Patent & Utility Model Number Search

You can retrieve a variety of patent and utility model gazettes by their numbers.

Selected Gazette

JP,2002-055176,A

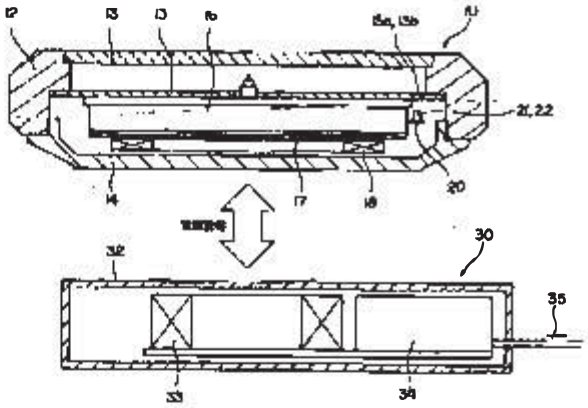
*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

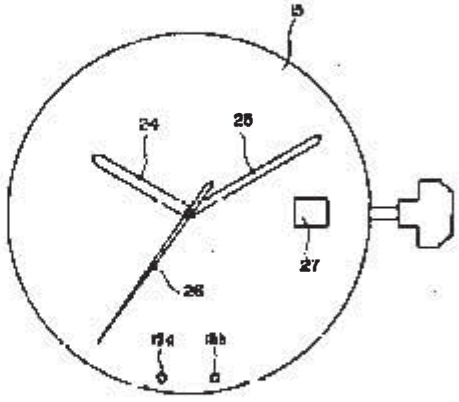
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

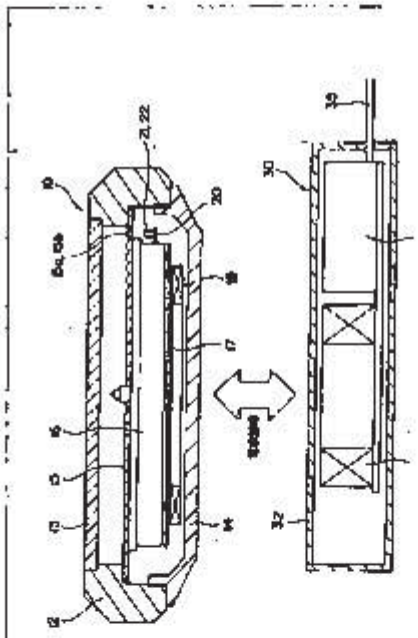
[Drawing 1]



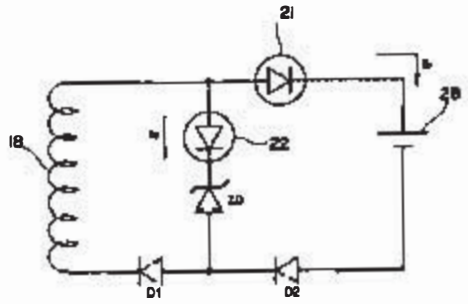
[Drawing 2]



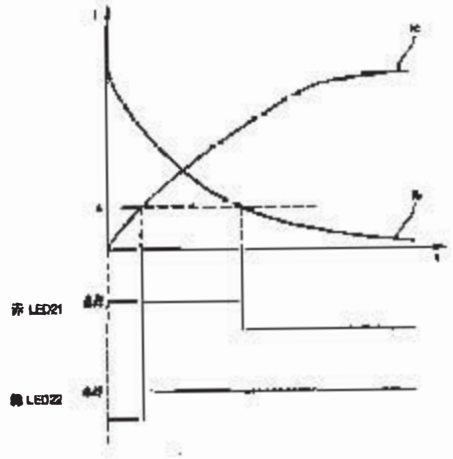
[Drawing 3]



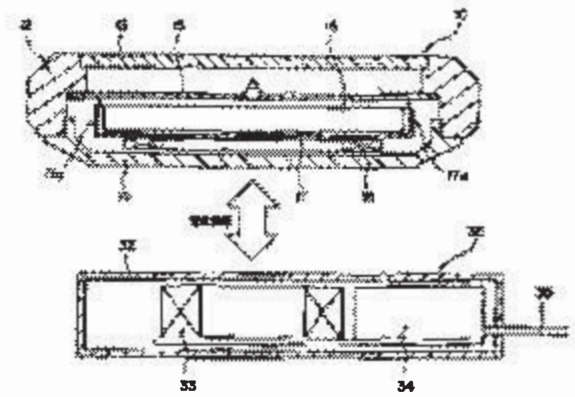
Representative drawing

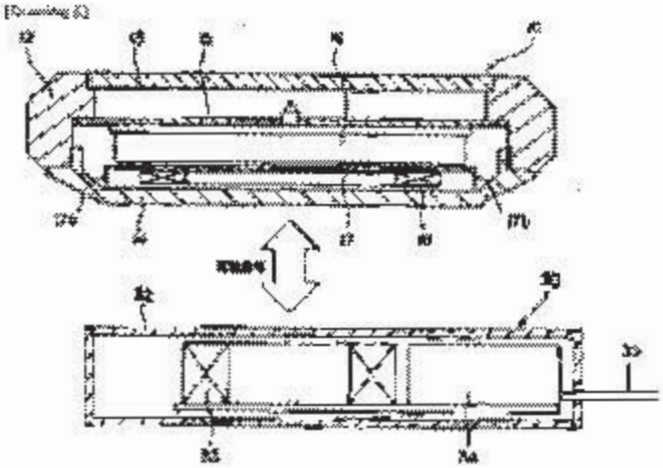


[Drawing 4]

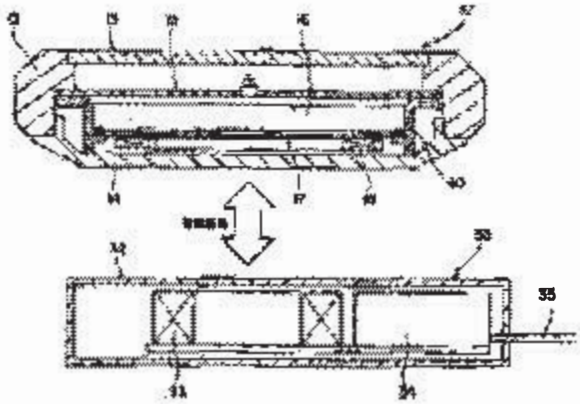


[Drawing 5]





[Drawing 7]



Previous Document 1/1 Next Doc

To return to the top of

[Translation done.]

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2

CONFIRMATION NO. 4659

14443
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

IMPROPER CFR REQUEST

OC000000083239328

Date Mailed: 05/27/2016

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Continuity, Priority Claims, Petitions, and Non-Publication Requests

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- The priority or continuity claim has not been entered because it was not filed during the required time period. Applicant may wish to consider filing a petition to accept an unintentionally delayed claim for priority. See 37 CFR 1.55 or 1.78.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ctuazon/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

14443 7590 08/17/2016
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

EXAMINER	
NGUYEN, TUYEN T	

ART UNIT	PAPER NUMBER
2837	

MAIL DATE	DELIVERY MODE
08/17/2016	PAPER

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.

Office Action Summary	Application No. 14/120,197	Applicant(s) BOYS ET AL.	
	Examiner TUYEN NGUYEN	Art Unit 2837	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 ____.

☐ 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) 72-79 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) 72-79 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 ____ 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 5/16/16 12/7/15 2/9/15 11/17/14 & 5/5/14.

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

4) ☐ Other: ____.

The present application is being examined under the pre-AIA first to invent provisions.

3DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim(s) 72 is/are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Eto [US 5,469,036.]

Eto discloses an inductive power transfer device/pad comprising:

- a coil [33] having at least one turn of conductor in a first layer; and

- a plurality of magnetic material [35] arranged in a second layer substantially parallel to that of the coil wherein the magnetic material arranged so as to be spaced apart from one another about the coil with their lengths extending across a longitudinal length of the coil.

Claim Rejections - 35 USC § 103

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, 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.

Claims 73-79 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Eto.

Regarding claims 73-74, the specific arrangement of the magnetic materials and shape of the coil would have been an obvious design consideration based on the intended applications and/or environments uses.

Regarding claim 78, ferrite material is a known magnetic material use in magnetic device.

Regarding claim 75-77 and 79, the specific additional magnetic materials and/or positioning of the magnetic materials would have been obvious for the purpose providing intended magnetic flux/field desired.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to TUYEN NGUYEN whose telephone number is (571)272-1996. The examiner can normally be reached on M-F 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, ELVIN ENAD can be reached on 571-272-1990. 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.

/TUYEN NGUYEN/
Primary Examiner, Art Unit 2837

Notice of References Cited	Application/Control No. 14/120,197	Applicant(s)/Patent Under Reexamination BOYS ET AL.	
	Examiner TUYEN NGUYEN	Art Unit 2837	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-7,463,131 B1	12-2008	Hwang; Kyuwoon	H01F17/0006	336/200
*	B	US-6,429,651 B1	08-2002	Choi; Sang-on	G01R33/04	324/225
*	C	US-8,102,236 B1	01-2012	Fontana, Jr.; Robert E.	H01F3/14	336/200
*	D	US-7,875,955 B1	01-2011	Hopper; Peter J.	H01F17/0006	257/516
*	E	US-2008/0238601 A1	10-2008	Das; Anirban	H01F1/24	336/200
	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	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Receipt date: 05/16/2016

Dkt. 1172/69068-Div 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner:

Date Filed : May 5, 2014 GAU:

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd.
Suite 327
Huntington Station, NY 11746

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

INFORMATION DISCLOSURE STATEMENT

The information listed in the attached form PTO-1449 is brought to the attention of the Examiner. In accordance with 37 C.F.R. §1.92(a)(2)(ii), copies of U.S. Patents listed herein need not be provided.

The listed documents have been made of record in sister divisional application Serial No. 13/999,663. It is respectfully requested that the information cited in annexed Forms PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

May 13, 2016
Richard F. Jaworski Date
Reg. No. 33,515

The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The items listed are submitted in good faith, but are not intended to substitute for the Examiner's search. It is hoped, however, that in addition to apprising the Examiner of the particular items, they will assist in identifying fields of search and in making as full and complete a search as possible.

The filing of this Information Disclosure Statement is not an admission that the information cited herein is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b).

This Information Disclosure Statement is being submitted prior to issuance of a first action on the merits. Accordingly, it is believed that no fees are required. However, if a fee is deemed necessary for consideration of the present Information Disclosure Statement the Office is authorized to charge the fee to Deposit Account 50-5504.

Early and favorable consideration of the case is respectfully requested.

Respectfully submitted,

RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
Customer No. 14443
The Law Office of Richard F. Jaworski, PC
Tel. (631) 659-3608

Form PTO-1449

U.S. Department of Commerce
Patent and Trademark Office

INFORMATION DISCLOSURE CITATION
BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	20030052647	Mar. 20, 2003	Yoshida et al.			
/TN/	AB	5559418	Apr. 10, 1995	Nor et al.			
/TN/	AC	20090278492	Nov. 2009	Shimizu et al.			
/TN/	AD	8036088	Oct. 2011	Pandya et al.			
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	EP1205402	May 15, 2002	EP				
/TN/	AR	11505099	Mar. 26, 1999	Japan			Yes	
/TN/	AS	11252810	SEPT. 17, 1999	Japan			Yes	
/TN/	AT	10193969	July 21, 1998	Japan			Yes	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED

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

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. 14/120,197
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date May 5, 2014	Group

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	2002551756	Feb. 20, 2002	Japan			Yes	
	AR							
	AS							
	AT							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED
/Tuyen Nguyen/	08/16/2016

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

Receipt date: 02/09/2015

Dkt. 1172/69068-Div. 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner:

Date Filed : May 5, 2014 GAU:

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd.
Suite 327
Huntington Station, NY 11746

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

INFORMATION DISCLOSURE STATEMENT

The information listed in the attached form PTO-1449 is brought to the attention of the Examiner. In accordance with 37 C.F.R. §1.92(a)(2)(ii), copies of U.S. Patents listed herein need not be provided.

The listed documents were cited in a corresponding Australian application. It is respectfully requested that the information cited in annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Richard F. Jaworski
Reg. No. 33,515

February 6, 2015
Date

The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The items listed are submitted in good faith, but are not intended to substitute for the Examiner's search. It is hoped, however, that in addition to apprising the Examiner of the particular items, they will assist in identifying fields of search and in making as full and complete a search as possible.

The filing of this Information Disclosure Statement is not an admission that the information cited herein is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b).

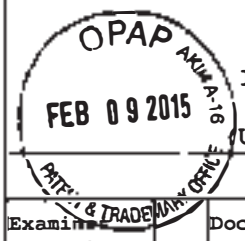
This Information Disclosure Statement is being submitted prior to receipt of an action on the merits. Accordingly, it is believed that no fee is required for consideration of the present Information Disclosure Statement. However, if a fee is deemed to be required, the Office is authorized to charge any fees to Deposit Account 50-5504.

Early and favorable consideration of the case is respectfully requested.

Respectfully submitted,

RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
Customer No. 14443
The Law Office of Richard F. Jaworski, PC
Tel. (631) 659-3608

Form PTO-1449 U.S. Department of Commerce Patent and Trademark Office



INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div. 2	14/120,197
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	5 2 0 2 6 1 7	Apr. 13, 1993	NOR			
/TN/	AB	7 1 6 4 2 5 5	Jan. 16, 2007	HUI			
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
	AQ							
	AR							
	AS							
	AT							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	/Tuyen Nguyen/	DATE CONSIDERED	08/16/2016

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

Receipt date: 11/17/2014

Dkt. 1172/69068-Div. 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner:

Date Filed : May 5, 2014 GAU: 3742

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd.
Suite 327
Huntington Station, NY 11746

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

INFORMATION DISCLOSURE STATEMENT

The information listed in the attached form PTO-1449 is brought to the attention of the Examiner. In accordance with 37 C.F.R. §1.92(a)(2)(ii), copies of U.S. Patents listed herein need not be provided.

The cited documents were both third party submissions in a corresponding Japanese patent application. In addition, document WO 03/105308 was recently cited by the EPO in an extended European Search Report.

It is respectfully requested that the information cited in annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Richard F. Jaworski — Date: NOV. 14, 2014
Reg. No. 33,515

The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The items listed are submitted in good faith, but are not intended to substitute for the Examiner's search. It is hoped, however, that in addition to apprising the Examiner of the particular items, they will assist in identifying fields of search and in making as full and complete a search as possible.

The filing of this Information Disclosure Statement is not an admission that the information cited herein is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b).

This Information Disclosure Statement is being submitted prior to receipt of an action on the merits. Accordingly, it is believed that no fee is required for consideration of the present Information Disclosure Statement. However, if a fee is deemed to be required, the Office is authorized to charge any fees to Deposit Account 50-5504.

Early and favorable consideration of the case is respectfully requested.

Respectfully submitted,

RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
Customer No. 14443
The Law Office of Richard F. Jaworski, PC
Tel. (631) 659-3608

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div. 2	Serial No. 14/120,197
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date March 14, 2014	Group 3742

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	JP 2006-425191	Feb. 9, 2006	Japan			X	
/TN/	AR	WO 03/105308	Dec. 18, 2003	WIPO				
	AS							
	AT							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	/Tuyen Nguyen/	DATE CONSIDERED	07/25/2016

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : Div. of 12/451,436 Examiner:

Date Filed : Concurrently Herewith GAU: 2832

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd.
Suite 327
Huntington Station, NY 11746

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

INFORMATION DISCLOSURE STATEMENT

The information listed in the attached form PTO-1449 is brought to the attention of the Examiner. In accordance with 37 C.F.R. §1.92(a)(2)(ii), copies of U.S. Patents listed herein need not be provided.

It is respectfully requested that the information cited in annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The items listed are submitted in good faith, but are not intended to substitute for the Examiner's search. It is hoped, however, that in addition to apprising the Examiner of the particular items, they will assist in identifying fields of search and in making as full and complete a search as possible.

The filing of this Information Disclosure Statement is not an admission that the information cited herein is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b).

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

This Information Disclosure Statement is being submitted along with filing of the present Divisional Application of Application Serial No. 12/451,436 filed January 13, 2010. Since each of the documents cited herein is of record in that parent application, it is believed that copies of the documents are not required.

It is believed that no fee is required for consideration of the present Information Disclosure Statement. However, if a fee is deemed to be required, the Office is authorized to charge any fees to Deposit Account 50-5504.

Early and favorable consideration of the case is respectfully requested.

Respectfully submitted,

RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
Customer No. 14443
The Law Office of Richard F. Jaworski, PC
Tel. (631) 659-3608

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. NYA
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date Herewith	Group 2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	5 4 6 9 0 3 6	Nov. 21, 1995	Eto			
/TN/	AB	4 8 7 3 6 7 7	Oct. 10, 1989	Sakamoto et al.			
/TN/	AC	6 5 0 1 3 6 4	Dec. 31, 2002	Hui et al.			
/TN/	AD	6 9 0 6 4 9 5	June 14, 2005	Cheng et al.			
/TN/	AE	5 5 2 8 1 1 3	June 18, 1996	Boys et al.			
/TN/	AF	5 7 1 0 5 0 2	Jan. 20, 1998	Poumey			
/TN/	AG	5 8 2 1 6 3 8	Oct. 13, 1998	Boys et al.			
/TN/	AH	6 9 3 4 1 6 7	Aug. 23, 2005	Jang et al.			
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	JP 06 - 27 73 5 8	Oct. 4, 1994	Japan			Abst.	
/TN/	AR	JP 20 02 - 23 15 45	Aug. 16, 2002	Japan			Abst.	
/TN/	AS	JP 8 - 23 83 2 6	Sept. 17, 1996	Japan			Abst.	
/TN/	AT	JP T2 00 7- 50 54 80		Japan				

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

/TN/	AU	Notice of Reasons for Rejection in corresponding Japanese application p2010-507347 (Original and English Translation)
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED
/Tuyen Nguyen/	07/25/2016

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449 U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. NYA
INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Applicant John Talbot BOYS et al.	
	Filing Date Herewith	Group 2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
	AQ							
/TN/	AR	03 - 23 9 1 3 6	Oct. 24, 1991	Japan			Abst.	
/TN/	AS	WO 20 05 02 48 6 5	March 17, 2005	PCT				
/TN/	AT	WO 20 06 10 12 8 5	Sept. 28, 2006	PCT				

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	/Tuyen Nguyen/	DATE CONSIDERED	07/25/2016

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449 U.S. Department of Commerce Patent and Trademark Office

INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	NYA
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
Herewith	2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	06 - 6 4 3 9 3	Sept. 9, 1994	Japan			X	
/TN/	AR	6 - 6 6 2 0 6	Sept. 16, 1994	Japan			X	
/TN/	AS	11 - 09 7 2 6 3	Apr. 9, 1999	Japan			X	
/TN/	AT	20 04 - 47 7 0 1	Feb. 12, 2004	Japan			X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

AU	
AV	
AW	
AX	

EXAMINER	DATE CONSIDERED
/Tuyen Nguyen/	07/25/2016

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. NYA
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date Herewith	Group 2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	WO 2008/051635 A1	May 2, 2008	WIPO				
/TN/	AR	2002-345365	Nov. 29, 2002	Japan			X	
/TN/	AS	2000-207025	July 18, 2000	Japan			X	
/TN/	AT	6-86321	Dec. 13, 1994	Japan			X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	/Tuyen Nguyen/	DATE CONSIDERED	07/25/2016

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

The PTO did not receive the following listed item(s)

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449 — U.S. Department of Commerce, Patent and Trademark Office

INFORMATION DISCLOSURE CITATION BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div. 2	14/120,197
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	20060219448	Oct. 5, 2006	Grieve et al.			
/TN/	AB	5821731	Oct. 13, 1998	Kuki et al.			
/TN/	AC	6389318	May 14, 2002	Zarinetchi et al.			
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	9-13373	Aug. 1997	Japan			Yes	
/TN/	AR	10-2004-0028312	April 2004	Korea			Yes	
/TN/	AS	2006-203959	Aug. 2006	Japan			Yes	
/TN/	AT							
/TN/								

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

AU	
AV	
AW	
AX	

EXAMINER /Tuyen Nguyen/ DATE CONSIDERED 08/16/2016

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

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
14/120,197		2837	

OC000000087980201

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 14443 on 12/16/2016

- **Correspondence Address**

The address of record for Customer Number 14443 is:

14443
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

Dkt. 1172/69068-Div 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner: Tuyen T. Nguyen

Date Filed : May 5, 2014 GAU: 2837

For : MULTI POWER SOURCED ELECTRIC VEHICLE

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

AMENDMENT

Sir:

In response to the Office Action dated August 17, 2016, the time for responding to which having been extended to Monday, December 19, 2016 by the accompanying Petition for Extension of Time, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dec. 19, 2016
Date

Richard F. Jawor
Reg. No. 33,515

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Please amend the claims as shown below:

Claims 1-71 (previously canceled)

Claims 72-79 (presently canceled)

80. (new) An inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising:

one or more permeable magnetic material members in a first layer;

a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members; and

a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux generated by said transmitting pad.

81. (new) The inductive power transfer pad as claimed in claim 80, having a plurality of permeable magnetic material members in a form of bars each being arranged such that its length extends radially from a common point but spaced apart therefrom.

82. (new) The inductive power transfer pad as claimed in claim 81 wherein the coil is positioned to wind around the common point such that it passes each bar at approximately a center of the length of each bar.

83. (new) The inductive power transfer pad as claimed in claim 80 wherein a plane of the backplate is substantially parallel to planes of each of the permeable magnetic material members and the coil, the plane of the or each permeable magnetic material member is located between the plane of the backplate and the plane of the coil.

84. (new) The inductive power transfer pad as claimed in claim 80 wherein the backplate is formed from a material which substantially inhibits the passage of magnetic flux therethrough.

85. (new) The inductive power transfer pad as claimed in claim 84 wherein the backplate is formed from one at least one of copper and aluminum.

86. (new) The inductive power transfer pad as claimed in claim 80 wherein the backplate extends beyond coil and slabs.

87. (new) The inductive power transfer pad as claimed in claim 80, wherein the or each permeable magnetic material member comprises ferrite.

88. (new) The inductive power transfer pad as claimed in claim 80, wherein the backplate is arranged to control the electromagnetic flux substantially perpendicular to the third layer.

89. (new) The inductive power transfer pad as claimed in claim 80 wherein the shield member is arranged to control the electromagnetic flux between the inductive power transfer pad and the transmitting pad.

90. (new) The inductive power transfer pad as claimed in claim 80 wherein the backplate is arranged to direct electromagnetic flux generated by the transmitting pad.

91. (new) An inductive power transfer pad as claimed in claim 90 wherein the electromagnetic flux is directed substantially perpendicular to the third layer.

92. (new) An inductive power transfer system comprising a wireless power receiver pad separable from a wireless power transmitter pad, the two said pads each comprising:

one or more permeable magnetic material members in a first layer;

a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members; and

a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux.

REMARKS

The application has been reviewed in light of the Office Action dated August 17, 2016. Claims 80-92 are pending in this application, with claims 80 and 92 being in independent form. Claims 72-79 have been canceled without prejudice and claims 80-92 have been added. It is submitted that no new matter has been added and no new issues have been raised by the present Amendment.

Claim 72 was rejected under 35 U.S.C. §102(b) as allegedly anticipated by U.S. Patent 5,469,036 to Eto. Claims 73-79 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Eto. Applicants have carefully considered the Examiner's comments and the cited art, and respectfully submit new independent claims 80 and 92 are patentable over the cited art, for at least the following reasons.

Independent claim 80 relates to an inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising one or more permeable magnetic material members in a first layer, a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of the permeable magnetic material members and a shield member comprising a backplate defining a third layer, the backplate arranged to control electromagnetic flux generated by the transmitting pad.

Eto, as understood by Applicants, relates to an inductive power transfer mechanism for a horse riding game for recreational entertainment purposes and in which an artificial horse is positioned above a track base and is provided with power for movement with respect to the base. The base includes a plurality of windings located above magnets to provide a wide magnetic flux field around the track for reception by corresponding receiving coils in the moving horse.

Independent claim 80 relates to an inductive power transfer pad to *receive* power from a

transmitting pad. In contrast the coils of Eto (33, 35) referenced in the Office Action are arranged on the transmitting side. Eto shows a transmitting coil for providing power to a toy horse. The coils of Eto (33, 35) are formed by a plurality of panels connected in a track shape (col. 4, lines 31-32) and placed beneath the toy horse. This structure is designed to stay in a fixed position and transmit power to a different receiver. There is no suggestion in Eto that such an arrangement provides a useful receiver. The person skilled in the art would not be led to modify the structure into a receiver because it relies on a plurality of connected panels which would be unwieldy in a receiver.

Eto is not understood to teach or suggest a shield for controlling the magnetic field as recited in independent claim 80. The arrangement in Eto is intended to promote a wide uncontrolled magnetic field in order to provide a wide and sufficiently continuous magnetic flux around the track to enable operation of the horse. Eto is not concerned with controlling the splaying of the magnetic flux, but instead the opposite to allow for movement of the horse. Eto's primary concern is to avoid the use of contact brushes for transferring electrical power (Col. 1, lines 49-63). Accordingly, a person of ordinary skill in the art would have no motivation to consider restriction or controlling of the magnetic flux since this would limit the effectiveness of horse's movements.

Applicants find no teaching or suggestion in the cited art of an inductive power transfer pad to receive power from a transmitting pad, the inductive power transfer pad comprising one or more permeable magnetic material members in a first layer, a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of the permeable magnetic material members and a shield member comprising a backplate defining a third layer,

the backplate arranged to control electromagnetic flux generated by the transmitting pad, as recited in independent claim 80.

Accordingly, Applicants submit independent claim 80 is patentably distinct from the cited art.

Applicants also find no teaching or suggestion of an inductive power transfer system comprising a wireless power receiver pad separable from a wireless power transmitter pad, the two said pads each comprising one or more permeable magnetic material members in a first layer, a coil having at least one turn of a conductor, the coil being arranged in a second layer substantially parallel to that of said permeable magnetic material members and a shield member comprising a backplate defining a third layer, said backplate arranged to control electromagnetic flux, as recited in independent claim 92.

Accordingly, independent claim 92 is also believed to be patentably distinct from the cited art.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition, and the Commissioner is authorized to charge the requisite fees to our Deposit Account No. 50-5504.

Any additional fees required for consideration of this Amendment may be charged to Deposit Account No. 50-5504.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Entry of this amendment and allowance of this application are respectfully requested.

Respectfully submitted,

RICHARD F. JAWORSKI
Reg. No. 33,515
Attorney for Applicant
The Law Office of
Richard F. Jaworski, P.C.
Tel.: (631) 659-3608
Customer No. 14443

Dkt. 1172/69068-Div 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner: Tuyen T. Nguyen

Date Filed : May 5, 2014 GAU: 2837

For : MULTI POWER SOURCED ELECTRIC VEHICLE

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

PETITION FOR EXTENSION OF TIME

Sir:

It is respectfully requested that the period for filing a response to the Office Action dated August 17, 2016, be extended by one month, i.e. from November 17, 2016 to Monday, December 19, 2016.

The $200.00 statutory extension fee for filing a response within the first month pursuant to 1.136(a) by (other than) a small entity may be charged to the below indicated deposit account.

The Commissioner is authorized to charge any additional fees, or credit any overpayment, to our Deposit Account No. 50-5504.

Respectfully submitted,

RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
The Law Office of
Richard F. Jaworski, P.C.
Tel.: (631) 659-3608

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

DEC 19, 2016
Richard F. Jaworski Date
Reg. No. 33,515

12/27/2016 MBLANCO 00000003 505504 14120197
01 FC:1251 200.00 DA

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

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	To be Mailed
14/120,197	05/05/2014	☐

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 **12/22/2016**

	(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))	* 13	Minus	** 20	= 0	x $80 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	x $420 =	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
EVELYN NIMMONS

Dkt. 1172/69068-Div. 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IFW

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner: Tuyen T. Nguyen

Date Filed : May 5, 2014 GAU: 2837

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd.
Suite 327
Huntington Station, NY 11746

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

INFORMATION DISCLOSURE STATEMENT

The information listed in the attached form PTO-1449 is brought to the attention of the Examiner. In accordance with 37 C.F.R. §1.92(a)(2)(ii), copies of U.S. Patents listed herein need not be provided.

It is respectfully requested that the information cited in annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Dec. 22, 2016
Date

Richard F. Jaworski
Reg. No. 33,515

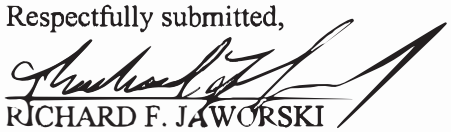
The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The items listed are submitted in good faith, but are not intended to substitute for the Examiner's search. It is hoped, however, that in addition to apprising the Examiner of the particular items, they will assist in identifying fields of search and in making as full and complete a search as possible.

The filing of this Information Disclosure Statement is not an admission that the information cited herein is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b).

This Information Disclosure Statement is being submitted after receipt of an action on the merits but prior to receipt of a final office action or notice of allowance. Any fees required for consideration of the present Information Disclosure Statement may be charged to the Deposit Account 50-5504.

Early and favorable consideration of the case is respectfully requested.

Respectfully submitted,



RICHARD F. JAWORSKI
Registration No. 33,515
Attorney for Applicant
Customer No. 14443
The Law Office of Richard F. Jaworski, PC
Tel. (631) 659-3608

Form PTO-1449 — U.S. Department of Commerce, Patent and Trademark Office

INFORMATION DISCLOSURE CITATION BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197

Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	2837

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA	4 8 0 0 3 2 8	Jan. 24, 1989	Bolger et al.			
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
	AQ	20 07 00 8 6 4 6	Jan. 18, 2007	WIPO				
	AR	08 5 0 5 2 7 9	2008	Japan			X	
	AS	20 02 13 7 6 5 9	May 14, 2002	Japan			X	
	AT	20 05 10 1 3 9 2	April 14, 2005	Japan			X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED

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

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. 14/120,197
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date May 5, 2014	Group 2837

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
	AQ	2008873	April 17, 2008	Japan			X	
	AR							
	AS							
	AT							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED

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

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

(19) World Intellectual Property Organization
International Bureau

PCT

(43) International Publication Date
18 January 2007 (18.01.2007)

(10) International Publication Number
WO 2007/008646 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/US2006/026480

(22) International Filing Date: 5 July 2006 (05.07.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/698,442 12 July 2005 (12.07.2005) US

(71) Applicant *(for all designated States except US)*: **MASSACHUSETTS INSTITUTE OF TECHNOLOGY** [US/US]; 77 Massachusetts Avenue, Cambridge, MA 02139 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **JOANNOPOULOS, John, D.** [US/US]; 64 Douglas Road, Belmont, MA 02478 (US). **KARALIS, Arsteidis** [GR/US]; 70 Pacific Street, Apt. #907, Cambridge, MA 02139 (US). **SOLAJACIC, Marin** [HU/US]; 67 Fairfax Street, Somerville, MA 02744 (US).

(74) Agents: **CONNORS, Matthew, E.** et al.; Gauthier & Connors LLP, 225 Franklin Street, Suite 2300, Boston, MA 02110 (US).

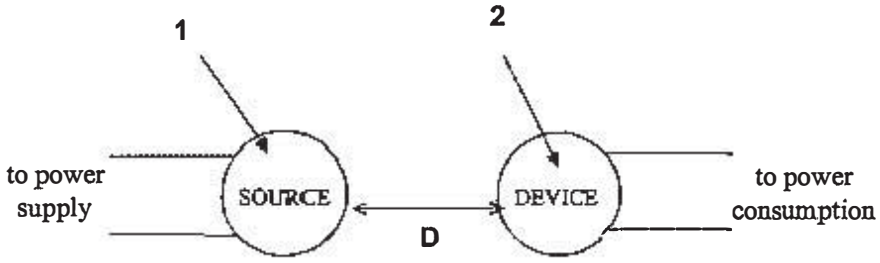
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ,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

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

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: WIRELESS NON-RADIATIVE ENERGY TRANSFER



(57) Abstract: The electromagnetic energy transfer device includes a first resonator structure receiving energy from an external power supply. The first resonator structure has a first Q-factor. A second resonator structure is positioned distal from the first resonator structure, and supplies useful working power to an external load. The second resonator structure has a second Q-factor. The distance between the two resonators can be larger than the characteristic size of each resonator. Non-radiative energy transfer between the first resonator structure and the second resonator structure is mediated through coupling of their resonant-field evanescent tails.

WO 2007/008646 A2

WIRELESS NON-RADIATIVE ENERGY TRANSFER

PRIORITY INFORMATION

This application claims priority from provisional application Ser. No. 60/698,442 filed July 12, 2005, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

The invention relates to the field of oscillatory resonant electromagnetic modes, and in particular to oscillatory resonant electromagnetic modes, with localized slowly evanescent field patterns, for wireless non-radiative energy transfer.

In the early days of electromagnetism, before the electrical-wire grid was deployed, serious interest and effort was devoted towards the development of schemes to transport energy over long distances wirelessly, without any carrier medium. These efforts appear to have met with little, if any, success. Radiative modes of omni-directional antennas, which work very well for information transfer, are not suitable for such energy transfer, because a vast majority of energy is wasted into free space. Directed radiation modes, using lasers or highly-directional antennas, can be efficiently used for energy transfer, even for long distances (transfer distance $L_{TRANS} \gg L_{DEV}$, where L_{DEV} is the characteristic size of the device), but require existence of an uninterruptible line-of-sight and a complicated tracking system in the case of mobile objects.

Rapid development of autonomous electronics of recent years (e.g. laptops, cell-phones, house-hold robots, that all typically rely on chemical energy storage) justifies revisiting investigation of this issue. Today, the existing electrical-wire grid carries energy *almost* everywhere; even a medium-range wireless non-radiative energy transfer would be quite useful. One scheme currently used for some important applications relies on induction, but it is restricted to very close-range ($L_{TRANS} \ll L_{DEV}$) energy transfers.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided an electromagnetic energy transfer device. The electromagnetic energy transfer device includes a first resonator structure receiving energy from an external power supply. The first resonator structure has a first Q-factor. A second resonator structure is positioned distal from the first resonator structure, and supplies useful working power to an external load. The second resonator structure has a second Q-factor. The distance between the two resonators can be larger than the characteristic size of each resonator. Non-radiative energy transfer

between the first resonator structure and the second resonator structure is mediated through coupling of their resonant-field evanescent tails.

According to another aspect of the invention, there is provided a method of transferring electromagnetic energy. The method includes providing a first resonator structure receiving energy from an external power supply. The first resonator structure has a first Q-factor. Also, the method includes a second resonator structure being positioned distal from the first resonator structure, and supplying useful working power to an external load. The second resonator structure has a second Q-factor. The distance between the two resonators can be larger than the characteristic size of each resonator. Furthermore, the method includes transferring non-radiative energy between the first resonator structure and the second resonator structure through coupling of their resonant-field evanescent tails.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating an exemplary embodiment of the invention;

FIG. 2A is a numerical FDTD result for a high-index disk cavity of radius r along with the electric field; FIG. 2B a numerical FDTD result for a medium-distance coupling between two resonant disk cavities: initially, all the energy is in one cavity (left panel); after some time both cavities are equally excited (right panel).

FIG. 3 is schematic diagram demonstrating two capacitively-loaded conducting-wire loops;

FIGs. 4A-4B are numerical FDTD results for reduction in radiation-Q of the resonant disk cavity due to scattering from extraneous objects;

FIG. 5 is a numerical FDTD result for medium-distance coupling between two resonant disk cavities in the presence of extraneous objects; and

FIGs. 6A-6B are graphs demonstrating efficiencies of converting the supplied power into useful work (η_w), radiation and ohmic loss at the device (η_d), and the source (η_s), and dissipation inside a human (η_h), as a function of the coupling-to- κ/Γ_d ; in panel (a) Γ_w is chosen so as to minimize the energy stored in the device, while in panel (b) Γ_w is chosen so as to maximize the efficiency η_w for each κ/Γ_d .

DETAILED DESCRIPTION OF THE INVENTION

In contrast to the currently existing schemes, the invention provides the feasibility of using long-lived oscillatory resonant electromagnetic modes, with localized slowly evanescent field patterns, for wireless non-radiative energy transfer. The basis of this

technique is that two same-frequency resonant objects tend to couple, while interacting weakly with other off-resonant environmental objects. The purpose of the invention is to quantify this mechanism using specific examples, namely quantitatively address the following questions: up to which distances can such a scheme be efficient and how sensitive is it to external perturbations. Detailed theoretical and numerical analysis show that a mid-range ($L_{TRANS} \approx few * L_{DEV}$) wireless energy-exchange can actually be achieved, while suffering only modest transfer and dissipation of energy into other off-resonant objects.

The omnidirectional but stationary (non-lossy) nature of the near field makes this mechanism suitable for mobile wireless receivers. It could therefore have a variety of possible applications including for example, placing a source connected to the wired electricity network on the ceiling of a factory room, while devices, such as robots, vehicles, computers, or similar, are roaming freely within the room. Other possible applications include electric-engine buses, RFIDs, and perhaps even nano-robots.

The range and rate of the inventive wireless energy-transfer scheme are the first subjects of examination, without considering yet energy drainage from the system for use into work. An appropriate analytical framework for modeling the exchange of energy between resonant objects is a weak-coupling approach called "coupled-mode theory". FIG. 1 is a schematic diagram illustrating a general description of the invention. The invention uses a source and device to perform energy transferring. Both the source 1 and device 2 are resonator structures, and are separated a distance D from each other. In this arrangement, the electromagnetic field of the system of source 1 and device 2 is approximated by $\mathbf{F}(\mathbf{r},t) \approx a_1(t)\mathbf{F}_1(\mathbf{r}) + a_2(t)\mathbf{F}_2(\mathbf{r})$, where $\mathbf{F}_{1,2}(\mathbf{r}) = [\mathbf{E}_{1,2}(\mathbf{r})\ \mathbf{H}_{1,2}(\mathbf{r})]$ are the eigenmodes of source 1 and device 2 alone, and then the field amplitudes $a_1(t)$ and $a_2(t)$ can be shown to satisfy the "coupled-mode theory":

$$\begin{aligned} \frac{da_1}{dt} &= -i(\omega_1 - i\Gamma_1)a_1 + i\kappa_{11}a_1 + i\kappa_{12}a_2 \\ \frac{da_2}{dt} &= -i(\omega_2 - i\Gamma_2)a_2 + i\kappa_{22}a_2 + i\kappa_{21}a_1 \end{aligned} \qquad (1)$$

where $\omega_{1,2}$ are the individual eigen-frequencies, $\Gamma_{1,2}$ are the resonance widths due to the objects' intrinsic (absorption, radiation etc.) losses, $\kappa_{12,21}$ are the coupling coefficients, and $\kappa_{11,22}$ model the shift in the *complex* frequency of each object due to the presence of the other.

The approach of Eq. 1 has been shown, on numerous occasions, to provide an excellent description of resonant phenomena for objects of similar complex eigen-frequencies (namely $|\omega_1 - \omega_2| \ll |\kappa_{12,21}|$ and $\Gamma_1 \approx \Gamma_2$), whose resonances are reasonably well

defined (namely $\Gamma_{1,2} \& \mathrm{Im}\{\kappa_{11,22}\} \ll |\kappa_{12,21}|$) and in the weak coupling limit (namely $|\kappa_{12,21}| \ll \omega_{1,2}$). Coincidentally, these requirements also enable optimal operation for energy transfer. Also, Eq. (1) show that the energy exchange can be nearly perfect at exact resonance ($\omega_1=\omega_2$ and $\Gamma_1=\Gamma_2$), and that the losses are minimal when the "coupling-time" is much shorter than all "loss-times". Therefore, the invention requires resonant modes of high $Q=\omega/(2\Gamma)$ for low intrinsic-loss rates $\Gamma_{1,2}$, and with evanescent tails significantly longer than the characteristic sizes L_1 and L_2 of the two objects for strong coupling rate $|\kappa_{12,21}|$ over large distances D, where D is the closest distance between the two objects. This is a regime of operation that has *not* been studied extensively, since one usually prefers short tails, to minimize interference with nearby devices.

Objects of nearly infinite extent, such as dielectric waveguides, can support guided modes whose evanescent tails are decaying exponentially in the direction away from the object, slowly if tuned close to cutoff, and can have nearly infinite Q. To implement the inventive energy-transfer scheme, such geometries might be suitable for certain applications, but usually finite objects, namely ones that are topologically surrounded everywhere by air, are more appropriate.

Unfortunately, objects of finite extent cannot support electromagnetic states that are exponentially decaying in *all* directions in air, since in free space: $\vec{k}^2 = \omega^2 / c^2$. Because of this, one can show that they cannot support states of infinite Q. However, very long-lived (so-called "high-Q") states can be found, whose tails display the needed exponential-like decay away from the resonant object over long enough distances before they turn oscillatory (radiative). The limiting surface, where this change in the field behavior happens, is called the "radiation caustic", and, for the wireless energy-transfer scheme to be based on the near field rather than the far/radiation field, the distance between the coupled objects must be such that one lies within the radiation caustic of the other.

The invention is very general and *any* type of resonant structure satisfying the above requirements can be used for its implementation. As examples and for definiteness, one can choose to work with two well-known, but quite different electromagnetic resonant systems: dielectric disks and capacitively-loaded conducting-wire loops. Even without optimization, and despite their simplicity, both will be shown to exhibit fairly good performance. Their difference lies mostly in the frequency range of applicability due to practical considerations, for example, in the optical regime dielectrics prevail, since conductive materials are highly lossy.

Consider a 2D dielectric disk cavity of radius r and permittivity ε surrounded by air that supports high-Q whispering-gallery modes, as shown in FIG. 2A. Such a cavity is studied using both analytical modeling, such as separation of variables in cylindrical coordinates and application of boundary conditions, and detailed numerical finite-difference-time-domain (FDTD) simulations with a resolution of *30pts/r*. Note that the physics of the 3D case should not be significantly different, while the analytical complexity and numerical requirements would be immensely increased. The results of the two methods for the complex eigen-frequencies and the field patterns of the so-called "leaky" eigenmodes are in an excellent agreement with each other for a variety of geometries and parameters of interest.

The radial modal decay length, which determines the coupling strength $\kappa \equiv |\kappa_{21}| = |\kappa_{12}|$, is on the order of the wavelength, therefore, for near-field coupling to take place between cavities whose distance is much larger than their size, one needs subwavelength-sized resonant objects ($r \ll \lambda$). High-radiation-Q and long-tailed subwavelength resonances can be achieved, when the dielectric permittivity ε is as large as practically possible and the azimuthal field variations (of principal number m) are slow (namely m is small).

One such TE-polarized dielectric-cavity mode, which has the favorable characteristics $Q_{rad}=1992$ and $\lambda / r = 20$ using $\varepsilon = 147.7$ and $m = 2$, is shown in FIG. 2A, and will be the "test" cavity 18 for all subsequent calculations for this class of resonant objects. Another example of a suitable cavity has $Q_{rad}=9100$ and $\lambda / r = 10$ using $\varepsilon = 65.61$ and $m = 3$. These values of ε might at first seem unrealistically large. However, not only are there in the microwave regime (appropriate for meter-range coupling applications) many materials that have both reasonably high enough dielectric constants and low losses, for example, Titania: $\varepsilon \approx 96$, $Im\{\varepsilon\}/\varepsilon \approx 10^{-3}$; Barium tetratitanate: $\varepsilon \approx 37$, $Im\{\varepsilon\}/\varepsilon \approx 10^{-4}$; Lithium tantalite: $\varepsilon \approx 40$, $Im\{\varepsilon\}/\varepsilon \approx 10^{-4}$; etc.), but also ε could instead signify the effective index of other known subwavelength ($\lambda/r \gg 1$) surface-wave systems, such as surface-plasmon modes on surfaces of metal-like (negative-ε) materials or metallodielectric photonic crystals.

With regards to material absorption, typical loss tangents in the microwave (e.g. those listed for the materials above) suggest that $Q_{abs} \sim \varepsilon / Im\{\varepsilon\} \sim 10000$. Combining the effects of radiation and absorption, the above analysis implies that for a properly designed resonant device-object d a value of $Q_d \sim 2000$ should be achievable. Note though, that the resonant source s will in practice often be immobile, and the restrictions on its allowed geometry and size will typically be much less stringent than the restrictions on the design

of the device; therefore, it is reasonable to assume that the radiative losses can be designed to be negligible allowing for Q_s~*10000*, limited only by absorption.

To calculate now the achievable rate of energy transfer, one can place two of the cavities 20, 22 at distance D between their centers, as shown in FIG. 2B. The normal modes of the combined system are then an even and an odd superposition of the initial modes and their frequencies are split by the coupling coefficient κ, which we want to calculate. Analytically, coupled-mode theory gives for dielectric objects $\kappa_{12} = \omega_2/2 \cdot \int d^3r \mathbf{E}_1^*(\mathbf{r}) \mathbf{E}_2(\mathbf{r}) \varepsilon_1(\mathbf{r}) \Big/ \int d^3r \left|\mathbf{E}_1(\mathbf{r})\right|^2 \varepsilon(\mathbf{r})$, where $\varepsilon_{1,2}(\mathbf{r})$ denote the dielectric functions of only object 1 alone or 2 alone excluding the background dielectric (free space) and $\varepsilon(\mathbf{r})$ the dielectric function of the entire space with both objects present. Numerically, one can find κ using FDTD simulations either by exciting one of the cavities and calculating the energy-transfer time to the other or by determining the split normal-mode frequencies. For the "test" disk cavity the radius r_C of the radiation caustic is $r_C \approx 11r$, and for non-radiative coupling $D < r_C$, therefore here one can choose *D/r=10, 7, 5, 3*. Then, for the mode of FIG. 3, which is odd with respect to the line that connects the two cavities, the analytical predictions are $\omega/2\kappa$=*1602, 771, 298, 48*, while the numerical predictions are $\omega/2\kappa$=*1717, 770, 298, 47* respectively, so the two methods agree well. The radiation fields of the two initial cavity modes interfere constructively or destructively depending on their relative phases and amplitudes, leading to increased or decreased net radiation loss respectively, therefore for any cavity distance the even and odd normal modes have Qs that are one larger and one smaller than the initial single-cavity Q=*1992* (a phenomenon not captured by coupled-mode theory), but in a way that the average Γ is always approximately $\Gamma \approx \omega/2Q$. Therefore, the corresponding coupling-to-loss ratios are κ/Γ=*1.16, 2.59, 6.68, 42.49*, and although they do not fall in the ideal operating regime $\kappa/\Gamma \gg 1$, the achieved values are still large enough to be useful for applications.

Consider a loop 10 or 12 of N coils of radius r of conducting wire with circular cross-section of radius a surrounded by air, as shown in FIG. 3. This wire has inductance $L = \mu_o N^2 r\left[\ln(8r/a) - 2\right]$, where μ_o is the magnetic permeability of free space, so connecting it to a capacitance C will make the loop resonant at frequency $\omega = 1/\sqrt{LC}$. The nature of the resonance lies in the periodic exchange of energy from the electric field inside the capacitor due to the voltage across it to the magnetic field in free space due to the current in the wire. Losses in this resonant system consist of ohmic loss inside the wire and radiative loss into free space.

For non-radiative coupling one should use the near-field region, whose extent is set roughly by the wavelength λ, therefore the preferable operating regime is that where the loop is small ($r«\lambda$). In this limit, the resistances associated with the two loss channels are respectively $R_{ohm} = \sqrt{\mu_o \rho \omega / 2} \cdot Nr / a$ and $R_{rad} = \pi / 6 \cdot \eta_o N^2 (\omega r / c)^4$, where ρ is the resistivity of the wire material and $\eta_o \approx 120\pi\ \Omega$ is the impedance of free space. The quality factor of such a resonance is then $Q = \omega L / (R_{ohm} + R_{rad})$ and is highest for some frequency determined by the system parameters: at lower frequencies it is dominated by ohmic loss and at higher frequencies by radiation.

To get a rough estimate in the microwave, one can use one coil ($N=1$) of copper ($\rho=1.69 \cdot 10^{-8} \Omega m$) wire and then for $r=1cm$ and $a=1mm$, appropriate for example for a cell phone, the quality factor peaks to $Q=1225$ at $f=380MHz$, for $r=30cm$ and $a=2mm$ for a laptop or a household robot $Q=1103$ at $f=17MHz$, while for $r=1m$ and $a=4mm$ (that could be a source loop on a room ceiling) $Q=1315$ at $f=5MHz$. So in general, expected quality factors are $Q \approx 1000\text{-}1500$ at $\lambda / r \approx 50\text{-}80$, namely suitable for near-field coupling.

The rate for energy transfer between two loops 10 and 12 at distance D between their centers, as shown in FIG. 3, is given by $\kappa_{12} = \omega M / 2\sqrt{L_1 L_2}$, where M is the mutual inductance of the two loops 10 and 12. In the limit $r«D«\lambda$ one can use the quasi-static result $M = \pi / 4 \cdot \mu_o N_1 N_2 (r_1 r_2)^2 / D^3$, which means that $\omega / 2\kappa \sim \left(D / \sqrt{r_1 r_2}\right)^3$. For example, by choosing again $D/r=10, 8, 6$ one can get for two loops of $r=1cm$, same as used before, that $\omega/2\kappa=3033, 1553, 655$ respectively, for the $r=30cm$ that $\omega/2\kappa=7131, 3651, 1540$, and for the $r=1m$ that $\omega/2\kappa=6481, 3318, 1400$. The corresponding coupling-to-loss ratios peak at the frequency where peaks the single-loop Q and are $\kappa/\Gamma=0.4, 0.79, 1.97$ and $0.15, 0.3, 0.72$ and $0.2, 0.4, 0.94$ for the three loop-kinds and distances. An example of dissimilar loops is that of a $r=1m$ (source on the ceiling) loop and a $r=30cm$ (household robot on the floor) loop at a distance $D=3m$ (room height) apart, for which $\kappa / \sqrt{\Gamma_1 \Gamma_2} = 0.88$ peaks at $f=6.4MHz$, in between the peaks of the individual Q's. Again, these values are not in the optimal regime $\kappa/\Gamma » 1$, but will be shown to be sufficient.

It is important to appreciate the difference between this inductive scheme and the already used close-range inductive schemes for energy transfer in that those schemes are *non-resonant*. Using coupled-mode theory it is easy to show that, keeping the geometry and the energy stored at the source fixed, the presently proposed resonant-coupling inductive mechanism allows for Q approximately 1000 times more power delivered for work at the device than the traditional non-resonant mechanism, and this is why mid-range energy transfer is now possible. Capacitively-loaded conductive loops are actually being

widely used as resonant antennas (for example in cell phones), but those operate in the far-field regime with $r/\lambda \sim 1$, and the radiation Q's are intentionally designed to be small to make the antenna efficient, so they are not appropriate for energy transfer.

Clearly, the success of the inventive resonance-based wireless energy-transfer scheme depends strongly on the robustness of the objects' resonances. Therefore, their sensitivity to the near presence of random non-resonant extraneous objects is another aspect of the proposed scheme that requires analysis. The interaction of an extraneous object with a resonant object can be obtained by a modification of the coupled-mode-theory model in Eq. (1), since the extraneous object either does not have a well-defined resonance or is far-off-resonance, the energy exchange between the resonant and extraneous objects is minimal, so the term κ_{12} in Eq. (1) can be dropped. The appropriate analytical model for the field amplitude in the resonant object $a_1(t)$ becomes:

$$\frac{da_1}{dt} = -i\left(\omega_1 - i\Gamma_1\right)a_1 + i\kappa_{11}a_1 \qquad (2)$$

Namely, the effect of the extraneous object is just a perturbation on the resonance of the resonant object and it is twofold: First, it shifts its resonant frequency through the real part of κ_{11} thus detuning it from other resonant objects. This is a problem that can be fixed rather easily by applying a feedback mechanism to every device that corrects its frequency, such as through small changes in geometry, and matches it to that of the source. Second, it forces the resonant object to lose modal energy due to scattering into radiation from the extraneous object through the induced polarization or currents in it, and due to material absorption in the extraneous object through the imaginary part of κ_{11}. This reduction in Q can be a detrimental effect to the functionality of the energy-transfer scheme, because it cannot be remedied, so its magnitude must be quantified.

In the first example of resonant objects that have been considered, the class of dielectric disks, small, low-index, low-material-loss or far-away stray objects will induce small scattering and absorption. To examine realistic cases that are more dangerous for reduction in Q, one can therefore place the "test" dielectric disk cavity 40 close to: a) another off-resonance object 42, such as a human being, of large $Re\{\varepsilon\}=49$ and $Im\{\varepsilon\}=16$ and of same size but different shape, as shown in FIG. 4A; and b) a roughened surface 46, such as a wall, of large extent but of small $Re\{\varepsilon\}=2.5$ and $Im\{\varepsilon\}=0.05$, as shown in FIG. 4B.

Analytically, for objects that interact with a small perturbation the reduced value of radiation-Q due to scattering could be estimated using the polarization

$\int d^3r \left|P_{X1}(r)\right|^2 \propto \int d^3r \left|E_1(r)\cdot \mathrm{Re}\{\varepsilon_X(r)\}\right|^2$ induced by the resonant cavity 1 inside the extraneous object X=42 or roughened surface X=46. Since in the examined cases either the refractive index or the size of the extraneous objects is large, these first-order perturbation-theory results would not be accurate enough, thus one can only rely on numerical FDTD simulations. The absorption-Q inside these objects can be estimated through $\mathrm{Im}\{\kappa_{11}\} = \omega_1/2 \cdot \int d^3r \left|E_1(r)\right|^2 \mathrm{Im}\{\varepsilon_X(r)\} \Big/ \int d^3r \left|E_1(r)\right|^2 \varepsilon(r)$.

Using these methods, for distances *D/r=10, 7, 5, 3* between the cavity and extraneous-object centers one can find that Q_{rad}*=1992* is respectively reduced to Q_{rad}*=1988, 1258, 702, 226*, and that the absorption rate inside the object is Q_{abs}*=312530, 86980, 21864, 1662*, namely the resonance of the cavity is not detrimentally disturbed from high-index and/or high-loss extraneous objects, unless the (possibly mobile) object comes *very* close to the cavity. For distances *D/r=10, 7, 5, 3, 0* of the cavity to the roughened surface we find respectively Q_{rad}*=2101, 2257, 1760, 1110, 572*, and Q_{abs}*>4000*, namely the influence on the initial resonant mode is acceptably low, even in the extreme case when the cavity is embedded on the surface. Note that a close proximity of metallic objects could also significantly scatter the resonant field, but one can assume for simplicity that such objects are not present.

Imagine now a combined system where a resonant source-object *s* is used to wirelessly transfer energy to a resonant device-object *d* but there is an off-resonance extraneous-object *e* present. One can see that the strength of all extrinsic loss mechanisms from *e* is determined by $|\mathbf{E}_s(\mathbf{r}_e)|^2$, by the square of the *small* amplitude of the tails of the resonant source, evaluated at the position $\mathbf{r}_e$ of the extraneous object. In contrast, the coefficient of resonant coupling of energy from the source to the device is determined by the *same-order* tail amplitude $|\mathbf{E}_s(\mathbf{r}_d)|$, evaluated at the position $\mathbf{r}_d$ of the device, but this time it is not squared! Therefore, for equal distances of the source to the device and to the extraneous object, the coupling time for energy exchange with the device is much shorter than the time needed for the losses inside the extraneous object to accumulate, especially if the amplitude of the resonant field has an exponential-like decay away from the source. One could actually optimize the performance by designing the system so that the desired coupling is achieved with smaller tails at the source and longer at the device, so that interference to the source from the other objects is minimal.

The above concepts can be verified in the case of dielectric disk cavities by a simulation that combines FIGs. 2A-2B and 4A-4B, namely that of two (source-device) "test" cavities 50 placed *10r* apart, in the presence of a same-size extraneous object 52 of ε*=49* between them, and at a distance *5r* from a large roughened surface 56 of ε*=2.5*, as

shown in FIG. 5. Then, the original values of $Q=1992$, $\omega/2\kappa=1717$ (and thus $\kappa/\Gamma=1.16$) deteriorate to $Q=765$, $\omega/2\kappa=965$ (and thus $\kappa/\Gamma=0.79$). This change is acceptably small, considering the extent of the considered external perturbation, and, since the system design has not been optimized, the final value of coupling-to-loss ratio is promising that this scheme can be useful for energy transfer.

In the second example of resonant objects being considered, the conducting-wire loops, the influence of extraneous objects on the resonances is nearly absent. The reason for this is that, in the quasi-static regime of operation ($r\ll\lambda$) that is being considered, the near field in the air region surrounding the loop is predominantly magnetic, since the electric field is localized inside the capacitor. Therefore, extraneous objects that could interact with this field and act as a perturbation to the resonance are those having significant magnetic properties (magnetic permeability $Re\{\mu\}>1$ or magnetic loss $Im\{\mu\}>0$). Since almost all common materials are non-magnetic, they respond to magnetic fields in the same way as free space, and thus will not disturb the resonance of a conducting-wire loop. The only perturbation that is expected to affect these resonances is a close proximity of large metallic structures.

An extremely important implication of the above fact relates to safety considerations for human beings. Humans are also non-magnetic and can sustain strong magnetic fields without undergoing any risk. This is clearly an advantage of this class of resonant systems for many real-world applications. On the other hand, dielectric systems of high (effective) index have the advantages that their efficiencies seem to be higher, judging from the larger achieved values of κ/Γ, and that they are also applicable to much smaller length-scales, as mentioned before.

Consider now again the combined system of resonant source s and device d in the presence of a human h and a wall, and now let us study the efficiency of this resonance-based energy-transfer scheme, when energy is being drained from the device for use into operational work. One can use the parameters found before: for dielectric disks, absorption-dominated loss at the source $Q_s\sim10^4$, radiation-dominated loss at the device $Q_d\sim10^3$ (which includes scattering from the human and the wall), absorption of the source- and device-energy at the human $Q_{s\text{-}h}$, $Q_{d\text{-}h}\sim10^4\text{-}10^5$ depending on his/her not-very-close distance from the objects, and negligible absorption loss in the wall; for conducting-wire loops, $Q_s\sim Q_d\sim10^3$, and perturbations from the human and the wall are negligible. With corresponding loss-rates $\Gamma=\omega/2Q$, distance-dependent coupling κ, and the rate at which working power is extracted Γ_w, the coupled-mode-theory equation for the device field-amplitude is

$$\frac{da_d}{dt} = -i\left(\omega - i\Gamma_d\right)a_d + i\kappa a_s - \Gamma_{d-h}a_d - \Gamma_w a_d \,. \qquad (3)$$

Different temporal schemes can be used to extract power from the device and their efficiencies exhibit different dependence on the combined system parameters. Here, one can assume steady state, such that the field amplitude inside the source is maintained constant, namely $a_s(t)=A_s e^{-i\omega t}$, so then the field amplitude inside the device is $a_d(t)=A_d e^{-i\omega t}$ with $A_d=i\kappa/(\Gamma_d+\Gamma_{d-h}+\Gamma_w)A_s$. Therefore, the power lost at the source is $P_s=2\Gamma_s|A_s|^2$, at the device it is $P_d=2\Gamma_d|A_d|^2$, the power absorbed at the human is $P_h=2\Gamma_{s-h}|A_s|^2+2\Gamma_{d-h}|A_d|^2$, and the useful extracted power is $P_w=2\Gamma_w|A_d|^2$. From energy conservation, the total power entering the system is $P_{total}= P_s+P_d+P_h+P_w$. Denote the total loss-rates $\Gamma_s^{tot}=\Gamma_s+\Gamma_{s-h}$ and $\Gamma_d^{tot}=\Gamma_d+\Gamma_{d-h}$. Depending on the targeted application, the work-drainage rate should be chosen either $\Gamma_w=\Gamma_d^{tot}$ to minimize the required energy stored in the resonant objects or $\Gamma_w=\Gamma_d^{tot}\sqrt{1+\kappa^2/\Gamma_s^{tot}\Gamma_d^{tot}} > \Gamma_d^{tot}$ such that the ratio of useful-to-lost powers , namely the efficiency $\eta_w=P_w/P_{total}$, is maximized for some value of κ. The efficiencies η for the two different choices are shown in FIGs. 6A and 6B respectively, as a function of the κ/Γ_d figure-of-merit which in turn depends on the source-device distance.

FIGs. 6A-6B show that for the system of dielectric disks and the choice of optimized efficiency, the efficiency can be large, e.g., at least 40%. The dissipation of energy inside the human is small enough, less than 5%, for values $\kappa/\Gamma_d>1$ and $Q_h>10^5$, namely for medium-range source-device distances ($D_d/r<10$) and most human-source/device distances ($D_h/r>8$). For example, for $D_d/r=10$ and $D_h/r=8$, if *10W* must be delivered to the load, then, from FIG. 6B, *~0.4W* will be dissipated inside the human, *~4W* will be absorbed inside the source, and *~2.6W* will be radiated to free space. For the system of conducting-wire loops, the achieved efficiency is smaller, ~20% for $\kappa/\Gamma_d\approx 1$, but the significant advantage is that there is no dissipation of energy inside the human, as explained earlier.

Even better performance should be achievable through optimization of the resonant object designs. Also, by exploiting the earlier mentioned interference effects between the radiation fields of the coupled objects, such as continuous-wave operation at the frequency of the normal mode that has the larger radiation-Q, one could further improve the overall system functionality. Thus the inventive wireless energy-transfer scheme is promising for many modern applications. Although all considerations have been for a static geometry, all the results can be applied directly for the dynamic geometries of mobile objects, since

the energy-transfer time $\kappa^{-1} \sim 1\mu s$, which is much shorter than any timescale associated with motions of macroscopic objects.

The invention provides a resonance-based scheme for mid-range wireless non-radiative energy transfer. Analyses of very simple implementation geometries provide encouraging performance characteristics for the potential applicability of the proposed mechanism. For example, in the macroscopic world, this scheme could be used to deliver power to robots and/or computers in a factory room, or electric buses on a highway (source-cavity would in this case be a "pipe" running above the highway). In the microscopic world, where much smaller wavelengths would be used and smaller powers are needed, one could use it to implement optical inter-connects for CMOS electronics or else to transfer energy to autonomous nano-objects, without worrying much about the relative alignment between the sources and the devices; energy-transfer distance could be even longer compared to the objects' size, since $Im\{\varepsilon(\omega)\}$ of dielectric materials can be much lower at the required optical frequencies than it is at microwave frequencies.

As a venue of future scientific research, different material systems should be investigated for enhanced performance or different range of applicability. For example, it might be possible to significantly improve performance by exploring plasmonic systems. These systems can often have spatial variations of fields on their surface that are much shorter than the free-space wavelength, and it is precisely this feature that enables the required decoupling of the scales: the resonant object can be significantly smaller than the exponential-like tails of its field. Furthermore, one should also investigate using acoustic resonances for applications in which source and device are connected via a common condensed-matter object.

Although the present invention has been shown and described with respect to several preferred embodiments thereof, various changes, omissions and additions to the form and detail thereof, may be made therein, without departing from the spirit and scope of the invention.

What is claimed is:

CLAIMS

1. A method of transferring energy comprising:

providing a first resonator structure receiving energy from an external power supply, said first resonator structure having a first resonant frequency ω_1, and a first Q-factor Q_1, and characteristic size L_1, and

providing a second resonator structure being positioned distal from said first resonator structure, at closest distance D, said second resonator structure having a second resonant frequency ω_2, and a second Q-factor Q_2, and characteristic size L_2

wherein the two said frequencies ω_1 and ω_2 are close to within the narrower of the two resonance widths Γ_1, and Γ_2,

transferring energy non-radiatively between said first resonator structure and said second resonator structure, said energy transfer being mediated through coupling of their resonant-field evanescent tails, and the rate of energy transfer between said first resonator and said second resonator being denoted by κ,

wherein non-radiative means D is smaller than each of the resonant wavelengths λ_1 and λ_2, wherein c is the propagation speed of radiation in the surrounding medium.

2. The method of claim 1, wherein said method comprising said resonators with $Q_1>100$, and $Q_2>100$, and $\kappa/\mathrm{sqrt}(\Gamma_1*\Gamma_2)>0.2,0.5,1,2,5$, and $D/L_2>1,2,3,5$.

3. The method of claim 1, wherein said method comprising said resonators with $Q_1>200$, and $Q_2>200$, and $\kappa/\mathrm{sqrt}(\Gamma_1*\Gamma_2)>0.2,0.5,1,2,5$, and $D/L_2>1,2,3,5$.

4. The method of claim1, said method comprising said resonators with $Q_1>500$, and $Q_2>500$, and $\kappa/\mathrm{sqrt}(\Gamma_1*\Gamma_2)>0.2,0.5,1,2,5$, and $D/L_2>1,2,3,5$.

5. The method of claim 1, said method comprising said resonators with $Q_1>1000$, and $Q_2>1000$, and $\kappa/\mathrm{sqrt}(\Gamma_1*\Gamma_2)>0.2,0.5,1,2,5$, and $D/L_2>1,2,3,5$.

6. An energy transfer device comprising:

a first resonator structure receiving energy from an external power supply, said first resonator structure having a first resonant frequency ω_1, and a first Q-factor Q_1, and characteristic size L_1, and

a second resonator structure being positioned distal from said first resonator structure, at closest distance D, said second resonator structure having a second resonant frequency ω_2, and a second Q-factor Q_2, and characteristic size L_2,

wherein the two said frequencies ω_1 and ω_2 are close to within the narrower of the two resonance widths Γ_1, and Γ_2,

wherein non-radiative energy transfer between said first resonator structure and said second resonator structure is mediated through coupling of their resonant-field evanescent tails, and the rate of energy transfer between said first resonator and said second resonator is denoted by κ,

wherein non-radiative means D is smaller than each of the resonant wavelengths λ_1 and λ_2, wherein c is the propagation speed of radiation in the surrounding medium.

7. The energy transfer device of claim 6, said method comprising said resonators with $Q_1>200$, and $Q_2>200$, and $\kappa/\mathrm{sqrt}(\Gamma_1*\Gamma_2)>0.2,0.5,1,2,5$, and $D/L_2>1,2,3,5$.

8. The energy transfer device of claim 7, wherein said resonant field in said device is electromagnetic.

9. The energy transfer device of claim 8 and said first resonator structure comprises a dielectric sphere, where the characteristic size L_1 is the radius of the sphere.

10. The energy transfer device of claim 8, and said first resonator structure comprises a metallic sphere, where the characteristic size L_1 is the radius of the sphere.

11. The energy transfer device of claim 8, and said first resonator structure comprises a metallodielectric sphere, where the characteristic size L_1 is the radius of the sphere.

12. The energy transfer device of claim 8, and said first resonator structure comprises a plasmonic sphere, where the characteristic size L_1 is the radius of the sphere.

13. The energy transfer device of claim 8, and said first resonator structure comprises a polaritonic sphere, where the characteristic size L_1 is the radius of the sphere.

14. The energy transfer device of claim 8, and said first resonator structure comprises a capacitively-loaded conducting-wire loop, where the characteristic size L_1 is the radius of the loop.

15. The energy transfer device of claim 8, and said second resonator structure comprises a dielectric sphere, where the characteristic size L_2 is the radius of the sphere.

16. The energy transfer device of claim 8, and said second resonator structure comprises a metallic sphere where the characteristic size L_2 is the radius of the sphere.

17. The energy transfer device of claim 8, and said second resonator structure comprises a metallodielectric sphere where the characteristic size L_2 is the radius of the sphere.

18. The energy transfer device of claim 8, and said second resonator structure comprises a plasmonic sphere where the characteristic size L_2 is the radius of the sphere.

19. The energy transfer device of claim 8, and said second resonator structure comprises a polaritonic sphere where the characteristic size L_2 is the radius of the sphere.

20. The energy transfer device of claim 8, and said second resonator structure comprises a capacitively-loaded conducting-wire loop where the characteristic size L_2 is the radius of the loop.

21. The energy transfer device of claim 7, wherein said resonant field in said device is acoustic.

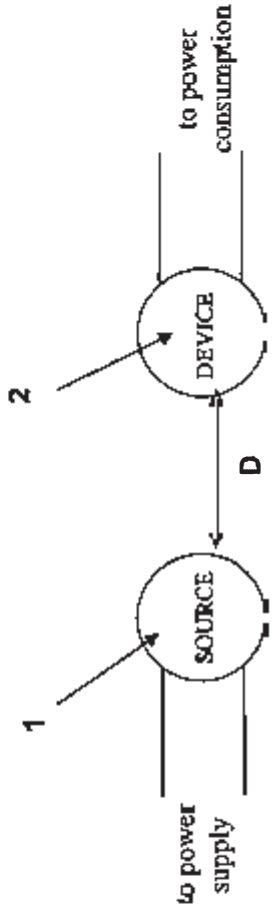


FIG. 1

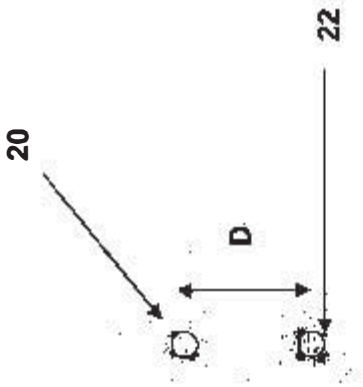


FIG 2A

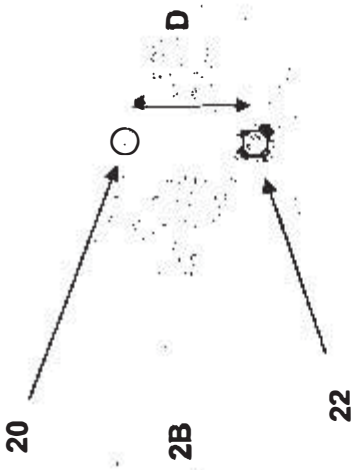


FIG. 2B

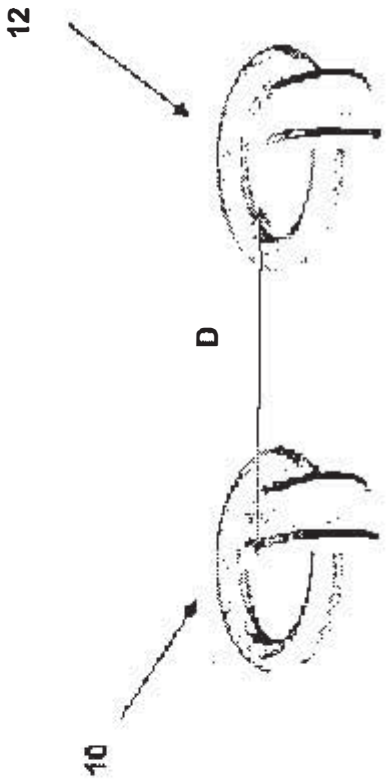


FIG. 3

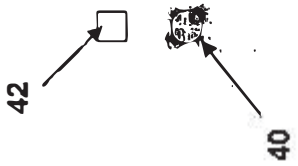


FIG. 4A

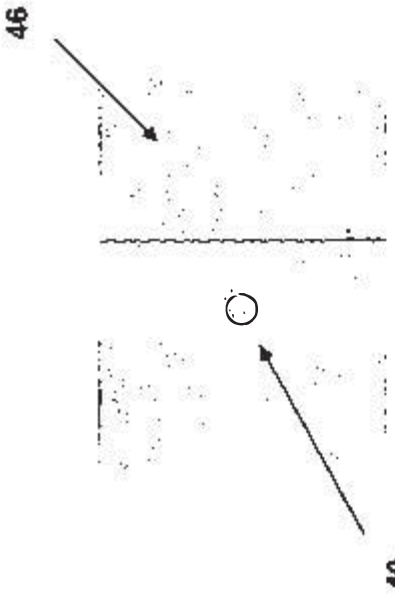


FIG. 4B

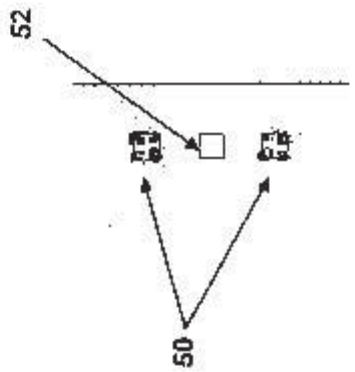


FIG. 5

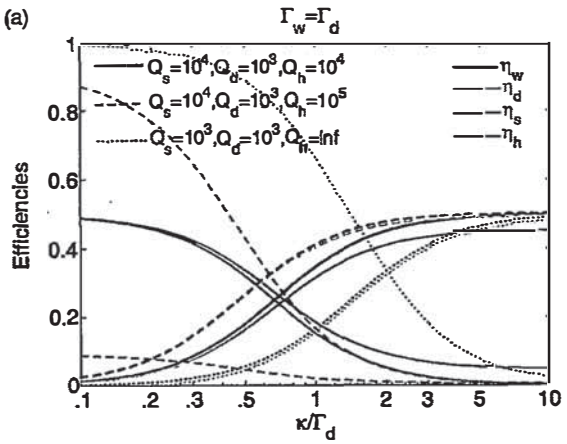

(a)
$\Gamma_w=\Gamma_d$
$Q_s=10^4, Q_d=10^3, Q_h=10^4$
$Q_s=10^4, Q_d=10^3, Q_h=10^5$
$Q_s=10^3, Q_d=10^3, Q_h=\inf$
η_w
η_d
η_s
η_h
Efficiencies
κ/Γ_d

FIG. 6A

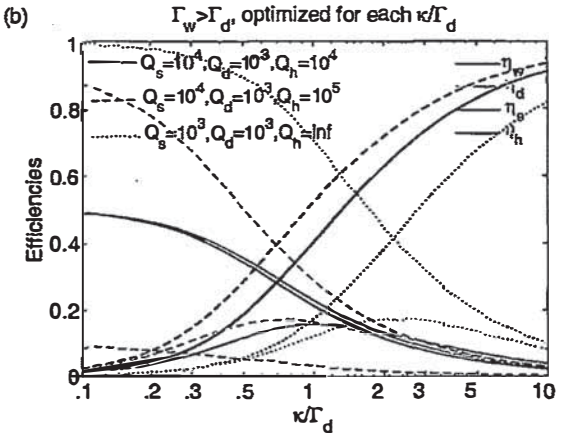

(b)
$\Gamma_w>\Gamma_d$, optimized for each κ/Γ_d
$Q_s=10^4, Q_d=10^3, Q_h=10^4$
$Q_s=10^4, Q_d=10^3, Q_h=10^5$
$Q_s=10^3, Q_d=10^3, Q_h=\inf$
η_w
η_d
η_s
η_h
Efficiencies
κ/Γ_d

FIG. 6B

JP,08-505279,A

Previous Document 1/1 Next Doc

Detail | Image

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

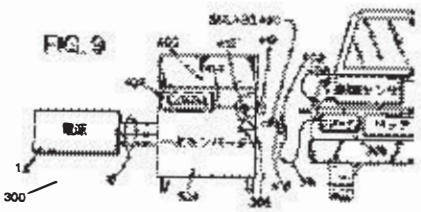
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

1. In uncontacted charge station which charges battery mounted on a plurality of electric loads which have respectively conductor loops and secondary converter for charging by charging rate which was connected to this, converted AC electric power to DC power, and had battery chosen,
an uncontacted charge station comprising:
A magnetic core.
A connecting link which is a connecting link which has the core attachment conductor partially surrounded at least by these magnetic cores, and is made into an outline for which core attachment conductors surround each load loop partially alternative at least.
A primary converter for converting electric power from a power supply to AC electric power by a selected charging rate corresponding to load, when it is the primary converter connected to the above-mentioned core attachment conductor and is connected to load by the above-mentioned link.

2. Uncontacted charge station according to claim 1 which above-mentioned primary converter responds to charging rate indicator for instructing selected charging rate, and converts electric power by the selected charging rate.
3. Uncontacted charge station according to claim 2 where it is for charging load which generates charging rate indication signal, and above-mentioned primary converter responds to above-mentioned charging rate indication signal.
4. Uncontacted charge station according to claim 2 which is for charging load which has optical fiber transmitter which conveys charging rate indication signal, and is provided with optical fiber receiver for above-mentioned primary converter responding to above-mentioned optical fiber transmitter, and receiving above-mentioned charging rate indication signal.
5. the above-mentioned link is provided with a chamber which forms a flow path which receives a cold fluid for cooling the above-mentioned core attachment conductor -- and -- The above-mentioned station, The uncontacted charge station according to claim 1 provided with a cold fluid circulation system connected to the above-mentioned chamber since it circulated through a cold fluid to a flow path of the above-mentioned connecting link.
6. Uncontacted charge station according to claim 1 which can be closed so that above-mentioned link can be opened so that each load loop may be accepted, and it may be surrounded substantially.
7. Uncontacted charge station according to claim 1 by which pivotal mounting combination is carried out so that above-mentioned link can be separated into at least two link segments, these segments may be opened so that each load loop may be accepted or it may dissociate, and it may engage with each load loop and it may close at pivotal mounting ceremony.
8. Connect a longitudinal shaft to a plurality of load loops which it has respectively, can separate the above-mentioned link into at least two link segments, and these segments, The uncontacted charge station according to claim 1 which can be radially closed in order to be able to open radially in order [which separates from a longitudinal shaft of a portion by which each load loop was surrounded respectively, or goes to it] to set radially and to dissociate each load loop, and to engage with each load loop.
9. Uncontacted charge station according to claim 1 which can be closed by advancing-side-by-side movement so that above-mentioned link can be separated into at least two link segments, these segments can be opened by advancing-side-by-side movement so that each load loop may be dissociated, and each load loop may be engaged.
10. It is an uncontacted charge station which charges a battery of loading in the 1st which has respectively a secondary converter for converting AC electric power to DC power so that it may charge by a charging rate which had a battery chosen, and second electric load, In an uncontacted charge station which the 1st load of the above has the 1st load loop made into size charged by the 1st charging rate, and has the 2nd load loop made into size charged by the 2nd charging rate with the 2nd bigger load of the above than the 1st charging rate of the above,
an uncontacted charge station comprising:
A magnetic core.
It is a connecting link which has the core attachment conductor partially surrounded at least by the magnetic cores, A connecting link which is made into size in which these links surround each of the 1st and 2nd loops partially exchangeable at least by being made an outline for which core attachment conductors surround each load loop partially alternative at least.
A primary converter for converting electric power from a power supply to AC electric power by



Representative drawing

Representative drawing | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 11 | 12 | 13 | 14 | 15 | 16 | 17

a selected charging rate corresponding to the load, when it is the primary converter connected to the above-mentioned core attachment conductor and is connected to load by the above-mentioned link.

11. The uncontacted charge station according to claim 10 which the above-mentioned primary converter responds to a charging rate indicator for instructing a selected charging rate, and converts electric power by the selected charging rate.
12. The uncontacted charge station according to claim 10 where it is for charging load which generates a charging rate indication signal, and the above-mentioned primary converter responds to the above-mentioned charging rate indication signal.
13. the above-mentioned link is provided with a chamber which forms a flow path which receives a cold fluid for cooling the above-mentioned core attachment conductor -- and -- The above-mentioned station, The uncontacted charge station according to claim 10 provided with a cold fluid circulation system connected to the above-mentioned chamber since it circulated through a cold fluid to a flow path of the above-mentioned connecting link.
14. The uncontacted charge station according to claim 10 which can be closed so that the above-mentioned link can be opened so that each load loop may be accepted, and it may be surrounded substantially.
15. The uncontacted charge station according to claim 10 by which pivotal mounting combination is carried out so that the above-mentioned link can be separated into at least two link segments, these segments may be opened so that each load loop may be accepted or it may dissociate, and it may engage with each load loop and it may close at a pivotal mounting ceremony.
16. Can separate the above-mentioned link into at least two link segments, and these segments, The uncontacted charge station according to claim 10 which can be radially closed in order to be able to open radially in order [which separates from a longitudinal shaft of a portion by which each load loop was surrounded respectively, or goes to it] to set radially and to dissociate each load loop, and to engage with each load loop.
17. The uncontacted charge station according to claim 10 which can be closed by advancing-side-by-side movement so that the above-mentioned link can be separated into at least two link segments, these segments can be opened by advancing-side-by-side movement so that each load loop may be dissociated, and it may engage with each load loop.
18. In a core attachment conductor which surround some conductor loops connected to a power supply or load,
A connecting link comprising:
A core attachment conductor connected to another side of a power supply or load.
A magnetic core which surround the above-mentioned core attachment conductor partially at least.
A cold fluid chamber which forms a flow path for circulating through a cold fluid through a link.

19. The connecting link according to claim 18 where the above-mentioned cold fluid chamber is arranged in the above-mentioned core attachment conductor.
20. In a core attachment conductor which surround some conductor loops connected to a power supply or load,
A connecting link comprising:
A core attachment conductor connected to another side of a power supply or load.
A magnetic core which surround the above-mentioned core attachment conductor partially at least.
A cold fluid chamber which is arranged in the above-mentioned core attachment conductor, and forms a flow path for circulating through a cold fluid through a link.
Husks which are husks of an insulating material which stores the above-mentioned core and a core attachment conductor, and form a loop acceptance portion for accepting the above-mentioned loop.

21. The connecting link according to claim 18 where the above-mentioned cold fluid chamber is provided with a plurality of fluid transportation conduit tubes arranged between the above-mentioned core and a core attachment conductor.
22. The connecting link according to claim 18 which can be closed so that the above-mentioned link can be opened so that a loop may be accepted, and a loop may be surrounded substantially.
23. The connecting link according to claim 18 by which pivotal mounting combination is carried out so that the above-mentioned link can be separated into at least two link segments, these segments may be opened so that a loop may be accepted or it may dissociate, and it may engage with a loop and it may close at a pivotal mounting ceremony.
24. Can separate the above-mentioned link into at least two link segments, and these segments, The connecting link according to claim 18 which can be radially closed in order to be able to open radially in order [which separates from a longitudinal shaft of a portion by which the above-mentioned loop was surrounded respectively, or goes to it] to set radially and to dissociate a loop, and to engage with a loop.
25. The connecting link according to claim 18 which can be closed by advancing-side-by-side movement so that the above-mentioned link can be separated into at least two link segments, these segments can be opened by advancing-side-by-side movement so that a loop may be dissociated, and it may engage with a loop.
26. In an electric vehicle which enabled it to receive AC electric power from a primary converter of outside of a vehicle,
An electric vehicle comprising:
The above-mentioned primary converter is a magnetic core.
A connecting link which has the core attachment conductor partially surrounded at least by the

magnetic cores is included, and it is the above-mentioned vehicle, A battery of vehicle loading A secondary converter for having a loading charging system and converting the system and AC electric power to DC power for charging the above-mentioned battery.
Conductor loops which are the conductor loops for being connected to the above-mentioned secondary converter and transmitting AC electric power from a primary converter to a secondary converter, and were made into form selectively surrounded by a magnetic core of the above-mentioned connecting link, and at least 1 portions of a core attachment conductor.

27. It is for charging a battery from a primary converter of fixing which responds to a charging rate indicator which instructs a selected charging rate, and converts electric power by the selected charging rate, The electric vehicle according to claim 26 by which the above-mentioned electric vehicle generates a charging rate indicator which constitutes a charging rate indication signal.
28. The electric vehicle according to claim 27 by which the above-mentioned secondary converter generates the above-mentioned charging rate indication signal.
29. Are for charging by a primary converter which has an optical fiber receiver, and the above-mentioned charging rate indication signal, The electric vehicle according to claim 27 which constitutes an optical fiber signal which is transmitted by an optical fiber transmitter supported by the above-mentioned loop, and is read with an optical fiber receiver of a primary converter.
30. The electric vehicle according to claim 26 connected to a secondary converter by a connector line with the above-mentioned flexible loop.
31. the above-mentioned loop was made into size which charges a battery at the usual rate -- it usually having a loop and the above-mentioned vehicle, furthermore having boost charge conductor loops connected to a secondary converter in order to charge a battery at a rate of urgency quicker than the above-mentioned usual rate and -- The electric vehicle according to claim 26 by which the above-mentioned secondary converter is connected to either the above-mentioned usual loop or boost charge conductor loops exchangeable.
32. the above-mentioned loop is made into size which charges a battery at the usual rate -- the above-mentioned charging rate indicator, To a primary converter that a battery is charged at the usual rate a finger example and the above-mentioned vehicle, furthermore -- having boost charge conductor loops connected to a secondary converter in order to charge a battery at a rate of urgency quicker than the above-mentioned usual rate -- and -- The above-mentioned vehicle, The electric vehicle according to claim 26 containing a rate indicator of boost charge supported by the above-mentioned boost charge conductor loops in order to instruct to a primary converter that a battery is charged at the above-mentioned rate of urgency.
33. In an uncontacted charging system for charging a plurality of energy storage devices which have at least one selected charging rate respectively,
an uncontacted charging system comprising:
A secondary converter for being a plurality of secondary converters for converting AC electric power to DC power, and charging respectively one each of the above-mentioned energy storage devices of a plurality of.
A plurality of conductor loops respectively connected to one each of the above-mentioned secondary converters of a plurality of.
A magnetic core.
A connecting link which is a connecting link which has the core attachment conductor partially surrounded at least by the magnetic cores, and is what the above-mentioned core attachment conductors surround partially one each of the above-mentioned loops of a plurality of alternative at least, and transmits electric power among them.
A primary converter for being connected to the above-mentioned core attachment conductor, and converting electric power from a power supply to AC electric power by a charging rate chosen [above-mentioned].

34. The uncontacted charging system according to claim 33 which converts electric power by a charging rate which the above-mentioned primary converter responded to a charging rate indicator, and was chosen.
35. The uncontacted charging system according to claim 34 which comprises a charging rate indication signal with which the above-mentioned charging rate indicator was generated by the above-mentioned secondary converter.
36. the above-mentioned link is provided with a chamber which forms a flow path for receiving a cold fluid which cools the above-mentioned core attachment conductor -- and -- The above-mentioned charging system, The uncontacted charging system according to claim 33 provided with a cold fluid circulation system for being connected to the above-mentioned chamber and circulating through a cold fluid to a flow path of the above-mentioned connecting link.

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

The field present invention of uncontacted battery charging system invention relates to a battery recharge system generally, and more, in order to improve safety, reliability, and a user's expedient nature in details, the improved uncontacted battery recharge system which can be used for an electric vehicle etc. is started.

If the description electrical-and-electric-equipment vehicle of the advanced technology increases as expected, it will be necessary to arrange the dispersed recharge construct standardized appropriately at a vehicle driver's dwelling, a workshop, a car barn, a recharge station, etc., for example. The main points which should be taken into consideration when determining the standardization system carried out on a large scale are an initial cost, operating cost, reliability, and a user's safety.

when the technology which can be used now is used, the solution most promising for a battery recharge is supplying exchange (AC) or direct-current (DC) electric power to a vehicle by metal-metallic contact of a plug and the conductor in socket composition. Charge is performed when the driver of a vehicle connects the outlet of a power supply with a vehicle physically. Especially the thing that a driver without the level of skill which does not have this connection trained performs when high current and voltage required to carry out the recharge of the electric vehicle are given operationally will cause unnecessary danger, if a means to cut a vehicle from charging power promptly automatically is not provided. The necessity of giving the opportunity of charge in the position dispersed as mentioned above is affected according to these same problems.

It is included that framework weight produces an electric vehicle, and wear and a crack especially produce the exposure contact of a high current largely, and there is a problem in the safety under misuse of failure mode and an owner as other defects. Recognition of the general public about the safety deterioration accompanying ******** of big electric power has had the adverse effect on the important thing at taking in of a customer of an electric vehicle.

A chance that an expensive separation converter is needed from the probability that the standard and safe organization like a under rye TAZU laboratory demand electric separation between an AC power and a vehicle battery being high is high.

Then, it can be used for supplying electric power to an electric vehicle, and is turned to conquering the above-mentioned restrictions and a defect, and an uncontacted battery recharge system which is not subject to those influences is demanded.

According to one characteristics of the summary present invention of invention the uncontacted recharge system and method for carrying out the recharge of the energy storage device mounted on the electric vehicle have a primary converter for converting the electric power from a power supply to high-frequency power. It is connected to a battery and the secondary converter mounted on the vehicle is converted to the charging power to which high-frequency power is supplied by the energy storage device. Primary [these] and the secondary converter of each other are connected by uncontacted combination of conductor loops and a connecting link which forms a coaxial winding transformer. A connecting link has a magnetic core and the core attachment conductor partially surrounded at least by the magnetic cores. These core attachment conductors surround some conductor loops partially alternative at least, and transmit electric power among them. A core attachment conductor is connected to either primary or a secondary converter, and conductor loops are attached to another side of primary and a secondary converter.

The overall object of the present invention is to provide the battery recharge system and method of using the battery of an electric vehicle for carrying out a recharge.

The another object of the present invention is to provide the connecting link for combining an electric vehicle with a power supply.

The additional object of the present invention is to provide the battery recharge system which improves a user's safety, improves expedient nature, shortens recharge time, and moreover increases battery recharge efficiency and a battery shelf life rather than the conventional system.

The another object of the present invention is to provide the battery recharge system for the electric vehicle which reliability can install and use at rational high and cost.

The present invention relates to the above-mentioned characteristics and the object separately, and it relates also to the whole. These, other objects, the characteristics, and the effect of the present invention will become clear [to a person skilled in the art] from the following descriptions and an accompanying drawing.

The easy description Fig 1 of Drawings is a partial outline rear view showing one form of the

uncontacted recharge system of the present invention for carrying out the recharge of an energy storage device like the battery mounted on the electric vehicle.
Fig.2 is a radial cross sectional view showing one form of the disengageable connecting link of Fig.1.
Fig.3 is a radial cross sectional view showing one form of another disengageable connecting link of the present invention.
Fig.4 is a schematic block diagram showing one form of the uncontacted recharge system of Fig.1.
Fig.5 is a partial outline rear view showing another form of the uncontacted recharge system of the present invention.
Fig.6 is a radial cross sectional view showing one form of the disengageable connecting link of Fig.5.
Fig.7 is a schematic block diagram showing one form of the uncontacted recharge system of Fig.5.
Fig.8 is a partial outline rear view showing another form of the uncontacted recharge system of the present invention.
Fig.9 is the partial outline and partial fracture rear view showing another additional form of the uncontacted recharge system of the present invention.
Fig.10 is a partial outline plan showing one form of the disengageable connecting link which surround the conductor loops of one form shown in Fig.9.
Fig.11 is the front cross sectional view which was along 11 to 11 line of Fig.10.
Fig.12 is a schematic view of the fluid cooling system used with the link of Fig.10.
Fig.13 is a front cross sectional view of the link shown by opening wide, in order to accept the loop of Fig.10.
Fig.14 is an elevation showing one form of another working example of the connecting link of the present invention shown by opening wide, in order to accept the loop of Fig.10.
Fig.15 is an elevation showing one form of another working example of the connecting link of the present invention shown by opening wide, in order to accept the loop of Fig.10.
Fig.16 and 17 are the elevations of the link of Fig.10, and are the figures showing the state of surrounding the conductor loops of two another forms of the present invention.
Many another working examples of detailed description uncontacted charging system of a preferable working example are described below about charge of an energy storage device. These working examples are described about charge of the DC battery 12 of loading in an electric vehicle. Probably, it will be clear to a person skilled in the art that the charging system's [uncontacted] disclosed here it can be used also for other energy storage devices and mechanisms like a mobile robot or a space vehicle.
First working-example Fig.1 shows the working example of the uncontacted recharge system 10 constituted by the present invention, in order to supply the charging power which carries out the recharge of the battery system of the electric vehicle 14, or an energy storage device like the battery 12. Although the energy storage device is shown as the battery 12 for simplification, probably, it will be clear that the recharge system's described here the energy storage device of other forms, such as a superconductivity magnetic energy storage device and an electromagnetic flywheel, can be used also for carrying out a recharge. Probably the working example of an electric vehicle will only be described as an example, and it will be clear that this system's it can be used for any electric loads which have an inside or loading energy pooling capacity.
The recharge system 10 receives electric power from the power supply 16 through the conductor 18. The power supply 16 is the AC power supply (AC) of single phase or a polyphase or the direct-current (DC) power supply for which it asks by a specific use. A primary converter like the source converter 20 of the high frequency current converts the electric power received from the power supply 16, for example, AC electric power of line frequency (the U.S. 60 Hz), to high about frequency, for example, 2 thru/or 50 kHz. After operation of various elements of the recharge system 10 like the primary converter 20 summarizes the relation of operation between various elements, it is further described below.
The high-frequency AC electric power from the primary converter 20 is supplied to the joint sheath, i.e., a coupling means like the link 25, described in detail below by a connector conductor, i.e., the connector line 22, (Fig.2 and 3). The link 25 is constituted so that it may clamp to the secondary electric power pickup conductor loops 30 attached to the vehicle 14. The word used here of "no contacting" means that there is no electric contact between two conductors except for the magnetic connection between two conductors. When the link 25 is connected to the conductor loops 30, the structure constituted in this way can be called "a coaxial winding transformer (CWT)" here, and this can be analyzed using various theories from the field of current transmission.
The secondary loop 30 is connected to the secondary converter 32. This converter 32 converts AC electric power of the high frequency received from the primary converter 20 through the link 25 and the loop 30 to the charging power used for charge of the vehicle battery 12. This charging power may be AC, DC power, or its combination, for example, the superimposed thing carried out may be sufficient as AC electric power on DC waveform. A specific form of the charging power used for a given use is instructed by the energy demand of a specific energy storage device by which a recharge is carried out.
The recharge system 10 can be operated by the same method as the usual gasoline pump of the service station of the roadside. The driver of a vehicle parks the vehicle 14 near the primary converter 20, and connects with the electric power pickup loop 30 to which the connector link 25 was attached by the vehicle 14. After clamping the link 25 manually to the electric power pickup 30 of a vehicle, the control logic contained in the primary converter checks whether a circuit is the right, before starting supply of AC electric power of high frequency. The high-frequency AC electric power received from the link 25 by the pickup 30 is used for converting to charging power and charging the battery 12 by the secondary converter 32.

If Fig.2 is referred to, it is connected to the conductor loops 3 0 and the working example shown in here [of the connecting link 25] is shown that it forms CWT. The link 25 is provided with the disengageable magnetic core 40 divided and shown in two core parts, i.e., the segment 42, and 42', and two segments are pivotally mounted together in the hinge 44. It may be joined by other various means (not shown), and the core segment 42 and 42' may be operated by motion of other ways, are based on the translation motion instead of pivotal mounting movement, or may be operated with the combination. Combination with the link 25 and the loop 30 may be performed so that the loop 30 may exercise an open sand mold (not shown) and may accept the link 25.

The link 25 also has the core attachment conductor 45, and this is divided and shown in two conductor parts, i.e., the segment 46, and 46'. In the working example shown here, the conductor 45 is a copper reality tubular member, for example. However, it is clear that the conductor 45 can be formed for example, using a plurality of individual conductors, and in this case, an individual conductor is uniformly distributed by the inner surface of a core so that uniform current distribution may be made substantially.

Each of the conductor segment 46 and 46' is respectively supported by the core segment 42 and 42'. As shown in Fig.2, after the link 25 has closed, the two minimum air gaps arise at the place where the core segment 42 and 42' abut. After the link 25 has closed, the conductor 45 forms the region 48 between winding in the link 25. In the state where the conductor loops 30 have been arranged to the region 48 between winding, the space S between winding is formed between the conductor loops 30 and the core attachment conductor 45.

When the link 25 is energized, momentary current (not shown) flows into both directions through the conductor loops 30 and the core attachment conductor 45. Namely, when current flows in the direction which goes to a paper side at the conductor loops 30, current flows in the direction which comes out in the conductor 45 from a paper side.

Although deleted from Fig.2 for clarification, the conductor loops 30 are the insulated conductors with which the inner part of the conductive material was surrounded by the outer layers of the insulating material. Similarly, as for the conductor 45, a conductive material is surrounded by an insulating material (not shown).

The conductor 45 adjoins the region 48 between winding between the conductive part of the conductor 45, and the core 40, and contains the insulating material. The core 40 also has an insulating material (not shown) on the periphery. The core 40 may have a jacket (not shown) of elasticity and durability material, in order to protect from a damage while using the link 25.

If Fig.3 is referred to, another working example of the link of Fig.1 is shown as the link 25'. This link 25' is provided with the disengageable core, i.e., split core 50, which were shown as what has the two core segments 52 and 54. The core segment 52 supports the core attachment conductor 55 shown as a C channel member of reality copper, for example. Probably, it will be clear that this conductor's 55 it may comprise a plurality of individual components as described above about the conductor 45 of Fig.2. If Fig.1 is referred to, the core attachment conductor 55 will be connected to the primary converter 20 by the conductor (not shown) in the connector line 22.

As for the core segment 54, being eternally attached to the vehicle 14 is preferable. The core segment 52 and 54 each are considered as the composition mutually abutted so that the magnetic flux path of the magnetic adjuster in which these core segments have the two minimum air gaps in the place where it abuts may be formed. the two core segments 52 and 54 abut mutually -- as -- having -- having -- at the time, these magnetic flux paths surround the conductor loops 30.

The illustrated conductor 30 passes through the core segment 54 front freely, and extends it to the mounting points (not shown) of the vehicle 14 through the region between winding, and is electrically connected to the converter 32. Or the conductor loops 30 may be supported from the core segment 54 by the base material (not shown) of an insulating material again. As the core segments 52 and 54 show Fig.3, when it turns mutually and is pulled, the region 58 between winding is formed among them, and the axial direction portion of the conductor loops 30 is surrounded substantially.

The two core segments 52 and 54 can be fixed together when operating using a mechanical latch mechanism or instrument (not shown). However, when the effective current which flows into the conductors 30 and 55 is reverse mutually at the time of energization, like the core segment 42 of Fig.2, and 42', the two core segments 52 and 54 are turned conveniently and mutually, and are pulled by attendant magnetism. If it puts in another way, when flowing in the direction with same magnetic flux of each core segment, a core segment is turned mutually and these magnetism pulls it. On the contrary, when the magnetic flux of each core segment is reverse, a core segment is opposed mutually. These suction forces are supported so that joint junction of a conductor segment of a core segment as a result may be started also conveniently and it may maintain. By using reverse magnetic flux flow, a core segment is made to repel, and power can be used so that it may separate, while controlling a charge link.

Fig.4 describes an operation method of the primary converter 20 and the secondary converter 32.

The link 25 and the conductor loops 30 are shown roughly.

** BE ******** optimizes system performance here using power erection RINIKUSU, and it satisfies the actual design requirement realized now. In the working example shown here, the power supply 16 supplies electric power to the primary converter 20. The converter 20 prepares the primary power electronic input stage 60 for the case where the electric power supplied by the power supply 16 is AC electric power shown in Fig.4 as three phase AC electric power. This primary input stage 60 is the conventional thyristor rectification bridge which used a thyristor, a transistor, a gate turn-off thyristor (GTO), etc., and converts received AC electric power to DC power.

In the case of a large-sized vehicle or short charging time, largely from one MW (one MW), Or in the case of a passenger vehicle, in the power level which is a 1 thru/or 10-kW level and

which is commercially interested, the solution with one sufficient cost performance includes using a power electronics converter with a thyristor rectifier as a primary input stage.
The voltage source converter which has a transistor device in the case of a low charging level is a preferable working example. A rectifier supplies DC power to the choke coil 62, and commits these as a DC current source over the high frequency converter 64. As long as the high frequency converter 64 can generate a high frequency output like a current source inverter, the inverter of what kind of form may be sufficient as it. The converter 64 has a plurality of switching devices constituted and controlled as giving a desired high frequency output to the link 25 was known for this field. When the power supply 16 supplies DC power to the primary converter 20, also conveniently, the primary input stage 60 can be removed.
Each of the primary input stage 60 and the high frequency converter 64 receives each control signal 66 and 68 from the control logic unit 70 which is a device of a micro processor base. The control logic unit 70 receives "a conduction start" or the various operator inputs 72 like "DN" switch signal.
The control power 74 like the DC power needed for a digital control system is given to the control logic unit 70. The feedback signal 76 also receives the control logic unit 70, and this, The signal from the current transducer (not shown) which monitors charge of the battery load 12, And the output of the high frequency converter 64 given to the link 25; the signal from the microswitch sensor (not shown) which instructs that the link 25 was connected to the conductor coil 30, or instructs a "charge preparation" signal etc. is included.
The control logic unit 70 can generate communication or the control signal 78. This control signal 78 is sent to the secondary converter 32, or the converter 32 gives a feedback signal to the control logic unit 70 via this signal transmission 78.
Communication or the control signal 78 is sent in frequency fairly higher usually than the electric power given by the high frequency converter 64. For example, the control signal 78 is a signal of the frequency of megahertz cost. Such transmission of a control signal is daily performed, when an electric power company transmits a control signal through a power line.
The secondary converter 32 has the secondary power electronic input stage 80 which receives electric power from the conductor loops 30. This secondary input stage 80 converts the high-frequency power transmitted through the link 25 to the combination of AC instructed by the demand of the battery 12 and/or DC power, or AC and DC power. The filter of the necessary output power given by the secondary input stage 80 is carried out with the filter 82, it ranks next, and Is supplied to the battery 12 as charging power. Of course, when an energy storage device needs the combination of AC charging power or AC, and DC charging power, the power electronics of the secondary input stage 80 can be changed as giving required charging power was known well.
The secondary converter 32 may be provided with any power conditioner 84 which receives electric power from the output side of the secondary input stage 80 through the conductor 86. However, in a certain use, it is effective to take out before rectification the high-frequency power received by the conductor 30 in the input side of the secondary input stage 80. The power conditioner 84 supplies the electric power needed for the vehicle 14 by other loads 88 which are usually mounted and are attached. In order to accept a demand of other loads 88, in the case of a DC output, the power conditioner 84 is a bridge rectifier.
In the case of a variable DC output, it is an AC/DC control converter, or a variable AC output case is an AC/AC cycloconverter.
or other loads 88 energized by the regulator 84 are AC or a DC load -- or -- the -- it combines and comes out.
For example, when the vehicle 14 is a motor home (mobile house automobile), while the battery 12 is charged, a resident sometimes wants to watch television, to cook with an electric heater, and/or to use other electrical machinery and apparatus in a motor home. Other loads 88, The auxiliary relay of the battery charging system 10; so that it may be maintained at the state where the link 25 closed around the conductor 30 during charge. The electronic latch mechanism to secure; the ventilation fan for the battery 12 surrounded in battery supervising system [for monitoring the charging level of the battery 12 like a charging state indicator]; and limited small space is also included.
In the recharge system 10, control of other 88 load of the electric power supplied to the battery 12 can be performed without feedback from the primary converter 20, when there is nothing. For example, the secondary converter 32 and the battery 12 are monitored and controlled by the signal transmission 78. The signal 78 is injected into the core attachment conductor 45, and is induced to the secondary conductor loop 30 of the link 25 which works as a carrier. This another working example of the recharge system 10 minimizes the cost to the moving system of the working example described here. By controlling the current which flows into the primary core attachment conductor 45, the primary converter 20 is an open loop mode, namely, can supply electric power without feedback. Monitoring, control, and a guard signal can be obtained without needing individual control wire connection between a primary converter and the vehicle 14.
The recharge system 10 can also treat the many load which is visible as in-series impedance for the primary converter 20. The converter 20 adjusts current and a voltage change so that change of the battery load 12 and other loads 88 may be accepted. Such a system may have a certain loading control means about the current supplied to the battery 12 using the secondary converter 32. It is preferable to have [in the case of a single energy storage device] a loading controller in addition to main control Logical unit 70. Since the big flexibility and capability for accepting a various battery form, various manufacturers, and various equipment specifications are given, this is carried out preferably.
There is an effect of the recharge system 10 in having the very easy structure included in the vehicle 14, i.e., the electric power pickup loop 30, and the converter 32. Therefore, the system 10 can be carried out by the minimum cost and complexity in reconstruction or a new vehicle. It can standardize to various vehicle modes, and can adapt this structure by the minimum

investment by the manufacturer and owner of a vehicle. Control and a protection feature are given, the equipment, i.e., primary converter 20, of fixing. The owner of the fixing converter 20 performs maintenance and updating to a control device. Since this system is very well alike to the conventional oil supply station, it is easily received in the general public.

One defect considered by the system 10 to other working examples described below needs the control logic by which the electric power supply position of each station was improved, and is having to update with progress of technology. In the system 10, an energy supply person will perform the greatest investment in a converter and control logic.

The system 10 has low flexibility about selection of the vehicle owner about a recharge position, unless industry and commercial basic facilities standardize completely to this system. The driver of the electric vehicle 14 has a degree larger than the case of the system of the Fig.5 described below depending on the owner and operator of a converter station, in order to perform suitable recharge operation. Therefore, when the equipment of a vehicle receives damage or it turns out that the life of a battery is shorter than anticipation, it may develop into argument.

Another working example of the uncontacted recharge system 100 of the present invention is shown in second working-example Fig.5.

In this another charging system 100, another primary converter 102 receives electric power from the power supply 16 through the conductor 18. Although the conductor 18 is shown to the three-phase-circuit AC power, probably, it will be clear that its DC or other polyphase AC powers work as the suitable power supply 16. The primary converter 102 is converted to high frequency AC electric power so that it may be described below in response to electric power from the power supply 16, and it gives high frequency output electric power to the conductor loops 104. About operation of various elements of the recharge system 100 like the primary converter 102, it describes, after summarizing the relation of operation between various elements.

The vehicle 106 has the energy storage device which was described above about the vehicle 14, and this calls it the battery 12 for simplification. However, the vehicle 106 differs in the method of the connection with a primary converter, and contrnl in the vehicle 14. It does not have only the conductor loops 30 (Fig.1) attached to the vehicle, but the vehicle 106 has a connector conductor, i.e., the connector line 108, and this connects a joint sheath, i.e., a coupling means like the link 110, to the vehicle 106. What was described above about the connector line 22 of Fig.1 may be sufficient as the connector line 108, and the link 110 is constituted as described above about Fig.1, but there are the following the different features.

The link 110 has the disengageable core 112 with a disengageable core part, i.e., the segment 114, and 114', and a core segment is joined together by pivotal mounting or other methods, as described above about the core segment 42 of Fig.2, and 42'. Therefore, these core segments 114 and 114' are pivotally mounted together, and are shown by the hinge 116.

The link 110 has the core attachment conductor 120 divided into two core parts, i.e., the segment 122, and 122'. Each of the conductor segment 122 and 122' is respectively supported by the core segment 114 and 114'. As shown in Fig.6, after the link 110 has closed, the two minimum air gaps arise at the place where the core segment 114 and 114' abut. After the link 110 has closed, the conductor 120 forms the region 124 between winding in the link 110. In the state where the conductor loops 104 have been arranged to the region 124 between winding, space between winding S' is formed between the conductor loops 104 and the core attachment conductor 120.

If Fig.6 is referred to, the method of operating the link 110 differs from the method of the link 25 and 25' in that it is said that the coaxial winding transformer (CWT) formed by combination with the link 110 and the conductor loops 104 has different electric power flow from the link 25 and 25' which are shown in Fig.1 thru/or 3. More, in an electric power flow system, to details, the primary conductor way of the conductor loops 104 is carried out, and they are committed in them. The core attachment conductor 120 works as a secondary conductor, and receives electric power from the conductor loops 104 by derivation. Although shown the same [the link 110 / the link 25 on a description, and structure], the link 110 can also take the composition shown in Fig.3 as 25'. Other geometrical form is considered about the coaxial winding transformer for transmitting electric power between a core attachment conductor and a looped conductor.

The working example the uncontacted recharge system 100 of Fig.5 was indicated to be is roughly shown in Fig.7. Electric power is received from the power supply 16 described above about the system of Fig.1 by the primary converter 102. The power supply 16 supplies electric power to the primary power electronics input stage 130 described above about the primary input stage 60 of Fig.4. When DC power is supplied by the power supply 16, the primary input stage 130 can be removed.

In the example shown here, the primary input stage 130 converts the electric power from the power supply 16 to DC power, and this is supplied to a high frequency converter like the series resonance high frequency converter 132. Fixed DC voltage is given to the inverter 132 using the capacitor 134. The high frequency series resonance inverter 312 is shown by the example shown here as what has the four legs 136a, 136b, 136c, and 136d with a switch. Each inverter leg like 136 d has the diode 138 connected between the collector of the transistor 140, and the emitter. Instead of the switch 140, other power electronic devices like a thyristor or a gate turn-off thyristor (GTO) can be used. The high frequency output of the inverter 312 is supplied to the resonance capacitor 142.

resonance converter technology is publicly known -- the [for example, / IEEE transactions IA] -- IA-15 volumes, F.C. Schwartz who entitles "the controllable 45-kW current source (Controllable 45 kW Current Source for DCMachines) for DC machine" published on the 437th thru/or 444 pages in No. 4 and July, 1979/August, and].

B. It discloses in the paper written by Klassen. If resonance inverter topology is used, the part rating to primary and a secondary converter is maintainable to a convenient thing at an

economical level. The resonance capacitor 142 works so that the volt-ampere invalidity (VAR) demand of the conductor loops 104 may be supplied, therefore the inverter 132 should supply only the active power (watt) demanded by a system. The first problem that influences selection of converter topology is that the inverter switched on high frequency is usually restricted by the switching loss in a device. use of resonance topology -- a device -- substantially null voltage -- or at a zero-electric-current crossing, it can switch substantially, and this is deteriorated remarkably about switching loss, and higher frequency is obtained.

Therefore, the output of the primary converter 102 is supplied to the conductor loops 104, and is supplied to the core attachment conductor 120 of the link 110 by derivation (each of it is roughly shown in Fig.7). If Fig.5 is referred to, the electric power received by the link 110 will be supplied to the secondary converter 150 by which loading attachment was carried out through the conductor in the connector line 108 at the vehicle 106. It has the secondary power electronic input stage 152, and this receives electric power from the core attachment conductor 120, and the converter 150 rectifies it to charging power, and sends it to the filter 154. The secondary input stage 152 and the filter 154 are easy to be what was respectively described above about the secondary input stage 80 and the filter 82 of Fig.4. A filter is carried out and the rectified charging power is supplied to the battery 12 by the secondary converter 150 for a recharge.

The secondary converter 150 can be changed, as this field may be sufficient and it was known so that the charging power of other forms might be given to an energy storage device. If it is a request, secondary charging current can be adjusted with a frequency change, a voltage change, or a phase change. For example, in the case of a DC output, the secondary power electronic input stage 152 is a bridge rectifier.

In the case of a variable DC output, it is an AC/DC control converter, or, in the case of a variable AC output, is an AC/AC cycloconverter.

Such enforcement is an working example with what [preferable as an working example of DC charging current] has a certain control means in the both sides of the link 110 at least.

The secondary converter 150 is provided also with any power conditioner 156 which takes out a part of DC power rectified by the secondary input stage 152 through the conductor 158. In a certain use, before the power conditioner 156 passes through the secondary input stage 152, it is effective to receive high-frequency power from the conductor 120 directly. The power conditioner 156 supplies electric power to other loads 160 described above about other loads 88 of Fig.4.

The secondary converter 150 is provided with the control logic unit 162 which is the same form as having described above about the control logic unit 70 of Fig.4. This control logic unit 162 is the operator input 164, the control power 166, and a plurality of feedback signals.

168 is received and each of it describes above about the operator input 72, the control power 74, and the feedback signal 76 of Fig.4.

The control logic unit 162 communicates with the primary converter 102 with communication or the control signal 170. This communication control signal 170 acts with ultrahigh frequency communication and the control signal of megahertz cost, as described above about the control signal 78. The kilohertz electric power shown in here it sent here through the link 110 works as a carrier of the signal transmission 170.

For example, the primary converter 102 and the power supply 16 are monitored and controlled by the signal transmission 170. The signal transmission 170 is each digital pulse of whether it is a modulated analog signal induced to the looped conductor 104, or a series. The monitoring between the primary converter 102 and the vehicle 106, control, and a guard signal are obtained without needing an individual control wire combination between the primary converter 102 and the vehicle 106 also conveniently.

The recharge system 100 which the secondary converter 150, the control logic unit 162, and the link 110 were altogether mounted on the vehicle 106, and was attached has a many effect. For example, in the method of operation, the driver of the vehicle 106 parks a vehicle near the primary converter 102, and clamps the link 110 by hand around the conductor loops 104 of fixing non-carrying. The mounted secondary converter 150 gives electric power adjustment, recharge strategy logic, circuit protection, and a safe allowable function.

As for the effect of the system 110, many of control systems are mounted on a vehicle, therefore a vehicle is at the point which can have the capability to be adapted for the non-standard primary converter power source at various places. An early investment required for an electric power supply person to constitute a recharge place decreases, namely, the primary converter 102 only has easy topology without the control strategy of the charging system 10 of Fig.1.

The recharge system 100 is dramatically suitable for carrying out the recharge of the vehicle during parking in meter. The owner of the vehicle 106 has the responsibility which maintains and protects the link 110 and the connector line 108, therefore these will receive more prudent handling. The recharge system 100 needs only standardization of the minimum of a fundamental institution, but the greatest option of an energy source is granted to the driver of the vehicle 106.

However, the recharge system 100 brings about a high initial cost for the owner of the vehicle 106, and a loading system becomes a complicated thing which needs maintenance. The energy supply person who takes charge of the primary converter 102 is largely influenced by whether a vehicle owner's equipment operates appropriately to prevent the damage to the primary converter 102. The vehicle 106 must support additional weight and must provide the additional space for a control logic unit, the connector line 108, and the link 110. Expensive control and converter arrangement function under a load factor lower than the recharge system 10 of Fig.1, namely, the frequency in use per day of the expensive hardware of the system 100 is lower than the converter arrangement of Fig.1.

It has the link 25 or 25' which the 3rd working-example Fig.8 shows the automatic uncontacted recharge system 200, this operated as roughly shown in Fig.4, and was shown in Fig.2 or 3.

This recharge system 200 has the primary converter 202 which receives electric power from the power supply 16 through the conductor 18, as described above about Fig.1. The electric vehicle 14 of Fig.8 is the same as the vehicle 14 of Fig.1, and has the electric power pickup conductor loops 30 connected to the secondary converter 32. The secondary converter 32 gives necessary charging power to an energy storage device, as described above about the working example of Fig.1, and the energy storage device is shown as the battery 12 for simplification. Although what was described above about the converter 20 may be sufficient as the primary converter 202, it is preferable to include many additional control characteristics. The connector line 22 and not the manual connection link 25 but automatic recharge system 200 of Fig.1 have the arm 204 by which an actuator operation is carried out and which can position a robot type. This arm 204 is extended to the method of outside from the primary converter 202, and supports a joint sheath, i.e., an automatic coupling means like the link 205. When the link 205 has a disengageable core like the core 40 of Fig.2, the robot arm 204 is extension / grip type arm which opens the link 205 and closes a link around the vehicle attachment conductor 30 so that the conductor loops 30 may be accepted. When the link 205 is the same as the link 25' shown in Fig.3, a robot arm maintains the position of the core segment 52 to the core segment 54, and the conductor 55 so that the minimum air gap may be given between the core segments 52 and 54.

The operation method of the automatic link 205 is a point constituted so that the pickup looped conductor 30 attached to the vehicle 14 may be ****ed and surrounded, and is the same as that of the manual connecting link 25. The magnetic flux and the position sensor (not shown) like the Hall effect and an optical position sensor may be respectively attached to the housing of the arm 204, the link 205, or the converter 202. These position sensors are used for controlling the arm 204 which goes to holding engagement with the pickup loop 30, and the stretch of the link 205. The converter 202 moved the arm 204 and the link 205 to the charging position using these position sensor signals in response to the signal from these position sensors, and is provided with the control logic unit for retracting to neutrality, a start, or a "pause" position after charge. Magnetic flux and a position sensor can be attached to a link and/or the vehicle 14, the arm position to the conductor loops 30 can be fed back, and an arm can be positioned automatically. Positioning which is the arm 204 according to such a way and it of the sensor that are used is well known for the field of a robot.

In the operation method of the automatic recharge system 200 of Fig.8, the driver of the vehicle 14 adjoins the primary converter 202, and parks a vehicle in the boundary area 208. A vehicle is positioned by the optical indicator, the limit switch, or various means like the simple dent 210 which were provided by the paved road 212 contiguous to the converter 202.

In the case of operation, the automated system 200 performs automatically uncontacted clamp-on combination with the link 205 and the conductor loops 30 of vehicle attachment. The automated system 200 can stand the schedule of charging time and tactics, performs an automatic recharge, detaches by monitoring, and recording and ranking the result next, and gives the driver of the vehicle 14 a completion instruction.

The effect of the automatic recharge system 200 includes that the maximum safety degree is programmable using the positioning controller which the field of a robot arm may be sufficient as and is known.

The automated system 200 is well suitable also in formation (fleet) operation which cohere. That is, a formation vehicle has a typical case where he is a single driver, to park at the appointed area is demanded, and an automatic recharge serves as an option very attractive for this formation use.

Give the maximum capability to exert a high usage rate and to minimize a work labor as compared with other systems described here, and the automated system 200. The capability to give equalization of load or the automatic scheduling of an electric power supply as some energy management systems, and to reduce peak power demand, namely, to perform a recharge during the non-peak load time of an electric power company is given. The system 200 is well suitable to an automated diagnosis, tendency monitoring, and an automatic-recording holding system.

In this automated system 200, it is the minimum which is required of a user and it only parks a vehicle at the position of the specification which adjoined the primary converter 202. However, the automated system 200 is the most complicated among three systems proposed here. The system 200 is remarkably influenced by standardization of the converter circuit 32 of the standardized vehicle dimension and vehicle loading. the recharge of the system 200 is carried out at various dispersed places .. as it is hard to carry out.

Another working example of the uncontacted recharge system 300 constituted by the present invention for supplying the electric power which carries out the recharge of an energy storage device like the battery 12 mounted on the electric vehicle 302 is shown in the 4th working example Fig.9. This recharge system 300 has the primary converter 304 for receiving electric power from the power supply 16 through the conductor 18. The loading battery 12 of the vehicle 302 is connected to the secondary converter 306. Primary and the secondary converters 304 and 306 are easy to be what was respectively described above about the primary converter 20 and the secondary converter 32 which are shown in Fig.4. Or what was respectively described above about the primary converter 102 and the secondary converter 150 which were shown in Fig.7 may be sufficient as the converters 304 and 306 again.

Preferably, the primary converter 304 is provided with the dent portion 308 for receiving the joint sheath, i.e., a connecting link like another working example of the link 310, constituted by the present invention as shown in Fig.10 thru/or 12. This connecting link 310 is installed in the dent portion 308 of the primary converter 304 for protection. This link 310 is shown as a double bond link which has the two link members 312 and 314. As for this link 310, it is preferable to be surrounded, the protection jacket, i.e., husks 316, of a durability insulating material like a plastic, rubber, or other elastomers.

The core segments 318, 320, 322, and 324 are ferrite core materials like a PC-40 type ferrite

core. As for the gap in a core separation part, minimizing is preferable. For example, in design study and an experiment, the effective gap of 0.1 mm is obtained and it is shown that a bigger gap than about 2 mm brings about low dissatisfied performance.

The double link 310 also has the primary conductor of the core attachment which grows into each link member 312 and 314 from two portions arranged respectively. The link member 312 has the segmented primary conductor portion which was divided and shown in the two core attachment conductor segments 326 and 328. The link member 314 has the segmented primary conductor portion which was divided and shown in the two core attachment conductor segments 330 and 332. These primary conductor segments 326, 328, 330, and 332 are electrically connected together, as the conductor 334 shows to Fig.10 roughly. As illustrated, the segmented link 310 has that to which the 1st upside portion 336 fits into the 2nd lower portion 338. The upper link part 336 was provided with the core segments 318 and 322 and the primary conductor segments 326 and 330, and, on the other hand, the lower link portion 338 is provided with the core segments 320 and 324 and the primary conductor segments 328 and 332.

Or it may be formed in upper continuous U shape portion (not shown) instead of the double link frame formation which shows the lower link parts 336 and 338 to Fig.10 thru/or 11 by reaching again. For example, the conductor segments 326 and 330 are the legs of single U shape upper conductor segment (not shown), and the conductor segments 328 and 332 may be joined together in a similar manner as a single U shape lower conductor segment (not shown).

When using the primary conductor of U shape, the leakage loss of end winding decreases, and the necessity for the individual conductor 334 is eliminated. Reduction in leakage inductance can be further attained by [of U shape / upper] reaching and forming a lower core segment (not shown) so that the primary conductor segment of the upper part of such each U shape and the lower part may be surrounded substantially. About the link frequency of a 20-kHz range, press sintering core materials are preferable, and although this is conveniently molded in various form like U shape core, in order to form the channel which receives a primary conductor, it needs subsequent finish processing.

As shown in Fig.11, the link member 312 has the segmentation core divided and shown in the two core segments 318 and 320. Similarly, the link member 314 also has the segmentation core divided and shown in the two core segments 322 and 324. Although the core of the link members 312 and 314 is shown as cylindrical shape, the core segments 318, 320, 322, and 324 may be the rectangles or squares which were shown in sectional shape other than the illustrated semicircle shape, for example, Fig.3, so that clearly [a person skilled in the art].

If Fig.12 is referred to, it is arbitrary, but the primary converter 304 is provided with the fluid cooling system 340 for making the link 310 circulate through gas or a liquid, for example, a cold fluid like the water 342. The link 310 has a cold fluid chamber which forms a flow path, and this flow path is divided into a plurality of flow paths shown in Fig.11 by a tubular conduit tube like the conduit tube 344. Preferably, the fluid transportation conduit tube of these plurality is a nonmagnetic electrical insulation material like a plastic, and it is arranged between the core segment 318 and the primary conductor segment 326 so that it may be shown in between a core and core attachment conductors (for example, Fig.11). Or a fluid chamber may be arranged in a core attachment conductor, for example, each of the conduit tube 344 is a copper material, and it may make it commit it also as a primary conductor of core attachment again.

The fluid cooling system 340 shown in Fig.12 has the storage machine 346 which communicates a pump or the compressor unit 348, and a compressor unit supplies the fluid from the storage machine 346 to a heat radiator like the air-cooling heat exchange mechanism 350. The cooled fluid flows into the supply manifold 352 from the heat exchange mechanism 350. The supply manifold 352 is divided and shown in four ON ROKONJITTO 354, 356, 358, and 360, and supplies the fluid 342 to the conduit tube 344 respectively arranged near the primary conductor segments 330, 326, 332, and 328. A fluid flows into the discharge manifold 362 through the conduit tube 344 of the link 310. This discharge manifold 362 is shown near the primary conductor segments 330, 326, 332, and 328 as what mixed the four exit conduit tubes 364, 366, 368, and 370 which receive the fluid 342 from the conduit tube 344 arranged respectively. The cooling system 340 has the return conduit tube 372 which returns the fluid 342 to the storage machine 346 from the discharge manifold 362. Probably, it will be clear that the fluid cooling system's 340 it can constitute from an equivalent form on a different structure of the versatility well known to a person skilled in the art.

If Fig.9 thru/or 11 are referred to again, the flexible connector conductor 374 will connect the uncontacted secondary conductor loop 380 to the secondary converter 306 preferably. The loop 380 is shown by Fig.11 as a charge loop of the large scale which has the four parallel conductors 382, 384, 386, and 388 as shown in Fig.13, or the rate of urgency.

Three another working examples which separate a link segment into Fig.13 thru/or 15, or it joins to it together are shown. The link parts 336 and 338 are disengageable so that this may open and the loop 380 may be accepted among them. The link parts 336 and 338 can be opened if it ranks next, it is closed in order to charge the battery 12, and charge is completed. The link 310 has a shell type opening and Fig.13 shows that by which pivotal mounting junction of the two link parts 336 and 338 is carried out together with the hinge 390.

Preferably, as the arrow 392 shows, upper 336 can be opened in a pivotal mounting type so that it may separate from the lower part 338, as the arrow 393 shows, it can insert the loop 380 among them, it can rank next, can be closed at a pivotal mounting ceremony, and can transmit electric power among them.

If Fig.14 is referred to, by separating the portions 336 and 338 in the direction shown by the arrow 394 radially, it is constituted and another link 310' is shown that it opens radially. If the link 310' opens radially, as the arrow 395 shows, the loop 380 can be inserted among the open link parts 336 and 338.

Furthermore Fig.15 was constituted so that it might open by translation motion by sliding and

separating the segment 336 from the segment 338 as the arrow 396 showed, it shows another link 310". By opening of the translation motion of the link 310", the loop 380 can be inserted, as the arrow 397 shows. The link 310" is closed by moving the link part 336 in the direction opposite to the arrow 396, as long as there is gap where the portion 336 is sufficient to exceed the loop 380. Such a gap is given by moving the link part 336 to above [perpendicular to the level arrow 396 which constitutes the unsymmetrical link part (not shown) which has the fixed portion in which the deep loop acceptance outline 398 was formed, or is shown in Fig.15]. Or advancing-side-by-side movement of the link part 336 may be carried out in a parallel axial direction again substantially [longitudinal shaft / 399 / of the link 310" shown in Fig.15 with the end elevation as the point 399]. On other structures about Fig.14, the radial direction of 15, an advancing-side-by-side move link opening mechanism, and the pivotal mounting opening mechanism of Fig.13, an equivalent change and combination may be carried out by the cam, the link, the lever, or a servo function (not shown), as well known to a person skilled in the art.

If Fig.9 is referred to again, the uncontacted recharge system 300 had the communications system 400 preferably, and the communications system is provided with the primary converter station 304 containing the communication (COMM) control device 402 in the working example shown here.

The communication apparatus 402 has a dialog with the control logic unit of the primary converter 304 like Logical unit 70 of Fig.4, or has a dialog via Logical unit 162 and the signal 170 of the secondary converter 150 of Fig.7.

The control device 402 receives the input from the charging rate indicator for instructing the charging rate selected to the battery 12. The converter 304 responds to a charging rate indicator, and converts the electric power from the power supply 16 to AC electric power sent to the link 310 by the selected charging rate. A charging rate indicator can be carried out by various different methods. In one working example, the selected charging rate is an operator input supplied to the primary converter 304 by an operator from the keypad (not shown) arranged at the place away from the converter 304 or there, for example.

Or as described above, a charging rate indication signal may be superimposed by the kilohertz electric power of the high frequency supplied through the conductors 382, 384, 386, and 388 of the loop 380 in the megahertz signal of ultrahigh frequency again.

The interactive communications system 400 is shown in the working example of Fig.9. The electric vehicle 302 has the control sensor array 404 for generating a charging rate indication signal.

This mounted control sensor array 404 is the secondary converter 306 (not shown).

It may be connected there, as ******** could be constituted or it was shown to Fig.9 by the dashed line. The sensor array 404 monitors a battery about a charging state, a charging rate, a fault cell, etc., as the sensor signal 405 showed roughly.

A charging rate indication signal is conveyed by the communication conductor 406 from the sensor array 404. In the working example shown in Fig.9, the communication conductor 406 is adjoined and extended to it through the connector line 374, and is connected to the indicator interface device 408 attached to the handle 410 of the loop 380. The indicator device 408 aligns so that it may communicate with the communication interface device 412, when the loop 380 is connected to the link 310. The communication interface device 412 adjoins the dent 308 by the converter 340, and is supported, and is connected to the communication apparatus 402 of a primary converter by the conductor 414.

In Fig.10 and any working example of 11, the loop 380 supports the indicator interface device 415 attached to the outer surface 416 of the loop 380, in order to instruct the selected charging rate over the battery 12. In the working example shown here, the communication conductor 406 is extended through the connector line 374 and the loop 380, and is connected to the indicator 415. In the state where the indicator 415 has been arranged at the loop 380, a communication interface device is arranged in another position shown not as the dent 308 but as the equipment 412', in order to communicate with the indicator 415, when the loop 380 is connected to the link 310.

As shown in Fig.9 and 10, an optical fiber transmitter is used for one preferable working example as the indicator interface devices 408 and 415, and an optical fiber receiver is used for it as the communication interface devices 412 and 412'. Instead of the optical fiber device shown here, on other structures so that clearly [a person skilled in the art] Equivalent converter communication and an indicator interface device, For example, the interface device, the optical reader and the electromagnetism, or the derivation interface device (not shown) of metal versus metallic contact may be used. The indicator signal which occurs by the loading sensor array 404 may communicate other information from the vehicle 302 to the primary converter 304, for example, a charging state, and the state of a battery, for example, the short circuit of a battery cell, identification of a vehicle, and **, such as charge calculation permission.

The uncontacted recharge system 300 is easily applicable so that various electric vehicles by which charging rates differ may be charged or one vehicle may usually be charged by the charging rate and two different charging rates or more of the rate of boost charge. For example, the loop 380 is made into size which carries out rapid high-speed charge of the battery 12 with the rating of about 120 kW. Fig.16 shows another coupling loop 420 connected to the loading secondary converter 306 by the flexible conductive connector line 374. This loop 420 has capacity smaller than the loop 380, as the small cross-sectional area of the loop 420 shows as compared with the loop 380. Although the loop 420 also comprises one or more the parallel loops or winding which showed the secondary loop 380, it is shown having the power conductor 422 single for simplification. The loop 420 is shown as what supports the above communication loop conductors 406. Space between winding S" shown in Fig.11 to the mass loop 380 is small to ** in the space S" between winding where the conductor loops 420 were shown in Fig.16.

Another thin wall tubular conductor lube 430 a s what is replaced with the single winding loop 420 shown in Fig.16 is shown in Fig.17. In the link 310, this tubular loop 430 occupies big volume, and it approaches the primary conductor of core attachment of the conductive material of the loop 430, and it makes it arrange it rather than the loop 420. For example, let the section outer diameter of the loop 430 be the size which produces space between winding S" of the same diameter as having been shown in Fig.11 as the loop 380.

Small space between winding S" obtained by the loop 430 decreases leakage inductance as compared with what is obtained using the loop 420 of single winding also conveniently.

The leakage inductance per 1 m of axial directions of core length (it is parallel to the longitudinal shaft 399) is similarly determined with what is used for the coaxial transmission line. For example, it is as follows when an outside primary conductor is infinitely approximated with a thin current sheet.

L= [(N^2mu_0) / (8 pi)] and [1+41n(K)] H/m (1) K=(R1/R2) >=1 (2) -- however, The winding ratio of the number of times of N= secondary wind, and the number of times of a primary wind, and clrcumradius of an R1= distribution primary-current sheet radius R2= secondary conductor Amplitude permeability of mu_0= free space (4pix10 $^{-7}$H/m)

for example, the thing for which the circumradius R2 of a secondary conductor is increased ratio -- leakage inductance L's decreasing also conveniently is clear by bringing K close to 1.

As shown in Fig.17, the packing 432 of an insulating non-magnetic material is filled in the inside of the loop 430. or [or / the inside of the loop 430 being hollow and filling up with air again] -- or it may be exhausted. The inside of the loop 430 is filled up with an insulating nonmagnetic cooling medium (not shown) in another working example. Although not illustrated, when used, the optical communication conductor 406 moves in parallel along with the outside or the inside of the tubular loop 430.

The vehicle 302 can usually be equipped [charge] with the conductor loops of the dimorphism type of the loop 380 about the loop 420 or 430, and boost charge. Both of loops 380 and 420 (or 430) may be eternally connected to the secondary converter 306. These loops are exchangeable and it is preferable that only the one loop 380 or 420 (or 430) is connected to the converter 306 at given time. For example, in a long-distance road travel, while carrying out operation rest along the expressway between states, etc., the boost charge loop 380 is installed for high-speed charge. In everyday commuting, the usual loop 420 or 430 is used, and the loop 380 for high-speed charge with weight can be kept in a vehicle owner's car barn, for example, can make a payload light, and can raise efficiency.

or equipping the vehicle 302 only with the mass rate loop 380 of boost charge again -- the charging rate indicators 408 and 415 or an operator input (not shown) -- usually -- or the rapid selected charging rate may be made to communicate to the primary converter 304 It is preferable to charge by a low charging rate from the economical efficiency of a customer's use, at home with preferable usually charging by a low charging rate in the present battery technology, so that the life of a battery may be prolonged, when possible.

As an example, the typical uncontacted charging system 300 in the U.S. is actually constituted so that AC electric power may be received from the power supply 16 with 30 ampacity of the single phase of 230V $_{AC}$. If the standard loss of primary and the secondary converters 304 and 306 is assumed, it is shown that the total efficiency of 95% can be realized. When it is the typical electric vehicle 302 whose energy pooling capacity is 20 kWh, it is based also on the specific format of the battery 12 which is trickle-charging-required and is chosen, but the charging time of 3 thru/or 6 hours is expected. In the case of remoteness or an extraordinary use, the extraordinary battery charger of low rating for operating from the single phase 115V $_{AC}$ power supply 16 has 1.3-kW rating.

In order to replace today's of an internal-combustion engine vehicle formation efficiently, the electric vehicle 302 can accept high-speed high power charge in the service station of the roadside during a long-distance travel. For example, although the charging time for 15 minutes is based also on the size of the vehicle 302, it needs a charging rate (50 kW thru/or 370 kW). Growing up as the energy pooling capacity of a battery increases these rating shown here with improvement of battery technology is expected. As for the electric vehicle 302 which has high power charging capacity, it is preferable that it can connect also with 230V $_{AC}$ for home use and the 115V $_{AC}$ primary converter station 302 for emergencies, without needing additional hardware. While the system 300 operates over such a wide power range, it minimizes the weight and cost of loading and permanent residence battery-charger parts.

Use of the coaxial winding transformer which comprises the link 310 and the loop 380 can be designed over a wide power range, for example, and unprecedented scale variability is acquired by a main parasitism component like the leakage flux of a transformer being controllable. By arranging without mounting no transformer core materials on the charge station 304, loading transformer parts are restricted to the easy wire loop 380 made into the size which obtains a maximum current level. The loop 380 does not have a magnetic material but sensitivity to clock frequency or magnetic flux density is the minimum by extension.

The system 300 can operate with various converter topology and core materials over a wide frequency range.

Since a loading secondary conductor comprises the easy wire loop 380, the loop 380 can be made large-sized only by cost or weight very slight for the user of a vehicle being imposed. The small loop 420 of low rating can be used, and it can be made to suit in form restrictions of the big loop 380 about a low-electric-power use, without imposing substantial cost. By comparing 16 with Fig.11, like the center versus center span between the link members 312 and 314, the inner diameter of the primary conductor segment of the link members 312 and 314 is the same, and it is clear that its charge scale variability is effectively given using the single link 310. These dimensions are used in order to describe the interface of the general-purpose loop shape shown by the loops 320 and 420.

Therefore, the system 300 treats this wide power range efficiently, without imposing remarkable restrictions on the parts designed to low power level.

The following tables 1 show the calculated data of the 6.6-kW system to the loop 420 of the Fig.16 optimized so that it might operate at 77 kHz, and the computer calculated data of 6.6 kW (Fig.16) and a 120-kW working example (Fig.10 thru/or 11). In a 6.6-kW design, especially the overall restrictions about the size and efficiency (and probably cost) of the system 300 are the minimum, seeing from the user of the electric vehicle 302. One 6.6-kW system was created without including any water cooling system 400, and was tested by satisfaction at the laboratory.

Table 1 Coaxial winding transformer design data

	6．6kWのみについて最適化	汎用設計	定格
電力	6.6kW	6.6kW	120kW
一次電圧	200V	200V	200V
一次電流	57Amp	58Amp	600Amp
二次電圧	400V	400V	400V
二次電流	25Amp	25Amp	300Amp
周波数	77kHz	77kHz	20kHz
Bm(PC-40フェライト)	210mT	210mT	210mT
変成器寸法：			
コア全長	260.0mm	260.0mm	260.0mm
内側導体の外径ｘ4	3.4mm	3.4mm	15.0mm
外側導体の内径	11.2mm	46.4mm	46.4mm
外側導体の外径	11.6mm	46.9mm	47.4mm
コアの内径	12.2mm	47.4mm	58.0mm
コアの外径	23.8mm	59.2mm	102.8mm
全有効エアギャップ	0.5mm	0.5mm	0.5mm
変成器重量：			
コア重量(PC-40)	0.414kg	1.225kg	7.07kg
一次銅重量	0.055kg	0.389kg	0.77kg
二次銅重量	0.038kg	0.066kg	0.67kg
全重量	0.507kg	1.680kg	8.51kg
電力密度(kW/kg)	19.98	6.0	14.1
効率	99.58%	99.01%	99.70%

As the Conclusion above was carried out, each system has the characteristics and a defect. The system 10 of Fig.1 resembles the form of the gasoline service station aesthetic. The recharge system 100 of Fig.5 resembles the conventional electrical machinery and apparatus for consumers which has the code inserted in a power receptacle. Therefore, notionally, the recharge systems 10 and 100 will be received enough in general consumers by considering whether an electric vehicle is similar to a gasoline energization vehicle, or it is similar to an electrical machinery and apparatus. Charm that it is not necessary to contact a connection part at all is for the automated system 200 of Fig.8 to start charge except that a user parks the vehicle 14 appropriately near the primary converter 42. However, a robot arm requires cost for it being more complicated than Fig.1 and the system of 5, and carrying out. The system 300 is preferable about scale variability.

A vehicle by which charging capacity differs can be charged from the single charge station 304, and different charging rates, such as usual and a rate of boost charge, can be chosen to the one vehicle 302.

For example, the loop 380 of Fig.11 is 120 kW in charge rating, and, on the other hand, the loop 420 is 6.6 kW in charge rating. The recharge system 300 also shows the fluid cooling system 400 used to the connecting links 25, 25', and 110 by adding a cooling conduit tube (not shown), as the conduit tube 344 of the link 310 was described. Fluid cooling of a link dissipates conveniently the heat which occurred by the loss of I^2R, and can perform high-speed charge by the core attachment conductor of a low initial cost.

Therefore, the uncontacted battery current collection system described here fits operation with a high frequency of 2 thru/or about 50 kHz by the CWT link conductor and converter of the

very high power flux density which operates in very quick response time. The conductor exposed at any times is not needed for connection of the electric power between a primary converter and a vehicle. In addition, the recharge circuit is insensible in a position to the core to an inside conductor in all the directions of an axial direction and a radial direction. It allows the big gap between winding that it is insensible in this way in the position of the inside conductor to an outer conductor, though output performance is maintained. A connecting link is a power neutral.

Radial power does not show power of an axial direction between a core attachment conductor and conductor loops, either.

while the recharge system stated here according to these various characteristics is physically easy in a practical meaning ** the user to various parts of a system, and environment ** it is strong so that physical abuse may be compensated.

The recharge systems 10, 100, and 200 supply [load / of 1 thru/or 100 kW] electric power to each of those links in the high frequency of about 2 kHz about the load of about 20 kHz and one MW or more. The primary current given by the converter of fixing induces the ampere turn of a reverse quantity equal to a loading secondary winding and, without being accompanied by physical contact between the conductors of CWT. It fills up with a non-magnetic material for an insulation electric [the space between winding in CWT], and environmental. When both primary [of CWT] and a secondary circuit transmit electric power to a convenient thing, they have neither the exposed conductor nor the exposed magnetic core material in it. Therefore, in these systems, the conductor and core part which the both sides of CWT were encapsulated completely, namely, were attached to the primary converter, and a vehicle attachment conductor and a core part are encapsulated, and the maximum safety can be attained.

The cost imposed more than the recharge systems 10, 100, 200, and 300 with the link and loop which were combined inductively give peculiar electrical isolation to the power supply 16 and the battery load 12, therefore it gives electric separation is the minimum. Other effects of the systems 10, 100, 200, and 300 contain the following.

- A power-factor is 1 and harmonic current is low;
- Interface suitable for the range of vehicle size;
- Interface suitable for the range of power level;
- Loop of minimum weight for a customer to treat;
- Peculiar safety, the benign defective mode;, and -low cost.

The technology described about the recharge system described here is a thing of the initial stage. Therefore, it is preferable that it is sufficiently suitable for change which any judgment made about standardization produces with technical growth. Therefore, the parts described here can be replaced to ****, such as such structures top, as ****, such as a structure top known by the person skilled in the art, progress.

Although the principle of the present invention was illustrated and described about many preferable working examples, probably, it will be clear to a person skilled in the art that the present invention's composition and details can be changed, without deviating from such a principle. For example, he may use other core composition to the link described here, and also do other equipment known as other composition can be used also about a core attachment conductor and it can exchange by a person skilled in the art and replacement with composition. The position of a core may be contrary to a control logic unit, for example, may use Fig.1 thru/or the CWT composition of 3 with primary [of Fig.7], and the secondary converters 102 and 150. The operator inputs 72 and 174 may be received by Fig.4 and primary [of 7], or any of a secondary converter. In addition, replacement and dimension change of a suitable material may be made to the parts of the link described here. The composition of primary and a secondary converter can be substantially changed based on power electronics and the actual condition technology of other switching devices. Such all change shall be included at the pneuma of the Claim of the present invention, and within the limits.

JP,08-505279,A

Previous Document 1/1 Next Doc

Detail Image

CLAIMS DETAILED DESCRIPTION

DRAWINGS

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

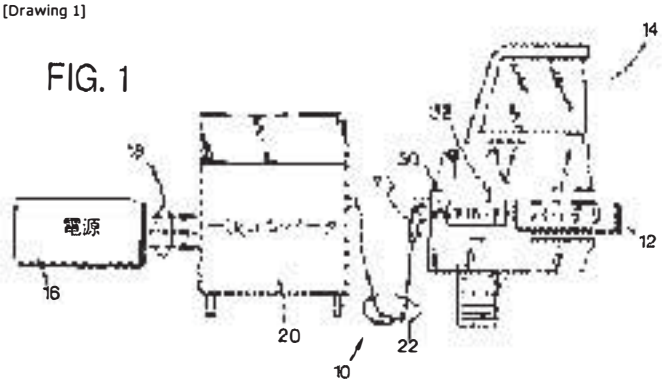
2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DRAWINGS

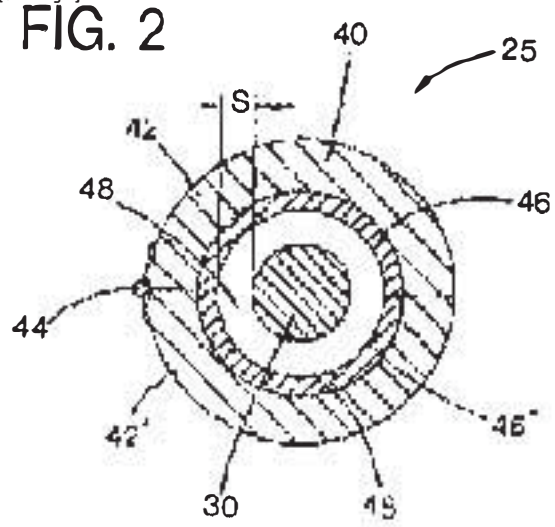
[Drawing 1]

FIG. 1



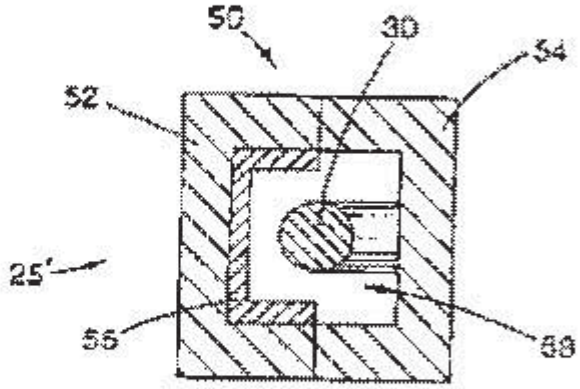
[Drawing 2]

FIG. 2



[Drawing 3]

FIG. 3



[Drawing 4]

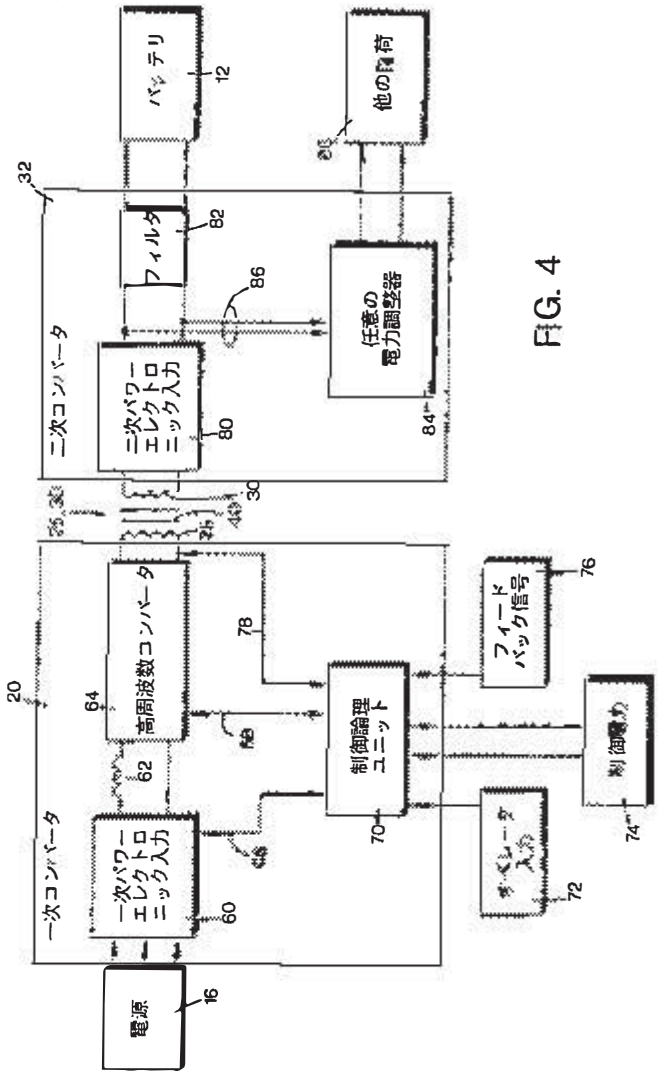
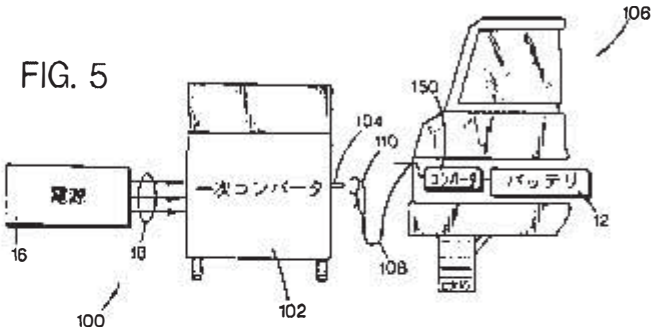


FIG. 4

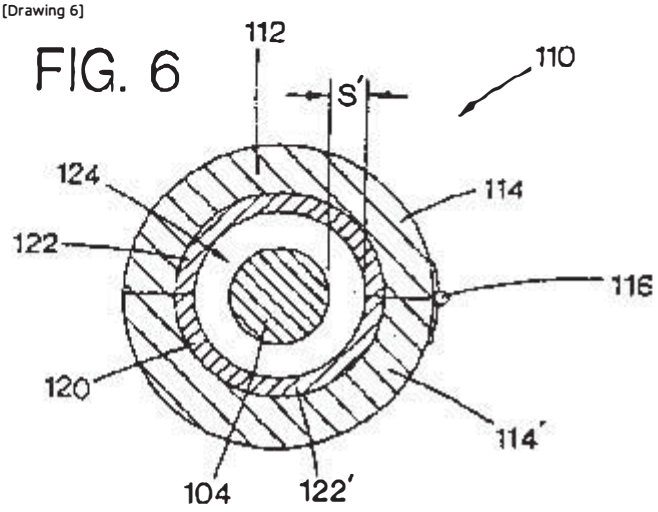
[Drawing 5]

FIG. 5



[Drawing 6]

FIG. 6



[Drawing 7]

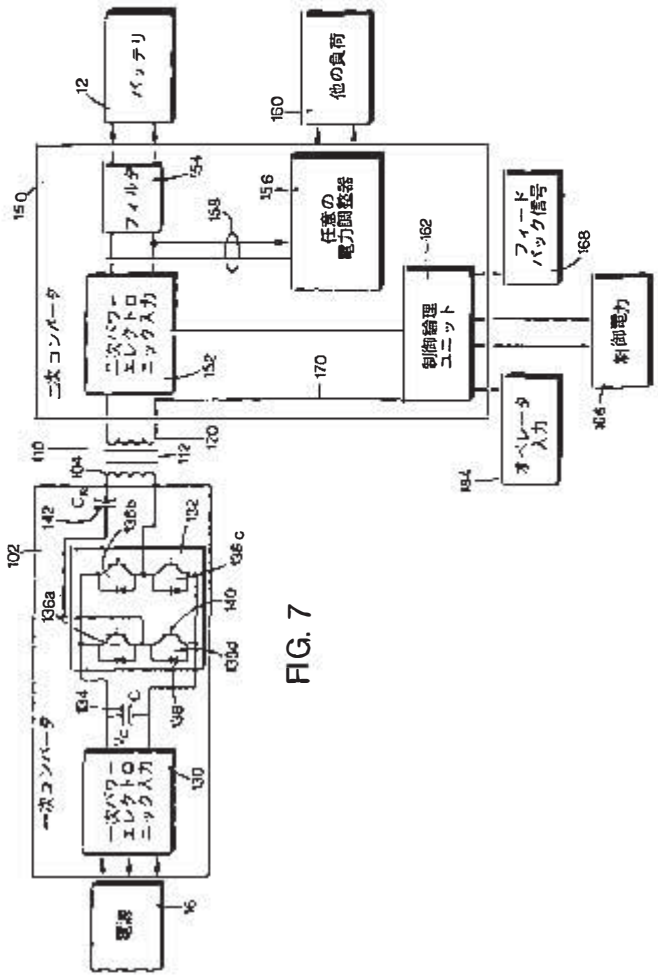
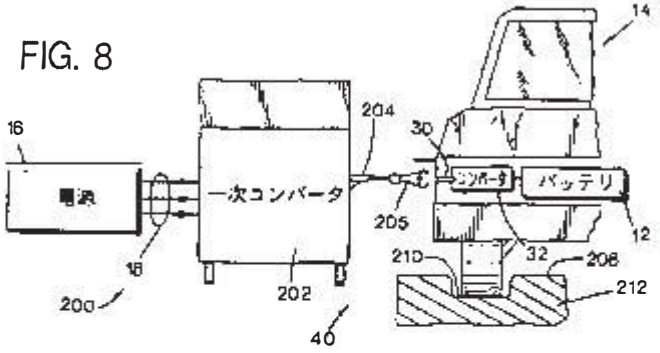


FIG. 7

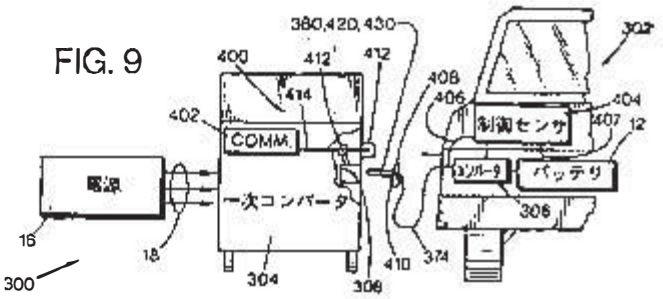
[Drawing 8]

FIG. 8



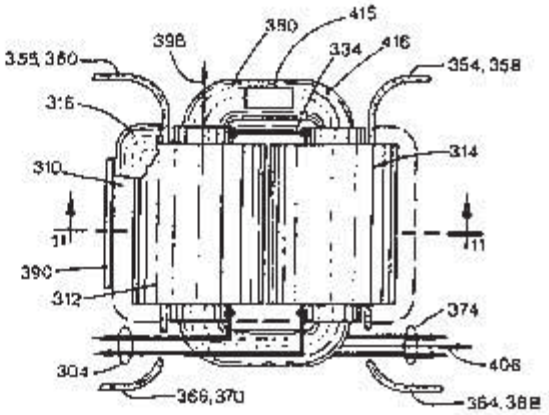
[Drawing 9]

FIG. 9



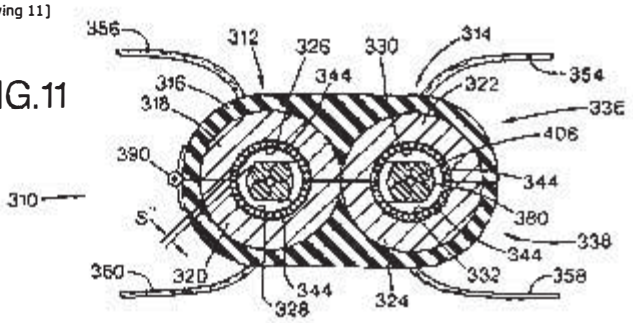
[Drawing 10]

FIG. 10



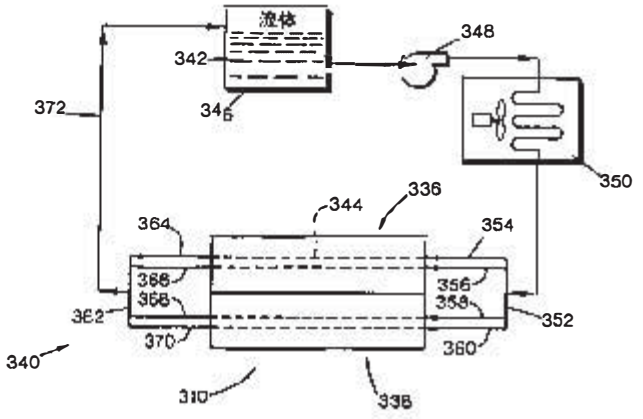
[Drawing 11]

FIG.11



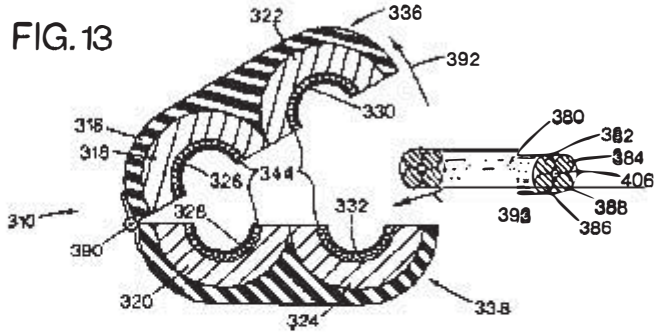
[Drawing 12]

FIG.12



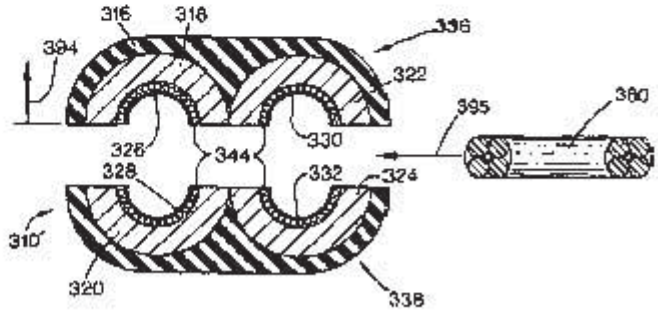
[Drawing 13]

FIG. 13



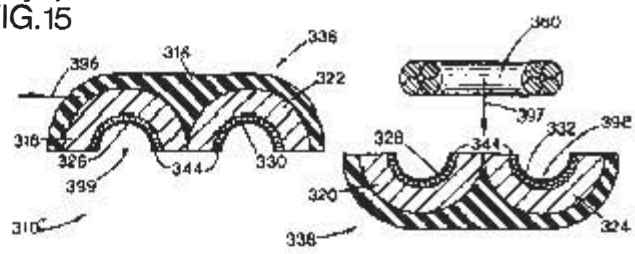
[Drawing 14]

FIG. 14



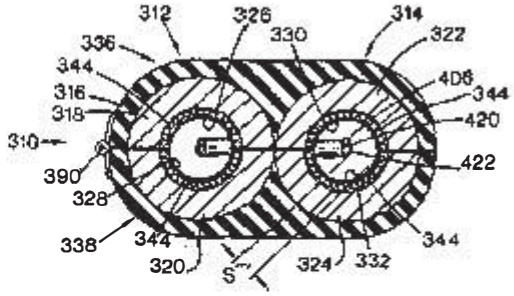
[Drawing 15]

FIG. 15



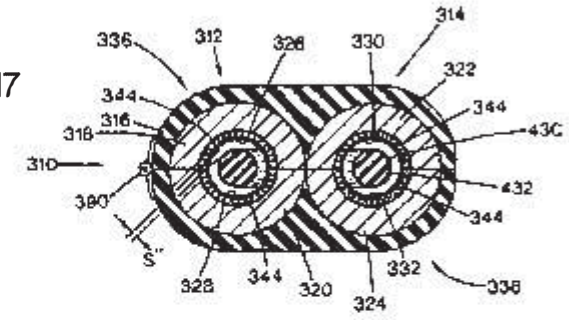
[Drawing 16]

FIG. 16



[Drawing 17]

FIG. 17


336
312
328
330
314
322
344
316
318
310
380
S
344
344
320
324
332
344
432
430
336

(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2002－137659
（P2002－137659A）
(43)公開日　平成14年５月14日(2002.5.14)

(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード（参考）
Ｂ６０Ｍ　7/00		Ｂ６０Ｍ　7/00	Ｘ	５Ｈ００７
Ｂ６０Ｌ　5/00		Ｂ６０Ｌ　5/00	Ｂ	５Ｈ１０５
Ｈ０１Ｆ　38/14		Ｈ０２Ｊ　17/00	Ｂ	
Ｈ０２Ｊ　17/00		Ｈ０２Ｍ　7/5387	Ｚ	
Ｈ０２Ｍ　7/5387		Ｈ０１Ｆ　23/00	Ｂ	

審査請求　未請求　請求項の数16　ＯＬ　（全 14 頁）

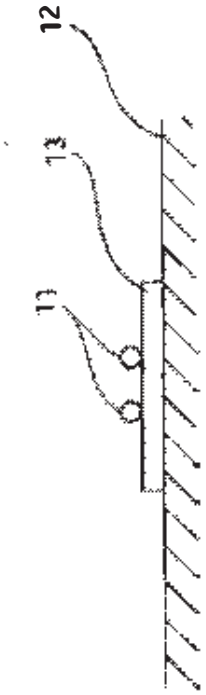
(21)出願番号　特願2000－266306(P2000－266306)
(22)出願日　平成12年９月１日(2000.9.1)
(31)優先権主張番号　特願2000－253043(P2000－253043)
(32)優先日　平成12年８月23日(2000.8.23)
(33)優先権主張国　日本（ＪＰ）

(71)出願人　000002059
神鋼電機株式会社
東京都江東区東陽七丁目２番14号
(72)発明者　藤井　隆良
三重県伊勢市竹ヶ鼻町100番地　神鋼電機株式会社伊勢事業所内
(72)発明者　黒田　光義
三重県伊勢市竹ヶ鼻町100番地　神鋼電機株式会社伊勢事業所内
(74)代理人　100064908
弁理士　志賀　正武　（外６名）

最終頁に続く

(54)【発明の名称】　非接触給電装置

(57)【要約】
【課題】　一次側給電線からの磁界がこの給電線が設置される所定領域内にある鉄類に漏れ込むのを簡単な構成にてローコストに抑制可能にする。
【解決手段】　高周波電源から一次側給電線１１に供給した高周波電力を、二次巻線に誘導させて受電設備に供給する非接触給電装置であり、一次側給電線１１とこの一次側給電線１１に近接する鉄類との間に、磁気遮蔽材１３を介在する。



【特許請求の範囲】
【請求項１】　高周波電源から一次側給電線に供給した高周波電力を、二次巻線に誘導させて受電設備に供給する非接触給電装置において、前記一次側給電線と、この一次側給電線に近接する鉄類との間に磁気遮蔽材を介在したことを特徴とする非接触給電装置。
【請求項２】　前記磁気遮蔽材が、一次側給電線を被うようなコ字状断面形状をなすことを特徴とする請求項１に記載の非接触給電装置。
【請求項３】　前記磁気遮蔽材が、一次側給電線の全体を被うような筒状断面形状をなすことを特徴とする請求項１に記載の非接触給電装置。
【請求項４】　前記一次側給電線を平板の鉄類に貫通させる場合には、少なくともその貫通部位付近の一次側給電線に円筒状の磁気遮蔽材が被覆されることを特徴とする請求項１に記載の非接触給電装置。
【請求項５】　前記磁気遮蔽材が、非磁性・導電体であることを特徴とする請求項１から請求項５のうちいずれかに記載の非接触給電装置。
【請求項６】　移動体の走行経路に沿って敷設された給電線から移動体に対し非接触にて給電を行う非接触給電装置において、
直流電圧を受電して矩形波電圧を出力する電圧形インバータと、
該電圧形インバータの基本波周波数に共振周波数が調整される前記移動体側のピックアップと、
前記電圧形インバータの基本波周波数に前記給電線との間の共振周波数が調整される同調フィルタとを備えて、該同調フィルタを、電流制限用リアクトルを介して前記電圧形インバータに接続したことを特徴とする非接触給電装置。
【請求項７】　前記給電線の長さを規格化し、前記同調フィルタと組み合わせてモジュール化したことを特徴とする請求項６に記載の非接触給電装置。
【請求項８】　前記給電線の長さを規格化し、前記同調フィルタおよび電圧形インバータと組み合わせてモジュール化したことを特徴とする請求項６に記載の非接触給電装置。
【請求項９】　前記給電線の両サイドの末端を、前記ピックアップのトランスの通過を妨害しない位置へ折り返したことを特徴とする請求項７または請求項８に記載の非接触給電装置。
【請求項１０】　前記モジュール化した給電線および同調フィルタ、または給電線、同調フィルタおよび電圧形インバータを一組として、これらの複数組を前記移動体の走行経路に沿って継ぎ足すようにまたは増設するように配置したことを特徴とする請求項７または請求項８に記載の非接触給電装置。
【請求項１１】　前記モジュール化した給電線および同調フィルタを一組として、これらの複数組を少なくとも一つの電圧形インバータに共通に接続したことを特徴とする請求項７に記載の非接触給電装置。
【請求項１２】　前記電流制限用リアクトルを前記各同調フィルタごとに該同調フィルタの入力側に接続したことを特徴とする請求項７または請求項８に記載の非接触給電装置。
【請求項１３】　前記各同調フィルタを、電圧形インバータの出力側に接続された電流制限用リアクトルに対し共通に接続したことを特徴とする請求項７または請求項８に記載の非接触給電装置。
【請求項１４】　前記モジュール化した給電線および同調フィルタ、または給電線、同調フィルタおよび電圧形インバータの少なくとも一組を回転可能に配置し、該一組の給電線の周囲に配置した他の複数組の給電線の一方から他方へ、これらに非接触給電状態にて移動体を任意の方向へ移動可能にしたことを特徴とする請求項７または請求項８に記載の非接触給電装置。
【請求項１５】　前記移動体に取り付けるピックアップのトランスを複数個とし、各トランスの間隙を前記モジュール化されて隣合う給電線どうしの間隙より大きくしたことを特徴とする請求項１０から請求項１４のうちいずれかに記載の非接触給電装置。
【請求項１６】　前記電圧形インバータが汎用インバータであることを特徴とする請求項６から請求項１５のうちいずれかに記載の非接触給電装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、物品搬送用台車、枚葉搬送ロボットやトンネル灯具清掃機等の移動体に対し、非接触状態にて給電を行う移動体の非接触給電装置に関する。
【０００２】
【従来の技術】従来の非接触給電装置は、高周波電力を発生する高周波電源と、この高周波電力が供給される一次側給電線と、この一次側給電線に対し誘導結合される二次巻線と、この二次巻線に接続されて二次電力を受けて作動する受電設備とを備えている。このうち、一次側給電線は高周波電源のある位置から壁面や支柱に沿うように、無造作に、つまり磁気的影響について何ら配慮されずに配線および固定されている。また、この一次側給電線は、電源を基点に閉じており、同軸線またはツイスト線、あるいは平行線を用いて配線される。
【０００３】そして、この一次側給電線に高周波電源から高周波電圧を印加すると、二次巻線に所定レベルの電圧が誘導され、この電圧が、受電設備である例えば自走する台車などのモータに供給され、このモータに駆動電流が流れ、このモータの駆動によって台車がレールに沿って走行するという動作をする。この場合において、一次側給電線は、レールからレールへの渡り線部で鉄柱に配線されたり、鉄板に沿って配線されたりしている。

【０００４】ところで、移動体に対する従来の接触式の給電装置には、ケーブルベア方式やトロリー方式などがある。しかし、ケーブルベア方式では移動距離に制約があり、トロリー方式では防爆や感電の問題がある。また、接触式には摩耗による発塵と寿命の問題が避けられず、このため非接触方式の給電装置が提案されている。図２０はこの非接触方式の給電装置を示す回路図であり、同図において、２１は直流電圧を受電し、給電線の電流値が基準値になるように、トランジスタのオン／オフをパルス幅変調して、出力電流を調整するチョッパ、２２は電流形の主回路構成で、チョッパ２１が出力する直流電流を入力し、トランジスタブリッジのオン／オフをパターン制御することによって、１８０度導通の矩形波電流に変換するインバータ、２３は矩形波電流の基本波成分を共振増幅させる同調フィルタ、２４は移動体が移動する距離・区間に合わせて地上側に敷設され、ピックアップ２６のトランスＴ４の１次巻線２７を含む給電線で、前記ピックアップ２６は、移動体２５に固定し、給電線２４に接触することなく、移動方向に移動可能である。ピックアップ２６の出力は、移動体２５の負荷Ｒに接続される。

【０００５】図２１および図２２はピックアップ２６のトランスＴ４の構造を示す。同図において、２４は、給電線で、これが地上側に支持体（図示していない）で固定され、移動体２５が移動する距離・区間に合わせ、あらかじめ敷設される。また、給電線２４は、トランスＴ４の１次巻線２７をも兼用している。トランスＴ４の鉄心２８は、移動体２５側に固定され、給電線２４に接触することなく、移動方向に移動可能である。トランスＴ４の鉄心２８には、２次巻線２９が巻かれ、２次巻線２９はピックアップ２６のコンデンサＣ４に並列接続される。

【０００６】前記トランスＴ４は、通常のトランスに比べ、エアギャップが極めて大きく、磁気的な結合が低い。このため、共振現象を利用し、電力を２次回路に伝達させる。ピックアップ２６（トランスＴ４＋コンデンサＣ４）の電力－周波数特性を図２３に示す。図示のごとく、共振周波数でピーク電力が伝達可能である。なお、共振周波数は、トランスＴ４の自己インダクタンスとコンデンサＣ４の静電容量で決定され、定数を変更することで、任意の周波数に設定可能である。また、ピックアップ２６の電力は、給電線２４の電流を大きくすることで大きくできる。

【０００７】次に、給電動作について説明する。まず、前記チョッパ２１は、直流電圧を受電し、給電線２４の電流値が基準値になるように、トランジスタのオン／オフをパルス幅変調して、出力電流を調整する。インバータ２２は、チョッパが出力する直流電流を入力し、トランジスタブリッジのオン／オフをパターン制御することによって、１８０度導通の矩形波電流に変換し、続いて同調フィルタ２３は、矩形波電流の基本波成分を共振増幅させる。この同調フィルタ２３の出力は、正弦波電流となる。また、ピックアップ２６の特性として、給電線２４の電流を大きくするほど、給電電力を大きくできるので、同調フィルタ２３で、給電線２４の電流を共振増幅させている。なお、ピックアップ２６は移動体２５に固定し、給電線２４に接触することなく、移動方向に移動し、ピックアップ２６の出力は、移動体２４の負荷Ｒに接続される。この給電方式では地上側に電気的に接触することなく、移動体２４の負荷Ｒに電力を給電する。

【０００８】ここで、前記同調フィルタ２３の同調周波数とピックアップ２６の共振周波数は、インバータ２２の基本波周波数と一致するように調整している。同調フィルタ２３の同調は、給電線２４のインダクタンス（Ｌ３＋トランスＴ４の１次自己インダクタンス）に応じて、リアクトルＬ２のインダクタンスやコンデンサＣ２の静電容量を調整して行う。

【０００９】

【発明が解決しようとする課題】しかしながら、かかる従来の非接触給電装置にあっては、一次側給電線に発生する高周波磁界が、この一次側給電線をガイドする前記鉄柱や鉄板などの鉄類（磁性体）に流れ込み、この磁界による電磁力を受けてこの鉄類が振動して、鉄類どおしの接触音やこれらの表面を放射面とする雑音を発生するという問題があった。

【００１０】特に、高周波電流の周波数（またはその整数倍）が可聴範囲の場合には耳障りとなるほか、一次側給電線が平行線の場合に発生音が顕著になり、ツイスト線の場合には平行線に比べて多少小さくなるものの耳障りな音となる。なお、同軸線ではケーブル内で磁界が閉じるため、発生音は低いが一次側給電線の全体を同軸線にすることは不可能であり、また、一次側給電線が設置される全領域の鉄類を非磁性体に変更することも現実的に不可能である。図１９はこのような一次側給電線の長手方向断面の右半分について、電流をその一次側給電線１１に流したときの、平らな鉄板１２に対する磁束分布の解析結果を示す説明図である。

【００１１】一方、上述した図２０から図２２における従来の非接触給電装置にあっては、給電線２４の電流制御（チョッパ）を行う場合に、制御対象が共振回路であるため、安定化が難しく、また、制御の応答を下げることで安定化を図れるものの、逆に負荷変動に対する安定性が低下してしまい、このため、給電線２４の距離や負荷Ｒの特性に合わせ、その都度、最適化調整が必要になるという問題があった。また、市場に出ているインバータの大多数は電圧形の主回路構成であるため、主素子（トランジスタ）も電圧形インバータを製作し易い回路構成でモジュール化されて市販されている。市販されている主素子は、トランジスタに逆並列にダイオードが接続されている。一方、電流形インバータの主素子は、電

流の方向を順方向に制限するため、図示のようにトランジスタに直列にダイオードを接続する必要があり、このダイオードが、電圧形インバータの場合と比較し、余分に必要になるほか、配線も多くなり、電流形インバータのコストが割高になるという問題があった。

【００１２】さらに、現状の非接触給電装置は、必要電力を移動体２５に非接触給電するために、給電線２４の電流が所定の電流値／周波数に設定され、また、給電線２４のインダクタンスＬ３は、長さに比例し、例えば、１．５μＨ／１ｍである。そこで、長距離化として、給電線２４の距離を１０ｋｍとすると、給電線２４の電圧は数十ｋＶ（特別高圧）にもなり、絶縁対策や安全性に問題が出てくる。このため、実用的な距離は、１００ｍ程度に制約されるという問題があった。

【００１３】また、既設の非接触給電装置に設備を追加し、距離・区間を延長する場合、給電線２４の張り替え、同調フィルタ２３の再調整および給電線２４の電流制御の再調整が必要になる。これらのうち同調フィルタ２３の再調整は、延長された給電線２４の長さ（インダクタンス）に応じて、リアクトルＬ２のインダクタンスやコンデンサＣ２の静電容量を調整するのであるが、この場合、専用の調整機器と専門知識を有する人員を現地へ派遣する必要があり、現地での調整は、環境（作業スペース、安全性）や時間などに制約があって、十分な調整ができないという不都合があった。

【００１４】本発明はこのような事情に鑑みてなされたもので、その目的は、一次側給電線からの磁界がこの一次側給電線が設置される所定領域内にある鉄類に漏れ込むのを、簡単な構成にてローコストに抑制でき、これにより鉄類の振動にもとづく音の発生を防止できる非接触給電装置を提供することにある。

【００１５】また、本発明の他の目的は、給電線の電流制御をしなくても、非接触給電を安定的に実現でき、回路をシンプルにしてインバータのコストダウンを図れるとともに、非接触給電の長距離化を安全に実現でき、加えて非接触給電設備の継ぎ足しや増加を任意に実現できる非接触給電装置を得ることにある。

【００１６】

【課題を解決するための手段】前記目的達成のために、本発明にかかる非接触給電装置は、高周波電源から一次側給電線に供給した高周波電力を、二次巻線に誘導させて受電設備に供給する非接触給電装置であって、前記一次側給電線と、この一次側給電線に近接する鉄類との間に磁気遮蔽材を介在するようにしたものである。この態様により、一次側給電線から発生する高周波の磁界を磁気遮蔽材によって鉄類に漏れ込むのを抑制でき、従って鉄類が高周波の磁界を受けて振動するのを未然に防止可能にしている。

【００１７】また、本発明にかかる非接触給電装置は、前記磁気遮蔽材を一次側給電線を被うようなコ字状断面形状としたものである。この態様により、一次側給電線から発生する高周波の磁界の殆どが、コ字状断面形状の磁気遮蔽材によって付近の鉄類に漏れ込むのを阻止可能にしている。

【００１８】また、本発明にかかる非接触給電装置は、前記磁気遮蔽材を一次側給電線の全体を被うような筒状断面形状としたものである。この態様により、一次側給電線から発生する高周波の磁界が磁気遮蔽材内で閉じるようにして、鉄類に漏れ込むのを完全に阻止し、鉄類の振動およびこれに伴う音の発生を確実に防止可能としている。

【００１９】また、本発明にかかる非接触給電装置は、前記一次側給電線を平板の鉄類に貫通させる場合には、少なくともその貫通部位付近の一次側給電線に円筒状の磁気遮蔽材が被覆されるようにしたものである。この態様により、一次側給電線が貫通する鉄類に、一次側給電線が発生する磁界が漏れ込むのを有効に防止可能にしている。

【００２０】また、本発明にかかる非接触給電装置は、前記磁気遮蔽材を非磁性・導電体としたものである。この態様により、一次側給電線が発生する磁界を非磁性・導電体に導いて消耗させることで、この非磁性・導電体を通り抜けるのを阻止し、これによりその磁界が鉄類へ漏れ込むのを有効に防止可能にしている。

【００２１】また、この発明にかかる非接触給電装置は、移動体の走行経路に沿って敷設された給電線から移動体に対し非接触にて給電を行う非接触給電装置において、直流電圧を受電して矩形波電圧を出力する電圧形インバータと、該電圧形インバータの基本波周波数に共振周波数が調整される前記移動体側のピックアップと、前記電圧形インバータの基本波周波数に前記給電線との間の共振周波数が調整される同調フィルタとを備えて、該同調フィルタを、電流制限用リアクトルを介して前記電圧形インバータに接続したものである。

【００２２】また、本発明にかかる非接触給電装置は、前記給電線の長さを規格化し、前記同調フィルタと組み合わせてモジュール化したものである。

【００２３】また、本発明にかかる非接触給電装置は、前記給電線の長さを規格化し、前記同調フィルタおよび電圧形インバータと組み合わせてモジュール化したものである。

【００２４】また、本発明にかかる非接触給電装置は、前記給電線の両サイドの末端を、前記ピックアップのトランスの通過を妨害しない位置へ折り返したものである。

【００２５】また、本発明にかかる非接触給電装置は、前記モジュール化した給電線および同調フィルタ、または給電線、同調フィルタおよび電圧形インバータを一組として、これらの複数組を前記移動体の走行経路に沿って継ぎ足すようにまたは増設するように配置したもので

ある。

【００２６】また、本発明にかかる非接触給電装置は、前記モジュール化した給電線および同調フィルタを一組として、これらの複数組を少なくとも一つの電圧形インバータに共通に接続したものである。

【００２７】また、本発明にかかる非接触給電装置は、前記電流制限用リアクトルを前記各同調フィルタごとに該同調フィルタの入力側に接続したものである。

【００２８】また、本発明にかかる非接触給電装置は、前記各同調フィルタを、電圧形インバータの出力側に接続された電流制限用リアクトルに対し共通に接続したものである。

【００２９】また、本発明にかかる非接触給電装置は、前記モジュール化した給電線および同調フィルタ、または給電線、同調フィルタおよび電圧形インバータの少なくとも一組を回転可能に配置し、該一組の給電線を介してこれの周囲に配置した他の複数組の給電線の一方から他方へこれらに非接触給電状態にて移動体を任意の方向へ移動可能にしたものである。

【００３０】また、本発明にかかる非接触給電装置は、前記移動体に取り付けるピックアップのトランスを複数個とし、各トランスの間隙を前記モジュール化されて隣合う給電線どうしの間隙より大きくしたものである。

【００３１】また、本発明にかかる非接触給電装置は、前記電圧形インバータを汎用インバータとしたものである。

【００３２】

【発明の実施の形態】以下、本発明の実施の一形態を図について説明する。図１は本発明の非接触給電装置の要部を示す概念図であり、同図において、１１は高周波電源から高周波電力が供給される一対の一次側給電線であり、この一次側給電線１１が例えば板状の鉄類１２に沿って配線されている。また、これらの一次側給電線１１と鉄類１２との間には平板状の磁気遮蔽材１３が介在される。

【００３３】この場合に、前記磁気遮蔽材１３としては銅やアルミニウムなどの非磁性・導電体が用いられるとともに、その厚さは一次側給電線が発生する磁界が通り抜けることがない所定の表皮厚さδ（ｓｋｉｎ　ｄｅｐｔｈ）以上（裕度としてその３倍程度）とされる。ここで、表皮厚さδは、ωを周波数（ｒａｄ／ｓ）、μを透磁率（Ｈ／ｍ）、σを導電率（１／Ωｍ）として、$\delta = (2/\omega\mu\sigma)^{1/2}$となる。従って、磁気遮蔽材１３としてアルミ板を用い、ある電源周波数設定された場合には、表皮厚さは、０．８３ｍｍであるから、その約３倍の２．５ｍｍ程度とすることが望ましい。

【００３４】従って、このような非接触給電装置では、一次側給電線１１からの高周波磁界は、この一次側給電線１１に近い所定厚さを持つ磁気遮蔽材１３に流れ込み、これを通り抜けることがないため、鉄類１２へ磁界が漏れるのを抑制でき、鉄類１２の振動およびこれに伴う音の発生を小さく抑えることができる。図２は、このときの磁束線の分布を示す説明図であり、ここでは対称モデルとなるため、一次側給電線１１の側方から磁束線の一部が漏れてはいるものの、鉄類１２に流れ込む磁束線数が、図１９の場合に比べて大きく低下している状態が確認できる。

【００３５】図３はコ字状の磁気遮蔽材１３Ａを用いた場合を示す。この場合には、この磁気遮蔽材１３Ａによって一次側給電線１１が包囲されるため、鉄類１２に流れ込む磁束線の数が大幅に減ることとなる。図４は、所定の電流値と周波数の電流を一次側給電線１１に流したときの磁束線の分布を示す。これによれば、磁気遮蔽材１３Ａの側方からは僅かの磁束線が鉄類１２に流れるだけであり、従って、鉄類１２の振動や音の発生を略確実に抑止できることとなる。

【００３６】図５は矩形筒状の磁気遮蔽材１３Ｂを用いた場合を示す。この場合には、一次側給電線１１から発生する磁束が磁気遮蔽材１３Ｂ内に閉じて、この磁気遮蔽材１３Ｂの外へ漏れるのを完全に防止でき、従って鉄類１２に対する磁束線の影響は生じることがなく、鉄類の振動や音の発生を完全に防止できることとなる。

【００３７】さらに、図６は、図３および図５が一次側給電線１１を包むように磁気遮蔽材１３Ａ、１３Ｂを設けたのに対し、逆に鉄類１２の外側面に、その外側面を複数枚（一枚でもよい）の磁気遮蔽材１３Ｃ、１３Ｄ、１３Ｅによって包むように設けた場合を示す。この場合にも、一次側給電線１１からの磁束線が鉄類１２に漏れ込むを完全に防止できる。

【００３８】次に、請求項６から請求項１６にかかる本発明の実施の一実施形態を図面を用いて説明する。図７は、本発明の非接触給電装置を示す回路図であり、これが従来技術の電流形変換器（チョッパ＋電流形インバータ）と異なるところは、電圧形変換器としての電圧形インバータ２２Ａを採用した点である。従って、他の構成は、図２０に示したものと同一である。なお、チョッパ２１が省かれている。この電圧形インバータ２２Ａは、直流電圧を受電し、トランジスタＱｐ、Ｑｎのオン／オフをパターン制御することによって、図８のごとく、１８０度導通の矩形波電圧を出力電圧として出力する。またコンデンサＣｐ、Ｃｎは、直流電圧を分圧して中性点Ｃを作る。この電圧形インバータ２２Ａの出力は電圧源となるため、電流制限用リアクトルＬ１を介して、同調フィルタへ接続する。

【００３９】次に本発明の動作を図９（ａ）～（ｄ）等価回路を参照しながら説明する。なお、各等価回路への変換は、電圧形インバータ２２Ａの基本波周波数（非接触給電の基本波周波数）に着目して行う。まず、図７の回路は、図９（ａ）の第１等価回路に変換できる。ここで、Ｌ４はトランスＴ４の相互インダクタンスに相当す

る。ピックアップ２６は、図２３のごとく、ピーク値で電力を出力させるために、Ｌ４またはＣ４’を調整し、Ｌ４とＣ４’を並列共振させる。これによって、図９（ｂ）の第２等価回路に変換できる。さらに、インダクタンスＬ２、Ｌ３と負荷Ｒ’の直列回路は、図９（ｃ）の第３等価回路のごとく、インダクタンスＬ２３と負荷Ｒ”の並列回路に変換できる。

【００４０】ここで、同調フィルタを調整して、Ｃ２とＬ２３を並列共振させると、図９（ｄ）の第４等価回路のごとく、シンプルな等価回路に変換できる。この回路ではＬ１のインピーダンスを小さくすれば、電圧形インバータ２２Ａの出力電圧Ｖ１を図８のような単純な電圧源とするだけでも、移動体の負荷に非接触で給電が可能である。つまり、電圧形インバータ２２Ａは、負荷に応じて出力を制御する必要がなく、単に一定周波数の矩形波電圧を出力すればよい。なお、前記電圧形インバータ２２Ａの回路構成は、図７に限定されず、図１０に示すように、前記中性点Ｃを作るコンデンサＣｐ、Ｃｎに代えて、スイッチング用のトランジスタとこれらを逆並列接続したダイオードとからなる回路構成としても、同じ効果が得られる。また、図１１に示すように、市販の汎用インバータ２２Ｂも採用することができる。この場合、汎用インバータ２２Ｂのキャリア周波数を非接触給電の基本波周波数に設定し、出力電圧を設定可能な最小値（０Ｖがベスト）に設定すれば、図８の電圧波形が出力できる。汎用インバータ２２Ｂは大量生産されており、低価格で購入できるので、非接触給電装置の生産数量が少ない機種については、専用設計するよりもコストダウン可能である。

【００４１】図１２は、前記非接触給電装置は前記給電線２４の長さを規格化して、種々の単位長を用意し、その規格化した給電線２４と同調フィルタ２３を組合せてモジュール化した給電線モジュールＭを示す。給電線２４の長さを規格化することで、給電線モジュールＭの生産工程で面倒な同調を完了できる。この場合において、ピックアップ２６のトランスＴ４は、移動体２５に固定されており、図１２に示す矢印方向（符号５０）に移動可能である。移動体２５は、メンテナンスのために軌道から取り外せる構造が要求され、リニアガイドによって支持されている移動体２５は、矢印方向に移動することで、軌道から取り外せる構造が要求される。そこで、給電線２４の両サイドの末端を図１２に示すごとく折り返すことで、トランスＴ４が給電線２４に接触することなく、移動体を軌道から取り外すことが可能とな。

【００４２】また、長距離区間の非接触給電を行う場合には、給電線モジュール（給電線＋同調フィルタ）Ｍを図１３および図１４のごとく増設したり継ぎ足すことによって、給電線２４の全体を長距離化することである。この場合、給電線２４の単位長を押えることができるので、給電線２４の電圧を安全な低圧に押えたまま、非接触給電が可能な距離・区間を長距離化できる。また、非接触給電の設備追加に対する発明は、給電線モジュール（給電線＋同調フィルタ）Ｍを図１３および図１４のごとく増設することによって、給電線２４を設備追加することである。給電線モジュール（給電線＋同調フィルタ）Ｍは工場で同調調整されているので、現地で同調調整や給電線２４を張り替えることなく、簡単に非接触給電が可能な距離・区間を設備追加できる。なお、給電線２４の両サイドの末端は図示のごとく折り返されているので、ピックアップ２６のトランスＴ４は、一方の給電線モジュールＭから他方の給電線モジュールＭへ、給電線２４に接触することなく移動することができる。

【００４３】前記給電線モジュールＭに対する電圧形インバータ２２Ａの接続構成を図１５に示す。なお、この図１５には表示されていないが、電流制限用リアクトルＬ１は、同調フィルタ２３の入力側に個別に接続してもよく、または、電圧形インバータ２２Ａの出力側に一括して接続してもよい。電圧形インバータ２２Ａは、前記したように電圧源として動作し、各給電線モジュール（給電線＋同調フィルタ）Ｍに沿って移動するピックアップ２６の負荷Ｒに応じて電力を供給する。補足説明すると、給電線モジュールＭにピックアップ２６がある（位置している）場合、図９（ｄ）の第４等価回路で考えると、負荷Ｒのインピーダンスに応じて、電圧形インバータ２２Ａから同調フィルタ２３に電流が流れ込む。逆に、給電線モジュールＭにピックアップ２６がない場合、負荷Ｒのインピーダンスは無限大になるので、電圧形インバータ２２Ａから同調フィルタ２３に流れ込む電流（非接触給電の基本波電流）は無くなる。このため、電圧形インバータ２２Ａの出力容量は、接続した給電線モジュールＭを移動する移動体２５の要求電力にあわせて選定すればよく、給電線モジュールＭの接続数量には影響を受けない。

【００４４】さらに、図１５に示す給電線モジュールＭの複数組と各一の電圧形インバータ２２Ａの組合せを規格化およびモジュール化して、図１６に示すごとく連結することで、制限のない長距離化、設備追加が可能となる。なお、配電線３０の電圧は電圧形インバータ２２Ａの受電仕様にあわせ、直流電圧としてもよく、または交流電圧としてもよい。

【００４５】また、図１７に示すように、移動体２５に非接触給電しながら、この移動体２５を任意の角度にカーブまたは分岐して移動させることができる。図１７において、３１はターンテーブルであり、これが時計方向または反時計方向に所定角度まで回転可能とされている。給電線２４Ｂはこのターンテーブル３１上に固定されている。このターンテーブル３１を図１７に示すような回転角度に固定すると、移動体２５は給電線２４Ａから給電線２４Ｃの間を直線方向に移動可能である。一方、移動体２５を給電線２４Ｄに分岐案内する場合に

は、移動体２５を給電線２４Ｂまで移動させてから、ターンテーブル３１を回転させる。そして、給電線２４Ｂから給電線２４Ｄに移動できる回転角度でターンテーブル３１を固定し、移動体２５を給電線２４Ｄに移動させる。なお、カーブまたは分岐する角度は、任意に設定可能である。

【００４６】さらに、給電線２４どうしのギャップにより発生する無給電エリアを防止し、常時、移動体２５への非接触給電を可能するために、本発明では、図１８に示すように、移動体２５に取り付けるピックアップ２６のトランスＴ４を２個として、下式の関係が成立する位置に実装する。

トランスの間隔＞給電線のギャップ

こうすることで、一方のトランスＴ４が給電線２４のギャップ部に対向して給電できない場合でも、他方のトランスＴ４は給電線２４に対向するため、必ず、移動体２５への非接触給電が可能となる。なお、トランスＴ４の数量を３個以上とすれば、給電能力はさらに増加することはいうまでもない。

【００４７】

【発明の効果】以上のように、本発明によれば、一次側給電線と、この一次側給電線に近接する鉄類との間に磁気遮蔽材を介在したので、一次側給電線から発生する高周波の磁界を、磁気遮蔽材の設置によって鉄類に漏れ込むのを抑制でき、従って鉄類が高周波の磁界を受けて振動するのを未然に防止できるという効果が得られる。従って、これまでのように、一次側給電線を居住空間から離して設置したり、設置空間と居住空間との仕切の開口部を小さくしたり、設置空間と居住空間の壁に遮音材を貼るという間接的で非効率的な遮音対策とせずに、本発明では、音の発生源を封じ込めるという方法で、音の発生を根本的にかつ確実に抑制できる。また前記磁気遮蔽材を一次側給電線を被うようなコ字状断面形状としたので、一次側給電線から発生する高周波の磁界の殆どが、コ字状断面形状の磁気遮蔽材によって付近の鉄類に漏れ込むのを阻止でき、さらに、前記磁気遮蔽材を一次側給電線の全体を被うような筒状断面形状としたので、一次側給電線から発生する高周波の磁界が鉄類に漏れ込むのを完全に阻止でき、鉄類の振動およびこれに伴う音の発生を確実に防止できるという効果が得られる。

【００４８】また、本発明によれば、前記一次側給電線を平板の鉄類に貫通させる場合には少なくともその貫通部位付近の一次側給電線に円筒状の磁気遮蔽材が被覆されるようにしたので、一次側給電線が貫通する鉄類に、一次側給電線が発生する磁界が漏れ込むのを有効に防止でき、さらに、磁気遮蔽材を非磁性・導電体とすることで、一次側給電線が発生する磁界を非磁性・導電体に導いて消耗させることができ、その磁界がこの非磁性・導電体を通り抜けるのを阻止でき、これによりその磁界が鉄類へ漏れ込むのを有効に防止できるという効果が得られる。

【００４９】また、本発明によれば、従来の電流形変換器（チョッパ+電流形インバータ）に代えて回路構成がシンプルな電圧形インバータを採用することで、コストを大幅に低減できるほか、電圧形インバータは負荷に応じて出力を制御する必要がなく、単に一定周波数の矩形波電圧を出力すれば、移動体に非接触で給電できるため、従来実施していた共振回路の電流制御が不要となり、面倒な安定化調整は不要になるという効果が得られる。また、電圧形インバータとして市販の低価格な汎用インバータを採用した場合には、生産数量が少ない機種については電圧形インバータを専用設計するよりも、大幅なコストダウンを図ることができる。

【００５０】また、本発明によれば、給電線の長さを規格化し、給電線と同調フィルタを組合せてモジュール化することによって、モジュールの生産工程で面倒な同調の調整を完了させることができ、給電線の両サイドの末端を折り返すことで、トランスが給電線に接触することなく、前記移動体を軌道から取り外すことが可能となる。さらに、給電線モジュール（給電線＋同調フィルタ）を継ぎ足すことによって、給電線の電圧を安全な低圧に押えたまま、非接触給電が可能な距離・区間を長距離化できるほか、その給電線モジュール増設することによって、現地で同調の調整や給電線の張り替えをすることなく、簡単に非接触給電が可能な距離・区間を設備追加できる。

【００５１】また、本発明によれば、給電線モジュールにピックアップがない場合、負荷インピーダンスは無限大となり、電圧形インバータから同調フィルタに流れ込む電流（非接触給電の基本波電流）が無くなるため、電圧形インバータの出力容量は接続した給電線モジュールを移動する移動体の要求電力にあわせて選定すればよく、給電線モジュールの接続数量には影響されないという利点が得られる。さらに、各給電線モジュールと電圧形インバータの組合せを規格化およびモジュール化して、配電線に連結することで、制限のない給電線の長距離化、設備追加が可能となる。さらに、本発明によれば、給電線のいずれかを回転自在に設けることで、移動体に非接触給電しながら、移動体を任意の角度にカーブまたは分岐案内させることができるほか、トランスの間隔を給電線間のギャップより大とすることにより、給電線のギャップによって発生する無給電エリアを防止し、常時、移動体への非接触給電を実現できるという効果が得られる。

【図面の簡単な説明】

【図１】　本発明の実施の一形態による非接触給電装置を示す要部の概念図である。

【図２】　図１における鉄類への磁束線の分布状況を示す説明図である。

【図３】　本発明の実施の他の形態による非接触給電装

置を示す要部の概念図である。

【図４】　図３における鉄類への磁束線の分布状況を示す説明図である。

【図５】　本発明の実施の他の形態による非接触給電装置を示す要部の概念図である。

【図６】　本発明の実施の他の形態による非接触給電装置を示す要部の概念図である。

【図７】　本発明の実施の一形態による非接触給電装置を詳細に示す回路図である。

【図８】　図７における電圧形インバータの出力電圧を示すタイミングチャートである。

【図９】　図７に示す非接触給電装置の等価回路図である。

【図１０】　本発明における電圧形インバータの他の例を示す回路図である。

【図１１】　本発明における電圧形インバータの他の例を示す回路図である。

【図１２】　本発明における給電線と同調フィルタをモジュール化する単位を示す説明図である。

【図１３】　本発明における給電線モジュールの増設状況を概念的に示す説明図である。

【図１４】　本発明における給電線モジュールの継ぎ足し状況を概念的に示す説明図である。

【図１５】　本発明による非接触給電装置の長距離化方法を概念的に示す説明図である。

【図１６】　本発明による非接触給電装置の長距離化方法を概念的に示す説明図である。

【図１７】　本発明における移動体のカーブまたは分岐案内の方法を示す説明図である。

【図１８】　本発明における給電線間の無給電エリアの防止方法を示す説明図である。

【図１９】　従来の非接触給電装置における鉄類への磁束線の分布状況を示す説明図である。

【図２０】　従来の非接触給電装置を示す回路図である。

【■２１】　図２０におけるピックアップのトランスを示す斜視図である。

【図２２】　図２０におけるピックアップのトランスを示す断面図である。

【図２３】　図２０のピックアップにおける電力対周波数の関係を示す共振特性図である。

【符号の説明】

１１　一次側給電線

１２　鉄類

１３、１３Ａ、１３Ｂ、１３Ｃ、１３Ｄ、１３Ｅ　磁気遮蔽材

２２Ａ　電圧形インバータ

２２Ｂ　汎用インバータ

２３　同調フィルタ

２４　給電線

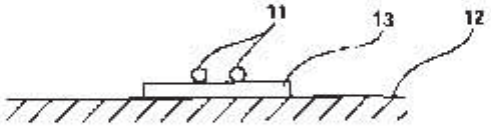
２５　移動体

２６　ピックアップ

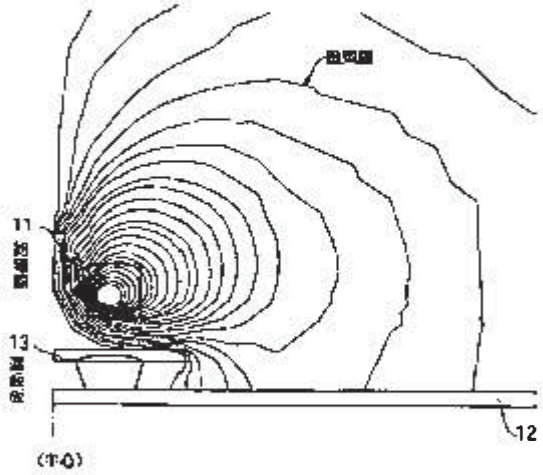
Ｌ１　電流制限用リアクトル

Ｔ４　トランス

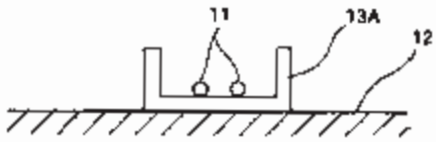
【図１】



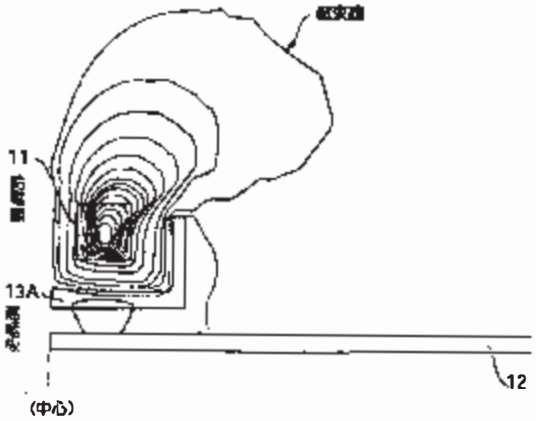
【図２】



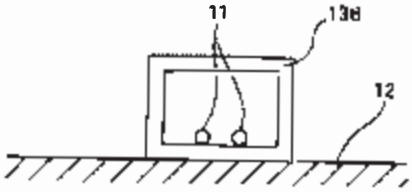
【図3】



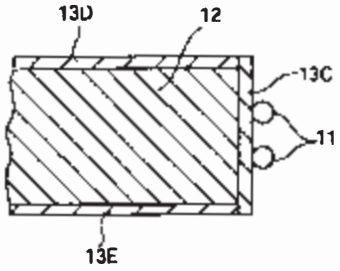
【図4】



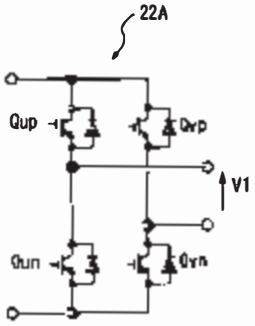
【図5】



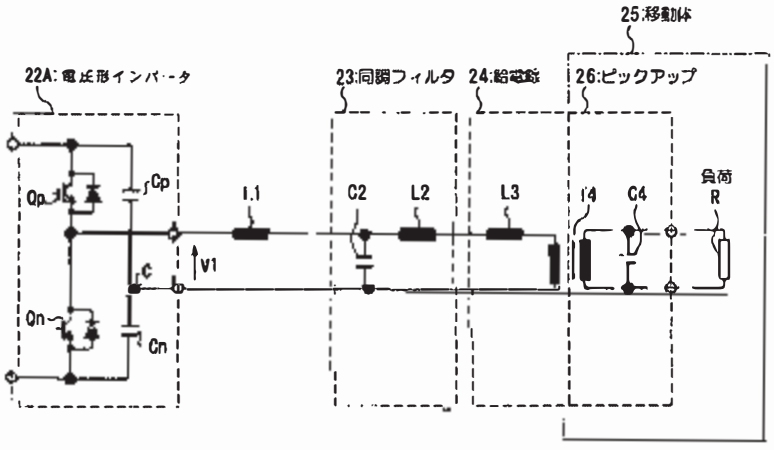
【図6】



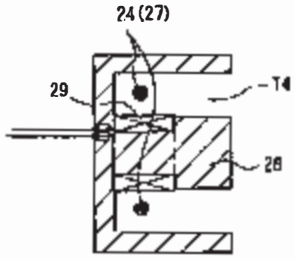
【図10】



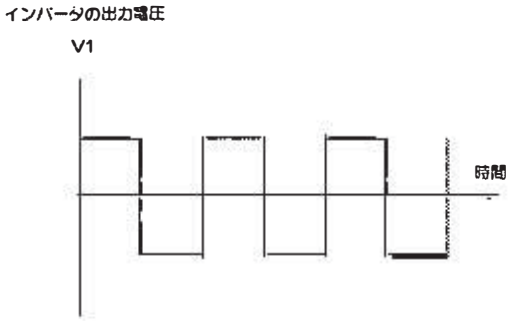
【図7】



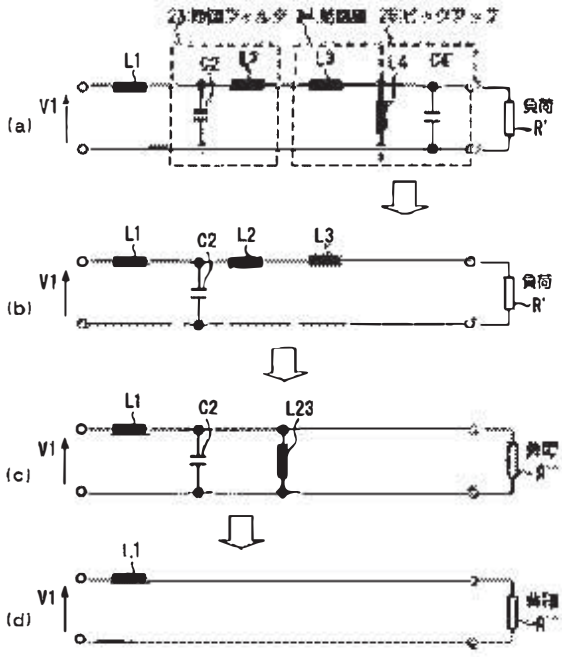
【図22】



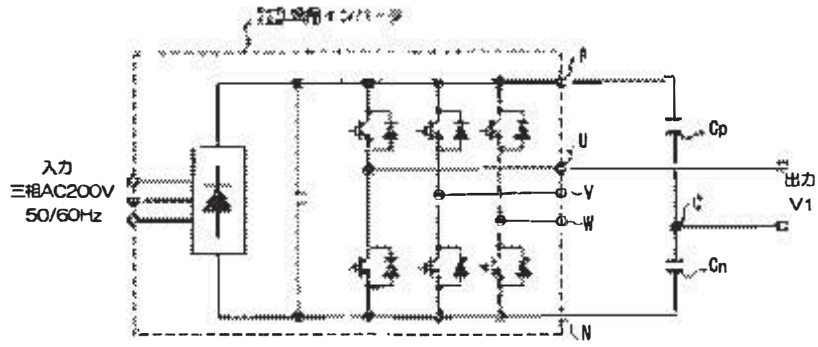
【図8】


インバータの出力電圧
V1
時間

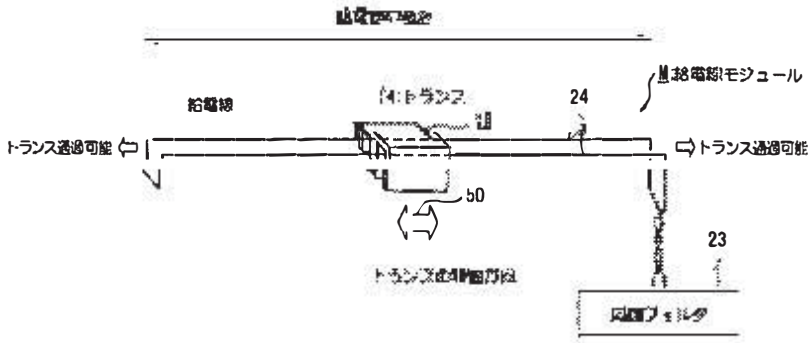
【図9】


L1
C2
L2
L3
L4
C4
V1
(a)
負荷
R'
(b)
(c)
L23
(d)

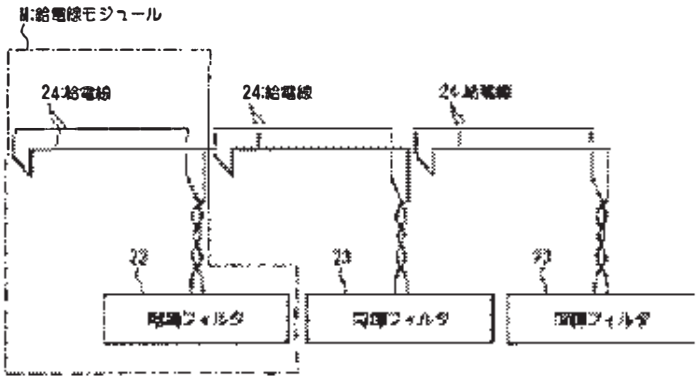
【図11】


入力
三相AC200V
50/60Hz
U
V
W
Cp
Cn
出力
V1
N

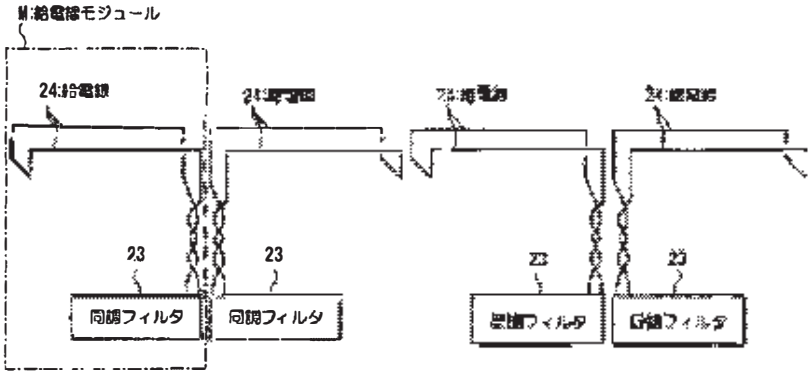
【図12】


給電線
24
トランス通過可能
トランス通過可能
50
23

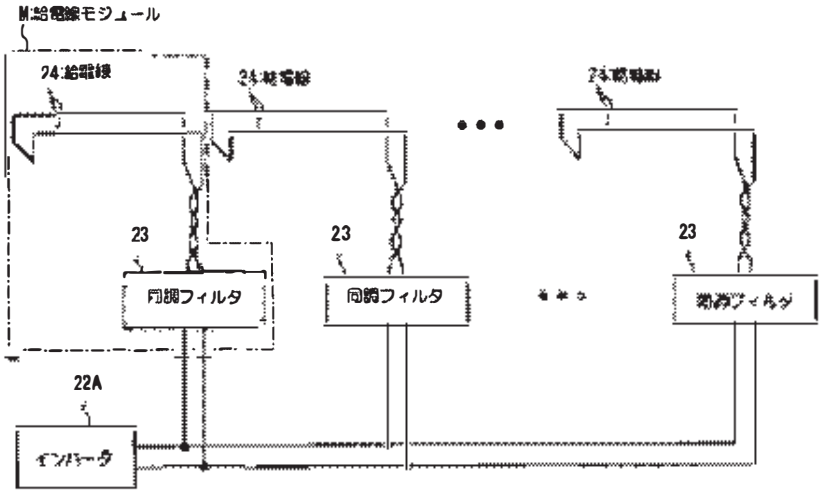
【図13】


M:給電線モジュール
24:給電線
24:給電線
24:給電線
22
23
23
同調フィルタ
同調フィルタ

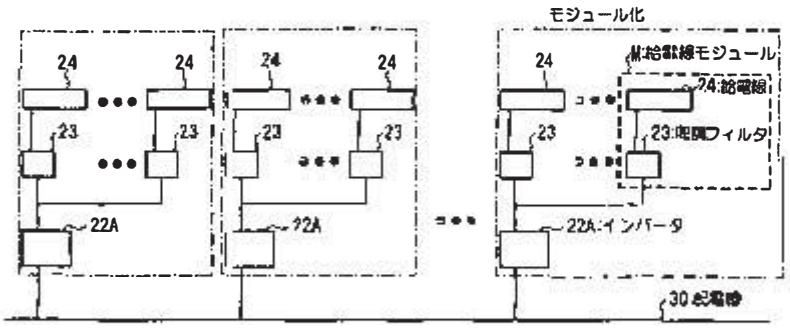
【図14】


M:給電線モジュール
24:給電線
23
23
同調フィルタ
同調フィルタ

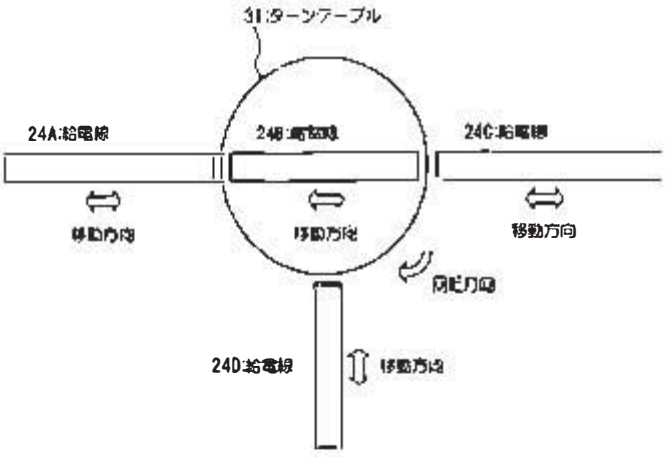
【図15】


M:給電線モジュール
24:給電線
23
23
同調フィルタ
同調フィルタ
22A

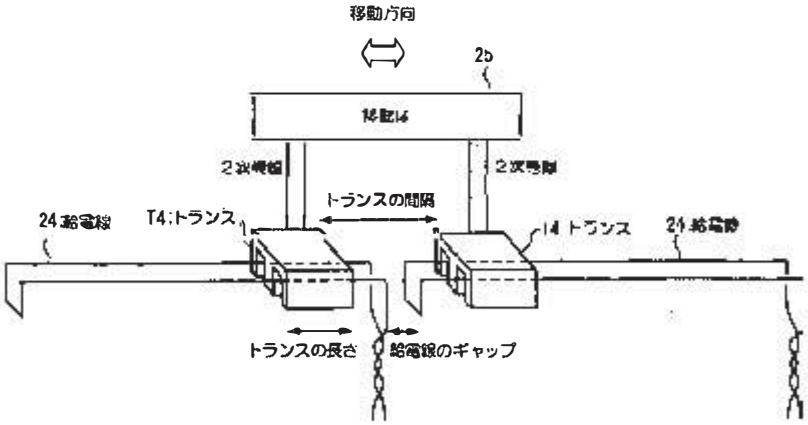
【図16】


モジュール化
24
23
22A
22A:インバータ
30:給電線

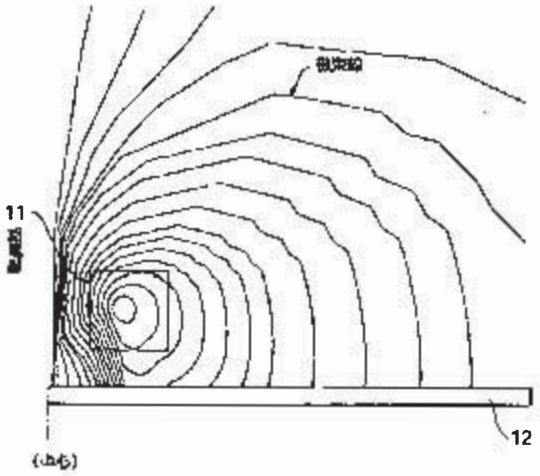
【図17】


31:ターンテーブル
24A:給電線
24C:給電線
移動方向
回転方向
24D:給電線

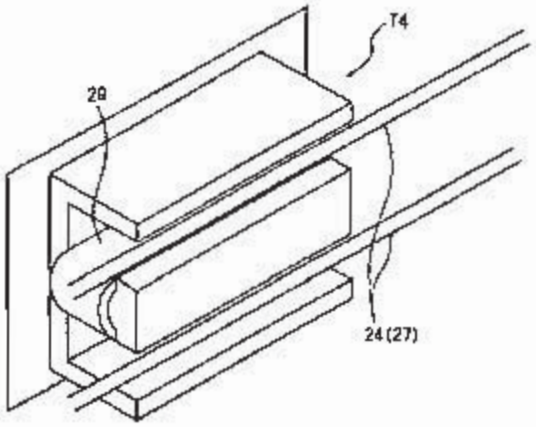
【図18】


移動方向
2b
2次側線
トランスの間隔
24:給電線
T4:トランス
トランスの長さ
給電線のギャップ

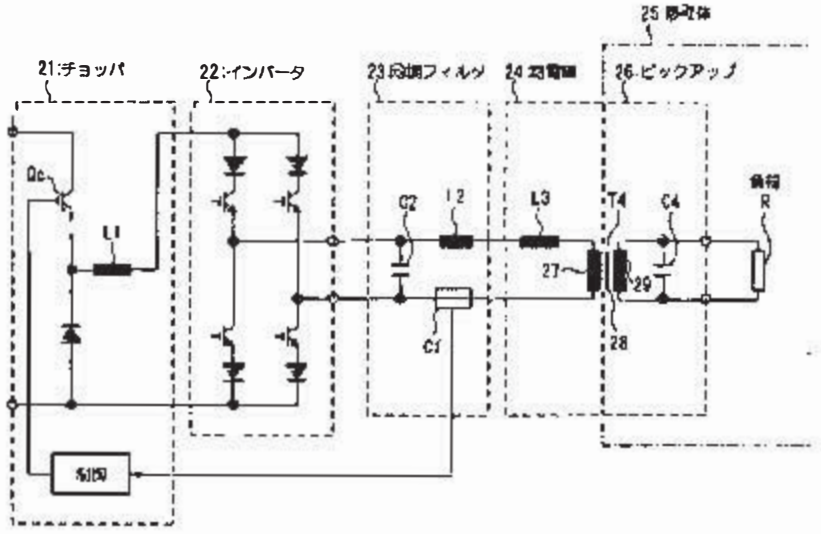
【図１９】


磁束線
11
12

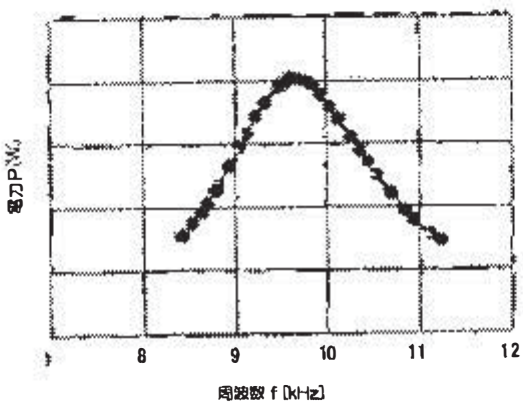
【図２１】


T4
29
24(27)

【図２０】


21:チョッパ
22:インバータ
26:ピックアップ
Qc
L1
C2
L2
L3
T4
C4
R
27
29
28
C1

【図２３】



(72)発明者　石黒　正治
愛知県豊橋市三弥町字元屋敷150　神鋼電機株式会社豊橋事業所内
(72)発明者　▲高▼門　祐三
愛知県豊橋市三弥町字元屋敷150　神鋼電機株式会社豊橋事業所内

Fターム(参考)　5H007 AA00 BB00 CA01 CB02 CB12 CB23 CB25 CC01 CC09 HA02 HA04
5H105 AA14 AA20 BB07 BB10 CC03 CC17 CC19 DD10

Patent & Utility Model Number Search

Back | Help | Search | List

You can retrieve a variety of patent and utility model gazettes by their numbers.

Selected Gazette

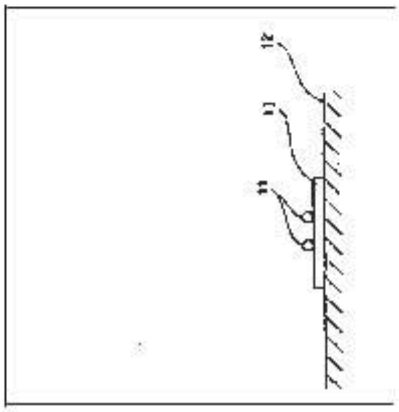
Previous Document 1/1 Next Doc

JP,2002-137659,A

PAJ | Detail | Image

(11)Publication number : 2002-137659
(43)Date of publication of application : 14.05.2002
(51)Int.Cl. : B60M 7/00
B60L 5/00
H01F 38/14
H02J 17/00
H02M 7/5387

(21)Application number : 2000-266306
(22)Date of filing : 01.09.2000
(71)Applicant : SHINKO ELECTRIC CO LTD
(72)Inventor : FUJII TAKAYOSHI
KURODA MITSUYOSHI
ISHIGURO MASAHARU
TAKAKADO YUZO



(30)Priority
Priority number : 2000253043 Priority date : 23.08.2000 Priority country : JP

(54)NON-CONTACT FEEDER

(57)Abstract
PROBLEM TO BE SOLVED: To reduce leakage of a magnetic field from a primary side feeder line into steel and the like arranged within a predetermined area for installation of the feeder line at a low cost.
SOLUTION: By means of this non-contact feeder, high frequency electric power fed from a high frequency power source to the primary side feeder line 11 is guided by means of a secondary coil so as to be fed to electric power receiving facility. A magnetism shielding material 13 is arranged between the primary side feeder line 11 and the steel and the like is the proximity of the feeder line 11.

Previous Document 1/1 Next Doc
To return to the top of
Notice on Usage | Privacy Policy | Questionnaire

JP,2002-137659,A

Previous Document 1/1 Next Doc

CLAIMS DETAILED DESCRIPTION

DESCRIPTION OF DRAWINGS DRAWINGS

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]A non-contact feeder system interposing magnetic-shielding material in a non-contact feeder system which makes high-frequency power supplied to a primary side electric supply line from an RF generator derive to a secondary winding, and supplies it to power receiving facilities between the aforementioned primary side electric supply line and the iron close to this primary side electric supply line.

[Claim 2]The non-contact feeder system according to claim 1, wherein the aforementioned magnetic-shielding material makes U-shaped sectional shape which covers a primary side electric supply line.

[Claim 3]The non-contact feeder system according to claim 1, wherein the aforementioned magnetic-shielding material makes cylindrical sectional shape which covers the whole primary side electric supply line.

[Claim 4]The non-contact feeder system according to claim 1 characterized by cylindrical magnetic-shielding material being covered at least by primary side electric supply line near [the] a penetration part when making the iron of a plate penetrate the aforementioned primary side electric supply line.

[Claim 5]It is a non-contact feeder system of a description to either among Claim 1, wherein the aforementioned magnetic-shielding material is nonmagnetic and a conductor to Claim 5.

[Claim 6]In a non-contact feeder system which supplies electric power in non-contact to a mobile body from an electric supply line laid in accordance with a travel path of a mobile body, A non-contact feeder system which is provided with the following and characterized by connecting the tunable filter to the aforementioned voltage form inverter via a reactor for current limiting.

A voltage form inverter which receives direct current voltage and outputs rectangular wave voltage.

A pickup on the aforementioned mobile body side by which resonance frequency is adjusted to fundamental wave frequency of the voltage form inverter.

A tunable filter in which resonance frequency between the aforementioned electric supply lines is adjusted to fundamental wave frequency of the aforementioned voltage form inverter.

[Claim 7]The non-contact feeder system according to claim 6 having standardized the length of the aforementioned electric supply line and modularizing in combination with the aforementioned tunable filter.

[Claim 8]The non-contact feeder system according to claim 6 having standardized the length of the aforementioned electric supply line and modularizing in combination with the aforementioned tunable filter and a voltage form inverter.

[Claim 9]The non-contact feeder system according to claim 7 or 8 turning up to a position which does not block passage of a transformer of the aforementioned pickup of a non-end of both sides of the aforementioned electric supply line.

[Claim 10]An electric supply line and a tunable filter or an electric supply line, a tunable filter, and a voltage form inverter which modularized [aforementioned] are made into a lot, The non-contact feeder system according to claim 7 or 8 having arranged so that two or more of these sets may be added in accordance with a travel path of the aforementioned mobile body, or so that it may extend.

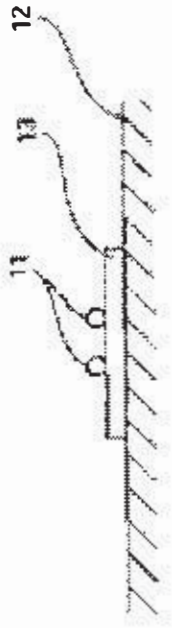
[Claim 11]The non-contact feeder system according to claim 7 connecting two or more of these sets to at least one voltage form inverter in common by making into a lot an electric supply line and a tunable filter which modularized [aforementioned].

[Claim 12]The non-contact feeder system according to claim 7 or 8 connecting the aforementioned reactor for current limiting to an input side of the tunable filter for every aforementioned tunable filter.

[Claim 13]The non-contact feeder system according to claim 7 or 8 connecting each aforementioned tunable filter in common to a reactor for current limiting connected to an output side of a voltage form inverter.

[Claim 14]At least 1 set of an electric supply line and a tunable filter or an electric supply line which modularized [aforementioned], a tunable filter, and a voltage form inverter is arranged pivotable, The non-contact feeder system according to claim 7 or 8 characterized by making a mobile body movable in any direction in a non-contact feed condition to another side at these from one side of two or more sets of other electric supply lines arranged around an electric supply line of the lot.

[Claim 15]It is a non-contact feeder system of a description to either among Claim 10 having



Representative drawing

Representative drawing | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22

made [two or more] a transformer of a pickup attached to the aforementioned mobile body, and enlarging a gap of each transformer from a gap of the electric supply lines which are modularized [aforementioned] and adjoin each other to Claim 14.
[Claim 16]It is a non-contact feeder system of a description to either among Claim 6, wherein the aforementioned voltage form inverter is a general-purpose inverter to Claim 15.

Previous Document 1/1 Next Doc

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]The present invention relates to the non-contact feeder system of the mobile body which supplies electric power in a noncontact state to mobile bodies, such as a cart for article carrying, a sheet carrier robot, and a tunnel lighting fixture cleaner.

[0002]

[Description of the Prior Art]The conventional non-contact feeder system is provided with the RF generator which generates high-frequency power, the primary side electric supply line with which this high-frequency power is supplied, the secondary winding by which inductive coupling is carried out to this primary side electric supply line, and the power receiving facilities which are connected to this secondary winding and operate in response to secondary electric power. Among these, the primary side electric supply line is wired and fixed easily that is, without being considered at all about magnetic effect so that it may be along a wall surface and a support from a position with an RF generator. This primary side electric supply line is closed on the basis of a power supply.

It wires using a coaxial line, a twisted wire, or parallel lines.

[0003]And if high frequency voltage is applied to this primary side electric supply line from an RF generator, The voltage of a predetermined level is derived to a secondary winding, this voltage is supplied to motors, such as a cart which is power receiving facilities and which runs by itself, for example, driving current flows into this motor, and it carries out operation that a cart runs along with a rail by the drive of this motor. In this case, in the crossover part from a rail to a rail, a primary side electric supply line is wired by the steel pole, or is wired along with a griddle.

[0004]By the way, there are a cable-bare system, a trolley system, etc. in the feeder system of the conventional contact process to a mobile body. However, by a cable-bare system, migration length has restrictions, and there are explosion prevention and a problem of an electric shock by a trolley system. The problem of the raising dust by wear and a life is not avoided by the contact process, but, for this reason, the feeder system of the noncontact method is proposed. In [Fig.20 is a circuit diagram showing the feeder system of this noncontact method, and] the figure, The chopper which carries out Pulse Density Modulation of the ON/OFF of a transistor, and adjusts output current, and 22 are the main circuit composition of a current form so that 21 may receive direct current voltage and the electric current value of an electric supply line may turn into reference value, By inputting a direct current which the chopper 21 outputs and carrying out pattern control of the ON/OFF of a transistor bridge, 23 is an inverter converted to the rectangular current of conduction 180 degree, and a tunable filter which carries out resonance amplification of the fundamental wave component of rectangular current. It is movable to a moving direction, without laying 24 at the ground side in accordance with the distance and the section where a mobile body moves, being an electric supply line containing the primary winding 27 of the transformer T4 of the pickup 26, fixing the aforementioned pickup 26 to the mobile body 25, and contacting the electric supply line 24. The output of the pickup 26 is connected to the load R of the mobile body 25.

[0005]Fig.21 and Fig.22 show the structure of the transformer T4 of the pickup 26. In the figure, 24 is an electric supply line, this is fixed to the ground side with a base material (not shown), and is doubled with the distance and the section where the mobile body 25 moves, and is laid beforehand. The electric supply line 24 is also making the primary winding 27 of the transformer T4 serve a double purpose. The iron core 28 of the transformer T4 is movable to a moving direction, without fixing to the mobile body 25 side and contacting the electric supply line 24. The secondary winding 29 is coiled around the iron core 28 of the transformer T4, and multiple connection of the secondary winding 29 is carried out to the capacitor C4 of the pickup 26.

[0006]The aforementioned transformer T4 has the low combination with an air gap magnetic very largely compared with the usual transformer. For this reason, resonance phenomena are used and electric power is made to transmit to a secondary circuit. The electric power-frequency characteristic of the pickup 26 (transformer T4+ capacitor C4) is shown in Fig.23. A peak power can be transmited with an illustrated profit and resonance frequency. Resonance frequency is determined with the self-inductance of the transformer T4, and the electrostatic capacitance of the capacitor C4, and it is changing a constant and it can set it as any frequency. Electric power of the pickup 26 can be largely done by enlarging the current of the electric supply line 24.

[0007]Next, it describes about feed operation. First, the aforementioned chopper 21 carries out Pulse Density Modulation of the ON/OFF of a transistor, and adjusts output current so that direct current voltage may be received and the electric current value of the electric supply line 24 may turn into reference value. By the inverter 22 inputting a direct current which a chopper outputs, and carrying out pattern control of the ON/OFF of a transistor bridge, it converts to the rectangular current of conduction 180 degree, and the tunable filter 23 carries out resonance amplification of the fundamental wave component of rectangular current continuously. The output of this tunable filter 23 serves as sinusoidal current. Since supplies power can be largely done as the characteristic of the pickup 26 so that the current of the electric supply line 24 is enlarged, resonance amplification of the current of the electric supply line 24 is carried out with the tunable filter 23. The pickup 26 is fixed to the mobile body 25, without contacting the electric supply line 24, it moves to a moving direction and the output of the pickup 26 is connected to the load R of the mobile body 24. In this feed system, electric power is supplied to the load R of the mobile body 24 in electric power, without contacting the ground side electrically.

[0008]Here, the tuning frequency of the aforementioned tunable filter 23 and the resonance frequency of the pickup 26 are adjusted so that it may correspond with the fundamental wave frequency of the inverter 22. Alignment of the tunable filter 23 is performed according to the inductance (primary self-inductance of the L3+ transformer T4) of the electric supply line 24 by adjusting the inductance of the reactor L2, and the electrostatic capacitance of the capacitor C2.

[0009]

[Problem to be solved by the invention]However, if it is in this conventional non-contact feeder system, The high frequency magnetic field which occurs in a primary side electric supply line flowed into the iron (magnetic body) which guide this primary side electric supply line, such as the aforementioned steel pole and a griddle, these iron vibrated in response to the electromagnetic force by this magnetic field, and there was a problem of generating the noise which makes a radial plane the contact sounds and these surfaces of iron entirety.

[0010]Especially, when the frequency (or the integral multiple) of the high frequency current is an auditory sensation area, it becomes jarring, and also it becomes a jarring sound, although a generating sound becomes remarkable when primary side electric supply lines are parallel lines, and it becomes somewhat small compared with parallel lines in being a twisted wire. Since a magnetic field closes within a cable in a coaxial line, although a generating sound is low, it is impossible to make the whole primary side electric supply line into a coaxial line, and it is also actually impossible to change into a nonmagnetic material the iron of the whole region in which a primary side electric supply line is installed. Fig.19 is an explanatory view showing the analysis result of the magnetic flux distribution over the even griddle 12 when current is sent through the primary side electric supply line 11 about the right half of the longitudinal direction section of such a primary side electric supply line.

[0011]On the other hand, if it is in the conventional non-contact feeder system in Fig.22 from the Fig.20 mentioned above, Since a controlled object is a resonant circuit when performing current control (chopper) of the electric supply line 24, Although stabilization could be attained because stabilization is difficult and lowers the response of control, the stability to a load change was deteriorated conversely, for this reason, it doubled with the distance of the electric supply line 24, or the characteristic of the load R, and there was a problem that optimizing adjustment was needed each time. Since the large majority of the inverter which has come out to the commercial scene is the main circuit composition of a voltage form, a main element (transistor) is also modularized by the circuit configuration which is easy to manufacture a voltage form inverter, and he is marketed. As for the main element marketed, the diode is connected to the transistor at contrary parallel. On the other hand, the main element of a current form inverter is, in order to restrict the direction of current to a forward direction. There was an illustrated problem that it is necessary to connect a diode to a transistor in series like, and this diode is too much needed as compared with the case of a voltage form inverter, and also wiring also increased in number and the cost of a current form inverter became comparatively high-priced.

[0012]In order that the present non-contact feeder system may carry out non-contact electric supply of the necessary power at the mobile body 25, the current of the electric supply line 24 is set as predetermined electric current value/frequency, and the inductance L3 of the electric supply line 24 is proportional to length, for example, are 1.5 microhenries/1 m. Then, as long-distance-izing, if the distance of the electric supply line 24 shall be 10 km, the voltage of the electric supply line 24 can also be tens of kV (extra-high tension), and a problem will come out at an insulating measure or safety. For this reason, there was a problem that a practical distance was restrained by about 100m.

[0013]When adding equipment to an established non-contact feeder system and extending distance and the section, re-covering of the electric supply line 24, readjustment of the tunable filter 23, and readjustment of the current control of the electric supply line 24 are needed. Among these, although the inductance of the reactor L2 and the electrostatic capacitance of the capacitor C2 are adjusted according to the length (inductance) of the extended electric supply line 24, readjustment of the tunable filter 23, In this case, the staff who have adjusting equipment for exclusive use and know how needed to be dispatched to the spot, adjustment at a spot had restrictions in environment (work space, safety), time, etc., and there was inconvenience that sufficient adjustment could not be performed.

[0014]The present invention was made in view of such a situation, and the object, It can inhibit with easy composition that the magnetic field from a primary side electric supply line leaks to the iron in the predetermined region in which this primary side electric supply line is installed low-cost, and is in providing the non-contact feeder system which can prevent generating of the sound based on vibration of iron by this.

[0015]Even if it does not carry out current control of an electric supply line, while being able to

realize non-contact electric supply stably, making a circuit simple and being able to aim at the cost cut of an inverter, other objects of the present invention, It is in obtaining the non-contact feeder system which can realize long-distance-ization of non-contact electric supply safely, and can, in addition, realize arbitrarily the extension and the increase in non-contact power supply equipment.

[0016]

[Means for solving problem]The non-contact feeder system built over the present invention for the aforementioned purpose achievement, It is a non-contact feeder system which makes the high-frequency power supplied to the primary side electric supply line from the RF generator derive to a secondary winding, and supplies it to power receiving facilities, and makes magnetic-shielding material interpose between the aforementioned primary side electric supply line and the iron close to this primary side electric supply line. Prevention of being able to inhibit leaking to iron the magnetic field of the high frequency which occurs from a primary side electric supply line by magnetic-shielding material, therefore vibrating by this modes, in response to the magnetic field whose iron is high frequency is enabled beforehand.

[0017]The non-contact feeder system concerning the present invention makes the aforementioned magnetic-shielding material U-shaped sectional shape which covers a primary side electric supply line. By this modes, most magnetic fields of the high frequency which occurs from a primary side electric supply line are enabling inhibition of leaking to neighboring iron by the magnetic-shielding material of U-shaped sectional shape.

[0018]The non-contact feeder system concerning the present invention makes the aforementioned magnetic-shielding material cylindrical sectional shape which covers the whole primary side electric supply line. It prevents completely that it leaks to iron by this modes as the magnetic field of the high frequency which occurs from a primary side electric supply line closes within magnetic-shielding material, and is enabling prevention of generating of the sound accompanying vibration and this of iron reliably.

[0019]When the non-contact feeder system concerning the present invention makes the iron of a plate penetrate the aforementioned primary side electric supply line, cylindrical magnetic-shielding material is covered at least by the primary side electric supply line near [the] a penetration part. Prevention of the magnetic field which a primary side electric supply line generates leaking by this modes to the iron which a primary side electric supply line penetrates is enabled effectively.

[0020]The non-contact feeder system concerning the present invention uses the aforementioned magnetic-shielding material as nonmagnetic and a conductor. Prevention of preventing passing through this nonmagnetic and conductor, and that magnetic field leaking to iron by this by leading the magnetic field which a primary side electric supply line generates to nonmagnetic and a conductor, and making it exhaust by this modes, is enabled effectively.

[0021]In the non-contact feeder system which supplies electric power in non-contact to a mobile body from the electric supply line with which the non-contact feeder system concerning this invention was laid in accordance with the travel path of a mobile body, The voltage form inverter which receives direct current voltage and outputs rectangular wave voltage, and the pickup on the aforementioned mobile body side by which resonance frequency is adjusted to the fundamental wave frequency of the voltage form inverter, It has a tunable filter in which the resonance frequency between the aforementioned electric supply lines is adjusted to the fundamental wave frequency of the aforementioned voltage form inverter, and is a thing connected to the aforementioned voltage form inverter via the reactor for current limiting about the tunable filter.

[0022]The non-contact feeder system concerning the present invention standardizes the length of the aforementioned electric supply line, and modularizes it in combination with the aforementioned tunable filter.

[0023]The non-contact feeder system concerning the present invention standardizes the length of the aforementioned electric supply line, and modularizes it in combination with the aforementioned tunable filter and a voltage form inverter.

[0024]The non-contact feeder system concerning the present invention is turned up to the position which does not block passage of the transformer of the aforementioned pickup of the non-end of both the sides of the aforementioned electric supply line.

[0025]The non-contact feeder system concerning the present invention is arranged so that two or more of these sets may be added in accordance with the travel path of the aforementioned mobile body by making into a lot the electric supply line and the tunable filter or the electric supply line, tunable filter, and voltage form inverter which modularized [aforementioned], or so that it may extend.

[0026]The non-contact feeder system concerning the present invention makes a lot the electric supply line and tunable filter which modularized [aforementioned], and is a thing connected to community about two or more of these sets at at least one voltage form inverter.

[0027]The non-contact feeder system concerning the present invention is a thing connected to the input side of the tunable filter for every aforementioned tunable filter about the aforementioned reactor for current limiting.

[0028]The non-contact feeder system concerning the present invention is a thing connected to community to the reactor for current limiting by which each aforementioned tunable filter was connected to the output side of a voltage form inverter.

[0029]The non-contact feeder system concerning the present invention is the electric supply line and tunable filter which modularized [aforementioned]. Or a mobile body is made these movable in any direction in a non-contact feed condition to another side from one side of two or more sets of other electric supply lines which have arranged at least 1 set of an electric supply line, a tunable filter, and a voltage form inverter pivotable, and it has arranged around this via the electric supply line of the lot.

[0030]The non-contact feeder system concerning the present invention makes [two or more] the transformer of a pickup attached to the aforementioned mobile body, and it enlarges the

gap of each transformer from the gap of the electric supply lines which are modularized [aforementioned] and adjoin each other.

[0031]The non-contact feeder system concerning the present invention uses the aforementioned voltage form inverter as a general-purpose inverter.

[0032]

[Mode for carrying out the invention]Hereinafter, one form of enforcement of the present invention is described about the figure. Fig.1 is a key map showing the essential part of the non-contact feeder system of the present invention, in the figure, 11 is a pair of primary side electric supply line with which high-frequency power is supplied from an RF generator, and this primary side electric supply line 11 is wired along with the plate-like iron 12. These primary side electric supply lines 11 and iron 12 of in between, the plate-like magnetic-shielding material 13 interposes.

[0033]In this case, while nonmagnetic and conductors, such as copper and aluminum, are used as the aforementioned magnetic-shielding material 13, that thickness is made more than predetermined skin-depth delta (skin depth) (those about 3 times as tolerance) through which the magnetic field which a primary side electric supply line generates does not pass. Here, it makes sigma conductivity (1-/omegam) for omega by making frequency (rad/s) and mu into amplitude permeability (H/m), and skin-depth delta becomes delta=(2/omegamusigma) $^{1/2}$. Therefore, since the skin depth is 0.83 mm, using an aluminum board as the magnetic-shielding material 13 when [a certain] power-supply-frequency setting out is carried out, the about 3 times as many things set to about 2.5 mm are desirable.

[0034]Therefore, in such a non-contact feeder system the high frequency magnetic field from the primary side electric supply line 11, Since it flows into the magnetic-shielding material 13 with the prescribed thickness near this primary side electric supply line 11 and does not pass through this, it can inhibit that a magnetic field leaks to the iron 12, and can suppress small generating of the sound accompanying vibration and this of the iron 12. Fig.2 is an explanatory view showing distribution of the lines of magnetic flux at this time, and although some lines of magnetic flux have leaked from the side of the primary side electric supply line 11 since it becomes a symmetric model here, it can check the state where the number of lines of magnetic flux which flows into the iron 12 is deteriorated largely compared with the case of Fig.19.

[0035]Fig.3 shows the case where the U-shaped magnetic-shielding material 13A is used. In this case, since the primary side electric supply line 11 is surrounded by this magnetic-shielding material 13A, the number of the lines of magnetic flux which flow into the iron 12 will become fewer substantially. Fig.4 shows distribution of lines of magnetic flux when a predetermined electric current value and the current of frequency are sent through the primary side electric supply line 11. According to this, from the side of the magnetic-shielding material 13A, slight lines of magnetic flux will only flow into the iron 12, therefore vibration of the iron 12 and generating of a sound can be prevented to abbreviated authenticity.

[0036]Fig.5 shows the case where the magnetic-shielding material 13B of rectangular cylinder form is used. In this case, the magnetic flux which occurs from the primary side electric supply line 11 closes in the magnetic-shielding material 13B, and it can prevent completely leaking out of this magnetic-shielding material 13B, therefore the influence of lines of magnetic flux on the iron 12 will not arise, and can prevent vibration of iron, and generating of a sound completely.

[0037]While Fig.6 provided the magnetic-shielding material 13A and 13B so that Fig.3 and Fig.5 might wrap the primary side electric supply line 11, it shows the case where it provides conversely so that the outer side surface may be wrapped in the outer side surface of the iron 12 by the magnetic-shielding material 13C, 13D, and 13E of two or more sheets (one sheet may be sufficient). Also in this case, the lines of magnetic flux from the primary side electric supply line 11 leak to the iron 12, and it can prevent **** completely.

[0038]Next, one embodiment of enforcement of the present invention concerning Claim 16 is described using Drawings from Claim 6. Fig.7 is a circuit diagram showing the non-contact feeder system of the present invention, and the place where this differs from the current form converter (chopper + current type inverter) of a prior art is the point which adopted the voltage form inverter 22A as a voltage form converter. Therefore, other composition is the same as that of what was shown in Fig.20. The chopper 21 is excluded. This voltage form inverter 22A outputs the rectangular wave voltage of conduction as output voltage 180 degree like Fig.8 by receiving direct current voltage and carrying out pattern control of the ON/OFF of the transistor Qp and Qn. The capacitor Cp and Cn carry out the partial pressure of the direct current voltage, and make the neutral point C. Since the output of this voltage form inverter 22A serves as a voltage source, alignment FIRUTAHE connection of it is made via the reactor L1 for current limiting.

[0039]Next, operation of the present invention is described while referring to a Fig.9 (a) - (d) equivalent circuit. Conversion to each equivalent circuit is performed paying attention to the fundamental wave frequency (fundamental wave frequency of non-contact electric supply) of the voltage form inverter 22A. First, the circuit of Fig.7 can be converted to the 1st equivalent circuit of Fig.9 (a). Here, L4 is equivalent to the mutual inductance of the transformer T4. Since the pickup 26 makes electric power output with a peak value like Fig.23, it adjusts L4 or C4', and carries out parallel resonance of L4 and C4'. By this, it can convert to the 2nd equivalent circuit of Fig.9 (b). The series circuit of the inductances L2 and L3 and load R' can be converted to the parallel circuit of the inductance L23 and load R" like the 3rd equivalent circuit of Fig.9 (c).

[0040]Here, if a tunable filter is adjusted and parallel resonance of C2 and L23 is carried out, it can convert to a simple equivalent circuit like the 4th equivalent circuit of Fig.9 (d). In this circuit, if impedance of L1 is made small, making output voltage V1 of the voltage form inverter 22A into a simple voltage source like Fig.8 can also supply electric power to the load of a mobile body by non-contact. That is, the voltage form inverter 22A does not need to control an output according to load, and should just only output the rectangular wave voltage of constant frequency. As the circuit configuration of the aforementioned voltage form inverter 22A is not

limited to Fig.7 but it is shown in Fig.10, it replaces with the capacitor Cp and Cn which make the aforementioned neutral point C, and the effect same also as a circuit configuration which consists of a diode which carried out antiparallel connection of the transistor for switching and these is acquired. As shown in Fig.11, the commercial general-purpose inverter 22B is also employable. In this case, if the carrier frequency of the general-purpose inverter 22B is set as the fundamental wave frequency of non-contact electric supply and it sets to the minimum (0V is the best) which can set up output voltage, the voltage waveform of Fig.8 can be outputted. Since the general-purpose inverter 22B is mass-produced and can be purchased with a low price, about a model with few amounts of burst sizes of a non-contact feeder system, the cost can be cut down rather than carrying out an exclusive design.

[0041]The aforementioned non-contact feeder system standardizes the length of the aforementioned electric supply line 24, and Fig.12 prepares various unit lengths, and shows the electric supply line module M modularized combining the electric supply line 24 and tunable filter 23 which were standardized. By standardizing the length of the electric supply line 24, troublesome alignment can be completed by the production process of the electric supply line module M. In this case, the transformer T4 of the pickup 26 is fixed to the mobile body 25, and is movable to the arrow direction (code 50) shown in Fig.12. It is that the mobile body 25 which the structure which can be removed from a trajectory for a maintenance is required, and is supported by the linear guide moves the mobile body 25 to an arrow direction, and the structure which can be removed from a trajectory is required. then, ** [without the transformer T4 contacting the electric supply line 24 by turning up, as the end of both the sides of the electric supply line 24 is shown in Fig.12 / be / removing a mobile body from a trajectory / possible].

[0042]When performing non-contact electric supply of the section for a long distance, it is changing the whole electric supply line 24 for a long distance by extending the electric supply line module (electric supply line + tunable filter) M like Fig.13 and Fig.14, or adding. In this case,-izing of the distance and the section in which non-contact electric supply is possible can be carried out [long distance], pressing down the voltage of the electric supply line 24 to safe low pressure, since the unit length of the electric supply line 24 was pressed down. Invention to the equipment addition of non-contact electric supply is carrying out the equipment addition of the electric supply line 24 by extending the electric supply line module (electric supply line + tunable filter) M like Fig.13 and Fig.14. The equipment addition of the distance and the section in which non-contact electric supply is possible can be carried out simply, without re-covering a tuning control and the electric supply line 24 there, since the tuning control of the electric supply line module (electric supply line + tunable filter) M is carried out at the factory. Since the end of both the sides of the electric supply line 24 is turned up like the graphic display, the transformer T4 of the pickup 26 can be moved without contacting electric supply line module M HE of another side, and the electric supply line 24 from one electric supply line module M.

[0043]The connection configuration of the voltage form inverter 22A to the aforementioned electric supply line module M is shown in Fig.15. Although not displayed on this Fig.15, it may connect with the input side of the tunable filter 23 individually, or may connect the reactor L1 for current limiting to the output side of the voltage form inverter 22A collectively. The voltage form inverter 22A operates as a voltage source, as described above, and it supplies electric power according to the load R of the pickup 26 which moves along with each electric supply line module (electric supply line + tunable filter) M. If it thinks in the 4th equivalent circuit of Fig.9 (d) when it explains supplementarily and the electric supply line module M has the pickup 26 (it is placed), according to the impedance of the load R, current will flow into the tunable filter 23 from the voltage form inverter 22A. On the contrary, since the impedance of the load R becomes infinite when there is no pickup 26 in the electric supply line module M, the current (fundamental wave current of non-contact electric supply) which flows into the tunable filter 23 disappears from the voltage form inverter 22A. For this reason, the output capacitance of the voltage form inverter 22A may be selected in accordance with the required power of the mobile body 25 which moves the connected electric supply line module M, and is not affected in the connection quantity of the electric supply line module M.

[0044]Two or more sets of the electric supply line module M and the combination of the voltage form inverter 22A of each 1 which are shown in Fig.15 are standardized and modularized, and long-distance-izing without restriction and an equipment addition are attained by connecting, as shown in Fig.16. The voltage of the power line 30 is good also as direct current voltage in accordance with the power receiving specification of the voltage form inverter 22A, or good also as alternating current voltage.

[0045]Carrying out non-contact electric supply, it can curve or branch and can make any angle move this mobile body 25 to the mobile body 25, as shown in Fig.17. In Fig.17, 31 is a turntable and this is made pivotable to the predetermined angle at the clockwise rotation or the counterclockwise rotation. The electric supply line 24B is fixed on this turntable 31. If it fixes to angle of rotation as shows this turntable 31 to Fig.17, the mobile body 25 is movable to linear direction in between the electric supply line 24A to the electric supply lines 24C. On the other hand, in carrying out the branching guide of the mobile body 25 to the electric supply line 24D, since the mobile body 25 is moved to the electric supply line 24B, it rotates the turntable 31. And the turntable 31 is fixed with angle of rotation which can move to the electric supply line 24D from the electric supply line 24B, and the mobile body 25 is moved to the electric supply line 24D. The angle which curves or branches can be set up arbitrarily.

[0046]In order to prevent the area which occurs with the gap of electric supply line 24 unsupplied electric power and to always carry out possible [of the non-contact electric supply to the mobile body 25], in the present invention, As shown in Fig.18, it is considered as the two transformers T4 of the pickup 26 attached to the mobile body 25, and mounts in the position where the relation of a lower type is materialized.

Even when one transformer T4 cannot oppose and supply electric power to the gap part of the electric supply line 24 by the thing of the interval > electric supply line of a transformer to do

for gap ****, since the transformer T4 of another side opposes to the electric supply line 24, the non-contact electric supply of it to the mobile body 25 is certainly attained. If it is considered as the quantity with three or more pieces of the transformer T4, it cannot be overemphasized that electric supply capability further increases.

[0047]

[Effect of the Invention]As mentioned above, since magnetic-shielding material was interposed between a primary side electric supply line and the iron close to this primary side electric supply line according to the present invention, The effect that it can prevent beforehand is acquired [being able to inhibit leaking to iron the magnetic field of the high frequency which occurs from a primary side electric supply line by installation of magnetic-shielding material, therefore vibrating in response to the magnetic field whose iron is high frequency, and]. Therefore, like the former, separate a primary side electric supply line from residential space, and install it, or. By the present invention, generating of a sound can be inhibited fundamentally and reliably by the method of confining the source of release of a sound, without considering it as being indirect and the inefficient measure against sound insulation of making small the opening of the partition of installation space and residential space, or sticking an insulator on the wall of installation space and residential space. Since the aforementioned magnetic-shielding material was made into U-shaped sectional shape which covers a primary side electric supply line, Since most magnetic fields of the high frequency which occurs from a primary side electric supply line could prevent leaking to neighboring iron by the magnetic-shielding material of U-shaped sectional shape and it made the aforementioned magnetic-shielding material further cylindrical sectional shape which covers the whole primary side electric supply line, It can prevent completely that the magnetic field of the high frequency which occurs from a primary side electric supply line leaks to iron, and the effect that generating of the sound accompanying vibration and this of iron can be prevented reliably is acquired.

[0048]Since according to the present invention cylindrical magnetic-shielding material was covered at least by the primary side electric supply line near [the] a penetration part when making the iron of a plate penetrate the aforementioned primary side electric supply line, Can prevent effectively the magnetic field which a primary side electric supply line generates from leaking to the iron which a primary side electric supply line penetrates, and by using magnetic-shielding material as nonmagnetic and a conductor further, The magnetic field which a primary side electric supply line generates can be led to nonmagnetic and a conductor, and it can be made to exhaust, and can prevent that that magnetic field passes through this nonmagnetic and conductor, and the effect that it can prevent effectively is acquired [that that magnetic field leaks to iron by this, and].

[0049]By what according to the present invention it replaces with the conventional current form converter (chopper + current type inverter), and a circuit configuration adopts a simple voltage form inverter for, Since electric power can be supplied to a mobile body by non-contact if cost can be reduced substantially, and also the voltage form inverter does not need to control an output according to load and the rectangular wave voltage of constant frequency is only outputted. The effect that the current control of the resonant circuit which was being carried out conventionally becomes unnecessary, and troublesome stabilization adjustment becomes unnecessary is acquired. When a low price [as a voltage form inverter] marketing general-purpose inverter is adopted, a large cost cut can be aimed at rather than carrying out the exclusive design of the voltage form inverter about a model with few amounts of burst sizes.

[0050]By according to the present invention, standardizing the length of an electric supply line and modularizing combining an electric supply line and a tunable filter, Adjustment of troublesome alignment can be completed by a modular production process, and it becomes possible by turning up the end of both the sides of an electric supply line to remove the aforementioned mobile body from a trajectory, without a transformer contacting an electric supply line. By adding an electric supply line module (electric supply line + tunable filter), The equipment addition of the distance and the section in which non-contact electric supply is possible can be carried out simply, without being able to carry out [long distance]-izing of the distance and the section in which non-contact electric supply is possible, pressing down the voltage of an electric supply line to safe low pressure, and also carrying out adjustment of alignment, and re-covering of an electric supply line by [the] carrying out electric supply line module growth at a spot.

[0051]Since according to the present invention load impedance becomes infinite and the current (fundamental wave current of non-contact electric supply) which flows into a tunable filter disappears from a voltage form inverter when there is no pickup in an electric supply line module. The output capacitance of a voltage form inverter may be selected in accordance with the required power of the mobile body which moves the connected electric supply line module, and the advantage of not being influenced is acquired by the connection quantity of an electric supply line module. The combination of each electric supply line module and a voltage form inverter is standardized and modularized, and long-distance-izing of an electric supply line without restriction and an equipment addition are attained by connecting with a power line. By what either of the electric supply lines is rotatably provided for according to the present invention, A mobile body at any angle, carrying out non-contact electric supply at a mobile body a curve or by being able to carry out a branching guide and also making the interval of a transformer larger than the gap between electric supply lines, The area which occurs with the gap of an electric supply line unsupplied electric power is prevented, and the effect that the non-contact electric supply to a mobile body is always realizable is acquired.

CLAIMS DETAILED DESCRIPTION

DESCRIPTION OF DRAWINGS DRAWINGS

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a key map of an essential part showing the non-contact feeder system by one form of enforcement of the present invention.
[Drawing 2]It is an explanatory view showing the distributed situation of the lines of magnetic flux to the iron in Fig.1.
[Drawing 3]It is a key map of an essential part showing the non-contact feeder system by other forms of enforcement of the present invention.
[Drawing 4]It is an explanatory view showing the distributed situation of the lines of magnetic flux to the iron in Fig.3.
[Drawing 5]It is a key map of an essential part showing the non-contact feeder system by other forms of enforcement of the present invention.
[Drawing 6]It is a key map of an essential part showing the non-contact feeder system by other forms of enforcement of the present invention.
[Drawing 7]It is a circuit diagram showing the non-contact feeder system by one form of enforcement of the present invention in detail.
[Drawing 8]It is a timing chart which shows the output voltage of the voltage form inverter in Fig.7.
[Drawing 9]It is a representative circuit schematic of the non-contact feeder system shown in Fig.7.
[Drawing 10]It is a circuit diagram showing other examples of the voltage form inverter in the present invention.
[Drawing 11]It is a circuit diagram showing other examples of the voltage form inverter in the present invention.
[Drawing 12]It is an explanatory view showing the unit which modularizes the electric supply line and tunable filter in the present invention.
[Drawing 13]It is an explanatory view showing notionally the extension situation of the electric supply line module in the present invention.
[Drawing 14]It is an explanatory view showing notionally the extension situation of the electric supply line module in the present invention.
[Drawing 15]It is an explanatory view showing notionally the long-distance-ized method of the non-contact feeder system by the present invention.
[Drawing 16]It is an explanatory view showing notionally the long-distance-ized method of the non-contact feeder system by the present invention.
[Drawing 17]It is an explanatory view showing the curve of the mobile body in the present invention, or the method of a branching guide.
[Drawing 18]It is an explanatory view showing the prevention method of the area between the electric supply lines in the present invention unsupplied electric power.
[Drawing 19]It is an explanatory view showing the distributed situation of the lines of magnetic flux to the iron in the conventional non-contact feeder system.
[Drawing 20]It is a circuit diagram showing the conventional non-contact feeder system.
[Drawing 21]It is a perspective view showing the transformer of the pickup in Fig.20.
[Drawing 22]It is a cross sectional view showing the transformer of the pickup in Fig.20.
[Drawing 23]It is a resonance characteristic figure showing the relation of electric power versus the frequency in the pickup of Fig.20.
[Explanations of letters or numerals]
11 Primary side electric supply line
12 Iron
13, 13A, 13B, 13C, 13D, and 13E Magnetic-shielding material
22A Voltage form inverter
22B Inverters in general
23 Tunable filter
24 Electric supply line
25 Mobile body
26 Pickup
L1 Reactor for current limiting
T4 Transformer

Representative drawing

Representative drawing | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22

JP,2002-137659,A

Previous Document 1/1 Next Doc

PAJ Detail Image

CLAIMS DETAILED DESCRIPTION

DESCRIPTION OF DRAWINGS DRAWINGS

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

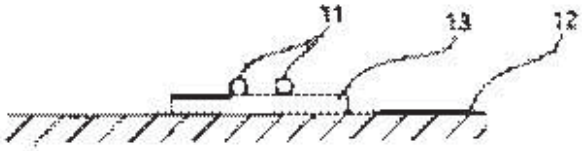
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

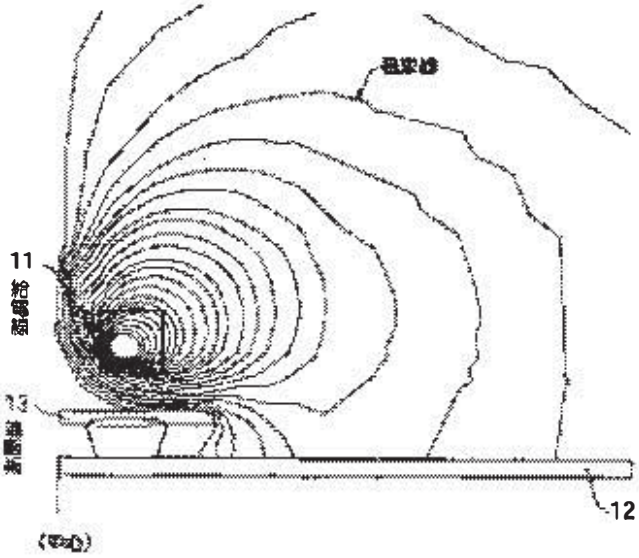
3.In the drawings, any words are not translated.

DRAWINGS

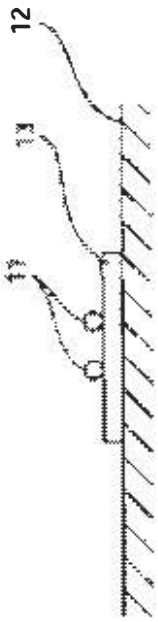
[Drawing 1]



[Drawing 2]

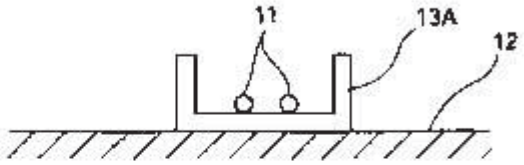


[Drawing 3]

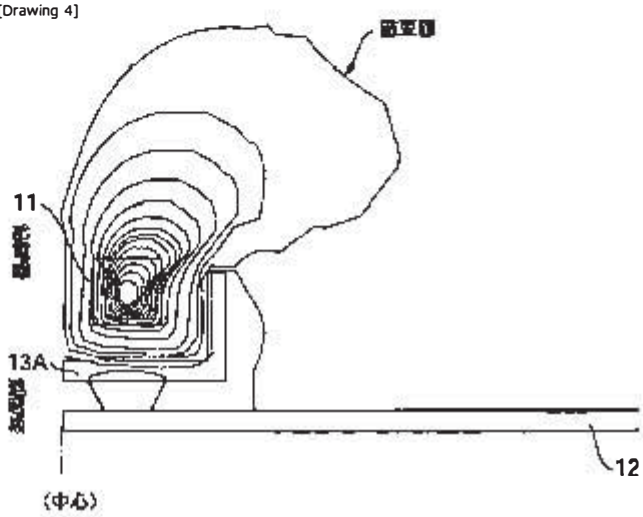


Representative drawing

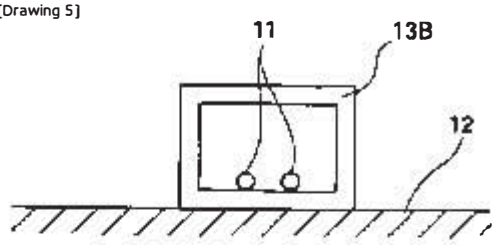
Representative drawing | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22



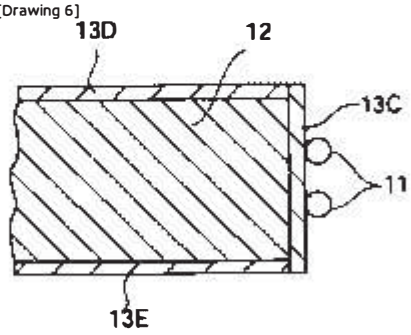
[Drawing 4]



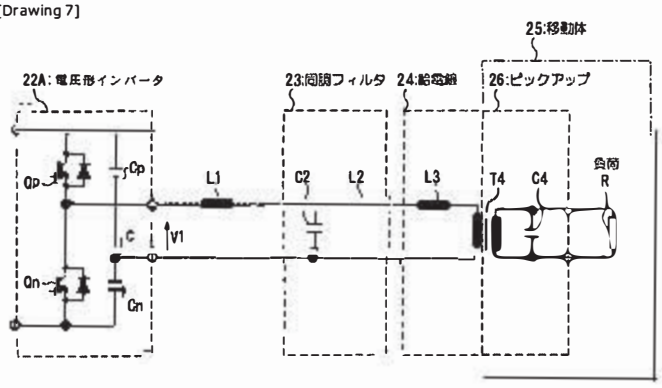
[Drawing 5]



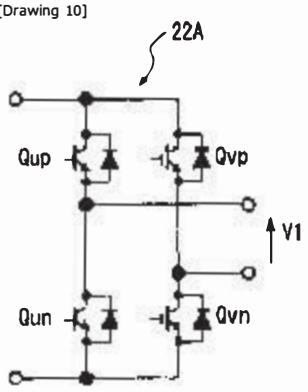
[Drawing 6]



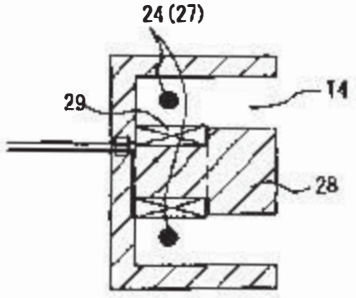
[Drawing 7]



[Drawing 10]

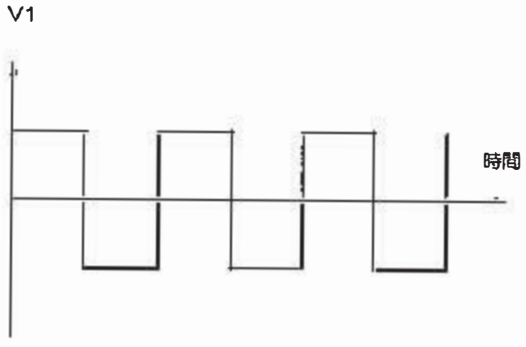


[Drawing 22]

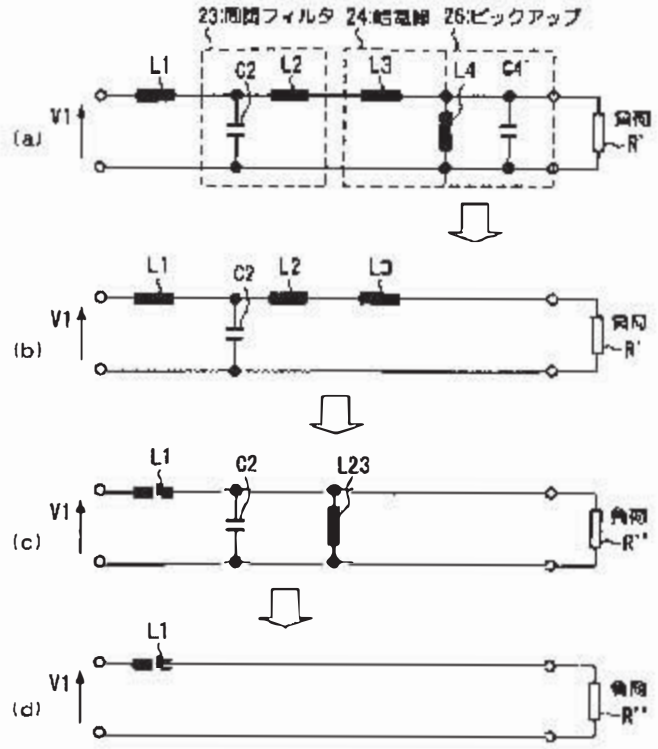


[Drawing 8]

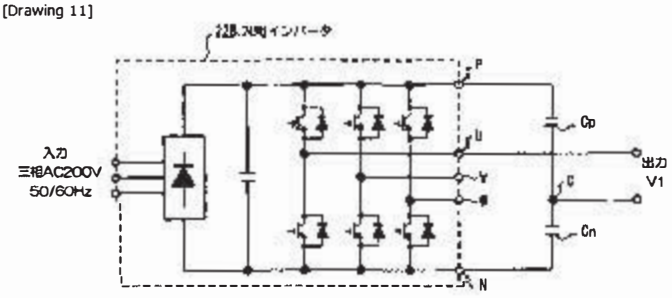
インバータの出力電圧



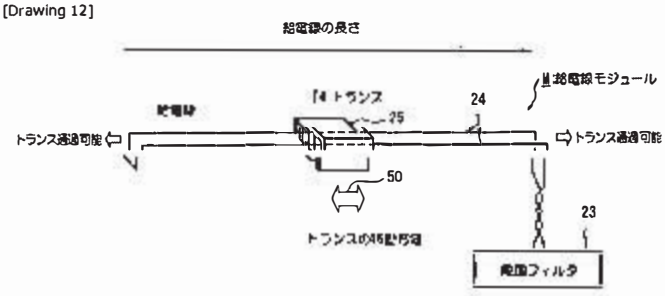
[Drawing 9]



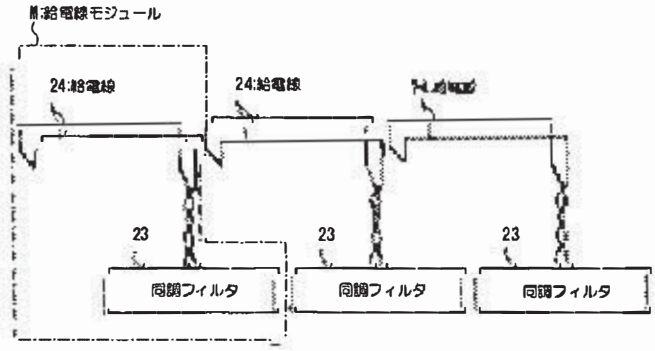
[Drawing 11]



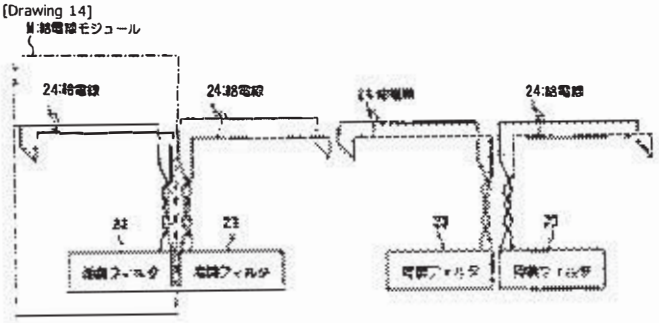
[Drawing 12]



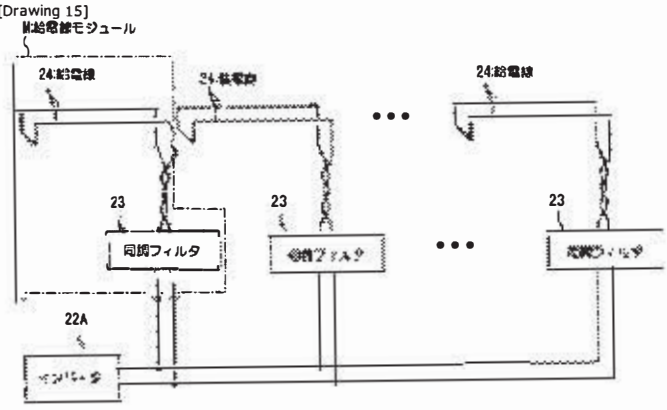
[Drawing 13]



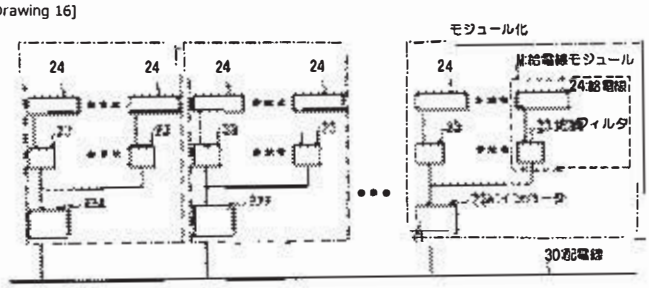
[Drawing 14]



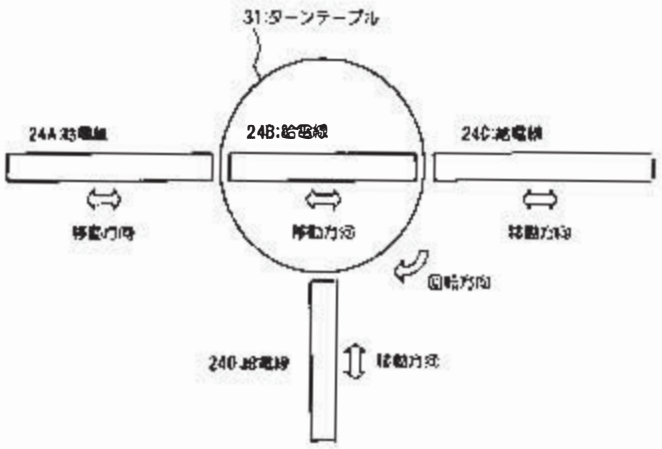
[Drawing 15]



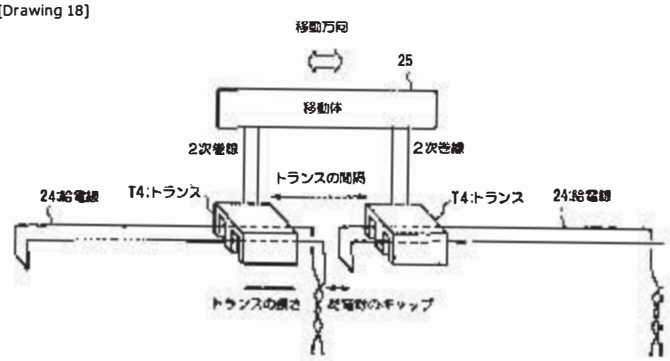
[Drawing 16]



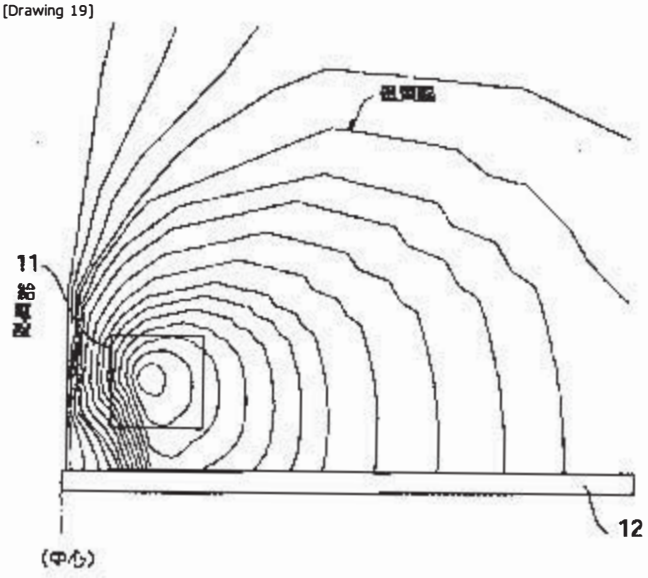
[Drawing 17]



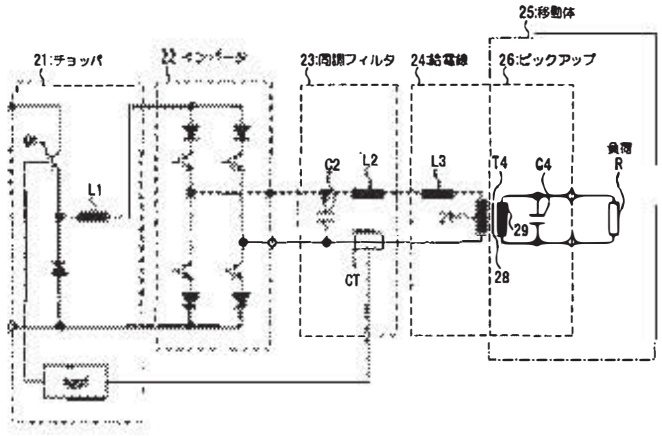
[Drawing 18]



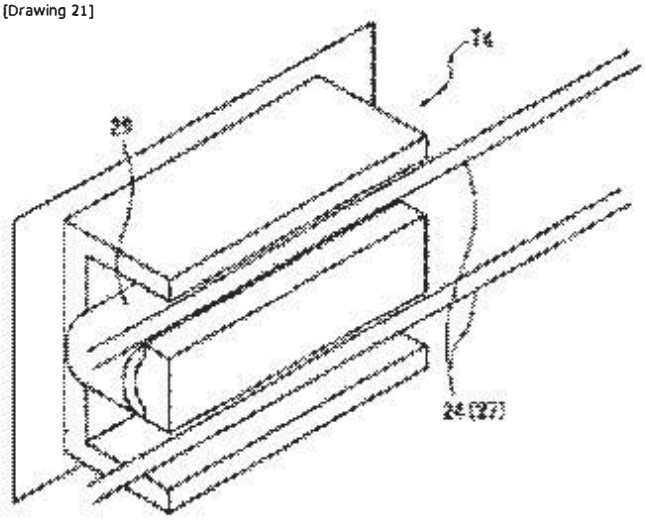
[Drawing 19]



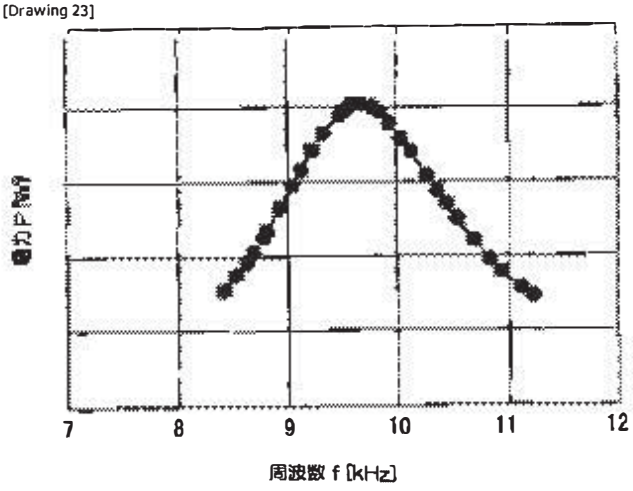
[Drawing 20]



[Drawing 21]



[Drawing 23]



(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2005-101392
(P2005-101392A)
(43)公開日　平成17年4月14日(2005.4.14)

(51)Int.Cl.[7]	F I		テーマコード(参考)
H01F 38/14	H01F 23/00	B	
H02J 17/00	H02J 17/00	B	

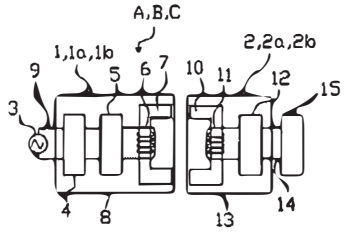
審査請求 未請求　請求項の数 6　OL　(全 11 頁)

(21)出願番号　特願2003-334575(P2003-334575)
(22)出願日　平成15年9月26日(2003.9.26)

(71)出願人　000116666
愛知電機株式会社
愛知県春日井市愛知町1番地
(72)発明者　佐藤　秀隆
愛知県春日井市愛知町1番地　愛知電機株式会社内
(72)発明者　伊藤　康裕
愛知県春日井市愛知町1番地　愛知電機株式会社内

(54)【発明の名称】非接触給電装置

(57)【要約】
【課題】　１次側鉄心から放出される磁束がこれを収容する外筐から２次側鉄心と鎖交する方向以外の外部に漏出することを極力抑制することのできる非接触給電装置を提供する。
【解決手段】　１次側ユニット１と２次側ユニット２の外筐８，１３を銅またはアルミニウム等の金属から形成するとともに、前記外筐８，１３内に収容される１次側鉄心７と２次側鉄心１０が対向する外筐位置に開口部１８を設け、前記開口部１８内に該開口部１８の形状と合致する金属以外の非磁性体からなる正面板１７を抜脱不能に嵌合して構成した。
【選択図】　図１



【特許請求の範囲】
【請求項1】
交番電流を印加する１次側巻線を巻装した１次側鉄心を収容してなる１次側ユニットと、前記１次側巻線と分離可能に構成した結合トランスの２次側巻線を巻装した２次側鉄心を収容してなる２次側ユニットを備え、前記結合トランスの電磁誘導作用により、前記１次側ユニットから２次側ユニットへ非接触で電力を供給する非接触給電装置において、前記１次側ユニットと２次側ユニットは、銅またはアルミニウム等の金属からなる外筐の前記１次側鉄心と２次側鉄心の対向位置に開口部を設け、かつ、前記開口部内に、該開口部と合致する金属以外の非磁性体を抜脱不能に嵌合して構成したことを特徴とする非接触給電装置。
【請求項2】
交番電流を印加する１次側巻線を巻装した１次側鉄心を収容してなる１次側ユニットと、前記１次側巻線と分離可能に構成した結合トランスの２次側巻線を巻装した２次側鉄心を収容してなる２次側ユニットを備え、前記結合トランスの電磁誘導作用により、前記１次側ユニットから２次側ユニットへ非接触で電力を供給する非接触給電装置において、前記１次側ユニットと２次側ユニットは、非磁性体からなる外筐の前記１次側鉄心と２次側鉄心の対向位置を除く内側に、箔状または板状の銅またはアルミニウム等の金属部材を固着して構成したことを特徴とする非接触給電装置。
【請求項3】
前記１次側ユニットは、これを構成する各種回路を前記外筐の外部にこれと着脱自在に別置の形態で備えたことを特徴とする請求項１，２記載の非接触給電装置。
【請求項4】
前記各種回路は、銅またはアルミニウム等の金属からなるケース内に収容して構成したことを特徴とする請求項３記載の非接触給電装置。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、結合トランスの電磁誘導作用を利用して、１次側ユニットから２次側ユニットに非接触で電力を供給する際、前記１次側ユニットの１次側鉄心から放出される磁束が無駄に外部へ漏出することを極力抑制することのできる非接触給電装置の構造に関する。
【背景技術】
【0002】
従来から、結合トランスの１次側と２次側をそれぞれ収容する１次側ユニットと２次側ユニットを分離可能に構成して、前記１次側ユニットと２次側ユニットを対向させた状態で、前記結合トランスの電磁誘導作用を利用して、前記１次側ユニットから２次側ユニットへ非接触で電力を供給する、所謂、非接触給電装置は存在する（特許文献１参照）。
【0003】
前記非接触給電装置を使用する場合、前記１次側ユニットの電源コードを屋内コンセント等の電源部に差し込み、前記１次側ユニットと２次側ユニット間に金属以外の介在物（窓ガラス等）を挟んで対向配置させることにより、前記１次側ユニットの１次側巻線と２次側ユニットの２次側巻線から前記結合トランスを形成する。
【0004】
そして、前記１次側ユニットに備えた起動スイッチを投入することにより、前記電源部から１次側ユニットに電力が供給される。このとき、前記１次側ユニットと２次側ユニットは、前述の如く、窓ガラス等の介在物を挟んで、１次側巻線と２次側巻線から結合トランスを形成しているため、前記１次側ユニットに供給された電力は前記結合トランスの電磁誘導作用によって、前記介在物を介して２次側ユニットに非接触で供給されて、２次側ユニットに接続された負荷を良好に動作させる。
【特許文献1】特開２００３－１５８０２７号公報
【発明の開示】

【発明が解決しようとする課題】
【0005】
前記［特許文献１］記載の非接触給電装置は、前記１次側ユニットと２次側ユニットの外筐としてのケーシングを、樹脂材等、金属以外の非磁性体によって形成することによって、前記１次側巻線を巻回した１次側鉄心から放出される磁束は、前記非磁性体のケーシングを良好に通過して、前記２次側ユニットを構成する２次側鉄心に確実に鎖交する。
【0006】
しかし、前述の如く、前記ケーシングが金属以外の非磁性体から形成された場合、前記１次側鉄心に発生する磁束は、該１次側鉄心の端部から外部に向けて放射状に放出されるので、前記非磁性体からなるケーシングを通過して種々の方向に放出される。つまり、前記１次側鉄心の正面位置にあるケーシングを通過して前記２次側鉄心に鎖交する方向のみならず、前記２次側鉄心と鎖交しない方向にも放出される。
【0007】
これにより、前記ケーシング外部に放出された磁束が、例えば、１次側ユニットと屋内電源等の固定電源を接続する前記電源コードに鎖交した場合、固定電源から前記１次側ユニットに供給される電圧にノイズが発生し、前記１次側ユニットから２次側ユニットを介して、該２次側ユニットと接続コードを介して接続される負荷に対して不安定な電圧が供給されて、前記負荷の動作不良や故障，不具合を誘発する可能性があった。
【0008】
そこで、本発明は、前記１次側ユニットの１次側鉄心から放出される磁束が外部に漏出して電源コード等に鎖交することを良好に回避して、1次側ユニットに供給される電圧にノイズ等が発生することを確実に阻止するように構成した非接触給電装置を提供することを目的とする。
【課題を解決するための手段】
【0009】
第１の局面によれば、交番電流を印加する１次側巻線を巻装した１次側鉄心を収容してなる１次側ユニットと、前記１次側巻線と分離可能に構成した結合トランスの２次側巻線を巻装した２次側鉄心を収容してなる２次側ユニットを備え、前記結合トランスの電磁誘導作用により、前記１次側ユニットから２次側ユニットへ非接触で電力を供給する非接触給電装置において、前記1次側ユニットと２次側ユニットは、銅またはアルミニウム等の金属からなる外筐の前記１次側鉄心と２次側鉄心の対向位置に開口部を形成し、該開口部内に、当該開口部と合致する金属以外の非磁性体を抜脱不能に取り付けて構成した。
【0010】
第２の局面によれば、交番電流を印加する１次側巻線を巻装した１次側鉄心を収容してなる１次側ユニットと、前記１次側巻線と分離可能に構成した結合トランスの２次側巻線を巻装した２次側鉄心を収容してなる２次側ユニットを備え、前記結合トランスの電磁誘導作用により、前記１次側ユニットから２次側ユニットへ非接触で電力を供給する非接触給電装置において、前記１次側ユニットと２次側ユニットは、非磁性体からなる外筐の前記１次側鉄心と２次側鉄心の対向面を除く内側に箔状若しくは板状の銅またはアルミニウム等の金属部材を取り付けて構成した。
【0011】
第３の局面によれば、第１，２の局面において、前記１次側ユニットは、これを構成する各種回路を前記外筐外部に着脱自在に別置の形態で備えて構成した。
【0012】
第４の局面によれば、第３の局面において、前記各種回路は、銅やアルミニウム等の金属からなるケース内に収容して構成した。
【発明の効果】
【0013】
請求項１記載の発明によれば、１次側ユニットと２次側ユニットの外筐を銅やアルミニウム等の金属によって形成し、前記外筐の１次側鉄心と２次側鉄心の対向位置に開口部を

形成し、前記開口部内に非磁性体を嵌合して構成したので、前記１次側鉄心から放出された磁束は、前記非磁性体を通過して前記２次側鉄心に確実に鎖交するとともに、前記外筐は銅やアルミニウム等の金属からなるので、前記１次側鉄心から放出された磁束は、２次側鉄心に鎖交する方向以外は、前記外筐によって外部への通過が極力抑制され、例えば、１次側ユニットと固定電源等を接続する給電コードに漏出した磁束が鎖交して、供給電圧にノイズが発生する問題を確実に防止することができる。

【0014】

請求項２記載の発明によれば、非磁性体からなる外筐の内側面に銅箔またはアルミニウム箔を貼り付けたり、或いは、銅板またはアルミニウム板等の金属板を取り付けることによって、請求項１記載の発明と同様の効果を得ることができるとともに、前記外筐は、金属と非磁性体からなる結合構造ではなく、非磁性体による単一構造であるため、構造を簡素化して、製作時間の短縮化が図れるとともに、外観の美観性にも優れている。

【0015】

請求項３記載の発明によれば、１次側ユニットを構成する各種回路を前記外筐の外部にこれと着脱自在に別置の形態で備えることによって、例えば、構造が相違する複数の１次側ユニットを択一的に選択することによって、前記各種回路を実装した単一の電気基板を利用して、複数の１次側ユニットを選択的に動作させることができる。さらに、前記各種回路を前記外筐の外部に備えることによって、前記外筐をコンパクトに構成することができ、非接触給電装置を使用する際、前記ユニットの設置自由度を拡大することができる。

【0016】

請求項４記載の発明によれば、前記１次側ユニットと２次側ユニットを構成する各種回路を前記外筐の外部に備えるとともに、前記各種回路を収容するケースを鋼またはアルミニウム等の金属によって構成することによって、前記１次側鉄心から放出される磁束が前記各種回路に鎖交して、悪影響を与えることを確実に阻止することができる。

【発明を実施するための最良の形態】

【0017】

１次側ユニットの１次側鉄心から放出される磁束が、前記１次側ユニットの外筐外部へ漏洩して、種々の問題を誘発することを確実に阻止することのできる非接触給電装置を簡易な構造により実現した。

【実施例】

【0018】

以下、本発明の実施の形態を図１ないし図５により説明する。図１は、本発明の非接触給電装置の構成を示すブロック図であり、図１において、１は１次側ユニットであり、２は前記１次側ユニット１との間に所定の間隔を開けて対向配置されて使用される２次側ユニットを示している。

【0019】

前記１次側ユニット１は、商用電源等の電源部３から供給される交流電圧を直流に変換する第１の整流平滑回路４と、前記第１の整流平滑回路４の出力を高周波の交番電流に変換して１次側巻線６に印加する駆動回路５、前記１次側巻線６を脚鉄部に巻回する１次側鉄心７から構成されており、これら各回路は外筐としてのケーシング８内に収容されて、給電コード９を介して前記電源部３から電力の供給を受ける。

【0020】

一方、２次側ユニット２は、１次側ユニット１の１次側鉄心７と端部を突き合せて配置される２次側鉄心１０と、該２次側鉄心１０に巻回される２次側巻線１１と、該２次側巻線１１の出力に接続した第２の整流平滑回路１２を具備して、外筐としてのケーシング１３内に収容されている。そして、接続コード１４を介して負荷１５（直流負荷）を接続することにより、前記１次側ユニット１から供給された電力を前記負荷１５に対して供給することができる。

【0021】

図２は、前記非接触給電装置Ａの使用状態の一例を示す側面図であり、前記１次側ユニ

ット１と２次側ユニット２の間には、金属以外の介在物（ガラス窓等）１６が介在している。このとき、前記１次側ユニット１と２次側ユニット２は、例えば、前記介在物１６に設置する図示しない固定手段により取り付けられて、互いに対向配置される。

【0022】

前記１次側ユニット１を組み立てる場合は、最初に、ＡＢＳ樹脂やＰＢＴ（ポリブチレンテレフタレート）樹脂またはポリカードネート等、金属以外の非磁性体からなる薄肉矩形状に形成した小型の正面板１７を用意する。前記正面板１７の側面縦方向中途部には、後述するネジ部材の挿通孔を形成した固定鍔１７ａが、前記正面板１７の平面部に対して後方へ段差を形成しつつ、側方へ張り出して具備されている。

【0023】

次に、前記１次側ユニット１のケーシング８を構成する２種類の部材を準備する。１つは銅やアルミニウム等の金属からなる矩形状の薄平板８ａであり、もう１つは、同じく銅やアルミニウム等の金属からなる略有底直方形状の収容部８ｂである。前記薄平板８ａには、ケーシング８内に収容する前記１次側鉄心７が対向する位置（１次側鉄心７の正面位置）に前記正面板１７の平面部と合致する形状の開口部１８が形成されている。

【0024】

一方、前記収容部８ｂには、その開口位置から側方へ突出する支持片１９が具備されており、当該支持片１９を利用して前記収容部８ｂは前記薄平板８ａに対して揺動不能に結合される。

【0025】

前記薄平板８ａに正面板１７を取り付ける場合は、前記薄平板８ａに形成した開口部１８内に前記正面板１７の平面部を嵌め込むことにより、前記固定鍔１７ａを前記薄平板８ａに当接させる。この状態で、図３に示すように、皿ネジ２０を前記薄平板８ａと前記正面板１７に具備した固定鍔１７ａの各々に形成した挿通孔２１ａ，２１ｂに前記薄平板８ａの一方面（図３の下方）側から挿入し、その先端部を前記正面板１７に具備した固定鍔１７ａの上方に突出させる。

【0026】

そして、前記固定鍔１７ａの上方に先端部を突出した前記皿ネジ２０に締付ナット２２を締付け固定することにより、前記正面板１７を、その平面部が前記薄平板８ａに形成した開口部１８内に完全に嵌め込まれた状態で抜脱不能に確実に固定する。

【0027】

次に、１次側鉄心７の脚鉄部を軸部２３ａ内に穿設した図示しない中空部に収容・固定して、１次側巻線６を前記軸部２３ａの外周に所定巻回数巻装したコイルボビン２３を、前記１次側鉄心７の端部が前記正面板１７に当接するように当てがい、前記コイルボビン２３のヨーク部に複数個形成した挿通孔２４内に固定ボルト２５を挿通して、前記正面板１７の前記挿通孔２４と対応する位置に形成した螺着孔２６にその先端部をネジ止めすることによって、前記コイルボビン２３に固定した１次側鉄心７を前記正面板１７に確実に固定する。

【0028】

つづいて、前記正面板１７に固定した１次側鉄心７の周囲に銅またはアルミニウム等の金属からなる略矩形箱状のシールド２７を被せることによって、前記１次側鉄心７を周囲と隔絶する。前記シールド２７は、挿通孔２８を挿通して前記正面板１７に形成した螺着孔２９に固定ボルト３０を螺着することによって、前記正面板１７に固定される。

【0029】

一方、前記薄平板８ａには、図１に示す１次側ユニット１を構成する各種回路を実装した電気基板３１が、図４に示すように、固定ボルト３２によって確実に固定されている。なお、図１に示す駆動回路５は、前記シールド２７内に収容した前記１次側巻線６に電気的に接続されている。

【0030】

さらに、前記収容部８ｂには、図３に示すように、前記１次側ユニット１を外部電源と

接続する端子３３が端子台３４によって固定されている。したがって、収容部８ｂを前記薄平板８ａに固定する場合は、前記電気基板３１上の第１の整流平滑回路４を前記端子３３に電気的に接続した後、前記収容部８ｂの開口部から側方へ延出した支持片１９を前記薄平板８ａに当接して、前記支持片１９と薄平板８ａの同一位置に形成した挿通孔３５，３６内に皿ネジ３７を挿通し、当該皿ネジ３７の先端部を前記薄平板８ａと支持片１９を介して締付ナット３８で締め付けることにより、前記収容部８ｂと薄平板８ａとを離隔不能に結合する。

【0031】

そして、前記収容部８ｂに取り付けた端子３３に前記給電コード９を接続することによって、前記１次側ユニット１はその組み立てを終了する。なお、２次側ユニット２の組み立てについては、前記１次側ユニット１の組み立てる場合と同様であるので、説明は割愛する。

【0032】

図５は、組み立て終了後の前記１次側ユニット１または２次側ユニット２の外観を示す斜視図である。図５に示すように、前記１次側ユニット１と２次側ユニット２は、互いに対向する薄平板８ａ，１３ａの一部に開口部１８を形成し、この開口部１８内にＡＢＳ樹脂やＰＢＴ（ポリブチレンテレフタレート）樹脂、ポリカーボネート等、金属以外の非磁性体からなる正面板１７を嵌め込んで構成されている。

【0033】

また、前記薄平板８ａ，１３ａは、銅やアルミニウム等の金属からなり、同様に、銅やアルミニウム等の金属からなる収容部８ｂ，１３ｂの支持片１９と皿ネジ３７、締付ナット３８（図３参照）を利用して一体的に固定されている。

【0034】

次に、前記非接触給電装置Ａを使用する場合について、得られる効果とともに説明する。前記非接触給電装置Ａを使用する場合は、まず、１次側ユニット１と２次側ユニット２を、図２に示すように、ガラス窓等の介在物１６を介して、図示しない固定手段等を利用して対向配置させる。

【0035】

この状態で、前記１次側ユニット１に接続した給電コード９を図示しない商用電源等の電源部３に接続し、１次側ユニット１に具備した図示しない起動スイッチを投入することによって、前記電源部３の電力を図１に示す第１の整流平滑回路４に供給する。

【0036】

前記第１の整流平滑回路４は、供給された交流電圧を直流に変換して駆動回路５に出力し、該駆動回路５は前記第１の整流平滑回路４の出力を高周波の交番電流に変換して１次側巻線６に印加する。このとき、前記１次側巻線６は、１次側鉄心７の脚鉄部に巻回されているので、前記１次側巻線６に高周波の交番電流が印加されると、前記１次側鉄心７内に磁束が発生する。

【0037】

前記１次側鉄心７に発生した磁束は、該１次側鉄心７の端部から図３ないし図５に示す薄平板８ａに形成した開口部１８内に嵌合した非磁性体からなる正面板１７を良好に通過して、図２に示す窓ガラス等の介在物１６を介した後、２次側ユニット２の薄平板１３ａに形成した開口部１８内に嵌合した正面板１７を確実に通過して、前記２次側ユニット２のケーシング１３内に収容した２次側鉄心１０に確実に鎖交する。

【0038】

このとき、前記１次側鉄心７に発生した磁束は、その端部から放射状に外部に放出されて、１次側ユニット１の薄平板８ａを通過しようとするが、前記薄平板８ａは、前述したように、銅やアルミニウム等の金属によって構成されているので、この薄平板８ａの磁気抵抗によって前記磁束の外部へ通過量（漏れ磁束量）は確実に抑制される。

【0039】

この結果、前記ケーシング８の外部に漏れた磁束が、１次側ユニット１と電源部３間を

接続する給電コード９に鎖交して、１次側ユニット１に供給される電力にノイズを発生させたり、また、図２に示すガラス窓等の介在物１６を通過して、２次側ユニット２に到達した場合においても、前記２次側ユニット２を構成する銅やアルミニウム等の金属からなる薄平板１３ａによって２次側ユニット２のケーシング１３内に鎖交する磁束量を確実に減少させることができるので、前記漏れ磁束がケーシング１３内に収容した電気基板３１上の各種回路に悪影響を及ぼすことを極力排除することができる。

【0040】

つまり、１次側鉄心７から放出された磁束は、前記１次側鉄心７の正面位置に存在する非磁性体からなる正面板１７と、ケーシング１３を構成する非磁性体からなる正面板１７を良好に通過して２次側鉄心１０に確実に鎖交するとともに、銅やアルミニウム等の金属からなる薄平板８ａと収容部８ｂによって、無用に外部へ漏出することが極力抑制される

【0041】

また、前記１次側ユニット１の薄平板８ａを通過して僅かに外部へ漏出した漏れ磁束においても、図２に示す介在物１６を通過した後、銅やアルミニウム等の金属からなる２次側ユニット２の薄平板１３ａの存在によって、ケーシング１３内に鎖交することを確実に阻止することができるので、前記２次側ユニット２のケーシング１３内に収容した電気基板３１上の各種回路が前記漏れ磁束によって故障したり、不具合を生じることを完全に阻止することができる。

【0042】

なお、前記１次側鉄心７から正面板１７を良好に通過して、２次側鉄心１０に鎖交した磁束は、前記２次側鉄心１０の脚鉄部に巻回した２次側巻線１１に交流電圧を誘起させる

【0043】

前記２次側巻線１１に誘起された交流電圧は、図１に示す第２の整流平滑回路１２に入力され、前記第２の整流平滑回路１２は入力した交流電圧を直流電圧に変換した後、接続コード１４にて接続された負荷１５に供給し、前記負荷１５を漏れ磁束によるノイズ等の影響を受けていない安定した電力によって動作させることができる。

【0044】

つづいて、本発明の第２実施例を図６によって説明する。図６は第２実施例の非接触給電装置Ｂを示す正面図であり、図６の１次側ユニット１ａにおいて、図４に示す第１実施例の１次側ユニット１と相違するところは、薄平板８ａをＡＢＳ樹脂やＰＢＴ（ポリブチレンテレフタレート）樹脂、または、ポリカーボネート等の非磁性体によって形成することと、１次側鉄心７の正面位置に正面板１７を嵌め込む開口部１８を形成しないことである。

【0045】

この結果、前記１次側鉄心７を囲繞する銅またはアルミニウム等の金属からなるシールド２７の下方に、銅またはアルミニウム等の金属からなる箔状または板状の漏れ磁束防止材３９を取り付けて構成することが必要となる。

【0046】

前記漏れ磁束防止材３９を取り付ける場合は、１次側ユニット１ａを組み立てる際に、箔状または板状の銅またはアルミニウム等からなる前記漏れ磁束防止材３９を薄平板８ａに、例えば、接着剤等を利用して貼り付け、この状態で、ケーシング８を構成する収容部８ｂの支持片１９と前記薄平板８ａ間に前記漏れ磁束防止材３９を挟持した後、皿ネジ３１と締付ナット２２を利用して固定すればよい。

【0047】

こうすることで、前記１次側鉄心７に発生した磁束は、非磁性体からなる薄平板８ａから図２に示すガラス窓等の介在物１６を通過した後、前記１次側ユニット１ａのケーシング８と同様に形成した２次側ユニット２ａのケーシング１３を構成する非磁性体の薄平板１３ａを通過して、前記ケーシング１３内に収容された２次側鉄心１０に鎖交する。

【0048】
また、前記１次側鉄心７の漏れ磁束は、前記１次側ユニット１ａのケーシング８を構成する薄平板８ａに取り付けた箔状または板状の銅またはアルミニウム等からなる漏れ磁束防止材３９によって外部へ漏出することを極力抑制することができ、かつ、僅かに外部へ漏出した漏れ磁束においても、２次側ユニット２ａの薄平板１３ａに取り付けた銅またはアルミニウム等の金属からなる漏れ磁束防止材３９によってケーシング１３内に侵入することを確実に防止することができるので、前記１次側ユニット１ａと電源部３とを結ぶ給電コード９や、２次側ユニット２ａの電気基板３１上に実装した各種回路に前記漏れ磁束が鎖交して悪影響を及ぼすことを確実に阻止することができる。
【0049】
図７は、本発明の第３実施例における非接触給電装置Ａの構造を説明する側面図である。つまり、図７に示す非接触給電装置Ｃは、図１に示す１次側ユニット１ｂを構成する各種回路を実装した電気基板３９をケーシング８の外部に、これを内部に収容するケース４０とともに別置の形態で備えている。
【0050】
そして、前記ケース４０内に収容した電気基板３９は、図１に示す第１の整流平滑回路４に接続される第１の給電コード９ａと、駆動回路５の出力に接続される第２の給電コード９ｂを備えて構成されており、第１の給電コード９ａは、前記電源部３に接続可能に構成されている。
【0051】
一方、１次側ユニット１ｂには、一方端を１次側巻線６に接続した第３の給電コード９ｃが接続されており、前記第３の給電コード９ｃの他方端は、前記第２の給電コード９ｂと抜き差し可能なコネクタを具備して構成されている。
【0052】
図７に示す非接触給電装置Ｃは、前記１次側鉄心７に発生した磁束を、銅やアルミニウム等の金属からなるシールド２７と収容部８ｂの両方によって外部への漏出を阻止することができる。さらに、前記電気基板３９を収容するケース４０を銅またはアルミニウム等の金属とすることで、前記ケース４０内の電気基板３９に取り付けた各種回路が前記漏れ磁束の悪影響を受けることを、より一層確実に防止することができる。
【0053】
また、前記電気基板３９をケーシング８の外部に備えることで、ケーシング８自体を小型化することができ、１次側ユニット１ｂを設置する際の自由度を拡大できる。さらに、前記電気基板３９は、ケース４０とともに１次側ユニット１ｂと着脱自在に構成されているので、例えば、構造が相違する複数の１次側ユニットを択一的に選択して前記電気基板３９を接続することにより、利用者は、複数の１次側ユニットの各々に対応する電気基板３９をそれぞれ用意する必要はなく、単一の電気基板３９を利用して、複数の１次側ユニットを択一的に選択して動作させることが可能となる。
【0054】
さらに、図７に示す２次側ユニット２ｂを構成する電気基板３９をケーシング１３の外部に別置の形態で備えることにより、前記１次側ユニット１ｂ同様、２次側ユニット２ｂをコンパクトに形成して設置時の自由度を拡大するように構成してもよい。
【0055】
なお、前述の非接触給電装置Ａ～Ｃは、図１に示す共振式に限らず、位相制御式等、その他の公知構造からなるものでもよい。また、前記２次側ユニット２，２ａ，２ｂに接続する負荷は直流負荷に限定されるものではなく、交流負荷であってもよいことは当然である。
【0056】
以上説明したように、本発明の非接触給電装置Ａ～Ｃは、１次側ユニット１の１次側鉄心７から放出される磁束がケーシング８，１３に形成した開口部１８に嵌合した非磁性体からなる正面板１７、若しくは、非磁性体からなるケーシング８，１３を良好に通過して

、２次側ユニット２の２次側鉄心１０に確実に鎖交するとともに、２次側鉄心１０に鎖交する方向以外の磁束は、銅やアルミニウム等の金属からなる薄平板８ａ，１３ａと収容部８ｂ，１３ｂ、若しくは、薄平板８ａ，１３ａに取り付けた箔状または板状の銅やアルミニウム等の金属からなる漏れ磁束防止材３９によって外部に漏出することを極力抑制することができる。この結果、前記漏れ磁束が給電コード９に鎖交して１次側ユニット１に供給される電力にノイズが発生したり、２次側ユニット２の電気基板３１上に実装した各種回路に故障や不具合が発生することを確実に防止することができる。

【0057】

また、前記１次側ユニット１の電気基板３９を１次側ユニット１のケーシング８外部に、これを収容するケース４０とともに別置の形態で配置することにより、前記電気基板３９が１次側鉄心７から放出される磁束の悪影響を受けることを確実に阻止することができる。さらに、前記電気基板３９を１次側ユニット１と着脱自在に構成することにより、複数の１次側ユニット１を択一的に選択して接続することにより、単一の電気基板３９を利用して複数の１次側ユニット１を選択的に動作させることができる。

【図面の簡単な説明】

【0058】

【図1】本発明の非接触給電装置の構成を示すブロック図である。

【図2】前記非接触給電装置の使用状態を示す側面図である。

【図3】前記非接触給電装置を構成する１次側ユニットおよび２次側ユニットの内部構造を示す横断面図である。

【図4】前記１次側ユニットおよび２次側ユニットを示す正面図である。

【図5】前記１次側ユニットおよび２次側ユニットを示す斜視図である。

【図6】本発明の第２実施例における１次側ユニットおよび２次側ユニットを示す正面図である。

【図7】本発明の第３実施例における非接触給電装置の構造を示す側面図である。

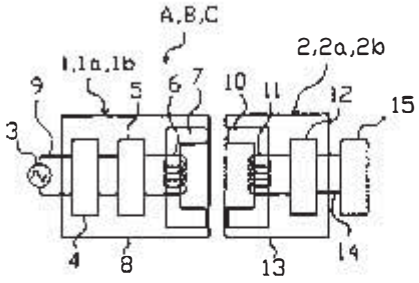
【符号の説明】

【0059】

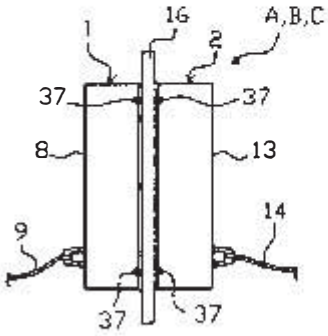
１，１ａ，１ｂ　１次側ユニット
２，２ａ，２ｂ　２次側ユニット
３　電源部
４　第１の整流平滑回路
５　駆動回路
６　１次側巻線
７　１次側鉄心
８，１３　ケーシング
９　給電コード
９ａ～９ｃ　第１～3の給電コード
１０　２次側鉄心
１１　２次側巻線
１２　第２の整流平滑回路
１４　接続コード
１５　負荷
１６　介在物
１７　正面板
１８　開口部
１９　支持片
２０，３７　皿ネジ
２１ａ，２１ｂ，２４，２８，３５，３６　挿通孔
２２，３８　締付ナット
２３　コイルボビン

２３ａ　軸部
２５，３０，３２　固定ボルト
２６，２９　螺着孔
２７　シールド
３１　電気基板
３３　端子
３４　端子台
３９　漏れ磁束防止部材
４０　ケース
Ａ～Ｃ　非接触給電装置

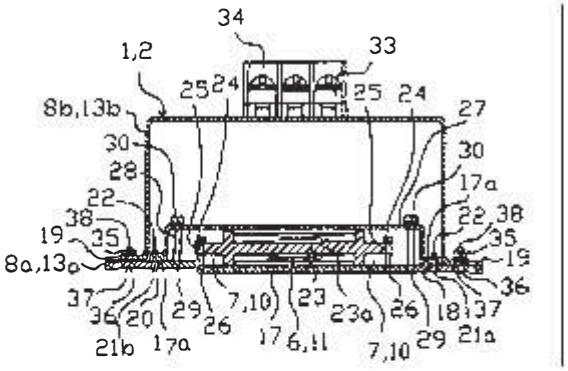
【図1】



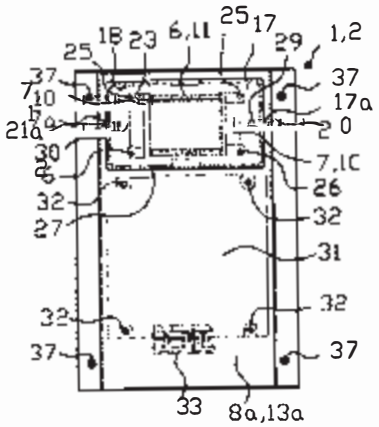
【図2】



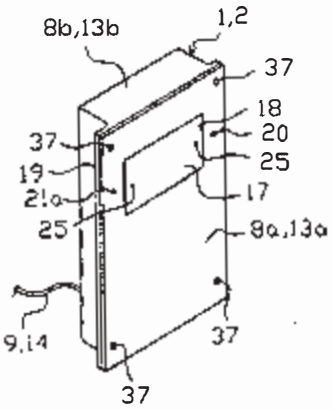
【図3】



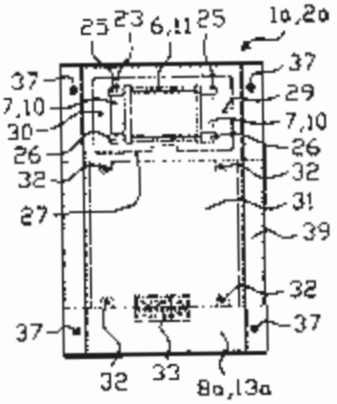
【図4】


25
18
23
6,11
25
17
29
1,2
37
7,10
1b
21a
30
8
32
27
37
17a
20
7,10
26
32
31
32
37
37
33
8a,13a

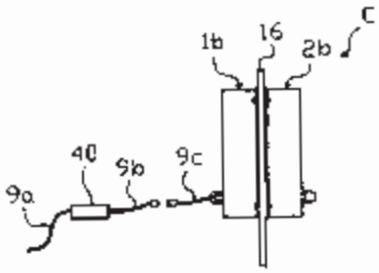
【図5】


8b,13b
1,2
37
18
20
25
17
37
19
21a
25
8a,13a
9,14
37
37

【図6】


25
23
6,11
25
1a,2a
37
37
7,10
29
30
7,10
26
26
32
32
27
31
39
32
37
37
32
33
8a,13a

【図7】


C
1b
16
2b
40
9b
9c
9a

Patent & Utility Model Number Search

(11)Publication number : 2005-101392
(43)Date of publication of application : 14.04.2005
(51)Int.Cl. H01F 38/14
H02J 17/00

(21)Application number : 2003-334575
(22)Date of filing : 26.09.2003
(71)Applicant : AICHI ELECTRIC CO LTD
(72)Inventor : SATO HIDETAKA
ITO YASUHIRO

(54)NON-CONTACT POWER FEEDING DEVICE

(57)Abstract
PROBLEM TO BE SOLVED: To provide a non-contact power feeding device capable of suppressing a leakage of a magnetic flux emitted from a primay side core from its outside case which houses the flux to the outside other than a direction interlinkaging to a secondary side core as much as possible.
SOLUTION: Outside cases 8, 13 of the primary side unit 1 and the secondary unit 2 are formed by a metal such as an aluminum or the like, an opening part 18 is provided at an opposed position of the outside case in which the primary core 7, and the secondary core 10 are housed in the outside cases 8, 13. A front plate 17 having the same shape as that of the opening part 18 and comprising a nonmagnetic material other than the metal is fit within the opening part 18 incapable of escaping from the part 18.

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]

A primary side unit which stores a primary side iron core which wound a primary side coil which applies an alternating current, Have a secondary unit which stores a secondary side iron core which wound the aforementioned primary side coil and a secondary side coil of a coupling transformer constituted disengageable, and by an electromagnetic induction action of the aforementioned coupling transformer, In a non-contact feeder system to supply, electric power from the aforementioned primary side unit by non-contact to a secondary unit the aforementioned primary side unit and a secondary unit, A non-contact feeder system having fitted into pulling-out impossible and constituting nonmagnetic materials other than metal which provides an opening to an opposed position of the aforementioned primary side iron core and a secondary side iron core of an outer case which consists of metal, such as copper or aluminum, and agrees with the opening in the aforementioned opening.

[Claim 2]

A primary side unit which stores a primary side iron core which wound a primary side coil which applies an alternating current, Have a secondary unit which stores a secondary side iron core which wound the aforementioned primary side coil and a secondary side coil of a coupling transformer constituted disengageable, and by an electromagnetic induction action of the aforementioned coupling transformer, In a non-contact feeder system to supply, electric power from the aforementioned primary side unit by non-contact to a secondary unit the aforementioned primary side unit and a secondary unit, A non-contact feeder system fixing and constituting metallic members, such as foil form, plate-like copper, or aluminum, in the inside except an opposed position of the aforementioned primary side iron core and a secondary side iron core of an outer case which consists of a nonmagnetic material.

[Claim 3]

Claim 1, a non-contact feeder system of two descriptions, wherein the aforementioned primary side unit equips outside of the aforementioned outer case with various circuits which constitute this with this and a form of a separate type freely attachable/detachable.

[Claim 4]

The non-contact feeder system according to claim 3 having stored said various circuits in a case which consists of metal, such as copper or aluminum, and constituting them.

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Field of the Invention]

[0001]

When the present invention supplies electric power to a secondary unit by non-contact from a primary side unit using the electromagnetic induction action of a coupling transformer, it relates to the structure of the non-contact feeder system which can inhibit that the magnetic flux emitted from the primary side iron core of the aforementioned primary side unit leaks out to outside vainly as much as possible.

[Background of the Invention]

[0002]

In the state where constituted from the former the primary side unit and secondary unit which store a secondary a primary coupling transformer side, respectively disengageable, and it made the aforementioned primary side unit and the secondary unit oppose, What is called a non-contact feeder system that supplies electric power to a secondary unit by non-contact from the aforementioned primary side unit exists using the electromagnetic induction action of the aforementioned coupling transformer (see Patent Document 1).

[0003]

When using the aforementioned non-contact feeder system, the power cord of the aforementioned primary side unit is inserted in power supply sections, such as an indoor electric socket, By making it arrange oppositely on both sides of inclusion (windowpane etc.) other than metal between the aforementioned primary side unit and a secondary unit, the aforementioned coupling transformer is formed from the primary side coil of the aforementioned primary side unit, and the secondary side coil of a secondary unit.

[0004]

And electric power is supplied to a primary side unit from the aforementioned power supply section by supplying the start switch with which the aforementioned primary side unit was equipped. At this time, the aforementioned primary side unit and a secondary unit, Since inclusion, such as a windowpane, is inserted and the coupling transformer is formed from the primary side coil and the secondary side coil like the above-mentioned, The electric power supplied to the aforementioned primary side unit is supplied to a secondary unit by non-contact via the aforementioned inclusion by the electromagnetic induction action of the aforementioned coupling transformer, and operates satisfactorily the load connected to the secondary unit by it.

[Patent document 1] JP,2003-158027,A

[Description of the Invention]

[Problem to be solved by the invention]

[0005]

The non-contact feeder system of the aforementioned [a Patent document 1] description, A resin material etc. the casing as an outer case of the aforementioned primary side unit and a secondary unit by forming with nonmagnetic materials other than metal, The magnetic flux emitted from the primary side iron core which wound the aforementioned primary side coil passes the casing of the aforementioned nonmagnetic material satisfactorily, and interlinks it reliably to the secondary side iron core which constitutes the aforementioned secondary unit.

[0006]

However, when the aforementioned casing is formed from nonmagnetic materials other than metal like the above-mentioned, since the magnetic flux which occurs in the aforementioned primary side iron core is radiately emitted towards outside from the end of the primary side iron core, it passes the casing which consists of the aforementioned nonmagnetic material, and is emitted in the various directions. That is, it is emitted not only in the direction which passes the casing in the front position of the aforementioned primary side iron core, and it interlinks to the aforementioned secondary side iron core but in the direction which is not interlinked with the aforementioned secondary side iron core.

[0007]

When the magnetic flux emitted to the aforementioned casing outside interlinks by this to the aforementioned power cord which connects fixed power sources, such as an indoor power supply, with a primary side unit, for example, A noise occurs on the voltage supplied to the aforementioned primary side unit from a fixed power source, and via a secondary unit from the aforementioned primary side unit, Unstable voltage was supplied to the load connected via the secondary unit and connecting cord, and the malfunction of the aforementioned load, and failure and fault may have been induced.

[0008]

Then, it avoids satisfactorily that the magnetic flux emitted from the primary side iron core of the aforementioned primary side unit leaks the present invention outside, and interlinks it to a power cord etc., It aims at providing the non-contact feeder system constituted so that it might prevent reliably that a noise etc. occur on the voltage supplied to a primary side unit.
[Means for solving problem]
[0009]
The primary side unit which stores the primary side iron core which wound the primary side coil which applies an alternating current according to the first aspect of affairs, Have a secondary unit which stores the secondary side iron core which wound the aforementioned primary side coil and the secondary side coil of the coupling transformer constituted disengageable, and by the electromagnetic induction action of the aforementioned coupling transformer, In the non-contact feeder system to supply, electric power from the aforementioned primary side unit by non-contact to a secondary unit the aforementioned primary side unit and a secondary unit, The opening was formed in the opposed position of the aforementioned primary side iron core and secondary side iron core of an outer case which consists of metal, such as copper or aluminum, and nonmagnetic materials other than the metal which agrees with the opening concerned in the opening were attached to pulling-out impossible, and were constituted.
[0010]
The primary side unit which stores the primary side iron core which wound the primary side coil which applies an alternating current according to the second aspect of affairs, Have a secondary unit which stores the secondary side iron core which wound the aforementioned primary side coil and the secondary side coil of the coupling transformer constituted disengageable, and by the electromagnetic induction action of the aforementioned coupling transformer, In the non-contact feeder system to supply, electric power from the aforementioned primary side unit by non-contact to a secondary unit the aforementioned primary side unit and a secondary unit, Metallic members, such as foil form, plate-like copper, or aluminum, were attached and constituted in the inside except the opposed face of the aforementioned primary side iron core and secondary side iron core of an outer case which consists of a nonmagnetic material.
[0011]
According to the 3rd aspect of affairs, in the 1st and 2 aspect of affairs, the aforementioned primary side unit provided with and constituted the various circuits which constitute this from a separate-type form freely attachable/detachable in the aforementioned outer case outside.
[0012]
According to the 4th aspect of affairs, in the 3rd aspect of affairs, the above-mentioned various circuits were stored in the case which consists of metal, such as copper and aluminum, and were constituted.
[Effect of the Invention]
[0013]
According to the invention according to claim 1, the outer case of a primary side unit and a secondary unit is formed with metal, such as copper and aluminum, Since the opening was formed in the opposed position of the primary side iron core and secondary side iron core of the aforementioned outer case and the nonmagnetic material was fitted in and constituted in the aforementioned opening, the magnetic flux emitted from the aforementioned primary side iron core, Since the aforementioned outer case consists of metal, such as copper and aluminum, while passing the aforementioned nonmagnetic material and interlinking reliably to the aforementioned secondary side iron core, the magnetic flux emitted from the aforementioned primary side iron core, Except the direction interlinked to a secondary side iron core, the magnetic flux leaked to the power supplying cord which the passage to outside is inhibited as much as possible by the aforementioned outer case, for example, connects a fixed power source etc. with a primary side unit can interlink, and it can prevent reliably the problem which a noise generates in service voltage.
[0014]
According to the invention according to claim 2, stick copper foil or aluminium foil on the inner side surface of the outer case which consists of a nonmagnetic material, or, While being able to acquire the same effect as the invention according to claim 1 by attaching metal plates, such as a copper plate or an aluminum plate, the aforementioned outer case, Since it is not the geometry which consists of metal and a nonmagnetic material but the single structure by a nonmagnetic material, while simplifying structure and being able to attain shortening of manufacture time, it excels also in the fine sight nature of appearance.
[0015]
By equipping the outside of the aforementioned outer case with the various circuits which constitute a primary side unit with a separate-type form freely attachable/detachable with this according to the invention according to claim 3, For example, a plurality of primary side units can be selectively operated using the single electric board which mounted the above-mentioned various circuits by choosing alternatively a plurality of primary side units from which structure is different. When the aforementioned outer case can be constituted compactly and a non-contact feeder system is used by equipping the outside of the aforementioned outer case with the above-mentioned various circuits, the installation flexibility of the aforementioned unit can be expanded.
[0016]
While equipping the outside of the aforementioned outer case with the various circuits which constitute the aforementioned primary side unit and a secondary unit according to the invention according to claim 4, By constituting the case where the above-mentioned various circuits are stored, with metal, such as copper or aluminum, it can prevent reliably the magnetic flux emitted from the aforementioned primary side iron core interlinking in the above-mentioned various circuits, and having an adverse effect.
[Best Mode of Carrying Out the Invention]
[0017]

The magnetic flux emitted from the primary side iron core of a primary side unit was leaked to the outer case outside of the aforementioned primary side unit, and realized the non-contact feeder system which can prevent inducing various problems reliably by a simple structure.
[Working example]
[0018]
Hereinafter, an embodiment of the invention is described by Fig.1 thru/or Fig.5. Fig.1 is a block diagram showing composition of a non-contact feeder system of the present invention.
In Fig.1, 1 is a primary side unit and 2 shows a secondary unit used between the aforementioned primary side units 1 opening a predetermined interval and arranging oppositely.

[0019]
The first rectification smoothing circuit 4 where the aforementioned primary side unit 1 converts the alternating current voltage supplied from the power supply sections 3, such as commercial power, to a direct current, It comprises the drive circuit 5 which converts an output of the above-mentioned first rectification smoothing circuit 4 to an alternating current of high frequency, and it applies to the primary side coil 6, and the primary side iron core 7 which winds the aforementioned primary side coil 6 around a leg steel part.
Each of these circuits are stored in the casing 8 as an outer case, and receive supply of electric power from the aforementioned power supply section 3 via the power supplying cord 9.

[0020]
The secondary side iron core 10 which the secondary unit 2 compares the primary side iron core 7 and end of the primary side unit 1, and is arranged on the other hand, The second rectification smoothing circuit 12 connected to the output of the secondary side coil 11 wound around the secondary side iron core 10 and the secondary side coil 11 is provided, and it is accommodated in the casing 13 as an outer case. And the electric power supplied from the aforementioned primary side unit 1 can be supplied to the aforementioned load 15 by connecting the load 15 (direct current load) via the connecting cord 14.
[0021]
Fig.2 is a side view showing an example of a busy condition of the aforementioned non-contact feeder system A.
Between the aforementioned primary side unit 1 and the secondary unit 2, the inclusion (glass window etc.) 16 other than metal interposes.
At this time, the aforementioned primary side unit 1 and the secondary unit 2 are attached by the fixing means which is installed in the aforementioned inclusion 16 and which is not illustrated, for example, and are arranged oppositely mutually.
[0022]
When the aforementioned primary side unit 1 is being assembled, ABS plastics, PBT (polybutylene terephthalate) resin, or poly card NETO first prepares the small front board 17 formed in the thin walled rectangular shape which consists of nonmagnetic materials other than metal. The fixed guard 17a which formed in the side surface longitudinal direction halfway part of the aforementioned front board 17 the insertion hole of the screw member mentioned below projects and possesses to the side, forming a level difference back to the plane part of the aforementioned front board 17.
[0023]
Next, two kinds of components which constitute the casing 8 of the aforementioned primary side unit 1 are prepared. One is the thin plate 8a of the rectangular shape which consists of metal, such as copper and aluminum, and, similarly another is the accommodation part 8b of the approximately bottomed Naokata form which consists of metal, such as copper and aluminum. The opening 18 of the form which agrees with the plane part of the aforementioned front board 17 is formed in the position (front position of the primary side iron core 7) where the aforementioned primary side iron core 7 stored in the casing 8 opposes to the aforementioned thin plate 8a.
[0024]
On the other hand, in the aforementioned accommodation part 8b, the holding piece 19 projected from the opening position to the side possesses.
The aforementioned accommodation part 8b is combined with swing impossible to the aforementioned thin plate 8a using the holding piece 19 concerned.

[0025]
When attaching the front board 17 to the aforementioned thin plate 8a, the aforementioned thin plate 8a is made to abut the aforementioned fixed guard 17a by inserting in the plane part of the aforementioned front board 17 in the opening 18 formed in the aforementioned thin plate 8a. In this state, as shown in Fig.3, the flat countersunk head screw 20 is inserted in the insertion holes 21a and 21b formed in each of the fixed guard 17a provided in the aforementioned thin plate 8a and the aforementioned front board 17 from the one surface (lower part of Fig.3) side of the aforementioned thin plate 8a, The point is made to project above the fixed guard 17a provided in the aforementioned front board 17.
[0026]
And the plane part fixes the aforementioned front board 17 to pulling-out impossible reliably in the state where it was completely inserted in in the opening 18 formed in the aforementioned thin plate 8a, by binding tight and fixing the nut 22 with a bundle to the aforementioned flat countersunk head screw 20 which projected the point above the aforementioned fixed guard 17a.
[0027]
Next, the leg steel part of the primary side iron core 7 is stored and fixed at the hollow section which was drilled in the shank 23a and which is not illustrated, The coil bobbin 23 which carried

out predetermined winding number winding of the primary side coil 6 at the periphery of the aforementioned shank 23a, Reliance is so that the aforementioned front board 17 may be abutted, and the end of the aforementioned primary side iron core 7 inserts in the securing bolt 25 in the insertion hole 24 formed in the yoke part of the aforementioned coil bobbin 23, [multiple] By carrying out the screw stop of the point to the aforementioned insertion hole 24 of the aforementioned front board 17, and the screwing hole 26 formed in the corresponding position, the primary side iron core 7 fixed to the aforementioned coil bobbin 23 is reliably fixed to the aforementioned front board 17.

[0028]

It continues and the aforementioned primary side iron core 7 is isolated with the circumference by putting the shield 27 of approximately rectangular case shape which consists of metal, such as copper or aluminum, on the circumference of the primary side iron core 7 fixed to the aforementioned front board 17. The aforementioned shield 27 is fixed to the aforementioned front board 17 by screwing the securing bolt 30 on the screwing hole 29 which inserted in the insertion hole 28 and was formed in the aforementioned front board 17.

[0029]

On the other hand, the electric board 31 which mounted the various circuits which constitute the primary side unit 1 shown in Fig.1 is reliably fixed to the aforementioned thin plate 8a with the securing bolt 32, as shown in Fig.4. The drive circuit 5 shown in Fig.1 is electrically connected to the aforementioned primary side coil 6 stored in the aforementioned shield 27.

[0030]

As shown in Fig.3, the terminal 33 which connects the aforementioned primary side unit 1 with an external power is fixed to the aforementioned accommodation part 8b by the terminal block 34. Therefore, when fixing the accommodation part 8b to the aforementioned thin plate 8a, After electrically connecting the first rectification smoothing circuit 4 on the aforementioned electric board 31 to the aforementioned terminal 33, the aforementioned thin plate 8a is abutted in the holding piece 19 which extended from the opening of the aforementioned accommodation part 8b to the side, The aforementioned accommodation part 8b and the thin plate 8a are combined with separation impossible by inserting in the flat countersunk head screw 37 in the insertion hole 35 and 36 formed in the same position of the aforementioned holding piece 19 and the thin plate 8a, and binding tight the point of the flat countersunk head screw 37 concerned with the nut 38 with a bundle via the aforementioned thin plate 8a and the holding piece 19.

[0031]

And the aforementioned primary side unit 1 ends the assembly by connecting the aforementioned power supplying cord 9 to the terminal 33 attached to the aforementioned accommodation part 8b. Since it is the same as that of the case where the aforementioned primary side unit 1 is being assembled, about an assembly of the secondary unit 2, a description is omitted.

[0032]

Fig.5 is a perspective view in which assembling and showing the appearance of the primary side unit 1 aforementioned [after an end], or the secondary unit 2. As shown in Fig.5, the aforementioned primary side unit 1 and the secondary unit 2, The opening 18 is formed in some thin plates 8a and 13a which oppose mutually, and in this opening 18, ABS plastics, PBT (polybutylene terephthalate) resin, polycarbonate, etc. insert in the front board 17 which consists of nonmagnetic materials other than metal, and are constituted.

[0033]

The aforementioned thin plates 8a and 13a consist of metal, such as copper and aluminum, and are integrally fixed in a similar manner using the holding piece 19 of the accommodation parts 8b and 13b which consists of metal, such as copper and aluminum, the flat countersunk head screw 37, and the nut 38 (refer to Fig.3) with a bundle.

[0034]

Next, it describes with the effect acquired about the case where the aforementioned non-contact feeder system A is used. When using the aforementioned non-contact feeder system A, the primary side unit 1 and the secondary unit 2 are made to arrange oppositely via the inclusion 16, such as a glass window, first, using the fixing means etc. which are not illustrated, as shown in Fig.2.

[0035]

The electric power of the aforementioned power supply section 3 is supplied to the first rectification smoothing circuit 4 shown in Fig.1 by connecting with the power supply sections 3, such as commercial power which does not illustrate the power supplying cord 9 connected to the aforementioned primary side unit 1, in this state, and supplying the start switch which is provided in the primary side unit 1 and which is not illustrated.

[0036]

The above-mentioned first rectification smoothing circuit 4 converts the supplied alternating current voltage to a direct current, outputs it to the drive circuit 5, and the drive circuit 5 converts the output of the above-mentioned first rectification smoothing circuit 4 to the alternating current of high frequency, and it applies it to the primary side coil 6. Since the aforementioned primary side coil 6 is wound around the leg steel part of the primary side iron core 7 at this time, if the alternating current of high frequency is applied to the aforementioned primary side coil 6, magnetic flux will occur in the aforementioned primary side iron core 7.

[0037]

The magnetic flux which occurred in the aforementioned primary side iron core 7 passes satisfactorily the front board 17 which consists of the nonmagnetic material which fitted in in the opening 18 formed in the thin plate 8a shown in Fig.3 thru/or Fig.5 from the end of the primary side iron core 7, After passing the inclusion 16, such as a windowpane shown in Fig.2, the front board 17 which fitted in in the opening 18 formed in the thin plate 13a of the secondary unit 2 is passed reliably, and it interlinks reliably to the secondary side iron core 10

stored in the casing 13 of the aforementioned secondary unit 2.

[0038]

Although the magnetic flux which occurred in the aforementioned primary side iron core 7 is radiately emitted outside from that end at this time and it is going to pass the thin plate 8a of the primary side unit 1, Since the aforementioned thin plate 8a is constituted by metal, such as copper and aluminum, as mentioned above, through put (the amount of leakage flux) is reliably inhibited by the magnetic resistance of this thin plate 8a in the outside of the aforementioned magnetic flux.

[0039]

As a result, the magnetic flux which leaked to the outside of the aforementioned casing 8 interlinks to the power supplying cord 9 which connects between the power supply sections 3 with the primary side unit 1, Also in the case where made the electric power supplied to the primary side unit 1 generate a noise, and passed the inclusion 16, such as a glass window shown in Fig.2, and it reaches the secondary unit 2, Since the magnetic flux amount interlinked in the casing 13 of the secondary unit 2 with the thin plate 13a which consists of metal, such as copper and aluminum, which constitutes the aforementioned secondary unit 2 can be decreased reliably, It can eliminate having an adverse effect on the various circuits on the electric board 31 which the aforementioned leakage flux stored in the casing 13 as much as possible.

[0040]

That is, the magnetic flux emitted from the primary side iron core 7, While passing satisfactorily the front board 17 which consists of the nonmagnetic material which exists in the front position of the aforementioned primary side iron core 7, and the front board 17 which consists of the nonmagnetic material which constitutes the casing 13 and interlinking reliably to the secondary side iron core 10, Leaking out to outside unnecessarily is inhibited as much as possible by the thin plate 8a and the accommodation parts 8b which consists of metal, such as copper and aluminum.

[0041]

Also in the leakage flux which passed the thin plate 8a of the aforementioned primary side unit 1, and was slightly leaked to outside, After passing the inclusion 16 shown in Fig.2, since it can prevent interlinking in the casing 13 reliably, by existence of the thin plate 13a of the secondary unit 2 which consists of metal, such as copper and aluminum, It can prevent completely that the various circuits on the electric board 31 stored in the casing 13 of the aforementioned secondary unit 2 break down by the aforementioned leakage flux, or produce fault.

[0042]

The magnetic flux which passed the front board 17 satisfactorily from the aforementioned primary side iron core 7, and was interlinked to the secondary side iron core 10 makes the secondary side coil 11 wound around the leg steel part of the aforementioned secondary side iron core 10 induce alternating current voltage.

[0043]

The alternating current voltage induced by the aforementioned secondary side coil 11, It is after it inputs into the second rectification smoothing circuit 12 shown in Fig.1 and the above-mentioned second rectification smoothing circuit 12 converts the input alternating current voltage to direct current voltage. The load 15 connected by the connecting cord 14 can be supplied, and it can be made to operate with the stable electric power which is not subject to the influence of the noise according the aforementioned load 15 to leakage flux etc.

[0044]

It continues and describes the 2nd working example of the present invention by Fig.6. Fig.6 is a front view showing the non-contact feeder system B of the 2nd working example, and the place which is different from the primary side unit 1 of the 1st working example shown in Fig.4 in the primary side unit 1a of Fig.6, It is forming the thin plate 8a with nonmagnetic materials, such as ABS plastics, PBT (polybutylene terephthalate) resin, or polycarbonate, and not forming in the front position of the primary side iron core 7 the opening 18 in which the front board 17 is inserted.

[0045]

As a result, the thing of the shield 27 which consists of metal, such as copper or aluminum, which surrounds the aforementioned primary side iron core 7 for which the foil form or the plate-like leakage flux prevention material 39 which consists of metal, such as copper or aluminum, are attached and constituted caudad is needed.

[0046]

When attaching the aforementioned leakage flux prevention material 39, When assembling the primary side unit 1a, stick on the thin plate 8a the aforementioned leakage flux prevention material 39 which consists of foil form, plate-like copper, or aluminum using adhesives etc., and, for example in this state, After pinching the aforementioned leakage flux prevention material 39 between the holding piece 19 of the accommodation part 8b which constitutes the casing 8, and the aforementioned thin plate 8a, it may fix using the flat countersunk head screw 31 and the nut 22 with a bundle.

[0047]

The magnetic flux which occurred in the aforementioned primary side iron core 7 by carrying out like this, After passing the inclusion 16, such as a glass window shown in Fig.2 from the thin plate 8a which consists of a nonmagnetic material, The thin plate 13a of the nonmagnetic material which constitutes the casing 8 of the aforementioned primary side unit 1a and the casing 13 of the secondary unit 2a formed similarly is passed, and it interlinks to the secondary side iron core 10 stored in the aforementioned casing 13.

[0048]

the leakage flux of the aforementioned primary side iron core 7 can inhibit leaking out to outside by the leakage flux prevention material 39 which consists of the foil form or plate-like copper attached to the thin plate 8a which constitutes the casing 8 of the aforementioned

primary side unit 1a, or aluminum as much as possible, and, Since it can prevent reliably entering in the casing 13 also in the leakage flux slightly leaked to outside by the leakage flux prevention material 39 which consists of metal, such as copper attached to the thin plate 13a of the secondary unit 2a, or aluminum, It can prevent reliably the aforementioned leakage flux interlinking in the power supplying cord 9 which connects the aforementioned primary side unit 1a and the power supply section 3, and the various circuits mounted on the electric board 31 of the secondary unit 2a, and having an adverse effect on them.

[0049]

Fig.7 is a side view which describes the structure of the non-contact feeder system A in the 3rd working example of the present invention. That is, it has the non-contact feeder system C shown in Fig.7 with the separate-type form with the case 40 where store the electric board 39 which mounted the various circuits which constitute the primary side unit 1b shown in Fig.1 in the outside of the casing 8, and it stores this in an inside.

[0050]

And the electric board 39 stored in the aforementioned case 40 is provided with the first power supplying cord 9a connected to the first rectification smoothing circuit 4 shown in Fig.1, and the second power supplying cord 9b connected to an output of the drive circuit 5, and is constituted.

The first power supplying cord 9a is constituted so that connection with the aforementioned power supply section 3 is possible.

[0051]

On the other hand, a one end is connected to the primary side unit 1b in the 3rd power supplying cord 9c connected to the primary side coil 6.

An another side end of the 3rd above-mentioned power supplying cord 9c possesses the above-mentioned second power supplying cord 9b and a connector which can be taken out and inserted, and is constituted.

[0052]

The non-contact feeder system C shown in Fig.7 can prevent the break through to outside for the magnetic flux which occurred in the aforementioned primary side iron core 7 by both the shield 27 which consists of metal, such as copper and aluminum, and the accommodation part 8b. The various circuits which attached to the electric board 39 in the aforementioned case 40 the case 40 where the aforementioned electric board 39 was stored, by considering it as metal, such as copper or aluminum, can be prevented more from receiving the adverse effect of the aforementioned leakage flux much more reliably.

[0053]

By equipping the outside of the casing 8 with the aforementioned electric board 39, casing 8 the very thing can be miniaturized and the flexibility at the time of installing the primary side unit 1b can be expanded. Since the aforementioned electric board 39 is constituted [side unit / primary / 1b] freely attachable/detachable with the case 40, For example, by choosing alternatively a plurality of primary side units from which structure is different, and connecting the aforementioned electric board 39 a user, It is not necessary to prepare the electric board 39 corresponding to each of a plurality of primary side units, respectively, and it becomes possible to choose a plurality of primary side units alternatively, and to operate them using the single electric board 39.

[0054]

By equipping the outside of the casing 13 with the electric board 39 which constitutes secondary unit 2b shown in Fig.7 with a separate-type form, it may constitute so that secondary unit 2b may be formed compactly and the flexibility at the time of installation may be expanded like the aforementioned primary side unit 1b.

[0055]

The thing which consists of the publicly known structure of others, such as not only the resonance type shown in Fig.1 but a phase control type, may be sufficient as above-mentioned non-contact feeder system A-C. The load linked to the aforementioned secondary units 2 and 2a and 2b is not limited to direct current load, and that of it being alternating current load is natural.

[0056]

As described above, non-contact feeder system A-C of the present invention, the front board 17 which consists of the nonmagnetic material which fitted into the opening 18 which the magnetic flux emitted from the primary side iron core 7 of the primary side unit 1 formed in the casings 8 and 13 -- or, While passing satisfactorily the casings 8 and 13 which consists of a nonmagnetic material and interlinking reliably to the secondary side iron core 10 of the secondary unit 2, magnetic flux other than the direction interlinked to the secondary side iron core 10, It can inhibit leaking out outside by the leakage flux prevention material 39 which consists of the metal attached to the thin plates 8a and 13a which consists of metal, such as copper and aluminum, the accommodation parts 8b and 13b, or the thin plates 8a and 13a, such as foil form or plate-like copper, and aluminum, as much as possible. As a result, failure and fault can be reliably prevented from a noise occurring to the electric power which the aforementioned leakage flux interlinks to the power supplying cord 9, and is supplied to the primary side unit 1, or occurring in the various circuits mounted on the electric board 31 of the secondary unit 2.

[0057]

The aforementioned electric board 39 can prevent reliably receiving the adverse effect of the magnetic flux emitted from the primary side iron core 7 by arranging the electric board 39 of the aforementioned primary side unit 1 with a separate-type form with the case 40 where this is stored in casing 8 outside of the primary side unit 1. A plurality of primary side units 1 can be selectively operated using the single electric board 39 by choosing alternatively a plurality of

primary side units 1, and connecting by constituting the aforementioned electric board 39 freely attachable/detachable with the primary side unit 1.

[Brief Description of the Drawings]

[0058]

[Drawing 1]It is a block diagram showing the composition of the non-contact feeder system of the present invention.

[Drawing 2]It is a side view showing the busy condition of the aforementioned non-contact feeder system.

[Drawing 3]It is a cross-sectional view showing the internal structure of the primary side unit which constitutes the aforementioned non-contact feeder system, and a secondary unit.

[Drawing 4]It is a front view showing the aforementioned primary side unit and a secondary unit.

[Drawing 5]It is a perspective view showing the aforementioned primary side unit and a secondary unit.

[Drawing 6]It is a front view showing the primary side unit and secondary unit in the 2nd working example of the present invention.

[Drawing 7]It is a side view showing the structure of the non-contact feeder system in the 3rd working example of the present invention.

[Explanations of letters or numerals]

[0059]

1, 1a, 1b primary side unit
2, 2a, 2b secondary unit
3 Power supply section
4 A first rectification smoothing circuit
5 Drive circuit
6 Primary side coil
7 Primary side iron core
8 and 13 Casing
9 Power supplying cord
9a-9c The 1-3rd power supplying cords
10 Secondary side iron core
11 Secondary side coil
12 A second rectification smoothing circuit
14 Connecting cord
15 Load
16 Inclusion
17 Front board
18 Opening
19 Holding piece
20, 37 flat countersunk head screws
21a, 21b, 24, 28, 35, and 36 Insertion hole
22 and 38 Nut with a bundle
23 Coil bobbin
23a Shank
25, 30, 32 securing bolts
26 and 29 Screwing hole
27 Shield
31 Electric board
33 Terminal
34 Terminal block
39 Leakage flux prevention member
40 Case
A-C Non-contact feeder system

*** NOTICES ***

JPO and INPIT are not responsible for any damages caused by the use of this translation.

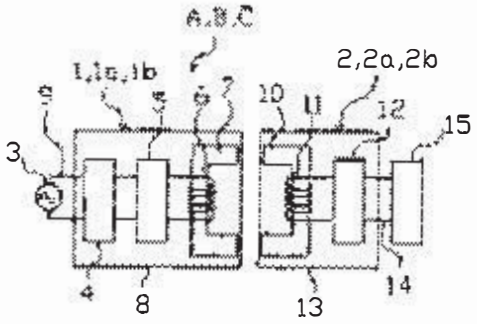
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

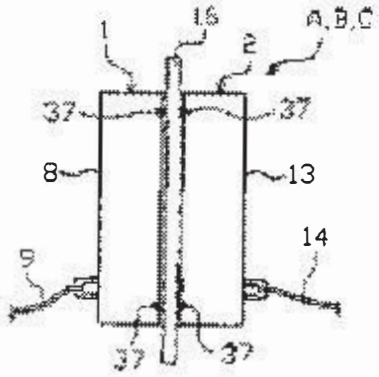
3.In the drawings, any words are not translated.

DRAWINGS

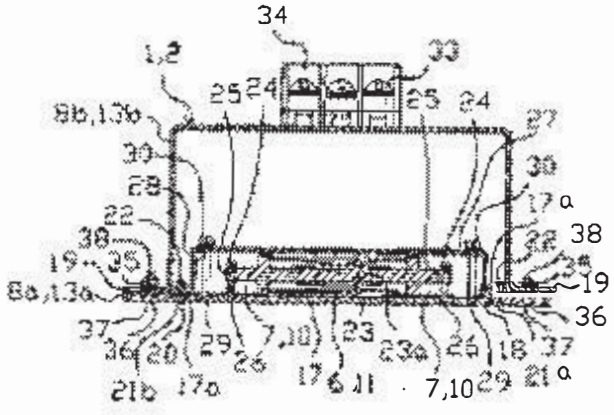
[Drawing 1]



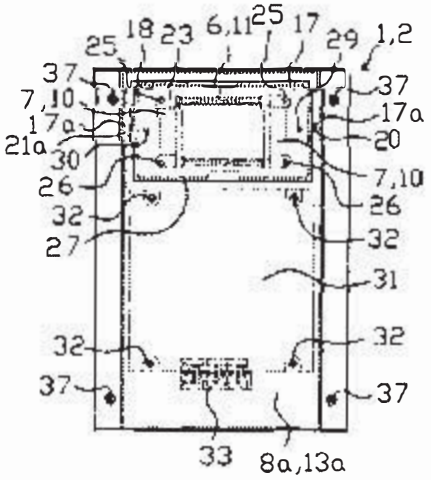
[Drawing 2]



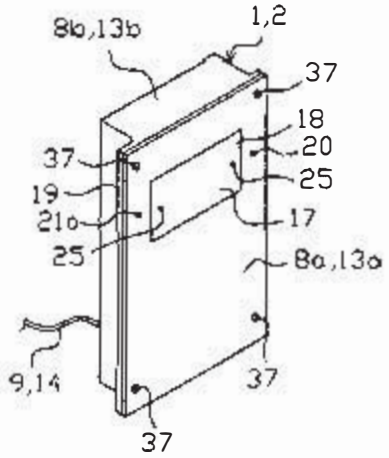
[Drawing 3]



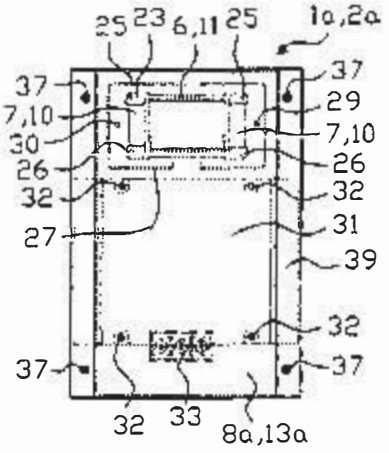
[Drawing 4]



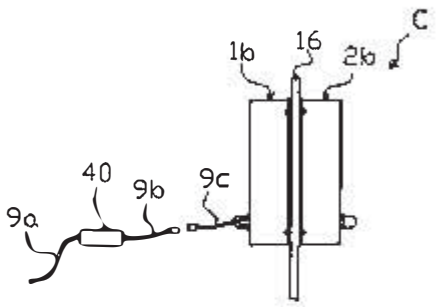
[Drawing 5]



[Drawing 6]



[Drawing 7]



(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2008-87733
(P2008-87733A)
(43)公開日　平成20年4月17日(2008.4.17)

(51)Int.Cl.		F I		テーマコード(参考)
B60M 7/00	(2006.01)	B60M 7/00	X	

審査請求 未請求　請求項の数 2　OL　(全 12 頁)

(21)出願番号　特願2006-273933 (P2006-273933)
(22)出願日　平成18年10月5日 (2006.10.5)

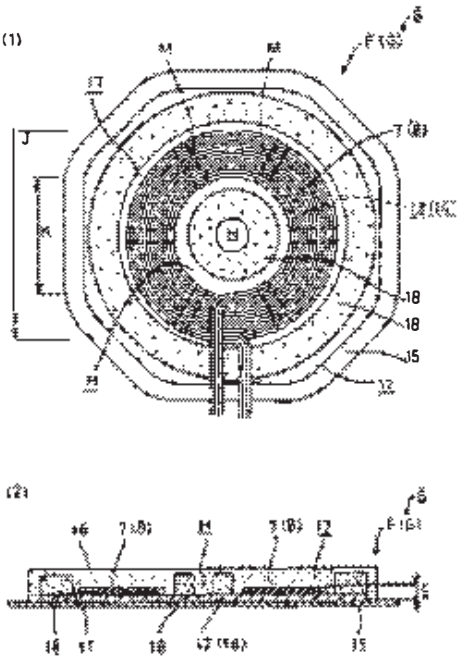
(出願人による申告) 国等の委託研究の成果に係る特許出願（平成１７，１８年度、独立行政法人新エネルギー・産業技術総合開発機構「エネルギー使用合理化技術戦略的開発，エネルギー有効利用基盤技術先導研究，非接触給電装置の研究」産業活力再生特別措置法第３０条の適用を受ける特許出願）

(71)出願人　000187208
昭和飛行機工業株式会社
東京都昭島市田中町６００番地
(71)出願人　504157024
国立大学法人東北大学
宮城県仙台市青葉区片平二丁目１番１号
(74)代理人　100086092
弁理士　合志　元延
(72)発明者　山本　喜多男
東京都昭島市田中町６００番地　昭和飛行機工業株式会社内
(72)発明者　鈴木　義雄
東京都昭島市田中町６００番地　昭和飛行機工業株式会社内

最終頁に続く

(54)【発明の名称】非接触給電装置

(57)【要約】
【課題】第１に、充電効率が向上し、第２に、大ギャップ化が実現されて、使い易さが向上すると共に、第３に、小型，軽量化も実現される、非接触給電装置を提案する。
【解決手段】この非接触給電装置６は、例えば電気自動車のバッテリー充電用に使用され、電磁誘導の相互誘電作用に基づき、１次側，給電側の１次コイル７から、２次側，受電側の２次コイル８に、電力を供給する。１次コイル７および２次コイル８は、複数本の平行導線を１セットとして、同一面で扁平に渦巻き巻回した構造よりなり、一定ピッチで捲回されている。１次コイル７や２次コイル８が配設される１次磁心コア１３や２次磁心コア１４は、フェライト製等よりなり、平板状をなす。そして、１次コイル７と１次磁心コア１３の表面、および２次コイル８と２次磁心コア１４の表面は、それぞれモールド樹脂１７にて被覆固定されると共に、モールド樹脂１７中に発泡材１８が混入されている。
【選択図】図１



【特許請求の範囲】
【請求項１】
電磁誘導の相互誘電作用に基づき、１次コイルから２次コイルに電力を供給する非接触給電装置において、該１次コイルおよび２次コイルは、同一面で扁平に渦巻き巻回された構造よりなり、該１次コイルや２次コイルが配設される磁心コアは、平板状をなすこと、を特徴とする非接触給電装置。
【請求項２】
請求項１に記載した非接触給電装置において、該１次コイルとその該磁心コアの表面、および該２次コイルとその該磁心コアの表面は、それぞれ、モールド樹脂にて被覆固定されると共に、該モールド樹脂中に発泡材が混入されていること、を特徴とする非接触給電装置。

【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、非接触給電装置に関する。すなわち、電磁誘導の相互誘電作用に基づき、例えば電気自動車のバッテリーを外部から非接触で充電する、非接触給電装置に関するものである。
【背景技術】
【０００２】
《技術的背景》
図４の（１）図は、この種の非接触給電装置について、その基本原理の説明に供する、斜視説明図である。
同図にも示したように、電磁誘導の相互誘電作用に基づき、１次コイル１から２次コイル２に電力を供給する非接触給電装置３は、従来より知られており、例えば電気自動車のバッテリー充電用に使用されている。
すなわち、１次磁心コア４に巻回された１次コイル１が、２次磁心コア５に巻回された２次コイル２に対峙配置され、もって、１次コイル１での磁束形成により、２次コイル２に誘電起電力を生成して、電力を供給する。
【０００３】
《先行技術文献情報》
このような非接触給電装置３としては、例えば、次の特許文献１，２，３に示されたものが挙げられる。
【０００４】
【特許文献１】特許第３６３０４５２号公報（特開平６－２５６５０５号公報）
【特許文献２】国際公開第９２／１７９２９号
【特許文献３】国際公開第９９／０８３５９号
【０００５】
《従来技術》
図３は、この種従来例の説明に供し、（１）図は、１次側の平面図（２次側の平面図）であり、（２）図は、１次側と２次側の正面図、（３）図は、１次側と２次側の側断面図である。
まず、この種の非接触給電装置３では、１次側Ａと２次側Ｂとが、対称構造をなす。そして、この従来例の非接触給電装置３において、１次磁心コア４や２次磁心コア５は、例えば略Ｕ字状や略Ｅ字状の凹凸形状をなすと共に、多数個が所定相互間隔で平面的に配置されていた。そして、この１次磁心コア４や２次磁心コア５を利用して、それぞれ、その凹部間に１次コイル１や２次コイル２が、全体で図示のように方形あるいは円形に巻回されていた。
そして、このような１次側Ａと２次側Ｂを、エアギャップＣを介して対峙配置し、１次コイル１への励磁電流通電，磁束Ｄ形成により、２次コイル２に誘電起電力が生成され、

もって、電力が１次側Ａから２次側Ｂに供給され、２次側Ｂに接続されたバッテリーが充電されていた。

【発明の開示】

【発明が解決しようとする課題】

【０００６】

ところで、このような従来例については、次の問題が指摘されていた。

《第１の問題点》

第１に、この種従来例の非接触給電装置３については、より一層の効率化，充電効率の向上が、望まれていた。

例えば、この種従来例では、凹凸形状の１次，２次の磁心コア４，５が使用されていたので、磁束Ｄ分布が、図２の（３）図の正面説明図に示したようになる。すなわち、給電に際し対峙配置される１次側Ａと２次側Ｂ間のエアギャップＣ中の磁束Ｄが、極に向け湾曲，集中するように分布するので、極付近では、磁束Ｄ密度が極めて高くなる。空気中の磁束Ｄ密度とその起磁力とは、比例するので、高密度の分だけ大きな起磁力を要することになり、結局、１次コイル１について、より大きな励磁電流が必要となり、その分、ジュール熱損失も多くなり、充電効率低下の一因となっていた。

更に、充電効率低下の要因として、渦電流発生によるジュール熱損失も、指摘されていた。すなわち、方形に巻回された１次コイル１や２次コイル２について、図３の（１）図では紙面に垂直な方向に、形成された交番磁束Ｄが通過することにより、その線間に、一種の渦電流であるループ電流Ｌが流れ（後述する図２の（４）図も参照）、その分だけ、ジュール熱損失が発生していた。

これらにより、この種従来例の非接触給電装置３は、その充電効率が８６％程度とされており、一層の省エネルギー化が望まれていた。

【０００７】

《第２の問題点》

第２に、この種従来例の非接触給電装置３については、更なる大ギャップ化が望まれていた。

すなわち、この種従来例では、図２の（３）図を参照して前述したように、エアギャップＣ中の磁束Ｄ密度が高いので、その分、大きな励磁電流を要し、多大なジュール熱損失を招くという難点がある。これに対し、使い易さ向上のため、更にエアギャップＣを広げるためには、より過大な励磁電流を必要とすることになってしまう。

結局、磁束Ｄ密度が高いこの種従来例では、エアギャップＣは５０ｍｍ程度が限界とされており、大ギャップ化が切望されていた。

すなわち、給電に際し対峙配置される１次側Ａと２次側Ｂは、その間のエアギャップＣが広い程、給電の為の位置決め操作が容易化される等、使い易い。これに対し、この種従来例のように小ギャップのもとでは、給電のためのセットアップに際し、１次側Ａと２次側Ｂ間の衝突回避に配慮する必要がある等、操作が面倒であり、大ギャップ化，より一層の使い易さ向上が望まれていた。

【０００８】

《第３の問題点》

第３に、この種従来例の非接触給電装置３については、より一層の小型，軽量化が望まれていた。

特に、ピックアップとも称される２次側Ｂについては、例えばマイクロバス等の電気自動車のバッテリー充電用として常時車載されることに鑑み、小型，軽量化が切望されていた。これに対し、この種従来例のものは、例えばその重量が７０ｋｇ程度となっていた。

その一因としては、この種従来例では、前述したように凹凸形状の１次，２次の磁心コア４，５が用いられており、図３の（２）図，（３）図中に示したように、その凹凸分だけ肉厚が厚くなり、大型化や重量増の一因となっていた。

又、１次側Ａの１次コイル１，１次磁心コア４等や、２次側Ｂの２次コイル２，２次磁心コア５等は、それぞれ、放熱や位置決め固定用のモールド樹脂で、被覆固定されていた

が（後述する図１の（２）図参照）、このモールド樹脂の重量がかさむ点も、重量増の一因となっていた。

【０００９】

《本発明について》

本発明の非接触給電装置は、このような実情に鑑み、上記従来例の課題を解決すべくなされたものである。

そして本発明は、第１に、充電効率が向上し、第２に、大ギャップ化が実現されて、使い易さが向上すると共に、第３に、小型，軽量化も実現される、非接触給電装置を提案することを、目的とする。

【課題を解決するための手段】

【００１０】

《請求項について》

このような課題を解決する本発明の技術的手段は、次のとおりである。請求項１については次のとおり。

請求項１の非接触給電装置は、電磁誘導の相互誘電作用に基づき、１次コイルから２次コイルに電力を供給する。そして、該１次コイルおよび２次コイルは、同一面で扁平に渦巻き巻回された構造よりなり、該１次コイルや２次コイルが配設される磁心コアは、平板状をなすこと、を特徴とする。

請求項２については次のとおり。請求項２の非接触給電装置は、請求項１において、該１次コイルとその該磁心コアの表面、および該２次コイルとその該磁心コアの表面は、それぞれ、モールド樹脂にて被覆固定されると共に、該モールド樹脂中に発泡材が混入されていること、を特徴とする。

【００１１】

《作用等について》

本発明は、このような手段よりなるので、次のようになる。

（１）この非接触給電装置では、給電に際し、１次側と２次側がエアギャップを存して対峙配置される。

（２）そして、１次コイルに励磁電流が流されると、磁束が形成され、磁路が１次コイルと２次コイル間に形成されて、２次コイルに起電力が生成される。

（３）このようにして、電磁誘導の相互誘電作用により、電力が１次側から２次側に供給される。

（４）さて、この非接触給電装置では、平板状の磁心コアと扁平渦巻き状のコイルが、組合わせて採用されている。そこで給電に際し、エアギャップ中において、磁束が平行，一様，疎に分布するようになり、磁束密度が低くなるので、磁束形成用の起磁力そして励磁電流が小さくて済み、ジュール熱損失も低減される。

（５）更に、コイルを一定ピッチで捲回しておくと、一種の渦電流であるループ電流の起電力が相殺され、もって、ループ電流そしてジュール熱損失が低減される。

（６）この非接触給電装置は、上述したように、磁束密度が低く、起磁力そして励磁電流が小さくで済むので、エアギャップを、その分だけ広く設定可能である。

（７）なお、巻回されたコイルについて、外径と内径との比を、２：１程度としておくと、高い結合係数が得られ、エアギャップを広くしても、強力な電磁結合が保持される。

（８）更に、この非接触給電装置は、平板状の磁心コアと扁平なコイルとを採用したので、１次側，２次側共に肉厚が薄く、その分だけ小型，軽量化される

（９）又、軽量化は、１次側，２次側のモールド樹脂中に発泡材を混入しておくことにより、促進される。

（１０）さてそこで、本発明の非接触給電装置は、次の効果を発揮する。

【発明の効果】

【００１２】

《第１の効果》

第１に、充電効率が向上する。すなわち、本発明の非接触給電装置は、平板状の磁心コ

アと扁平渦巻き状のコイルとを組合わせて採用したので、形成される磁束密度が低い。
もって、磁束形成用の起磁力そして励磁電流が小さくて済み、ジュール熱損失も低減される等により、高効率化が実現される。
前述したこの種従来例、つまり凹凸形状の磁心コアにコイルを巻回していた従来例に比し、磁束密度が低いので、その分、充電効率が向上し省エネルギー化が達成される。

【００１３】

《第２の効果》

第２に、大ギャップ化が実現され、使い易さが向上する。すなわち、本発明の非接触給電装置は、平板状の磁心コアと扁平渦巻き状のコイルを採用したことにより、エアギャップ中の磁束密度が低い。

そして磁束密度が低いので、１次側と２次側間のエアギャップを、使い易さ向上のため、より広く設定可能である。例えば、凹凸形状の磁心コアにコイルを巻回していた従来例に比し、磁束密度が疎化されるので、その分、エアギャップを広く設定することが可能となる。

このように大ギャップ化が実現されるので、給電に際し対峙位置される１次側と２次側間について、位置決め操作が容易であり、衝突回避の配慮も軽減される等、使い易さが向上する。

【００１４】

《第３の効果》

第３に、小型，軽量化も実現される。すなわち、本発明の非接触給電装置は、平板状磁心コアと扁平コイルを採用したことにより、凹凸形状の磁心コアにコイルを巻回していた従来例に比し、肉厚が半減され重量が軽減される。更に、放熱や位置決め固定用のモールド樹脂中に、発泡材が混入されているので、その分の重量も軽減される。

これらにより、２次側つまりピックアップの重量が、この種従来例の半分程度となる。そしてピックアップは、例えばマイクロバスその他の電気自動車のバッテリー充電用として、常時車載されることに鑑み、このような小型，軽量化の意義は大きい。

このように、この種従来例に存した課題がすべて解決される等、本発明の発揮する効果は、顕著にして大なるものがある。

【発明を実施するための最良の形態】

【００１５】

《図面について》

以下、本発明の非接触給電装置を、図面に示した発明を実施するための最良の形態に基づいて、詳細に説明する。

図１および図２は、本発明を実施するための最良の形態の説明に供する。そして、図１の（１）図は、１次側の平断面図（２次側の平断面図）であり、（２）図は、１次側（２次側）の正（側）断面図である。

図２の（１）図は、電磁結合の正（側）断面説明図、（２）図は、磁束分布の正面説明図、（４）図は、渦電流の平面説明図、（５）図は、捻じりコイルの平面説明図である。図４の（２）図は、非接触給電装置の適用例のブロック図である。

【００１６】

《非接触給電装置６の概要について》

まず、図２の（１）図，図４の（２）図等を参照して、非接触給電装置６について概説する。

非接触給電装置６において、電磁誘導の相互誘導作用に基づき電力を供給する一般構成は、公知公用である。すなわち、給電時に近接対峙配置された１次側Ｆの１次コイル７と２次側Ｇの２次コイル８との間で、１次コイル７での磁束Ｄ形成により、２次コイル８に誘導起電力を生成させて、１次コイル７から２次コイル８に電力を送る点は、公知公用である。

そして、図４の（２）図の代表例に示したように、外部地上側の電源９の電源盤に接続された給電側，１次側Ｆが、マイクロバスその他の電気自動車や電車に車載された受電側

，２次側Ｇに対し、給電時において、物理的接続なしに空隙空間であるエアギャップＣを介して対峙配置され、もって電力が送られる。

２次側Ｇは、例えば車載のバッテリー１０に接続されており、給電により充電されたバッテリー１０にて、そのモータ１１が駆動される。なお１２は、給電用の通信制御装置である。

【００１７】

上述した電磁誘導の相互誘電作用については、次のとおり。１次側Ｆの１次コイル７と２次側Ｇの２次コイル８とを、非接触で対峙配置して、１次コイル７に交流を励磁電流として通電すると、電流に比例した磁界がその軸上に生じ、磁束Ｄが直角方向に環状に形成される。そして、このように形成され変化する磁束Ｄが、２次コイル８を貫き鎖交することにより、２次コイル８に起電力が生成される。

このように、磁場を形成し磁界を利用して電力を送る１次コイル７と２次コイル８の両回路は、図２の（１）図に示したように、磁束Ｄの磁路が形成され電磁結合されており、相互間の結合係数の高低は、１次，２次のコイル７，８の位置，形状，寸法，エアギャップＣの距離寸法，磁束Ｄの漏洩量等によって、変化する。

非接触給電装置６の概要は、このようになっている。

【００１８】

《１次側Ｆや２次側Ｇの構造について》

次に、図１，図２の（１）図を参照して、１次側Ｆや２次側Ｇの対称構造や内部構造について、説明する。

まず非接触給電装置６は、図２の（１）図に示したように、この種従来例と同様、１次側Ｆと２次側Ｇとが、給電時において上下等で対称の同一構造をなす。すなわち非接触給電装置６は、１次側Ｆが１次コイル７，１次磁心コア１３，背板１５，カバー１６等を備え、２次側Ｇが、２次コイル８，２次磁心コア１４，背板１５，カバー１６等を備えている。

そして、１次側Ｆと２次側Ｇとは、給電時に例えば上下対峙配置された場合、上下対称の同一構造をなす。それぞれ、対称面の内側から外側に向け、カバー１６，１次コイル７（２次コイル８），１次磁心コア１３（２次磁心コア１４），背板１５の順に配されている。

【００１９】

又、１次側Ｆおよび２次側Ｇの内部構造については、次のとおり。１次側Ｆの１次コイル７と１次磁心コア１３の表面、および２次コイル８と２次磁心コア１４の表面は、それぞれ、モールド樹脂１７にて被覆固定されている。

すなわち、図１の（２）図に示した例では、１次側Ｆ，２次側Ｇ共に、背板１５とカバー１６間にモールド樹脂１７が充填され、もって、内部の１次，２次コイル７，８、更には１次，２次磁心コア１３，１４の表面が、被覆固定されている。

モールド樹脂１７は、例えばシリコン樹脂製よりなり、このように内部を固めることにより、１次，２次コイル７，８を位置決め固定し、その機械的強度を確保すると共に、放熱機能も発揮する。すなわち、１次，２次コイル７，８は、励磁電流が流れジュール熱により発熱するが、モールド樹脂１７の熱伝導により放熱され、冷却される。

【００２０】

又、このようなモールド樹脂１７中には、発泡材１８が混入され埋め込まれている。発泡材１８は、例えば発泡スチロール，その他の発泡プラスチック製よりなり、モールド樹脂１７の重量を減らして軽量化を図るべく使用される。

図示例では、このような発泡材１８が、１次，２次コイル７，８の内側と外側とに、大小の円環鏡状に周設されているが、図示例によらず、発泡材１８の小片群をモールド樹脂１７中に混入してもよい。

１次側Ｆや２次側Ｇの構造は、このようになっている。

【００２１】

《１次，２次コイル７，８や、１次，２次磁心コア１３，１４について》

次に、図１，図２を参照して、１次，２次コイル７，８、および１次，２次磁心コア１３，１４について説明する。

１次コイル７および２次コイル８は、導線を同一面で扁平に渦巻き巻回した構造よりなる。１次コイル７や２次コイル８が配設される１次磁心コア１３や２次磁心コア１４は、平板状をなす。

【００２２】

これらについて、更に詳述する。まず、１次，２次磁心コア１３，１４は、フェライト製，固化砂鉄製，その他の鉄性材料製のものが代表的であり、透磁率が大の強磁性体よりなり、磁束Ｄの強力化機能やガイド機能を発揮する。すなわち、１次，２次コイル７，８間インダクタンスを増し、相互間の電磁的結合を強化すると共に、形成された磁束Ｄを、誘導，収集して，方向付けるべく機能する。

そして、この１次，２次磁心コア１３，１４は、図１に示したように、凹凸のないフラットな平板状をなす。もって、図２の（２）図に示したように、１次側Ｆと２次側Ｇ間において、極が点在，偏在せず全体化，均一化し、もって形成される磁路の磁束Ｄ分布が平行，一様となり、磁束Ｄの偏在，集中が回避されるようになる（この種従来例に関する図２の（３）図と、比較対照）。

【００２３】

これに対応し、１次，２次コイル７，８は、同一平面で渦巻き状に巻回されており、もって円状の扁平形状をなす。

すなわち図１に示したように、１次，２次コイル７，８は、ジュール熱損失を低減すべく複数本に並列化されると共に、絶縁された平行導線を、巻回中心部を円空間Ｈとしつつ、渦巻き状に多数回巻回してなり、もって、全体が円環フランジ状，肉厚の薄い扁平状をなす。そして、このような１次，２次コイル７，８が、それぞれ、対応する１次，２次磁心コア１３，１４の対称前面側に、近接配設されている。図示例では、当接配設されている。

又、図１の（１）図中に示したように、このように巻回された１次，２次コイル７，８の外径Ｊと内径Ｋとの比は、２：１程度に設定されており、このような設定により、１次，２次コイル７，８間の結合係数が高い値となる。この点は、実験によっても裏付けられている。

もって、１次，２次コイル７，８間の電磁的結合が、例え両者間のエアギャップＣを広く取っても、強力に保持されるようになる。

【００２４】

更に、このように巻回された１次，２次コイル７，８は、一定ピッチ間隔で捻じられている。すなわち、巻回された１次，２次コイル７，８については、図２の（４）図に示したように、紙面に垂直な方向に交番磁束Ｄ（励磁電流の交流に対応して変化を伴い交番形成される磁束Ｄ）が通過すると、線間に一種の渦電流である環状のループ電流Ｌが誘起されてしまう。もってジュール熱損失の原因となる。

そこで、この１次，２次コイル７，８にあっては、図２の（５）図に示したように、巻回された複数本の平行導線が、扁平さを維持しつつ、途中で一定ピッチ間隔で捻回されている。すなわち、各捻じり箇所Ｍ毎に、複数本ｍ本相互間の位置関係を、順次１本ずつ変換して行き、ｍ回の捻じりにより元の位置関係に戻るように、捻回が実施されている。捻じり箇所Ｍは、巻回１周当たり例えば５～６個のピッチで形成される。

このような捻回により、ループ電流Ｌの起電力が相殺され、ループ電流Ｌそしてジュール熱損失が、大幅に低減される。

１次，２次コイル７，８、および１次，２次磁心コア１３，１４は、このようになっている。

【００２５】

《作用等》

本発明の非接触給電装置６は、以上説明したように構成されている。そこで、以下のようになる。

（１）この非接触給電装置６では、給電に際し、１次コイル７，１次磁心コア１３等を備えた給電側つまり１次側Ｆと、２次コイル８，２次磁心コア１４等を備えた受電側つまり２次側Ｇとが、エアギャップＣを存して対峙配置される。

【００２６】

（２）そして、１次側Ｆの１次コイル７に、励磁電流として交流が通電されると、磁束Ｄが形成される（図２の（１）図を参照）。

もって、この磁束Ｄの磁路が、１次側Ｆの１次コイル７と、２次側Ｇの２次コイル８間に、形成される。１次コイル７と２次コイル８は、両回路間が電磁結合され、両者間に磁場が形成されて、２次コイル８を磁束Ｄが貫き、２次コイル８に起電力が生成される。

【００２７】

（３）この非接触給電装置６では、このようにして、電磁誘導の相互誘電作用により、電力が１次側Ｆから２次側Ｇに供給される。

すなわち電力が、外部の電源９、そしてこれに接続された１次側Ｆから供給され、２次側Ｇにて取出されて、これに接続されたバッテリー１０を充電する（図４の（２）図を参照）。

【００２８】

（４）さてそこで、この非接触給電装置６にあっては、次のようになる。まず、この非接触給電装置６では、平板状の１次，２次磁心コア１３，１４と、扁平渦巻き巻回された１次，２次コイル７，８とが、組合わせて採用されている。

そこで、給電に際し対峙配置された１次側Ｆと２次側Ｇ間のエアギャップＣ中の磁路において、磁束Ｄが平行，一様，疎に分布するようになり、磁束Ｄ密度が低くなる（図２の（２）図と、この種従来例に関する図２の（３）図とを、比較対照）。

空気中の磁束Ｄ密度と、その磁束Ｄを形成させる起磁力とは、比例関係にあるので、このように磁束Ｄ密度が低いことにより、磁束Ｄ形成用の起磁力そして励磁電流が小さくて済み、回路のジュール熱損失もその分低減される。

そこで例えば、同じ密度の磁束Ｄが形成される場合は、本発明の方が前述したこの種従来例より、はるかに小さな起磁力，励磁電流，ジュール熱損失で済むようになる。

【００２９】

（５）更にこの点は、この非接触給電装置６の１次，２次コイル７，８を、一定ピッチの捻じり箇所Ｍで捻回しておくことによって、一段と促進される（図２の（５）図を参照）。

すなわち、このような捻回により、一種の渦電流であるループ電流Ｌ（図２の（４）図を参照）について、その起電力が相殺され、もって、ループ電流Ｌそしてジュール熱損失が、大幅に低減されるようになる。

例えば、このような上記（４），（５）の点に基づき、この非接触給電装置６は、充電効率が、前述したこの種従来例の８６％に対し、９２％程度まで高効率化される。

【００３０】

（６）又、この非接触給電装置６は、平板状の１次，２次磁心コア１３，１４と、扁平渦巻き状の１次，２次コイル７，８とを、組合わせて採用したので、上述したように、磁束Ｄの密度が低く、磁束Ｄを形成する起磁力，励磁電流が小さくて済む。

そこで、１次，２次コイル７，８間のエアギャップＣを、その分だけ広く設定することが可能となる。例えば、同じ値の励磁電流の場合、本発明の方が前述したこの種従来例より、エアギャップＣをより広く設定することが可能となり、エアギャップＣが５０ｍｍ程度であったこの種従来例に比し、エアギャップＣを１００ｍｍに倍増可能となる。

【００３１】

（７）なおこの点は、渦巻き巻回されたこの非接触給電装置６の１次，２次コイル７，８について、その外径Ｊと内径Ｋとの比を、２：１程度としておくことによって、フォローされる。

すなわち、これにより１次，２次コイル７，８間について、高い結合係数が得られるので、エアギャップＣを広くしても、両者間の強力な電磁結合が維持される。

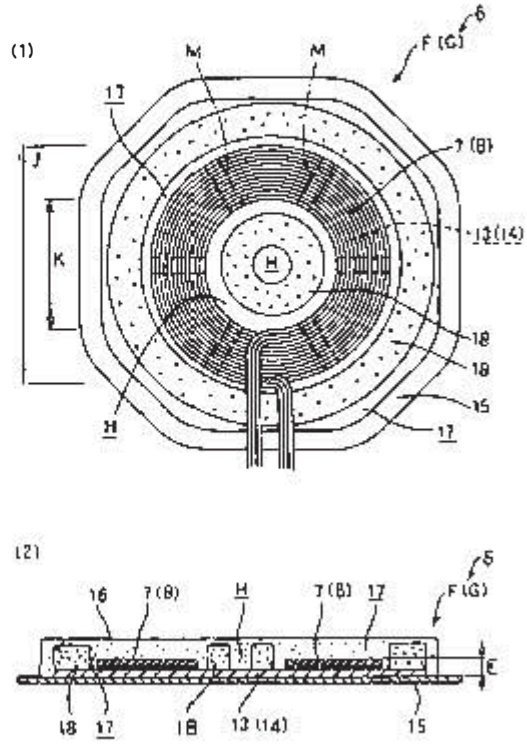
【００３２】
（８）更に、この非接触給電装置６は、平板状の１次，２次磁心コア１３，１４と、扁平な１次，２次コイル７，８とを採用したので、１次側Ｆ，２次側Ｇ共に、その肉厚Ｅが薄く、その分だけ小型，軽量化される（図１の（２）図と、この種従来例に関する図３の（２）図，（３）図とを、比較対照）。肉厚Ｅは、前述したこの種従来例に比し、半減される。
【００３３】
（９）又、このような非接触給電装置６の軽量化は、１次側Ｆ，２次側Ｇのモールド樹脂１７中に、発泡材１８を混入しておくことにより（図１を参照）、更に促進される。すなわち、発泡材１８を混入した分だけ、モールド樹脂１７の充填量が減らされ、もって一段と軽量化が進むようになる。
例えば、このような上記（８），（９）の点に基づき、この非接触給電装置６は、２次側Ｂつまりピックアップの重量が、前述したこの種従来例の７０ｋｇ程度に対し、３５ｋｇ程度と半減される。
【００３４】
《その他》
なお、図示例等に基づき以上説明したところによれば、１次コイル７および２次コイル８は、共に、同一面で扁平に渦巻き巻回された構造よりなり、かつ、このような１次コイル７や２次コイル８が配設される１次磁心コア１３や２次磁心コア１４は、共に、平板状をなした構造よりなっていた。
しかしながら、非接触給電装置６については、このような構成によらず、次のような構成も考えられる。
すなわち、１次コイル７又は２次コイル８のいずれか一方側のみ、例えば１次コイル７のみを、上述した同一面で扁平に渦巻き巻回された構造とし、かつ、それが配設される一方側の１次磁心コア１３又は２次磁心コア１４のみを、平板状の構造とした構成が考えられる。この場合には、このような構造，構成が採用されない他方側は、前述したこの種従来例の１次コイル１又は２次コイル２や、凹凸形状をなす１次磁心コア４又は２次磁心コア５を、使用可能である。
このような構成例として、代表的には、同一平面で扁平に渦巻き巻回された構造の１次コイル７と、平板状をなす構造の１次磁心コア１３とを、１次側として採用した構成の非接触給電装置６が、考えられる。
この場合には、このような１次側は、単独かつ２次側とは別体の構成として、成立、適用可能である。
そして、このような非接触給電装置６について、その機能，作用，効果等については、図示例等に基づき前述した所が、準用される。
このように、本発明思想のより広い適用も、考えられる。
【図面の簡単な説明】
【００３５】
【図１】本発明に係る非接触給電装置について、発明を実施するための最良の形態の説明に供し、（１）図は、１次側の平断面図（２次側の平断面図）であり、（２）図は、１次側（２次側）の正（側）断面図である。
【図２】同発明を実施するための最良の形態の説明に供し、（１）図は、電磁結合の正（側）断面説明図、（２）図は、磁束分布の正面説明図、（４）図は、渦電流の平面説明図、（５）図は、捻じりコイルの平面説明図である。なお（３）図は、この種従来例の磁束分布の正面説明図である。
【図３】この種従来例の説明に供し、（１）図は、１次側の平面図（２次側の平面図）であり、（２）図は、１次側と２次側の正面図、（３）図は、１次側と２次側の側断面図である。
【図４】非接触給電装置の説明に供し、（１）図は、基本原理の斜視説明図であり、（２）図は、適用例のブロック図である。

【符号の説明】

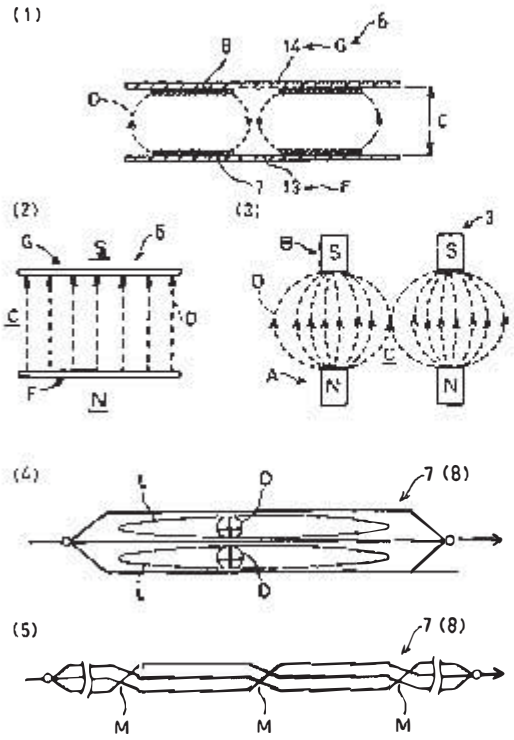
【００３６】

１　１次コイル（従来例）
２　２次コイル（従来例）
３　非接触給電装置（従来例）
４　１次磁心コア（従来例）
５　２次磁心コア（従来例）
６　非接触給電装置（本発明）
７　１次コイル（本発明）
８　２次コイル（本発明）
９　電源
１０　バッテリー
１１　モータ
１２　通信制御装置
１３　１次磁心コア（本発明）
１４　２次磁心コア（本発明）
１５　背板
１６　カバー
１７　モールド樹脂
１８　発泡材
Ａ　１次側（従来例）
Ｂ　２次側（従来例）
Ｃ　エアギャップ
Ｄ　磁束
Ｅ　肉厚
Ｆ　１次側（本発明）
Ｇ　２次側（本発明）
Ｈ　円空間
Ｊ　外径
Ｋ　内径
Ｌ　ループ電流
Ｍ　捻じり箇所

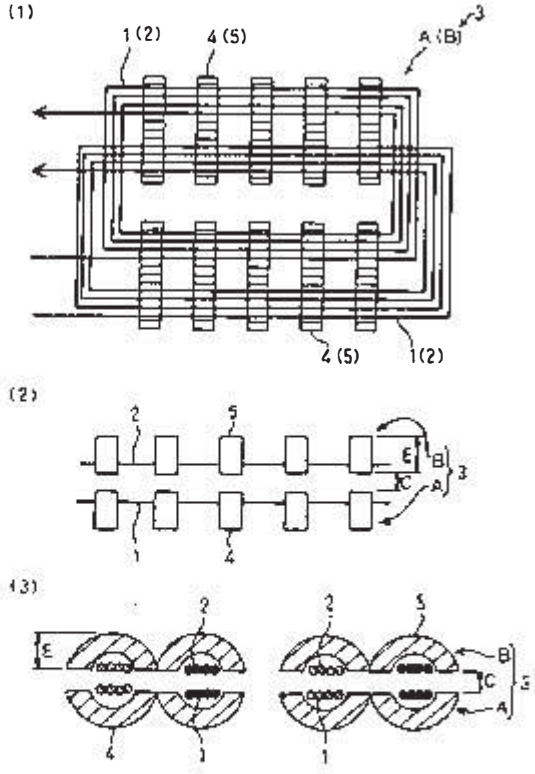
【図１】


(1)
M
M
F (G)
6
17
7 (8)
J
K
H
12 (14)
18
18
15
17
(2)
16
7 (8)
H
7 (8)
17
F (G)
6
E
18
17
18
12 (14)
15

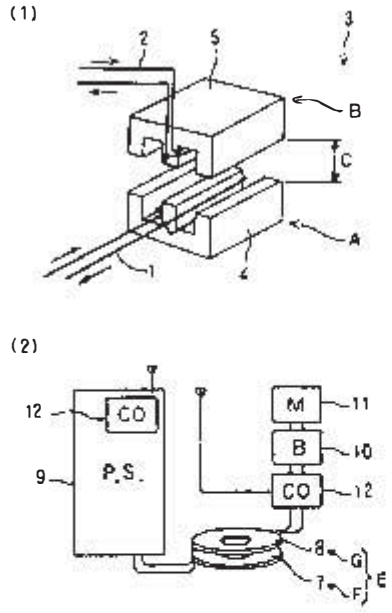
【図２】


(1)
B
14
G
6
D
C
7
13
F
(2)
G
S
6
C
D
F
N
(3)
B
S
S
3
D
C
A
N
N
(4)
L
D
7 (8)
L
D
(5)
7 (8)
M
M
M

【図３】


(1)
1 (2)
4 (5)
A (B)
3
4 (5)
1 (2)
(2)
2
5
E
B
C
A
3
1
4
(3)
2
2
5
E
B
C
A
3
4
1
1

【図４】


(1)
2
5
3
B
C
A
1
4
(2)
12
CO
P.S.
9
M
11
B
10
CO
12
8
G
7
F
E

フロントページの続き

(72)発明者 佐藤 剛
東京都昭島市田中町６００番地 昭和飛行機工業株式会社内
(72)発明者 松木 英敏
宮城県仙台市青葉区片平二丁目１番１号 国立大学法人東北大学内
(72)発明者 佐藤 文博
宮城県仙台市青葉区片平二丁目１番１号 国立大学法人東北大学内

Print | Close

Patent Record View Tuesday, October 5 2010

Patent/Publication: JP2008087733A NONCONTACT POWER SUPPLY DEVICE

Bibliography

DWPI Title
Non-contact electric power feeder used to charge from exterior the battery of electric vehicle has magnetic-cores connected by primary and secondary coils which swirls and wounds flatly on surfaces

Original Title
NONCONTACT POWER SUPPLY DEVICE

Assignee/Applicant
Standardized: **SHOWA AIRCRAFT IND** **UNIV TOHOKU**
Original: SHOWA AIRCRAFT IND CO LTD TOHOKU UNIV

DWPI Assignee/Applicant
UNIV TOHOKU (TOHO); UNIV TOHOKU NAT CORP (TOHO); SHOWA AIRCRAFT IND CO LTD (SHOW); SHOWA AIRPLANE IND KK (SHOW); SHOWA HIKOKI KOGYO KK (SHOW)

Inventor
YAMAMOTO KITAO; SUZUKI YOSHIO; SATO TAKESHI; MATSUKI HIDETOSHI; SATO FUMIHIRO

DWPI Inventor
GITAO Y; HIDETOSHI M; HIDETOSI M; KATASHI S; MATSUKI H; SATO F; SATO T; SUZUKI Y; YAMADA S; YAMAMOTO K

Publication Date (Kind Code)
2008-04-17 (A)

DWPI Accession / Update
2008-G43503 / 200841

Application Number / Date
JP2006273933A / 2006-10-05

Priority Number / Date / Country
JP2006273933A / 2006-10-05 / JP

Abstract

DWPI Abstract
(JP2008087733A_)
Novelty
The magnetic-cores (13, 14) are connected by primary coils (7) and secondary coils (8) which swirls and wounds flatly on surfaces. The primary and secondary coils relays electric power based on the mutual dielectric effect of the electromagnetic induction operation.

Use
Non-contact electric power feeder used to charge from exterior the battery of electric vehicle.

Advantage
Provides a power feeder that is lightweight with size lessened, and can increase the charging efficiency to fill battery with sufficient power.

Drawing Description
The figures are the sectional views of the non-contact electric power feeder.
7 - Primary coils.
8 - Secondary coils.
13, 14 - Magnetic-cores.
17 - Mold resin.
18 - Foaming material.

Abstract

PROBLEM TO BE SOLVED: To provide a noncontact power supply device capable of first improving charging efficiency, secondly expanding a gap to enhance usability and thirdly reducing a size and weight.

SOLUTION: This noncontact power supply device 6 is, for example, used for the battery charging of an electric automobile, and supplies electric power from a primary coil 7 at a primary and power supply side to a secondary coil 8 at a secondary and power reception side based on the mutual dielectric action of electromagnetic induction. The primary coil 7 and the secondary coil 8 have structures in each of which a plurality of parallel conductors used as one set are flatly and spirally wound on the identical face and twisted at constant pitches. A primary magnetic core 13 and a secondary magnetic core 14 in which the primary coil 7 and secondary coil 8 are arranged are made of ferrite etc., and formed to have flat plate shapes. Surfaces of the primary coil 7 and primary magnetic core 13 and surfaces of the secondary coil 8 and the secondary magnetic core 14 are covered with mold resin 17 and fixed, respectively. A foamed material 18 is mixed in the mold resin 17.

Classes/Indexing

IPC

Current IPC-R	Invention	Version	Additional	Version
Advanced	B60M 7/00	20060101	-	-
Core	B60M 7/00	20060101	-	-
Subclass	-	-	-	-

Original IPC-R	Invention	Version	Additional	Version
Advanced	B60M 7/00	20060101	-	-
Core	B60M 7/00	20060101	-	-
Subclass	-	-	-	-

JP FI Codes
B60M 7/00 X; H01F 23/00 B; H02J 17/00 B

JP F Terms
5E060
5G063
5G391

DWPI Class
A95 U24 V03 X21

DWPI Manual Codes

Expand DWPI Manual Codes

Legal Status

INPADOC Legal Status
Get Family Legal Status

Family

Family

INPADOC Family (5)

Publication Number	Publication Date	Inventor	Assignee/Applicant	Title

KR2008031795A	2008-04-11	YAMAMOTO Kitao	Showa Aircraft Industry Co. Ltd. TOHOKU UNIVERSITY	NON-CONTACTING SUDDEN CHARGING APPARATUS, CAPABLE OF CHARGING A BATTERY OF AN ELECTRIC CAR BASED ON THE MUTUAL INDUCTION OF AN ELECTROMAGNETIC INDUCTION WITHOUT BEING IN CONTACT WITH OUTSIDE
JP2008087733A	2008-04-17	YAMAMOTO KITAO	SHOWA AIRCRAFT IND CO LTD TOHOKU UNIV	NONCONTACT POWER SUPPLY DEVICE
CN101179208A	2008-05-14	Yamada Shindo	Showa Airplane Industry KK	Non-contact power supply device
JP04356844B2	2009-11-04	-	SHOWA HIKOKI KOGYO KK UNIV TOHOKU	Non-contact electric power feeder
CN101179208B	2010-08-18	-	-	-

DWPI Family (6)

Publication	DWPI Update	Publication Date	IPC Code	Language
JP2008087733A_	200841	2008-04-17	B60M000700	Japanese
CN101179208A_	200848	2008-05-14	H02J001700	Chinese
KR2008031795A_	200868	2008-04-11	H02J001700	Korean
TW200828720A_	200924	2008-07-01	-	Chinese
JP04356844B2	200972	2009-11-04	B60M000700	Japanese
Local appls.: 2008087733 Filed: 2008-04-17				
KR976061B1	201057	2010-08-17	H02J001700	Korean
Local appls.: 2008031795 Filed: 2008-04-11				

Claims

Claims

All Claims (2)

Claims (English)

1. The non-contact electric power feeder which supplies electric power to a secondary coil from a primary coil based on the mutual dielectric effect|action of an electromagnetic induction
WHEREIN:
This primary coil and a secondary coil consist of a structure which swirled flatly the surface [the same] and was wound,
The magnetic-core core in which this primary coil and secondary coil are arrange|positioned is a non-contact electric power feeder characterized by making flat form.

2. The non-contact electric power feeder described in Claim 1
WHEREIN:

The non-contact electric power feeder characterized by the following.
While coating|coated fixing of the surface of this primary coil and this its magnetic-core core and the surface of this secondary coil and this its magnetic-core core is respectively carried out by mold resin, the foaming material is mixed into this mold resin.

{Translation from Thomson Reuters}

Description

DWPI Drawing Description
The figures are the sectional views of the non-contact electric power feeder.
7 - Primary coils.
8 - Secondary coils.
13, 14 - Magnetic-cores.
17 - Mold resin.
18 - Foaming material.

Drawing Description

Drawing Description

Description

Description

TECHNICAL FIELD

This invention relates to a non-contact electric power feeder.
That is, based on the mutual dielectric effect|action of an electromagnetic induction, it is related with the non-contact electric power feeder which charges the battery of an electric vehicle by non-contact from the exterior.

DESCRIPTION OF RELATED ART

<<Technological background>>
(1) figure of FIG. 4 is isometric view explanatory drawing in which it uses for description of that basic principle about this kind of non-contact electric power feeder.
As shown also to this figure, based on the mutual dielectric effect|action of an electromagnetic induction, the non-contact electric power feeder 3 which supplies electric power to the secondary coil 2 from the primary coil 1 is known conventionally,
For example, it is used for battery charging of an electric vehicle.
That is, mutual-opposition arrangement|positioning is carried out, the primary coil 1 wound by the primary magnetic-core core 4 has in the secondary coil 2 wound by the secondary magnetic-core core 5, and magnetic-flux formation with the primary coil 1 produces|generates a dielectric electromotive force in the secondary coil 2,
Electric power is supplied.

<<The Prior Art literature information>>
As such a non-contact electric power feeder 3, what was shown by the following patent document 1,2,3 is mentioned, for example.

Patent 3630452 (Unexamined-Japanese-Patent No. 6-256505)International publication 92/17929International publication 99/08359

<<PRIOR ART>>
FIG. 3 uses for description of this seed|species prior art example,

(1) Figure is top view by the side of primary (top view of secondary side),
(2) Figure is front view of the primary side and secondary side,
(3) A figure is a sectional side view of the primary side and a secondary side.
First, in this kind of non-contact electric power feeder 3, secondary-side B makes a symmetrical structure the primary side A.
And in the non-contact electric power feeder 3 of this seed|species prior art example, while the primary magnetic-core core 4 and the secondary magnetic-core core 5 made substantially U-shape and the uneven|corrugated shape of the substantially E-shape, for example, many is planarly arrange|positioned by both the predetermined space|interval.
And this primary magnetic-core core 4 and the secondary magnetic-core core 5 are utilized,
The primary coil 1 and the secondary coil 2 were respectively wound by the rectangle or the round shape like illustration on the whole between the concave part.
And mutual-opposition arrangement|positioning of the secondary-side B is carried out via an air gap C the such primary side A,
The dielectric electromotive force was produced|generated by exciting-current electricity_supply in the primary coil 1, and magnetic-flux D formation, it had in the secondary coil 2 by them, electric power was supplied to secondary-side B from the primary side A, and the battery connected to secondary-side B was charged.

DISCLOSURE of the INVENTION

PROBLEM to be solved by the Invention

By the way, the following problem was pointed out about such a prior art example.
<<The 1st problem>>
1stly, about the non-contact electric power feeder 3 of this seed|species prior art example, an improvement of much more increase-in-efficiency and charging efficiency was desired.
For example, in this seed|species prior art example, uneven|corrugated shaped primary and the secondary magnetic-core cores 4 and 5 were used,
Therefore
Magnetic-flux D distribution came to have shown in front explanatory drawing of (3) figure of FIG. 2.
That is, it is distributed so that the magnetic flux D in the air gap C between the primary side A by which mutual-opposition arrangement|positioning is carried out, and the secondary side B may turn and curve and concentrate on a pole in the case of electric power feeding,
Therefore
At vicinity, a magnetic-flux D density becomes extremely high very much.
An in-air magnetic-flux D density is proportional to its magnetomotive force,
Therefore
Only a high-density part will require a big magnetomotive force,
Eventually, a bigger exciting current is needed about the primary coil 1,
The part and Joule-heat loss also increased and it had become a cause of the charging efficiency fall.
Furthermore, the Joule-heat loss by electrical-eddy-current generating was also pointed out as a factor of a charging efficiency fall.
Namely, when the alternate magnetic flux D formed in the direction perpendicular|vertical to a paper surface in (1) figure of FIG. 3 about the primary coil 1 and the secondary coil 2 which were wound by the rectangle passes
The loop electric current L which is a kind of electrical eddy current flowed into the line (also refer the (4) figures of FIG. 2 mentioned later), and Joule-heat loss had generate|occur|produced by that much.
As for the non-contact electric power feeder 3 of this seed|species prior art example, that charging efficiency is made about 86% by these,
Energy saving of one layer was desired.

<<The 2nd problem>>
2ndly, the further large gap-ization was desired about the non-contact electric power feeder 3 of this seed|species prior art example.
That is, in this seed|species prior art example, since the magnetic-flux D density in an air gap C is high as mentioned above with reference to (3) figures of FIG. 2, that part and a big exciting current are required,
There exists a difficulty of causing great Joule-heat loss.
On the other hand, in order to use and to extend an air gap C further for an easy improvement, a more excessive exciting current will be required.
Eventually, the air gap C lets about 50mm be a limit in this seed|species prior art example with a high magnetic-flux D density,
It was anxious for large gap-ization.

That is, as for the primary side A and secondary-side B by which mutual-opposition arrangement|positioning of in the case of electric power feeding is carried out, positioning operation for electric power feeding is facilitated, so that the air gap C in the meantime is wide,
Etc.,
Thus, it is easy to use.
On the other hand, it is necessary to consider to the collision avoidance between the primary side A and the secondary side B under a small gap like this seed|species prior art example in the case of the setup for electric power feeding,
Etc.,
Thus, operation is troublesome,
The formation of a large gap and a much more usage easy improvement were desired.

<<The 3rd problem>>
3rdly, about the non-contact electric power feeder 3 of this seed|species prior art example, much more small size and weight reduction were desired.
About especially secondary-side B called a pick-up, it was anxious for small size and weight reduction in view of always vehicle-mounting, for example as an object for battery charging of electric vehicles, such as a micro bus.
On the other hand, as for the thing of this seed|species prior art example, that weight was set to about 70kg, for example.
As that cause, by this seed|species prior art example, as mentioned above, uneven|corrugated shaped primary and the secondary magnetic-core cores 4 and 5 are used,
(2) figures of FIG. 3,
(3) As shown in the drawing(s), by the unevenness|corrugation, thickness became thick and had become an enlargement and a cause of the increase of a weight.
Moreover, the primary coil 1 by the side of [A] primary, primary magnetic-core core 4 grade|etc., and the secondary coil 2 of secondary-side B and secondary magnetic-core core 5 grade|etc.,
Although coating|coated fixing was respectively carried out by the mold resin for heat radiation or positioning fixing (refer (2) figure of FIG. 1 mentioned later), the point in which the weight of this mold resin increases had also become a cause of the increase of a weight.

<<About this invention>>
The non-contact electric power feeder of this invention is made in view of such a situation that the subject of the said prior art example should be solved.
And 1stly charging efficiency improves this invention,
2ndly, large gap-ization is implement|achieved,
While the ease of using improves, it targets to propose the non-contact electric power feeder by which small size and weight reduction are also implement|achieved 3rdly.

MEANS to solve the Problem

<<About a claim>>
The technical means of this invention which solves such a subject is as follows.
About Claim 1, it is as follows.
The non-contact electric power feeder of Claim 1 supplies electric power to a secondary coil from a primary coil based on the mutual dielectric effect|action of an electromagnetic induction.
And this primary coil and a secondary coil consist of a structure which swirled flatly the surface [the same] and was wound,
The magnetic-core core in which this primary coil and secondary coil are arrange|positioned is characterized by making flat form.
About Claim 2, it is as follows.
As for the non-contact electric power feeder of Claim 2, in Claim 1, while coating|coated fixing of the surface of this primary coil and this its magnetic-core core and the surface of this secondary coil and this its magnetic-core core is respectively carried out by mold resin, the foaming material is mixed into this mold resin,
It is characterized by the above-mentioned.

<<About an effect|action etc.>>
Since this invention consists of such a means, it is as follows.
(1) In this non-contact electric power feeder, a secondary side exists an air gap the primary side, and mutual-opposition arrangement|positioning of in the case of electric power feeding is carried out.
(2) And if exciting current is sent by primary coil, magnetic flux will be formed and magnetic path will be formed between primary coil and secondary coil,
An electromotive force is produced|generated by the secondary coil.

(3) Thus, electric power is supplied to a secondary side by the mutual dielectric effect|action of an electromagnetic induction from the primary side.
(4) Now, in this non-contact electric power feeder, a flat magnetic-core core and the coil of flat spiral form combine, and are employ|adopted.
Then -- in in an air gap in the case of electric power feeding -- magnetic flux -- a parallel -- coming to be distributed uniformly and sparse
A magnetic flux density becomes low,
Therefore
The magnetomotive force and exciting current for magnetic-flux formation are small, and completed and Joule-heat loss are also reduced.
(5) Furthermore, if the coil is twisted in the fixed pitch, the electromotive force of the loop electric current which is a kind of electrical eddy current will be canceled, it will have, and a loop electric current and Joule-heat loss will be reduced.
(6) As above-mentioned, this non-contact electric power feeder has a low magnetic flux density, and since a magnetomotive force and an exciting current are easy to come out small, it is widely settable by that much in an air gap.
(7) If ratio of an outer diameter and an internal diameter is made in addition about into 2:1, even if a high coupling coefficient will be obtained and it will make an air gap wide about the wound coil, a forceful inductive coupling is hold|maintained.
(8) Furthermore, flat magnetic-core core and flat coil were employ|adopted for this non-contact electric power feeder,
Therefore
Thickness of a secondary side is [primary side] thin -- by that much -- small size , it reduces in weight
(9) Moreover, as for a primary side, weight reduction is promoted by mixing the foaming material into the mold resin of a secondary side.
(10) Now, the non-contact electric power feeder of this invention exhibits the following effect there.

ADVANTAGE of the Invention

<<The 1st effect>>
1stly, charging efficiency improves.
That is, the non-contact electric power feeder of this invention was employ|adopted combining the flat magnetic-core core and the coil of flat spiral form,
Therefore
The magnetic flux density formed is low.
A high efficiency-increase is implement|achieved [that have, and the magnetomotive force and exciting current for magnetic-flux formation are small, and completed and Joule-heat loss are also reduced, etc. and].
It compares with this seed|species prior art example mentioned above, i.e., the prior art example which was winding the coil to the uneven|corrugated shaped magnetic-core core,
Since the magnetic flux density is low, the part and charging efficiency improve and energy saving is achieved.

<<The 2nd effect>>
2ndly, large gap-ization is implement|achieved and the ease of using improves.
That is, the non-contact electric power feeder of this invention has a low magnetic flux density in an air gap by having employ|adopted the flat magnetic-core core and the coil of flat spiral form.
And since the magnetic flux density is low, it is more widely settable using the air gap between the primary side and a secondary side because of an easy improvement.
For example, it compares with the prior art example which was winding the coil to the uneven|corrugated shaped magnetic-core core,
A magnetic flux density is made sparse,
Therefore
The part and an air gap can be set widely.
Thus, large gap-ization is implement|achieved,
Therefore
About between the primary side by which position facing is carried out, and a secondary side, positioning operation is easy in the case of electric power feeding,
Consideration of collision avoidance is also reduced,
Etc.,
Thus, the ease of using improves.

<<The 3rd effect>>
3rdly, small size and weight reduction are also implement|achieved.

That is, the non-contact electric power feeder of this invention is compared with the prior art example which was winding the coil to the uneven|corrugated shaped magnetic-core core by having employ|adopted the flat magnetic-core core and the flat coil,
Thickness is reduced by half and a weight is reduced.
Furthermore, since the foaming material is mixed into the mold resin for heat radiation or positioning fixing, the weight of the part is also reduced.
By these, a secondary side, i.e., the weight of a pick-up, becomes half extent of this seed|species prior art example.
And in view of a pick-up always being vehicle-mounted, for example as an object for battery charging of a micro-bus other electric vehicle, such small size and the significance of weight reduction are large.
Thus, all the subjects that existed in this seed|species prior art example are solved,
Etc.,
Thus, the effect which this invention exhibits is made remarkable and has a large thing.

Preferred EMBODIMENT of the Invention

<<About drawing>>
Hereafter, the non-contact electric power feeder of this invention is demonstrated in detail based on the Best mode for carrying out the invention shown on drawing.
It uses for description of a best form for FIG. 1 and FIG. 2 to implement this invention.
And (1) figure of FIG. 1 is a plane-cross-section figure by the side of primary (plane-cross-section figure of a secondary side),
(2) A figure is positive (side) sectional drawing by the side of primary (secondary side).
(1) figure of FIG. 2 is positive (side) cross-section explanatory drawing of an inductive coupling,
(2) Figure is front explanatory drawing of magnetic-flux distribution,
(4) Figure is planar explanatory drawing of electrical eddy current,
(5) A figure is planar explanatory drawing of a twisting coil.
(2) figures of FIG. 4 are block diagrams of the example of application of a non-contact electric power feeder.

<<About the outline|summary of the non-contact electric power feeder 6>>
First, (1) figure of FIG. 2,
With reference to (2) figures of FIG. 4 etc., it summarizes about the non-contact electric power feeder 6.
In the non-contact electric power feeder 6, the general structure which supplies electric power based on the mutual-induction effect|action of an electromagnetic induction is publicly known and used.
That is, the secondary coil 8 is made to produce|generate an induced electromotive force by magnetic-flux D formation with the primary coil 7 between the primary coil 7 by the side of [F] primary and the secondary coil 8 of secondary-side G by which proximity|contact mutual-opposition arrangement|positioning was carried out at the time of electric power feeding.
The point which sends electric power to the secondary coil 8 from the primary coil 7 is publicly known and used.
And as shown to the representative example of (2) figure of FIG. 4, the electric-power-feeding [which was connected to the power-supply disc|board of the power supply 9 by the side of the external ground] and receiving side by which the primary side F was vehicle-mounted by the micro-bus other electric vehicle and the electric train|tram sets with respect to secondary-side G at the time of electric power feeding.
Mutual-opposition arrangement|positioning is carried out via the air gap C which is space|gap space without a physical connection, it has, and electric power is sent.
Secondary-side G is connected to the vehicle-mounted battery 10, for example,
The motor 11 drives with the battery 10 charged by electric power feeding.
In addition, 12 is a telecommunication control apparatus for electric power feeding.

About the mutual dielectric effect|action of the electromagnetic induction mentioned above, it is as follows.
Mutual-opposition arrangement|positioning of the primary coil 7 by the side of [F] primary and the secondary coil 8 of secondary-side G is carried out by non-contact,
If it supplies with electricity to the primary coil 7 considering alternating current as an exciting current, the magnetic field proportional to an electric current will arise on the axis|shaft, and the magnetic flux D will be formed in a right angle direction at cyclic|annular form.
And an electromotive force is produced|generated by the secondary coil 8 when the magnetic flux D which is formed in this way and changes penetrates and links the secondary coil 8.
Thus, as shown to (1) figure of FIG. 2, the magnetic path of the magnetic flux D is formed and the inductive coupling of both the circuits of the primary coil 7 and the secondary coil 8 to which a magnetic field is formed in and electric power is sent using a magnetic field is carried out,
The height of a mutual coupling coefficient changes with the position of the coils 7 and 8 of primary and secondary, a shape, a dimension, the distance dimension of an air gap C, the amounts of leakages of the

magnetic flux D, etc.
The outline|summary of the non-contact electric power feeder 6 is become like this.

<<About the structure of the primary side F and secondary-side G>>
Next, with reference to (1) figure of FIG. 1, FIG. 2, the symmetrical structure and internal structure of the primary side F and secondary-side G are demonstrated.
First, as the non-contact electric power feeder 6 was shown to (1) figure of FIG. 2, secondary-side G makes the same symmetrical structure by the upper and lower sides etc. the primary side F like this seed|species prior art example at the time of electric power feeding.
Namely, the primary side F was equipped with the primary coil 7, the primary magnetic-core core 13, the back board 15, and cover 16 grade|etc., and, as for the non-contact electric power feeder 6, secondary-side G is equipped with the secondary coil 8, the secondary magnetic-core core 14, the back board 15, and cover 16 grade|etc.,.
And the primary side F and secondary-side G make the same vertically symmetrical structure, when up-and-down mutual-opposition arrangement|positioning is carried out, for example at the time of electric power feeding.
It respectively distribute|arranges towards the outer side in order of the cover 16, the primary coil 7 (secondary coil 8), the primary magnetic-core core 13 (secondary magnetic-core core 14), and the back board 15 from the inner side of the plane of symmetry.

Moreover, about the primary side F and the internal structure of secondary-side G, it is as follows.
Coating|coated fixing of the primary coil 7 by the side of [F] primary, the surface of the primary magnetic-core core 13, and the surface of the secondary coil 8 and the secondary magnetic-core core 14 is respectively carried out by mold resin 17.
That is, mold resin 17 is filled with the example shown to (2) figure of FIG. 1 between the back board 15 and a cover 16, it has the primary side F and secondary-side G in it, and they are internal primary and the secondary coils 7 and 8,
Furthermore, coating|coated fixing of the surface of primary and the secondary magnetic-core cores 13 and 14 is carried out.
Mold resin 17 consists of a product made of a silicone resin, for example,
Thus, by hardening an inside, positioning fixing of primary and the secondary coils 7 and 8 is carried out,
While ensuring the mechanical strength, a heat radiation function is also exhibited.
That is, an exciting current flows and primary and the secondary coils 7 and 8 heat-generate|emit with a Joule heat,
However,
The heat conduction of mold resin 17 thermally radiates, and it cools.

Moreover, the foaming material 18 is mixed and embedded into such mold resin 17.
The foaming material 18 consists of expanded polystyrene and a product made from another foamed plastics, for example,
It is used in order to reduce the quantity of mold resin 17 and to achieve weight reduction.
In the example of illustration, such a foaming material 18 is arranged around the inner side and outer side of primary and the secondary coils 7 and 8 in the shape of [large and small] an annular-ring collar,
However,
It may not be based on the example of illustration, but the small-piece group of the foaming material 18 may be mixed into mold resin 17.
The structure of the primary side F and secondary-side G is become like this.

<<About primary, the secondary coils 7 and 8, and primary and the secondary magnetic-core cores 13 and 14>>
Next, FIG. 1, FIG. 2 is referred,
Primary, the secondary coils 7 and 8 and primary, and the secondary magnetic-core cores 13 and 14 are demonstrated.
The primary coil 7 and the secondary coil 8 consist of a structure which swirled flatly the surface [the same] and wound conducting wire.
The primary magnetic-core core 13 and the secondary magnetic-core core 14 in which the primary coil 7 and the secondary coil 8 are arrange|positioned make flat form.

These are explained further in full detail.
First, primary and the secondary magnetic-core cores 13 and 14 have a product made from a ferrite, a product made of solidification iron sand, and a typical thing made from other ferrous material,
Magnetic permeability consists of an adult ferromagnetic material,
The forceful-ized function and guide function of the magnetic flux D are exhibited.
Namely, primary, increase of the inductance between the secondary coils 7 and 8,
While reinforce|strengthening a mutual electromagnetical coupling|bonding, the formed magnetic flux D is

induced|guided|derived and collected,
It functions in order to direct.
And as shown in FIG. 1, this primary and the secondary magnetic-core cores 13 and 14 make flat flat form without an unevenness|corrugation.
As it has and being shown to (2) figure of FIG. 2, it is between the primary side F and the secondary side G.
WHEREIN:
A pole dots with and is not unevenly distributed -- whole-izing -- equalize|homogenizing
It is parallel and magnetic-flux D distribution of the magnetic path formed by having becomes uniform,
The maldistribution of the magnetic flux D and concentration come to be avoided.
((3) figures of FIG. 2 regarding this seed|species prior art example, and comparison and contrast).

In response to this, in the same plane, primary and the secondary coils 7 and 8 are wound by spiral form, and it has them, and they make a circular flat shape.
That is, as shown in FIG. 1, the winding time of a large number is carried out to spiral form, primary and the secondary coils 7 and 8 have in it the parallel conducting wire insulated while being parallelized by several that Joule-heat loss should be reduced, making winding center part the circle space H, and the whole makes an annular-ring flange shape and a flat-shape with thin thickness.
And such primary and the secondary coils 7 and 8 are closely disposed by the symmetrical front side of the primary and the secondary magnetic-core cores 13 and 14 which respectively respond|correspond.
Contact|abutting arrangement|positioning is carried out in the example of illustration.
(1) of FIG. 1 -- as shown in the drawing(s), ratio of the outer diameter J of primary and the secondary coils 7 and 8 and the internal diameter K which were wound in this way is set to about 2:1 [moreover,]
By such a setting, the coupling coefficient between primary and the secondary coil 7 and 8 becomes a high value.
This point is supported by experiment.
It has, and even if the electromagnetical coupling|bonding between primary and the secondary coil 7 and 8 takes the wide air gap C between example both, it comes to be hold|maintained strongly|forcefully.

Furthermore, the primary and the secondary coils 7 and 8 which were wound in this way are twisted by the fixed pitch space|interval.
Namely, about the primary and the secondary coils 7 and 8 which were wound
If alternate-magnetic-flux D(Magnetic flux D by which alternation formation is carried out with a change corresponding to alternating current of an exciting current) passes in a direction perpendicular|vertical to a paper surface as shown to (4) figure of FIG. 2, the cyclic|annular loop electric current L which is a kind of electrical eddy current will be induced by line, and it will flow into it, it will have in it, and will become a cause of Joule-heat loss.
So, with this primary and the secondary coils 7 and 8, as shown to (5) figure of FIG. 2, it is twisted by the fixed pitch space|interval on the way, the wound multiple parallel conducting wire maintaining flatness.
That is, the positional relationship between several mth is transform|converted into each twisting location M of every sequentially 1 each, and it goes, and the twisting is implemented so that it may return to an original-position relationship by m times of twistings.
The twisting location M is formed in the pitch per 1 round of winding (for example, 5-6).
The electromotive force of the loop electric current L is canceled by such twisting, and the loop electric current L and Joule-heat loss are significantly reduced.
Primary, the secondary coils 7 and 8 and primary, and the secondary magnetic-core cores 13 and 14 are become like this.

<<Effect|action>> etc.
As explained above, the non-contact electric power feeder 6 of this invention is comprised.
Then, it is as follows.
(1) In this non-contact electric power feeder 6, provided with provided with primary coil 7 and primary magnetic-core core 13 grade|etc., electric-power-feeding side, i.e., primary side F and secondary coil 8, and secondary magnetic-core core 14 grade|etc., receiving side, i.e., secondary side, G exists an air gap C, and mutual-opposition arrangement|positioning of in the case of electric power feeding is carried out.

(2) And if alternating current supplies with electricity to the primary coil 7 by the side of [F] primary as an exciting current, the magnetic flux D will be formed (refer the (1) figure of FIG. 2).
It has and the magnetic path of this magnetic flux D is formed between the primary coil 7 by the side of [F] primary, and the secondary coil 8 of secondary-side G.
As for the primary coil 7 and the secondary coil 8, the inductive coupling of between both circuits is carried out, and a magnetic field is formed among both,
The magnetic flux D penetrates the secondary coil 8, and an electromotive force is produced|generated by the secondary coil 8.

(3) In this non-contact electric power feeder 6, electric power is supplied to secondary-side G by the mutual

dielectric effect|action of an electromagnetic induction from the primary side F.
That is, electric power is supplied from the external power-supply 9 and primary side F connected to this, and is taken out in secondary-side G,
The battery 10 connected to this is charged (refer the (2) figures of FIG. 4).

(4) Now, by this non-contact electric power feeder 6, it is as follows there.
First, in this non-contact electric power feeder 6, flat primary, the secondary magnetic-core cores 13 and 14, and the primary and the secondary coils 7 and 8 by which flat swirl|vortex winding was carried out combine, and are employ|adopted.
Then, it is a magnetic path in the air gap C between the primary side F by which mutual-opposition arrangement|positioning was carried out, and the secondary side G in the case of electric power feeding.
WHEREIN:
The magnetic flux D -- a parallel -- it comes to be distributed uniformly and sparse and a magnetic-flux D density becomes low
((2) figures of FIG. 2 and (3) figures of FIG. 2 regarding this seed|species prior art example are compared and contrasted.).
An in-air magnetic-flux D density and the magnetomotive force in which the magnetic flux D is formed exist in proportionality relation,
Therefore
Thus, by a magnetic-flux D density being low, the magnetomotive force and exciting current for magnetic-flux D formation are small, and completed and the Joule-heat loss of a circuit are also reduced that much.
Then -- for example, -- better than this seed|species prior art example that the direction of this invention mentioned above, when the magnetic flux D of the same density is formed at a far small magnetomotive force, an exciting current, and Joule-heat loss -- coming.

(5) Furthermore, this point is promoted much more by twisting the primary of this non-contact electric power feeder 6, and the secondary coils 7 and 8 in the twisting location M of the fixed pitch (refer the (5) figures of FIG. 2).
That is, about the loop electric current L (refer the (4) figures of FIG. 2) which is a kind of electrical eddy current, the electromotive force is canceled by such twisting, it has by it, and the loop electric current L and Joule-heat loss come to be reduced significantly.
For example, based on such said (4) and the point of (5), this non-contact electric power feeder 6 is highly efficiency-increased to about 92% with respect to 86% of this seed|species prior art example that charging efficiency mentioned above.

(6) Moreover, this non-contact electric power feeder 6 was employ|adopted combining flat primary, secondary magnetic-core cores 13 and 14 and primary of flat spiral form, and secondary coils 7 and 8,
Therefore
As above-mentioned, the density of the magnetic flux D may be low and the magnetomotive force and exciting current which form the magnetic flux D may be small.
Then, the air gap C between primary and the secondary coil 7 and 8 can be set widely by that much.
For example, in the case of the same exciting current of a value, it becomes possible to set an air gap C more widely from this seed|species prior art example that the direction of this invention mentioned above,
An air gap C compares with this seed|species prior art example that was about 50mm,
An air gap C can be doubled in 100mm.

(7) In addition, this point is followed up by what ratio of that outer diameter J and internal diameter K is made about into 2:1 for about the primary of this non-contact electric power feeder 6 by which swirl|vortex winding was carried out, and the secondary coils 7 and 8.
That is, thereby, a high coupling coefficient is obtained about between primary and the secondary coil 7 and 8,
Therefore
Even if it makes an air gap C wide, the forceful inductive coupling between both is maintained.

(8) Furthermore, flat primary, secondary magnetic-core cores 13 and 14, and flat primary and secondary coils 7 and 8 were employ|adopted for this non-contact electric power feeder 6,
Therefore
The primary side F and secondary-side G -- the thickness E is [both] thin -- by that much -- small size it reduces in weight
((2) figures of FIG. 1, and (2) figures of FIG. 3 regarding this seed|species prior art example and (3) figures are compared and contrasted.).
Thickness E is compared with this seed|species prior art example mentioned above, and is reduced by half.

(9) moreover, the thing for which the weight reduction of such a non-contact electric power feeder 6 mixes the

foaming material 18 the primary side F and into the mold resin 17 of secondary-side G -- (FIG. 1 -- reference) -- it promotes further.
That is, the filling amount of mold resin 17 is reduced, it has only the part which mixed the foaming material 18, and weight reduction comes to progress much more.
For example, based on such said (8) and the point of (9), this non-contact electric power feeder 6 is reduced by half with about 35kg with respect to about 70kg of this seed|species prior art example which the weight of secondary-side B, i.e., a pick-up, mentioned above.

<<Others>>
In addition, according to the place demonstrated above based on the example of illustration etc., the primary coil 7 and the secondary coil 8 consist of a structure which both swirled flatly the surface [the same] and was wound, And both the primary magnetic-core core 13 in which such a primary coil 7 and the secondary coil 8 are arrange|positioned, and the secondary magnetic-core core 14 consisted of a structure which comprised flat form.
However, about the non-contact electric power feeder 6, it is not based on such a structure but the following structures are also considered.
That is, only the any one side of the primary coil 7 or the secondary coil 8 makes only the primary coil 7 the structure which was mentioned above and which swirled flatly the surface [the same] and was wound, for example,
And the structure which made the flat structure only the primary magnetic-core core 13 or the secondary magnetic-core core 14 of one side in which it is arrange|positioned can be considered.
In this case, the other side as which such a structure and a structure are not employ|adopted is useable in the primary coil 1 or the secondary coil 2 of this seed|species prior art example mentioned above, and the primary magnetic-core core 4 or the secondary magnetic-core core 5 which makes uneven|corrugated shape.
The non-contact electric power feeder 6 of the structure which employ|adopted the primary coil 7 of the structure which swirled flatly and was typically wound in the same plane as such an example of a structure, and the primary magnetic-core core 13 of the structure of making flat form, as a primary side can be considered.
In this case, the such primary side formation and is applicable as individual and a structure separate from a secondary side.
And the place mentioned [effect / the function, the effect|action, and] above about such a non-contact electric power feeder 6 based on the example of illustration etc. is applied correspondingly.
Thus, wider application of this-invention thought is also considered.

BRIEF DESCRIPTION OF THE DRAWINGS

[FIG. 1]
It uses for description of Best mode for carrying out the invention about the non-contact electric power feeder based on this invention,
(1) Figure is plane-cross-section figure by the side of primary (plane-cross-section figure of secondary side),
(2) A figure is positive (side) sectional drawing by the side of primary (secondary side).
[FIG. 2]
It uses for description of this Best mode for carrying out the invention,
(1) Figure is positive (side) cross-section explanatory drawing of inductive coupling,
(2) Figure is front explanatory drawing of magnetic-flux distribution,
(4) Figure is planar explanatory drawing of electrical eddy current,
(5) A figure is planar explanatory drawing of a twisting coil.
In addition, (3) figures are front explanatory drawing of magnetic-flux distribution of this seed|species prior art example.
[FIG. 3]
It uses for description of this seed|species prior art example,
(1) Figure is top view by the side of primary (top view of secondary side),
(2) Figure is front view of the primary side and secondary side,
(3) A figure is a sectional side view of the primary side and a secondary side.
[FIG. 4]
It uses for description of a non-contact electric power feeder,
(1) Figure is isometric view explanatory drawing of basic principle,
(2) A figure is a block diagram of the example of application.

Description of Symbols

1 primary coil (prior art example)

2 secondary coil (prior art example)
3 non-contact electric power feeder (prior art example)
4 Primary magnetic-core core (prior art example)
5 Secondary magnetic-core core (prior art example)
6 non-contact electric power feeder (this invention)
7 Primary coil (this invention)
8 Secondary coil (this invention)
9 Power supply
10 Battery
11 Motor
12 Telecommunication control apparatus
13 Primary magnetic-core core (this invention)
14 Secondary magnetic-core core (this invention)
15 Back board
16 Cover
17 Mold resin
18 Foaming material
A Primary side (prior art example)
B Secondary side (prior art example)
C Air gap
D Magnetic flux
E Thickness
F Primary side (this invention)
G Secondary side (this invention)
H Circle space
J Outer diameter
K Internal diameter
L Loop electric current
M Twisting location
[FIG. 1]
[MAT_IMAGE 000003]
[FIG. 2]
[MAT_IMAGE 000004]
[FIG. 3]
[MAT_IMAGE 000005]
[FIG. 4]
[MAT_IMAGE 000006]

Citations

Citation

Citing Patents (0)

Expand Cited Patents (8)

Cited Non-patents (0)

Other

Title Terms
NON CONTACT ELECTRIC POWER FEED CHARGE EXTERIOR BATTERY VEHICLE MAGNETIC CORE CONNECT PRIMARY SECONDARY COIL SWIRL WOUND SURFACE

Related Accessions

Type	DWPI Update	Accession Number	DWPI Title
C	200841	2008-204315	-
N	200841	2008-504717	-

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

14443 7590 04/19/2017

The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

EXAMINER	
NGUYEN, TUYEN T	
ART UNIT	PAPER NUMBER
2837	

DATE MAILED: 04/19/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

TITLE OF INVENTION: Multi power sourced electric vehicle

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/19/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

14443 7590 04/19/2017
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

TITLE OF INVENTION: Multi power sourced electric vehicle

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/19/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, TUYEN T	2837	336-08400C

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

14443 7590 04/19/2017

The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

EXAMINER	
NGUYEN, TUYEN T	
ART UNIT	PAPER NUMBER
2837	

DATE MAILED: 04/19/2017

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

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 disclosure of these records is required by the Freedom of Information Act.
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 inspection 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.

Notice of Allowability

Application No.	Applicant(s)		
14/120,197	BOYS ET AL.		
Examiner	**Art Unit**	**AIA (First Inventor to File) Status**	
TUYEN NGUYEN	2837	No	

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 12/22/2016.*
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are *80-92.* As a result of the allowed claim(s), 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.
4. ☐ 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)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 12/27/2016
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/TUYEN NGUYEN/
Primary Examiner, Art Unit 2837

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14120197	BOYS ET AL.
	Examiner	**Art Unit**
	TUYEN NGUYEN	2837

CPC					
Symbol				**Type**	**Version**
H01F	38	/	14	F	2013-01-01
B60L	11	/	182	I	2013-01-01
H01F	5	/	00	I	2013-01-01
B60L	1	/	1816	I	2013-01-01
B60L	1	/	1829	I	2013-01-01
B60L	1	/	1842	I	2013-01-01
B60L	11	/	1844	I	2013-01-01
B60L	2230	/	16	A	2013-01-01
B60L	2250	/	16	A	2013-01-01
H02J	5	/	005	I	2013-01-01
Y02T	10	/	7088	A	2013-01-01
Y02T	10	/	7005	A	2013-01-01
Y02T	90	/	125	A	2013-01-01
Y02T	90	/	163	A	2013-01-01
Y02T	90	/	121	A	2013-01-01
Y02T	90	/	14	A	2013-01-01
Y02T	90	/	128	A	2013-01-01
Y02T	90	/	122	A	2013-01-01
Y04S	10	/	126	A	2013-01-01
Y02E	60	/	721	A	2013-01-01
H02J	7	/	0042	I	2013-01-01
H02J	7	/	025	I	2013-01-01

CPC Combination Sets					
Symbol			**Type**	**Set**	**Ranking**	**Version**

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	13	
/TUYEN NGUYEN/ Primary Examiner.Art Unit 2837	04/16/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14120197	BOYS ET AL.
	Examiner	**Art Unit**
	TUYEN NGUYEN	2837

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	1	F	5 / 00 (2006.01.01)						

CROSS REFERENCE(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	13	
/TUYEN NGUYEN/ Primary Examiner.Art Unit 2837	04/16/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14120197	BOYS ET AL.
	Examiner	**Art Unit**
	TUYEN NGUYEN	2837

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	80														
2	81														
3	82														
4	83														
5	84														
6	85														
7	86														
8	87														
9	88														
10	89														
11	90														
12	91														
13	92														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	13	
/TUYEN NGUYEN/ Primary Examiner.Art Unit 2837	04/16/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14120197	BOYS ET AL.
	Examiner	Art Unit
	TUYEN NGUYEN	2837

CPC- SEARCHED

Symbol	Date	Examiner
H01F 5/00; 27/00-30	4/15/2017	TN

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner
336	84R, 84M, 200, 232	4/15/2017	TN

SEARCH NOTES

Search Notes	Date	Examiner

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
336	84R, 84M, 200, 232	4/15/2017	TN
H01F	5/00; 27/00-30	4/15/2017	TN

	/TUYEN NGUYEN/ Primary Examiner.Art Unit 2837

Form PTO-1449

U.S. Department of Commerce
Patent and Trademark Office

INFORMATION DISCLOSURE CITATION
BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	2837

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/T.T.N./	AA	4 8 0 0 3 2 8	Jan. 24, 1989	Bolger et al.			
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/T T N/	AQ	20 07 00 8 6 4 6	Jan. 18, 2007	WIPO				
/T T N/	AR	08 5 0 5 2 7 9	2008	Japan			X	
/T T N/	AS	20 02 13 7 6 5 9	May 14, 2002	Japan			X	
/T T N/	AT	20 05 10 1 3 9 2	April 14, 2005	Japan			X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

AU	
AV	
AW	
AX	

/TTN/ 04/16/2017

EXAMINER — DATE CONSIDERED

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

Form PTO-1449 — U.S. Department of Commerce, Patent and Trademark Office

INFORMATION DISCLOSURE CITATION BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197
Applicant	
John Talbot BOYS et al.	
Filing Date	**Group**
May 5, 2014	2837

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/[illegible]/	AQ	2008 8 7 7 3 3	April 17, 2008	Japan			X	
	AR							
	AS							
	AT							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

AU	
AV	
AW	
AX	

/TUAN T NGUYEN/ — 04/10/2017

EXAMINER — DATE CONSIDERED

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

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

14443 7590 05/30/2017

The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

EXAMINER	
NGUYEN, TUYEN T	

ART UNIT	PAPER NUMBER
2837	

MAIL DATE	DELIVERY MODE
05/30/2017	PAPER

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.

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 14120197
Applicant : Boys
Filing Date : 05/05/2014
Date Mailed : 05/30/2017

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Quang Nguyen/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 14120197

SPECIFICATION NOT IN COMPLIANCE WITH 37 CFR 1.52(b)(5)

The pages of the specification document coded SPEC dated 05/05/2014 have not been numbered. Per 37 CFR 1.52(b)(5), "the pages of the specification including claims and abstract must be numbered consecutively, beginning with 1, the numbers being centrally located above or preferably below, the text." In response to this notice, the applicant must submit a substitute specification in which the pages are so numbered.

NOTE: Although 37 CFR 1.52(b)(5) refers to page numbering for "the specification including claims and abstract," any abstract or claims submitted in response to this notice will not be entered. Only the substitute specification, and any amendment thereto entered during prosecution, will be entered.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

14443 7590 04/19/2017
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Richard F. Jaworski (Depositor's name)
(Signature)
July 19, 2017 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

TITLE OF INVENTION: Multi power sourced electric vehicle

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/19/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, TUYEN T	2837	336-08400C

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 Law Office of Richard F. Jaworski, PC
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Auckland Uniservices Limited
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Auckland, New Zealand

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 50-5504 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____
Typed or printed name Richard F. Jaworski
Date July 19, 2017
Registration No. 33,515

07/20/2017 AVUONG2 00000001 505504 14120197
01 FC:1501 960.00 DA

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Dkt. 1172/69068-Div 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner: Tuyen T. Nguyen

Filing Date : May 5, 2014 G.A.U.: 2837

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd, Suite 327
Huntington Sta. NY 11746-4149

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION

Sir:

In Response to the Notice to File Corrected Application Papers dated May 30, 2017, Applicants submit herewith a Substitute Specification including page numbering as requested. A copy of the Notice is submitted herewith. No new matter has been added to the Substitute Specification.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

July 19, 2017
Richard F. Jaworski Date
Reg. No. 33,515

The Commissioner is authorized to charge any additional fees as required for entry of this Response, or to credit any overpayment, to our Deposit Account No. 50-5504.

If a petition for an additional extension of time is required to make this response timely, this paper should be considered to be such a petition, and the Commissioner is authorized to charge the requisite fees to our Deposit Account No. 50-5504.

Respectfully submitted,

RICHARD F. JAWORSKI
Reg. No. 33,515
Attorney for Applicants
The Law Office of Richard F. Jaworski, PC
Tel.: (631) 659-3608

69068 - Div. 2

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 14120197
Applicant : Boys
Filing Date : 05/05/2014
Date Mailed : 05/30/2017

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Quang Nguyen/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 14120197

SPECIFICATION NOT IN COMPLIANCE WITH 37 CFR 1.52(b)(5)

The pages of the specification document coded SPEC dated 05/05/2014 have not been numbered. Per 37 CFR 1.52(b)(5), "the pages of the specification including claims and abstract must be numbered consecutively, beginning with 1, the numbers being centrally located above or preferably below, the text." In response to this notice, the applicant must submit a substitute specification in which the pages are so numbered.

NOTE: Although 37 CFR 1.52(b)(5) refers to page numbering for "the specification including claims and abstract," any abstract or claims submitted in response to this notice will not be entered. Only the substitute specification, and any amendment thereto entered during prosecution, will be entered.

SUBSTITUTE SPECIFICATION
Serial No. 14/120,197

MULTI POWER SOURCED ELECTRIC VEHICLE

Field of the Invention

The present invention relates to an Inductive Power Transfer (IPT) pad, a system, method and means for charging a battery of an electric vehicle using multiple power sources and an electric vehicle powered by said battery. More particularly, the invention relates to charging the battery for an electric vehicle selectively using a high power source for charging at a high rate or a lower power source for charging at a lower rate.

Background

In the development of pure electric vehicles (i.e., those powered solely by electricity as opposed to hybrid vehicles), there are a number of problems to be solved before these vehicles can gain widespread acceptance. These include the limited range compared with more conventionally fuelled vehicles, the inconvenience of having to remember to recharge a vehicle (even if it is possible to do so at the user's premises or home) and the severe restrictions that occur should the vehicle not be charged. These problems have been subjected to greater consideration in recent times due to heightened concerns about global warming. Pure electric vehicles may have a role to play in reducing the effects of global warming as they are clearly the lowest polluters of all vehicle types and are capable of operating with a lower carbon 'footprint' than vehicles powered by more widespread and conventional means.

Many problems with electric vehicles stem directly from the battery used to store energy to power the vehicle. Virtually all battery types must be charged at a rate that is less than the allowable discharge rate, they have a limited capacity, and their cycle life is not great. Thus, it takes quite a long time to charge a vehicle, the time between charges is shorter than ideal, and the functionality of the battery declines rapidly with age.

In use, electric vehicles are however very convenient and make ideal shopping baskets and short trip commuter vehicles. Other tasks such as dropping off children at schools and running errands are also well suited. If the accumulated distance travelled in a day is within the range of the vehicle, then the battery may be recharged over-night, with service capable of being resumed the next day. This is an ideal scenario. However, if the available range is exceeded or the battery has not been sufficiently charged, the driver and passengers may be

left stranded, there will likely be a recovery fee, the battery will need to be fully charged over a longer period of time than a conventional charge cycle and, when using conventional batteries, these will almost certainly be degraded such that their available capacity is permanently reduced from what it was previously. Opportunity charging can help to eliminate this problem and involves partially charging the vehicle whenever an opportunity presents itself.

In perhaps a more serious situation where circumstances call for the vehicle to be taken on a long trip, there is little that can be done. Here hybrid vehicles may be a good solution as they can travel great distances on fossil fuels and refuel at conventional petrol stations.

For these reasons conventional pure electric vehicles have not met all of the modern requirements for a passenger transport vehicle.

Inductive Power Transfer (IPT) provides a useful alternative to more conventional charging. A charger using IPT is described in New Zealand Patent Application No. 545664, entitled "Single Phase Power Supply for Inductively Coupled Power Transfer Systems" and is incorporated herein by reference. This charger provides many advantages in that it will operate from a standard single phase supply typically available in the home, has an excellent power factor and very low harmonics. As a result of this, it would be possible to operate with several thousand of these connected to a utility network without the quality of supply being degraded. Moreover, the use of IPT obviates the need for a user to manually connect a cable to the battery.

Summary of the Invention

It is an object of the invention to provide an improved Inductive Power Transfer (IPT) pad.

It is an object of the invention to provide means for charging a vehicle which mitigates the aforementioned problems associated with conventional electric vehicles.

An alternative object of the invention is to provide a system for charging an electric vehicle.

An alternative object of the invention is to provide a method of charging an electric vehicle.

Alternatively, it is an object of the invention to at least provide a useful choice.

According to a first aspect of the invention, there is provided an inductive power transfer (IPT) pad comprising a coil having at least one turn of a conductor; one or more ferromagnetic slabs; and a shield member arranged around both said coil and said ferromagnetic slabs for channelling electromagnetic flux when in use.

Preferably, the conductor is litz wire.

Preferably, the coil comprises a plurality of turns of wire.

Preferably, the ferromagnetic slabs are monolithic slabs.

Preferably, the ferromagnetic slabs are ferrite slabs.

Preferably, each ferromagnetic slab is arranged in substantially the same plane.

Preferably, each ferromagnetic slab is arranged such that its length extends radially from a common point but spaced apart therefrom.

Preferably, each ferromagnetic slab is spaced apart from adjacent slabs by substantially the same angle.

According to a preferred embodiment, the IPT pad comprises eight ferromagnetic slabs each spaced apart from adjacent slabs by approximately 45º. Other configurations may be selected depending on system requirements.

Alternatively, in another embodiment, the IPT pad comprises a plurality of ferromagnetic slabs whereby a subset of the ferromagnetic slabs extend radially from a common point but are spaced apart therefrom, a further subset of the ferromagnetic slabs extend radially from a different common point but are spaced apart therefrom, and a still further subset of the ferromagnetic slabs are aligned perpendicularly to the direction of an imaginary straight line connecting the said common points, whereby the still further subset of ferromagnetic slabs are positioned equidistantly from the imaginary line but spaced equally along its length and equally on each side of the imaginary line.

Preferably, the coil is arranged in a plane substantially parallel to that of the ferromagnetic slabs.

Preferably, the coil is positioned to wind around the common point such that it passes each slab at approximately the centre of the length of each slab.

Preferably, the IPT pad comprises a substantially rigid backplate.

Preferably, the backplate is substantially planar,

Preferably, the plane of the backplate is substantially parallel to the planes of the ferromagnetic slabs and the coil, with the plane of the slabs located between the planes of the backplate and the coil.

Preferably, each ferromagnetic slab is spaced apart from the backplate by a thermally conductive and mechanically insulating material so as to allow the transfer of heat there between and protect the slab from mechanical shock. According to one embodiment, each slab may be spaced apart from the backplate using foam or rubber pads. The material making up the slabs is brittle and such steps serve to prevent cracking in the slabs caused by rapid temperature changes and also due to mechanical stresses exerted on the IPT pad.

According to preferred embodiments, the backplane is formed from a material which substantially inhibits the passage of magnetic flux therethrough. In one embodiment, this material is aluminium.

Preferably, the shield member is formed from a strip of material with the ends thereof joined to form a ring.

Preferably, the shield member is formed from aluminium.

Preferably, the shield member is coupled to the backplane.

Preferably, the IPT pad comprises a member having spaces formed therein for holding the ferromagnetic slabs in position and having a channel for accommodating the coil.

Preferably, the member is formed from a material which does not significantly affect magnetic flux. In one embodiment, foam or rubber is used.

Preferably, the member is formed by a moulding process.

Preferably, the IPT pad comprises a cover plate formed from a material that is substantially transparent to magnetic flux. In one embodiment this material is a non-toxic plastic.

According to preferred embodiments, the cover plate and the backplate provide front and rear walls of a housing for the IPT pad, with side walls provided by the shield member, the shield member preferably being configured to extend from the backplate to the cover plate.

The IPT pad according to the first aspect provides for improved performance in use by channelling the flow of flux from the charging pad. More particularly, the backplate and the shield member serve to direct flux upwards from the plane of the backplate with less splay of flux in and parallel to the plane of the backplate. This not only improves the inductive coupling but also reduces the chance that any undesired objects will be subjected to the induced fields during use. It is important to note that if this leakage is not controlled, it can lead to damage of such objects. For example, in the case of an electric vehicle, such leakage may result in the wheel bearings eroding.

The IPT pad of the present invention is also beneficial in that it is relatively slimline compared to more conventional IPT pickups. This is particularly important where pickup pads are coupled to the underside of an electric vehicle since it is important that ground clearance is maintained.

According to a second aspect, there is provided an inductive power transfer system comprising two inductive power transfer pads, wherein the two inductive power transfer pads are used in combination, one of the pads being used as a pickup pad and the other pad as a charging pad.

Preferably, the charging pad is coupleable to a power supply and inductively transfers power to the pickup pad, which is coupleable to a load, such as a battery.

According to a third aspect, there is provided an apparatus for charging a battery of an electric or a hybrid electric vehicle, the apparatus comprising first means for selectively

coupling the battery to a high power electrical supply; and second means for selectively coupling the battery to a lower power electrical supply wherein the second means for coupling comprises a pickup pad electrically coupled to the battery, wherein power is transferred to the pickup pad from a charging pad by inductive power transfer.

Preferably, the first means for coupling comprises a socket electrically coupled to the battery, wherein power is transferred by plugging a cable connected to the high power electrical supply into the socket. Thus, electrical energy may be rapidly transferred to the battery using the first means for coupling, resulting in rapid charging.

As would be apparent to one of skill in the art, alternatively, the first means for coupling comprises a plug electrically coupled to the battery, wherein power is transferred by plugging the plug into a socket connected to the cable connected to the high power electrical supply.

Preferably, the second means for coupling comprises a pickup pad according to the first aspect of the invention.

The use of IPT avoids the need for a user to plug in a cable for opportunity charging, including when a vehicle is parked overnight. Additionally or alternatively, a second socket may be provided or the first socket adapted, if required, so that the battery may be connected to a lower power supply using a cable. Again, in the alternative, the second socket may be substituted by a plug configured to mate with a socket connected to the lower power supply. Such embodiments provide for improved flexibility in that, where provided and where time permits, the battery may be charged using IPT. If rapid charging is required and a high power supply is available, the battery may be connected thereto. However, there remains the possibility that a battery will require charging where neither an IPT charging pad or a high power supply is available. A user could, perhaps, put the charging pad inside the vehicle when in transit so that, as required, it could be removed from the vehicle, appropriately positioned and used for charging. This is possible because embodiments of the invention involving IPT preferably work to widely available household voltages but this is inconvenient. Thus, the second socket may be provided, preferably on an outer surface of the vehicle, to enable the battery to be connected, via a cable, to a lower power supply, such as via a conventional household socket. According to preferred embodiments, the socket used for coupling to the high power supply may also be used to couple to a lower power supply. It is therefore possible to charge a battery via most household circuits, with only a cable needing to be carried in the vehicle.

Thus, depending on requirements and which types of power supply and forms of transfer are available, a user may selectively couple the battery to a high power supply or a lower power electrical supply, preferably using IPT for transferring power from the lower power supply.

Preferably, the high power supply has a transfer rating between 10 kW and 500 kW.

Preferably, the lower power supply has a transfer rating between 0.5 kW and 2.5 kW so that it may be provided by conventional household wiring. More preferably, the lower power supply is between 1.0 kW and 2.2 kW.

Use of the word "battery" throughout the specification is not used in a limiting way and may include one or any number of cells or batteries, or super capacitors.

Preferably, the apparatus comprises an indication means for indicating alignment between the charging pad and the pickup pad.

Preferably, the apparatus comprises an indication means for indicating when the battery is being charged.

According to a fourth aspect of the invention, there is provided an electric vehicle comprising a rechargeable battery and the apparatus of the third aspect for charging said battery.

The electric vehicle may be a "pure electric vehicle" in that it may be powered only by electrical energy. However, the invention is not limited thereto and may be applied to hybrid vehicles which may be powered by electrical energy and at least one other energy source, such as a combustible fuel. Thus, references to "electric vehicles" herein include both pure electric vehicles and hybrid vehicles having electrical energy as one source of power.

According to a fifth aspect of the invention, there is provided a method of charging a battery of an electric or a hybrid electric vehicle, the method comprising selectively coupling the battery to a high power supply or a lower power supply, wherein said coupling the battery to a lower power supply comprises positioning an inductive power transfer pickup pad electrically coupled to the battery in close proximity to an inductive power transfer charging pad.

Preferably, the step of connecting the battery to the high power supply comprises mating a plug with a socket, wherein the plug is associated with one of the battery and the high power supply, and the socket is associated with the other one of the battery and the high power supply.

More preferably, the pickup pad is coupled to the underside of the vehicle and the charging pad is provided on the ground, wherein said selectively coupling the battery to the lower power supply comprises driving the vehicle into a position such that the pickup pad is positioned above, or operably adjacent to, the charging pad.

Preferably, the charging and pickup pads can be variably distanced from each other. The charging pad may be raised and lowered from the ground by a raising and lowering means. Alternatively, the pickup pad may be raised and lowered from the underside of the vehicle by a raising and lowering means.

Preferably, the method comprises indicating alignment between the charging pad and the pickup pad.

Preferably, the method comprises indicating when the battery is being charged.

Placement of an IPT pickup pad on the underside of a vehicle is preferred for aesthetic reasons, because this arrangement provides no physical obstacle to those moving around the vehicle while it is being charged, and because it is improbable that people or other foreign objects will be subjected to the induced fields during charging. However, the invention is not limited to such placement. A pickup pad may be located essentially anywhere on the vehicle with the charging pad being mounted so that IPT transfer is enabled when the vehicle is parked in position. For example, a pickup pad may be provided on the front or rear surface of the vehicle with the charging pad being mounted on a wall in a garage so that they inductively couple when the vehicle is parked. While not preferred due to the requirement for user intervention, the invention does not preclude the mounting of the pickup pad and/or the charging pad on a moveable mounting or armature, whereby, following parking of a vehicle, a user may move one or both of the pads so that IPT transfer is enabled. While having the drawback of requiring greater user intervention, such embodiments do allow for greater tolerances in the parking position of the vehicle.

According to a sixth aspect, there is provided a system for charging a battery of an electric or a hybrid electric vehicle, the system comprising an electricity network or subnetwork having at least one generator; cabling for transferring energy generated by the at least one generator around the network; IPT coupling means for coupling the network to the battery; and control means for controlling the power transfer from the at least one generator to the battery.

Preferably, the network is coupled to a plurality of batteries of a corresponding plurality of electric or hybrid electric vehicles.

Any energy source may be used by the generator(s) to generate electrical energy. However, according to preferred embodiments, a renewable energy source is used. Through use of the control means, it is possible to overcome problems associated with the fluctuable nature of power generated from renewable sources and enhance the stability of the network by varying the power supplied to the battery so that the power demand on the network better matches the available power. These benefits are more marked according to embodiments of the system in which the network is coupled to a plurality of batteries of a corresponding plurality of electric or hybrid electric vehicles.

Preferably, the control means is configured to vary the power transfer so as to optimise the load factor. Thus, a network controller (e.g. a utility company) may vary the power transfer to batteries connected to their network to better match supply and demand.

According to one embodiment, the batteries in the vehicles are owned by a network controller which operates the network and are leased to the owners of the vehicles.

The system of the sixth aspect preferably comprises at least one IPT pad according to the first aspect and/or at least one apparatus for charging according to the third aspect and/or at least one electric vehicle according to the fourth aspect.

Preferably, the control means is controlled by way of a communications channel.

According to a seventh aspect of the invention, there is provided a method of charging a battery of an electric or a hybrid electric vehicle, the method comprising the steps of coupling the battery to an electricity network or subnetwork using inductive power transfer; transferring

electrical energy to the battery via the network; and varying the power transfer according to at least one predetermined criteria.

Preferably, the at least one predetermined criteria may comprise one or more of: a time of day; the level of demand on the network; the level of available supply in the network, which is particularly relevant where the energy source for the network is fluctuable.

Preferably, the method further comprises the steps of coupling batteries of a plurality of electric vehicles to the network and selectively transferring power to all or a subset thereof.

Preferably, the method further comprises the steps of: coupling batteries of a plurality of electric vehicles to the network; and selectively transferring power to all batteries or a subset thereof.

Preferably, the method comprises the step of varying the electricity mains frequency to determine the battery load on the network.

According to an eighth aspect of the invention there is provided a system for supplying power to an electricity network, the system comprising: an electricity network or subnetwork having at least one generator; a plurality of batteries of a plurality of electric or electric hybrid vehicles; cabling for transferring energy stored in the plurality of batteries; IPT coupling means for coupling the batteries to the network; and control means for controlling the power transfer from the plurality of batteries to the network.

According to a ninth aspect of the invention there is provided a method of supplying power to an electricity network, the method comprising the steps of: coupling a plurality of batteries of a plurality of electric or hybrid electric vehicles to the network using inductive power transfer; transferring electrical energy to the network from the battery; and varying the power transfer according to at least one predetermined criteria.

According to a tenth aspect of the invention there is provided a system for controlling load demand in an electricity network, the system comprising: an electricity network having at least one generator, the frequency of power supplied by the network being allowed to vary; at least one load connected to the network; and control means to monitor the frequency of power supplied by the network, the control means increasing or reducing power consumed by the load dependent on the frequency.

According to an eleventh aspect of the invention there is provided a method of controlling load demand on an electricity network, the method comprising: allowing the frequency of power supplied by the network to vary; monitoring the frequency of power supplied by the network; and increasing or reducing the power consumed by the load dependent on the frequency.

Further aspects of the invention, which should be considered in all its novel aspects, will become apparent to those skilled in the art upon reading the following description which provides at least one example of a practical application of the invention.

Brief Description of the Drawings

One or more embodiments of the invention will be described below by way of example only and without intending to be limiting with reference to the following drawings, in which:

Figure 1	is a perspective view showing a preferred relative positioning of an IPT charging pad and an electric vehicle during charging;
Figure 2	is a perspective view of a preferred embodiment of an IPT pad;
Figures 3 to 5	are alternative perspective views of the embodiment of the IPT pad of Figure 2, with portions removed in Figures 3 and 5, and portions shown in ghost outline in Figure 4 so as to show internal detail;
Figure 5A	is a view of an alternative embodiment of an IPT pad configuration;
Figure 5B	is a plan view of the alternative embodiment of the IPT pad of Figure 5A;
Figure 6	is a schematic representation of an electric vehicle being charged according to an embodiment of the invention; and
Figure 7	is a schematic representation of an embodiment of a system according to the invention.

Detailed Description of Preferred Embodiments

Embodiments of the invention provide for a multi-source electric vehicle that is able to operate in most situations that may occur in terms of types, length and frequency of trips. References to "multi-source electric vehicles" are used to refer to electric vehicles embodying or capable of operating with embodiments of the present invention where the batteries and/or cells used to power the vehicle may be charged using various electrical power sources. Embodiments of the invention provide all of the advantages of a plug-in electric vehicle in that it can be recharged 'at home' overnight but, according to preferred embodiments, it does so without the disadvantage of requiring a cable to be plugged in. More particularly, according to preferred embodiments, a charging pad is preferably provided on the floor

where the vehicle is usually parked, such as in the floor of a user's garage. While the vehicle is parked, the charging pad transfers energy to the vehicle's battery by Inductive Power Transfer (IPT) via a pickup provided on the underside of the vehicle. With nothing to plug in there is nothing to remember and the battery will be fully charged dependent only on the time available.

The charging pad provided on the floor is energised by a power supply and the magnetic field produced thereby couples power into the pickup attached to the vehicle and charges the on-board battery. Power transfer rates of up to around 2.2 kW are compatible with household outputs on most utility networks. The control of this power flow may be achieved using the technique described in US Patent No. 5,293,308, which is incorporated herein by reference. Other methods are also within the scope of the invention.

Figure 1 shows a preferred relative positioning of charging pad 20 and vehicle 10 during charging. The pickup pad (not shown) is preferably of the same shape and configuration of charging pad 20 and is positioned on the underside of vehicle 10 so that it is substantially directly above charging pad 20 when vehicle 10 is parked. The magnetic flux produced by charging pad 20 links the two pads. There is no functional requirement for the pickup pad to be positioned underneath the vehicle but this is preferred for aesthetic reasons and relative ease of installation for retrofitted vehicles.

Figures 2 to 5 show alternative perspective views of charging pad 20 according to preferred embodiments of the invention. More particularly, Figure 2 shows the outer housing of the pad, Figure 3 shows the pad with a portion of the outer housing cut away to show interior detail, Figure 4 corresponds to the view of Figure 3 with exterior features shown as see-through to provide additional detail of the internal arrangement of the components, and Figure 5 shows the pad with the top cover removed. Note that the pickup pad is of the same configuration as charging pad 20 and description of charging pad 20 also applies to the pickup pad, except that charging pad 20 is coupled to an electrical supply (e.g. the mains electricity supply) and the pickup pad is attached to a load (i.e., the vehicle battery to be charged).

Pads 20 are preferably placed an object formed from a material which substantially limits the passage of magnetic flux, such as a metallic backplate 21 (which is formed from aluminium in a preferred embodiment) with 8 ferrite bars 22 displaced at 45 degrees with respect to each other. Bars 22 are held in position by rubbery moulding 23. A coil of litz wire 27 (see Figure

5) is linked by the magnetic flux passing through ferrite bars 22. Preferably, the coil of litz wire 27 is located on ferrite bars 22 in region 24 of pad 20 so that the coils wind round the generally circular body of the pad approximately half way along the lengths of bars 22. Aluminium strip 25 is coupled or formed integral to backplate 21 to assist in controlling the pattern of the flux generated. Cover 28 is coupled to the top of the main circular body of the pad. Cover 28 is formed from a material, such as PVC, or preferably a non-toxic plastic, which does not obstruct the passage of flux therethrough. The particular configuration shown enables the pads to be relatively slim-line which is particularly important for the pickup pad when retrofitted to existing vehicles so as to maintain ground clearance.

More particularly, backplate 21 and strip 25 are appropriately coupled to work together to direct flux generated by the charging pad through cover 28 in a generally perpendicular direction to backplate 21, thereby providing for improved coupling between a charging pad and a pickup pad since there is less leakage caused by the splay of flux in directions generally parallel to backplate 21. Backplate 21 and strip 25 are electrically connected in one embodiment of the invention.

Mechanical or shock insulating pads 26, preferably formed from foam or rubber, are provided to prevent bars 22 from coming into contact with other components of pad 20. Bars 22 are brittle and thermally sensitive, thus pads 26 are ideally also thermally conductive to keep the bars 22 cool. Mechanical insulating pads 26 also limit the transfer of mechanical stresses to bars 22 caused by knocks or impacts on pad 20 and also due to vibrations such as those generated when pad 20 is mounted on a vehicle.

Using pads configured as shown in the drawings, with a diameter of 400 mm and a thickness of 22 mm, power transfer at rates of up to 2 kW is readily achievable for lateral misalignments of up to +/- 50 mm and vertical separations of 25 mm to 75 mm. Power transfer with even larger tolerances is possible but this requires larger pads, increasing the cost. Where a charging pad is provided on a floor to couple with a pickup pad on the underside of a vehicle, these tolerances translate into tolerances for the parking position of the vehicle. Relatively simple methods may be used to assist a driver in parking in the correct position. For example, a ball on a string may be suspended from the ceiling and aligned with a spot on the windscreen when the vehicle is in the correct position. Alternatively, a charging indicator may be provided in the vehicle that lights up when the battery is charging and hence the vehicle is in the correct position. Other alternatives will be

readily apparent to one of skill in the art and all such alternatives are within the scope of the present invention.

According to preferred embodiments involving a transfer rate of up to around 2 kW, bars 22 preferably have a height of 10 mm, width of 30 mm and length of 120 mm, and coil 27 preferably comprises litz wire having 0.2 mm diameter individually insulated wires with 120 strands at 3.77 mm^2 or more. Strip 25 preferably has a thickness of around 4 mm and cover 28 preferably has a thickness of approximately 5 mm. It should be noted that the invention is not limited to these particular values and the skilled person will be aware that other values may be selected depending on the desired operational characteristics.

According to embodiments of the invention, the power pad on the floor under the vehicle takes the place of a 'track' in a more conventional IPT system and the power pad attached to and under the vehicle is the pickup coil. Using the technique described in the above mentioned New Zealand Patent Application No. 545664, this arrangement of coils allows power to be passed from the floor power pad to the vehicle power pad at high efficiency such that the battery on the vehicle may be charged overnight.

Embodiments of the IPT system make opportunity charging of an electric vehicle possible, not only for a single vehicle in the home, but also, for example, for a fleet of delivery vehicles and the like to allow continuous operation on a 24 x 7 basis given that the work schedule includes relatively long times where the vehicle can be parked over the floor mounted power pad. However, the typical charging rate of 2kW does not overcome the limited range problem of electric vehicles, where the total energy demand exceeds the available stored energy.

To address this problem, a high power, plug-in charger may be connected to the vehicle using a separate high power plug to provide rapid charging of the battery. Not all battery types are capable of accepting powers of the magnitude envisaged but lithium batteries are increasingly capable of doing this.

As noted above, the power pad intervention-free charger is a home-based IPT charging system providing a charging power of about 2 kW to stay within the ratings of conventional household wiring. A typical battery in an electric vehicle may store 50 kWH of energy or 170 AH (Ampere-Hours) at 300V so that the nominal charging rate is 0.04C (where C stands for the capacity of the battery in AH). This is a conservative and safe estimate. With a single 12

hour charge, 24 kWH of energy may be transferred and if the vehicle operates with an average power demand of 10 kW, it will have a range of about 2 hours of driving or approximately 160 km per day. With a longer charging time this range can be doubled by having the vehicle fully charged. On the other hand, embodiments of the high power battery charger may provide power at a rate of 10kW - 500 kW for 6 minutes corresponding to a charging rate of 10C. Thus in 6 minutes, the battery is fully charged and the vehicle is set for another 300 km before it needs to be charged again. Note that an electric power flow of 500 kW is high but is still low compared with the energy flow rate when pumping petrol or diesel fuel into a tank.

This rapid charging will need to be carefully supervised, as needed for pumping petrol, and is not suitable for home applications for a number of reasons. Few houses have access to a 500 kW utility network and at this power level the source of supply would be at a higher voltage than the normal distribution network. There is also a degree of hazard involved so that a commercially rated facility is required. In contrast, the IPT system is safe and easy to use, making it suitable for installation in the home or other places a car may be parked, such as in public car parks.

The combination of these technologies provides a vehicle with excellent characteristics. On a daily basis it is ideal for short trips, commuting and shopping, allowing relatively low cost travelling for typically 160 km/day with minimal maintenance and no queuing for fuel. It may be used for longer trips requiring refuelling about every 300 km.

Figures 5A and 5B show an alternative embodiment of the charging pad configuration 20 according to the present invention. In Figures 5A and 5B the pad 20 is an oval shape in plan. Oval power pads can be constructed by extending the circular power pads and adding identical rectangular sections in the middle. The construction of both power pads is again preferably identical. In Figure 5B it is shown that the coil 27 is lengthened and a subset of additional ferrite or ferromagnetic bars 22A are added with similar spacing to that of the subset of bars equivalent to those of the circular power pad described above.

The advantage of this oval-shaped arrangement is that the tolerance of the pad to lateral movement (in the x direction shown in Figure 5A) is improved over the circular pad. This is advantageous as it is relatively difficult to adjust the position of a vehicle in the x direction, corresponding to a side to side movement for the vehicle. The tolerance of the pads to pick-up movement in the y direction, corresponding to the forward and reverse directions of a

vehicle when positioned over the pad, is less that that for the circular pad. However, this is less critical when parking a vehicle since it is comparatively much easier to make adjustments in this direction so as to be optimally positioned over the pad in the y direction.

The ability to control the spacing between the charging pad and the pickup pad attached to the vehicle is also advantageous. This can be achieved using a variety of methods. For example, the charging pad on the floor may include means for raising and lowering it from the floor such as a jack. The jack may be hand or electrically powered. Alternatively, the pickup pad on the underside of the vehicle may include means for increasing or decreasing its distance from the underside of the vehicle. Again, this may be a jack or other known mechanisms.

One of the primary advantages of the system described herein is one of safety. An inductive charger means there is no plug connection between the charger and the vehicle, unlike in alternative electric vehicle charging systems. If a user accidentally drives the vehicle away whilst still connected in a plugged system, the apparatus may be damaged and a hazardous situation may arise through broken current-carrying equipment. In contrast, using an IPT system with no requirement to first safely disengage any plugs, the vehicle would be able to drive safely away, without fear of damage to the equipment or risk of electricity hazard. Furthermore, in the event of flood, the IPT system can function very safely without the obvious dangers of alternative plugged systems.

Figure 6 is a schematic drawing of battery 51 of electric vehicle 10 being charged by high power electrical supply 52 via cable 53. During opportunity charging, battery 51 is supplied with electricity from pickup 20 via wiring 54. High power electrical supply 52 may comprise a high power generator or alternatively merely provides an interface or conduit between a high power electricity network and cable 53. Cable 53 is provided with a plug (not shown) which mates with a socket (not shown) provided in vehicle 10. Wiring between the socket and battery 51 transfers electricity to battery 51. Preferably, the plug is provided with a safety housing to prevent access to the electrical contacts. The socket may be provided at any point on vehicle 10 with wiring provided between the socket and battery 51. Thus, the invention is not limited to the position of the socket shown in Figure 6.

Figure 7 is a schematic representation of a system, generally marked 60, according to an embodiment of the invention. Generator 61 provides high power electricity to facility 63 which includes high power electrical supplies 52 of Figure 6. Two high power electrical

supplies 52 are shown. However, as would be apparent to one skilled in the art, the invention is not limited thereto and facility 63 may include one or any number of supplies 52, limited only by the available space and the capacity of generator 61. High power cabling 62 acts as a conduit for the transfer of high power electricity to facility 63 and also to transformer 64 which reduces the supply to that of a lower power, such as that conventionally found in homes. Lower power cabling 65 then transfers lower power electricity to charging pads 20, preferably provided in the floor of a user's garage. Whilst single generator 61 is shown, system 60 may include a plurality of generators and may include separate generators for the high power supply and the lower power supply.

An important aspect of electric vehicles is their capital cost. They are typically more expensive than conventional motor cars due to the high cost of the battery. However, according to embodiments of the invention, the battery and the vehicle may be owned by different parties. More particularly, according to one embodiment of a system and method according to the invention, the battery may be owned by a utility company and leased to an owner of a vehicle. According to such embodiments, users of electric vehicles are clearly provided with the benefit of having a reduced capital outlay at the time of purchasing a vehicle. However, benefits may also be realised by utility companies and not only through charges levied for supplying the electricity. In particular, through appropriate control of power supplied to the IPT charging pads, utility companies may level their electric load, particularly overnight when a large number of batteries for electric vehicles may be charging.

With some modification to the electronics system it is also possible to transfer power in reverse from the battery to the utility. In this way at times of peak power in the utility, power may be taken from the vehicle battery and used to supply the peak. With a greater number of vehicles this reverse power may be very large and may avoid power shortages. The total energy may be small as the time that the reverse power flow occurs will likely be short.

There are significant financial advantages to a utility company being able to have a load factor of 1 and this source-side control of a demand-side load would allow this ideal to be approached, if not reached.

A communications channel may be provided between the controller of the network (typically, the utility company) and the vehicles under charge so as to enable monitoring of the charging of these vehicles. A simple cell-phone channel may be used for this purpose. As the available power varies the network controller may vary the battery charging demand to match

it. This would allow the utility company to operate near their maximum power with safety as the electric vehicle load can be varied so quickly. This is similar to but more sophisticated than a ripple control system commonly used to control hot water heating. The essential differences are that partial loads are possible, and the loads can be varied more quickly and precisely.

The ability to manipulate the demand makes it more readily possible to integrate highly fluctuable 'renewable' sources of energy into power networks. The manipulation may alternatively be made by allowing the frequency of the network or grid to vary in response to variations in the fluctuable source. Thus, in strong gusts of wind over a whole wind farm the power surge may be such that the mains frequency increases by a small fraction of 1 Hz. These variations in frequency are measured by the power supply to the IPT charging pad and used to control the power pad or track current. In principle, the power transferred is made proportional to the pad current so that by varying the pad current the charging load can be matched to the available power. The variation can take place in as short a period as one cycle of the mains power.

For a large number of battery chargers, say 100,000, the pad current could be programmed so that, for example, at 49.5 Hz the pad current is zero, and at a frequency 1Hz higher the pad current is the full rated current. If all the chargers were at full demand the charging load would vary from 100,000 x 2 kW = 200 MW at a frequency of 50.5 Hz to zero at a frequency of 49.5 Hz. The 49.5 Hz set-point can of course also be varied so that full power occurs at whatever frequency is required. For example, if the set point was 49 Hz then full power would be taken at 50Hz or higher. In this manner, high surges in power caused by strong gusts of wind over large wind farms can be compensated for.

On the other hand, in the integration of wind power into a power network, there are also commonly periods where the wind completely 'dies'. In practice, these periods must be covered by having a separate spinning generator of the same power capacity, on standby. Thus, if a 200 MW wind farm is to be used then 200MW of spinning reserve must be connected to the grid, and under ideal circumstances it provides no real power at all. This protection is very expensive and in many cases makes wind power uneconomic. According to the present invention, this precaution is not required. If the wind 'dies' then all the battery charging load drops as soon as the mains frequency reaches the given set point (e.g. 49.5 or 50 Hz). As the vehicles charge they will individually disengage themselves as soon as their batteries are fully charged so that the actual load is indeterminate and is not simply the total

number of vehicles connected. The load could be determined using a communication channel with each vehicle as discussed above but this would take time and a simpler option is available. If the set point was at 49.5 Hz then all of the connected vehicles that are still charging would be at 50% power if the frequency was 50 Hz. If the set point was then changed to 49.6 Hz then the charging vehicles would drop to 40% of their rated power and the change in power, over the whole country, would be 10% of the connected (total) power sink. In this particular example the actual power being taken could be increased by 6 times this change, or reduced by 4 times. In essence, the controllable battery charging load has been precisely determined.

In these circumstances a very high percentage of wind power and/or other fluctuable energy sources can now be included into the generation mix without standby generators knowing how much power is available if the wind dies, and how much spare sink capacity is available if there is a surge. This is a significant advantage over most wind farm integration schemes and will allow the percentage of wind power to be increased above the presently used 6% commonly in, for example, Ireland and Germany, with zero or minimal standby generators necessary. Other schemes for achieving this flexibility use huge batteries locally at the wind farm to store surplus power but it is more efficient if the energy is transferred directly to its destination, namely the batteries in the vehicles, since this requires only one battery charging operation. Batteries at wind farms are therefore significantly less efficient if the ultimate use of the energy is in electric vehicles.

The financial justifications of the invention are interesting. If a typical battery cost $10,000 it might be leased to the car owner for $40/week plus electricity charges of 12c/kWH charged on the basis of what has been used. A user doing 300 km per week might use 45 kWH at a cost of $5.40 plus the battery lease fee of $40 for a total cost of $45.40 or 15 c / km. Some form of road-user charge would also likely be involved or again added to the cost of the electricity. This cost/km is perhaps high but is for very moderate usage and if the distance travelled is doubled the cost/km is significantly reduced at $50.80 for 600 km or 8.5 c/km.

Electricity generated from renewable sources other than wind power (e.g. solar, tidal etc) is also applicable to embodiments of the invention. All of these are not particularly stable and like wind may vary considerably over relatively short time scales. For example, measured rates of change for wind power in New Zealand have been as high as 200 MW in 5 minutes from a wind farm with a nominal rating of 200MW. Thus the integration of such highly fluctuable sources into an electricity network is a huge advantage. With the source-side

control as outlined the charging load varies at a rate sufficient to match the fluctuable power on almost a cycle by cycle basis using small changes in the frequency of supply, allowing the use of energy that would otherwise simply be wasted. This energy would be generated at a considerably lower cost than electricity from more conventional sources.

The invention thus allows off-peak power to be used effectively and safely for electric vehicle charging. It also allows energy generated from renewable sources to be conveniently put to use to charge electric vehicles. Furthermore, the invention allows load demand to be controlled.

Unless the context clearly requires otherwise, throughout the specification, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

It should be noted that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the invention and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be included within the present invention.

Dkt. 1172/69068-Div 2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : John Talbot BOYS et al.

Serial No. : 14/120,197 Examiner: Tuyen T. Nguyen

Filing Date : May 5, 2014 G.A.U.: 2837

For : MULTI POWER SOURCED ELECTRIC VEHICLE

273 Walt Whitman Rd, Suite 327
Huntington Sta. NY 11746-4149

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

REQUEST FOR CORRECTED FILING RECEIPT

Sir:

The present Request For Corrected Filing Receipt is being submitted merely to update the lineage information and in particular the national stage filing benefit of the present application. Attached is a marked up copy of the filing receipt showing the proposed change. Also attached is a copy of a revised Application Data Sheet (ADS) showing the updated information in underline and strikethrough.

Although the lineage information was submitted in the original Application Data Sheet filed concurrently with the present application, the information was apparently not listed correctly in that original ADS.

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

July 19, 2017
Richard F. Jawo rski Date
Reg. No. 33,515

Since the correct information was previously submitted, albeit not in the proper places in the original ADS, it is believed that a petition fee to correct the filing receipt is not required.

The present application has been allowed. Accordingly, prompt issuance of a corrected filing receipt is respectfully requested.

The Commissioner is authorized to charge any fees as required for entry of this Response, or to credit any overpayment, to our Deposit Account No. 50-5504.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition, and the Commissioner is authorized to charge the requisite fees to our Deposit Account No. 50-5504.

Respectfully submitted,

RICHARD F. JAWORSKI
Reg. No. 33,515
Attorney for Applicants
The Law Office of Richard F. Jaworski, PC
Tel.: (631) 659-3608

Corrected Filing Receipt

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/120,197	05/05/2014	3742	2000	1172/69068-Div. 2	8	1

CONFIRMATION NO. 4659

UPDATED FILING RECEIPT

14443
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

Date Mailed: 09/29/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

John Talbot Boys, Auckland, NEW ZEALAND;
Grant Anthony Covic, Auckland, NEW ZEALAND;

Applicant(s)

John Talbot Boys, Auckland, NEW ZEALAND;
Grant Anthony Covic, Auckland, NEW ZEALAND;

Assignment For Published Patent Application

Auckland Uniservices Limited, Auckland, NEW ZEALAND

Power of Attorney:

Christopher Dunham--22031
Ivan Kavrukov--25161
Norman Zivin--25385
John White--28678
Peter Phillips--29691
Robert Katz--30141
Richard Jaworski--33515
Richard Milner- 33970
Paul Teng--40837

which is a 371 of
PCT/NZ2008/000103 05/09/2009

Domestic Priority data as claimed by applicant

This application is a DIV of 12/451,436 01/13/2010 PAT 8749334

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76. New Zealand 555128 05/10/2007

New Zealand 556616 07/20/2007

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 05/16/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/120,197**

Projected Publication Date: 01/08/2015

Non-Publication Request: No

Early Publication Request: No

Title

Multi power sourced electric vehicle

Preliminary Class

219

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Substitute Application Data Sheet

14/120,197

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

ication Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	

Title of Invention	Multi Power Sourced Electric Vehicle

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 [Remove]

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	John	Talbot	BOYS	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Auckland	Country of Residence [i]	NZ

Mailing Address of Inventor:

Address 1	41A Dominion Street		
Address 2			
City	Takapuna	State/Province	
Postal Code	1309	Country [i]	NZ

Inventor 2 [Remove]

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Grant	Anthony	COVIC	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Auckland	Country of Residence [i]	NZ

Mailing Address of Inventor:

Address 1	28 Haverstock Road		
Address 2			
City	Sandringham	State/Province	
Postal Code	1004	Country [i]	NZ

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. [Add]

Correspondence Information:

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	

Title of Invention	Multi Power Sourced Electric Vehicle

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	14443		
Email Address	rich@richardjaworski.com	Add Email	Remove Email

Application Information:

Title of the Invention	Multi Power Sourced Electric Vehicle		
Attorney Docket Number	1172/69068-Div 2	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	14443		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status	Pending			Remove
Application Number	Continuity Type		Prior Application Number	Filing Date (YYYY-MM-DD)
	Division of		12/451436	2010-01-13
Prior Application Status				Remove

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	
Title of Invention	Multi Power Sourced Electric Vehicle	

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
12/451436	a 371 of international	[redacted]	2008-05-09

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
[redacted]	[redacted]	[redacted]	

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
555128	NZ	2007-05-10	

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
556646	NZ	2007-07-20	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	
Title of Invention	Multi Power Sourced Electric Vehicle	

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	
Title of Invention	Multi Power Sourced Electric Vehicle	

Mailing Address Information For Applicant:			
Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee is an Organization check here. ☒

Organization Name	Auckland Uniservices Limited

Mailing Address Information For Non-Applicant Assignee:			
Address 1	Level 10, Symonds Street		
Address 2			
City	Auckland	**State/Province**	
Country	NZ	Postal Code	1010
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature		Date (YYYY-MM-DD)	~~2014 05 05~~ 2017-07-19

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1172/69068-Div 2
	Application Number	

Title of Invention	Multi Power Sourced Electric Vehicle

First Name	Richard	Last Name	Jaworski	Registration Number	33515

Additional Signature may be generated within this form by selecting the Add button.

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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 records.

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 C o o p eration 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.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2	4659

14443 7590 07/31/2017

The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

EXAMINER	
NGUYEN, TUYEN T	

ART UNIT	PAPER NUMBER
2837	

MAIL DATE	DELIVERY MODE
07/31/2017	PAPER

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.

Response to Rule 312 Communication	Application No.	Applicant(s)
	14120197	John Tolbot Boys
	Examiner	Art Unit

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

1. ☒ The amendment filed on *24 July 2017* under 37 CFR 1.312 has been considered, and has been:

a) ☒ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/ Timothy Caldwell /

Timothy Caldwell

Publishing Division

Office of Data Management

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/120,197	05/05/2014	John Talbot Boys	1172/69068-Div. 2

CONFIRMATION NO. 4659

14443
The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

IMPROPER CFR REQUEST

OC000000093134190

Date Mailed: 08/02/2017

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Continuity, Priority Claims, Petitions, and Non-Publication Requests

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- The priority or continuity claim has not been entered because it was not filed during the required time period. Applicant may wish to consider filing a petition to accept an unintentionally delayed claim for priority. See 37 CFR 1.55 or 1.78.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/hsarwari/

Form PTO-1449 U.S. Department of Commerce
Patent and Trademark Office

OPAP AKIMA-15 DEC 27 2016 PATENT & TRADEMARK OFFICE

INFORMATION DISCLOSURE CITATION
BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197
Applicant: John Talbot BOYS et al.	
Filing Date: May 5, 2014	Group: 2837

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/T. N./	AA	4 8 0 0 3 2 8	Jan. 24, 1989	Bolger et al.			
	AB						
	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
Change(s) applied to document, /T.N./	AO						
	AP						

5/25/2017

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/T. N./	AQ	2007008646	Jan. 18, 2007	WIPO				
/T. N./	AR	08 5 0 5 2 7 9 2008 OZ/2008		Japan			X	
/T. N./	AS	2002137659	May 14, 2002	Japan			X	
/T. N./	AT	2005103923	April 14, 2005	Japan			X	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

	AU	
	AV	
	AW	
	AX	

EXAMINER /T. N./ DATE CONSIDERED 04/16/2017

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

Form PTO-1449	U.S. Department of Commerce Patent and Trademark Office	Atty. Docket No. 1172/69068-Div 2	Serial No. NYA
		Applicant John Talbot BOYS et al.	
	INFORMATION DISCLOSURE CITATION BY APPLICANT (Use several sheets if necessary)	Filing Date Herewith	Group 2832

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	5 4 6 9 0 3 6	Nov. 21, 1995	Eto			
/TN/	AB	4 8 7 3 6 7 7	Oct. 10, 1989	Sakamoto et al.			
/TN/	AC	6 5 0 1 3 6 4	Dec. 31, 2002	Hui et al.			
/TN/	AD	6 9 0 6 4 9 5	June 14, 2005	Cheng et al.			
/TN/	AE	5 5 2 8 1 1 3	June 18, 1996	Boys et al.			
/TN/	AF	5 7 1 0 5 0 2	Jan. 20, 1998	Poumey			
/TN/	AG	5 8 2 1 6 3 8	Oct. 13, 1998	Boys et al.			
/TN/	AH	6 9 3 4 1 6 7	Aug. 23, 2005	Jang et al.			
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
Change(s) applied to document, /TN/ 5/25/2017	AP						

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	JP 06 - 27 73 5 8	Oct. 4, 1994	Japan			Abst.	
/TN/	AR	JP 20 02 - 23 15 45	Aug. 16, 2002	Japan			Abst.	
/TN/	AS	JP 8 - 23 83 2 6	Sept. 17, 1996	Japan			Abst.	
/TN/	AT	JP T2 00 7- 50 54 80	03/2007	Japan				

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

/TN/	AU	Notice of Reasons for Rejection in corresponding Japanese application p2010-507347 (Original and English Translation)
	AV	
	AW	
	AX	

EXAMINER	DATE CONSIDERED
/Tuyen Nguyen/	07/25/2016

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /TN/

Form PTO-1449

U.S. Department of Commerce
Patent and Trademark Office

INFORMATION DISCLOSURE CITATION
BY APPLICANT
(Use several sheets if necessary)

Atty. Docket No.	Serial No.
1172/69068-Div 2	14/120,197

Applicant: John Talbot BOYS et al.

Filing Date	Group
May 5, 2014	

U.S. PATENT DOCUMENTS

Examiner Initial		Document Number	Date	Name	Class	Subclass	Filing Date if Appropriate
/TN/	AA	20 03 00 52 64 7	Mar. 20, 2003	Yoshida et al.			
/TN/	AB	5 5 9 4 3 1 8	~~Apr. 18, 1995~~ 01/1997	Nor et al.			
/TN/	AC	20 09 02 78 4 9 2	Nov. 2009	Shimizu et al.			
/TN/	AD	8 0 3 0 8 8 8	Oct. 2011	Pandya et al.			
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
	AM						
	AN						
	AO						
	AP						

Change(s) applied to document
/C.B./TN/
8/2/2017

FOREIGN PATENT DOCUMENTS

		Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/TN/	AQ	EP 12 0 53 4 0	May 15, 2002	EP				
/TN/	AR	11 5 0 3 5 9 9	Mar. 26, 1999	Japan			Yes	
/TN/	AS	11 2 5 2 8 1 0	SEPT. 17, 1999	Japan			Yes	
/TN/	AT	10 1 8 9 3 6 9	July 21, 1998	Japan			Yes	

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

AU	
AV	
AW	
AX	

EXAMINER	DATE CONSIDERED

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

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/120,197	09/19/2017	9767955	1172/69068-Div. 2	4659

14443 7590 08/30/2017

The Law Office of Richard F. Jaworski, PC
273 Walt Whitman Road
Suite 327
Huntington Station, NY 11746-4149

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 493 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

John Talbot Boys, Auckland, NEW ZEALAND;
Grant Anthony Covic, Auckland, NEW ZEALAND;

505337528 02/20/2019

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT5384309

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	LICENSE

CONVEYING PARTY DATA

Name	Execution Date
QUALCOMM INCORPORATED	02/01/2019

RECEIVING PARTY DATA

Name:	WITRICITY CORPORATION
Street Address:	57 WATER STREET
City:	WATERTOWN
State/Country:	MASSACHUSETTS
Postal Code:	02472

PROPERTY NUMBERS Total: 69

Property Type	Number
Patent Number:	10079510
Application Number:	14386206
Patent Number:	9899145
Patent Number:	6621183
Patent Number:	6705441
Patent Number:	7969269
Application Number:	13930505
Application Number:	14529939
Application Number:	12998031
Patent Number:	8749334
Patent Number:	9466419
Patent Number:	9767955
Patent Number:	10106046
Application Number:	16138653
Application Number:	13261001
Application Number:	13389210
Application Number:	15324736
Patent Number:	9077194
Application Number:	13261259
Application Number:	14948702

Property Type	Number
Application Number:	13698851
Application Number:	13131155
Patent Number:	8923015
Patent Number:	9461480
Application Number:	15281591
Patent Number:	9653207
Application Number:	15449243
Application Number:	13389090
Patent Number:	9369058
Patent Number:	9912250
Application Number:	15902978
Application Number:	13992757
Patent Number:	9666358
Application Number:	15497819
Patent Number:	9620281
Application Number:	15483838
Patent Number:	9966797
Application Number:	15973105
Application Number:	14233261
Application Number:	14240191
Patent Number:	9283858
Patent Number:	9071061
Application Number:	14700770
Application Number:	13814415
Patent Number:	9406436
Application Number:	14365873
Application Number:	14379068
Application Number:	14376401
Application Number:	14424390
Patent Number:	9660702
Application Number:	15487267
Patent Number:	9747792
Application Number:	15676323
Patent Number:	10056784
Application Number:	16117261
Application Number:	14424384
Application Number:	15021440
Application Number:	15510686

Property Type	Number
Application Number:	14410817
Application Number:	14780102
Application Number:	15500314
Application Number:	15324699
Application Number:	15120385
Patent Number:	7279850
Patent Number:	8953340
Application Number:	15746120
Application Number:	15750451
Application Number:	16077219
Application Number:	11575449

CORRESPONDENCE DATA

Fax Number: (617)523-1231

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 6175701000
Email: sallirampersad@goodwinlaw.com
Correspondent Name: GOODWIN PROCTER LLP
Address Line 1: 100 NORTHERN AVENUE
Address Line 2: JOEL E. LEHRER
Address Line 4: BOSTON, MASSACHUSETTS 02210

ATTORNEY DOCKET NUMBER:	123279-186271
NAME OF SUBMITTER:	SHALEENA ALLI-RAMPERSAD/PARALEGAL
SIGNATURE:	/Shaleena Alli-Rampersad/
DATE SIGNED:	02/20/2019
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 45
source=Auckland License Agreement#page1.tif
source=Auckland License Agreement#page2.tif
source=Auckland License Agreement#page3.tif
source=Auckland License Agreement#page4.tif
source=Auckland License Agreement#page5.tif
source=Auckland License Agreement#page6.tif
source=Auckland License Agreement#page7.tif
source=Auckland License Agreement#page8.tif
source=Auckland License Agreement#page9.tif
source=Auckland License Agreement#page10.tif
source=Auckland License Agreement#page11.tif
source=Auckland License Agreement#page12.tif
source=Auckland License Agreement#page13.tif
source=Auckland License Agreement#page14.tif

source=Auckland License Agreement#page15.tif
source=Auckland License Agreement#page16.tif
source=Auckland License Agreement#page17.tif
source=Auckland License Agreement#page18.tif
source=Auckland License Agreement#page19.tif
source=Auckland License Agreement#page20.tif
source=Auckland License Agreement#page21.tif
source=Auckland License Agreement#page22.tif
source=Auckland License Agreement#page23.tif
source=Auckland License Agreement#page24.tif
source=Auckland License Agreement#page25.tif
source=Auckland License Agreement#page26.tif
source=Auckland License Agreement#page27.tif
source=Auckland License Agreement#page28.tif
source=Auckland License Agreement#page29.tif
source=Auckland License Agreement#page30.tif
source=Auckland License Agreement#page31.tif
source=Auckland License Agreement#page32.tif
source=Auckland License Agreement#page33.tif
source=Auckland License Agreement#page34.tif
source=Auckland License Agreement#page35.tif
source=Auckland License Agreement#page36.tif
source=Auckland License Agreement#page37.tif
source=Auckland License Agreement#page38.tif
source=Auckland License Agreement#page39.tif
source=Auckland License Agreement#page40.tif
source=Auckland License Agreement#page41.tif
source=Auckland License Agreement#page42.tif
source=Auckland License Agreement#page43.tif
source=Auckland License Agreement#page44.tif
source=Auckland License Agreement#page45.tif

ASSIGNMENT

This **ASSIGNMENT** (the "**Assignment**"), dated effective as of 1 February 2019 (the "**Effective Date**"), is made by WiTricity Corporation, a Delaware corporation (the "**Assignee**"), and QUALCOMM Incorporated, a Delaware corporation (the "**Assignor**").

RECITALS

WHEREAS, Assignor, Assignee and QUALCOMM Technologies, Inc., a Delaware corporation, are parties to that certain Asset Purchase Agreement, dated 1 February, 2019 (the "**Asset Purchase Agreement**"), pursuant to which Assignor assigned to Assignee, and Assignee assumed from Assignor, for the consideration, and upon the terms and conditions, set forth in the Asset Purchase Agreement, certain contracts of Assignor, including the Assigned Contract (as defined below).

WHEREAS, capitalized terms used herein but not otherwise defined shall have the meanings given to such terms in the Asset Purchase Agreement.

NOW, THEREFORE, pursuant to the Asset Purchase Agreement, and in consideration of these premises, and for good and valuable consideration, the receipt and adequacy of which is hereby acknowledged, it is agreed that:

1. Subject to the terms of the Asset Purchase Agreement, Assignor hereby grants, sells, conveys, transfers, sets over, delivers, and assigns unto Assignee, its successors and assigns, the contract listed on Schedule A, including without limitation all of Assignor's legal and equitable rights, privileges, interest and duties in and to such contract, and Assignor's rights and licenses in and to any proprietary rights under such contract (the "**Assigned Contract**") and Assignee hereby accepts such assignment.

2. Assignor hereby covenants that from time to time after the delivery of this instrument, at Assignee's reasonable request and without further consideration, Assignor will execute and deliver any further documents and take any further actions as reasonably may be required to convey, transfer to and vest in Assignee, and to put Assignee in possession of, any of the Assigned Contract transferred hereby.

3. Assignor hereby requests the United States Patent and Trademark Office Commissioner for Patents and any other applicable governmental entity or registrar (including any applicable foreign or international office or registrar), to record Assignee as the assignee and owner of the Assigned Contract.

4. Nothing contained in this Assignment shall be deemed to modify, supersede, enlarge or affect the rights of any person under the Asset Purchase Agreement. If any provision of this Assignment is inconsistent or conflicts with the Asset Purchase Agreement, the Asset Purchase Agreement shall control.

5. All of the covenants, terms and conditions set forth herein shall be binding upon and shall inure to the benefit of the parties hereto and their respective successors and assigns.

6. No modification, waiver or termination of this Assignment shall be binding unless executed in writing by the party to be bound thereby. No waiver of any of the provisions of this Assignment shall be deemed or shall constitute a waiver of any other provision hereof, nor shall such waiver constitute a continuing waiver unless otherwise expressly provided.

7. This Assignment is governed by, and all disputes arising under or in connection with this Assignment shall be resolved in accordance with, the laws of the State of Delaware, United States (to the exclusion of its conflict of laws rules).

8. This Assignment may be executed and delivered (including by facsimile or electronic transmission) in two or more counterparts, and by the different parties hereto in separate counterparts, each of which when executed and delivered shall be deemed to be an original but all of which taken together shall constitute one and the same agreement.

(REMAINDER OF PAGE INTENTIONALLY LEFT BLANK)

IN WITNESS WHEREOF, the parties have executed this Assignment on the date first above written.

QUALCOMM INCORPORATED

By: _____
Name: _____
Title: _____

ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California

County of San Diego)

On 1 February 2019, before me, Angela R. Gonzales, Notary Public, personally appeared Richard Hom, who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature Angela Gonzales (Seal)

ANGELA R. GONZALES
Commission # 2146531
Notary Public - California
San Diego County
My Comm. Expires Mar 28, 2020

WiTricity Corporation

By: _____
Name: Donald R. Peck
Title: Chief Financial Officer

[SIGNATURE PAGE TO ASSIGNMENT]

SCHEDULE A TO ASSIGNMENT

1. The Amended and Restated License Agreement, dated October 14, 2011, by and between Auckland UniServices Limited and Qualcomm Incorporated as the successor in interest to Halo Inductive Power Technologies Limited, as amended by that certain letter agreement dated July 31, 2012, by and between Auckland UniServices Limited and Qualcomm Incorporated, as amended by that certain Second Amendment, dated October 14, 2011, as amended by that certain Third Amendment, dated October 14, 2011, as amended by that certain Fourth Amendment, dated May 1, 2017.

Confidential

AUCKLAND UNISERVICES LIMITED,
a company incorporated and registered in New Zealand with company number 3736621
(the "Licensor")

HALO INDUCTIVE POWER TECHNOLOGIES LIMITED,
a company incorporated and registered in Guernsey, Channel Islands with company number 51792
(the "Licensee")

AMENDED AND RESTATED LICENCE AGREEMENT

AMENDED AND RESTATED
LICENSE AGREEMENT

THIS AMENDED AND RESTATED LICENSE AGREEMENT (this "Agreement") is executed by the Licensor (as defined below) and the Licensee (as defined below) on this 11th day of October 2011 (the "Execution Date"). This Agreement shall, however, have retroactive effect to May 10, 2010 since this Agreement shall supersede and replace in its entirety the Original Exclusive License Agreement (as defined below) and Original Joint License Agreement (as defined below) from their inception.

PARTIES

1. AUCKLAND UNISERVICES LIMITED, a company incorporated and registered in New Zealand with company number 373821 (the "Licensor"), and

2. HALO INDUCTIVE POWER TECHNOLOGIES LIMITED, a company incorporated and registered in Guernsey, Channel Islands, with company number 51792 (the "Licensee").

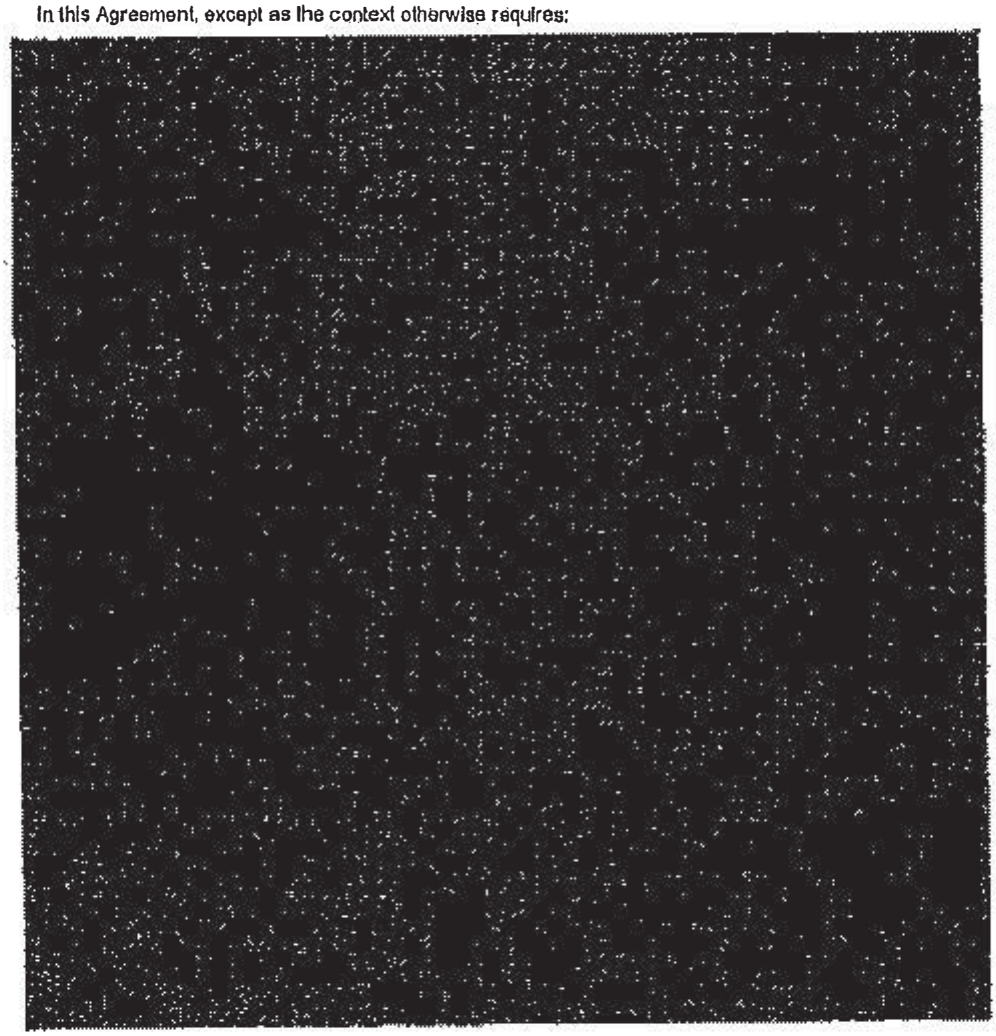
NOW, THEREFORE, for good and valuable consideration, the receipt and legal sufficiency of which is hereby acknowledged, the Licensor and the Licensee hereby amend and restate the Original Exclusive License Agreement and Original Joint License Agreement in their entirety and from their inception, as follows:

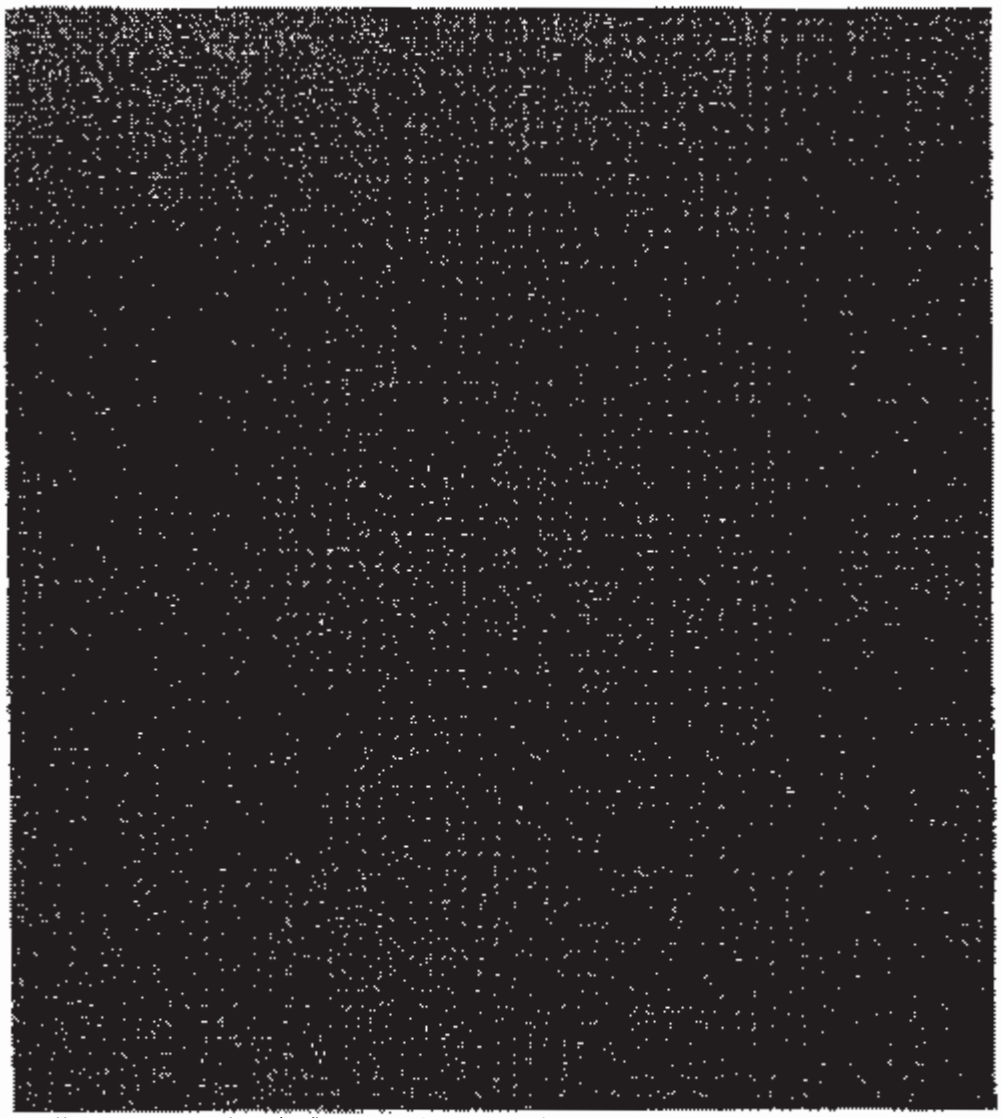
AGREEMENT

1. DEFINITIONS AND INTERPRETATION

Definitions

1.1 In this Agreement, except as the context otherwise requires:





"Dynamic Demand Control" means technology to adjust load elements on a power receiver or transmitter based on the monitoring of the frequency of the transmission or receipt of power, and possibly other power control parameters, in order to permit individual, intermittent power loads to switch on or off at optimal moments in order to balance an overall power system load generation, thereby reducing power mismatches.

[redacted]

"**Exclusive Intellectual Property Rights**" means all Intellectual Property Rights, including, without limitation, any patent rights and Know-How rights, claiming, protecting or relating to any of the following:

(a) the inventions claimed in the patents and patent applications listed on Schedule 1, including, without limitation, any patents or patent applications deriving priority therefrom;

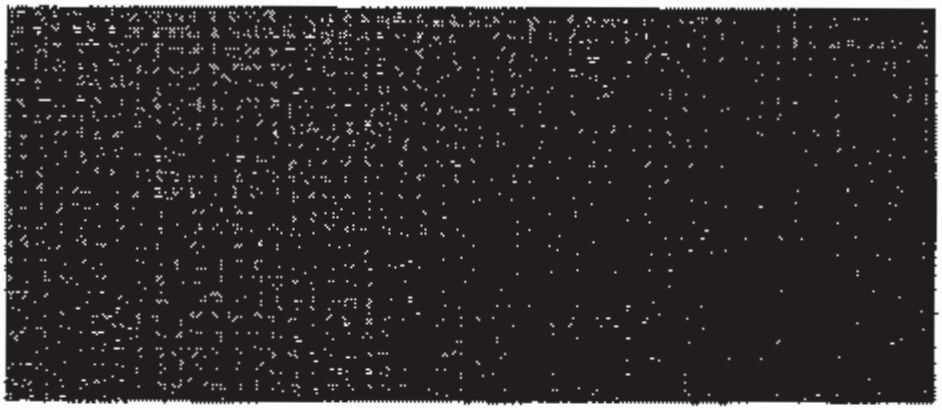
(b) any improvements to the same;

(c) any technology included in this Agreement by the Licensee through the exercise of its rights under the New Co-operation Agreement to include such technology within the exclusive license granted in this Agreement; or

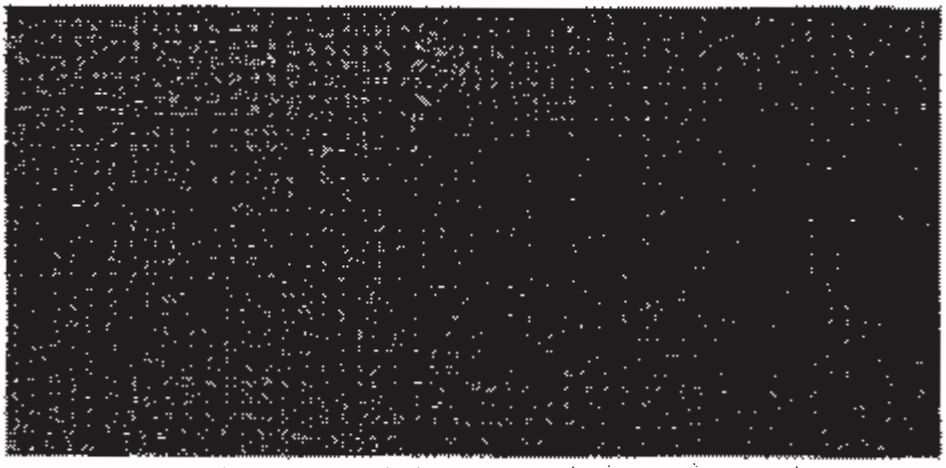
(d) such other technology relevant to the Field, including, but not limited to, technology relating to IP-DT and Dynamic Demand Control, which were solely owned or controlled by the Licensor on May 19, 2010; which for the avoidance of doubt excludes under this clause (d) the patent rights covered by the Licensor's IPT patent families 31, 32, 39, 40, 41 and 42 (as disclosed by the Licensor to the representatives of Qualcomm immediately prior to the Execution Date).

"**Exclusive Licensed Product**" means any product the manufacture, use, sale, importation, exportation or disposal of which would, but for the license granted hereunder, infringe any of the Exclusive Intellectual Property Rights.

[redacted]



"Field" means products which enable a Road Vehicle to initiate, capture, control, transmit and/or receive energy or power on a wireless basis by means of magnetic and/or resonant induction.



"Improvements" means any improvements, modifications, additions or developments of or to any of the claims made in a patent or patent application, permitted to be included in that patent or patent application.

"Intellectual Property Rights" means any and all rights to and interests in, or protecting, any and all industrial and intellectual property of any kind, whether or not in a material form, including but not limited to:

(a) copyrights (excluding those in academic articles), trade mark rights, design rights, all rights relating to confidential information and inventions, patent applications and patents (or equivalent in any jurisdiction), together with any right to apply for

registration of any such intellectual property rights anywhere in the world, any right to claim priority under international convention for any such applications and all rights conferred by such industrial or intellectual property when registered or granted; and

(b) all rights to and in any processes, formulae, designs, reports, drawings, specifications, software, blue prints, Know-How, experiences, characteristics, inventions, discoveries, improvements, and research data.

[redacted]

"IP-DT" means inductive power distribution technology.

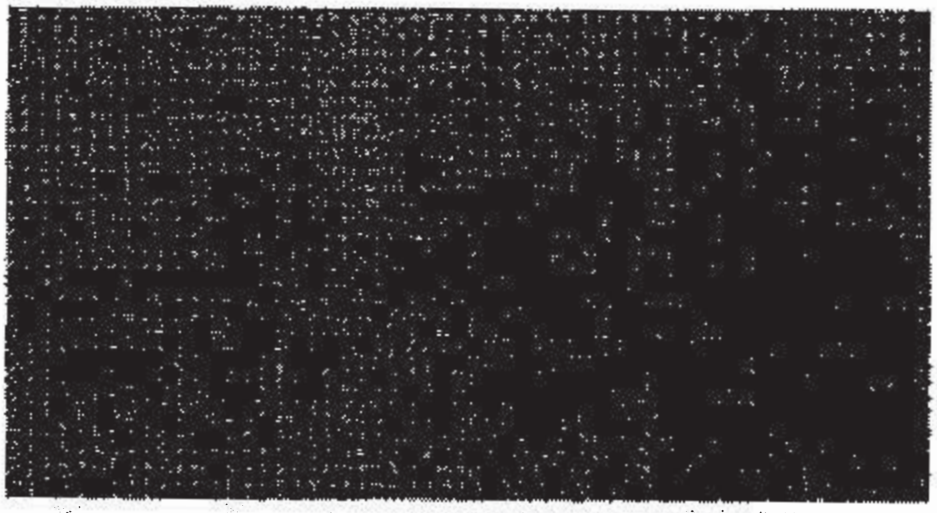
"IPT" means inductive power technology.

[redacted]

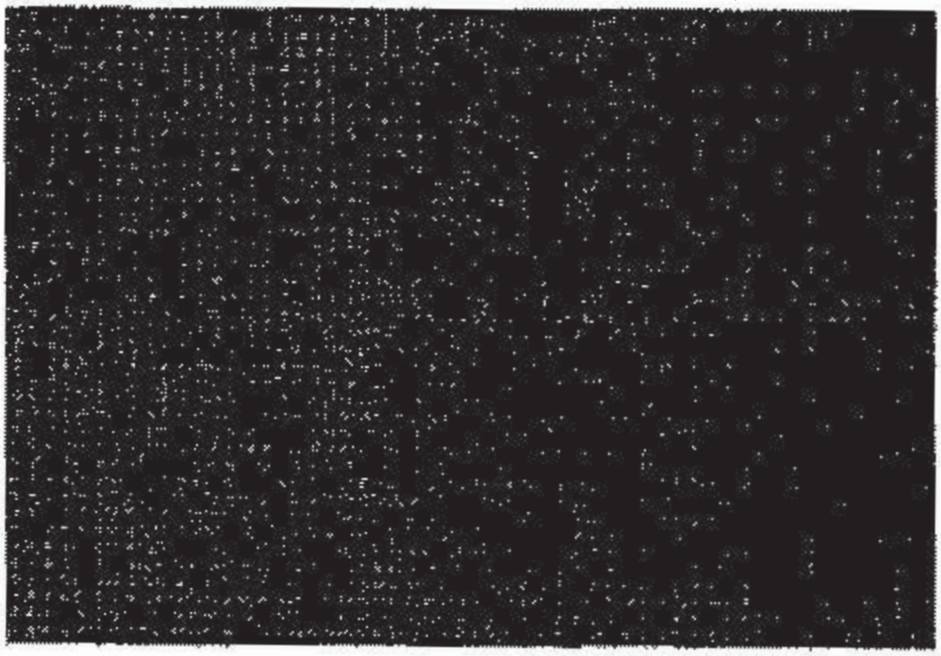
"Know-How" means any knowledge, proprietary information or data which is not generally publicly known, including, without limitation, all manufacturing, formulation and scientific research information, whether or not capable of precise separate description.

[redacted]

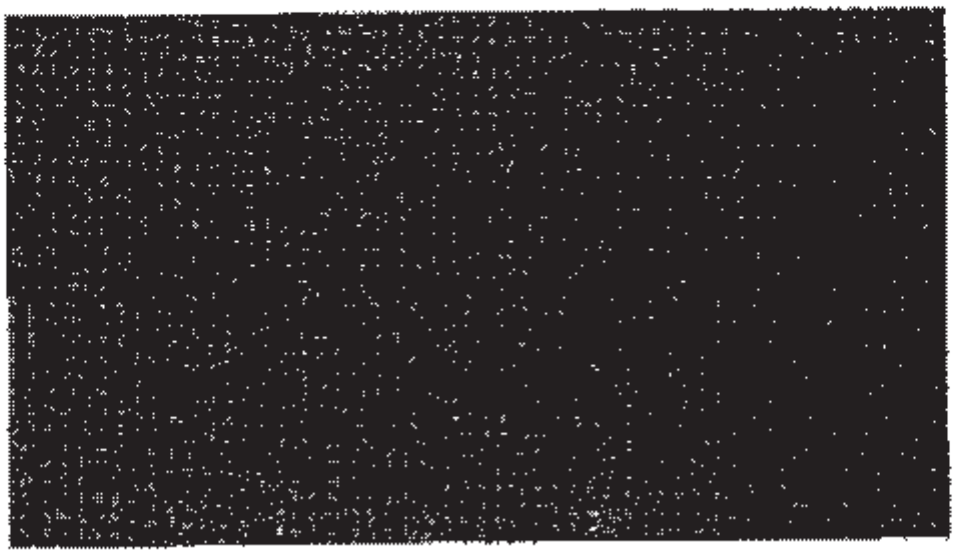
***Page 7 redacted



"New Co-operation Agreement" means that certain Amended and Restated Co-operation Agreement entered into between the Licensor and the Licensee on the Execution Date.



***Page 9 redacted



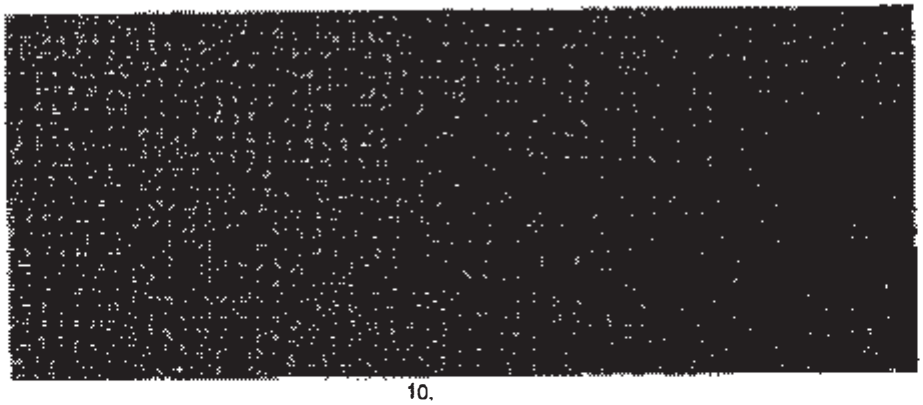
"Road Vehicle" means any vehicle having one or more wheels, which is designed:

(a) for use on a public or private road;

(b) to be driven or controlled by a human driver; and

(c) to transport people or goods.

Notwithstanding anything above, the term "Road Vehicle" does not include any vehicle primarily designed for materials handling use in ports, surface mining and underground mining sites and airports and any forklift, automatic guided vehicle, rail guided vehicle, golf cart, mobility scooter or similar vehicle not designed for use on either a public or private road.



***Page 11 redacted

[redacted]

2. LICENSE

License Grant

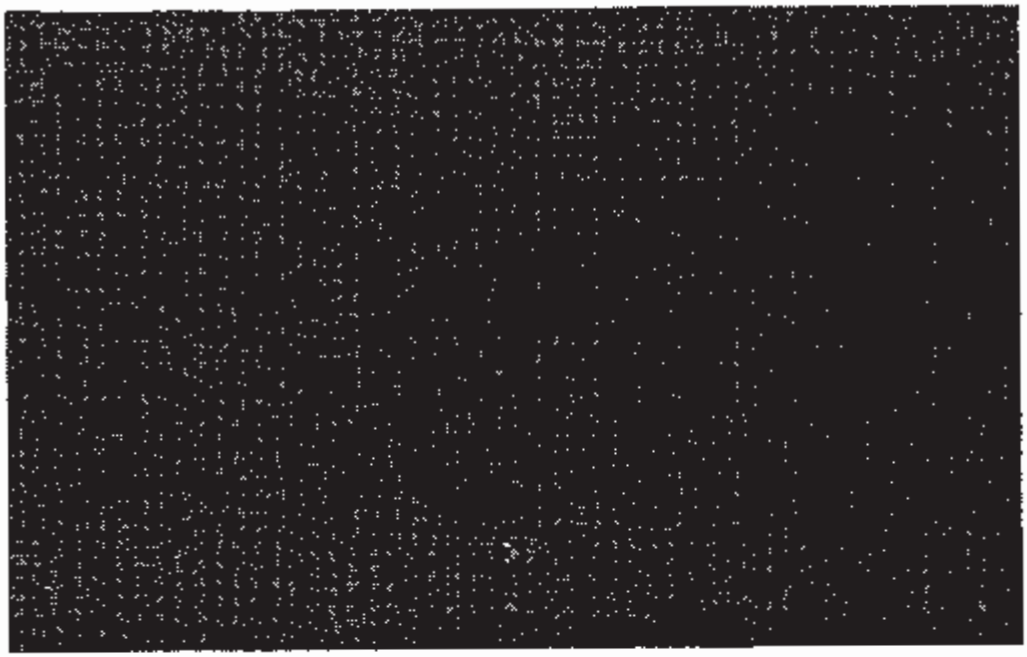
2.1 Subject to the terms and conditions of clause 9.7 of this Agreement, the Licensor hereby grants to the Licensee, and the Licensee hereby accepts:

(a) an exclusive (except as described in clause 2.2 and subject to clause 9.6), non-transferable (except as permitted in clause 11.10), worldwide license under the Exclusive Intellectual Property Rights to use all of the Exclusive Intellectual Property Rights in the Field, and to make, have made, use, sell, offer for sale, import, export and otherwise dispose of Exclusive Licensed Products in the Field. These rights include, without limitation, the right to use, reproduce, display, perform, modify, create improvements, enhancements, and derivative works of, and distribute directly or indirectly through multiple tiers, all works of authorship and technology forming part of the Exclusive Intellectual Property Rights for use in the Field, including without limitation creating Improvements. The Licensee shall have the right to grant sublicenses with respect to all or any portion of the rights granted in this clause 2.1(a), whether directly or indirectly through multiple tiers.

(b) [redacted]

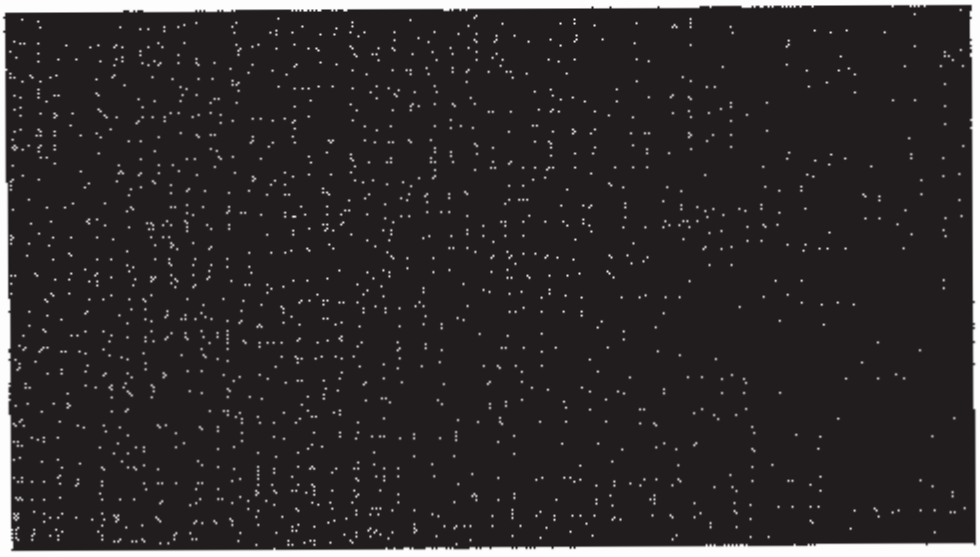
2.2 [redacted]

***Pages 13-43 redacted



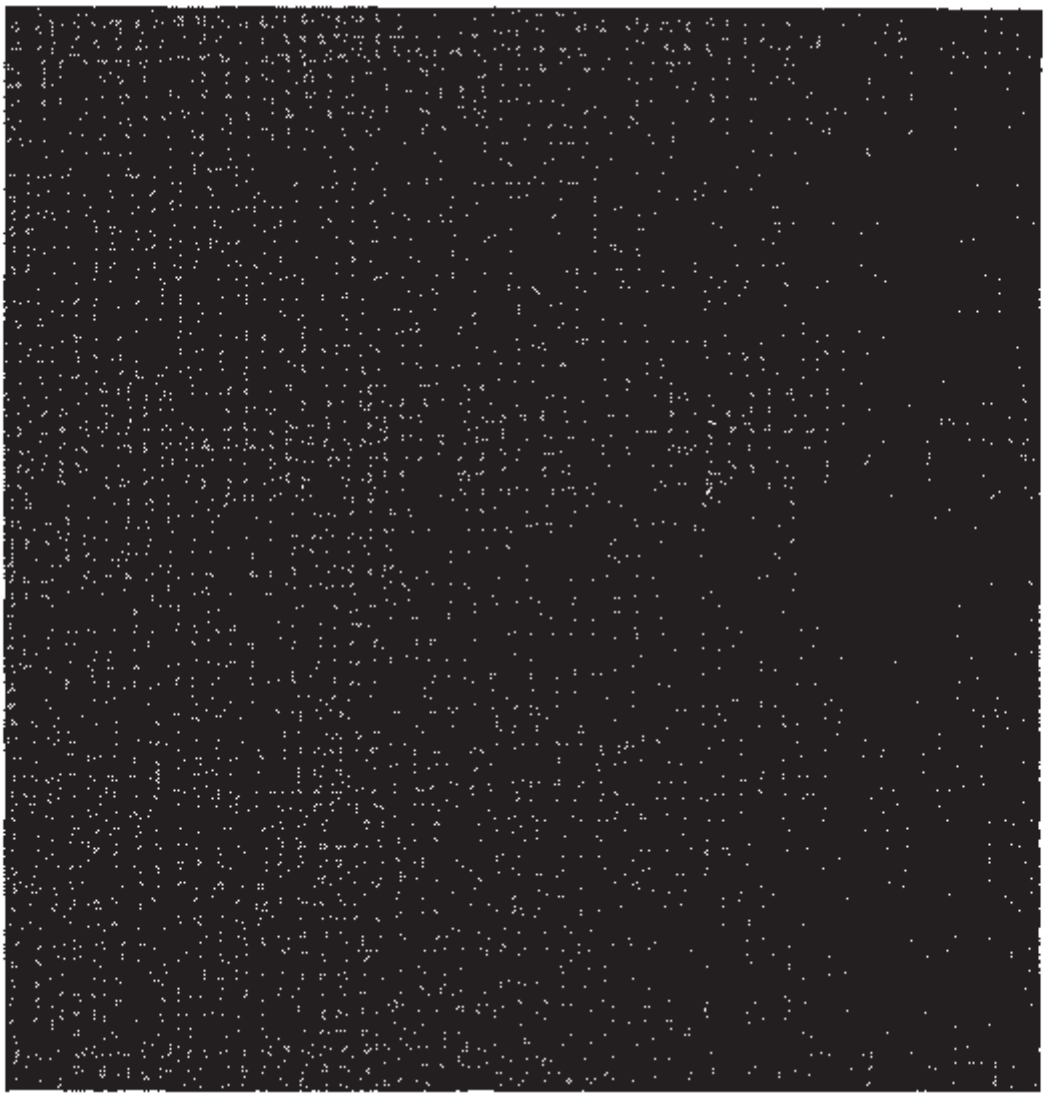
Assignment

11.10

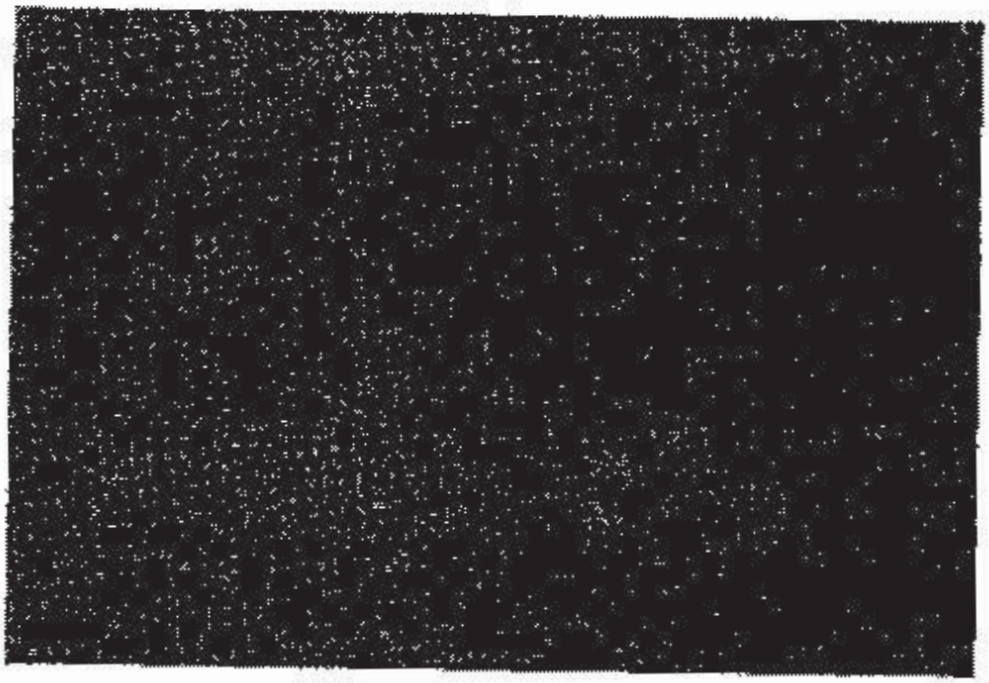


44.

Without limiting the foregoing, the Licensee shall also have the right to assign this Agreement, without obtaining the prior written consent of the Licensor, to Qualcomm or a Qualcomm-designated direct or indirect subsidiary of Qualcomm.



***Pages 46-47 redacted



EXECUTION

SIGNED on behalf of AUCKLAND UNISERVICES LIMITED by:	SIGNED on behalf of HALO RENEWABLE POWER TECHNOLOGIES LIMITED by:
Signature	Signature
Name: Peter Lee	Name: J. MILES
Title: CEO	Title: Director

THIRD AMENDMENT

THIS THIRD AMENDMENT is made to the Second Amendment that was made to the Amended and Restated License Agreement dated October 14, 2011, as amended by that certain letter agreement dated July 31, 2012, between Auckland UniServices Limited, a company incorporated and registered in New Zealand with company number 373821 and having its place of business at Level 10, 70 Symonds Street, Auckland Central, Auckland, New Zealand ("**UniServices**"), and QUALCOMM Incorporated, a Delaware corporation having its place of business at 5775 Morehouse Drive, San Diego, CA 92121 ("**Qualcomm**") (collectively, the "**Agreement**"), and is entered into effective as of October 14, 2011. UniServices and Qualcomm may be referred to individually as a "**Party**" and collectively as the "**Parties**" in this Third Amendment.

THIRD AMENDMENT:

NOW, THEREFORE, the Parties hereby agree as follows:

1. Headings; Definitions. Section headings used in this Third Amendment are inserted for the purpose of convenience only and are not intended to affect the meaning or interpretation of any provision of this Third Amendment. For the purpose of the construction and interpretation of this Third Amendment, the word "**including**" (and variations thereof such as "**include**" and "**includes**") will not be deemed to be a term of limitation, but rather will be deemed to be followed by the words "**without limitation**," and the words "**herein**," "**hereof**," and "**hereunder**" will refer to this Third Amendment as a whole. Unless otherwise specified herein, capitalized terms used in this Third Amendment given to such terms in the Agreement.

2. Schedules 1, 2 and 5. Schedule 1 to the Agreement is superseded and replaced in its entirety by Schedule 1 that is attached to this Third Amendment. Schedule 2 to the Agreement is superseded and replaced in its entirety by Schedule 2 that is attached to this Third Amendment. Schedule 5 to the Agreement is superseded and replaced in its entirety by Schedule 5 that is attached to this Third Amendment.

3. No Other Amendment. Except as expressly set forth in this Third Amendment, the Agreement shall remain in full force and effect without any modification. The terms and conditions of this Third Amendment and the Agreement supersedes all prior and contemporaneous oral or written understandings between the Parties with respect to their subject matter, and constitute the entire agreement of the Parties with respect to

such subject matter. The terms and conditions of this Third Amendment and the Agreement shall not be modified or amended, except by a writing signed by (i) an authorized representative of UniServices and (ii) the then-current President or Corporate Secretary of Qualcomm (or his or her authorized designee).

IN WITNESS WHEREOF, the Parties have, through their duly authorized representatives, caused this Third Amendment to be entered into effective as of the Third Amendment Date. This Third Amendment may be signed in counterparts.

Auckland UniServices Limited	**QUALCOMM Incorporated**
By: _____	By: _____
Printed Name: _____	Printed Name: _____
Title: _____	Title: _____
Date: _____	Date: _____

Schedule 1
Patent Families Exclusively Licensed

Inductive Power Distributions System - Inventors: Boys and Green

Case	QCPat No	Country	Filing Date	Application No	Grant Number	Status
IPT 04	121457WO	PCT	2/5/1992	PCT/GB1992/000220		Expired
IPT 04	121457NZP1	NZ	3/26/1991	237572		Expired
IPT 04	121457NZP3	NZ	9/30/1991	240018		Expired
IPT 04	121457NZP2	NZ	9/19/1991	239862		Expired
IPT 04	121457NZ	NZ	1/23/1992	237572	237572	Expired
IPT 04	121457NZ	NZ	7/1/1991	238815		Abandoned
IPT 04	121457AU	AU	2/5/1992	1992012373	658605	Expired
IPT 04	121457CA	CA	2/5/1992	2106784	2106784	Expired
IPT 04	121457EP	EP	2/5/1992	92904583.9	577611	Expired
IPT 04	121457FR	FR	2/5/1992	92904583.9	577611	Expired
IPT 04	121457DE	DE	2/5/1992	69227242.9	577611	Expired
IPT 04	121457GB	GB	2/5/1992	92904583.9	577611	Expired
IPT 04	121457NL	NL	2/5/1992	92904583.9	577611	Expired
IPT 04	121457IT	IT	2/5/1992	92904583.9	577611	Expired
IPT 04	121457SE	SE	2/5/1992	92904583.9	577611	Expired
IPT 04	121457ES	ES	2/5/1992	92904583.9	577611	Expired
IPT 04	121457EPD2	EP(Div 2)	2/5/1992	01130829.3		Abandoned
IPT 04	121457EPD1	EP	2/5/1992	97202324.6	818868	Revoked/Invalidated
IPT 04	121457JP	JP	2/5/1992	1992-504164	2667054	Expired
IPT 04	121457JPD1	JP(Div)	4/14/1995	1995-889076	3304677	Expired
IPT 04	121457JPD2	JP(Div 2)	3/15/2002	2002-071125	3729787	Expired
IPT 04	121457JPD3	JP(Div3)	8/10/2005	2005-231427	3776115	Expired
IPT 04	121457KR	KR	2/5/1992	10-1993-0702898	180047	Expired
IPT 04	121457MX	MX	3/13/1992	9201100	182161	Expired
IPT 04	121457US	US	1/30/1992	07/827,887	5293308	Granted
IPT 04	121457TW	TW	2/7/1992	081100829	201828	Expired

Resonant Power Supplies - Inventors: Boys and Green

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT05	121458NZP1	NZ	8/12/1991	239366		Expired
IPT05	121458NZP2	NZ	8/23/1991	239533	239533	Expired
IPT05	121458NZ	NZ	8/3/1992	239366	239366	Expired
IPT05	121458	US	8/5/1992	07/926,051	5450305	Expired

IPT05	121458AU	AU	8/7/1992	1992023966	656803	Abandoned
IPT05	121458JP	JP	8/7/1992	1993-504165	3178837	Abandoned
IPT05	121458KR	KR	8/7/1992	10-1994-0700424	10-0163412	Abandoned
IPT05	121458TW	TW	8/7/1992	94-700424	81106363	Abandoned
IPT05	121458WO	PCT	8/7/1992	PCT/GB1992/001463		Expired

Supply of Power to Primary Conductors (G2/G3) – Inventors: Boys and Green

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT09	121460NZP1	NZ	12/5/1997	329340		Expired
IPT09	121460NZP2	NZ	3/18/1998	329991		Expired
IPT09	121460	NZ	12/7/1998	504852	504852	Lapsed
IPT09	121460	NZ	12/4/2001	515941		Abandoned
IPT09	121460WO	PCT	12/4/1998	PCT/NZ1998/00179		Expired
IPT09	121460DE	DE	12/4/1998	69841810.7	1050094	Abandoned
IPT09	121460	US	12/4/1998	09/555,796	6621183	Granted
IPT09	121460EP	EP	12/4/1998	98962726.0	1050094	Abandoned
IPT09	121460AU	AU	12/4/1998	17898/99		Abandoned
IPT09	121460TW	TW	12/4/1998	87120180	125932	Abandoned
IPT09	121460KR	KR	12/4/1998	10-2000-7006157		Abandoned
IPT09	121460JP	JP	12/4/1998	2000-524850		Abandoned

Control of Series Resonant Inductive Pick-ups – Inventors: Boys and Stielau

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT10	121461NZP1	NZ	9/9/1999	337716		Abandoned
IPT10	121461PCT	PCT	9/9/2000	PCT/NZ2000/000175		Expired
IPT10	121461AU	AU	9/6/2000	74620/0	772748	Abandoned
IPT10	121461	US	9/6/2000	10/070,620	6705441	Granted
IPT10	121461JP	JP	9/6/2000	2001-522645	4456789	Granted
IPT10	121461NZ	NZ	9/6/2000	337716	337716	Abandoned
IPT10	121461CA	CA	9/6/2000	2383644	2383644	Abandoned
IPT10	121461EP	EP	9/6/2000	00963170.6	1219000	Granted
IPT10	121461DE	DE	9/9/2000	60045515.7	1219000	Granted
IPT10	121461FR	FR	9/9/2000	00963170.6	1219000	Granted
IPT10	121461GB	GB	9/9/2000	00963170.6	1219000	Granted

Pick-Up Apparatus for Inductive Power Transfer Systems – Inventors: Boys, Covic and Elliot

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT23	121462NZ1	NZ	5/2/2006	546955		Expired
IPT23	121462WO	PCT	5/2/2007	PCT/NZ2007/000097		Expired
IPT23	121462	US	5/2/2007	12/226,956	7969269	Re-Issue Filed - (see IPT81)
IPT23	121462R1	US	6/28/2013	12/930,505		Pending
IPT23	121462R1D1	US	10/31/2014	14/529,939		Pending
IPT23	121462NZ2	NZ	5/2/2007	546955	546955	Granted
IPT23	121462EP	EP	5/2/2007	07793941.1		Pending
IPT23	121462CN	CN	11/2/2008	200780020724.0	ZL200780020724.0	Granted

Inductively Coupled AC Power Transfer – Inventors: Boys and Green

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT27	121463NZP1	NZ	4/17/2009	576320		Expired
IPT27	121462NZ	NZ	9/11/2008	571222	571222	Granted
IPT27	121463EP	EP	9/11/2009	09813290.5		Pending
IPT27	121463JP	JP	9/11/2009	2011-526828	5756754	Granted
IPT27	121463KR	KR	9/11/2009	10-2011-7008327		Pending
IPT27	121463CN	CN	9/11/2009	200980143019.9	ZL200980143019.9	Granted
IPT27	121463	US	9/11/2009	12/998,031		Pending
IPT27	121463WO	PCT	9/11/2009	PCT/NZ2009/000191		Expired

Multi Power Sourced Electric Vehicle – Inventors: Boys and Covic

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT28	121464NZP1	NZ	5/10/2007	555128		Expired
IPT28	121464NZ	NZ	5/29/2008	555128	555128	Granted
IPT28	121464NZP2	NZ	7/20/2007	556646		Expired
IPT28	121464	US	5/9/2008	12/451,436	8749334	Granted
IPT28	121464NZD1	NZ(Div)	8/26/2009	579313	579313	Granted
IPT28	121464AU	AU	5/9/2008	2008251143	2008251143	Granted
IPT28	121464CN	CN	5/9/2008	200880023317.X	1142755	Granted
IPT28	121464WO	PCT	5/9/2008	PCT/NZ2008/000103		Expired
IPT28	121464KR	KR	5/9/2008	10-2009-7025202		Pending
IPT28	121464EP	EP	5/9/2008	08766952.9		Pending

IPT28	121464NZD1D1	NZ	3/1/2011	591463		Abandoned
IPT28	121464CA	CA	5/9/2008	2687060		Pending
IPT28	121464JP	JP	5/9/2008	2010-507347		Pending
IPT28	121464IN	IN	5/9/2008	7552/DELNP/2009		Pending
IPT28	121464AUD1	AU(Div)	2/28/2012	2012201155		Pending
IPT28	121464CND1	CN(Div)	1/14/2013	201310012148.2		Pending
IPT28	121464CND1D1	CN(Div)	5/9/2015	201510164448.1		Pending
IPT28	121464KRD1	KR(Div)	12/23/2013	10-2013-7034223		Pending
IPT28	121464KRD2	KR(Div)	3/25/2015	10-2015-7007587		Pending
IPT28	121464D1	US(Div)	3/14/2014	13/999,663		Pending
IPT28	121464D2	US(Div)	5/5/2014	14/120,197		Pending
IPT28	121464JPD1	JP(Div)	2/9/2015	2015-023233		Pending

Inductive Power Transfer Apparatus - Inventors: Boys and Huang

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT29A	121494NZP1	NZ	2/5/2009	574677		Expired
IPT29A	121494NZ	NZ	5/5/2010	574677/556137		Abandoned
IPT29A	121494WO	PCT	2/5/2010	PCT/NZ2010/000017		Expired
IPT29A	121494EP	EP	2/5/2010	10738795.3		Pending
IPT29A	121494	US	2/5/2010	13/138,299	9,283,858	Granted

Inductive Power Transfer Apparatus - Inventors: Boys, Covic, Hugang and Budhia

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT29B	121494NZP1	NZ	2/5/2009	574677		Expired
IPT29B	121497NZP1	NZ	4/8/2009	576137		Expired
IPT29B	121497NZD1	NZ(Div)	5/31/2010	585802		Abandoned
IPT29B	121497NZD1D1	NZ(Div)	11/30/2011	596792		Abandoned
IPT29B	121497NZD1D1D1	NZ	5/5/2010	611167		Abandoned
IPT29B	121497WO	PCT	2/5/2010	PCT/NZ2010/000018		Expired
IPT29B	121497CN	CN	2/5/2010	201080012846.7	ZL201080012846.7	Granted
IPT29B	121497CND1	CN(Div)	9/25/2015	201510621373.5		Pending
IPT29B	121497CA	CA	2/5/2010	2751595		Pending
IPT29B	121497IN	IN	2/5/2010	6327/DELNP/2011		Pending
IPT29B	121497JP	JP	2/5/2010	2011-549109		Pending
IPT29B	121497JPD1	JP(Div)	7/6/2015	2015-135622		Pending
IPT29B	121497EP	EP	2/5/2010	10738796.1		Pending
IPT29B	121497KR	KR	2/5/2010	10-2011-7020758		Pending

IPT29B	121497	US	2/5/2010	13/138,298	9,071,061	Granted
IPT29B	141497C1	US	4/30/2015	14/700,770		Pending

Inductive Power Transfer Apparatus and Electrical Autocycle Charger, Including the Inductive Power Transfer Apparatus – Inventors: Boys and Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT34	121465NZP1	NZ	5/12/2009	576909		Expired
IPT34	121465NZD1	NZ(Div)	11/14/2011	596393		Abandoned
IPT34	121465NZ	NZ	5/12/2010	576909		Abandoned
IPT34	121465WO	PCT	5/12/2010	PCT/NZ2010/000088		Expired
IPT34	121465JP	JP	5/12/2010	2012-510770		Pending
IPT34	121465JPD1	JP	11/13/2005	2015-223470		Pending
IPT34	121465CN	CN	5/12/2010	201080031336.4		Pending
IPT34	121465	US	5/12/2010	13/261,001		Pending
IPT34	121465EP	EP	5/12/2010	10775151.3		Pending

Vehicular Roadway Inductive Power Transfer Systems – Inventors: Boys and Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT35	121466P1	US	8/7/2009	61/273,701		Expired
IPT35	121466WO	PCT	8/6/2010	PCT/NZ2010/000159		Expired
IPT35	121466WO2	PCT	7/9/2015	PCT/NZ2015/050088		Expired
IPT35	121466CN	CN	8/6/2010	201080042396.6	201080042396.6	Granted
IPT35	121466	US	8/6/2010	13/389,210		Pending
IPT35	121466IN	IN	8/6/2010	1935/DELNP/2012		Pending
IPT35	121466EP	EP	8/6/2010	10806690.3		Pending
IPT35	121466KR	KR	8/6/2010	10-2012-7006120		Pending
IPT35	121466JP	JP	8/6/2010	2012-523582		Pending
IPT35	121466JPD1	JP(Div)	8/6/2010	2014-12113		Pending
IPT35	121466NZP1	NZ	7/9/2014	627280		Expired

Power Control in IPT Roadway– Inventors: Boys/Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT36	121467WO	PCT	9/9/2010	PCT/NZ2010/000181		Expired
IPT36	121467JP	JP	9/9/2010	2012-528772		Pending
IPT36	121467P1	US	9/9/2009	61/276,204		Expired
IPT36	121467	US	9/9/2010	13/395,173	9,077,194	Granted

IPT36	121467EP	EP	9/9/2010	10815680.3		Pending

Series AC Controller – Inventors: Boys, Covic and Wu

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT37	121469NZP1	NZ	10/12/2009	580388		Expired
IPT37	121469WO	PCT	10/12/2010	PCT/NZ2010/000203		Expired
IPT37	121469NZ	NZ	10/19/2010	580388	580388	Granted
IPT37	121469	US	10/12/2010	13/261,259		Pending
IPT37	121469C1	US	11/23/2015	14/948,702		Pending

Multiphase Inductive Power Transfer System – Inventors: Boys, Covic, Budhia and Kissin

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT43	121470NZP1	NZ	5/19/2010	585483		Expired
IPT43	121470NZP2	NZ	8/25/2010	587567		Expired
IPT43	121470NZ	NZ	6/3/2011	585483	585483	Granted
IPT43	121470WO	PCT	5/19/2011	PCT/NZ2011/000079		Expired
IPT43	121470	US	5/19/2011	13/698,851		Pending
IPT43	121470CN	CN	5/19/2011	201180035293.1		Pending
IPT43	121470EP	EP	5/19/2011	11783803.7		Pending
IPT43	121470JP	JP	5/19/2011	511125/2013		Pending
IPT43	121470MY	MY	5/19/2011	PI2012700954		Pending

Bi-Directional Inductive Power Transfer – Inventor: Madawala

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT45	121471NZP1	NZ	11/26/2008	573241		Expired
IPT45	121471NZP2	NZ	9/3/2009	579498		Expired
IPT45	121471WO	PCT	11/26/2009	PCT/NZ2009/000259		Expired
IPT45	121471	US	11/26/2009	13/131,155		Pending
IPT45	121471NZ	NZ	12/21/2009	573241	573241	Granted
IPT45	121471NZD1	NZ(Div)	1/03/2010	582580	582580	Granted

Primary Side Power Transfer for Inductive Power Transfer – Inventor: Madawala

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT46	121472NZP1	NZ	9/3/2009	579499		Expired
IPT46	121472NZP2	NZ	9/3/2009	579498		Expired

IPT46	121472NZ	NZ	11/26/2008	573241	573241	Granted
IPT46	121472WO	PCT	11/26/2009	PCT/NZ2009/000263		Expired
IPT46	121472	US	11/26/2009	13/131,153	8,923,015	Granted
IPT46	121472C1	US	12/29/2014	14/584,320		Pending

Inductive Power Transfer System – Inventors: Madawala and Thrimawithana

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT47	121473NZP1	NZ	6/30/2010	586526		Expired
IPT47	121473WO	PCT	6/30/2011	PCT/NZ2011/000124		Expired
IPT47	121473	US	6/30/2011	13/807,436		Pending
IPT47	121473NZ	NZ	7/28/2011	586526	586526	Granted

Inductive Power transfer Apparatus -- Inventors: Boys, Covic and Budhia

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT49	121498NZP1	NZ	8/5/2010	587222		Expired
IPT49	121498WO	PCT	8/5/2011	PCT/NZ2011/000153		Expired
IPT49	121498	US	8/5/2011	13/814,415		Pending
IPT49	121498NZ	NZ	8/19/2011	587222		Abandoned
IPT49	121498NZD1	NZ(Div)	2/20/2013	607346		Abandoned
IPT49	121498NZD1D1	NZ(Div)	6/12/2014	626194		Abandoned

Inductive Power Transfer System – Inventors: Covic and Kissin

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT50	121474WO	PCT	8/6/2010	PCT/NZ2010/000160		Expired
IPT50	121474	US	8/6/2010	13/389,090		Pending
IPT50	121474EP	EP	8/6/2010	10806691.1		Pending
IPT50	121474KR	KR	8/6/2010	10-2012-7006121		Pending
IPT50	121474IN	IN	8/6/2010	1947/DELNP/2012		Pending
IPT50	121474CN	CN	8/6/2010	201080042400.9		Pending
IPT50	121474JP	JP	8/6/2010	2012-523583		Pending
IPT50	121474JPD1	JP(Div)	10/22/2015	2015-208300		Pending

Inductive Power Transfer Control (IPT pick-up controller) – Inventors: Covic, Boys and Huang

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT51	121487NZP1	NZ	9/13/2010	587357		Expired

IPT51	121487NZ	NZ	8/18/2011	587357	587357	Granted
IPT51	121487WO	PCT	8/12/2011	PCT/NZ2011/000155		Expired
IPT51	121487IN	IN	8/12/2011	2106/DELNP/2013		Pending
IPT51	121487KR	KR	8/12/2011	10-2013-7005935		Pending
IPT51	121487US	US	8/12/2011	13/816,630	9,369,058	Granted
IPT51	121487D1	US	5/9/2016	15/150,385		Pending
IPT51	121487EP	EP	8/12/2011	11816674.3		Pending
IPT51	121487CN	CN	8/12/2011	201180049292.2		Pending
IPT51	121487JP	JP	8/12/2011	2013-524812		Pending

Inductive Power Transfer Apparatus with AC and DC Output – Inventors: Covic, Boys and Robertson

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT52	121488NZP1	NZ	12/10/2010	589865		Expired
IPT52	121488WO	PCT	12/9/2011	PCT/NZ2011/000256		Expired
IPT52	121488US	US	12/9/2011	13/992,757		Pending
IPT52	121488NZ	NZ	12/12/2011	589865	589865	Granted

Inductive Power Transfer Pick-up Circuits – Inventors: Covic and Robertson

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT53	121489NZP1	NZ	9/3/2010	587780		Expired
IPT53	121489WO	PCT	9/5/2011	PCT/NZ2011/000181		Expired
IPT53	121489IN	IN	9/5/2011	2869/DELNP/2013		Pending
IPT53	121489EP	EP	9/5/2011	11822189.4		Pending
IPT53	121489JP	JP	9/5/2011	2013-527033		Pending
IPT53	121489US	US	9/5/2011	13/82,0477		Pending
IPT53	121489CN	CN	9/5/2011	201180051750.6		Pending
IPT53	121489NZ	NZ	12/5/2011	587780	587780	Granted
IPT53	121489KR	KR	9/5/2011	10-2013-7008491		Pending

Inductive Power Receiver Apparatus (Bipolar Receiver Pad) – Inventors: Covic and Budhia

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT54	121490NZP1	NZ	11/1/2010	588937		Expired
IPT54	121490WO	PCT	8/5/2011	PCT/NZ2011/000154		Expired
IPT54	121490KR	KR	8/5/2011	10-2013-7005726		Pending
IPT54	121490JP	JP	8/5/2011	2013-524060	5941046	Granted
IPT54	121490EP	EP	8/5/2011	11814854.3		Pending

IPT54	121490IN	IN	8/5/2011	1921/DELNP/2013		Pending
IPT54	121490US	US	8/5/2011	13/814,542		Pending
IPT54	121490CN	CN	8/5/2011	201180048057.3		Pending

Load Control for Bi-Directional Inductive Power Transfer Systems – Inventors: Madawala, Thrimawithana

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT55	146623NZP1	NZ	6/27/2011	593764		Expired
IPT55	146623WO	PCT	6/27/2012	PCT/NZ2012/000107		Expired
IPT55	146623	US	6/22/2012	14127,882		Pending
IPT55	146623KR	KR	6/27/2012	10-2014-7001559		Pending
IPT55	146623JP	JP	6/27/2012	2014-518471		Pending
IPT55	146623EP	EP	6/27/2012	12804818.8		Pending
IPT55	146623CN	CN	6/27/2012	201280030503.2		Pending
IPT55	146623NZ	NZ	7/9/2012	593764	593764	Granted

Interoperability of Magnetic Structures for Inductive Power Transfer Systems – Inventors: Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT57	121491NZP1	NZ	7/8/2011	593977		Expired
IPT57	121491NZP2	NZ	12/23/2011	597367		Expired
IPT57	121491WO	PCT	7/9/2012	PCT/NZ2012/000121		Expired
IPT57	121491JP	JP	7/9/2012	2014-518475		Pending
IPT57	121491EP	EP	7/9/2012	12820784.2		Pending
IPT57	121491US	US	7/9/2012	14/131,138		Pending
IPT57	121491CN	CN	7/9/2012	201280037549.7		Pending
IPT57	121491KR	KR	7/9/2012	10-2014-7003472		Pending
IPT57	121491NZD1	NZ(Div)	3/31/2014	623198		Abandoned
IPT57	121491NZ	NZ	10/8/2012	593977		Abandoned

Double Conductor Single Phase Inductive Power Transfer Tracks – Inventors: Covic and Raabe

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT58	121492NZP1	NZ	7/19/2011	594158		Expired
IPT58	121492WO	PCT	7/19/2012	PCT/NZ2012/000127		Expired
IPT58	121492US	US	7/19/2012	14/233,261		Pending
IPT58	121492CN	CN	7/19/2012	201280038877.9		Pending
IPT58	121492EP	EP	7/19/2012	12819897.5		Pending
IPT58	121492JP	JP	7/19/2012	2014-521588		Pending

IPT58	121492KR	KR	7/19/2012	10-2014-7004312		Pending
IPT58	121492NZ	NZ	10/19/2012	594158		Abandoned
IPT58	121492NZD1	NZ(Div)	3/31/2014	623197		Abandoned

IPT Magnetic Shielding – Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT59	121493NZP1	NZ	9/7/2011	595056		Expired
IPT59	121493WO	PCT	9/7/2012	PCT/NZ2012/000160		Expired
IPT59	121493KR	KR	9/7/2012	10-2014-7007332		Pending
IPT59	121493EP	EP	9/7/2012	12829832.0		Pending
IPT59	121493CN	CN	9/7/2012	201280052907.1		Pending
IPT59	121493IN	IN	9/7/2012	1434/DELNP/2014		Pending
IPT59	121493JP	JP	9/7/2012	2014-529639		Pending
IPT59	121493US	US	9/7/2012	14/240,191		Pending

Magnetic Field Shaping for Inductive Power Transfer – Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT60	123493NZP1	NZ	10/28/2011	596080		Expired
IPT60	123493NZP2	NZ	12/16/2011	597166		Expired
IPT60	123493NZP3	NZ	9/6/2012	602304		Expired
IPT60	123493WO	PCT	10/29/2012	PCT/NZ2012/000198		Expired
IPT60	123493KR	KR	9/7/2012	10-2014-7014470		Pending
IPT60	123493US	US	10/29/2012	14/354,705		Allowed
IPT60	123493IN	IN	10/29/2012	4062/DELNP/2014		Pending
IPT60	123493EP	EP	10/29/2012	12843894.2		Pending
IPT60	123493JP	JP	10/29/2012	2014-538747		Pending
IPT60	123493CN	CN	10/29/2012	201280064914.3		Pending
IPT60	123493NZ	NZ	1/25/2013	606189		Abandoned
IPT60	123493NZD1	NZ(Div)	8/1/2014	628198		Abandoned

Inductive Power Transfer System and Method – Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No	Grant Number	Status
IPT61	123494NZP1	NZ	12/16/2011	597174		Expired
IPT61	123494WO	PCT	12/18/2012	PCT/IB2012/002730		Expired
IPT61	123494KR	KR	12/18/2012	10-2014-7019724		Pending
IPT61	123494JP	JP	12/18/2012	2014-546664		Pending

IPT61	123494US	US	12/18/2012	14/365,873		Pending
IPT61	123494EP	EP	12/18/2012	12858565.0		Pending
IPT61	123494GB	GB	12/18/2012	1412616.3		Pending
IPT61	123494CN	CN	12/18/2012	21280069521.1		Pending
IPT61	123494NZ	NZ	3/15/2013	608273	608273	Granted

Magnetic Structure Interoperability for IPT Systems – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT62	123495NZP1	NZ	9/16/2011	595251		Cognated with IPT57

Multiple Coil Flux Pad – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT63	123496NZP1	NZ	2/16/2012	598253		Expired
IPT63	123496WO	PCT	2/15/2013	PCT/NZ2013/000016		Expired
IPT63	123496KR	KR	2/15/2013	10-2014-7025625		Pending
IPT63	123496JP	JP	2/15/2013	2014-557594		Pending
IPT63	123496IN	IN	2/15/2013	7034/DELNP/2014		Pending
IPT63	123496CN	CN	2/15/2013	201380019993.0		Pending
IPT63	123496US	US	2/15/2013	14/379,068		Pending
IPT63	123496EP	EP	2/15/2013	13749300.3		Pending
IPT63	123496NZ	NZ	4/19/2013	609482	609482	Granted

VAR Control for IPT System – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT64	123497NZP1	NZ	2/2/2012	597987		Expired
IPT64	123497WO	PCT	2/1/2013	PCT/NZ2013/000009		Expired
IPT64	123497EP	EP	2/1/2013	13813549.6		Pending
IPT64	123497US	US	2/1/2013	14/376,401		Pending
IPT64	123497CN	CN	2/1/2013	201380017845.5		Pending
IPT64	123497JP	JP	2/1/2013	2014-555521		Pending
IPT64	123497KR	KR	2/1/2013	10-2014-7024432		Pending
IPT64	123497NZ	NZ	4/16/2013	609519		Abandoned

Flux Coupling Device and Magnetic Structures Therefor– Inventors: Covic and Budhia

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT65	150927NZP1	NZ	7/9/2012	601154		Expired
IPT65	150927WO	PCT	7/9/2013	PCT/NZ2013/000120		Expired
IPT65	150927JP	JP	7/9/2013	2015-521574		Pending
IPT65	150927CN	CN	7/9/2013	201380046716.9		Pending
IPT65	150927	US	7/9/2013	14/410,817		Pending
IPT65	150927KR	KR	7/9/2013	10-2015-7003352		Pending
IPT65	150927EP	EP	7/9/2013	13816491.8		Pending
IPT65	150927NZ	NZ	7/31/2013	613512		Abandoned

Design Considerations for Variable Coupling Lumped Coil Systems– Inventors: Chang-Yu and Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT66	131923NZP1	NZ	8/31/2012	602184		Expired
IPT66	131923NZP2	NZ	9/14/2012	602543		Expired
IPT66	131923WO	PCT	9/2/2013	PCT/NZ2013/000154		Expired
IPT66	131923NZ	NZ	11/29/2013	618318		Abandoned
IPT66	131923KR	KR	9/2/2013	10-2015-7008302		Pending
IPT66	131923EP	EP	9/2/2013	13833528.6		Pending
IPT66	131923US	US	9/2/2013	14/424,390		Pending
IPT66	131923JP	JP	9/2/2013	2015-529721		Pending
IPT66	131923CN	CN	9/2/2013	201380055662.2		Pending

Inductive Power Transfer Control Using Energy Injection

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT67	146628NZP1	NZ	10/1/2012	602767		Expired
IPT67	146628NZP2	NZ	10/9/2012	602903		Expired
IPT67	146628WO	PCT	10/1/2013	PCT/NZ2013/000184		Expired
IPT67	146628NZ	NZ	10/1/2013	616162		Abandoned
IPT67	146628CN	CN	10/1/2013	201380051407.0		Pending
IPT67	146628EP	EP	10/1/2013	13843553.2		Pending
IPT67	146628JP	JP	10/1/2013	2015-535601		Pending
IPT67	146628KR	KR	10/1/2013	10-2051-7007591		Pending
IPT67	146628	US	10/1/2013	14/432,120		Pending
IPT67	146628IN	IN	10/1/2013	2545/DELNP/2015		Pending

Wiring Harness and Wireless Power Transfer System—Inventors: Keeling, Beaver, van Boheemen, Kissin, Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT68	120822P1	US	3/20/2012	61/613,414		Expired
IPT68	120822WO	PCT	3/20/2013	PCT/NZ2013/000045		Expired
IPT68	120822EP	EP	3/20/2013	13764869.7		Pending
IPT68	120822	US	3/20/2013	14/386,206		Pending
IPT68	120822KR	KR	3/20/2013	10-2014-7029391		Pending
IPT68	120822CN	CN	3/20/2013	201380024923.4		Pending
IPT68	120822JP	JP	3/20/2013	2015-501611		Pending

Winding Arrangements in Wireless Power Transfer Systems– Inventors: Keeling, van Boheemen, Kissin, Beaver, Boys Covic, et al.

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT69	120823P1	US	3/20/2012	61/613,420		Expired
IPT69	120823WO	PCT	3/20/2013	PCT/NZ2013/000046		Expired
IPT69	120823	US	3/20/2013	14/386,311		Pending
IPT69	120823KR	KR	3/20/2013	10-2014-7029392		Pending
IPT69	120823CN	CN	3/20/2013	201380024920.0		Pending
IPT69	120823EU	EP	3/20/2013	13763812.8		Pending
IPT69	120823JP	JP	3/20/2013	2015-501612		Pending

Electromagnetic Field Confinement– Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No.	Grant Number	Status
IPT70	150928NZP1	NZ	3/27/2013	608759		Expired
IPT70	150928NZP2	NZ	7/10/2013	613099		Expired
IPT70	150928NZ	NZ	3/31/2014	623218		Abandoned
IPT70	150928WO	PCT	3/27/2014	PCT/NZ2014/000054		Expired
IPT70	150928EP	EP	3/27/2014	14774618.4		Pending
IPT70	150928KR	KR	3/27/2014	10-2015-7030134		Pending
IPT70	150928	US	3/27/2014	14/780,102		Pending
IPT70	150928IN	IN	3/27/2014	9057/DELNP/2015		Pending
IPT70	150928CN	CN	3/27/2014	201480028597.9		Pending
IPT70	150928JP	JP	3/27/2014	2016-505431		Pending

An Output Current Doubler for a Parallel Tuned IPT Pickup - Inventors: Keeling and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT72	120821NZP1	NZ	12/20/2013	619303		Expired
IPT72	120821NZP2	NZ	8/19/2014	628991		Expired
IPT72	120821WO	PCT	12/19/2014	PCT/NZ2014/050025		Expired
IPT72	120821	US	6/20/2016	15/106,642		Pending
IPT72	120821CN	CN		Unknown		Pending
IPT72	120821EP	EP	12/19/2014	Unknown	14871146.8	Pending
IPT72	120821IN	IN	12/19/2014	Unknown		Pending
IPT72	120821JP	JP	12/19/2014	Unknown	2016-541639	Pending

A Polyphase Inductive Power Transfer System with Individual Control of Phases– Inventors: Madawala and Thrimawithana

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT73	147303NZP1	NZ	8/28/2012	602095		Expired
IPT73	147303NZ	NZ	8/29/2013	614823		Abandoned
IPT73	147303WO	PCT	8/28/2013	PCT/NZ2013/000151		Expired
IPT73	147303	US	8/28/2013	14/424,384		Pending
IPT73	147303KR	KR	8/28/2013	10-2015-7008158		Pending
IPT73	147303JP	JP	8/28/2013	2015-529720		Pending
IPT73	147303CN	CN	8/28/2013	201380053814.5		Pending
IPT73	147303EP	EP	8/28/2013	13832921.4		Pending

Resonant Frequency Compensation– Inventors: Thrimawithana and Madawala

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT76	150997NZP1	NZ	8/11/2014	628544		Expired
IPT76	150997WO	PCT	8/11/2015	PCT/NZ2015/050105		Pending

Vehicle or Moving Object Detection– Inventors: Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT77	146626NZP1	NZ	11/12/2012	603566		Expired
IPT77	146626NZ	NZ	11/12/2013	617614		Abandoned
IPT77	146626WO	PCT	11/12/2013	PCT/NZ2013/000202		Expired
IPT77	146626CN	CN	11/12/2013	201380058928.9		Pending
IPT77	146626EP	EP	11/12/2013	13854136.2		Pending
IPT77	146626KR	KR	11/12/2013	10-2015-7015221		Pending
IPT77	146626JP	JP	11/12/2013	2015-541736		Pending

IPT77	146626	US	11/12/2013	14/441,682		Pending

Resonant Power Supply with Self Tuning– Inventors: Boys and Covic

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT78	147428NZP1	NZ	9/12/2013	615464		Expired
IPT78	147428WO	PCT	9/10/2014	PCT/NZ2014/000196		Expired
IPT78	147428IN	IN	4/11/2016	201617012657		Pending
IPT78	147428	US	5/15/2014	15/021,440		Pending
IPT78	147428CN	CN	5/15/2014	201480059590.3		Pending
IPT78	147428EP	EP	4/13/2016	14784558.0		Pending
IPT78	147428JP	JP	5/15/2014	2016-541933		Pending
IPT78	147428KR	KR	5/15/2014	10-2016-7009583		Pending

A Multilevel Converter– Inventors: Rahnamaee, Madawala, Thrimawithana

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT79	152419NZP1	NZ	2/23/2014	621294		Expired
IPT79	152419WO	PCT	2/23/2015	PCT/NZ2015/050016		Pending

Inductive Power Transfer Apparatus– Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT80	150998NZP1	NZ	7/8/2014	627210		Expired
IPT80	150998WO	PCT	7/8/2015	PCT/NZ2015/050087		Pending

Pick-Up Apparatus for Inductive Power Transfer Systems– Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT81	121462R1	US	5/2/2007	13/930,505		Pending (Re-issue, see IPT23)
IPT81	121462R1D1	US	10/31/2014	14/529,939		Pending (Re-issue, see IPT23)

Magnetic Flux Coupling Structures with Controlled Flux Cancellation– Inventors: Tejeda, Covic, Gawith, Boys and Pearce

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT82	150715NZP1	NZ	9/11/2014	631149		Expired
IPT82	150715NZP2	NZ	3/16/2015	706024		Expired
IPT82	150715NZP3	NZ	4/1/2015	706620		Expired
IPT82	150715WO	PCT	9/10/2015	PCT/NZ2015/050139		Pending

Vertically Stacked Coils for Magnetic Flux Coupling Structures– Inventors: Boys and Covic

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT83	157084NZP1	NZ	4/1/2015	706614		Converted to IPT83

Multi-Source IPT System for Dynamic EV Charging – Inventors: Duleepa, Udaya

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT84	161482NZP1	NZ	4/20/2015	708015		Expired
IPT84	161482WO	PCT	10/20/2016	PCT/NZ2016/050116		Pending

Hybrid IPT System – Inventors: Madawala, Thrimawithana, Zhao

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT85	161483NZP1	NZ	8/6/2015	710795		Pending

Resonant Power Transfer – Inventors: Covic and Boys

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT86	162716NZP1	NZ	2/11/2016	716869		Pending

Resonant Power Transfer – Inventors: Covic, Kamineni, Neath

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT87	164919NZP1	NZ	7/19/2016	722264		Pending

Resonant Power Transfer – Inventors: Covic, Kamineni, Neath

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT88	164878NZP1	NZ	8/1/2016	722771		Pending

Schedule 2
Patent Families Non-exclusively Licensed

Decoupling Circuits – Inventors: Boys and Covic

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT16	154381NZP1	NZ	4/9/2003	525219		Expired
IPT16	154381NZ	NZ	4/5/2004	525219	525219	Abandoned
IPT16	154381NZD1	NZ(Div)	4/5/2004	532156	532156	Abandoned
IPT16	154381WO	PCT	4/5/2004	PCT/NZ2004/000066		Expired
IPT16	154381	US	10/11/2005	11/246,166	7,279,850	Granted

Single phase power supply for inductively coupled power transfer systems – Inventor: Boys

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT22	154385NZP1	NZ	2/28/2006	545664		Expired
IPT22	154385NZ	NZ	2/28/2007	545664	545664	Granted
IPT22	154385EP	EP	2/28/2007	07715993.7		Pending
IPT22	154385WO	PCT	2/28/2007	PCT/NZ2007/000041		Expired
IPT22	154385JP	JP	8/27/2008	2008-557230	5399080	Granted
IPT22	154385	US	8/27/2008	12/224,534	8953340	Granted
IPT22	154385CN	CN	10/7/2008	200780012613.5	ZL200780012613.5	Granted

Schedule 5
Covenanted Solely Owned Patents

Pick-Up Apparatus for Inductive Power Transfer Systems – Inventors: Boys, Covic and Elliot

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT23	121462NZP1	NZ	5/2/2006	546955		Expired
IPT23	121462WO	PCT	5/2/2007	PCT/NZ2007/000097		Expired
IPT23	121462	US	5/2/2007	12/226,956	7969269	Re-Issue Filed - (see IPT81)
IPT23	121462R1	US	6/28/2013	13/930,505		Pending
IPT23	121462R1D1	US	10/31/2014	14/529,939		Pending
IPT23	121462NZ	NZ	5/2/2007	546955	546955	Granted
IPT23	121462EP	EP	5/2/2007	07793941.1		Pending
IPT23	121462CN	CN	11/2/2008	200780020724.0	ZL200780020724.0	Granted

Inductive Power Transfer Apparatus - Inventors: Boys and Huang

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT29A	121494NZP1	NZ	2/5/2009	574677		Expired
IPT29A	121494WO	PCT	2/5/2010	PCT/NZ2010/000017		Expired
IPT29A	121494EP	EP	2/5/2010	10738795.3		Pending
IPT29A	121494	US	2/5/2010	13/138,299	9,283,858	Granted

Inductive Power Transfer Apparatus - Inventors: Boys, Covic, Hugang and Budhia

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT29B	121494NZ	NZ	2/5/2009	574677		Expired
IPT29B	121497NZP1	NZ	4/8/2009	576137		Expired
IPT29B	121497NZD1	NZ(Div)	5/31/2010	585802		Abandoned
IPT29B	121497NZD1D1	NZ(Div)	11/30/2011	596792		Abandoned
IPT29B	121497NZD1D1D1	NZ	5/5/2010	611167		Abandoned
IPT29B	121497WO	PCT	2/5/2010	PCT/NZ2010/000018		Expired
IPT29B	121497CN	CN	2/5/2010	201080012846.7	ZL201080012846.7	Granted
IPT29B	121497CND1	CN(Div)	9/25/2015	201510621373.5		Pending
IPT29B	121497CA	CA	2/5/2010	2751595		Pending
IPT29B	121497IN	IN	2/5/2010	6327/DELNP/2011		Pending
IPT29B	121497JP	JP	2/5/2010	2011-549109		Pending
IPT29B	121497JPD1	JP(Div)	7/6/2015	2015-135622		Pending
IPT29B	121497EP	EP	2/5/2010	10738796.1		Pending

IPT29B	121497KR	KR	2/5/2010	10-2011-7020758		Pending
IPT29B	121497	US	2/5/2010	13/138,298	9,071,061	Granted
IPT29B	141497C1	US	4/30/2015	14/700,770		Pending

Inductively Powered Mobile Sensor System – Inventors: Budgett, Hu and Malpas

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT 42		NZ	9/16/2004	535390	535390	Granted
IPT 42		AU	9/16/2005	2005285545	2005285545	Granted
IPT 42		GB	9/16/2005	0706623.6	2433656	Granted
IPT 42		US	8/21/2007	11/575,449		Granted
IPT 42		WO	9/16/2005	PCT/NZ2005/000245		Expired

Bi-Directional Inductive Power Transfer – Inventor: Madawala

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT45	121471NZP1	NZ	11/26/2008	573241		Expired
IPT45	121471NZP2	NZ	9/3/2009	579498		Expired
IPT45	121471WO	PCT	11/26/2009	PCT/NZ2009/000259		Expired
IPT45	121471	US	11/26/2009	13/131,155		Pending
IPT45	121471NZ	NZ	12/21/2009	573241	573241	Granted
IPT45	121471NZD1	NZ(Div)	1/03/2010	582580	582580	Granted

Primary Side Power Transfer for Inductive Power Transfer – Inventor: Madawala

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT46	121472NZP1	NZ	9/3/2009	579499		Expired
IPT46	121472WO	PCT	11/26/2009	PCT/NZ2009/000263		Expired
IPT46	121472	US	11/26/2009	13/131,153	8923015	Granted
IPT46	121472C1	US	12/29/2014	14/584,320		Pending

Load Control for Bi-Directional Inductive Power Transfer Systems – Inventors: Madawala, Thrimawithana

Case	QC Ref No.	Country	Filing Date	Application No.	Grant Number	Status
IPT55	146623NZP1	NZ	6/27/2011	593764		Expired
IPT55	146623WO	PCT	6/27/2012	PCT/NZ2012/000107		Expired
IPT55	146623	US	6/22/2012	14127,882		Pending
IPT55	146623KR	KR	6/27/2012	10-2014-7001559		Pending
IPT55	146623JP	JP	6/27/2012	2014-518471		Pending
IPT55	146623EP	EP	6/27/2012	12804818.8		Pending

IPT55	146623CN	CN	6/27/2012	201280030503.2		Pending
IPT55	146623NZ	NZ	7/9/2012	593764	593764	Granted

Interoperability of Magnetic Structures for Inductive Power Transfer Systems – Inventors: Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT57	121491NZP1	NZ	7/8/2011	593977		Expired
IPT57	121491NZP2	NZ	12/23/2011	597367		Expired
IPT57	121491WO	PCT	7/9/2012	PCT/NZ2012/000121		Expired
IPT57	121491JP	JP	7/9/2012	2014-518475		Pending
IPT57	121491EP	EP	7/9/2012	12820784.2		Pending
IPT57	121491US	US	7/9/2012	14/131,138		Pending
IPT57	121491CN	CN	7/9/2012	201280037549.7		Pending
IPT57	121491KR	KR	7/9/2012	10-2014-7003472		Pending
IPT57	121491NZD1	NZ(Div)	3/31/2014	623198		Abandoned
IPT57	121491NZ	NZ	10/8/2012	593977		Abandoned

Magnetic Structure Interoperability for IPT Systems – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT62	123495NZ1	NZ	9/16/2011	595251		Cognated with IPT57

Multiple Coil Flux Pad – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT63	123496NZP1	NZ	2/16/2012	598253		Expired
IPT63	123496WO	PCT	2/15/2013	PCT/NZ2013/000016		Expired
IPT63	123496KR	KR	2/15/2013	10-2014-7025625		Pending
IPT63	123496JP	JP	2/15/2013	2014-557594		Pending
IPT63	123496IN	IN	2/15/2013	7034/DELNP/2014		Pending
IPT63	123496CN	CN	2/15/2013	201380019993.0		Pending
IPT63	123496US	US	2/15/2013	14/379,068		Pending
IPT63	123496EP	EP	2/15/2013	13749300.3		Pending
IPT63	123496NZ	NZ	4/19/2013	609482	609482	Granted

VAR Control for IPT System – Inventors: Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT64	123497NZP11	NZ	2/2/2012	597987		Expired

IPT64	123497WO	PCT	2/1/2013	PCT/NZ2013/000009		Expired
IPT64	123497EP	EP	2/1/2013	13813549.6		Pending
IPT64	123497US	US	2/1/2013	14/376,401		Pending
IPT64	123497CN	CN	2/1/2013	201380017845.5		Pending
IPT64	123497JP	JP	2/1/2013	2014-555521		Pending
IPT64	123497KR	KR	2/1/2013	10-2014-7024432		Pending
IPT64	123497NZ	NZ	4/16/2013	609519		Abandoned

Design Considerations for Variable Coupling Lumped Coil Systems– Inventors: Chang-Yu and Covic

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT66	131923NZP1	NZ	8/31/2012	602184		Expired
IPT66	131923NZP2	NZ	9/14/2012	602543		Expired
IPT66	131923WO	PCT	9/2/2013	PCT/NZ2013/000154		Expired
IPT66	131923NZ	NZ	11/29/2013	618318		Abandoned
IPT66	131923KR	KR	9/2/2013	10-2015-7008302		Pending
IPT66	131923EP	EP	9/2/2013	13833528.6		Pending
IPT66	131923US	US	9/2/2013	14/424,390		Pending
IPT66	131923JP	JP	9/2/2013	2015-529721		Pending
IPT66	131923CN	CN	9/2/2013	201380055662.2		Pending

Wiring Harness and Wireless Power Transfer System– Inventors: Keeling, Beaver, van Boheemen, Kissin, Covic and Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT68	120822P1	US	3/20/2012	61/613,420		Expired
IPT68	120822WO	PCT	3/20/2013	PCT/NZ2013/000045		Expired
IPT68	120822EU	EP	3/20/2013	13764869.7		Pending
IPT68	120822	US	3/20/2013	14/386,206		Pending
IPT68	120822KR	KR	3/20/2013	10-2014-7029391		Pending
IPT68	120822CN	CN	3/20/2013	201380024923.4		Pending
IPT68	120822JP	JP	3/20/2013	2015-501611		Pending

Winding Arrangements in Wireless Power Transfer Systems– Inventors: Keeling, van Boheemen, Kissin, Beaver, Boys Covic, et al.

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT69	120823PI	US	3/20/2012	61/613,414		Expired
IPT69	120823WO	PCT	3/20/2013	PCT/NZ2013/000046		Expired
IPT69	120823	US	3/20/2013	14/386,311		Pending

IPT69	120823KR	KR	3/20/2013	10-2014-7029392		Pending
IPT69	120823CN	CN	3/20/2013	201380024920.0		Pending
IPT69	120823EU	EP	3/20/2013	13763812.8		Pending
IPT69	120823JP	JP	3/20/2013	2015-501612		Pending

Vehicle or Moving Object Detection– Inventors: Boys

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT77	146626NZP1	NZ	11/12/2012	603566		Expired
IPT77	146626NZ	NZ	11/12/2013	617614		Abandoned
IPT77	146626WO	PCT	11/12/2013	PCT/NZ2013/000202		Expired
IPT77	146626CN	CN	11/12/2013	201380058928.9		Pending
IPT77	146626EP	EP	11/12/2013	13854136.2		Pending
IPT77	146626KR	KR	11/12/2013	10-2015-7015221		Pending
IPT77	146626JP	JP	11/12/2013	2015-541736		Pending
IPT77	146626	US	11/12/2013	14/441,682		Pending

Pick-Up Apparatus for Inductive Power Transfer Systems– Inventors: Covic and Boys; IPT 23 Re-Issue Applications

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT81	121462R1	US	5/2/2007	13/930,505		Pending (Re-issue, see IPT23)
IPT81	121462R1D1	US	10/31/2014	14/529,939		Pending (Re-issue, see IPT23)

Magnetic Flux Coupling Structures with Controlled Flux Cancellation– Inventors: Tejeda, Covic, Gawith, Boys and Pearce

Case	QC Ref No	Country	Filing Date	Application No	Grant Number	Status
IPT82	150715NZP1	NZ	9/11/2014	631149		Expired
IPT82	150715NZP2	NZ	3/16/2015	706024		Expired
IPT82	150715NZP3	NZ	4/1/2015	706620		Pending
IPT82	150715WO	PCT	9/10/2015	PCT/NZ2015/050139		Pending

FOURTH AMENDMENT

THIS FOURTH AMENDMENT is made to the Amended and Restated License Agreement dated October 14, 2011, as amended by that certain letter agreement last signed on July 31, 2012, by the Second Amendment effective October 14, 2011 and by the Third Amendment effective October 14, 2011 (collectively, the "**Agreement**") between Auckland UniServices Limited, a company incorporated and registered in New Zealand with company number 373821 ("**UniServices**") and QUALCOMM Incorporated, a Delaware corporation ("**Qualcomm**"), and is entered into effective as of May 1, 2017 (the "**Fourth Amendment Date**"). UniServices and Qualcomm may be referred to individually as a "**Party**" and collectively as the "**Parties**" in this Fourth Amendment.

FOURTH AMENDMENT:

NOW, THEREFORE, the Parties hereby agree as follows:

1. **Headings; Definitions.** Headings used in this Fourth Amendment are inserted for the purpose of convenience only and are not intended to affect the meaning or interpretation of any provision of this Fourth Amendment. For the purpose of the construction and interpretation of this Fourth Amendment, the word "**including**" (and variations thereof such as "**include**" and "**includes**") will not be deemed to be a term of limitation, but rather will be deemed to be followed by the words "**without limitation,**" and the words "**herein,**" "**hereof,**" and "**hereunder**" will refer to this Fourth Amendment as a whole. Unless otherwise specified herein, capitalized terms used in this Fourth Amendment given to such terms in the Agreement.

2. **Clause 1.1 Definitions.**
   a. The definition of "Road Vehicle" in the Agreement is deleted and replaced by the following
   "Road Vehicle" means any vehicle, scooter, motorcycle, bicycle, tricycle, Segway, wheelchair, or other similar apparatus or machine (whether controlled directly or indirectly through remote or autonomous means (and with or without human input)) having one or more wheels that is designed primarily: (i) for use on a public or private road, trail, pathway, driveway, pavement, race track and its surrounding areas (e.g., race pit, entrance and exit area to race track), garage surface, or parking lot (whether located indoors or outdoors); and (ii) to transport, or provide any service to or for, any person (or persons) or goods.

3. [redacted]

4. **No Other Amendment.** Except as expressly set forth in this Fourth Amendment, the Agreement shall remain in full force and effect without any modification. The terms and conditions of this Fourth Amendment and the Agreement supersedes all prior and contemporaneous oral or written understandings between the Parties with respect to their subject matter, and constitute the entire agreement of the Parties with respect to such subject matter. The terms and conditions of this Fourth Amendment and the Agreement shall not be modified or amended, except by a writing signed by the authorized representatives of both UniServices and Qualcomm.

IN WITNESS WHEREOF, the Parties have, through their duly authorized representatives, caused this Fourth Amendment to be entered into effective as of the Fourth Amendment Date. This Fourth Amendment may be signed in counterparts.

Auckland UniServices Limited	**QUALCOMM Incorporated**
By: _____	By: _____
Printed Name: W.H.H. CHARLES	Printed Name: John Han
Title: GENERAL MANAGER	Title: Sr Vice President & General Manager
Date: 4th May 2017.	Date: 5/30/2017