may be a separate charge-controller to control the recharging of the battery.

The control means may be dedicated analogue or digital electronics, or a microcontroller running a software program.

The communication from the receiver to the control means may be a simple hardware or software binary signal indicating whether or not the device is in proximity to the recharger, or it may be some more sophisticated hardware or software signal indicating for example the three conditions "far from recharger / close to recharger / on recharger".

The receiver may detect this condition for example simply by detecting that its received power has crossed a preset threshold. The detection may be conducted by component already mentioned, for example a regulator or charge-controller

It will be clear to those skilled in the art that the transition from one signal state to another (an "event") may be a useful trigger for causing actions to take place.

Optionally, a signal indicating that the device is being brought closer to the recharger may do any or all of the following:

- Cause the device to begin reception, transmission or synchronisation of its data with another device, for example a personal computer (PC). The data may be of any type, for example but not limited to calendar and contact data, photographic data, music data.
- Cause the device, if it is interacting with the user (for example a phone "off-hook", or a computer streaming live video from some expensive source) to cease the interaction (for example, the phone going "on-hook", or the

computer ceasing to stream the video). Indeed the device may simply turn-off, or appear to do so.

- Switch to a different mode of communication with other devices.

Optionally a signal indicating that the device is being taken further from the recharger may cause the device to do any or all of the following:

- Cause the device, if it is signalling for attention from the user (for example, a phone ringing or an alarm sounding) to change into a mode suitable for interaction with the user (for example, the phone going "off-hook" or the alarm silencing). Indeed the device may simply turn-on ready to be used, for example an electric shaver starting.
- "Finish-up" any ongoing data transfers in an ordered fashion, on the assumption that it may be about to go out of range, e.g. leave the house.
- Switch to a different mode of communication with other devices.
- Request a security verification from the user (for example, a PIN number or fingerprint). This would be useful in cases where a device is being recharged in a public place, to prevent thieves from find the device useful if they steal it.

Optionally, the location and/or orientation in which the device is placed relative to the recharger may be sensed by the device, the recharger or both, and made to control their behaviour or state. For example, placing a phone in a particular part of the recharger might mean "ring quietly" or "refuse calls". Moving a device relative to its charger might cause its light and/or a light on the recharger to illuminate, making it easier to pick-up in the dark.

Optionally, or additionally, to the control means detecting that it is close to a recharger via the power receiver (which indicates that it may be close-enough to actually charge), it may detect that it is in the region of a recharger by some other longer-range wireless interface. For example, both the recharger and the device may have bidirectional Bluetooth or 802.11 WiFi interfaces capable of interchanging information. This allows the control means to know when it is "close, but not close-enough to charge". If this is coupled with a means for detecting that the device needs

recharging, the recharger may for example light an indicator to indicate its useful presence.

Alternatively or additionally, the flow of power from the recharging means to the device may be modulated to encode data upon it. It may be modulated in either direction:

- by the recharger (e.g. by skipping power cycles) to send data to the device, and/or
- by the device (e.g. by shorting turns during power cycles) to send data to the recharger, and/or
- both of the above.

Such data may be a simple static identity number ("ID"), for example a unique ID or class ID. In the case of devices which also have another ID for different purposes (for example the phone number of a phone, or the Internet Protocol or Bluetooth address of a data device), the two IDs may be the same, thus communicating the other ID over the recharging link. The ID may even be the ID of a related item, for example the Social Security Number or email address of the owner of a device, or the IP address of a computer within wireless range of the recharging station.

Alternatively or additionally, such data may be a dynamic flow of novel information between devices, for example the data needed to synchronise a PDA with a PC.

Depending on the type of power transfer, the data transfer rate may be quite slow.

A device may set its internal state (e.g. the profile of a mobile phone) differently, and/or conduct certain actions (e.g. synchronisation) differently, dependant on the ID of the recharger on which it is placed. For example, a mobile phone may set its profile to ring more quietly when on a recharger with a "home" ID than on one with a "car" ID).

A recharger in a public place may read the phone number (or other ID) of a device so that it can bill the user for power received, or push adverts.

Once the power is exhausted on a device, it may refuse to work again until it is recharged on a recharger with a particular ID or class of ID's previously-defined.

It can be difficult for users of wireless devices to configure them such that they are able to communicate with to one another. Such devices tend to have long IDs which must somehow be exchanged in order for a link to be established, and this normally either has to be done by entering many numbers or letters, or by requesting a list of all devices within range and choosing one.

It will be seen that for such devices, for example a wireless PDA trying to synchronise with a PC, the simple reception or exchange of such an ID may be of great help in informing one device of the other's address automatically, so that it may establish a link on a separate communication means, possibly a wireless network with higher data-rate and greater-range.

The usable distance within which a device must be of a recharger in order to recharge is usually short and well-defined (compared to that of a typical wireless data system), and thus it is convenient for the user to point or wave the device at the recharger, to make it clear which device should be talking to which.

If, for example, a recharger has a separate wireless Access Point built-in, or attached to or nearby to it (for example one using the Bluetooth or 802.11 protocols), it can advertise the IP address of the Access Point to any devices placed on it. Without this, much button-pushing would be required of the user to configure the device to achieve a simple task, e.g. collecting email, at a new location such as a café or office, which may never be visited again.

As another example, imagine that an inductive recharger is placed on a mantelpiece in the living room of a home, and it is set to encode a unique "living room ID" onto its inductive field:

- If the user places a video-camera or digital camera on the recharger to recharge it, and the video camera has a wireless link on it, this ID mechanism can ensure that when "play" is pressed, the image is sent to the correct TV, and not to the one in the room next door.
- Likewise if the user places a music player (e.g. an MP3 player) with a wireless link, this ID mechanism can ensure that when "play" is pressed, the audio is sent to the correct loudspeaker music system, and not to the one in the room next door.

The same scenario could be imagined in a car – where a user may want to ensure that any device they place on an in-car recharger uses their own networks and not those e.g. of the car next door.

As another example, if every device remembers the ID of the last recharger it has encountered (including any recharger it may currently be on), then placing the device on the recharger, even momentarily, becomes a means of establishing a "rendezvous ID" which can be used to exchange data by some other wireless means between two devices.

If the recharger is capable of simultaneously recharging more than one device, the recharging station can even become a "proxy" – an area enabling devices to exchange data with each other.

The receiver may optionally have an alternative mode of operation where it is capable of generating power for transfer to another device, rather than receiving it. In such a case, two devices may exchange IDs or data as described above directly between them without the help of any recharger.

Any combination of all of the above may be possible.

For a better understanding of the present invention and to show it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawing(s), in which:

FIGURE 3 shows an embodiment of the present invention.

Referring to Figure 3, a recharger uses an inductive coil to create an alternating magnetic field. This field is picked-up by a device in proximity. The device rectifies smoothes and regulates the power, before delivering it to the control means and, via a charge-controller, to the device battery. The area bordered by a dotted line may be considered to be the "receiver" in the present invention. So far, this is a description typical of any inductively-charged electronic device.

What makes it novel is the signal line (heavy dotted line) from the regulator to the control means. In this embodiment, the regulator is measuring the power received, and setting the signal line high if the power received is above a threshold, and low otherwise. The control means uses this information to change certain behaviour, for example to set Profile A when the signal line is high and to set Profile B when the signal line is low.

In a more sophisticated embodiment, the recharger modulates the transmitted power with an ID number which is the ID of a local wireless access point. The receiver now decodes this ID data from the incoming power and passes it to the control means which makes more sophisticated use of it, for example to use it to access the Internet.

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and

"comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. A system for recharging portable devices comprising:
   - a recharging station ("recharger") and
   - a portable rechargeable device ("device"),
   - the device incorporating a means for receiving power from such a recharger without direct electrical contact ("receiver"),
   - the receiver having a means for detecting when it is in proximity to the recharger, and signalling this information to the rest of the device ("control means"),
   - the control means using this information to change the state of the device, or to take some predetermined action.

2. A system as claimed in claim 1, wherein the device includes a memory containing data, and wherein, when the control means detects increased proximity to the charger, the control means triggers the device to begin transmission, reception or synchronisation of the data to, from or with another computer.

3. A system as claimed in claim 1 or 2, wherein, when the control means detects increased proximity to the charger, the control means triggers the device to cease any ongoing interaction with a user of the device.

4. A system as claimed in any preceding claim, wherein, when the control means detects decreased proximity from the charger, the control means triggers the device to begin interacting with a user of the device.

5. A system as claimed in any preceding claim, wherein, when the control means detects decreased proximity from the charger, the control means triggers the device to finish any ongoing wireless communications.

6. A system as claimed in any preceding claim, wherein the device has a user interface and wherein, when the control means detects decreased proximity from the charger, the control means triggers the device to lock its user interface.

7. A system as claimed in any preceding claim, wherein a behaviour or operation of the control means changes dependant on where and/or in what rotation the device is placed on the recharger.

8. A system as in any preceding claim, wherein a flow of power from the recharger to the device is modulated to encode data upon it, either by the recharger, the device or both.

9. A system as claimed in claim 8, wherein the encoded data is a static identification number.

10. A system as in claim 9, wherein the number is a wireless network address of the recharger or device.

11. A method of altering the settings, and/or triggering certain behaviour of a portable rechargeable device by means of a receiver capable of detecting that it is in proximity to a recharging station and informing the control software or electronics of the device electronics of this fact.

12. A system for recharging portable devices, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

13. A method of altering the settings, and/or triggering certain behaviour of a portable rechargeable device, substantially as hereinbefore described with reference to or as shown in Figures 2 and 3 of the accompanying drawings.

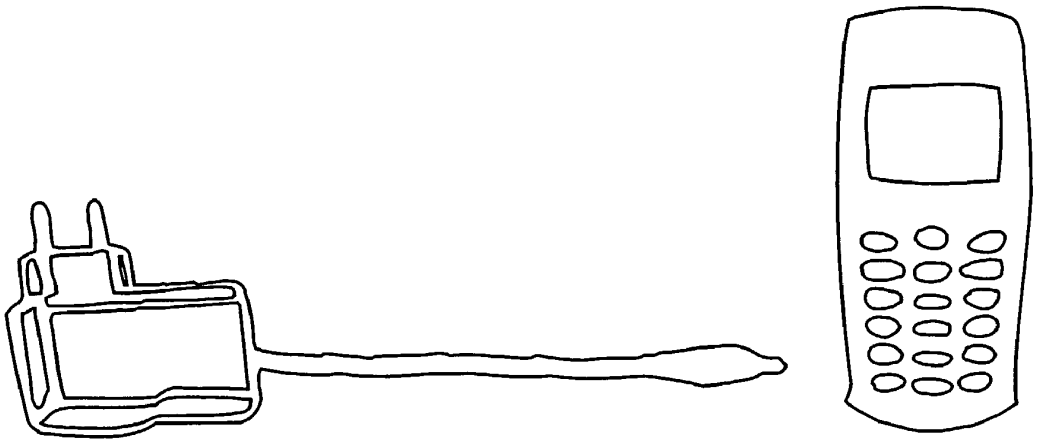


Figure 1 – Conventional "flying lead" charger, which plugs into a mobile device to charge it

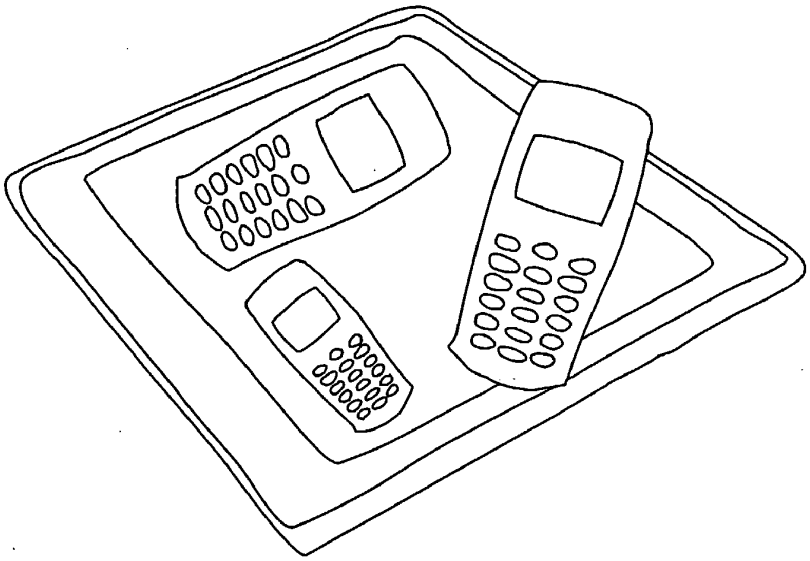


Figure 2 – Wirelessly-rechargeable devices, recharged by being placed onto, or in proximity to, a recharging pad.

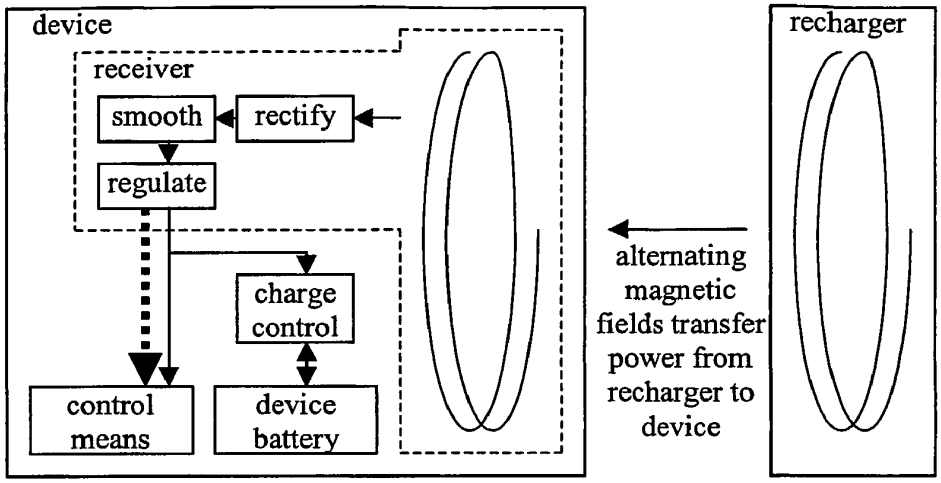


Figure 3 – Example configuration for informing control means of the proximity of the device to a recharger

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB 03/04642

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J5/00 H02J17/00

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)
IPC 7 H02J H04M

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 455 466 A (PARKS TERRY J ET AL) 3 October 1995 (1995-10-03) abstract; figure 2 column 2, line 5 - line 65 column 3, line 26 -column 4, line 56	1,2,5-8, 11
Y	---	9,10
X	EP 0 533 247 A (ERICSSON RADIO SYSTEMS BV) 24 March 1993 (1993-03-24) abstract column 1, line 36 - line 45 column 1, line 53 -column 8, line 14; figures 1,2 column 15, line 56 -column 16, line 27	1,8-11
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 February 2004	01/03/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lorenzo Feijoo, S

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 127 799 A (KRISHNAN RAJESH) 3 October 2000 (2000-10-03) abstract column 1, line 50 -column 2, line 52	1,2,8,11
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A	US 2002/082059 A1 (HASHIZUME HIROSHI ET AL) 27 June 2002 (2002-06-27) abstract; claims 1-3	2-5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 03/04642

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 12-13
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 12-13

Claims 12-13 have not been searched as they are not allowable under Rule 6.2 (a) PCT

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB 03/04642

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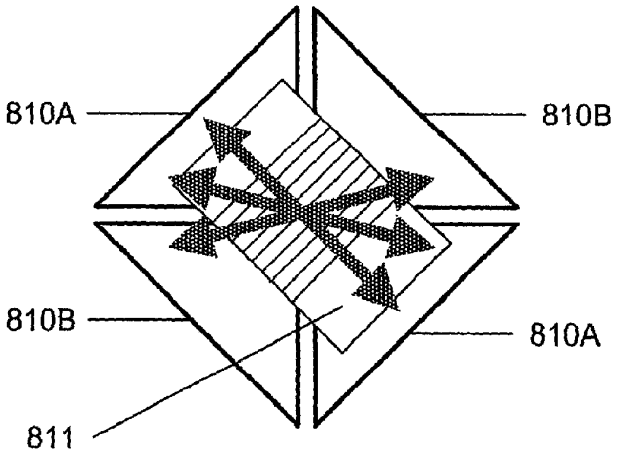
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Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

[Continued on next page]

(54) Title: IMPROVEMENTS RELATING TO CONTACT-LESS POWER TRANSFER



(57) Abstract: A unit (701) for transferring power in an inductive manner to at least one power-receiving device, and a system comprising such a unit and such a device. The unit (701) includes at least one coil structure (702, 703, 704) configured to allow various degrees of translational and rotational freedom of movement of the power-receiving device relative thereto. This provides increased ease of use, since it is not necessary for a user to place the power-receiving device in mechanical or other registration with the unit (701).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

IMPROVEMENTS RELATING TO CONTACT-LESS POWER TRANSFER

This invention relates to a new device for transferring power in a contact-less fashion, for example electromagnetic induction.

Today's inductively-chargeable portable devices, for example the Braun Oral B Plak Control power toothbrush, must typically be precisely aligned with their charger in order to charge them. This precision is necessary so that the coil in the device is correctly aligned with the coil in the charger – the coils being, in effect, the two halves of a conventional power transformer.

Some examples of typical prior art are shown in Figure 1. In Figure 1a, the primary coil of the charger is aligned with the secondary coil of the device. In Figure 1b, a horseshoe electromagnet on the charger is aligned with a similar electromagnet on the device. Figure 1c operates in a very similar way to Figure 1b: the field is created by two coils operating in antiphase (with the lower return circuit being an air gap), and the secondary coil is a flat wound coil. Prior art such as US4873677 works in such a fashion. Note in all cases the precise alignment that is required in order to achieve good coupling between the primary and secondary coils.

Referring now to Figure 2 which explains some terminology used in the present application: Figure 2a shows some charger 201 with a surface 203, the charger 201 emitting a field, and some device 202 charging from the charger 201 (and appreciating that in this figure the shapes of both are irrelevant). Figure 2b shows that the device 202 may move about on ("be translated relative to") the surface 203 of the charger 201 in two directions, depicted X and Y, which are at right angles to one another. The device 202 may also move nearer to and further from the charger 201 in direction Z, but as this will eventually take it out of the charging field, and this is therefore not considered here.

Figure 2c shows that in addition to the above translations, the device 202 may rotate around the X axis (rX), the Y axis (rY) and the Z axis (rZ). In the present application,

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only rotations about rZ, and not those around rX or rY, shall be considered. Each of these six translations and rotations is independent from (also known as "orthogonal to") the others, and is known as a "degree of freedom".

Figure 2d shows an alternative translation co-ordinate system. Instead of orthogonal (X,Y) movement, the position of the device 202 is determined by the radius (r) and the angle (θ) from some centre point. Even though θ involves rotation, it is still a translational degree of freedom, since the device 202 itself need not rotate about its own axis.

For maximum user convenience a system should allow up to five degrees of freedom - translation in the Z axis not being of practical use - so that a device 202 can be placed without regard to its position or orientation on the charger 201.

But today's toothbrush chargers and the like are typically much more constrained. Systems employing the transformer configuration shown in Figure 1a offer one degree of freedom (rotation in the plane of the coils), and those shown in Figure 1b and Figure 1c offer zero degrees of freedom, since if the device is to continue to receive adequate power it cannot be either rotated nor translated relative to the charger. Having zero - or only a few - degrees of freedom requires precise alignment which may be inconvenient to the user because it requires a degree of care and manual dexterity in placing the device 202 on the charger 201.

In addition, systems lacking the translational (X and Y) degrees of freedom cannot charge multiple devices simultaneously, because of course not more than one device can occupy the required (X,Y) position at once.

In addition, such systems requiring precise primary:secondary alignment are also not a universal inductive charging solution – one able to charge devices with very different power requirements – because the different coil sizes mandated by the power needs of different types of devices will not be a good match for any single size of charger coil – see Figure 3.

Various means of increasing the number of degrees of freedom have been proposed.

One simple method is to have a large coil in the charger, emitting a large field, allowing the device to pick-up sufficient power even if it is not perfectly aligned. Figure 4, for example, shows such a charger coil 401 and device coil 402. This is the method adopted by various RFID devices. However the coupling between the coils 401 and 402 will be poor and highly variable dependent on position, so this solution is inefficient and limits the power that can be transferred while still complying with emission legislation. Therefore this solution is far from ideal in charging applications, where efficiency is typically an important criterion.

A solution which improves upon the efficiency of such "large coil" systems, while still offering several degrees of freedom, is to use multiple coils in the charger, enabled as appropriate, ensuring that there is always a reasonable match between nearby charger coils and the device coil. See Figure 5, showing multiple charger coils 501 and single device coil 502. Prior art includes:

- A system is described in the Journal of the Magnetics Society of Japan titled "Coil Shape in a Desk-type Contactless Power Station System" (29th Nov 2001)

An alternative solution is the present applicant's UK patent application number 0210886.8 of 13 May 2002, which discloses a system generating a horizontal field across the surface of the charger, in contrast to conventional solutions which generate a vertical field out of the surface of the charger. A copy of equivalent International patent application no PCT/GB2003/002030 is being filed with the present application so as to form part of the file thereof, and the full contents of PCT/GB2003/002030 are hereby incorporated into the present application by reference. This offers the same two translational degrees of freedom (X and Y) as the above multiple-coil approach, but with better field uniformity and therefore worst-case efficiency. Optionally, the horizontal field may be rotated in the plane of the charger, offering an additional one degree of rotational freedom (rZ). See Figure 6 which shows a laminar

charger 601 generating a magnetic field in the plane of the charger 602 and a device 610 capable of receiving power from such a field when it is in a certain alignment 611. If the field generated by the charger is made to rotate, as shown, then there is no requirement to align the device in any particular orientation.

According to a first aspect of the present invention, there is provided a unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with at least one electrical coil, and the power-receiving device being capable of receiving power when placed in more than one position or rotation on the unit.

The unit may include a pad in which the coils are disposed, the pad serving as a surface upon which power-receiving devices may be placed in order to effect power transfer. The unit may incorporate a power supply or be connectable to a power supply. The pad is preferably a laminar pad, i.e. has a configuration of a lamina. In other words, the pad is preferably generally flat, and may be substantially planar, it being understood that the pad may take a curved form or be made conformal to a curved surface such as the inside of a glove compartment in an automobile. This may apply also to the further aspects of the invention set out hereinbelow.

According to a second aspect of the present invention, there is provided a unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with a plurality of electrical coils, the electrical coils not all being of the same shape.

The coils may be simple conductive loops, or may comprise a more complex arrangement of conductors. Where a more complex arrangement of conductors is provided, for example as disclosed in the present applicant's co-pending UK patent applications numbers 0210886.8 of 13th May 2002 and 0213024.3 of 7th June 2002 (the full disclosures of which are hereby incorporated into the present application by reference), the term "coil" in the context of the present application is intended to denote each separate arrangement of conductors that defines a given charging region

or active area on the primary unit and on which a secondary device is placed in order to effect charging.

The plurality of electrical coils preferably in this aspect may also not all be of the same size and/or not all enclose the same dimensional area.

According to a third aspect of the present invention, there is provided a unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with a plurality of electrical coils, the electrical coils not all being of the same size and/or not all enclosing the same dimensional area.

In some embodiments, all the coils may be of mutually different shapes and/or sizes and/or dimensional areas. In other embodiments, two or more of the plurality of coils may have the same shape and/or size and/or dimensional area, with the remaining coils having one or more different shapes and/or sizes and/or dimensional areas, or all having the same different shape and/or size and/or dimensional area.

The coils may be spatially separated from each other such that no coil is enclosed in or overlaps with any other coil. Alternatively, one or more smaller coils may be contained within a boundary of one or more larger coils. Where one or more smaller coils are contained within a boundary of a larger coil, the coils may be substantially concentric, or may have some other arrangement. For example, a plurality of smaller coils may be contained within a boundary of a larger coil in such a way that the smaller coils are not contained within each other or overlap with each other. Some smaller coils may be nested within each other within the boundary of a larger coil, with some other smaller coils not being nested within each other within the same outer boundary.

The coils may take various shapes, including circular, elliptical, generally ovate, triangular, rectangular, parallelogram, trapezoidal, star-shaped, regular polygonal, irregular polygonal or amorphous.

According to a fourth aspect of the present invention, there is provided a unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with at least one plurality of nested electrical coils and also with means for selectively activating one or more of the nested electrical coils so as to be adaptable to provide efficient power transfer to power-receiving devices of different sizes and/or power requirements and/or positions/rotations.

The means for selectively activating one or more of the nested coils may be adapted automatically to sense an appropriate size and/or power requirement and/or position/rotation determinant of the power-receiving unit (for example, a size or sizes of secondary power-receiving coils in the power-receiving device).

The nested coils may be substantially circular, or may take any other appropriate shape as outlined above.

In a particularly preferred embodiment, there are provided four nested sets of electrical coils, each having a substantially right-angled triangular shape, and arranged such that the right-angles of the four sets of coils all point towards a single origin point such that the four sets of nested coils have an overall substantially square or rectangular configuration. Preferably, adjacent sets of coils are driven in antiphase so as to cause rotation of a resultant electromagnetic field about the origin point, thereby providing a degree of rotational freedom in the positioning of a power-receiving device on the pad.

According to a fifth aspect of the present invention, there is provided a unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with an even number of electrical coils each having corner portion, the coils being arranged such that the corner portions all point towards an origin point, and wherein, in operation, adjacent coils are driven in antiphase so as to cause rotation of a resulting electromagnetic field about the origin point.

There is preferably provided four coils, which may each have a substantially right-angled triangle shape, a quarter circular shape or any other appropriate shape. Where more than four coils are provided, they may each have a generally triangular shape or take the shape of a sector of a circle.

Any of the first to fourth aspects of the present invention may be combined with at least one power-receiving unit so as to form a system for contact-less power transfer.

According to a sixth aspect of the present invention, there is provided a system for contact-less power transfer, the system comprising a power-transmitting unit provided with a primary coil and at least one power-receiving device incorporating a secondary coil, wherein the primary coil is generally elongate along an x-axis with respect to an orthogonal y-axis, and wherein the secondary coil is sized so as to be sufficiently similar in size to the primary coil with respect to the y-axis so as to provide efficient power transfer, but smaller in size with respect to the x-axis so as to provide a translational degree of freedom of movement along the x-axis.

In this way, several power-receiving devices may be simultaneously provided with power by the primary coil by placing the devices adjacent each other along the x-axis.

The primary coil may be generally rectangular, or any other appropriate shape, including elliptical or generally ovate. The secondary coil preferably has a corresponding rectangular (possibly square) or elliptical or ovate or other configuration, subject to the constraints that the extent of the primary coil along the y-axis is substantially similar to that of the secondary coil along the y-axis, and that the extent of the primary coil along the x-axis is greater than that of the secondary coil along the x-axis. Preferably, the extent of the primary coil along the x-axis is at least twice, advantageously at least three or four times, that of the secondary coil along the x-axis.

According to a seventh aspect of the present invention, there is provided a system for contact-less power transfer, the system comprising a power-transmitting unit provided with at least one primary coil having a boundary portion and at least one power-receiving device incorporating a secondary coil, wherein power transfer takes place by way of coupling of near-field flux flowing about the boundary portion of the at least one primary coil with windings of the secondary coil.

There may be provided just a single primary coil of appropriate configuration, or a plurality of adjacent primary coils which will enable a plurality of power-receiving devices to receive power simultaneously.

The at least one primary coil may be generally rectangular in shape, in which case there is one linear degree of freedom of movement of the secondary coil.

Alternatively, the at least one primary coil may be substantially circular or elliptical or the like, in which case a rotational degree of freedom of movement is provided.

According to an eighth aspect of the present invention, there is provided a system for contact-less power transfer, the system comprising a power-transmitting unit provided with first and second substantially concentric primary coils, the first being larger than the second, and at least one power-receiving device incorporating at least one secondary coil dimensioned so as to correspond to a distance between the first and second primary coils, wherein power transfer takes place by way of coupling of near-field flux flowing about the boundaries of the first and second primary coils with generally opposed edges of the secondary coil.

The first and second primary coils in this aspect are supplied with currents flowing in opposite directions. The coils may be generally circular, or may take any other appropriate shape as hereinbefore described.

Summarising the above, the table below lists the desirable characteristics of any inductive charging system, and illustrates how those of the present invention compare with prior art:

	Today's chargers	**Present invention**	**UK 0210886.8**
Simple *(therefore cheap to make)*	Y	Y	Y
Efficient and uniform field *(high-power within regulations)*	Y	Y	Y
Simultaneous *(more than one device at a time)*	N	Y	Y
Universal *(many types of devices)*	N	Y	Y
Degrees of freedom *(convenience)*	0 or 1 (rZ)	0..2 of (X,Y,rZ)	2 (X,Y) 3 (X,Y, rZ)

Embodiments of the present invention may therefore provide greater simplicity (and thus reduced cost) by offering a number of degrees of freedom which is less than that of GB 0210886.8, but greater than that of today's "toothbrush" chargers, while still preserving many of the benefits of GB 0210886.8 (Simplicity, Efficiency, Simultaneity and Universality).

Additionally, this may optionally be achieved while still retaining forward compatibility with devices and chargers of the type described in GB 0210886.8.

There shall now be described various embodiments of the present invention that fit into the following three categories:

1. No degrees of freedom – the charger has different positions for different types of device (Figure 7)
2. Only the rZ rotational degree of freedom, so the device has to be placed in the correct position on the charger. The charger has a single location with an effective coil size that alters with device needs (Figure 8 and Figure 9)

3. Only one translational degree of freedom (Figure 10), either:
    a. Linear translational
    b. Circular translational, and rotational

Addressing each of these categories in turn:

1. No degrees of freedom

Figures 7a,7b,7c show three different types of charger configuration 701 which each have several sizes or shapes of coil 702,703,704. Each coil could be, for example, a multiply-wound coil of a type similar to that in Figure 1a. The coils may all be driven simultaneously, or only when a device is sensed.

The location and/or rotation and/or type of each coil is made clear by some indicator, allowing the user to place their device onto the coil which best couples to it, and in the correct orientation if such is necessary.

In Figure 7a, the coils are spatially separate (allowing multiple devices to be charged simultaneously), in Figure 7b they are concentric, and in Figure 7c they are a mixture of the two.

The coils can of course be of any shape to suit the device, and some examples are shown in Figure 7d.

2. Only the one rZ rotational degree of freedom

Figures 1a and 8a show a prior art system with a single rotational degree of freedom – a coil on the primary 800 couples to a corresponding coil on the device 801 in the manner of a simple transformer.

Figure 8b shows an alternative method of achieving the same rotational degree of freedom for a device 811 which expects a field in the manner of Figure 1c. An antiphase field is driven into sets of coils 810A and 810B such that the field rotates from being aligned in the 810A axis to being aligned in the 810B axis and back to

810A. Thus over time the device receives a significant amount of power no matter what its orientation.

Figure 9 extends these two means of generating a rotational degree of freedom by adding universality. A charger 901 consists of a number of such coils, arranged concentrically, each of which can be driven independently. The charger behaves differently depending on which type of device is present 902.

- In Figure 9a no device is present, and so no charger coils are driven.
- In Figure 9b a physically small device with correspondingly small power requirements is present, and so only a few of the inner coils are driven.
- In Figure 9c a physically large device with correspondingly large power requirements is present, and so many of the coils are driven.

Figures 9d,9e,9f show a charger with a coil configuration 903 of the type shown in Figure 8b, but again arranged concentrically as above, with similar benefits.

3a. One linear translational degree of freedom

Figure 10 shows various configurations in which the primary charger coil is larger than the secondary device coil, but constrained in its dimensions such that it offers a reasonably efficiency with a single translational degree of freedom in the X axis, and therefore the option of simultaneous charging of multiple devices.

In Figure 10a a rectangular charger coil 1001 drives a smaller device coil 1002 by generating a field in the Z axis. By being similar in size to the device coil in the Y dimension, reasonable efficiency is obtained. By being significantly larger than the device coil in the X dimension, one degree of translational freedom is achieved.

Of course the coils could be any type of shape (for example ellipsoidal) rather than rectangular as shown – an important point is the aspect ratio.

Figures 10b and 10c achieve a similar result for devices of the Figure 1c type, 1003. In Figure 10b, a charger coil identical to Figure 10a is used. In Figure 10a it was be

considered to be generating a net flux out from the centre of the coil in the Z dimension, but it can equally be viewed "up close" to the edge of the coil as generating a flux which is rotating around the wire(s), as shown in Figure 10b. Therefore if a device of Figure 1c is placed across any edge of the coil, it will receive the flux.

In Figure 10c a second coil is placed below the first 1004. If placed along the boundary between the two, as shown, the device coil will receive power from each coil. Of course this concept can be extended indefinitely in the Y dimension, as shown with a dotted line, to produce any number of lines along which a device may receive power.

3b. One circular translational degree of freedom

Figure 11a shows a large coil 1101 with a small coil 1102 inside it. The coils carry current in opposite directions, and so will generate a net flux flowing in the Z axis (out of the page). If a device with a coil 1103 is placed anywhere within the annulus formed between the coils, it will receive this flux with reasonable efficiency. Thus the device has a circular translational degree of freedom, and multiple devices can be placed on the charger.

Figure 11b shows a similar scheme working with a device of Figure 1c type. The device straddles the outer coil 1101 to couple with it. This could be seen as a variant of Figure 10b.

It will be appreciated that the coils do not have to be circular.

In each of the above cases, the charger may sense if any device is present on any particular coil, and if so what its power needs are. Possible means for doing this include but are not limited to:

- Sensing the resonance ("Q") or other characteristics of the driven coils
- Communication by modulation of data signals onto the magnetic field (e.g. "back-scatter", as used by RFID devices).

In all embodiments of this present application, the user has limited degrees of freedom when placing devices. Therefore it may be advantageous to indicate these constraints to the user.

Such indications may be done in a variety of ways, for example:

- For chargers with placement restrictions, indicating the correct device position by means of:
  - Outlining of the coil area
  - Filling, or patterning, the active coil area.
- For chargers with rotational restrictions, indicating the correct device rotation by means of:
  - A line or arrow, or set of such.

The indications may be rendered in any number of media, for example:

- Printing ink, perhaps of a particular colour
- Raising or lowering the charger surface.
- Overall shape of the charger, or part of it.

The device may include corresponding indications.

Some examples of possible indications are shown in Figure 12, which:

- Figure 12a shows a printed or raised outline of two devices, for chargers which have no degrees of freedom.
- Figure 12b shows a printed or raised arrow on both the charger and the device, for chargers with 2 translational but not rotational degrees of freedom.
- Figure 12c shows similar to 12b, but with striped indication instead of arrows.
- Figure 12d shows a "target" of concentric circles on both charger and device, for chargers with only a rotational degree of freedom.
- Figure 12e shows a charger with one circular translational degree of freedom, designed such that the active area of the charger is obvious from its form.

Prior art such as US5952814 [Philips phone charger with interlock] describes how the casing of charger may be made to match the internal shape of the charger thus allowing for accurate alignment of the primary and secondary coils.

It will be appreciated that in the case of a device coil designed to receive power by picking-up flux travelling substantially in the plane of the charger, as opposed to orthogonal to it, numerous possible designs of core are possible, for example but not limited to:

- a rod of permeable material with wire coiled around it (Figure 13a) or
- a flat piece of permeable material with a wire coiled flat around it (Figure 13b), as in Figure 1c.

It will also be appreciated that in any of the above, the precise shape of any coils in the device and/or charger will have an effect on the efficiency and other characteristics. For example, replacing any square coil with a circular coil may reduce efficiency somewhat, but, thanks to the rotational symmetry of a circle, allows the device to have a rotational degree of freedom.

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. A unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with a plurality of electrical coils, the electrical coils not all being of the same shape.

2. A unit as claimed in claim 1, wherein the electrical coils are not all of the same size and/or do not all enclose the same dimensional area.

3. A unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with a plurality of electrical coils, the electrical coils not all being of the same size and/or not all enclosing the same dimensional area.

4. A unit as claimed in claim 3, wherein the electrical coils are not all of the same shape.

5. A unit as claimed in any preceding claim, wherein at least one of the electrical coils comprises a simple conductive loop.

6. A unit as claimed in any preceding claim, wherein at least one of the electrical coils comprises a complex arrangement of conductors defining a charging region on which a power-receiving device may be placed.

7. A unit as claimed in any preceding claim, wherein all of the electrical coils have mutually different shapes and/or sizes and/or enclose mutually different dimensional areas.

8. A unit as claimed in any one of claims 1 to 6, wherein two or more of the electrical coils have the same size and/or shape and/or enclose the same dimensional area.

9. A unit as claimed in claim 8, wherein one or more of the remaining coils have one or more different shapes and/or sizes and/or enclose different dimensional areas than the said two or more of the electrical coils.

10. A unit as claimed in any preceding claim, wherein the electrical coils are spatially separated from each other such that no coil is enclosed within or overlaps any other coil.

11. A unit as claimed in any one of claims 1 to 9, wherein one or more smaller coils are contained within a boundary of one or more larger coils.

12. A unit as claimed in any one of claims 1 to 9 and 11, wherein one or more coils overlap with one or more other coils.

13. A unit as claimed in claim 11, wherein the smaller coils contained within a boundary of at least one larger coil are arranged in a substantially concentric or nested configuration.

14. A unit as claimed in claim 11, wherein the smaller coils contained within the boundary of at least one larger coil are arranged such that the smaller coils do not overlap each other or are not contained within each other.

15. A unit as claimed in claim 11, wherein some of the smaller coils contained within the boundary of at least one larger coil have a nested configuration, and wherein some other of the said smaller coils are do not have a nested configuration within the same boundary.

16. A unit as claimed in any preceding claim, wherein the unit is provided with means for selectively activating one or more of the electrical coils in order to provide efficient power transfer to power-receiving devices of different sizes and/or power requirements and/or positions or rotations.

17. A unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with at least one plurality of nested electrical coils and also with means for selectively activating one or more of the nested electrical coils so as to be adaptable to provide efficient power transfer to power-receiving devices of different sizes and/or power requirements and/or positions/rotations.

18. A unit as claimed in claim 17, wherein at least one of the electrical coils comprises a simple conductive loop.

19. A unit as claimed in any claim 17 or 18, wherein at least one of the electrical coils comprises a complex arrangement of conductors defining a charging region on which a power-receiving device may be placed.

20. A unit as claimed in claim 17, wherein there is provided four nested sets of electrical coils, each having a substantially right-angled triangular shape, and arranged such that the right-angles of the four sets of coils all point towards a single origin point such that the four sets of nested coils have an overall substantially square or rectangular configuration.

21. A unit as claimed in claim 20, wherein, in operation, adjacent sets of coils are driven in antiphase so as to cause rotation of a resulting electromagnetic field about the origin point.

22. A unit for transferring power in an inductive manner to at least one power-receiving device, the unit being provided with an even number of electrical coils each having a corner portion, the coils being arranged such that the corner portions all point towards an origin point, and wherein, in operation, adjacent coils are driven in antiphase so as to cause rotation of a resulting electromagnetic field about the origin point.

23. A unit as claimed in claim 22, the unit being provided with four coils.

24. A unit as claimed in claim 22 or 23, wherein each coil has a substantially right-angled triangle shape or a quarter circular shape.

25. A system for contact-less power transfer, comprising a unit as claimed in any one of claims 1 to 25 and a discrete power-receiving device including a secondary coil for coupling inductively with the least one coil of the unit.

26. A system for contact-less power transfer, the system comprising a power-transmitting unit provided with a primary coil and at least one power-receiving device incorporating a secondary coil, wherein the primary coil is generally elongate along an x-axis with respect to an orthogonal y-axis, and wherein the secondary coil is sized so as to be sufficiently similar in size to the primary coil with respect to the y-axis so as to provide efficient power transfer, but smaller in size with respect to the x-axis so as to provide a translational degree of freedom of movement along the x-axis.

27. A system as claimed in claim 26, wherein an extent of the primary coil along the x-axis is at least twice, advantageously at least three or four times, that of the secondary coil along the x-axis.

28. A system for contact-less power transfer, the system comprising a power-transmitting unit provided with at least one primary coil having a boundary portion and at least one power-receiving device incorporating a secondary coil, wherein power transfer takes place by way of coupling of near-field flux flowing about the boundary portion of the at least one primary coil with windings of the secondary coil.

29. A system as claimed in claim 28, comprising a plurality of adjacent primary coils enabling a plurality of power-receiving devices to receive power simultaneously.

30. A system as claimed in claim 28 or 29, wherein the at least one primary coil is generally rectangular in shape, so as to provide is one linear degree of freedom of movement of the secondary coil.

31. A system as claimed in claim 28 or 29, wherein the at least one primary coil is substantially circular or elliptical or the like, so as to provide a rotational degree of freedom of movement of the secondary coil.

32. A system for contact-less power transfer, the system comprising a power-transmitting unit provided with first and second substantially concentric primary coils, the first being larger than the second, and at least one power-receiving device incorporating at least one secondary coil dimensioned so as to correspond to a distance between the first and second primary coils, wherein power transfer takes place by way of coupling of near-field flux flowing about the boundaries of the first and second primary coils with generally opposed edges of the secondary coil.

33. A system as claimed in claim 32, wherein the first and second primary coils, in operation, are supplied with currents flowing in opposite directions.

34. A system as claimed in claim 32 or 33, wherein the primary coils are generally circular or elliptical or the like.

35. A unit as claimed in any one of claims 1 to 24, wherein the at least one coil is incorporated in a laminar charging pad upon which a power-receiving device may be placed.

36. A unit as claimed in claim 35, wherein the charging pad is substantially planar.

37. A system as claimed in any one of claims 25 to 34, wherein the at least one coil is incorporated in a laminar charging pad upon which the power-receiving device may be placed.

38. A system as claimed in claim 37, wherein the charging pad is substantially planar.

39. A unit for transferring power in an inductive manner to at least one power-receiving device, substantially as hereinbefore described with reference to or as shown in Figures 7 to 13 of the accompanying drawings.

40. A system for contact-less power transfer, substantially as hereinbefore described with reference to or as shown in Figures 7 to 13 of the accompanying drawings.

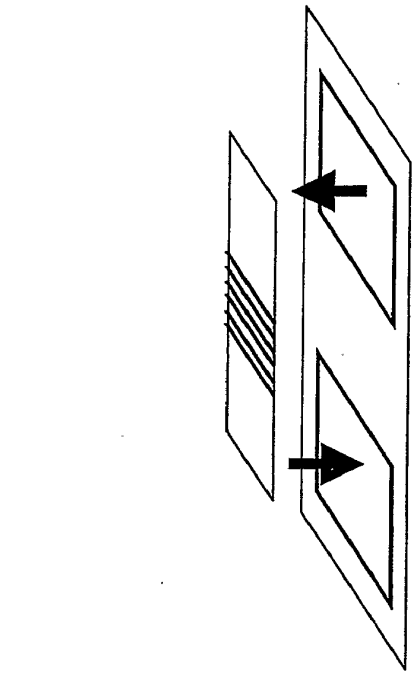


Figure 1c
(Prior Art)

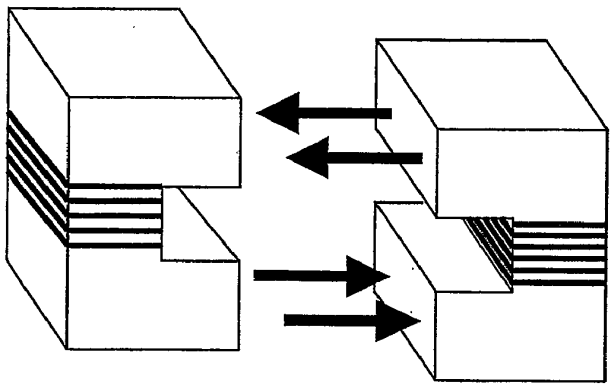


Figure 1b
(Prior Art)

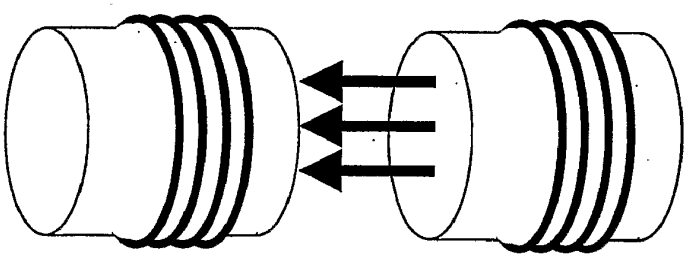


Figure 1a
(Prior Art)

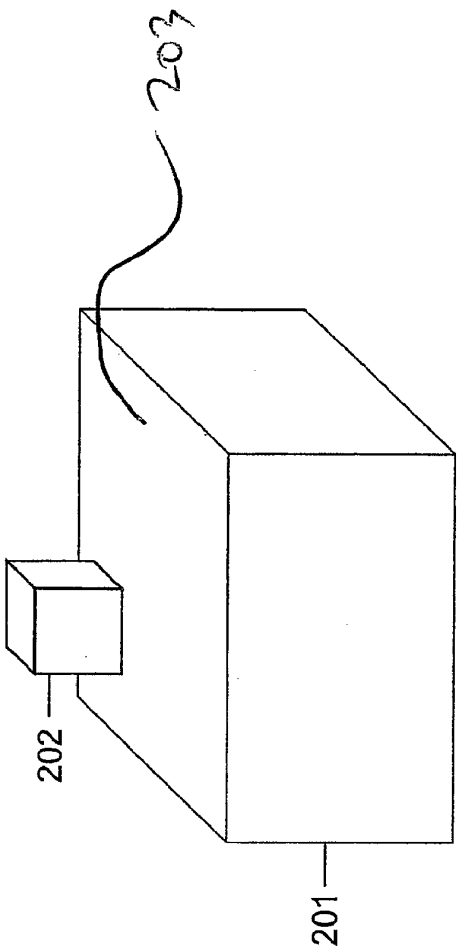


Figure 2a

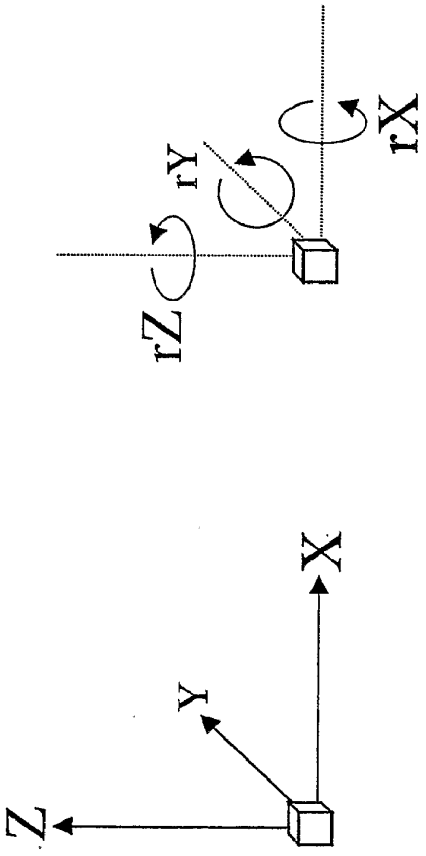


Figure 2b

Figure 2c

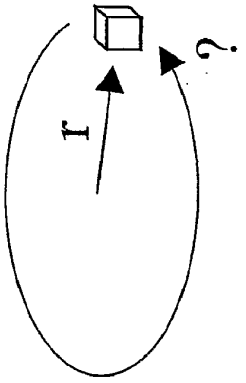


Figure 2d

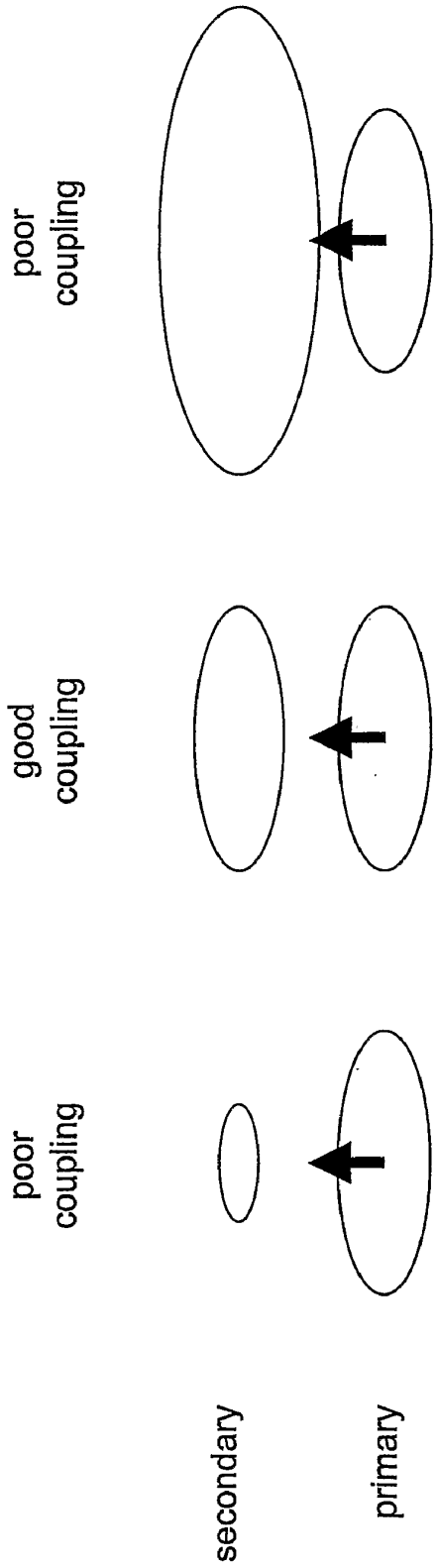

poor coupling
good coupling
poor coupling
secondary
primary

Figure 3

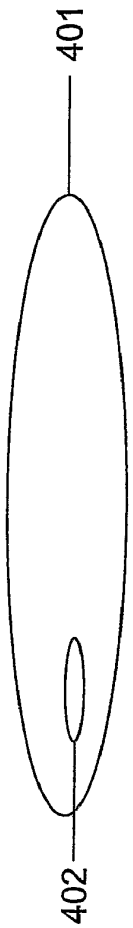


Figure 4 (Prior Art)

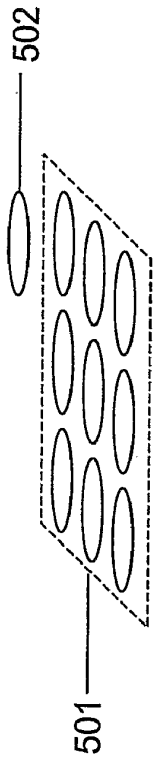


Figure 5
(Prior Art)

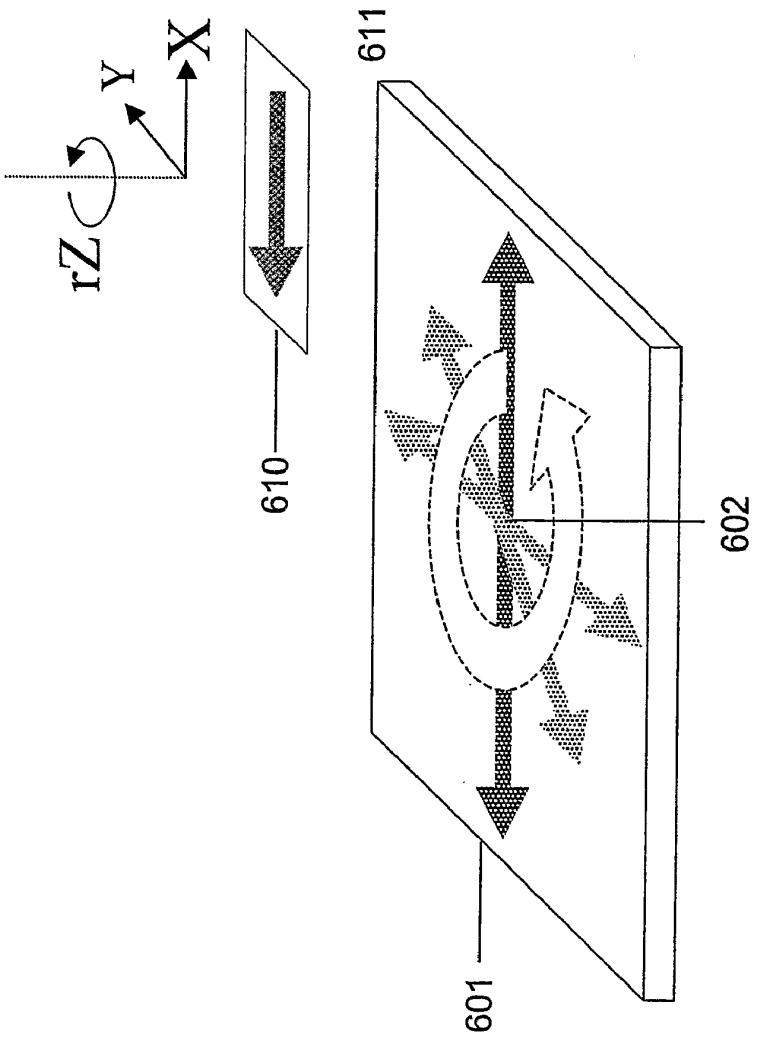


Figure 6 (Prior Art)

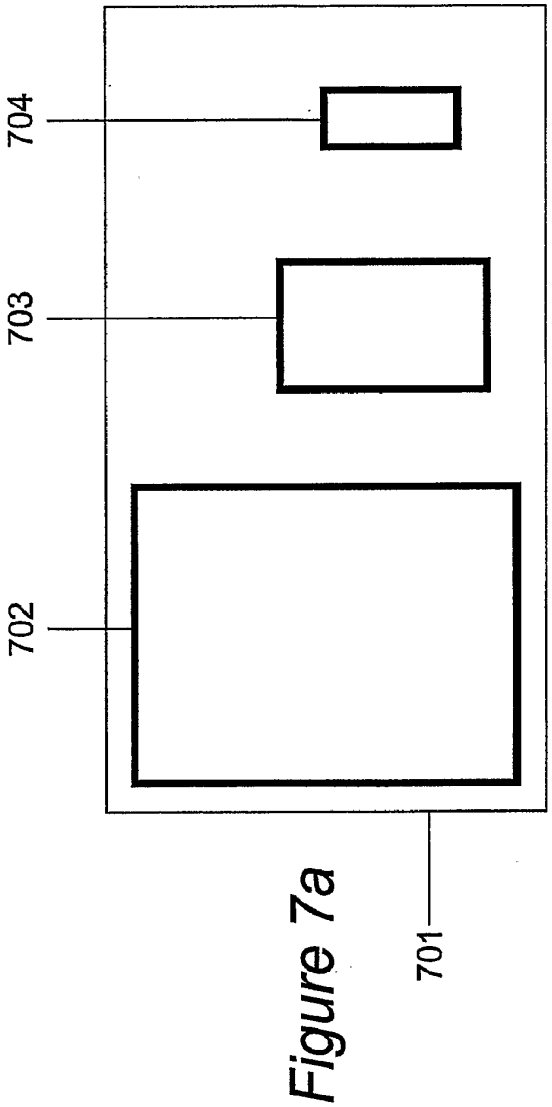


Figure 7a

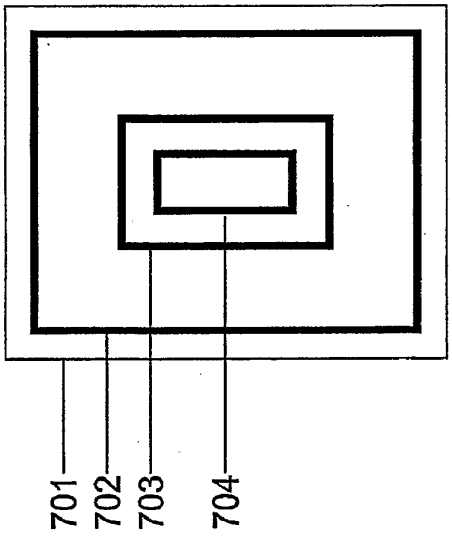


Figure 7b

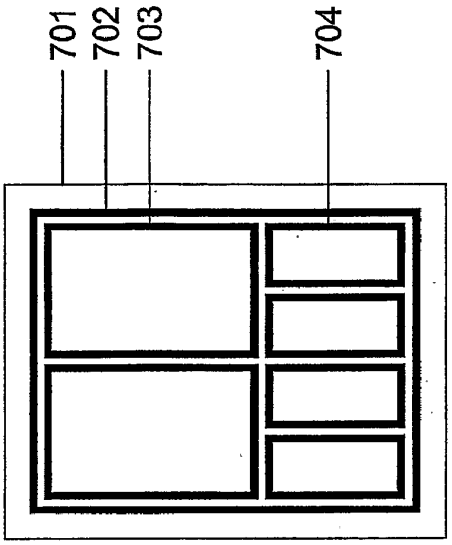


Figure 7c

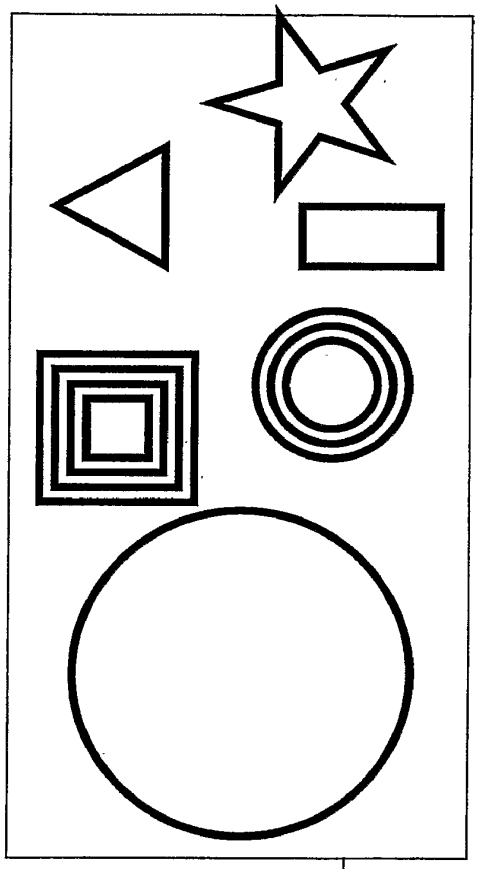


Figure 7d

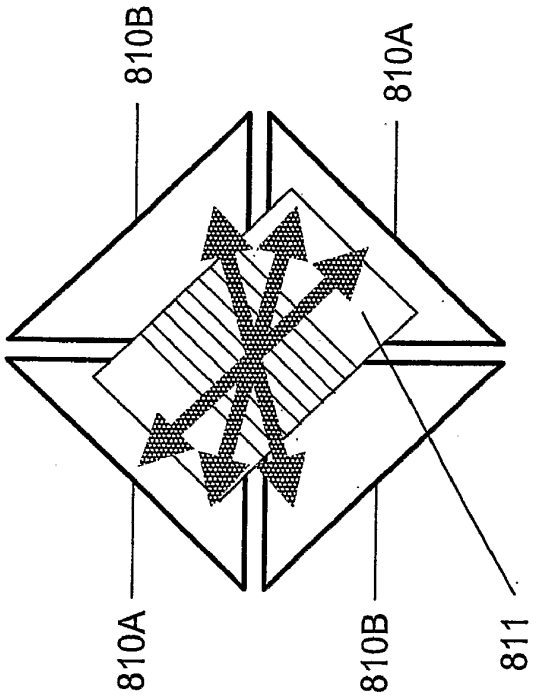


Figure 8b

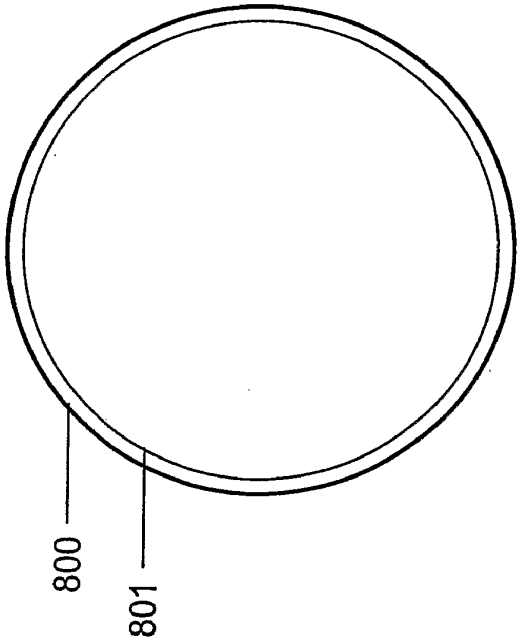


Figure 8a
(Prior Art)

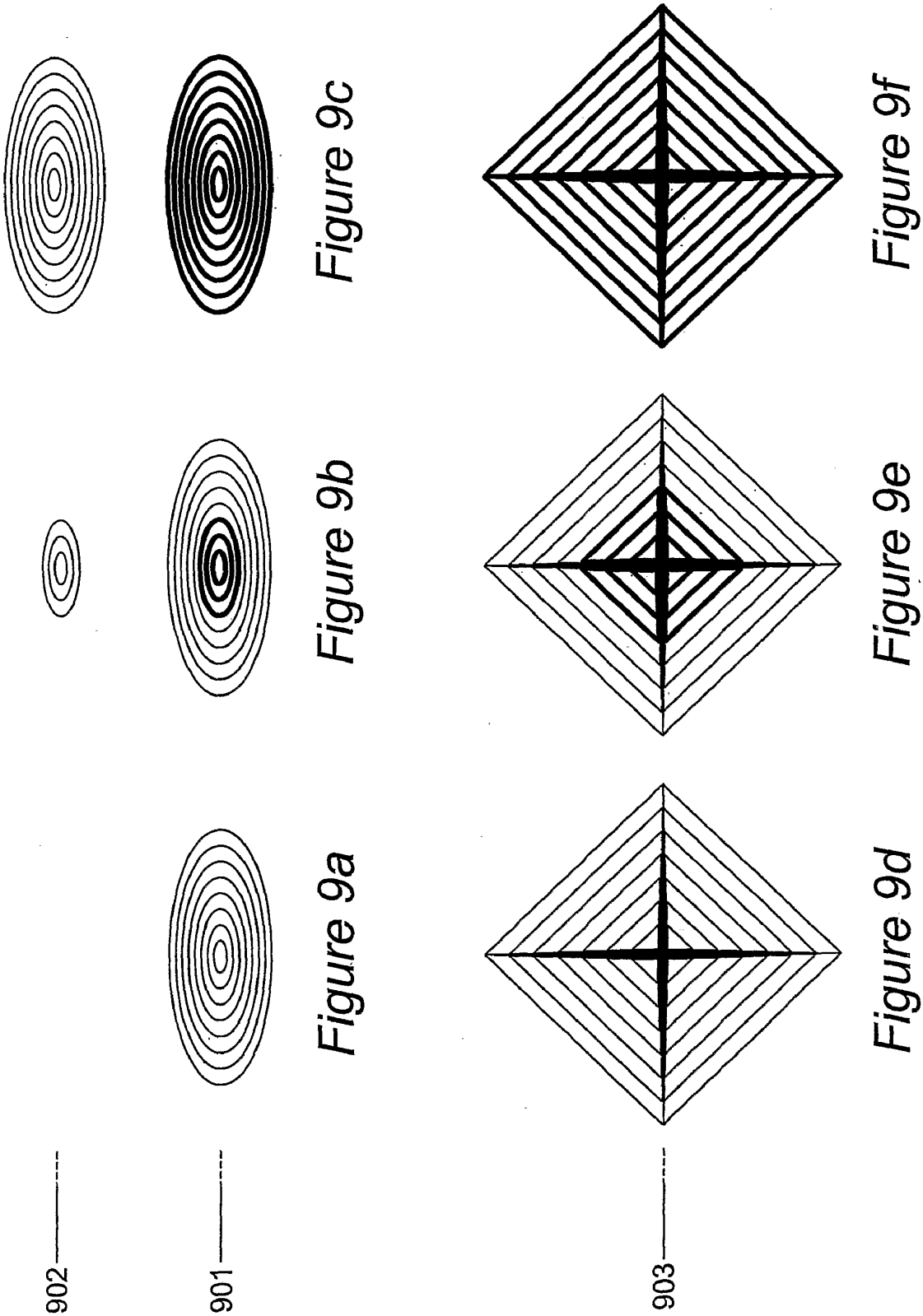


Figure 9a Figure 9b Figure 9c

Figure 9d Figure 9e Figure 9f

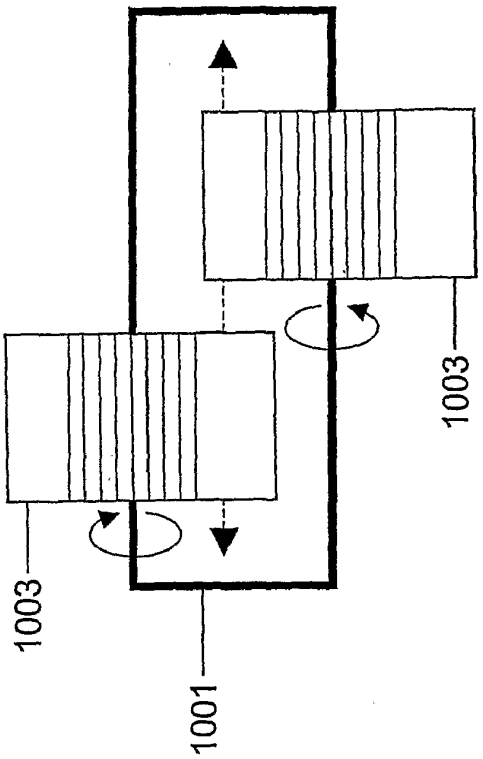


Figure 10b

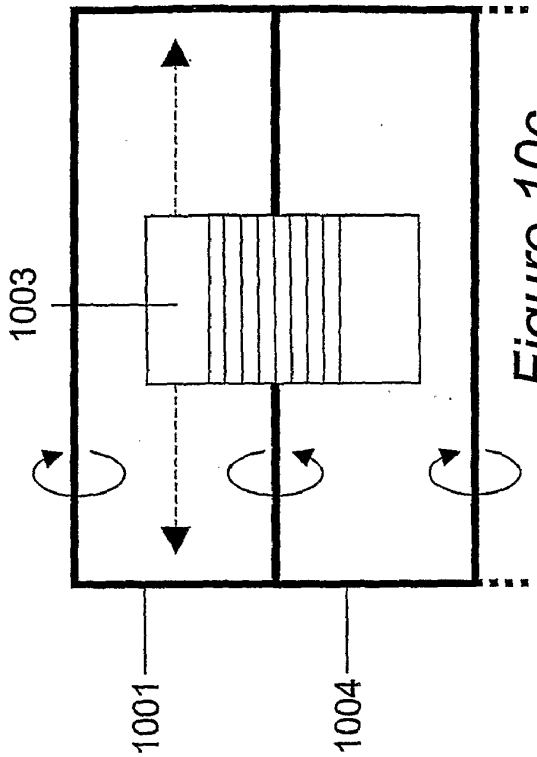


Figure 10c

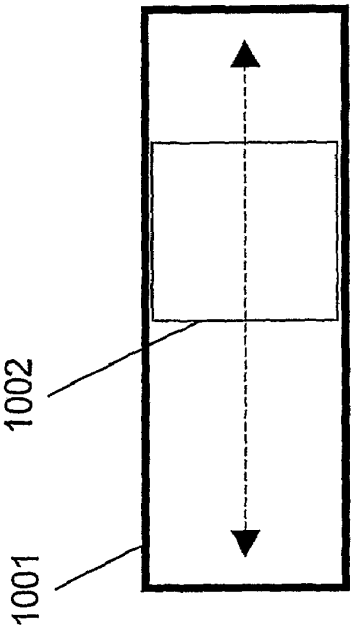
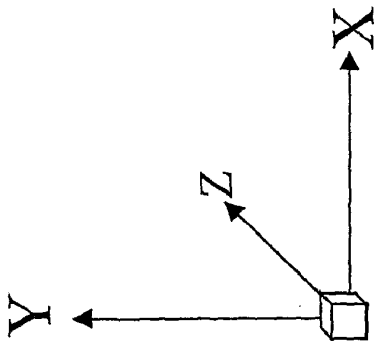


Figure 10a



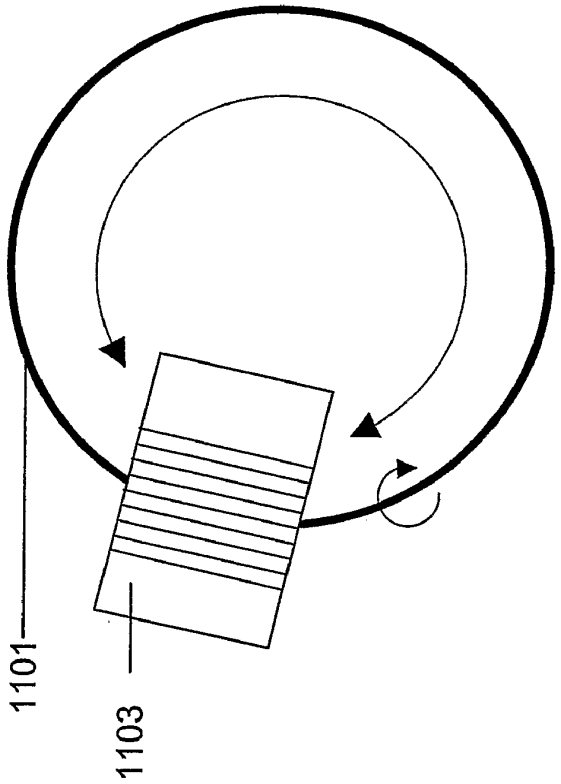


Figure 11b

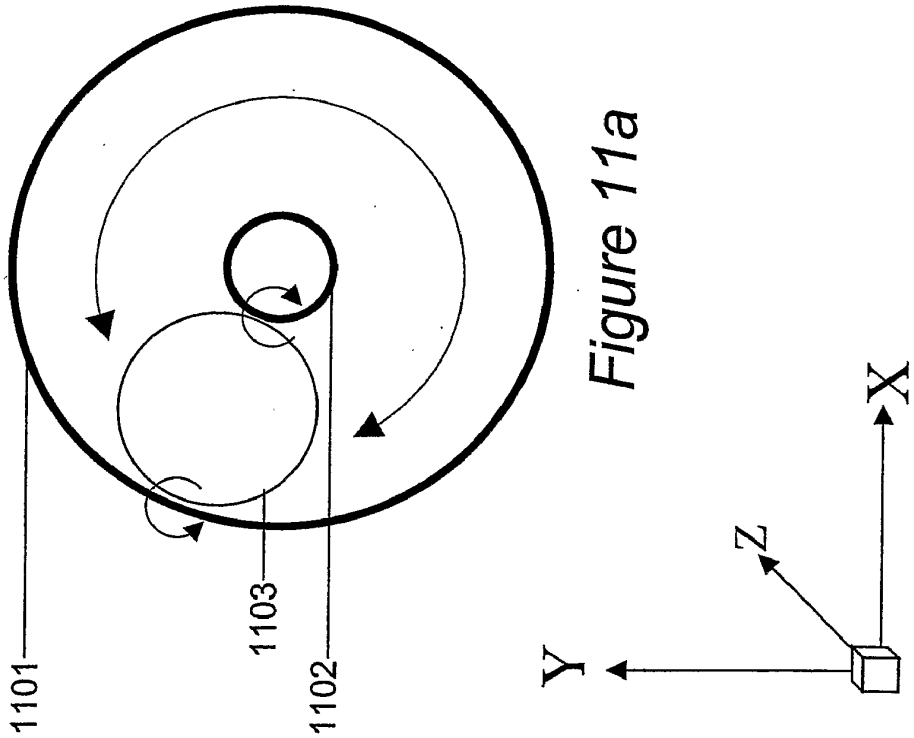


Figure 11a

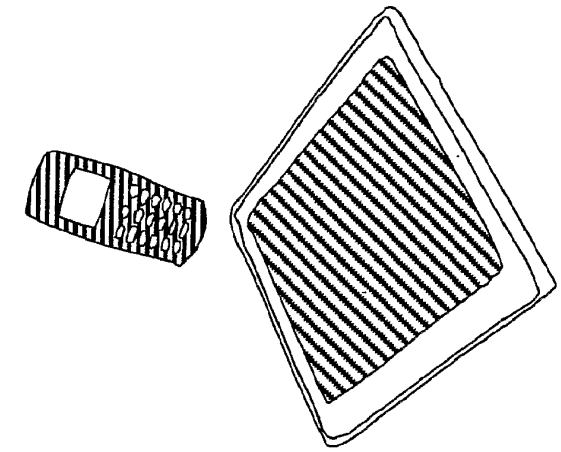


Figure 12c

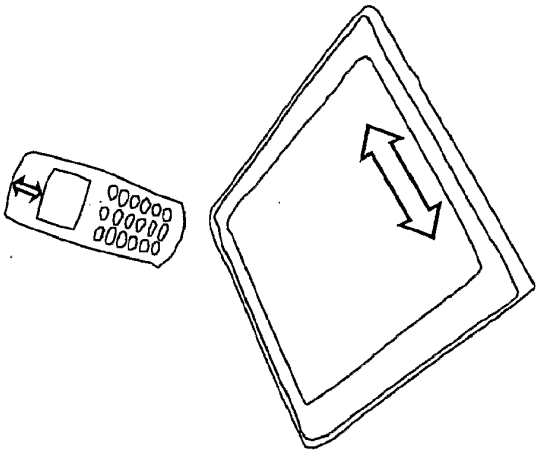


Figure 12b

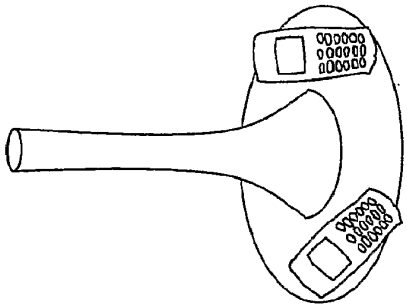


Figure 12e

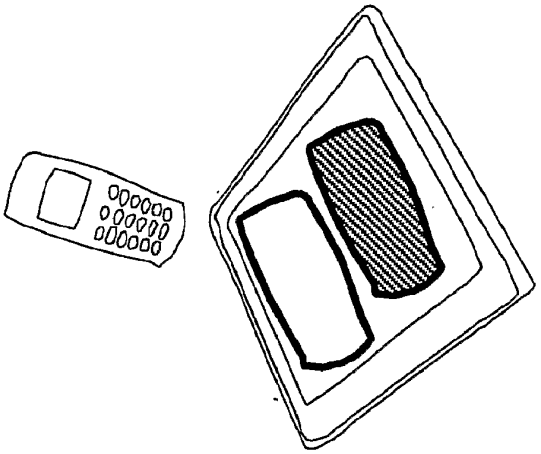


Figure 12a

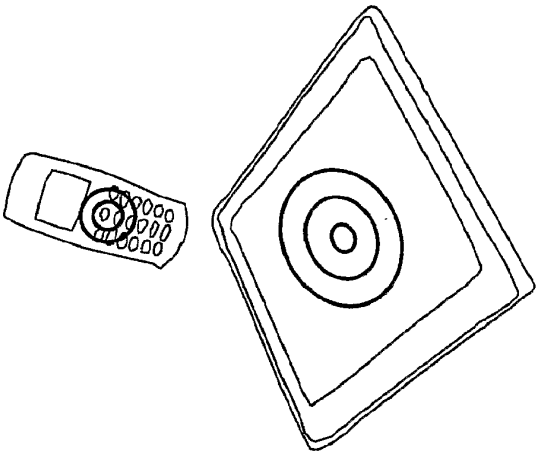


Figure 12d

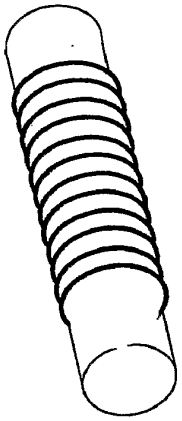


Figure 13a

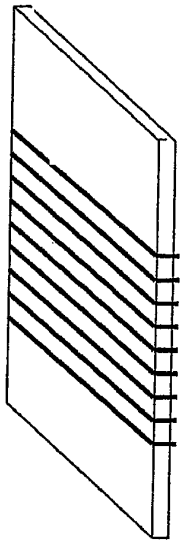


Figure 13b

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H02J 17/00	(2006.01)	H02J 17/00	B	

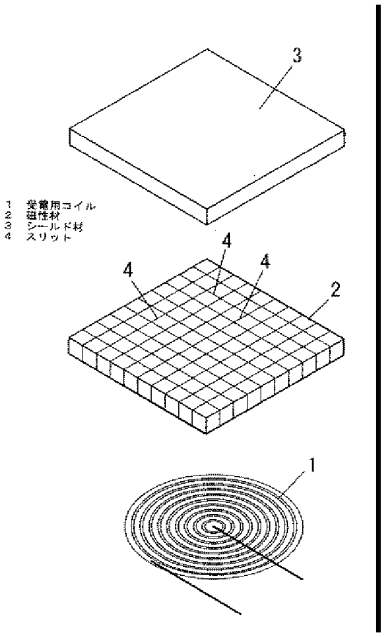
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(54)【発明の名称】非接触電力伝送機器

(57)【要約】
【課題】磁性材での渦電流の発生を抑制して電力伝送効率を高める。
【解決手段】一次側送電用コイルからの電力を受けるための二次側受電用のコイル１を備え、該コイル１の少なくとも片面に磁性材２が配設されている。上記磁性材２は上記両コイルの対向面と平行な面にスリット４が形成されている。電力伝送効率の向上のための磁性材に設けたスリットは、磁束が磁性材を通ることによって発生する渦電流を抑制するために、熱損失を低減する。
【選択図】図１



【特許請求の範囲】
【請求項1】
一次側送電用コイルからの電力を受けるための二次側受電用のコイルを備えた非接触電力伝送機器であって、上記二次側受電用コイルの少なくとも片面に磁性材が配設されているとともに、上記磁性材は上記両コイルの対向面と平行な面にスリットが形成されたものであることを特徴とする非接触電力伝送機器。
【請求項2】
上記スリットは磁性材の二次側受電用コイル側の面に磁性材を貫通しないものとして形成されていることを特徴とする請求項１記載の非接触電力伝送機器。
【請求項3】
上記スリットは、磁性材内を流れる磁束の方向に沿った方向のものであることを特徴とする請求項１または２記載の非接触電力伝送機器。
【請求項4】
上記スリットは、磁性材内を流れる磁束の密度が高い部分に密に設けられていることを特徴とする請求項１～３のいずれか１項に記載の非接触電力伝送機器。

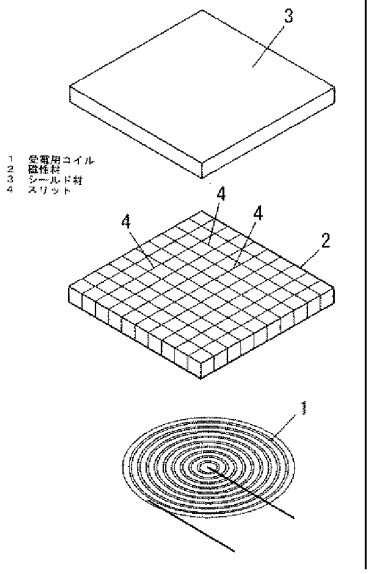
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、非接触で電力伝送を行う非接触電力伝送機器、殊にその受電側の機器に関するものである。
【背景技術】
【0002】
非接触電力伝送機器として、充電器側に設けた一次側送電用コイルと、負荷機器側に設けた二次側受電用コイルとの間でトランスを構成し、上記両コイル間の電磁誘導作用を利用して非接触で電力伝送を行う非接触充電器がある。非接触電力伝送では接点部分の露出がないために接点部分の劣化を気にしなくて良いことや防水性の確保が容易になること、電力送電側機器に対する電力受電側機器の着脱を容易に行うことができるなどの点からコードレス電話機、シェーバー、歯ブラシなど様々な商品に用いられている。
【0003】
また、これらの商品に搭載されている電力伝送用コイル及び電力受電用コイルは、コアに巻き線を巻いたものや成型品で形成されたボビンに巻き線を巻いたものが一般的に用いられているが、携帯端末機器を初めとした機器や先に述べた商品に対して、小型化、薄型化、高機能化が要求されており、このために負荷機器側の機器に設ける二次側受電用のコイルとして、薄型化のために平面コイルを用いることが提案されている。しかし平面コイルにした場合、コアに巻き線を巻いたコイルと比較すれば磁気特性が劣るために二次側から取り出せる電力が低減してしまう。
【0004】
この点を補うために、二次側受電用のコイルを平面コイルで形成する場合、その背面側（一次側送電用コイルと反対側）に磁性材を配置することで、電力伝送効率を向上させているのであるが、導電性である磁性材は、送電用コイルと受電用コイルとの対向面を貫く磁気によって渦電流が流れ、この渦電流が磁性材を発熱させてしまうとともに、発熱損失によって電力伝送効率が低下するという問題があった。
【特許文献1】特開２００６－３１１７１２号公報
【発明の開示】
【発明が解決しようとする課題】
【0005】
本発明は上記の従来の問題点に鑑みて発明したものであって、磁性材での渦電流の発生を抑制して電力伝送効率を高めることができる非接触電力伝送機器を提供することを課題とするものある。
【課題を解決するための手段】

【0006】
上記課題を解決するために本発明に係る非接触電力伝送機器は、一次側送電用コイルからの電力を受けるための二次側受電用のコイルを備えた非接触電力伝送機器であって、上記二次側受電用コイルの少なくとも片面に磁性材が配設されているとともに、上記磁性材は上記両コイルの対向面と平行な面にスリットが形成されたものであることに特徴を有している。電力伝送効率の向上のための磁性材に設けたスリットは、磁束が磁性材を通ることによって発生する渦電流を抑制するために、熱損失を低減する。
【0007】
上記スリットは磁性材の二次側受電用コイル側の面に磁性材を貫通しないものとして形成されていると、磁性材の取り扱い性が向上する。
【0008】
上記スリットは、磁性材内を流れる磁束の方向に沿った方向のものであれば、磁束の流れをスリットが阻害することがないと同時に、渦電流を効果的に抑制することができる。
【0009】
また上記スリットは、磁性材内を流れる磁束の密度が高い部分に密に設けられていることが渦電流の抑制に効果的である。
【発明の効果】
【0010】
本発明の非接触電力伝送機器は、その二次側受電用のコイルに磁性材が設けられている上に、この磁性材に磁束が流れることによって磁性材に流れる渦電流は磁性材に設けたスリットで抑制されるために、渦電流による熱損失を低減することができるものであり、磁性材を設けたことによる電力伝送効率の向上を効果的に得ることができる。
【発明を実施するための最良の形態】
【0011】
以下、本発明を添付図面に示す実施形態に基いて説明すると、図１は非接触電力伝送機器における受電側の構成を示しており、平面コイルで形成された二次側受電用のコイル１と、このコイル１における一次側送電用コイル（図示せず）との対向面と反対側である背面側に配された磁性材２と、磁性材２上に更に配された磁束漏れ防止用のシールド板３とで構成され、これらコイル１と磁性材２とシールド板３とは積層接着されている。
【0012】
ここにおける磁性材２は、一次側送電用コイルから二次側受電用コイル１への電磁誘導作用を利用した非接触電力伝送の効率を高めるために設けたもので、たとえばアモルファス系の導電性を有するものからなり、図２にも示すように、０．１～５．０ｍｍ間隔で多数のスリット４が格子状に形成されている。なお、図２に示すものでは周縁部にスリット４を形成せずに周縁部が枠として機能するようにしているが、これは取り扱いの便を考えてのものであり、周縁部までスリット４が形成されていてもよい。
【0013】
ここにおける上記スリット４は、磁性材２を貫く磁束Ｍによって磁性材２を流れる渦電流を抑制するものとして働く。すなわち、上記スリット４が無い場合、磁性材２には図３(a)に示すように磁束Ｍによって大きな渦電流Ｉが流れるが、スリット４が形成されることで細かく分割されている場合、図３(b)に示すように渦電流Ｉは細かく分割された部分で夫々生じるだけで、大きな渦電流Ｉが流れにくくなるために、渦電流が生じることによって発生する熱損失による電力伝送効率の低下を抑えることができるものであり、このために磁性材２を設けることによる電力伝送効率の向上を効果的に得られるものである。
【0014】
磁性材２の厚み方向に貫通するスリット４を設けた場合、スリット４によって磁性材２が完全に分断されるために取り扱い性が問題となるが、Ｖ字形の切り込みとしてスリット４を形成し、図４(a)に示すようにシールド板３や粘着性シートに貼り付けた後にローラ圧延等で圧力を加えることで磁性材２を割ったり、あるいは図４(b)に示すようにコイル１とともにラミネートシート６で包んだ後に圧力を加えて磁性材２を割るとよい。

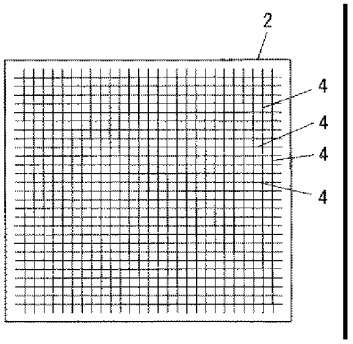
【0015】
図５に示すように磁性材２を厚み方向に貫通しないスリット４でもよく、この場合、磁性材２はその形状を自己保持するために、取り扱いが容易となる。また、スリット４のない他面側は、漏れ磁束を防ぐシールド板３としての機能を果たすことになるために、この場合、別途シールド板３を設けなくても済むものとなる。なお、この場合のスリット４は、磁性板２の厚みの２５～９５％程度の範囲で形成するのが好ましい。
【0016】
このほか、図６に示すように、磁性材２の両面から磁性材２を貫通しないスリット４を設けるとともに、一面側のスリット４と他面側のスリット４の位置とをずらして設けるようにしたものを用いてもよい。
【0017】
また、磁性材２としては、コイル１の一面側にのみ位置するのではなく、図７に示すように、コイル１の中央や周囲にも位置するものを好適に用いることができる。この場合、磁性材２による磁束の補足が効果的になされるために電力伝送効率が更に向上する。
【0018】
スリット４を格子状に設けたものを示したが、スリット４の配列はこの格子状に限るものではない。図８(a)は一筆書きとすることで磁性材２を貫通するにもかかわらず、分断されてしまうことがないようにしたスリット４の一例を示しており、図８(b)は十字状の多数のスリット４を設けた一例を示しており、図８(c)は平行線状の多数のスリット４を設けた例を示しており、図８(d)は図８(c)に示した平行線状のスリット４に交叉するスリット４を付加した例を示している。
【0019】
また、磁性材２に流れる磁束Mは、図９に示すように、コイル１の中心に該当する位置から放射状に広がるとともに、渦電流は該磁束Mと直交する方向に流れることから、図１０に示すように、磁束Mと平行となるスリット４を多数設けると、スリット４が磁束Mの流れを阻害することなく、効果的に渦電流を抑制することができるものとなる。
【0020】
ここで、図１０(a)は放射状にスリット４を設けて磁束Mの密度が高い部分にはスリット４の配置密度も高くなるようにしたものを示しており、図１０(b)は放射状スリット４を設けた場合に外周部のスリット４の配置密度が低くなってしまうことに鑑みて、外周部に更にスリット４を付加した例を示しており、図１０(c)は磁性材２の剛性確保のために、渦電流が流れないように留意しつつ、放射状のスリット４を内周側と外周側とで分けて形成した例を示している。ちなみに、このような放射状のスリット４は、渦電流による損失の低減効果が大きく、電力伝送効率の向上という点で極めて効果的であった。
【0021】
磁性材２は一枚だけを配置するのではなく、図１１に示すように、複数枚の磁性材２をコイル１の片面側に積層して配置してもよい。この場合、積層する磁性材２に設けるスリット４は、その位置をずらしておくことが好ましく、図１１(b)に示すものでは、平行線状のスリット４を備えた２枚の磁性材２をスリット４が公差するように設けており、図１１(c)に示すものでは２枚の磁性材２に設けた平行線状のスリット４の位置をずらしたものを示している。
【0022】
なお、このように複数枚の磁性材２を重ねて配置する場合においても、スリット４が磁性材２を厚み方向に貫通するものでは、図１２に示すようにシールド板３を配置しておくことが磁束漏れの防止という点で好ましく、この場合、シールド板３には放熱板としての機能も持たせておくことが好ましい。なお、シールド板３は磁性材２と同じ材料からなるものでも、別材料のものでもよい。
【図面の簡単な説明】
【0023】
【図1】本発明の実施の形態の一例を示す分解斜視図である。

【図2】同上の磁性材の平面図である。
【図3】磁性材を磁束が通る際の渦電流の流れを示す説明図であり、(a)はスリットがない場合、(b)はスリットがある場合を示している。
【図4】(a)(b)は夫々スリット作成についての説明図である。
【図5】他例を示すもので、(a)は表面側の斜視図、(b)は裏面側の斜視図である。
【図6】更に他例を示すもので、(a)は斜視図、(b)は断面図である。
【図7】別の例の断面図である。
【図8】(a)(b)(c)は夫々スリットの配列例を一部拡大模式で示している平面図、(c)はスリットの他の配列例を示している平面図、(d)はスリットの他の配列例を一部拡大模式で示している平面図である。
【図9】磁束の流れと渦電流の流れとを示した平面図である。
【図10】(a)(b)(c)は夫々スリットの放射状配列例を一部拡大模式で示している平面図である。
【図11】(a)(b)(c)は夫々他の例を示す分解斜視図である。
【図12】シールド板を更に付加した場合の分解斜視図である。
【符号の説明】
【0024】
1　受電用コイル
2　磁性材
3　シールド材
4　スリット

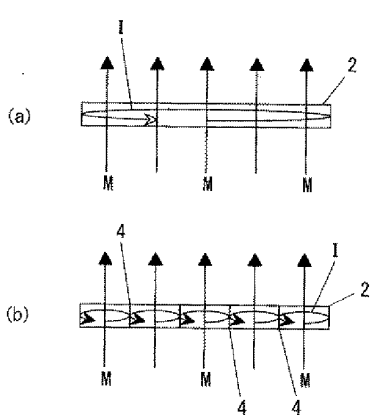
【図1】



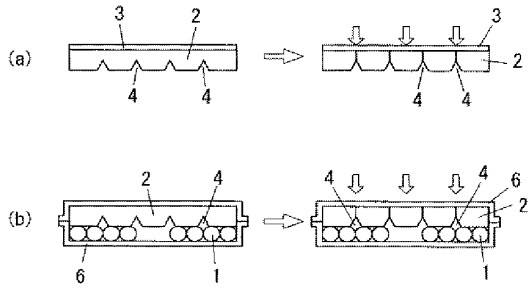
【図2】



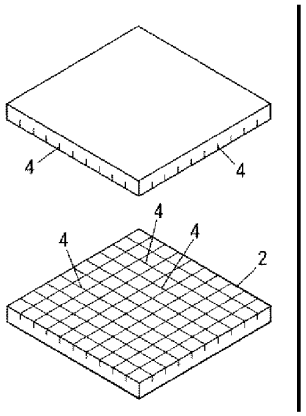
【図3】



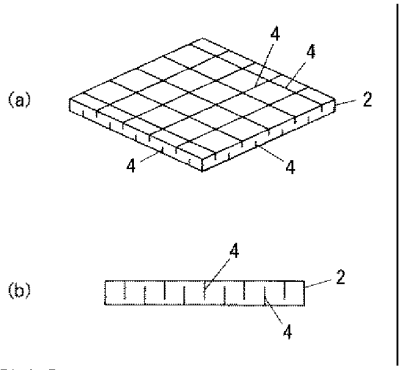
【図4】



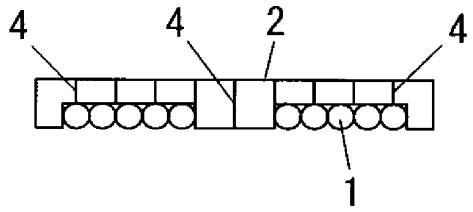
【図5】



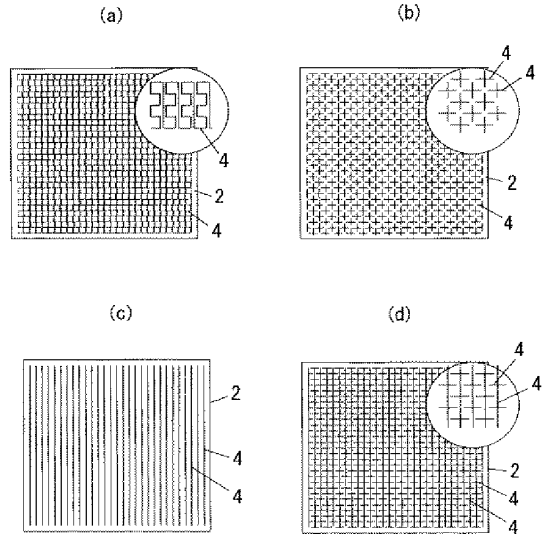
【図6】



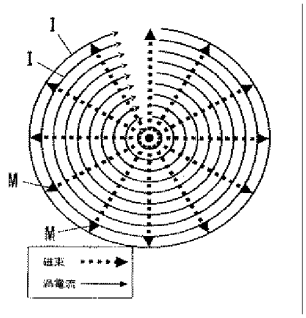
【図7】



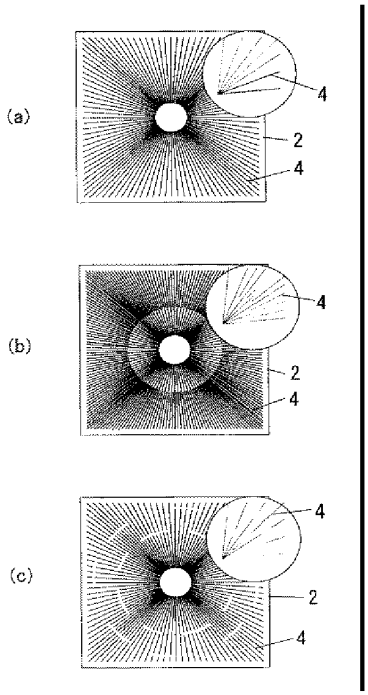
【図8】



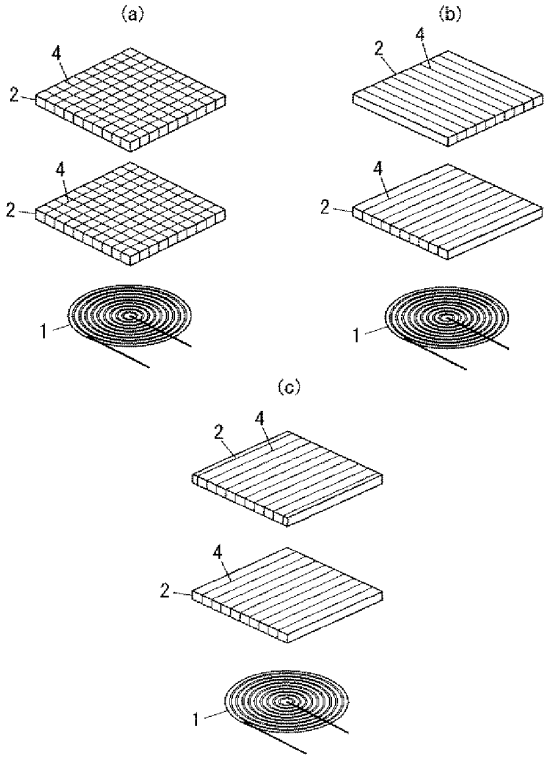
【図9】



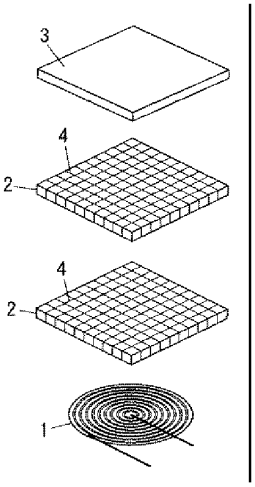
【図10】



【図11】



【図12】



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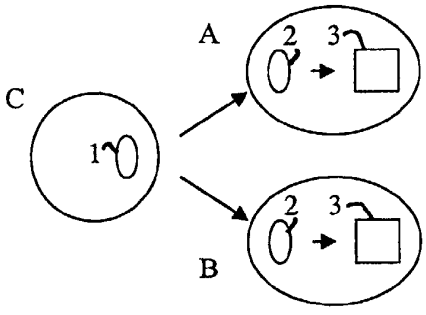
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(54) Title: BIDIRECTIONAL WIRELESS POWER TRASMISSION SYSTEM



Portable devices being charged

(57) Abstract: There is disclosed a system and method of power transfer, including at least first and second devices, each device having a power storage component and a power exchange component. The power exchange component of the first device is dynamically configurable so as selectively to receive power wirelessly from the power storage and exchange components of at least the second device and to direct the received power to the power storage component of the first device, and to transmit power wirelessly from the power storage component of the first device to the power exchange and power storage components of at least the second device. In this way, the first device may charge or power the second device and vice versa. For example, where the first device is a mobile telephone and the second device is a games console, a person carrying both devices may use one to power the other should the power supply of one of the devices run low.

BIDIRECTIONAL WIRELESS POWER TRANSMISSION SYSTEM

The present application claims priority from UK patent application no 0213023.5, filed on 7th June 2002.

This invention relates to a new system for the transfer of power between devices, and a new method for transferring power between devices.

As the use of portable devices increases, so does the use of rechargeable batteries for powering such devices. Some portable devices can be recharged by non-conductive means, such as magnetic fields, solar, microwaves, eliminating the need for exposed electrical contacts. Some examples include solar powered radios and inductively powered electric toothbrushes. Such non-conductive means for powering portable devices are typically part of a two-part recharging system:

1. A charging station, typically not very portable, which takes power from some source (for example a mains power supply, or a car power outlet) and uses it to transmit power in such a way that it can be received by the device. For example: in solar power systems, the charging station may emit light; in inductive systems, the station may emit a fluctuating magnetic field; in microwave systems, the station may generate microwaves.

2. A device, typically more portable, which, when located near the charging station, receives power from it via a charging component (which could be for example: a photovoltaic panel, a secondary coil or antennae) using it to power itself, and/or recharge its own batteries.

Examples of charging stations and devices of this nature are more fully explained in the present applicant's copending US patent application no 10/326,571 of 20th December 2002, and also International patent applications nos PCT/GB2003/002030 and PCT/GB2003/002038 of 13th May 2003, the full disclosures of which are hereby incorporated into the present application by reference.

However if users forget to recharge their portable devices, they may run out of power when far away from the charging station, which is inconvenient.

It is possible to construct a family of such portable devices which share a common design and/or have the same or similar charging component for receiving power, and which therefore can all be charged at the same type of charging station.

Typically a user owning several portable, rechargeable devices will discover that one of them runs out of power before the others. For example, a mobile phone may run out of power before a laptop computer. When the user is not in proximity to a charging station, he may wish to transfer some power from one device to another device. For example, if two users both have mobile phones but one has a fully charged battery and the other has an empty battery, they may wish to share the power between the two.

For portable devices which have power connections (for example devices complying to the common USB standard), it may be possible physically to connect the out-of-power device (e.g. the mobile phone) to a device which still has power (e.g. the laptop) via a cable, and thus power and/or recharge the out-of-power device. However, devices powered by non-conductive means have to-date been designed such that the module or charging component on portable devices is only able to receive power, therefore two such devices (e.g. mobile phone and laptop) cannot transfer power between each other.

According to a first aspect of the present invention there is provided a device capable of exchanging power with another device, the device including at least a power storage component and a power exchange component, wherein the power exchange component is dynamically configurable so as selectively:

a) to receive power by wireless transmission from an external transmitter into the power storage component; and

b) to transmit power by wireless transmission from the power storage component to an external receiver.

The external transmitter and/or receiver may be comprised as part of the power exchange component of the other device, or may be at least incorporated generally into the other device.

Such a device is advantageous because it allows the user conveniently to power one device from another, even if a convenient charger is not present. This adds a useful user feature without adding substantial additional cost.

It is desirable to have a number of devices with modules or charging components which are not only capable of receiving power but also capable of transmitting power and perform as a small temporary charging station. Such a family of devices would then be able to transfer power from one to another as required by the user.

According to a second aspect of the present invention, there is provided a system comprising at least first and second devices, each device including a power storage component and a power exchange component, wherein the power exchange component of the first device is dynamically configurable so as selectively:

a) to receive power wirelessly from the power storage and exchange components of at least the second device and to direct the received power to the power storage component of the first device; and

b) to transmit power wirelessly from the power storage component of the first device to the power exchange and power storage components of at least the second device.

According to a third aspect of the present invention, there is provided a method of exchanging power between a first device and a second device, each device including

a power storage component and a power exchange component, wherein the power exchange component of the first device selectively:

a) receives power wirelessly from the power storage and exchange components of at least the second device and directs the received power to the power storage component of the first device; and

b) transmits power wirelessly from the power storage component of the first device to the power exchange and power storage components of at least the second device.

According to a fourth aspect of the present invention, there is provided a method of exchanging power between a first device and a second device, each device including at least a power storage component and a power exchange component, wherein the power exchange component of each device is dynamically configurable so as selectively:

a) to receive power by wireless transmission from an external transmitter into the power storage component; and

b) to transmit power by wireless transmission from the power storage component to an external receiver.

The power storage component of one or more of the devices may be a rechargeable battery or the like. For a device that is intended only to transmit power and not to receive power, the power storage component need not be rechargeable.

The power exchange component may operate by transmission and/or reception of alternating electromagnetic energy, for example electromagnetic induction by way of an alternating electromagnetic field.

Alternatively or in addition, the power exchange component may operate by transmission and/or reception of light energy or the like.

Further means of power exchange are outlined hereinbelow.

Advantageously, the power exchange component may include a conductor, such as a wire or the like, wound or wrapped around or otherwise associated with a core component. The core component may be made of a magnetic material, such as a soft magnetic material, and in some embodiments is made of an amorphous metal material, optionally in an "as-cast" or non-annealed state.

Amorphous metal is a metal alloy, consisting for example of iron, boron and silicon, which has been melted and then cooled so rapidly ("quenched") that there is no time for it to crystallise as it solidifies, leaving it instead in a glass-like amorphous state. A more detailed description of amorphous metals may be found in US 4,877,464, the full disclosure of which is hereby incorporated into the present application by reference.

The following non-exhaustive list illustrates some examples of devices that may contain the said power-storage component and the power-exchange component. Possibilities are not limited to those described below:

- A mobile communication device, for example a radio, mobile telephone or walkie-talkie;
- A portable computing device, for example a personal digital assistant or palmtop or laptop computer;
- Portable entertainment devices, for example a music player, game console or toy;
- Personal care items, for example a toothbrush, shaver, hair curler, hair rollers;
- A portable imaging device, for example video recorder or camera;
- Containers of contents that may require heating, for example coffee mugs, plates, cooking pots, nail-polish and cosmetic containers;
- Consumer devices, for example torches, clocks and fans;

- A battery-pack for insertion into any of the above;
- A standard-sized battery pack (e.g. AA, C, D);

The following non-exhaustive list illustrates some examples of media via which non-conductive power transfer may be achieved:

- Magnetic or electromagnetic fields
- Light
- Infrared
- Microwaves
- Other frequencies of the electromagnetic spectrum
- Mechanical motion

For a better understanding of the present invention and to show it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawings, in which:

FIGURE 1 shows an embodiment of the present invention showing a charger (C) transmitting power by non-conductive or wireless means (for example, electromagnetic induction or transfer of light energy) to two portable devices (A) and (B). Charger (C) is energising its power exchange component (1) to transfer power to the power exchange components (2) of (A) and (B), which receive the power and use it to recharge their power storage components (3).

FIGURE 2 shows the same portable device (A) with its power exchange component (2) now configured to transmit power from its power storage component (3). Portable device (B), configured as before, is receiving power from portable device (A).

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise"

and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. A device capable of exchanging power with another device, the device including at least a power storage component and a power exchange component, wherein the power exchange component is dynamically configurable so as selectively:

a) to receive power by wireless transmission from an external transmitter into the power storage component; and

b) to transmit power by wireless transmission from the power storage component to an external receiver.

2. A device as claimed in claim 1, wherein the power storage component is a rechargeable battery.

3. A device as claimed in claim 1 or 2, wherein the power exchange component operates by transmission and reception of alternating electromagnetic energy.

4. A device as claimed in claim 3, wherein the power exchange component includes a conductive wire wound about a magnetic core.

5. A device as claimed in claim 4, wherein the magnetic core is made of amorphous metal.

6. A device as claimed in claim 1 or 2, wherein the power exchange component operates by transmission and reception of light energy.

7. A device as claimed in claim 1 or 2, wherein the power exchange component operates by transmission and reception of microwave energy.

8. A device as claimed in any one of the preceding claims, wherein the device is packaged in a battery pack enclosure.

9. A device as claimed in claim 8, wherein the battery pack enclosure is a standard-sized battery pack enclosure.

10. A device as claimed in any preceding claim, in combination with the said other device, wherein the external transmitter is incorporated into the said other device.

11. A device as claimed in claim 10, wherein the external transmitter is part of a power exchange component of the said other device.

12. A device as claimed in any preceding claim, in combination with the said other device, wherein the external receiver is incorporated into the said other device.

13. A device as claimed in claim 12, wherein the external receiver is part of a power exchange component of the said other device.

14. A system comprising at least first and second devices, each device including a power storage component and a power exchange component, wherein the power exchange component of the first device is dynamically configurable so as selectively:

a) to receive power wirelessly from the power storage and exchange components of at least the second device and to direct the received power to the power storage component of the first device; and

b) to transmit power wirelessly from the power storage component of the first device to the power exchange and power storage components of at least the second device.

15. A system as claimed in claim 14, wherein the power storage component of at least one of the first and second devices is a rechargeable battery.

16. A system as claimed in claim 14 or 15, wherein the power exchange components operate by transmission and reception of alternating electromagnetic energy.

17. A system as claimed in claim 16, wherein the power exchange component of at least one of the first and second devices includes a conductive wire wound about a magnetic core.

18. A system as claimed in claim 17, wherein the magnetic core is made of amorphous metal.

19. A system as claimed in claim 14 or 15, wherein the power exchange components operate by transmission and reception of light energy.

20. A system as claimed in claim 14 or 15, wherein the power exchange components operate by transmission and reception of microwave energy.

21. A system as claimed in any one of claims 14 to 20, wherein at least one of the first and second devices is packaged in a battery pack enclosure.

22. A system as claimed in claim 22, wherein the battery pack enclosure is a standard-sized battery pack enclosure.

23. A method of exchanging power between a first device and a second device, each device including a power storage component and a power exchange component, wherein the power exchange component of the first device selectively:

a) receives power wirelessly from the power storage and exchange components of at least the second device and directs the received power to the power storage component of the first device; and

b) transmits power wirelessly from the power storage component of the first device to the power exchange and power storage components of at least the second device.

24. A method according to claim 23, wherein the power storage component of at least one of the first and second devices is a rechargeable battery.

25. A method according to claim 23 or 24, wherein power exchange takes place by transmission and reception of alternating electromagnetic energy.

26. A method according to claim 25, wherein the power exchange component of at least one of the first and second devices includes a conductive wire wound about a magnetic core.

27. A method according to claim 26, wherein the magnetic core is made of amorphous metal.

28. A method according to claim 23 or 24, wherein power exchange takes place by transmission and reception of light energy.

29. A method according to claim 23 or 24, wherein power exchange takes place by transmission and reception of microwave energy.

30. A method according to any one of claims 23 to 29, wherein at least one of the first and second devices is packaged in a battery pack enclosure.

31. A method according to claim 30, wherein the battery pack enclosure is a standard-sized battery pack enclosure.

32. A device capable of exchanging power with another device, substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

33. A system comprising at least first and second devices, substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

34. A method of exchanging power between a first device and a second device, substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

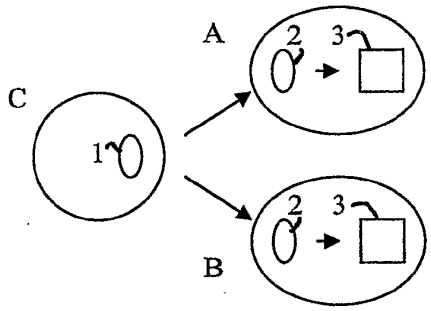


Figure 1 – Portable devices being charged

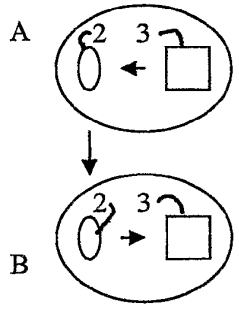


Figure 2 – Device A charging device B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/02475

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J17/00 H02J7/02

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 7 H02J

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

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Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 196 49 682 A (SCHLEIFRING & APPARATEBAU GMBH) 4 June 1998 (1998-06-04)	1-5, 10-18, 23-27, 32-34
Y	the whole document	6-9, 19-22, 28-31
Y	US 5 428 961 A (SAKAKIBARA TAKAHISA ET AL) 4 July 1995 (1995-07-04) abstract figures 6,7 column 6, line 15 - line 68	6,7,19, 20,28,29
Y	US 6 040 680 A (TOYA SHOICHI ET AL) 21 March 2000 (2000-03-21) abstract	8,9,21, 22,30,31

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 September 2003	19/09/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hurtado-Albir, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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0225006.6	28 October 2002 (28.10.2002)	GB
0228425.5	6 December 2002 (06.12.2002)	GB
10/326,571	20 December 2002 (20.12.2002)	US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

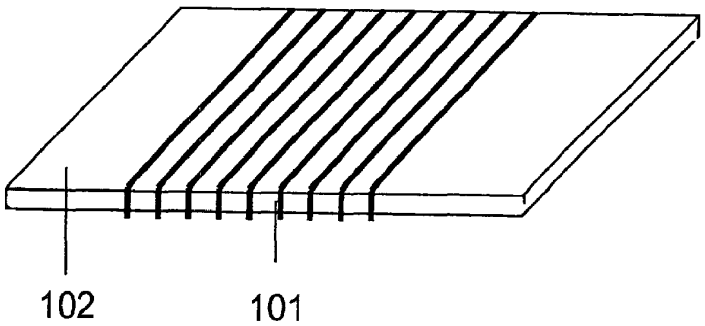
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Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVEMENTS RELATING TO THE TRANSFER OF ELECTROMAGNETIC POWER



(57) Abstract: There is disclosed a magnetic core component for receiving electrical power by induction. The core component includes a thin sheet of amorphous magnetic material in a substantially amorphous or non-annealed state. In contrast to known core components, which use annealed amorphous magnetic materials, the non-annealed material of the present invention is flexible and non-brittle. This means that it has significant advantages including resistance to physical shocks. This is of importance when the core component is used in portable electronic devices such as mobile telephones and the like which may be subject to physical shocks, for example by being accidentally dropped.

WO 03/096361 A1

IMPROVEMENTS RELATING TO THE TRANSFER OF ELECTROMAGNETIC POWER

The present application claims priority from UK patent applications nos 0210886.8 of 13th May 2002, 0213024.3 of 7th June 2002, 0225006.6 of 28th October 2002 and 0228425.5 of 6th December 2002, as well as from US patent application no 10/326,571 of 20th December 2002. The full contents of all of these prior patent applications is hereby incorporated into the present application by reference.

This invention relates to a new apparatus for transferring electromagnetic power, particularly in relation to the powering of portable devices.

In a conventional electrical transformer, an input alternating current flows through a primary coil, inducing an alternating magnetic flux within the transformer core. This alternating magnetic flux then induces an alternating current in a secondary coil.

In certain designs of transformer, for example U-U, U-I, E-I or E-E cores, there may be an air-gap between the two halves of the transformer (see Figure 1). Therefore it is possible to separate the transformer into two: a primary side and a secondary side. When brought together in the correct relative position, the alternating magnetic field in the primary side couples to the core in the secondary side, recreating a transformer and hence power is transferred inductively from the primary side to the secondary side without the need for direct electrical contacts.

Referring to Figure 2, if the primary part is contained within a base unit, and the secondary part within a portable device, then the transformer created when the portable device is placed onto the base unit can be used to provide power to the device without direct electrical contacts, for example to recharge a battery in the secondary device.

Those skilled in the art will recognize that this kind of "separable two-part" transformer system may be implemented with a variety of different core designs and

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magnetic field shapes. An alternative, for example, is the simple "axial" design shown in Figure 3. This has poorer field coupling because the magnetic flux must return through the air, but has the advantage of being freely rotatable about its axis.

As portable devices become smaller and thinner - particularly consumer devices in which aesthetic qualities are particularly important - the penalties in volume and weight of such cores makes them undesirable. Bulkiness is one of the reasons why inductive charging has not been widely used in these applications. It is therefore highly desirable to find an alternative magnetic core material for these applications which is not bulky, has as little weight as possible, is not brittle and hence can be made into a laminar (including curved) or substantially flat or planar form-factor while being able to survive drop-tests.

Existing cores are typically made of silicon steel, ferrite or permalloy, materials which are used because of their low cost and high saturation magnetic flux density but which have the following disadvantages:

- Steel (even silicon steel) suffers high loss at higher frequencies (>10kHz) because of low resistivity and hence the generation of eddy currents, and has low permeability. The losses are less severe at low frequencies but the core needs to be larger and more bulky
- Ferrite has high permeability and is low-loss, but is brittle
- Permalloy has a permeability which drops sharply at 10's of kHz.

The above disadvantages make these materials inappropriate for use in thin cores for thin devices: the low permeability of steel and permalloy means that in a flat "form factor" they have insufficient overall permeability, and the brittleness of ferrite means that in a flat form factor it would be unacceptably brittle, failing drop tests.

A possible alternative core material is so-called "amorphous metal". Amorphous metal is a metal alloy, consisting for example of iron, boron and silicon, which has been melted and then cooled so rapidly ("quenched") that there is no time for it to crystallise as it solidifies, leaving it instead in a glass-like amorphous state. A more

detailed description of amorphous metals may be found in US 4,877,464, the full disclosure of which is hereby incorporated into the present application by reference.

A two-stage manufacturing process is used to make (prior art) amorphous metal magnetic cores.

STEP 1 : A typical Production method for amorphous metal tape

The alloy is melted, poured onto a rotating drum and rapidly quenched. The metal emerges in the form of a very thin ribbon, typically 16-25um thick. The resulting amorphous metal tape is magnetically "soft", has high permeability, has a moderate saturation magnetic flux density and is flexible.

STEP 2 : Typical Manufacturing method of conventional bulk magnetic cores from amorphous metal tape

To create a conventional bulk magnetic core (for example: U core, toroidal core) for a transformer or motor, many strips of such amorphous metal tape are then laminated (stacked or wound), usually alternated with insulating adhesive, into the shape of the desired core. The core is then annealed (the temperature is raised and then lowered in a controlled fashion), usually in the presence of a magnetic field. The annealing allows controlled nano-crystallisation of the metal, improving the saturation magnetic flux density. However a negative side-effect of nano-crystallisation is that it increases the atomic order of the material, making it very brittle. In a bulky adhesive-bound core this is often not a problem because any stress is spread throughout the volume of the core.

However this brittleness makes the above "Step 2" core-manufacturing process unsuitable for the production of thin magnetic cores. Throughout the present application, the word "thin" is to be taken to describe a shape substantially smaller in one dimension than in either of its other two dimensions, for example to describe a

shape whose thickness is substantially less than (e.g. less than 1/5 or preferably less than 1/10 of) both its width and length, for example a section of tape.

In most applications of amorphous material as magnetic cores in transformers, this two-step process of first creating an amorphous ribbon, then turning it into a bulk core is highly undesirable because it requires intermediate manufacturing steps, and so research has been conducted to identify ways to achieve the same with a one-stage bulk amorphous alloy production process so that the need first to create thin ribbons is eliminated.

In a thin laminar magnetic core, any shear stress (force applied perpendicular to the plane of the material) is naturally concentrated across a very small cross-section. Any attempt to make a thin magnetic core using the above "Step 2" core-manufacturing stage would result in a very brittle object which is hard to work with in subsequent manufacturing steps, and therefore expensive. Further, such a core would be unsuitable for use in, for example, portable devices which are exposed to very high g forces when dropped.

According to a first aspect of the present invention there is provided a magnetic core component for transferring power by induction to or from a device, the magnetic core component including a thin sheet of metal in a substantially amorphous or non-annealed state and being provided with means for transferring induced electrical power from the core component to a device.

According to a second aspect of the present invention, there is provided a device provided with a magnetic core component for receiving or transmitting power by electromagnetic induction, characterised in that the magnetic core component includes a thin sheet of metal in a substantially amorphous or non-annealed state.

The device will generally be an electronic or electrical device, usually containing a rechargeable cell or battery. Alternatively or in addition, the device itself may be a rechargeable cell or battery.

The amorphous metal is preferably at least 70% amorphous or non-annealed, and even more preferably at least 90% amorphous or non-annealed.

In preferred embodiments, the metal is what is generally known in the art as an "amorphous metal" or alternatively a "metallic glass".

The means for transferring induced electrical power to the device may comprise an electrical conductor wound around or otherwise associated with the thin sheet of amorphous metal and having first and second terminals for connection to power inputs of the device.

The device will generally be a portable device, although non-portable devices may also be provided with a magnetic core component as herein described.

Embodiments of the first aspect of the present invention may be adapted for retro-fitting to an existing device, for example being in the form of a thin patch or sticker suitable for mounting (e.g. by way of adhesion) onto an appropriate internal or external surface of the device and having means for connection to a power input of the device.

The amorphous magnetic core component of embodiments of the present invention has several advantages for use in portable devices, compared with using conventional magnetic cores:

1. It is thin, preferably 0.5mm or even 0.1mm or less, allowing devices into which it is incorporated to be ergonomic, and/or allowing more space for other functionality within such devices
2. It is flexible, therefore:
    a. it is not brittle, despite its thinness, and so:
        i. it is suitable for use in portable devices which may be subject to physical shock.
        ii. it is easy to handle in subsequent manufacturing steps

b. it can easily be flexed into non-flat shapes, possibly to be conformal with the contours of a portable device such as a mobile phone or a wireless headset.

c. it can be a component within a device which is itself flexible (for example a watch strap or an intelligent credit-card), particularly devices which have to flex as part of their operation – for example battery cells tend to bulge somewhat when they are recharged.

3. Because the field travels along the thin core, if the core is placed within a device which is itself thin relative to its length (for example a cell, headset boom or pen), the device can be rotated freely around its axis within an axial magnetic field.

Also of potential benefit, compared to a conventional core, is that very little tooling is required to manufacture the core of embodiments of the present invention.

An example of the material for manufacturing the core is Metglas® 2714A as manufactured by Honeywell. This is a cobalt-based amorphous metal with an ultra-high permeability of >80,000 at DC in the as-cast state, supplied as ribbon on reels.

In use, the core will typically couple to external electromagnetic field lines running in the same plane as the material. Because of its relatively high permeability, it will concentrate nearby lines into it, so will even "capture" field lines running past it. This is shown in Figure 5.

The core will saturate when subjected to a magnetic field above a certain threshold, placing an upper limit on the operational power of the system. Therefore the core must have a sufficiently large cross-section to ensure that saturation does not occur at the desired operational power level. Saturation offers some protection from exposure to very strong magnetic fields, as in this situation the core will saturate, limiting the power transferred to the device.

The core may be located within or near a device which itself contains parallel planes of metal, for example a copper printed circuit board or an aluminium cover. In this case, the performance of the present invention is significantly better than that of a conventional core because the field lines through a conventional coil will suffer flux-exclusion if the coil is placed up against the metal plane (because the lines of flux must travel perpendicular to the plane of the core). Since in the present invention the lines of flux travel along the plane of the core, and therefore of the metal plane, performance is improved. See Figure 6. An additional benefit of embodiments of the present invention compared to a conventional coil is that the core in the present invention may act as a shield for items (e.g. electrical circuits, battery cells) in close proximity to the magnetic core.

Because its permeability is higher than that of air, the core of the present invention acts to concentrate magnetic flux, thus capturing more flux than would otherwise flow through an equivalent cross-section of air. The size of the core's "shape factor" (the equivalent flux-capturing sphere) is determined to a first-order approximation by the longest planar dimension of the core. Therefore if the core of the present invention has planar dimensions with a significantly non-square aspect ratio, for example a 4:1 rectangle instead of a 1:1 square, it will capture proportionally more of any flux travelling parallel to the direction of its longest planar dimension. Therefore if used in devices which have a constrained aspect ratio (for example a long thin device such as a headset or pen), a significant increase in performance will be experienced compared with that of a conventional coil of the same area.

The core may comprise more than one sheet of amorphous metal, the sheets being arranged in parallel with one another (laminated). The sheets may be made of the same amorphous metal material, or of two or more different amorphous metal materials.

The core may be wrapped, encircled, wound or otherwise provided with a coil of conductive wire or tape or a flexible printed circuit. This is preferably wrapped or wound around a smallest of the planar dimensions of the sheet of amorphous metal .

The coil may be tuned to a higher "Q" (quality factor) with a capacitor, in parallel or series, resulting in higher amounts of energy being induced by an external magnetic field, but also in higher dissipation in the module and the need for tuning to a precise driving frequency. The capacitor may be made from multiple layers of amorphous metal in the core, interposed with a dielectric material such as polythene or the like.

The coil may be connected to a half- or full-wave rectifier to convert AC into DC, and may also be connected to an optional smoothing capacitor, an optional regulator or a battery charge-controller.

The core may be provided with a flexible printed coil arranged such that the amorphous core passes through the coil but in the same plane. Alternatively, the magnetic core component may comprise at least two pieces of amorphous sheet or ribbon laminated to each other with a coil located between the sheets or ribbons (see Figure 9).

The core component may be formed from a substantially triangular sheet of amorphous metal which is folded in a concertina-like manner so as to form an elongate ribbon that is thicker in a middle part thereof than at its ends (see Figure 10). Alternatively, a similar structure may be formed by laminating successively shorter strips of ribbon or the like on top of each other, each strip being generally centred about a predetermined point. These structures have the advantage that there is more amorphous metal at a thicker central part of the structure, where there is most flux during operation, than at its thinner ends, where there is less flux. In this way, saturation can be avoided at the central part of the structure while reducing the amount of amorphous material required at the end portions.

The core may be wrapped or wound with first and second coils, the second coil being substantially orthogonal to the first coil, so that power may be captured regardless of a direction of an external field within the plane of the sheet or sheets forming the core (no need for external field to rotate).

The core may be incorporated on or within a portable device which receives and/or transmits power using the core. The following non-exhaustive list illustrates some examples of such devices, possibilities are not limited to those described below:

a. Mobile communication device, for example a radio, mobile telephone or walkie-talkie;
b. Portable computing device, for example a personal digital assistant or palmtop or laptop computer;
c. Portable entertainment devices, for example a music player, games console or toy;
d. Personal care items, for example a toothbrush, shaver, hair curler, hair rollers;
e. A portable imaging device, for example a video camcorder or a camera;
f. Containers of contents that may require heating, for example coffee mugs, plates, cooking pots, nail-polish and cosmetic containers;
g. Consumer devices, for example torches, clocks and fans;
h. Power tools, for example cordless drills and screwdrivers;
i. Wireless peripheral devices, for example wireless computer mouse, keyboard and headset;
j. Time keeping devices, for example clock, wrist watch, stop watch and alarm clock;
k. Battery-pack for insertion into any of the above;
l. Standard-sized battery cell.

For a better understanding of the present invention and to show how it may be carried into effect, reference shall now be made by way of example to the accompanying drawings, in which:

FIGURE 1 shows a prior-art U-U core transformer;

FIGURE 2 shows how two cores of the type shown in Figure 1 may be incorporated

into an electronic device;

FIGURE 3 shows a prior art configuration similar to that of Figure 1, but using an axial core with air as the return path;

FIGURES 4a and 4b show a simple core component of an embodiment of the present invention;

FIGURES 5a to 5c show how the core component of Figures 4a and 4b interacts with an external magnetic field;

FIGURE 6a shows a prior art core component in an electronic device including a metal plane;

FIGURE 6b shows a core component of an embodiment of the present invention in the electronic device of Figure 6a;

FIGURE 7 shows a wireless headset device provided with a core of an embodiment of the present invention;

FIGURE 8 shows an embodiment of the present invention including a coil;

FIGURE 9 shows an embodiment of the present invention comprising two sheets of amorphous metal laminated about a printed coil;

FIGURES 10a to 10e illustrate a method of manufacturing an embodiment of the present invention;

FIGURES 11a to 11c show three different embodiments of the present invention incorporated into a rechargeable battery or cell;

FIGURE 12 shows the battery or cell of Figure 11 located near an external inductive

charging unit; and

FIGURE 13 is a circuit diagram illustrating an embodiment of the present invention.

FIGURE 1 shows a prior-art U-U core transformer showing primary coil 112 through which an alternating current induces an alternating magnetic field in primary core 111. This field then flows between the end-pieces of core 111 and the end-pieces of secondary core 102 through the space therebetween. The field 1 flowing in 102 then induces a current in secondary coil 101.

FIGURE 2 shows how the two cores 111 and 102 of Figure 1 may be incorporated into a prior art electronic device 120 and a charger 130 such that the device 120 may be brought into proximity of the charger 130 to complete a magnetic circuit and transfer power from the charger 130 to the device 120.

FIGURE 3 shows a prior art configuration similar to Figure 1, but using axial cores 102, 111 with air as the return path.

FIGURE 4a shows a laminar sheet of amorphous, non-annealed metal 102 forming a magnetic core component of the present invention coupling to an external magnetic field 1.

FIGURE 4b shows the core component 102 of Figure 4a incorporated within a portable electronic device 120. In the illustrated embodiment, the core 102 is placed on a bottom side of the device 120.

FIGURE 5a shows the device 120 of Figure 4b in plan view and FIGURE 5b shows the device 120 in side view. It can be seen how the high permeability of the core 102 pulls the electromagnetic field 1 into the core 102. Because of this, a field running predominantly under the device 120, shown most clearly in Figure 5b, will be pulled into the device 120, thus coupling effectively to it. FIGURE 5c shows more detailed field lines when two such cores 102 are placed onto a surface which generates a

distributed horizontal field. Note how the field lines travel not only into the ends of the cores, but also into the side surfaces.

FIGURES 6a and 6b show a device 120 which, for reasons unrelated to the present invention, includes a metal plane 125. The flow of flux 1 vertically into a conventional core 108 (Figure 6a) must go through the metal plane 125 and therefore the core 108 suffers from flux exclusion. With a core 102 designed according to embodiments of the present invention (Figure 6b), the flux 1 flows horizontally, alongside the metal plane 125 and through the core 102 with no flux exclusion.

FIGURE 7 shows a portable electronic device 120 in the form of a wireless headset. For ergonomic and aesthetic reasons it is important that this encloses its electronics within a case which is as small and light as possible while conforming to a shape of a human face or head. This makes it a complex curved three-dimensional shape. The laminar amorphous metal core 102 of embodiments of the present invention is able to be bent somewhat to conform to the shape of the headset 120, allowing it to extend for a substantial part of the length of the headset 120, and thus couple very effectively with an external field (not shown).

FIGURE 8 shows a possible arrangement of an electrically-conductive coil 101 spirally wound around a laminar amorphous metal core 102. It is to be noted that the coil 101 is wound about a shorter dimension of the core 102, since most flux will be captured when travelling along the longest planar dimension of the core 102 and therefore more current will be induced in the coil 101 when wound in this configuration.

FIGURE 9 (exploded view) shows a convenient possible method of manufacture of a core with a winding. Two layers of amorphous metal 102, 102' have a printed-circuit coil 101 sandwiched between them. The flux (not shown but travelling horizontally across this Figure) will travel horizontally through the left hand layer 102, then vertically through the printed circuit coil 101, and then horizontally through the right hand layer 102'. This embodiment is easy to manufacture and can be very thin.

FIGURE 10a shows how magnetic field lines 101 entering the core 102 from the ends and sides result in the field strength within the core 102 being a maximum at its centre. As a result, more material is required in the centre to avoid saturation. FIGURE 10b shows a way to fold a single triangular piece of amorphous metal 200 in a concertina-like manner along fold lines 210 to achieve this effect. FIGURE 10c shows the resulting core 102 from above, FIGURE 10d a view from the end of the partially-folded assembly, and FIGURE 10e a view from the side. It will be appreciated that a similar core 102 may be constructed by cutting the sheet of material 200 into strips along the fold lines 210 of Figure 10b and then laminating the strips on top of each other to arrive at a core 102 similar to that of Figures 10c and 10e. Indeed, an equivalent core 102 may be constructed simply by laminating successively shorter strips of amorphous magnetic material on top of each other, the strips not necessarily having been cut from a triangular sheet.

FIGURES 11a to 11c show three possible arrangements of laminar metal core 102 used within a battery cell 140, capable of inductively receiving power for recharging the battery cell 140. In Figure 11a, the core 102 is wrapped completely around the cell 140 as a cylinder, with a coil 101 being wound or wrapped around the core 102. In Figure 11b, a smaller core 102 is placed on or near an outer surface of the cell 140 and bent into a curve to conform with the curvature of the cell 140, again with a coil 101 being wound or wrapped around the core 102 (but not around the cell 140 itself, as in Figure 11a). Figure 11c shows a core 102 placed inside the cell 140 and wound or wrapped with a coil 101.

FIGURE 12 shows an external unit in the form of a charging pad 150 generating a substantially horizontal electromagnetic field 1 and a cell 140 containing a laminar core component 102 in the manner of Figure 11. If the cell 140 is placed on or in proximity to the unit 150, the field 1 generated by the unit 150 will couple to the laminar core 102 and can thus charge the battery 140. The important point to note is that because the cell 140 is relatively thin, and the field 1 is flowing along its length, the cell 140 will receive power regardless of its axial rotation rA. This is particularly

useful if the cell 140 has been placed in a random orientation into a battery holder within a portable electronic device (not shown), as is often the case.

FIGURE 13 shows one possible implementation of the present invention in which an externally-applied alternating magnetic field 1 flows into the ends of an amorphous metal core 102. The core is composed of 6 pieces of Metglas® 2714A cobalt-based amorphous metal tape, each 50mm x 25mm x 0.018mm, stacked on top of one another into a thin laminar composite core. The number of pieces is chosen to prevent saturation at the operational field strength which oscillates at 40kHz.

Around this core 102 are wrapped 40 turns of 0.25 mm diameter enamelled copper wire, creating a flat-wound coil 101. The number of turns is chosen in order to develop sufficient voltage for the subsequent circuit. The gauge is chosen in order to keep resistive (heating) losses low. A thin layer of protective material (e.g. paper or plastic), not shown, may be interposed between the core and the windings to protect the enamel insulation of the windings. The thickness of this entire magnetic assembly is less than 1mm.

Optionally, capacitor C1 (150nF) increases the Q of the magnetic assembly to a moderate value, allowing more energy to be captured from the external magnetic field 1. Raising the Q also tunes the assembly, and increases the dissipation in the coil 101, but this low value still leaves the assembly relatively efficient and insensitive to variations in the frequency of the externally-applied magnetic field 1. An alternative circuit topology would be a capacitor in series with the load (series-resonant) rather than the parallel-resonant topology shown here. However this causes a large current to flow through the capacitor and large voltages to be developed across it, causing it to become hot and possibly break down due to excessive voltage.

Optionally, the power collected by the above magnetic assembly can flow directly into a component capable of utilizing AC power directly, for example resistor R1, which is a heating coil, providing heat to a cup-warming device (not shown) for example. However more typically the power is converted to DC for use by

conventional electric or electronic circuits.

In this regard, the coil 101 is centre-tapped and current flows from it into a full-wave rectifier consisting of power diodes D1, D2, and thence into smoothing capacitor C2 of 1uF which smoothes the 40kHz ripple to an acceptable level, providing a DC voltage of approximately 5V.

In some applications, the external alternating magnetic field 1 may, in addition to its alternation at 40kHz, also rotate approximately in the plane of the core 102, perhaps at some lower frequency. In this case the smoothing capacitor C2 must be of sufficient capacity to ride out the dips in voltage caused when the external field 1 is at 90 degrees to the coil 101 and thus induces no current therein.

An optional 3-terminal regulator Q1 may be provided to convert the smoothed DC into regulated DC.

The circuit then connects to the device 120 in/to which it is fitted, providing the device 120 with power. For example, the entire circuit above may be fitted inside the back casing of a mobile telephone and connected to its power/charging circuits, delivering 2W to charge at the same rate as a conventional plug-in charger.

Optionally, the device 120 might be a rechargeable cell, in which case regulator Q1 might be a charge-controller integrated circuit capable of managing fast-charging, trickle charging and the like.

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

CLAIMS:

1. A magnetic core component for transferring power by induction to or from a device, the magnetic core component including a thin sheet of metal in a substantially amorphous or non-annealed state and being provided with means for transferring induced electrical power from the core component to a device.

2. A core component as claimed in claim 1, wherein the metal is at least 70% amorphous or non-annealed.

3. A core component as claimed in claim 1, wherein the metal is at least 90% amorphous or non-annealed.

4. A core component as claimed in any preceding claim, wherein the sheet of metal has a thickness of 0.5mm or less.

5. A core component as claimed in any one of claims 1 to 3, wherein the sheet of metal has a thickness of 0.1mm or less.

6. A core component as claimed in any preceding claim, wherein the sheet of metal is flexible.

7. A core component as claimed in any preceding claim, wherein the sheet of metal is a multilayered sheet.

8. A core component as claimed in claim 7, wherein the multilayered sheet comprises layers of two or more different metals.

9. A core component as claimed in any preceding claim, wherein the sheet of metal is provided with a coil of conductive wire or tape or a flexible printed circuit.

10. A core component as claimed in claim 9, wherein the sheet of metal has a

longer and a shorter planar dimension, and wherein the coil of conductive wire or tape or the flexible printed circuit is wrapped or wound around the shorter planar dimension.

11. A core component as claimed in claim 9 or 10, wherein the coil or the flexible printed circuit is tuned to a higher quality factor (Q) with a capacitor connected in series or in parallel.

12. A core component as claimed in claim 11 depending ultimately from claim 7, wherein the capacitor is formed by separate metal layers of the multilayer sheet, separated by layers of a dielectric material.

13. A core component as claimed in claim 9 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a half- or full-wave rectifier.

14. A core component as claimed in claim 9 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a smoothing capacitor.

15. A core component as claimed in claim 9 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a regulator or a battery charge-controller.

16. A core component as claimed in any preceding claim, wherein the core component includes at least two sheets of metal material laminated to each other about a coil.

17. A core component as claimed in any preceding claim, wherein the sheet of metal material is thicker in a central part thereof than at end parts thereof.

18. A core component as claimed in claim 17, wherein the sheet of metal material is formed by folding a larger sheet of metal material in a concertina-like manner.

19. A core component as claimed in claim 18, wherein the larger sheet of metal material is generally triangular.

20. A core component as claimed in claim 9 or claim 16 or any claim depending therefrom, wherein an additional coil or flexible printed circuit is provided in a configuration substantially orthogonal to the said coil or flexible printed circuit.

21. A device provided with a magnetic core component for receiving or transmitting power by electromagnetic induction, characterised in that the magnetic core component includes a thin sheet of metal in a substantially amorphous or non-annealed state.

22. A device as claimed in claim 21, wherein the metal is at least 70% amorphous or non-annealed.

23. A device as claimed in claim 21, wherein the metal is at least 90% amorphous or non-annealed.

24. A device as claimed in claim 22 or 23, wherein the sheet of metal has a thickness of 0.5mm or less.

25. A device as claimed in claim 22 or 23, wherein the sheet of metal has a thickness of 0.1mm or less.

26. A device as claimed in any one of claims 21 to 25, wherein the sheet of metal is flexible.

27. A device as claimed in any one of claims 21 to 27, wherein the sheet of metal is a multilayered sheet.

28. A device as claimed in claim 27, wherein the multilayered sheet comprises

layers of two or more different metals.

29. A device as claimed in any one of claims 21 to 28, wherein the sheet of metal is provided with a coil of conductive wire or tape or a flexible printed circuit.

30. A device as claimed in claim 29, wherein the sheet of metal has a longer and a shorter planar dimension, and wherein the coil of conductive wire or tape or the flexible printed circuit is wrapped or wound around the shorter planar dimension.

31. A device as claimed in claim 29 or 30, wherein the coil or the flexible printed circuit is tuned to a higher quality factor (Q) with a capacitor connected in series or in parallel.

32. A device as claimed in claim 31 depending ultimately from claim 27, wherein the capacitor is formed by separate metal layers of the multilayer sheet, separated by layers of a dielectric material.

33. A device as claimed in claim 29 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a half- or full-wave rectifier.

34. A device as claimed in claim 29 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a smoothing capacitor.

35. A device as claimed in claim 29 or any claim depending therefrom, wherein the coil or the flexible printed circuit is connected to a regulator or a battery charge-controller.

36. A device as claimed in any one of claims 21 to 35, wherein the core component includes at least two sheets of metal material laminated to each other about a coil.

37. A device as claimed in any one of claims 21 to 36, wherein the sheet of metal

material is thicker in a central part thereof than at end parts thereof.

38. A device as claimed in claim 37, wherein the sheet of metal material is formed by folding a larger sheet of metal material in a concertina-like manner.

39. A device as claimed in claim 38, wherein the larger sheet of metal material is generally triangular.

40. A device as claimed in claim 29 or claim 36 or any claim depending therefrom, wherein an additional coil or flexible printed circuit is provided in a configuration substantially orthogonal to the said coil or flexible printed circuit.

41. A device as claimed in any one of claims 21 to 40, wherein the sheet of metal material is at least partially wrapped around an axis of the device such that it couples with an electromagnetic field in any rotation about the axis.

42. A magnetic core component, substantially as hereinbefore described with reference to or as shown in Figures 4, 5a, 5b, 5c, 6b and 7 to 13 of the accompanying drawings.

43. A device provided with magnetic core component, substantially as hereinbefore described with reference to or as shown in Figures 4, 5a, 5b, 5c, 6b and 7 to 13 of the accompanying drawings.

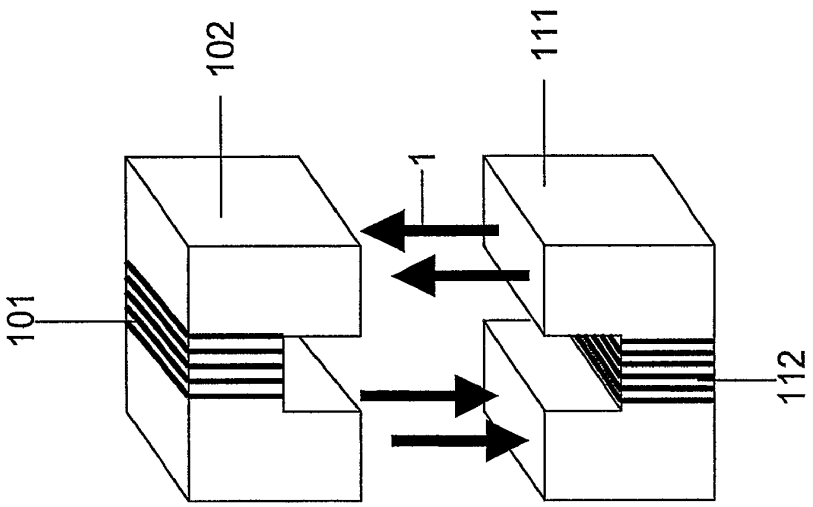


Figure 1 (Prior Art)

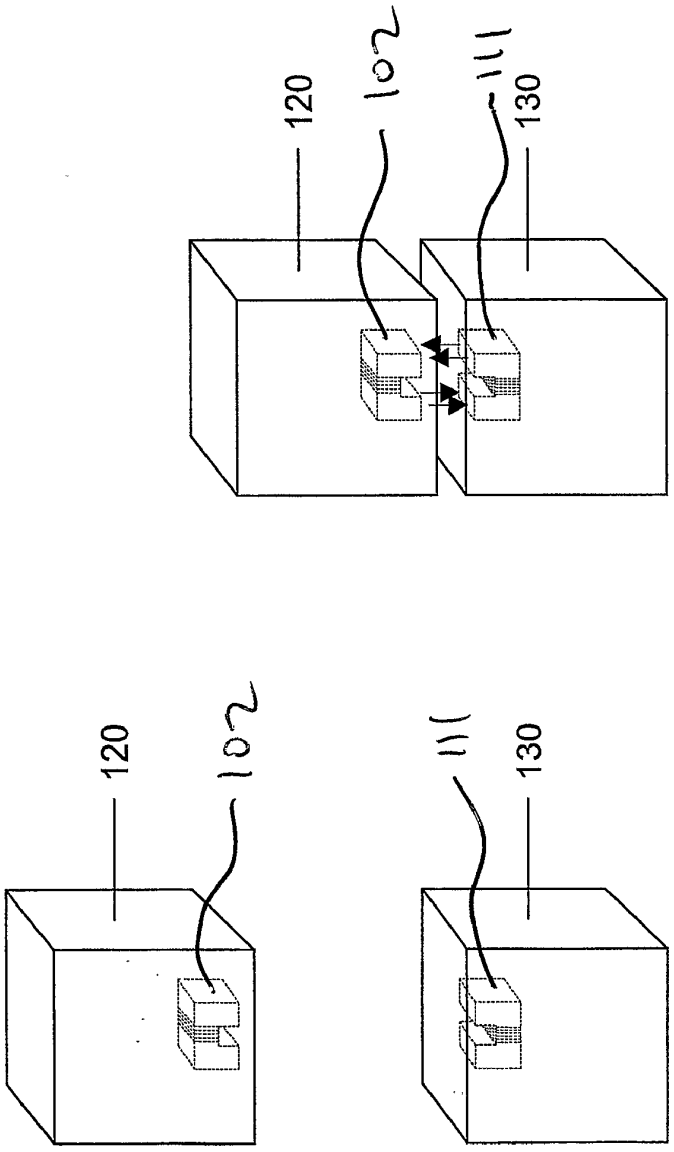


Figure 2 (Prior Art)

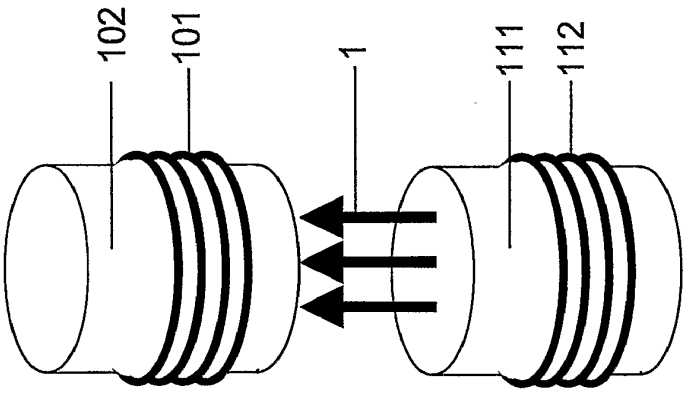


Figure 3 (Prior Art)

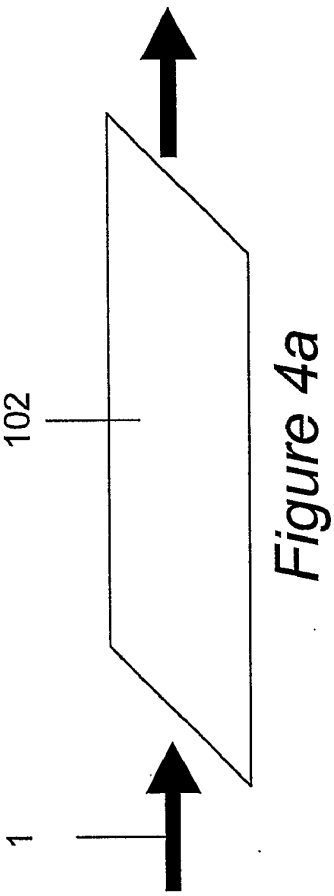


Figure 4a

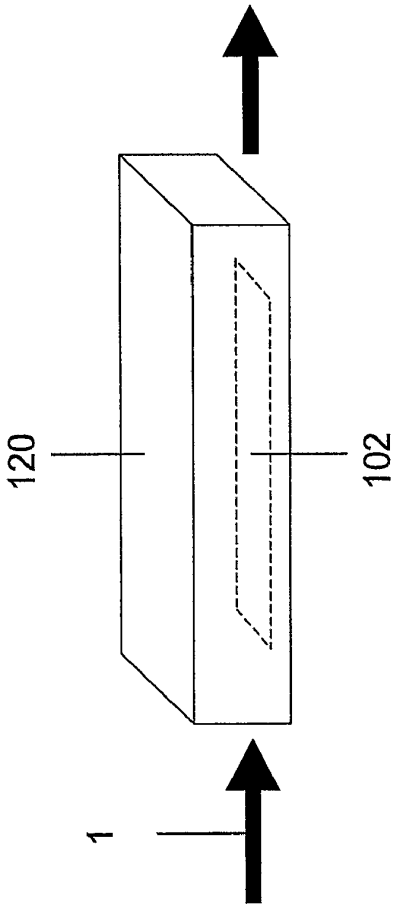


Figure 4b

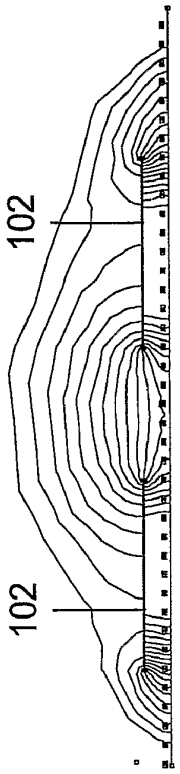


Figure 5c

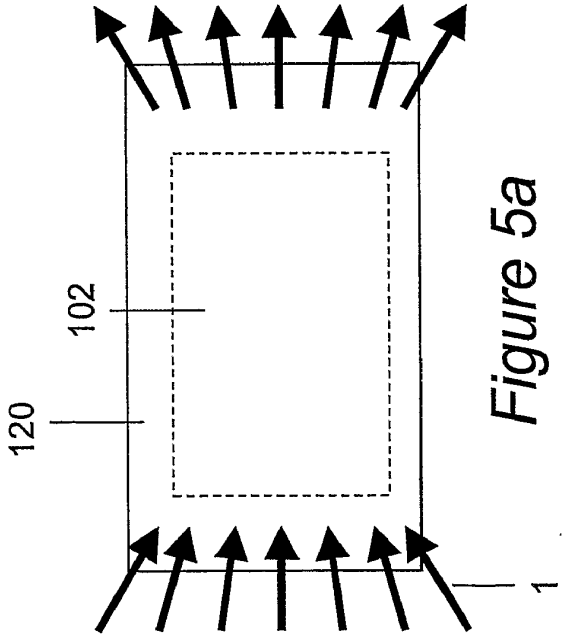


Figure 5a

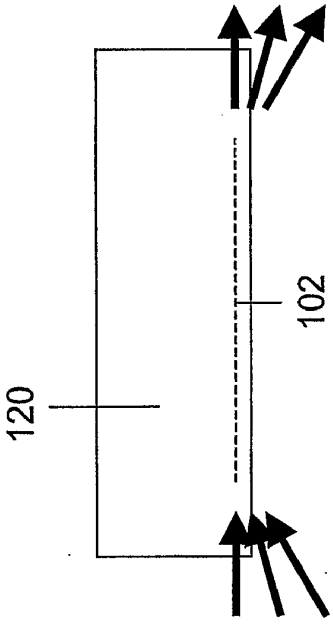
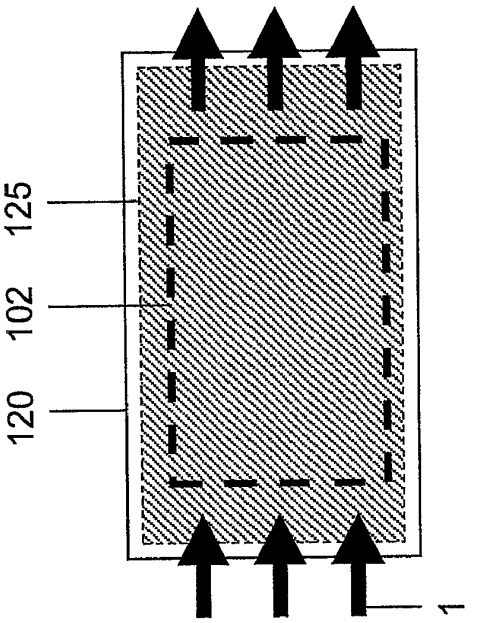


Figure 5b



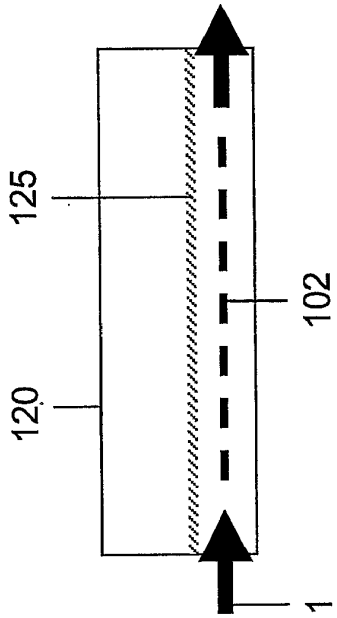
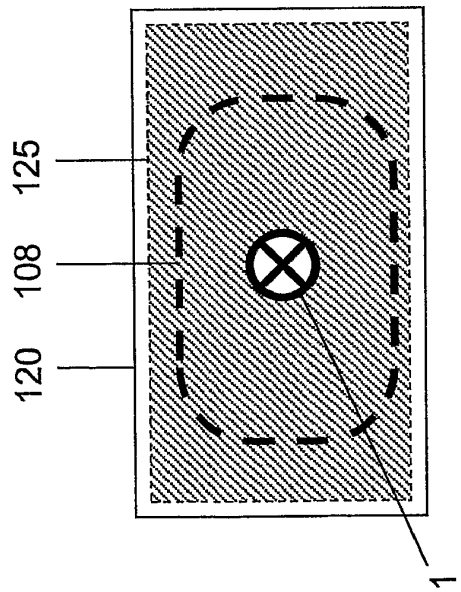


Figure 6b



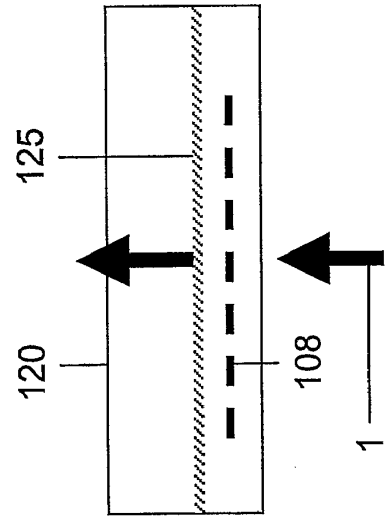


Figure 6a

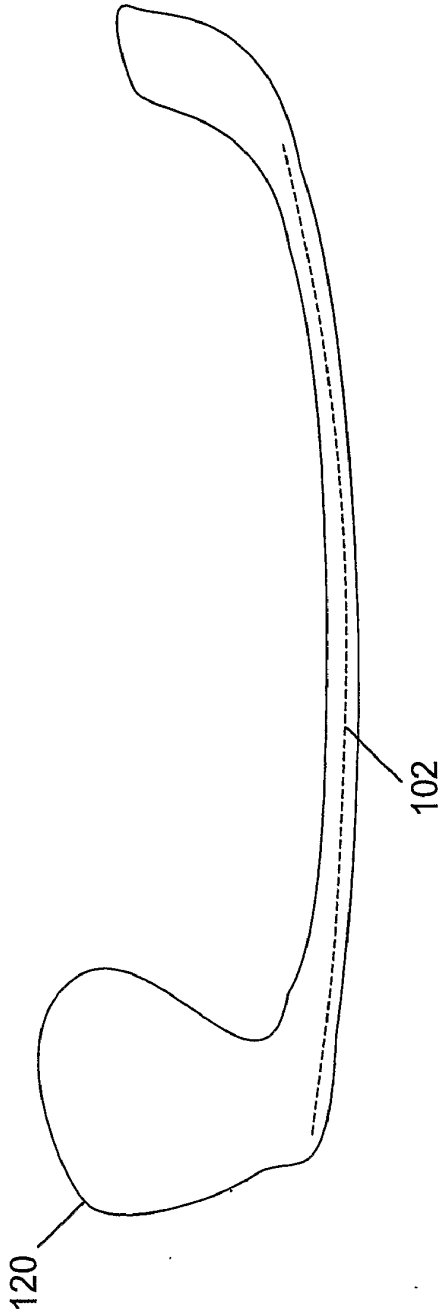


Figure 7

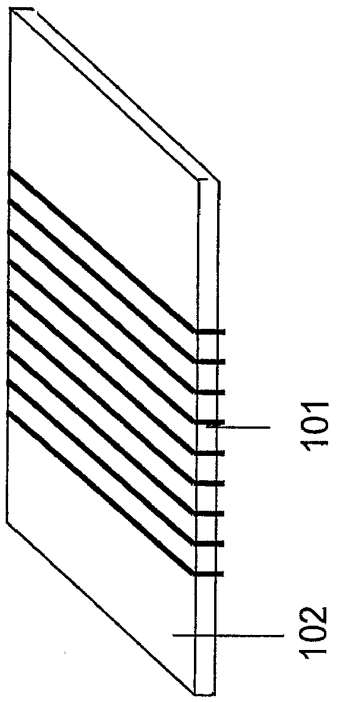


Figure 8

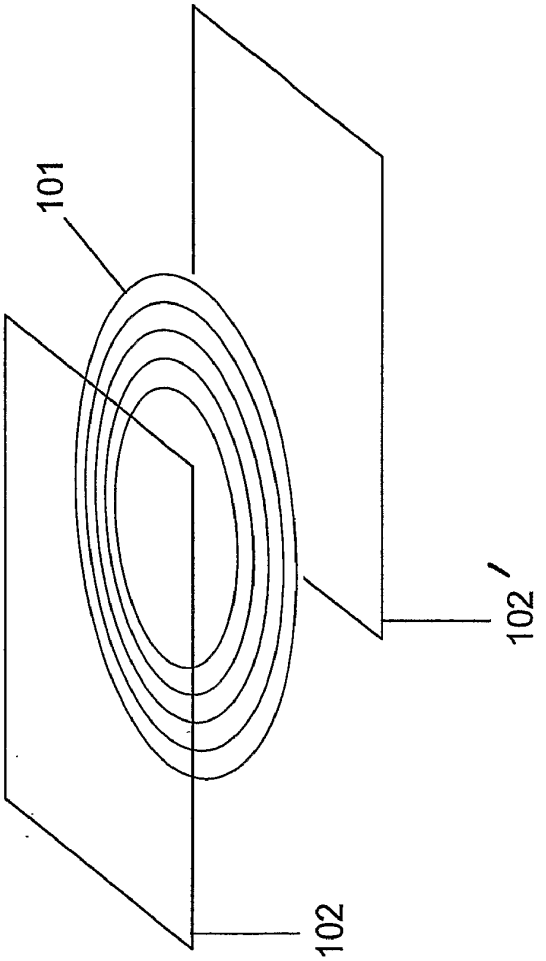


Figure 9
(exploded drawing)

Figure 10a

Figure 10d

Figure 10e

Figure 10b

Figure 10c

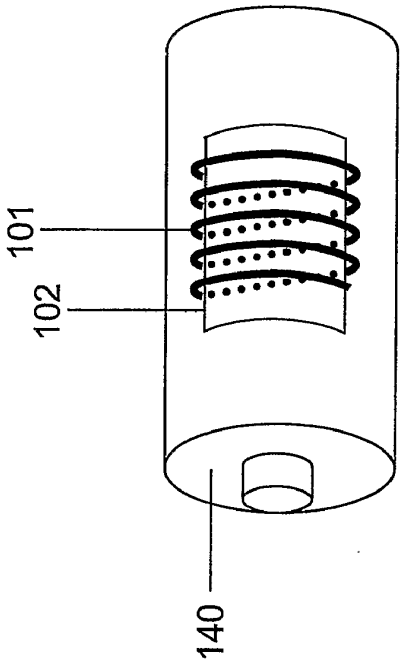


Figure 11b

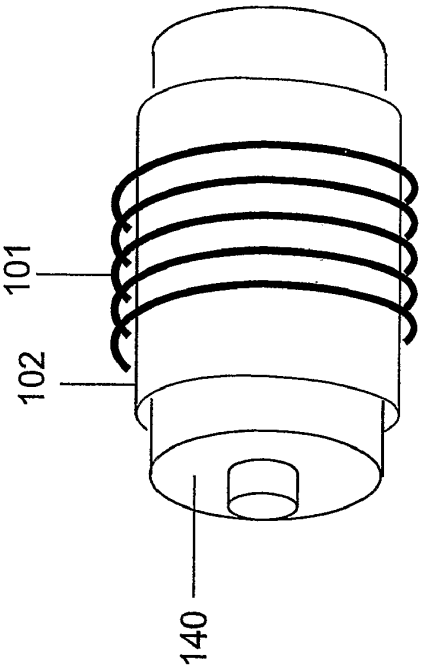


Figure 11a

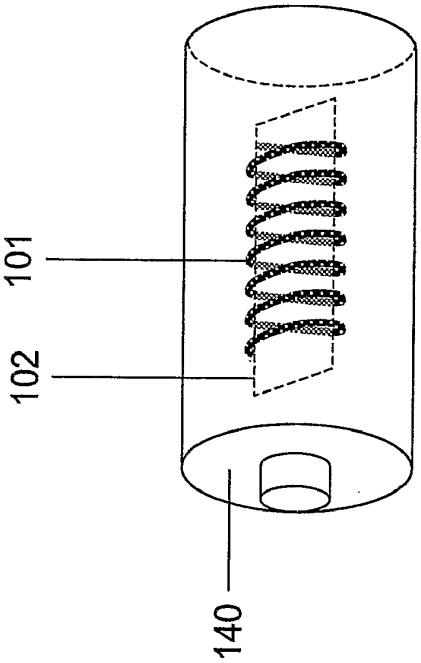


Figure 11c

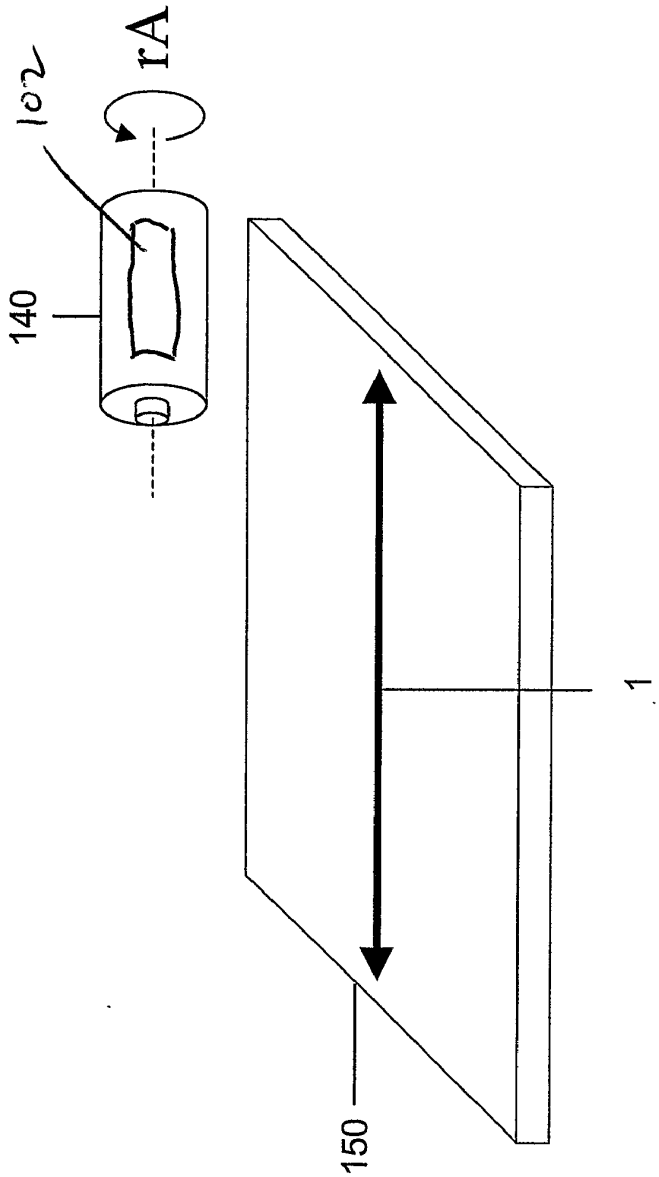


Figure 12

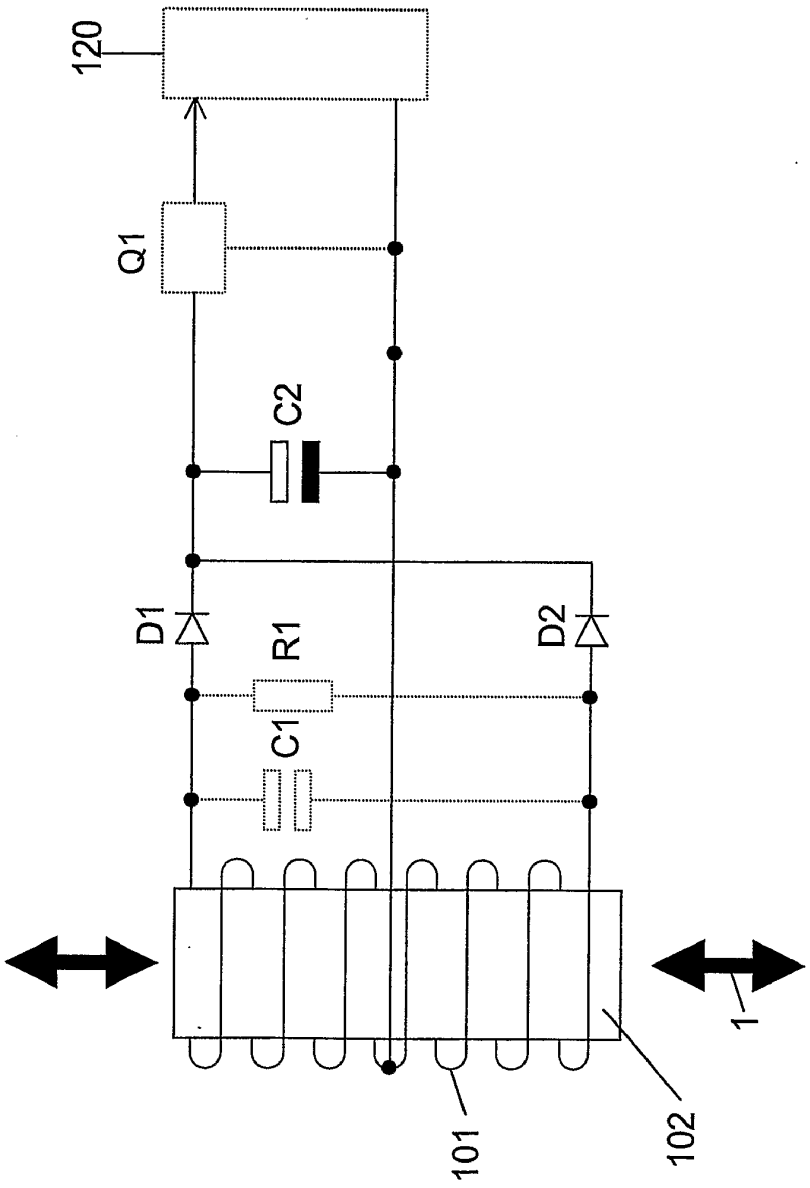


Figure 13

INTERNATIONAL SEARCH REPORT

Internat Application No
PCT/GB 03/02038

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01F41/02 H01F27/25 H02J7/02

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 7 H01F H02J

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 528 113 A (BOYS JOHN T ET AL) 18 June 1996 (1996-06-18) column 3, line 1-12; figure 2	1
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 14, 31 December 1998 (1998-12-31) & JP 10 241936 A (ALPS ELECTRIC CO LTD), 11 September 1998 (1998-09-11) abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"T" 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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2003	04/09/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Durville, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/GB 03/02038

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5528113 A	18-06-1996	AU 8006494 A	08-05-1995
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		DE 4498007 T0	21-11-1996
		DE 69432262 D1	17-04-2003
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		NZ 274939 A	24-06-1997
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JP 10241936 A	11-09-1998	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平8－838

(43)公開日　平成８年(1996)１月９日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ａ６３Ｈ　30/02		Ｚ		

審査請求　未請求　請求項の数３　ＦＤ　（全　６　頁）

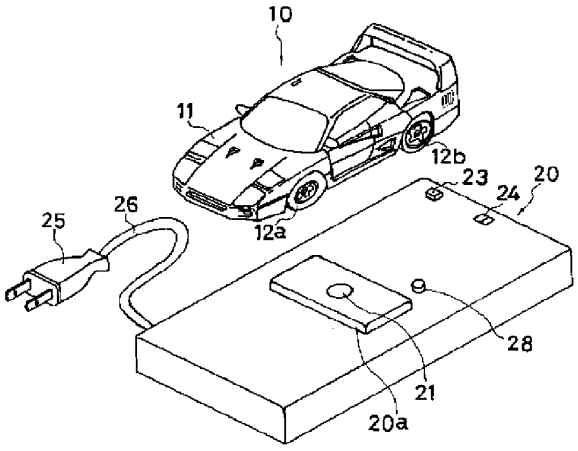
(21)出願番号　特願平6－159687

(22)出願日　平成６年(1994)６月20日

(71)出願人　390027889
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東京都葛飾区東四つ木１丁目23番17号
(74)代理人　弁理士　桜井　隆夫

(54)【発明の名称】　電磁誘導充電方式の乗物玩具

(57)【要約】
【目的】　電池を搭載したまま充電することにより電池の充電に際し電池の劣化を防ぎ、また充電器プラグなどの破損や腐食による接触不良をなくし、誰でも簡単に安全かつ確実に電池を充電できる乗物玩具を提供する。
【構成】　外部磁界による電磁誘導により、乗物玩具１０に内蔵された電池１７を充電する電磁誘導充電手段を備える。



1

【特許請求の範囲】
【請求項１】　外部磁界による電磁誘導により、乗物玩具に内蔵された電池を充電する電磁誘導充電手段を備えた電磁誘導充電方式の乗物玩具。
【請求項２】　電磁誘電により電流を発生する第１の誘導コイルと、第１の誘導コイルに発生した交流電流を直流に変換して充電する整流器と、該整流器の電流により充電される充電式電池と、該電池により駆動される駆動手段と、該電池と前記整流器または駆動手段との回路を切り換え接続する切り換え手段とを搭載した乗物玩具本体と、前記第１の誘導コイルに接近させると該第１の誘導コイルに電磁誘導電流を発生させるような磁界を発生する第２の誘導コイルと、第２の誘導コイルを充電制御手段を介して電源に接続する接続手段とを設けた充電台とを備えた請求項１に記載の電磁誘導充電方式の乗物玩具。
【請求項３】　前記乗物玩具本体を前記充電台の上に載せたときに、前記乗物玩具本体の整流器と充電式電池との回路がオンに、該電池と駆動手段との回路がオフになり、乗物玩具本体を充電台から下ろしたときは、前記整流器と充電式電池の回路がオフになり充電式電池と駆動手段との回路がオンになる第１の切り換え手段を乗り物玩具本体に備え、乗物玩具本体を充電台の上に載せたときは商用電源と充電台との回路がオンになり、乗物玩具本体を充電台から下ろしたときは、商用電源と充電台との回路がオフとなる第２の切り換え手段を充電台に備えた請求項１または２に記載の電磁誘導充電方式の乗物玩具。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、電池駆動の乗物玩具を誘電磁界を発生させる充電台の上に置くだけで乗物玩具に内蔵された電池に充電することのできる乗物玩具に関するものである。
【０００２】
【従来の技術】従来、電池駆動の乗物玩具などにおいて、使用する電池を充電する場合には、玩具から電池を取り出した後に専用の充電器により電池を充電するか、あるいは電池は玩具に内蔵したまま外部の充電器から接続プラグを介して充電を行っていた。
【０００３】しかしながら、玩具から電池を取り出して充電する場合には、頻繁に電池の脱着を繰り返すため電池の被膜などが劣化したり、外部の充電器からプラグを介して充電する場合には、プラグが破損したり腐食により充電しにくくなる欠点があった。また、電池を交換する場合に、電池の陽極と陰極の方向を間違えて入れてしまうことがあった。
【０００４】
【発明が解決しようとする課題】そこで本発明は、電池を搭載したまま充電することにより電池の充電に際し電池の劣化を防ぎ、また充電器プラグなどの破損や腐食による接触不良をなくし、誰でも簡単に安全かつ確実に電池を充電できる乗物玩具を提供することを目的とする。

2

【０００５】
【課題を解決するための手段】上記目的を達成するために、本発明の電磁誘導充電方式の乗物玩具は、外部磁界による電磁誘導により、乗物玩具に内蔵された電池を充電する電磁誘導充電手段を備えるものである。
【０００６】また、電磁誘電により電流を発生する第１の誘導コイルと、第１の誘導コイルに発生した交流電流を直流に変換して充電する整流器と、該整流器の電流により充電される充電式電池と、該電池により駆動される駆動手段と、該電池と前記整流器または駆動手段との回路を切り換え接続する切り換え手段とを搭載した乗物玩具本体と、前記第１の誘導コイルに接近させると該第１の誘導コイルに電磁誘導電流を発生させるような磁界を発生する第２の誘導コイルと、第２の誘導コイルを充電制御手段を介して電源に接続する接続手段とを設けた充電台とを備えることが好ましい。
【０００７】さらに、前記乗物玩具本体を前記充電台の上に載せたときに、前記乗物玩具本体の整流器と充電式電池との回路がオンに、該電池と駆動手段との回路がオフになり、乗物玩具本体を充電台から下ろしたときは、前記整流器と充電式電池の回路がオフになり充電式電池と駆動手段との回路がオンになる第１の切り換え手段を乗り物玩具本体に備え、乗物玩具本体を充電台の上に載せたときは商用電源と充電台との回路がオンになり、乗物玩具本体を充電台から下ろしたときは、商用電源と充電台との回路がオフとなる第２の切り換え手段を充電台に備えることが好ましい。
【０００８】
【作用】本発明の構成の電磁誘導充電方式の乗物玩具は、外部磁界による電磁誘導の原理で乗物玩具に内蔵された電池に充電される。
【０００９】また、乗物玩具本体を充電台の上に載せて、充電台に内蔵した電磁誘電効果を生ずる磁界を発生した第２の誘導コイルに乗物玩具本体に搭載した第１の誘導コイルを接近させて、該第１の誘導コイルに電磁誘導により交流電流を発生させる。この第１の誘導コイルに発生した交流電流を整流器により直流に変換して充電式電池に充電する。充電された電池は、切り換え手段により乗物玩具本体のの駆動手段に接続され駆動手段を駆動する。前記充電台の第２の誘導コイルは、充電制御手段を介して商用電源に接続され、接近した置かれた前記第１の誘導コイルに電磁誘電電流を発生させるような磁界を発生させる。
【００１０】さらに、乗物玩具本体を充電台の上に載せると内蔵した整流器と電池との回路がオンになり、電池と駆動部との回路がオフになる第１の切り換え手段を備えるので充電台に乗物玩具車体を載せるだけで内蔵した

電池に自動的に充電される。また、前記第１の切り換え手段は、乗物玩具車体を充電台から下ろすと整流器と電池の回路がオフになり、電池と駆動部との回路がオンになるので、直ちに駆動手段により駆動できる。

【００１１】

【実施例】以下、本発明を図示の一実施例により具体的に説明する。図１乃至図８は本発明の実施例であり、図１は乗物玩具本体及び充電台の斜視図、図２は乗物玩具本体内部の機器配置を示す断面図、図３は乗物玩具本体内部の機器配置を示す平面図、図４は充電台の機器配置を示す断面図、図５は充電台の機器配置を示す平面図、図６は送信機の斜視図、図７は送信機の内部構成を示す図、図８は全体構成を示すブロック図である。

【００１２】これらの図において、本発明の電磁誘導充電方式の乗物玩具は、乗物玩具本体１０と、この乗物玩具本体１０に内蔵した電池を充電するための充電台２０と、乗物玩具本体１０をラジオ・コントロールにより操縦するための送信機３０などとからなる。

【００１３】乗物玩具本体１０は、プラスチックなどの材料を成型して形成された車体１１に左右の操縦車輪１２ａ，１２ａと左右の駆動車輪１２ｂ，１２ｂとを備えており、操縦車輪１２ａ，１２ａは操縦部１３で左右に操縦され、駆動車輪１２ｂ，１２ｂは駆動部１４の駆動モータ１４ａで駆動されるようになっている。

【００１４】車体１１のほぼ中央部の下部側には、第１電磁誘導コイル１５が配設され、また車体１１内部には、整流器１６及び充電式電池１７が配設され、さらに切換えスイッチ１８（第１切換え手段）が車体１１を充電台２０に載せたときその充電台２０に形成された突起２８に対応する位置に設けられている。この切換えスイッチ１８（第１切換え手段）は、車体１１を充電台２０に載せたとき突起２８によって押し上げられて作動し、整流器１６と電池１７との間がオンに、電池１７と受信部１９との間がオフになり、車体１１を充電台２０から下ろすと、整流器１６と電池１７との間がオフになり、電池１７と受信部１９との間がオンになるようになっている。

【００１５】充電台２０は、例えば、プラスチックなどの材料からなり、上部に車体１１を載せることができる大きさの扁平な矩形状に形成されるとともに、中央部の上部は矩形状の低い突起部２０ａが形成されている。この充電台２０の突起部２０ａの内側部分には、車体１１を突起部２０ａに合わせて充電台２０に載せたとき、第１電磁誘導コイル１５ができるだけ接近するように、これに対応する位置に第２電磁誘導コイル２１が配設され、かつこの第２電磁誘導コイル２１を制御する充電制御部（充電制御手段）２２が配設されている。また、充電台２０には、車体１１に設けられた突起２９に対応する位置にスイッチ２３（第２の切換え手段）が設けられている。このスイッチ２３（第２の切換え手段）は、車体１１を充電台２０に載せないときは主スイッチ２４と充電制御部２２との間の回路を切断し、車体１１を充電台２０に載せたときは突起２９により押し下げられて主スイッチ２４と充電制御部２２の回路を接続するようになっている。充電台２０は、スイッチ２３（第２の切換え手段）、主スイッチ２４、電線２６及び接続プラグ２５を介して商用電源に接続されるようになっている。

【００１６】送信機３０は、そのケース３１の正面側にコントロール・スティック３５ａ，３５ｂ、上部の中央部にアンテナ３２が設けられ、内部には送信部３３、この送信部３３へ電源を供給する電池３４及びスイッチ３６が設けられている。

【００１７】上記構成によれば、まず接続プラグ２５を商用電源に接続し主スイッチ２４をオンにすると、充電台２０には電源が供給されるが、乗物玩具本体１０が充電台２０の上に載っていない状態では、スイッチ２３がオフになっており充電制御部２２には電流は流れない。

【００１８】次に、乗物玩具本体１０を充電台２０の上に載せると、充電台２０のスイッチ２３は車体１１下部の突起２９により押し下げられオンになる。これにより、充電台２０には充電制御部２２を介して第２誘導コイル２１に電流が流れて誘電磁界を発生する。

【００１９】充電台２０の上に載せた車体１１の切換えスイッチ１８は、電池１７と受信部１９の回路をオフし、整流器１６を電池１７に接続する。一方、充電台２０の上に載せられた車体１１に設けられた第１の誘導コイル１５は、充電台２０の第２の誘導コイル２１に対応する位置に接近するため、この第２の誘導コイル２１の磁場により第１の誘導コイル１５に電磁誘導の原理により誘導電流が発生する。この誘導電流は整流器１６により直流に変換され、電池１７を充電する。

【００２０】このようにして乗物玩具本体１０を充電台２０の上で所定時間載せたままにしておくことにより、充電が完了する。充電が完了して乗物玩具１０を充電台２０の上から下ろすと、充電台２０のスイッチ２３は車体１１の突起２９から離れるのでオフになり、充電制御部２２、第１誘導コイル２１の電流は断たれる。また、車体１１の切換えスイッチ１８は、充電台２０の突起２８から離れて切換わり第１の誘導コイル１５及び整流器１６と電池１７の回路がオフになり、電池１７と受信部１９の回路が接続される。

【００２１】そこで、乗物玩具１０を床の上に置き、送信器３０のスイッチ３６をオンにしてコントロール・スティック３５ａ，３５ｂを操作することにより操縦、駆動の信号がアンテナ３２から送信され、この信号が車体１１側の受信部１９で受信され、操縦部１３及び駆動部１４が制御されることにより、乗物玩具１０を前進、停止、前後左右に自在に操作できる。

【００２２】なお、上記実施例では、充電台２０に車体１１を載せたときに充電が行われるようにスイッチを設

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けた例を説明したが、これらのスイッチを設けず充電台に載せる車体の方向に無関係に充電できるようにすることもできる。

【００２３】本発明の好適な実施例について説明したが、本発明の精神を逸脱しない範囲において種々の改良及び変更をなし得ることはもちろんである。

【００２４】

【発明の効果】以上説明したように、本発明の電磁誘導充電方式の乗物玩具によれば、誘導コイルと電池を内蔵した乗物玩具を充電台の上に置くだけで、電磁誘導の原理で乗物玩具に内蔵された電池に容易に充電でき、乗物玩具から電池を取り出したり乗物玩具に接続プラグを直接つないだりする必要がない。したがって、充電が極めて容易で幼児でも充電操作を行うことができ、また電池の破損の機会が少なく、プラグの腐食などによる充電不良を防止できる。さらに、充電の際の取り扱いが簡単になり幼児にも安全である。

【図面の簡単な説明】

【図１】本発明実施例の乗物玩具本体及び充電台の斜視図である。

【図２】本発明実施例の乗物玩具本体内部の機器配置を示す断面図である。

【図３】本発明実施例の乗物玩具本体内部の機器配置を示す平面図である。

【図４】本発明実施例の充電台の機器配置を示す断面図である。

【図５】本発明実施例の充電台の機器配置を示す平面図である。

【図６】本発明実施例の送信機の斜視図である。

【図７】本発明実施例の送信機の内部構成を示す図である。

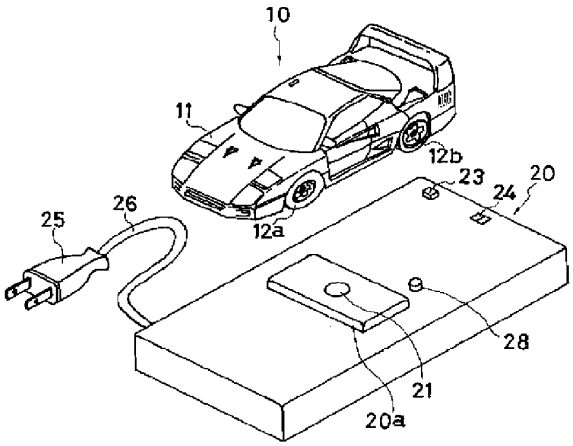
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【図８】本発明実施例の全体構成を示すブロック図である。

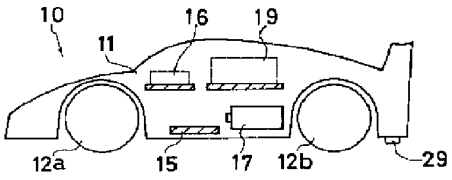
【符号の説明】

１０　乗物玩具
１１　車体
１２　車輪
１３　操縦部
１４　駆動部
１４ａ　駆動モータ
１５　第１の誘導コイル
１６　整流器
１７　電池
１８　切換えスイッチ
１９　受信部
２０　充電台
２１　第１の誘導コイル
２２　充電制御部
２３　スイッチ
２４　主スイッチ
２５　接続プラグ
２６　電線
２８　突起
２９　突起
３０　送信機
３１　ケース
３２　アンテナ
３３　送信部
３４　電池
３５　コントロール・スティック
３６　スイッチ

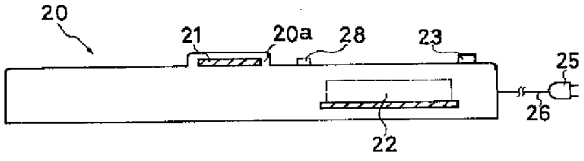
【図１】



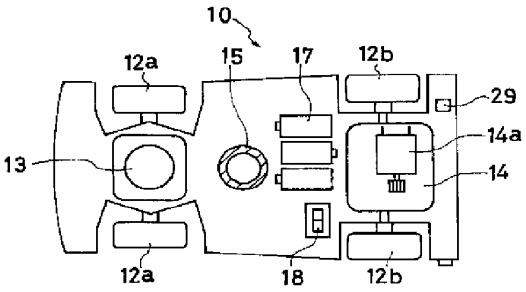
【図２】



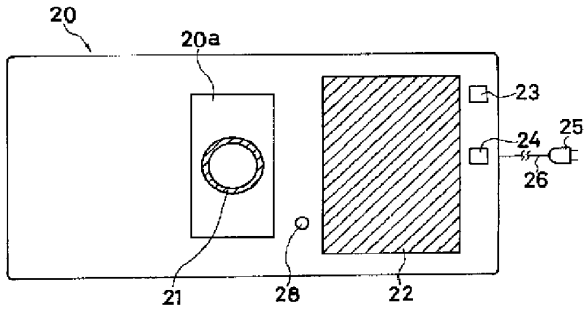
【図４】



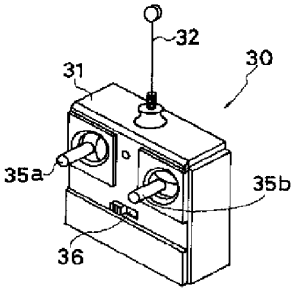
【図３】


10
12a
15
17
12b
29
14a
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14
12a
18
12b

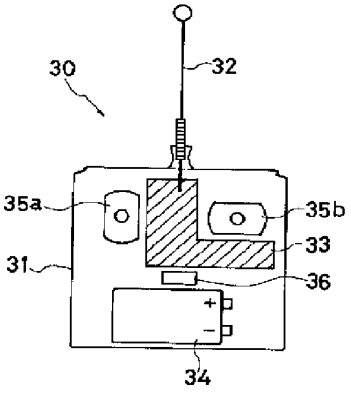
【図５】


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20a
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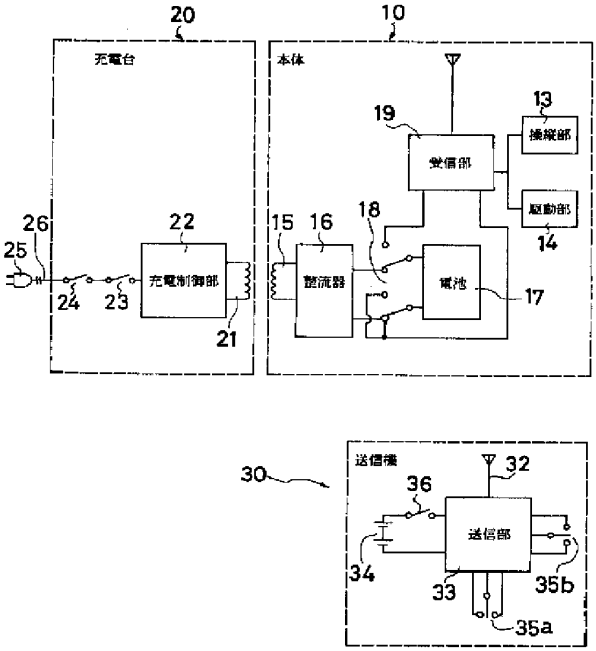
【図６】


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35a
35b
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【図７】


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35a
35b
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+
−
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【図８】


20
10
充電台
本体
19
13
受信部
操縦部
駆動部
14
26
25
22
15
16
18
24
23
充電制御部
整流器
電池
17
21
30
送信機
32
36
送信部
34
33
35b
35a

PAT-NO: JP408000838A

DOCUMENT-IDENTIFIER: JP 08000838 A

TITLE: VEHICLE TOY OF ELECTROMAGNETIC INDUCTION CHARGING SYSTEM

PUBN-DATE: January 9, 1996

INVENTOR-INFORMATION:

NAME	COUNTRY
SUDO, SHOHEI	

ASSIGNEE-INFORMATION:

NAME	COUNTRY
TAIYO KOGYO KK	N/A

APPL-NO: JP06159687

APPL-DATE: June 20, 1994

INT-CL (IPC): A63H030/02

ABSTRACT:

PURPOSE: To easily, safely and surely perform charging by eliminating any contact defect caused by the damage or corrosion of a charger plug by preventing a battery from being degraded in the case of charging by providing an electromagnetic induction charging means for charging the battery built in the vehicle toy with electromagnetic induction due to an external magnetic field.

CONSTITUTION: First of all, when a connection plug 25 is connected to a commercial power source and a main switch 24 is turned on, power is supplied to a charging stand 20. Next, when a main body 10 of the vehicle toy is put on the charging stand 20, a switch 23 is pushed down with a projection at the lower part of a car body 11 and turned on, a current flows through a charging control part to a second induction coil 21 of the charging stand 20, and an induction magnetic field is generated. On the other hand, since a first induction coil provided at the car body 11 put on the charging stand 20 is made closer to the position corresponding to the second induction coil 21 of the charging stand 20, with the magnetic field of this second induction coil 21, an induction current is generated at the first induction coil by the principle of electromagnetic induction. This induction current is converted to DC by a rectifier and charges the battery built in the car body 11.

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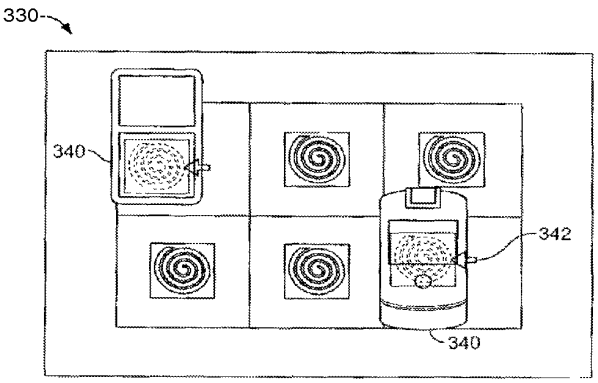
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[Continued on next page]

(54) **Title:** SYSTEM AND METHOD FOR INDUCTIVE CHARGING OF PORTABLE DEVICES



FIG, 16

(57) **Abstract:** A system and method for variable power transfer in an inductive charging or power system. In accordance with an embodiment the system comprises a pad or similar base unit that contains a primary, which creates an alternating magnetic field. A receiver comprises a means for receiving the energy from the alternating magnetic field from the pad and transferring it to a mobile device, battery, or other device. In accordance with various embodiments, additional features can be incorporated into the system to provide greater power transfer efficiency, and to allow the system to be easily modified for applications that have different power requirements. These include variations in the material used to manufacture the primary and/or the receiver coils; modified circuit designs to be used on the primary and/or receiver side; and additional circuits and components that perform specialized tasks, such as mobile device or battery identification, and automatic voltage or power-setting for different devices or batteries.

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Published:
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SYSTEIVI AMD METHOD FOR INDUCTIVE CHARGING OF PORTABLE DEVICES

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Afshin Partovi
Michael Sears

Cg℗γπght_Noɪigg

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Claim of Priority:

[0001] This application claims priority to U.S. patent application 12/1 16,876, filed May 7, 2008, titled "SYSTEM AND METHOD FOR INDUCTiVE CHARGING OF PORTABLE DEVICES", which is a continuation-in-part of U.S. patent application 11/669,1 13, filed 1/30/2007, titled "INDUCTiVE POWER SOURCE AND CHARGING SYSTEM", which application claims the benefit of U.S. provisional patent application 60/763,816, filed 1/31/2006, titled "PORTABLE INDUCTIVE POWER SOURCE"; U.S. provisional patent application 60/810,262, filed 6/1/2006, titled "MOBILE DEViCE, CHARGER, AND POWER SUPPLY"; U.S. provisionai patent appiication 60/810,298, filed 6/1/2006, titled "MOBILE DEVICE, BATTERY, CHARGiNG SYSTEM, AND POWER SUPPLY"; and U.S. provisional patent application 60/868,674, filed 12/5/2006, titled "SYSTEM FOR PROVIDING A PORTABLE iNDUCTIVE POWER SOURCE"; this application also claims the benefit of U.S. provisional patent application 60/916,748, filed 5/8/2007, titled "CHARGING AND POWERING MOBILE DEVICES, BATTERIES"; U.S. provisional patent application 60/952,835, filed 7/30/2007, titled "INDUCTIVE CHARGING OF PORTABLE DEVICES"; U.S. provisionai patent application 61/012,922, filed 12/12/2007, tified "WIRELESS CHARGER WITH POSITION INSENSITIVITY"; U.S. provisional patent application 61/012,924, fiied 12/12/2007, titled "CONTROL, REGULATION, AND COMMUNICATION IN CHARGERS"; U.S. provisionai patent application 61/015,606, filed 12/20/2007, titled "PORTABLE INDUCTIVE POWER SOURCE"; and U.S. provisional patent application 61/043,027. fiied 4/7/2008, titled "INDUCTIVE POWER SOURCE AND CHARGING SYSTEM"; this appiication is also related to copending U.S. patent application 11/757,067 fiied 6/1/2007, titied "POWER

SOURCE, CHARGING SYSTEM, AND INDUCTIVE RECEIVER FOR MOBILE DEVICES", each of which above applications are herein incorporated by reference.

Field of Invention:

[0002] The invention is related generally to power supplies, power sources, and particularly to a system and method for inductive charging of portable devices.

Background:

[0003] There is currently a need for powering portable or mobile devices for use in commercial, business, personal, consumer, and other applications. Examples of such devices include cellular telephones, persona! digital assistants (PDAs), notebook computers, mobile email devices, Blackberry devices, Bluetooth headsets, hearing aids, music players (for example, MP3 players), radios, compact disk players, video game consoles, digital cameras, walkie-talkie or other communication devices, GPS devices, laptop computers, electric shavers, and electric toothbrushes. fttost of these devices include a rechargeable internal battery that must be first charged by an externa! power supply or charger, before the device itself can be used. The power supply typically provides direct current (DC) voltage through a special connector to the device. The power supply can then be disconnected, and the device will continue to run for a short period of time until the battery is depleted. The voltage and power requirements of the different devices vary, and to date there is currently no standardized connector for the devices. As a result of this, each mobile device is invariably sold or distributed bundled with its own charger. The costs associated with these multiple different types and numbers of charger are paid by the consumer indirectly by being incorporated into the prices being charged for the mobile device.

|0004] The rapid increase in the total number and variety of mobile products has meant that most people have several of the above-mentioned devices. In a typical day, that user would have to separately connect their multiple devices to each of their appropriate chargers for charging of each device. In addition. many people find it necessary to charge their devices in different locations such as their offices and cars. Thus, many users have purchased additional chargers for their offices and cars, for use in charging their mobile phones, notebook computers, and music players in those locations.

[0005] It will be evident that the above situation has caused typical users to have a multitude of incompatible devices (i.e. power supplies and chargers) that essentially provide the same function of charging a mobile device, but because of the number and variety that must be kept by the user are inconvenient to use. In many situations, users simply forget to charge their devices, or else find they need to recharge their device in situations where no

appropriate charger is available. This leads to loss of ability to use the device when desired or needed.

[0006] In addition, when traveling way from home, mobile users have a particular problem in that they need to pack and carry the multiple chargers for their devices, In many situations, these chargers are bulkier and heavier than the devices themselves, and use of these devices in foreign countries requires clumsy adaptors, and sometimes voltage converters. This leads to a high degree of inconvenience for the ever-more-mobile consumer.

[0007] in addition, the power connector for the mobile devices is often cheaply manufactured, and a source of mechanical and electrical failure. In many applications, such as toothbrushes or applications where the device is exposed to water and needs to be hermetically seaied, such a physical connection can not be used. Thus an alternative means of powering those types of devices must be used.

[0008] Sβvβrai products have tried to address this situation. Some companies propose the use of a universal charger that consists of a power supply base unit, and interchangeable tips that both fit into the base unit and in turn fit different devices. The tip includes a customized regulator that sets the voltage required by the particular device. However, a user must carry the muitiple tips he or she needs for each of the various devices they have, and then charge each device serially by connecting the device to the power supply. While this product reduces the overall weight of the charging tools the user must *carry,* the user still needs to carry and exchange the tips to connect to different devices. In addition, the charging of muitiple devices simultaneously is often not possible.

[0009J Realizing that a power suppiy typically contains a transformer for voltage conversion, another approach is to split the transformer into two parts: a first part can contain the first winding and the electronics to drive this winding at the appropriate operating frequency, while the second part consists of a winding where power is received and then rectified to obtain DC voltage. If the two parts are brought into physical proximity to each other, power is transformed from the first part to the second inductively, i.e. by induction, without any physical electrical connection. This is the approach that is used in many electrical toothbrushes, shavers, and other products that are expected to be used in wet environments. However, a common problem with such inductive units is that the windings are bulky, which restricts their use in lightweight portable devices. Furthermore, to achieve adequate power transfer, the parts must be designed to fit together suitably so that their windings are closely aligned. This is typically done by molding the device casing (for example, an electric toothbrush) and its charger/hoider so that they fit together in only one

suitable way. However, the molded base and shape of the portable device means they cannot be used in a universal fashion to power other devices.

[0010] Some companies have proposed pad-like charging devices based on inductive concepts, but that also ostensibly allow for different types of devices to be charged. These pads typically include grids of wires in an x and y direction, that carry *an* electrical current, and that generate a uniform magnetic field parallel to the surface of the pad. A receiver coil wound around a magnetic core lies on the surface of the pad and picks up the magnetic field parallel b the surface, and in this manner energy can be transferred. However, each of these methods suffer from poor power transfer, in that most of the power in the primary is not picked up in the receiver, and thus the overaii power efficiency of the charger is very low. In addition, the magnetic cores used for the primary and receiver are often bulky and add to the total cost and size of the system, and limit incorporation into many devices.

[0011] Another point to note is that, while all of the above devices allow a user to charge a device, they also require the charging device or base unit to be electricaily connected to a power source, such as a power outlet or a DC source. In many cases, the user may not have access to such a power source such as when traveling, camping, or working in an area without access to power. However, to date, no device has been provided that is portable, and that allows for inductive charging of multiple devices with differing power requirements, and which itself can be intermittently or occasionally charged either by an external power source, or by other means, or that is self-powered or includes its own power source.

Summary:

[0012] A portable inductive power source, power device, or unit, for use in powering or charging electrical, electronic, battery-operated, mobile, and other devices or rechargeable batteries is disclosed herein. in accordance with an embodiment the system comprises 2 parts: The first part is a pad or similar base unit that contains a primary, which creates an alternating magnetic field by means of applying an alternating current to a winding, coil, or any type of current carrying wire. The second part of the system is a receiver that comprises a means for receiving the energy from the alternating magnetic field from the pad and transferring it to a mobiie or other device or rechargeable battery. The receiver may comprise coiis. windings, or any wire that can sense a changing magnetic field, and rectify it to produce a direct current (DC) voltage, which is then used to charge or power the device.

[0013] In some embodiments the receiver can also comprise eiectronic components or logic to set the voltage and current to the appropriate levels required by the mobile device

or the charging circuit in the device, or to communicate information to the pad. In additional embodiments, the charging or power system can provide for additional functionality such as communication of data stored in the electronic device or to be transferred to the device. Some embodiments may aiso incorporate efficiency measures that improve the efficiency of power transfer between the charger and receiver, and ultimately to the mobile device or battery. in accordance with an embodiment the charger or power supply includes an interna! battery for self-powered operation. In accordance with other embodiments the charger or power supply can include a solar eel! power source, hand crank, or other means of power suppiy for occasional self powered operation. Other embodiments can be incorporated into charging kiosks, automobiles, trains, airpianes, or other transport and other applications.

[0014] In accordance with various embodiments, additional features can be incorporated into the system lo provide greater power transfer efficiency, and to allow the system lo be easily modified for applications that have different power requirements. These include variations in the material used b manufacture the primary and/or the receiver coils; modified circuit designs to be used on the primary and/or secondary side; and additional circuits and components that perform specialized tasks, such as mobile device identification, and automatic voltage or power-setting for different devices.

Brief Description of the Figures;

[001 5] Figure 1 shows a pad using multiple transmitter or charger coils in accordance with an embodiment.

[0016] Figure 2 shows a figure of a circuit diagram in accordance with an embodiment.

[0017] Figure 3 shows a charging pad using multiple coiis in accordance with an embodiment.

[0018] Figure 4 shows a charging pad using multipie overlapping coil layers in accordance with an embodiment.

[0019] Figure 5 shows the use of multiple coil types and sizes in overlapping pad layers in accordance with an embodiment.

[0020] Figure 6 shows a receiver with an integrated battery in accordance with an embodiment.

[0021] Figure 7 shows a coupling of receiver with a device to be charged or powered in accordance with an embodiment

[0022] Figure 8 shows a pad aiiowing modular or multiple connectivity in accordance with an embodiment.

[0023] Figure 9 shows a figure of a circuit diagram in accordance with an embodiment.

[0024] Figure 10 shows a figure of a circuit diagram in accordance with an embodiment.

[0025] Figure 11 shows a figure of a circuit diagram in accordance with an embodiment.

[0026] Figure 12 shows a figure of power transfer chart in accordance with an embodiment.

[0027] Figure 13 shows a figure of a coil layout in accordance with an embodiment.

[0028] Figure 14 shows a figure of a coil layout in accordance with art embodiment.

[0029] Figure 15 shows a figure of a charging pad with muitiple coils in accordance with an embodiment.

[0030] Figure 18 shows a figure of a charging pad with movable coils and two devices receiving power or charge in accordance with an embodiment.

[0031] Figure 1? shows a figure of a circuit diagram in accordance with an embodiment.

[0032] Figure 18 shows an illustration of a means of stacking coils, in accordance with an embodiment.

[0033] Figure 19 shows a figure of a circuit diagram for identification verification in accordance with an embodiment.

[0034] Figure 20 shows a figure of a circuit diagram for bidirectionai communication in accordance with an embodiment.

[0035] Figure 21 shows a figure of a circuit diagram for output controller in accordance with an embodiment.

[0036] Figure 22 shows a figure of a circuit diagram for the receiver with regulator in accordance with an embodiment.

[0037] Figure 23 shows a figure of a circuit diagram for MCU regulation in accordance with an embodiment.

[0038] Figure 24 shows a figure of a circuit diagram for unidirectional communication in accordance with an embodiment.

[0039] Figure 25 shows a figure of a circuit diagram for time-based regulation in accordance with an embodiment.

[0040] Figure 26 shows a high level view of a flyback power supply geometry in accordance with an embodiment.

[0041] Figure 27 shows an embodiment in which the output voStage to a load is monitored and with changes in the load condition, a chip or a Micro Controller Unit (MCU) varies the frequency or the duty cycie of the FET driver to achieve optimum operation.

[0042] Figure **28** shows an implementation of a charger in accordance with an embodiment, wherein the primary stage and the receiver stage communicate wireSessiy.

[0043] Figure 29 shows an embodiment that inciudes Zero Voltage Setting (ZVS).

[0044] Figure 30 shows an embodiment in which, instead of a digital feedback circuit, an analog circuit based on coupling between a Sight emitting diode (LED) and a light detector can be used.

[0045] Figure 31 shows an embodiment in which the opto-coupSβr is replaced by a Voltage Controlled Oscillator (VCO) and FET and in the primary, the signal is sent to adjust a frequency controiler to provide optimum output voltage.

[004β] Figure 32 shows an embodiment in which the wireless link can be analog or digitai or can be integrated into the device to take advantage of existing wireless links in the device,

[0047] Figure **33** shows a basic schematic for an inductive single coil charging system in accordance with an embodiment.

[0048] Figure **34** shows the main components of a wireless power/charging system in accordance with an embodiment.

[0049] Figure 35 shows a typical experimental curve for power transferred and Power Transfer in accordance with an embodiment

[0050] Figure 36 shows an embodiment in which a coii mosaic is used to cover the surface area of a pad.

[0061] Figure 37 shows an embodiment in which the number of drive (and sensing) circuits may be reduced by using eiectrical or electronic switches,

[0052] Figure 38 shows an embodiment in which three coii iayer printed circuit board (PCB) is arranged to provide a duster for uniform power in an area using only one coii powered at any given time.

[0053] Figure 39 shows an embodiment in which the coils are arranged such that by powering only one of the coils in the ciuster, any receiver coil piaced with a center within any iocation in the effective area can receive the specified power if the appropriate charger coil is activated.

[0054] Figure 40 shows an embodiment in which the number of switches required is reduced.

[00S5] **Figure 41** shows an embodiment of a muiti-charger pad that incorporates a piuraSity of charging dusters.

[0056] Figure 42 shows an embodiment that uses a cluster of two layers of three coils and a centra! coil to create an effective area.

10057] Figure 43 shows a mosaic of hexagonal coils with the central port to each coil shown as circles.

[0058] Figure 44 shows an embodiment of a MEMS pad including the top view.

[0059] Figure 45 shows an embodiment of a MEMS pad including a segmented MEMS charger pad.

[0060] Figure 46 shows an embodiment in which one or more regulated power supplies are connected to the charger pad.

[0061] Figure 47 shows an array of contacts on the surface of a pad in accordance with an embodiment.

[00S2] Figure 48 shows the side view of a MEMS conductive charger pad in accordance with *an* embodiment,

[0063] Figure 4θ shows an embodiment wherein several regulated power supplies provide power to the pad, to allows charging of several devices simultaneously.

[0064] Figure 50 shows an alternative embodiment of a pad using a segmented surface.

[0065] Figure 51 shows an industry standard means that is used for measuring emissions from a product.

[00S6] Figure 52 shows an embodiment which illustrates absorption through a copper layer.

[0067] Figure 53 shows attenuation values for Copper and Aluminum layers for several thicknesses.

[0068] Figure 54 shows transmitted power through Copper and Aluminum layers of varying thickness for an incident field at 1 MHz.

[006S] Figure 55 shows *an* embodiment which allows for obtaining local alignment independence between coils in the charger and the receiver.

[0070] Figure 56 show an embodiment in which coil magnets can divided into sections.

[0071] Figure 57 shows an embodiment in which one or more alignment magnets can be used behind each coil.

[0072] Figure 58 shows an illustration of a device for inductive power charging that includes an internal battery for self-powered operation, in accordance with an **embodiment.**

[0073] Figure 59 shows an illustration of an inductive charger unit with a solar cell power source for self powered operation, in accordance with an embodiment.

[0074] Figure 60 shows an illustration of an inductive charger unit with an incorporated communications and/or storage unit, in accordance with an embodiment.

[0075] Figure 61 shows an illustration of a kiosk that incorporates an inductive charger unit in accordance with an embodiment.

[0076] Figure 62 illustrates some common regular (non-charger) mobile phone holders types, in accordance with an embodiment.

[0077] Figure 63 illustrates various products for a music player, that includes an external rechargeable battery pack, in accordance with an embodiment.

[0078] Figure 64 illustrates a multi-function device that includes a hard drive, rechargeable battery, and wireless connectivity, in accordance with an embodiment.

[007S] Figure 65 illustrates a system for use with a charger case to inductively power or charge a mobile device, in accordance with an embodiment.

[0080] Figure 66 shows a pad using muitiple receiver/energizer coils in accordance with an embodiment.

[0081] Figure 67 shows, in a multi-charger or power supply where multiple coils are used, such a high heat conductivity layer may be repeated around each coil or cover all areas between the multiple coils, in accordance with an embodiment.

[0082] Figure 68 shows a similar method that may be used for heat removal from wound coils of other shape and type.

[0083] Figure 69 shows an embodiment in which the layer can be patterned to provide heat conductivity channels rather than a continuous layer.

[0084] Figure 70 shows an illustration of the electronics for the PCB coil inductive charger and/or power supply or the inductive receiver as fabricated on the same PCB as the coil, in accordance with an embodiment.

[008S] Figure 71 shows an embodiment in which magnets placed at the center of a stationary coil or a moving, floating charger and/or power supply coil and the receiver coil can provide a method for alignment of the coils and to achieve this result.

[0086] Figure 72 shows an embodiment in which two or more magnets that do not cross the center of the coil are used.

[0087] Figure 73 is an illustration that shows how the magnets may be placed outside the PCB coil area, in accordance with an embodiment.

[0088] Figure 74 shows an embodiment in which magnetic arc-shaped parts around a circular coil are used.

[0089] Figure 75 illustrates the use of bar magnets on or around the coil, in accordance with an embodiment.

Detailed Description:

[0090] A portable inductive power source, power device, or unit, for use in powering or charging electrical, electronic, battery-operated, mobile, rechargeable batteries, and other devices is disclosed herein. in accordance with an embodiment the system comprises two parts: The first part is a pad or similar base unit that contains a primary, which creates *an* alternating magnetic field by means of applying an alternating current to a winding, coil, or any type of current carrying wire. In some embodiments the pad can also contain various signaling, and switching or communication circuitry, or means of identifying the presence of devices or batteries to be charged or powered. in some embodiments the pad can also contain multiple coils or sections to charge or power various devices or to aüow charging or powering of devices or batteries placed anywhere on the pad. The second part of the system is a receiver that comprises a means for receiving the energy from the alternating magnetic field from the pad and transferring it ƀ a mobile battery, or other device. The receiver can comprise coils, windings, or any wire that can sense a changing magnetic field, and rectify it ƀ produce a direct current (DC) voltage, which is then used to charge or power the device or battery.

[0091] In some embodiments the receiver can also comprise eiectronic components or iogic to set the voltage and current to the appropriate levels required by the mobile device or battery. in some embodiments, the receiver can also contain circuitry to sense and determine the status of the electronic device or battery to be charged, the battery inside a device, or a variety of other parameters and to communicate this information to the pad. In additional embodiments, the system can provide for additional functionality such as communtcatton of data stored in the electronic device (for example, digital images stored in cameras, telephone numbers in ceil phones, songs in MP3 piayers) or data into the device.

[0092] Embodiments can also incorporate efficiency measures that improve the efficiency of power transfer between the charger or power supply and the receiver, and ultimately to the mobile device or battery. In accordance with an embodiment, the charger or power supply comprises a switch, (for example, a MOSFET device or another switching mechanism), that is switched at an appropriate frequency to generate an alternative current (AC) voltage across a primary coil, and generates an AC magnetic field. This field in turn generates a voltage in the coil in the receiver that is rectified and then smoothed by a capacitor to provide power to a ioad, with the result being greater efficiency.

[0093] In accordance with other embodiments the coils are mounted such that they can move laterally within the pad and within an area of their segments, while continuing to be connected to their driver electronics placed on the edges of the area. The floating coils and the drive circuit are sandwiched in between thin upper and lower cover layers that act to

allow the coils lateral movement white limiting vertical movement. When a receiver is placed on the pad, the pad senses the position of the receiver coil and moves the coils to the right position to optimize power transfer. Magnets can be used to better orient the coils and improve greater power transfer efficiency.

[0094] Additional embodiments are also described herein. For example, in accordance with an embodiment the charging/power supply device includes an internal battery for self-powered operation, In accordance with other embodiments the charging/power supply device can include a solar cell power source, hand crank, or other means of power supply for occasional self powered operation. Other embodiments can be incorporated into charging kiosks, automobiles, computer cases, and other electronic devices and applications.

Inductive Charging System

[0095] While the above mentioned technologies describe various aspects of inductive charging, they do not address the basic requirements that a consumer and manufacturer desire in such a product. These include the foüœwing desired features:

- The pad should be able to charge or power a number of devices or batteries with various power requirements efficiently. A typical number may be one to six or even 12 or moredevices or batteries, including four or more Sow power (up to 5 W) devices or batteries simultaneously. When multiple devices or batteries are being charged, a method for energizing only those coils near a device or battery is preferable.
- The same pad should be able to power low-power devices (mobile phones, PDAs, cameras, game consoles, etc.) or batteries with power requirements of 5 W or less, and higher-power devices such as notebook computers (which often have a power requirement of 60 W or higher) or high power batteries.
- The power transfer efficiency between the primary coil and the receiver should be maximized. Lack of efficiency in the power transfer would necessitate larger and heavier AC to DC power supplies. This would add cost and decrease product attractiveness to customers. Thus methods where the entire pad is energized are not as attractive.
- A simple method for verification of the manufacturer of the receiver, and possibly information for power requirements, should be supported as necessary to ensure product compatibility and to provide means of product registration and licensing.
- The EM! radiation from the system should be minimized, and ideally, the system should radiate little or no EM! with no device present. A charger should preferably not emit any power until an appropriate device or battery is brought close b the charger or power supply itseif. In this way, electric power is not wasted, and electromagnetic power is not

emitted needlessly. In addition, accidental effects on magnetically sensitive devices such as credit cards, disk drives and such are minimized.

- The pad and the receiver should be reasonably simple to construct, and cost effective. Since both parts can be integrated into mobile devices or batteries, the overall size, weight, and form factor should be minimized.

[0096] As used herein, the term "charger" can refer to a device for supplying power to a mobile or stationary device for the purpose of either charging its battery, operating the device at that moment in time, or both. For example, as is common in portable computers, the power supply can operate the portable computer, or charge its battery, or accomplish both tasks simultaneously. The charger may include circuitry for driving a coil appropriately to generate an AC magnetic fteid, power or current sense or regulation circuitry, microcontrollers, and means of communication with a receiver, battery, or device. It may also be able to communicate data with a device or battery or perform other functions. As used herein, the term 'receiver' means an inductive coil or coils and the circuitry for rectiffcation and smoothing of received current, any possible control or communication circuitry for communication with the charger and regulation of power and any possible circuit for managing charging or measurement of status of a battery or a device to be charged or powered such as a charge management circuit, fuel gauge, current, voltage, or temperature sensor, etc. The receiver can also incorporate appropriate circuitry for data transfer between a device or battery and the charger. In accordance with an embodiment, the mobile device charger and/or power supply can have any suitable configuration, such as the configuration of a flat pad. The power received by the mobile device from the mobile device charger/power supply (such as the primary in the mobile device charger) can be rectified in the receiver and smoothed by a capacitor before being connected to the rechargeable battery which is represented by the load in the figures. To ensure proper charging of the battery, a regulator or charge management circuit can be placed between the output of the output of the rectifier/capacitor stage and the battery. This regulator or charge management circuit can sense the appropriate parameters of the battery (voltage, current, capacity), and regulate the current drawn from the receiver appropriately. The battery can contain a chip with information regarding its characteristics that can be read out by the regulator or charge management circuit. Alternatively, such information can be stored in the regulator or charge management circuit for the mobile device to be charged, and an appropriate charging profile can also be programmed into the regulator or charge management circuit.

[0097] Figure 1 shows a pad using multiple receiver/eπergizer coils in accordance with an embodiment. In its simplest format, the mobile device or battery charger or power supply preferably has a substantially flat configuration, such as the configuration of a pad

100, and comprises multiple coils or sets of wires 104. These coils or wires can be the same size as or larger than the coils or wires in the mobile devices, or battery and can have simiiar or different shapes, including for example a spiral shape. For example, for a mobile device charger or power suppiy designed to charge or provide power to up to four mobile devices of simiiar power (up to 10 W each) such as mobile phones, MP3 players, batteries, etc, four or more of the coils or wires will ideally be present in the mobile device or battery charger. The charger or power supply pad can be powered by plugging into a power source such as a wall socket or itseif be powered or charged inductively. The pad can also be powered by another eiectronic device, such as the pad being powered through the USB outlet of a laptop or by the connector that laptops have at the bottom for interfacing with docking stations, or powering other devices. The pad can also be incorporated into a docking station, such as may be used by notebook computers or built into a table or other surface.

[0098] In accordance with an embodiment, a mobile device can include a receiver that includes one or more coils or wires to receive the power from the mobile device charger or power supply. As described in further detail below, the receiver can be made part of the battery in the mobile device or of the shell of the mobile device. When it is part of the mobile device shell, the receiver can be part of the inside surface of the mobile device shell or of the outside surface of the mobile device shell. The receiver can be connected to the power input jack of the mobile device or can bypass the input jack and be directly connected to the battery or charge management circuit inside the mobile device. In any of these configurations, the receiver includes one or more appropriate coil or wire geometries that can receive power from the mobile device charger or power suppiy when it is placed adjacent to the mobile device charger or power supply. In accordance with an embodiment, the coils in the mobile device charger or power suppiy and/or the coils in the mobile devices or battery can be printed circuit board (PCB) coils, and the PCB coils can be placed in one or more layers of PCB.

[0099] In some embodiments, the charger or power supply can also itself be built into a mobile device or battery. For example, a laptop computer or other portable or mobile device can incorporate a charger or power supply section so that other mobile devices can be charged or powered as described above. Alternatively, using the same set of coils or wires, or a separate set of coils or wires, any mobile device or battery can itself be used as an inductive charger or power suppiy to power or charge other mobile devices or batteries.

[00100] In accordance with an embodiment, the mobile device charger/power supply or pad, and the various mobile devices or batteries, can communicate with each other to transfer data. In one embodiment, the coils in the mobile device charger/ power suppiy that are used for powering or charging the mobile device, or another set of coils in the same PCB

layer or in a separate layer, can be used for data transfer between the mobile device charger/power supply and the mobile device to be charged or powered or the battery directly. Techniques employed in radio and network communication, such as radio frequency identification (RFID), Bluetooth, WiFi, Wireless US8 ; or others can be used, In one embodiment a chip connected to an antenna {for example, the receiver coil or separate data antenna) or another means of transfer of information can be used to provide information about, for example, the presence of the mobile device or battery, its authenticity (for example its manufacturer code) and the devices' charging/power requirements (such as its required voltage, battery capacity, and charge algorithm profile).

[00101] In accordance with an embodiment, a typical sequence for charger/power supply operation is as follows:

- The mobile device charger or power supply can be in a low power status normally, thus minimizing power usage,
- Periodically, each of the coils (or a separate data coil in another PCB layer) is powered up in rotation with a short signal such as a short radiofrequency (RF) signal that can activate a signal receiver in the receiver such as an RF ID tag or a circuitry connected to the receiver coil.
- The mobile device charger/power supply then tries to identify a return signal from any mobile device, battery (or any receiver) that may be nearby.
- Once a mobile device, or battery (or a receiver) is detected, the mobile device charger or power supply and the mobile device or battery to proceed to exchange information.
- This information can inciude a unique ID code that can verify the authenticity and manufacturer of the charger or power supply and mobile device or battery, the voltage requirements of the battery or the mobile device, and the capacity of the battery. For security purposes or to avoid counterfeit device or pad manufacture, such information can be encrypted, as is common in some RFiD tags or other verification systems.

[00102] In accordance with various embodiments, other protocols such as Near Field Communications (NFC) or Felica can be used, wherein the circuitry containing the ID and the necessary information is powered either by the mobile device or battery or remotely by the mobile device charger or power supply. Depending on the particular implementation needs, Bluetooth, WSFi, Wireless USB, and other information transfer processes can be used. Additional information regarding the charging profile for the battery can also be exchanged and can include parameters that are used in a pre-programmed charge profile stored in the mobile device or battery charger. However, the information exchanged can be as simple as an acknowledge signal that shows the mobile device charger that a mobile device or

rechargeable battery is present. The charger or power supply can also contain means for detection and comparison of the strength of the signal over different locations on the charger or power supply. fn this way, it can determine the location of the mobile device or battery on the charger or power supply, and then proceed to activate the appropriate region for charging or powering,

[00103] In some embodiments that require greater simplicity, no communication need take place between the mobile device charger or power supply and the mobiie device or battery. In some embodiments the mobile device charger or power supply can sense the mobile device or battery by detecting a change in the conditions of a resonant circuit in the mobile device charger or power supply when the mobile device or battery is brought nearby. In other embodiments the mobile device or battery can be sensed by means of a number of proximity sensors such as capacitance, weight, magnetic, optical, or other sensors that determine the presence of a mobile device or battery near a coil in the mobile device or battery charger or power supply. Once a mobile device or battery is sensed near a primary coil or section of the mobile device or battery charger or power supply, the mobile device charger or power supply can then activate that primary coiS or section to provide power b the receiver coil in the mobile device's battery, shell, receiver module, battery, or the device itself.

Inductive Charging Circuit

[00104] Each mobile device and its battery has particular characteristics (voltage, capacity, etc). Sn order to facilitate these different devices or batteries with a single universal mobiie device charger or power supply, several circuit architectures are possible, some of which &r& described in further detail below.

[0010S] **Figure 2** shows the main components of a typical inductive power transfer system 110. The circuit illustrated is used to illustrate the principle of inductive power transfer and is not meant to be limiting to an embodiment. in accordance with an embodiment, the charger 112 comprises a power source 118, and a switch T 126 (which can be a MOSFET or other switching mechanism) that is switched at an appropriate frequency to generate an AC voltage across the primary coil Lp 116 and generate an AC magnetic field. This field in turn generates a voltage in the coil 120 in the receiver 114 that is rectified and then smoothed by a capacitor to provide power 122 to a load Ri 124. For ease of use, a receiver can be integrated with a mobile device, such as integrated inside the mobile device or attached to the surface of the mobile device during manufacture, to enable the device to receive power inductively from a mobile device charger or integrated into, or on its battery.

[00106] In accordance with an embodiment, the circuit shown in **Figure** 2 can receive energy fed to it from a power source, store the energy alternately in the inductor and the timing capacitor (much like a tank stores liquid), and subsequently produce an output as a continuous alternating current (AC) wave. As the voltage is applied to the primary side, the tank circuit supplies the energy to the receiver. One of the benefits of such a design is that the timing capacitor in the circuit can be easily replaced. For example, if a relatively higher value for capacitance (referred to in some instances as a timing capacitance) is used, then the frequency of operation is lowered. This increases the on-time for the circuit, and provides longer power transfer and current through the transformer, and thus more power. As such a higher vaiue of capacitance can be used for high power applications. Conversely, if a relatively lower value for capacitance is used, then the frequency of operation is increased. This reduces the on-time and provides less power transfer and current through the transformer, and thus less power. Thus, a Sower value of capacitance can be used for low power applications. Replacing the timing capacitance can be easily handled during manufacturing to tune the power requirement on a macro level, i.e. to get the output into an appropriate range for the chosen application. Additional techniques can then be used to set the voltage output on a more accurate basis.

[00107] The mobile device or its battery typically can include additional rectifier(s) and capacitor(s) to change the AC induced voltage to a DC voitage. This is then fed to a regulator/charge management chip which includes the appropriate information for the battery and/ or the mobile device. The mobile device charger provides power and the regulation is provided by the mobile device. The mobile device or battery charger or power supply, after exchanging information with the mobile device or battery, determines the appropriate charging/powering conditions to the mobile device. It then proceeds to power the mobile device with the appropriate parameters required. For example, to set the mobile device voltage to the right value required, the value of the voltage to the mobile device charger can be set. Alternatively, the duty cycle of the charger switching circuit or its frequency can be changed to modify the voitage in the mobile device or battery. Alternatively, a combination of the above two approaches can be followed, wherein regulation is partially provided by the charger or power supply, and partially by the circuitry in the receiver.

Inductive Charger Pad

[00108] To allow the operation of the mobile device or battery charger or power supply regardless of position of the mobile device or battery, the total area of the mobile device or battery charger or power supply can be covered by coils or by another wire geometry that creates magnetic field.

[00109] Figure 3 shows a charging pad using multiple coils in accordance with an embodiment. As shown in Figure 3, in accordance with an embodiment the pad 140 is largely covered with individual receiver coils 144.

[00110] Figure **4** shows a charging pad using multiple overiapping coil layers in accordance with an embodiment. This embodiment addresses the problem of voids between the multiple coils. As shown in Figure 4, any areas of the pad 150 with minimal magnetic field between a first set of coils 152 can be filled by a second set of coils 154, so that the coils are tiled such that the centers of this coil array fill the voids in the primary set. This second set can be at a different layer of the same PCB, or in a different PCB. In each of these geometries, the sensing circuitry can probe each location of a coil in a raster, predetermined, or random fashion. Once a mobile device or battery on or near a coil is detected, that coil is activated to provide power to the receiving unit receiver of the appropriate device.

£00111] It can be seen from the above example that by providing more layers of the PCB with coils, or by providing coils of different geometry or size, one can obtain as much resolution or coverage as desired.

[00112] In accordance with an embodiment, to power mobile devices or batteries with power requirements that exceed maximum powers attainable by typical coils in a surface, the mobile device or battery, during its hand shake and verification process can indicate its power/voltage requirements to the mobile device or battery charger or power supply. Several geometries for achieving power/voltage levels otherwise not attainabSe from a single primary coil of the mobile device or battery charger or power supply are possible.

[00113] In accordance with one embodiment of the system geometry, the power receiving unit of the mobile device or battery has several coils or receiving units that are connected such that the power from several primary coils or sets of wires of the mobile device or battery charger or power supply can add to produce a higher total power. For example, if each primary coil is capable of **outputiting** a maximum of 10 Watts, by using six primary coils and six receiver coils, a total output power of 60 Watts can be achieved. The number of primary and receiver coils need not be the same, and a large receiver coil (receiving unit) that is abie to capture the majority of magnetic flux produced by 6 or other number of primary coils or a large primary coil powering six or another number of receiver coils can achieve the same effect. The size and shape of the multiple primary coils and receiver coils also do not *need* to be the same. Furthermore, neither set of primary and receiver coils need to be in the same plane or PCB layer. For example, the primary coils in the examples shown above can be dispersed such that some lay on one PCB plane and the others in another plane.

[00114] In accordance with another geometry, the PCB of the mobile device or battery charger or power supply has multiple layers, wherein coiis or wire patterns of certain size and power range can be printed on one or more layers and other layers can contain coiis or wire patterns of larger or smaller size and power capability, In this way, for example, for iow power devices, a primary from one of the layers will provide power to the mobile device or battery, if a device or battery with higher power requirements is placed on the pad, the mobiie device or battery charger or power supply can detect its power requirements and activate a larger coil or wire pattern with higher power capabilities or a coil or wire pattern that is connected to higher power circuitry. One may also achieve similar results by using a combination of the different processes and geometries described above.

[00115] Figure **5** shows the use of multiple coil types and sizes in overlapping pad layers in accordance with an embodiment. As shown in **Figure** 5, the mobile device or battery charger or power supply or pad 160 can comprise two overiapping layers with a first layer 162 containing low power coils, and a second layer 164 containing high power coils.

Jnductive Charging Receiver

[00116] As described above, the inductive charging or power suppiy pad is used to power a receiver, which in turn is used to power or to charge a portable or mobile device or battery. in accordance with one embodiment of the receiver, the power from the mobile device or battery charger or power supply is emitted at a magnitude that is sufficient to power any foreseeable mobile device or battery (such as 5 W or 10 W for small mobile devices or batteries). The receiver that is appropriate for each mobile device or battery has a power receiving part that when matched to the mobile device or battery charger or power supply is able to receive sufficient power for the mobiie device or battery. For example a receiver for a mobile phone requiring 2.5 W can be a coil with certain diameter, number of turns, wire width, etc. to allow receipt of the appropriate power. The power is rectified, filtered, and then fed into the battery or power Jack of the device. As discussed above, a regulator or charge management circuit can be used before the power is provided to the battery or the mobile device.

[00117] To save energy, the power emitted by the mobiie device or battery charger or power suppiy can be regulated. It is desirable to regulate the power emitted by the charger or power supply because if the charger or power supply is emitting 10 W of power and the receiver is designed to receive 5 W. the rest of the emitted power is wasted, In one embodiment, the receiver or the mobile device can, through an electrical (such as RF), mechanicai, or optica! method, inform the charger or power supply about the voltage/current characteristics of the device or battery. The primary of the charger or power supply in the

circuit diagrams shown above then can be driven to create the appropriate voltage/current in the receiver. For exampie, the duty cycle of the switch in that circuit can be programmed with a microprocessor to be changed to provide the appropriate levels in the receiver.

[00118] In accordance with an embodiment, the programming can be performed by a look up table in a memory location connected to a microprocessor or by using an algorithm pre-programmed into the microprocessor. Alternatively, the frequency of the switch can be changed to move the circuit into, and out of, resonance to create the appropriate voltage in the receiver. In an alternate geometry, the voltage into the circuitry in the primary can be changed to vary the voltage output from the receiver. Furthermore, the induced voltage/current in the mobile device can be sensed and communicated to the charger to form a closed-loop, and the duty cycle, frequency, and/or voltage of the switch can be adjusted to achieve the desired voltage/current in the mobile device.

[00119] In accordance with an embodiment, the receiver is built onto or into the battery for the mobile device. The receiver can include one or more coils or wires shaped to receive power from the charger or power supply. The one or more coils or wires can be either printed on one or more PCBs, or formed from regular wires. As described above, the receiver can also contain rectifier(s) and capacitor(s) to produce a cleaner DC voltage. This output can be directly, or through a current limiting resistor, connected to one of the contacts on the battery. To avoid overcharging the battery, a battery regulator or charge management chip can also be used. This circuit then measures the various parameters of the battery (voltage, degree of charging, temperature, etc.) and uses an internal program to regulate the power drawn from the circuit to ensure over-charging does not occur. The circuit can also include LEDs to show the receiver being in the presence of a magnetic field from the charger, complete charge LEDs and/or audible signals.

[00120] In typical commercial and end-user applications, such as in ceil phones, PDAs, and MP3 players, the battery can be incorporated into the battery pack or the device by the original equipment manufacturer (OEM), or as an after-market size and shape compatible battery pack that can replace the original battery pack. The battery compartment in these applications is typically at the bottom of the device. The user can open the battery compartment, take out the conventional battery, replace it with a modified battery in accordance with an embodiment, and then replace the battery lid. The battery can then be charged inductively when the mobile device is placed adjacent a mobile device charger.

[00121] To enhance the ability of the receiver to receive power, it may be desirable to minimize the distance between the charger's primary coil and the receiver's coil or wire. In order to achieve this, in accordance with an embodiment the receiver's coil or wire can be put on the outside of the battery pack.

[00122] Figure 6 shows a battery with an integrated receiver in accordance with an embodiment. As shown in Figure 6, the receiver 170 comprises the battery 182, together with the receiver coil 172, and any rectifiers 174, capacitors 178, regulators or charge management chips 180 necessary for proper operation of the charging receiver, if the battery compartment Sid of the device prevents a power receiving light emitting diode (LED) to be seen, the lid can itself be repiaced with a see-through Sid or a lid with a Sight pipe that will aSSow the user to see the charging indicator LED when the mobiie device is piaced adjacent to the charger.

[00123] In an alternative embodiment, the receiver battery can include a mechanical, magnetic, or optical method of alignment of the coils or wires of the charger and mobile device for optimum power transfer. In accordance with an embodiment, the center of the primary in the charger contains a magnet such as a cyiinder or disk or ring with the poies para‖ei to the charger surface and the magnetic field perpendicular to the charger surface. The receiver aiso contains a magnet or magnetic metal part of a similar or different shape behind or in front of the coil or wire receivers. When the mobile device or battery is placed on or adjacent to the charger or power supply, the magnets attract and pull the two parts into alignment with the centers of the two coils or wires aligned. The magnets do not need to be especiaily strong to actively do this. Weaker magnets can provide guidance to the user's hand and largely achieve the intended results. Alternatively, audible, or visual signs (for exam pie an LED that gets brighter as the parts are cioser aiigned), or mechanical means (dimples, protrusions, etc.) can be used for alignment.

[00124] In accordance with another embodiment, the coil or wires and the magnet in the charger or power supply *are* mechanicaiiy attached to the body of the charger or power supply such that the coil can move to aügn itself appropriateiy with the mobile device or battery when it is brought into close proximity to the charger or power supply. In this way, an automatic alignment of coils or wire patterns can be achieved.

[0012S] In another embodiment, the receiver electronics described above are preferably made from flexible PCB which can be formed into a curved shape. Such a PCS can be placed on the surface of a battery pack, including one that is not flat, or that has a curved shape. The curve on the battery or back of a mobile device battery lid can be matched to a curved primary in the mobile device or battery charger or power supply and be used for alignment. One example of usage of this embodiment can be for example flashlights that have circular handles: the batteries can be charged with coils on the side of circular batteries, or circling the cylindrical battery. Similarly, the mobile device or battery charger or power supply can have a curved shape. For example, the charger or power suppiy surface can be in the shape of a bowl or some similar object. A mobile device or battery that

may have a fiat or curved back can be placed info the bow!. The shape of the bowl can be made to ensure that the coil of the mobile device or battery is aligned with a primary coil to receive power.

[00126] In another embodiment, the primary can be incorporated into a shape such as a cup. A mobiie device can be placed into the cup standing on end and the receiver can be built-in to the end of the mobile device (such as a mobile phone) or battery or on the back or circumference of the device or battery. The receiver can receive power from the bottom or wall of the cup.

[00127] In another embodiment, the primary of the charger can have a flat shape and the mobile devices or battery can be stood up to receive power. The receiver is built into the end of the device or battery in this case and a stand or some mechanical means can be incorporated to hold the device or battery while being charged.

[00128] In another embodiment, the charger or power supply can be made to be mounted on a waii or a similar surface, vertically or at an angle (such as on a surface in a car), so as to save space. The charger or power supply can incorporate physical features, magnets, fasteners or the like to enable attachment or holding of mobiie devices to be charged. The devices or batteries to be charged or powered can also incorporate a retainer, magnet, or physica! shape to enable them to stay on the charger or power supply in a vertical slanted, or some other position. In this way, the device or battery can be charged or powered by the primary while it is near or on it.

[00129] For those applications where the iid of the battery compartment or the bottom part of the mobile device is made from a metal, a replacement non-metallic lid or backing can be used. Alternatively, the coii can be attached to the outside of the metal surface. This allows electromagnetic (EM) fields to arrive at the power receiver coil or wires. The rest of the receiver (i.e. circuitry) can be placed behind a metal for the receiver to work. In some other applications where the battery has metal parts, these parts may interfere with the EM field and the operation of the coil in the receiver. In these cases, it may be desirable to provide a distance between the metai in the battery and the coils. This can be done with a thicker PCB or battery top surface. Alternatively, to provide additional immunity, ferrite material (such as those provided by Fβrrishieid Inc.) can be used between the receiver and the battery to shield the battery or device from the Elvl fields. These materials can be made so as to be thin, and then used during the construction of the integrated battery/receiver.

[00130] In accordance with another embodiment, the receiver in the battery or mobile device also includes a means for providing information regarding battery manufacturer, required voltage, capacity; current, charge status, serial number, temperature, etc. to the charger. In a simplified embodiment, only the manufacturer, required voltage, and/or seria!

number is transmitted. This information is used by the charger or power supply to adjust the primary to provide the correct charge or power conditions. The regulator or charge management chip in the receiver can then regulate the current and the load to charge the battery correctly and can end charge at the end. In another embodiment, the receiver can control the charging process fuify depending on the time dependent information on battery status provided to it. Alternatively, the charging process can be controlled by the charger in a similar manner, As described above, the information exchange between the charger and the receiver can be through an RF link or an optica! transmitter/ detector, RFID techniques, Near-Field Communication (NFC), Feiica, Bluetooth, WFi, or some other method of information transfer. Similarly, the receiver can send signals that can be used by the charger to determine the location of the receiver to determine which coil or section of the charger or power supply to activate. The communication link can also use the same coil or wires as antenna for data transfer or use a separate antenna. In some embodiments the received can use the actual capabilities of the mobile device (for example, the built-in Bluetooth or NFC capabilities of mobile phones) to communicated with the charging or power supply pad.

[00131] As described above, in accordance with some embodiments the receiver can be integrated into the body of the device or battery itself at a location that may be appropriate and can be exposed to Elvl radiation from outside. The output of the receiver can be routed to the electrodes of the battery internally inside the device and appropriate circuitry inside the device can sense and regulate the power. The device can include LEDs, messages, etc, or audible signs that indicate to the user that charging is occurring or complete or indicate the strength of the received power (i.e. alignment with a primary in the charger) or the degree of battery charge. In other embodiments, the receiver is built into an inner or outer surface of a component that is a part of the mobile device or battery's outer surface where it is ciosest to the charger. This can be done as original equipment or as an after-market item. The component can be the lid of the battery pack or the bottom cover of the mobile device. In yet other embodiments, the receiver can be integrated into the back or front of the battery compartment or an interchangeable shell for the mobile device for use in after-market applications. For example, in a mobile phone application, the back battery cover or shell can be removed and replaced with the new shell or battery cover with the receiver built in.

[00132] Figure 7 shows a coupling of receiver with a device to be charged or powered in accordance with an embodiment. As shown in Figure 7, the original mobile phone setup 190 includes a device 192 with sheii 194 and power jack 196. The after-market modification 200 replaces the original shell with a combination shell 210 that includes the necessary receiver coiis and battery couplings. The contacts from this circuitry can then make direct contact to the battery electrodes inside the mobile device or to some contact points inside the

mobile device if such contacts exist or become provisioned by the device manufacturer during manufacture. Alternatively, the receiver may be a component (such as a shell) that has a connector that plugs into the input power jack of the mobile phone or electrodes of a battery. The receiver can be fixed to, or detachable from, the mobile device or battery. This can be achieved by having a plug that is attached either rigidly or by a wire to the receiver (shell). Alternatively, the replacement receiver (shei!) can be Sargβr than the original sheSl and extend back further than the original shell and contain the plug so that when the receiver (shell) is attached, simultaneously, contact to the input power jack is made. Alternatively, the receiver (shell) can have a pass-through plug so that while contact is made to this input power connector, the connector allows for an external regular power supply plug to be also used as *&n* alternative. Alternatively, instead of a pass-through, this part can include a power jack in another location in the back so that a regular power supply can be used to charge the battery. In cases where the connector to the device performs other functions such as communication to the device, a pass-through connector can allow communication/ connectivity to the device.

[00133] In accordance with another embodiment, the replacement receiver (i.e. the replacement shell) or the plug in unit, in addition to the power receiver components and circuitry, can include additional circuitry that can provide further functionalities to the mobile device. These can include, for example, the ability to exchange data through Bluetooth, WSFi, NFC, Felica, vViMax, RFID, or another wireless or optical mechanism, it can also provide extended functionalities such as Globai Positioning System (GPS) location information, flashing lights, flashlight, or other decorative or electronic functions. As described above, various methods for improving coil alignment, or location, battery manufacturer, or battery condition information transfer can also be integrated into the receiver or replacement shell.

[00134] In another embodiment, the receiver is supplied in the form of a separate unit that is attached to the input jack of the mobile device or battery or integrated into a receiver protective skin for the mobile device. Many leather or plastic covers for mobile phones, cameras, and MP3 players already exist. The primary purpose of these covers is to protect the device from mechanical scratches, shocks, and impact during daily use. However, they typically have a mere decorative or advertising application, in accordance with one embodiment, the receiver is formed of a thin PCB with the electronics formed thereon, and the receiver coil or wire that is attached to the back of the device and plugs into the input jack similar to the shell described above. Alternatively, it can be connected through a flexible wire or flexible circuit board that is routed to a plug for the input power jack.

[00135] In accordance with another embodiment, the receiver can be a separate part that gets plugged into the input jack during charging and is piaced on the charger and can then be unplugged after charging is finished.

[00136] In another embodiment, the receiver is built in the inside or outside surface or in between two iayers of a plastic, leather, silicone, or cloth cover for the mobile device and piugs in or makes contact to the contact points on the device.

[00137] It will be noted that certain devices such as notebooks and some music piayers have metal bottom surfaces. The methods described above for changing the back surface or use of a plug in the mobile device or a secondary skin with an integrated receiver is particularly useful for these applications. As described previously, the effect of the metal surface can aiso be minimized, if necessary, by increasing the distance between the wires of the receiver and the metal surface or by placing a ferrite layer in between the receiver and the metal bottom.

[00128] It is aiso noted that the use of methods such as curving the receiver or integrating magnets, LEDs, audio signals or messages, etc. for alignment, or methods for location, manufacturer or charging condition identification, as described above are possible with ail embodiments of an embodiment described above. In any of the above cases, the charger or power supply can contain lights, LEDs, displays, or audio signals or messages to help guide the user to piace the mobile device or battery on a primary coil for maximum reception, to show charging is occurring, and to show the device is fully charged. Displays to show how full the battery is or other information can also be incorporated.

Ftextble/Modufar Charging Pad

[00129] In accordance with an embodiment a flexible mobile device charger or power supply is provided in the shape of a pad that can be folded or rolled up for carrying, in one impiementation of an embodiment, the eiectronics of the charger or power supply are placed on a thin flexible PCB or the coils are made of wires that can be rolled up or shaped. The electronics components made of silicon chips, capacitors, resistors and the like may not be flexible but take up very iittie space. These rigid components can be mounted on a flexible or rigid circuit board, while the main section of the pad containing the coils or wires for energy transfer can be made to be flexible to allow conformity to a surface or to be roiled up. Thus the pad resembles a thin mouse pad or the like.

[00130] In some cases, it may be advantageous to the user to have a mobile device charger or power supply that is extendibie in functionalities. The cases include but are not limited to:

- A user may purchase a mobile device or battery charger or power supply for charging or

powering a single low power device or battery but, at a later stage, may want to extend the capability to charge or power more devices or batteries simultaneousiy.

- A user may purchase a mobile device or battery charger or power supply for charging or supplying power to one or more low power devices or batteries but may want to charge or supply power to more low power or high power devices or batteries.
- A user may buy a mobile device or battery charger or power supply that can charge or supply power to one or more low-power or high-power devices or batteries and later wish to have the communication or local storage, or a rechargeable battery, or means of power generation such as solar panels or some other capability, added to the charger or power supply.

[00131] In all of the cases above and others, it can be useful to have a modular approach to expand the capabilities of the mobile device or battery charger or power supply.

[00132] Figure 8 shows a pad 220 in accordance with an embodiment that allows for modular or multiple connectivity. In this case, the user can purchase a first unit 222 that is powered by an electric outlet 224. However, interconnects 226 for power and data are provided so that additional units 228, 230 can simply fit or plug into this first one directly or indirectly and expand the capabilities as the customer's needs grow. Data communications and storage units 234 can also be attached in a modular fashion. This approach would enable the customer to use the technology at a low cost entry point and grow his/her capabilities over time.

[00133] Some of the electronics devices that can benefit from these methods include: mobile phones, cordless phones, personal data assistants (PDAs), pagers, walkie-talkies, other mobile communication devices, mobile electronic mail devices. Blackberry's, MP3 players, CD players, DVD players, game consoles, headsets, Bluetooth headsets, hearing aids, head-mounted displays, GPS units, flashlights, watches, cassette players, laptops, electronic address books, handheld scanning devices, toys, electronic books, still cameras, video cameras, film cameras, portable printers, portable projection systems, IR viewers, underwater cameras or any waterproof device, toothbrushes, shavers, medical equipment, scientific equipment, dental equipment, military equipment, coffee mugs, kitchen appliances, cooking pots and pans, lamps or any battery, DC, or AC operated device.

[00134] In addition, inductive power transfer can provide power to devices that are not so far battery operated. For example, a mobile device charger or power supply in the shape of a pad placed on a desk or a kitchen table can be used to power lamps or kitchen appliances. In one embodiment for the use in a kitchen, a flat charger, or power supply such as a pad, placed on or built into a counter can allow the chef to place devices on the charger or power supply to be inductively charged or powered during use and simply place them

away after use. The devices can be, for example, a blender, mixer, can opener, or even pot, pan, or heater. This can eliminate the need for a separate cooking and work area. It will be noted that placement of a metal pan close to the inductive pad can directly heat the pan and the contents while keeping the charger or power supply surface cool. Due to this reason, inductive kitchen ranges have been commercialized and shown to be more efficient than the electric ranges that work by resistive heating of a coil.

[00135] In another embodiment, rather than direct heating of metal pans by nearby inductive fields, cooking pans may include a receiver and heating or even cooling elements. Once placed on a charger, the pan wiil heat up or cool down as desired by a dial or the like on the pan allowing precise temperature control of the pan and the contents,

[00136] Similarly, in an office or work area setting, if a charger or power supply is readily available for charging or powering mobile devices or batteries, if can also be used to power up lamps for illumination of the desk or used to power or charge office appliances, such as fax machines, staplers, copiers, scanners, telephones, and computers. In one embodiment, the receiver can be built into the bottom of a table lamp and the received power is used to power the incandescent or LED lamp.

[00137] In another embodiment, a mug, cup, glass, or other eating appliance such as a plate can be fitted with a receiver at its bottom. The received power can be used to heat the mug, etc. with a heating coil thus keeping beverages or food warm to any degree desired. Furthermore, in accordance with an embodiment, by use of devices such as thermoelectric coolers the contents can be cooled or heated as desired.

[00138] Similarly, many children's toys often run out of battery power due to extended use or simple forgetfulness to turn the device off. Often these batteries are included inside a battery compartment that for safety reasons can only be opened by a screwdriver. Inclusion of the receiver into toys or batteries inside can reduce the need to change the device batteries and allow recharging with a much simpler method.

[00139] In another implementation, the receiver can be built into medical devices or their batteries that are implanted or inserted in the body. Since batteries in these devices such as pace makers, cochlear implants, hearing aids, or other monitoring devices may need periodic charging, inductive power transfer can provide an ideal non-contact method for charging and testing the performance of the devices (i.e. check up) or downloading data that the devices have logged.

[00140] In another implementation, some active RFID tags include batteries that can send out information about the status or location of a package or shipment. An inexpensive method for charging these tags is to include a receiver with each tag. Thus, a charger can be used to power or charge these RFID tags.

[00141] It will be noted that the effective working distance of the inductive charger is dependent on the power and the frequency of the source and the size and geometry of the coil. By increasing the frequency to several or tens of MHz, one can obtain a working distance of several inches or feet depending on the application for the technology, it will also be noted that any of the above embodiments that eliminate the input power jack are especiaiiy important because they add to product reliabiiity by removing a source of mechanicai or environmental failure. In addition, elimination of the jack is imperative for water proof appiications and for extra safety.

Efficiency Enhancements through Coi! Circuit

[00142] In accordance with an embodiment, in order for the power efficiency to be maximized and to minimize iosses in the coil, the coiis should be manufactured to have as low a resistance as possible. This can be achieved by use of more conductive materiai such as gold, silver, etc. However the costs of these materials are sometimes prohibitive. Sh practice, reduced resistivity can be obtained by using thicker copper-clad PCBs or wider tracks. Most common PCBs use 1-2 02 copper PCBs. in accordance with some embodiments the coii PCB used for the wireless charger can be made from PCBs clad with between 2 and 4, or even 6 oz copper. The process of manufacture of the PCB can also be optimized to achieve higher conductivity. For example, sputtered copper has a higher conductivity than rolled copper and is typically better for this appiication. In operation, the coil and the circuitry demonstrate a resonance at a frequency determined by the parameters of the design of the coil {for example, the number of windings, coii thickness, width, etc.). Previous work has concentrated on circuits driven by square waves with a MOSFET. This approach has the disadvantage that since a square wave is not a pure sinusoid, it produces harmonics. These harmonics are undesirable because;

- The PCB coii produces optimum power transfer efficiency at a particuiar frequency. The harmonics in the primary signal are not transferred as efficiently and decrease the overall system efficiency.
- The rapid voltage change in the leading and falling edge of the square wave creates osciiiations that create further harmonics resulting further EMI.
- The harmonics radiated by the primary create higher frequency components that contribute to the EMI that is more radiative (due to higher frequency). It is desirabie to limit the frequency range of the operation of the overall system to as Sow a frequency as possible while maintaining the other requirements of the system (such as sufficient working distance, etc.), so these harmonics must be avoided.
- At the instance of switch turn-on and turn-off, the change in the in-rush current to the

coil causes huge voltage swings across the coil for a short period of time. Ail the power is transferred to the receiver during these times that are short.

[00143] Previous attempts to achieve 90% transfer efficiency with PCB coil primary and receiver *have* used a laboratory power supply to drive thetr circuit. Whtie this approach has demonstrated the higher efficiency that can be achieved with a sinusoidal voltage on the coiL such power supplies are complex, costly, and too large to be able to be used for any practical charger application, sn accordance with an embodiment, a capacitor is added in paraiiei to the drain/source contacts of the MOSFET.

[00144] Figure 9 shows a figure of a circuit diagram 240 in accordance with an embodiment. The coil in the wireless charger system is driven by switching the FET at the resonance frequency of the circuit when the receiver is present. Without the receiver nearby, the circuit is detuned from resonance and radiates minimal EML The capacitor 244 acts as a reservoir of energy that discharges during switch off time and enhances energy transfer. As with the exampies described above, changing the value of the capacitance allows for tuning the power and efficiency levels on a lower-power/ high-power basis, and additional features and techniques can be used b fine tune the power output for particular devices.

[00145] The circuit designs illustrated in Figure 2 and Figure 9 use a zero-crossing power supply. Briefly, in a zero-crossing power supply, when the transistor in the primary coil is first turned on, electrical current passes through the primary coil and the transistor to ground. When the transistor is then turned off, the voltage level at the transistor swings high (for example, if the input voltage is 5V, then the voltage level may swing to 10V, or even 100V). A non-zero-crossing circuit allows the current to drop to zero, before the cycle is restarted. A forward mode circuit can then use an inductor in series with the load to revive the current and charge up the inductor, while a diode allows charging in both directions (when full phase AC is used),

[00146] In a traditional transformer design, zero-crossing is not used, since it invariably results in lower efficiency compared to non-zero designs, at least with higher power or ferrite cores. This is primarily because the traditional ferrite cores act as capacitors and store energy, which in turn reduces the circuit efficiency. As described above, in accordance with an embodiment, when a non ferrite coil there is no magnetic flux, so the efficiency is not affected to the same extent.

[00147] Furthermore, since the system does not use a ferrite or ferromagnetic core, the overall size and weight of the device can be reduced, in accordance with some embodiments the coil can be formed on a printed circuit board (PCB), with no heavy ferrite coils, no soldering and no wiring to the coils. in accordance with some embodiments there is

no need for a magnetic core in the secondary in the receiver. Since magnetic cores are usually iarge and heavy this results in considerable size savings.

[00148] By way of example, in accordance with an embodiment that uses an SRFR0220 chip as a FET and use 4 oz copper cotls with 9 turns and 1,25" diameter, the circuit in **Figure** 2 above, can be loaded with RL of 10 Ohm and tuned to operate at 1.3 MHz. With matching coils in the primary and secondary in the receiver, without capacitor C, totai circuit efficiency of the circuit inciuding the dock and FET driver circuit approaches 48%. Addition of a 1600 pF capacitor in parallel to the FET increases the total circuit efficiency to 75% (a better than 50% increase in efficiency), while simultaneously decreasing the voltage across the FET and also the harmonics in the circuit. The coil to coil transfer efficiency with the capacitor piaced in parallel with the FET is estimated to be approximately 90%. The advantages of this approach include:

- High efficiency (-90% coil to coil).
- Low ringing oscillation and EML
- Simplicity and low cost.
- Lower FET source-drain voltage swing allowing use of a larger selection of FETs.

[00149] In many applications, it is also desired that the pad and the receiver are arranged so that the pad does not emit power unless the receiver is nearby.

[00150] **Figure 10** and **Figure 11** show circuit diagrams in accordance with an embodiment. In addition to high efficiency, one method that is required for minimizing EMI and maintaining high overall efficiency is the ability to recognize the presence of a receiver nearby, and then turning on the pad only when appropriate. Two methods for this are described below.

[00151] As shown in **Figure 10,** in accordance with one embodiment, the pad circuit 260 incorporates a micro control unit (MCU1) 266 that can enable or disable the FET driver 268. The MCU1 receives input from another sensor mechanism that will provide information that it can then use to decide whether a device is nearby, what voltage the device requires, and/or to authenticate the device to be charged or powered.

[00152] One of the sensor mechanisms for this information are through the use of an RFID reader 280 that can detect an RFID tag of circuit and antenna in the receiver (i.e. device or battery to be charged or powered). The information on the tag can be detected to identify the voltage in the receiver required and to authenticate the circuit to be genuine or under license. The information on the tag can be encrypted to provide further security. Once a device or battery containing the tag is nearby the pad, the RFiD reader can be activated, can read the information on the tag memory, and compare with a table to determine authenticity/voltage required or other info. This information table can aiso reside on the

MCU 1 memory. Once the information is read and verified, the MCU 1 can enable the FET driver to start driving the coi! on the pad and to energize the receiver.

[00153] In another embodiment the MCU1 reiies on a dock 270 to periodically start the FET driver. The current through the FET driver is monitored through a current sensor 264. Severs! methods can be implemented with this implementation, including for example :.

- A small resistor can be placed in series with the FET to ground contact. The voltage across this resistor can be measured by a current sensor chip, such as a Linear Technology Current Sense Amplifier part number LT1787.
- A Hall sensor, such as a Sentron CSA- 1A, that measures the current from a wire running under it, can be placed on top of the PCB line from the FET to the ground to measure the current without any electrical connection to the circuit. The advantage of this approach is that no extra resistor in series with this portion of the circuit is necessary reducing the impedance.
- Other techniques may be used to measure the current.
- A Hal! sensor or a Reed switch can sense a magnetic field. If a small magnet is placed inside the receiver unit of the system, a Hail sensor or Reed switch can be used to sense presence of the magnet and can be used as a signal to start the FET.
- Other capacitance, optical, magnetic, or weight, etc. sensors can be incorporated to sense the presence of a secondary or receiver and to begin the energy transfer process.

[00154] Figure **11** shows a figure of a circuit diagram 290 in accordance with an embodiment. In accordance with an embodiment, the MCU1 can periodically start the FET driver. if there is a receiver nearby, it can power the circuit. The regulator 296, or another memory chip in the circuit can be programmed so that on power-up, it draws current in a pre-programmed manner. An example is the integration of an RFiD transponder chip in the path, such as ATMEL e5530 or another inexpensive microcontroller (shown here as MCU2 294), that upon power-up modulates the current in the receiver that can then be detected as current modulation in the primary. As with the previous example, other sensors, such as an RFID antenna 292 can also be used to provide positiona! and other information.

[00155] **Figure 12** shows a figure of a power transfer chart 300 in accordance with an embodiment, illustrating transferred power as a function of offset between coiSs.

Efficiency Enhancements in Coit Layout

[00156] An important aspect of power transfer efficiency relates to the alignment of coils with respect to each other.

[00157] Figure 13 and Figure **14** show figures of a coi! layout in accordance with an embodiment. If position independence is required, the pad PCS can be patterned with a coi!

pattern to cover the full area. Figure 13 shows a pad type charger or power supply 310 including a layer of coils 312 with minima! spacing 314 between the coils. Each coil has a center 316 associated with it. In accordance with an embodiment, the power transfer for a 1.25" diameter coil as the center of the receiver is offset from the center of primary. The power drops off to 25% of the maximum value when the two coils are offset by a coil radius, As described above, in order to better keep the coils aligned, use of magnets centered on the primary and the receiver coii can provide an automatic method of bringing the two parts into alignment.

[00158] In order to produce uniform fteids, a number of coiis around the receiver coil will typically need to be turned on to produce a field. However, with such a pattern, if a receiver coil is placed in between two primary coiis, the voltage is still not optimized. Research has shown that to obtain uniform fields, three layers of coil patterns offset with respect to each other are required.

[00159] Figure 14 shows a pad-type charger 320 with two of the three layers 322, 324 required to achieve position independent magnetic field pattern. For a receiver placed at the center of the circle, ail the coils nearby (in and around the circle 328) wii! need to be turned on to achieve a uniform field in the desired iocation 326. While this approach solves the offset issue and can be used to provide position independence, it does not produce high transfer efficiency. The reason is that ten or more coils have to be turned on near the receiver center to create the uniform field in that area, which in turn leads to inefficient power transfer.

Efficiency Enhancements through Independent Coil Movement

[00160] In accordance with some embodiments, techniques are included to provide high transfer efficiency while maintaining position independence,

[00161] Figure 15 shows a figure of a charging pad with multiple coils in accordance with an embodiment. The area of the pad 330 is divided into a plurality of, or multiple segments 332, that are bounded 336 by a wali or physical barrier, or simply some tethering means with no physical walls but that otherwise restrict movement to within the segment. The coiis 334 are mounted such that they can move laterally, or float, within the area of their segments while continuing to be connected to the drive electronics piaced on the edges of the area. In accordance with an embodiment, the floating coils and the drive circuit are sandwiched between thin upper and lower cover iayers that act to allow the coils lateral movement while limiting vertical movement. When a receiver coil is placed on the pad, the pad senses the position of the receiver coil and moves the coils to the right position to optimize power transfer.

[00162] Figure 16 shows a figure of a charging pad with movable coils in accordance with an embodiment. When the mobtie device, for exampie a eel! phone 340, or a battery is piacβd on the pad 330, the nearest coil moves 342 within its segment to better orient itseif with the mobtie device or battery, In accordance with one embodiment, the method used for achieving this is by attaching a magnet to the bottom center of each coil in the pad. A matching magnet at the center of the receiver coi! attracts the primary magnet nearby and centers it automatical ₅ with respect to the receiver cos!.

[00183] In accordance with an embodiment, each coii in this configuration can be suspended by the wires carrying power to the coil or by a separate wire/spring or by another mechanism so that each coi! can move freely in the plane of the pad while it can receive power from an individual or shared driving circuit. In order to facilitate movement, the surface of the coiis or the bottom surface of the top iayer for the base unit (the area where the coils move against) or both layers can be made smooth by use of a low friction materia!, attachment of a low friction materia!, or lubrication. The wire/spring or current carrying mechanism described above can also be used to center each coil in an area at the center of desired movement sector for each coii. In this way, without a receiver coil in the vicinity, each coii in the base unit stays at the central tøcation of its sector and responds and moves to match a receiver coil when a device or battery is brought nearby. Overiap of movement between adjacent charger or power suppiy coils can be controiied by means of iimiting movement through iimiting iength of current carrying wires to the coil, arrangement of the suspension, or spring, or piacement of dividing sectors, pillars or by any other mechanism.

[00184] in another embodiment, the pad wiii include a method for detecting the presence of the mobile device, battery/receiver and taking appropriate action to turn on the coil and/or to drive the coi! with the appropriate pattern to generate the required voitage in the receiver. This can be achieved through incorporation of RFiD ₁ proximity sensor, current sensor, etc. A sequence of events ᵬ enable position independence and automatic pad turn-on can be:

- MuStiple movable coiis are used to cover the pad surface area.
- The coiis in the pad are normally off and periodically powered *up* sequentially to sense whether the receiver is nearby by measuring the current through the primary coi!. Alternatively, proximity sensors under each section can sense the presence of a magnet or change in capacitance or other parameter to know where a device is piaced, RFiD techniques with localized antennas under each section or such can aSso be used.
- Once a device is identified as piaced in a section, the pad can interrogate the device through one of the processes described eariier to authenticate and to understand its volfage/power, etc. requirements.

* The MCU 1 unit uses the information received above to set the PVWI pattern which it will use to drive the FET drive to produce the appropriate voltage in the receiver.

• The board continues to 'search' for other devices on the pad by scanning coifs or using the RFID system, etc. and then turn on other coiSs as appropi ate,

• The pad aiso uses monitoring to find out when and if the first mobile device is removed from the pad, or when the end of charge is reached.

Efficiency Enhancements ïn Coif Registration and Switching

[00165] In accordance with an embodiment, a globai RFID system that can identify the approach of a mobile device to the pad can be used to 'Wake up' the board. This can be followed by sequentia! poiiing of individual coiis to recognize where the device is piaced in a manner similar to described above Other embodiments can be used to provide safeguards against faise charging of objects placed on the base unit. It is known that a metal object piaced on coils such as the ones in the base of the charger or power supply system wiii cause current to flow in the primary and transfer power dissipated as heat to the metal object. in practicai situations, this will cause placement of keys and other metai objects on the base unit to trigger a start and to neediessly draw current from the base unit cot! and possibly lead to failure due to over-heating. To avoid this situation, in embodiments such as described above, the switching of voitage to the coii wiil not start uniess an electronic device with a verifiabie RFiD tag is nearby thereby triggering the sequence of events for recognizing the appropriate coil to turn on and operate. in an aiternate geometry, the total system current or individual coii current is monitored, and, if a sudden unexpected drawn current is noticed, measures to investigate further or to shut down the appropriate coii indefiniteiy or for a period of time or to indicate an alarm is taken.

[00166J In another embodiment, the regulators or battery charging circuit in mobile devices or batteries, or the reguiator in a receiver eiectronics, typically has a start voltage (such as 5 V) that is required to start the charging process. Once the battery charge circuit detects the presence of this voltage, it switches on and then proceeds to draw current at a preset rate from the input to feed the battery for charging. The battery charger circuits operate such that an under or over voitage at the start will prevent startup. Once the startup occurs, the voltage at the battery charger output is typically the voitage of the battery and depends on the state of charge, but is for example 4.4 V to 3.7 V, or iower for Lithium-ion batteries. With a wireless charge system such as described here, the voitage on the receiver is highly dependent on relative position of the primary and receiver coil as shown in Figure 5. Since typicaiiy the start voltage of the battery charger is within a narrow range of the