



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 3231

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 031 939 A1 (TOPPAN PRINTING CO LTD [JP]) 30 August 2000 (2000-08-30) * figures 16B, 18B *	1-8	INV. G06K19/07
X	JP 2002 175508 A (DAINIPPON PRINTING CO LTD) 21 June 2002 (2002-06-21) * figure 2 *	1,2,5-8	
P,X	EP 1 385 120 A1 (HITACHI LTD [JP]) 28 January 2004 (2004-01-28) * figure 5 *	3,4	
X	JP 2003 218624 A (FEC INC) 31 July 2003 (2003-07-31) * figure 2 *	1,2,5-8	
X	EP 0 812 752 A2 (TROVAN LTD [US] TROVAN LTD ALGERNON PROMOTIONS INC [PA]) 17 December 1997 (1997-12-17) * figure 6 *	3,4	
X	US 5 305 002 A (HOLODAK GEORGE [US] ET AL) 19 April 1994 (1994-04-19) * figure 2 *	1,2,5-8	TECHNICAL FIELDS SEARCHED (IPC) G06K
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 November 2006	Examiner de Ronde, Jan
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document			

1
EPO FORM 1503 (01.02.05) (P/CA/01)

Electronic Patent Application Fee Transmittal				
Application Number:		12649635		
Filing Date:		30-Dec-2009		
Title of Invention:		WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-Q RESONATORS		
First Named Inventor/Applicant Name:		John D. Joannopoulos		
Filer:		Marc M. Wefers/Cheryl Forrest		
Attorney Docket Number:		01997-0359015 / MIT 11757		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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

Electronic Acknowledgement Receipt	
EFS ID:	15553709
Application Number:	12649635
International Application Number:	
Confirmation Number:	5891
Title of Invention:	WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-Q RESONATORS
First Named Inventor/Applicant Name:	John D. Joannopoulos
Customer Number:	26161
Filer:	Marc M. Wefers/Cheryl Forrest
Filer Authorized By:	Marc M. Wefers
Attorney Docket Number:	01997-0359015 / MIT 11757
Receipt Date:	18-APR-2013
Filing Date:	30-DEC-2009
Time Stamp:	14:32:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$180
RAM confirmation Number	786
Deposit Account	061050
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Multipart Description/PDF files in .zip description					
Document Description		Start	End		
Transmittal Letter		1	1		
Information Disclosure Statement (IDS) Form (SB08)		2	2		
Warnings:					
Information:					
2	Foreign Reference	FA1.pdf	1321042 [5a]3cc49f97c2f5a6b88817dd6e120507e6 235bc	no	26
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3	Non Patent Literature	NPL1.pdf	343540 a5d56ed1b4d21a28b4436c2c921905fddc 3401ae	no	7
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4	Fee Worksheet (SB06)	fee-info.pdf	30759 a23fe016d8e9021d824b28bc71401ac88b 12b4a	no	2
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : John D. Joannopoulos et al. Art Unit : 2836
Serial No. : 12/649,635 Examiner : Fritz Fleming
Filed : December 30, 2009 Conf. No. : 5891
Title : WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-
Q RESONATORS

MAIL STOP AMENDMENT

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

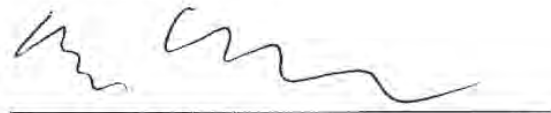
INFORMATION DISCLOSURE STATEMENT

Please consider the references listed on the enclosed PTO-1449 form. Foreign patent documents and non-patent literature are enclosed; cited U.S. patents and patent application publications will be provided on request. A copy of a communication from a foreign patent office in a counterpart application is also enclosed.

This statement is being filed after a first Office action on the merits, but before receipt of a final Office action or a Notice of Allowance. The fees in the amount of \$180 in payment of the late submission fee of 37 CFR §1.17(p) are being paid concurrently herewith. In addition, please apply any other necessary charges or credits to Deposit Account 06-1050, referencing the above attorney docket number.

Respectfully submitted,

Date: 4/18/13



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PLUS Search Results for S/N 12649635, Searched Wed May 15 08:35:36 EDT 2013
 The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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Information Disclosure Statement by Applicant (Use several sheets if necessary)		Applicant John D. Joannopoulos et al.	
		Filing Date December 30, 2009	Group Art Unit 2836

U.S. Patent Documents							
Examiner Initial	Desig. ID	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate
	1						

Foreign Patent Documents or Published Foreign Patent Applications								
Examiner Initial	Desig. ID	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation	
							Yes	No
	2	JP 11-75329	3/16/1999	Japan	H02J	17/00	Abstract and Machine Translation	
	3	JP 2003-179526	6/27/2003	Japan	H04B	5/02	Abstract and Machine Translation	
	4	JP 2004-166459	6/10/2004	Japan	H02J	7/00	Abstract and Machine Translation	
	5	JP 2004-201458	7/15/2004	Japan	H02M	3/28	Abstract and Machine Translation	
	6	JP 2005-57444	3/3/2005	Japan	H01Q	7/09	Abstract and Machine Translation	
	7							

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Desig. ID	Document
	8	Klaus Finkenzeller, "RFID Handbook (2 nd Edition)", The Nikkan Kogyo Shimbun, Ltd., pp. 19, 20, 38, 39, 43, 44, 62, 63, 67, 68, 87, 88, 291, 292 (Published on May 31, 2004)
	9	Copy of Translation of Information Statement by Third Party submitted to the Japanese Patent Office for Japanese Application No. 2011-83009, translation received on May 15, 2013
	10	Copy of Submission of Publication to the Japanese Patent Office for Japanese Application No. 2011-256,729, translation received on May 2, 2013
	11	Copy of Submission of Publication to the Japanese Patent Office for Japanese Application No. 2011-509,705, translation received on May 2, 2013
	12	

Examiner Signature	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Substitute Disclosure Form

No documents available for this priority number.



Espacenet

Bibliographic data: JPH1175329 (A) — 1999-03-18

NON-CONTACT TYPE IC CARD SYSTEM

Inventor(s): MAKUUCHI MASAMI; HAYASHI YOSHIHIKO; SUGA TAKU; KAMISAKA KOICHI; YOSHINO RYOZO ± (MAKUUCHI MASAMI; HAYASHI YOSHIHIKO; SUGA TAKU; KAMISAKA KOICHI; YOSHINO RYOZO)

Applicant(s): HITACHI LTD ± (HITACHI LTD)

Classification: - international: G06K17/00; H02J17/00; H04B5/00; (IPC1-7): G06K17/00; H02J17/00; H04B5/00

- cooperative:

Application number: JP19970233611 19970829

Priority number(s): JP19970233611 19970829

Abstract of JPH1175329 (A)

PROBLEM TO BE SOLVED: To maximize the power transmission efficiency from a reader or writer device to a proximity wireless card, by setting the respective Q values of a resonance circuit of the reader or writer device and the resonance circuit of an IC card using the Q of the whole communication route. **SOLUTION:** A reader and/or writer unit 1 constitutes a resonance circuit using a capacitor 104, an antenna drive impedance 120 and an R/W antenna coil 101. A wireless card 2 constitutes a resonance circuit using a card antenna coil 201, a capacitor, and a resistor 220. In such a system, the antenna drive impedance 120 is set so as to maximize the reception efficiency at the proximity wireless card 2 in the target communication distance, and the respective Qs of the resonance circuits are set so as to obtain the necessary bandwidth to secure the sufficient signal level to the target communication speed.



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特開平11-75329

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(51) Int.Cl.⁶ 識別記号
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G 0 6 K 17/00
H 0 4 B 5/00

F I
H 0 2 J 17/00 B
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H 0 4 B 5/00 Z

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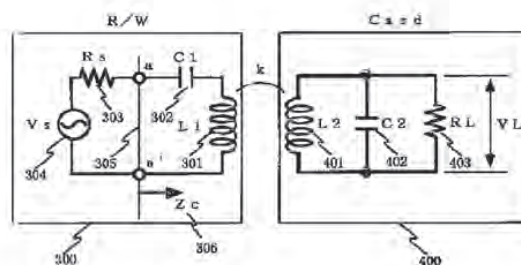
(54) 【発明の名称】 非接触 IC カードシステム

(57) 【要約】

【課題】非接触式 IC カードシステムにおいて、IC カードおよび IC カードのリーダまたは／およびライタそれぞれの共振回路の単体の Q を設定することにより、目標とする通信速度に対して十分な帯域幅を得ることができ、かつ IC カードでの受信効率を最大にする。

【解決手段】IC カードおよび IC カードのリーダまたは／およびライタに、それぞれ共振回路 3、4 を配設する。目標とする通信距離において該リーダまたは／およびライタのアンテナコイルから該 IC カードを見込んだインピーダンス Z_c と該アンテナコイルの駆動インピーダンス R_s を等しくし、かつ該 IC カードと該リーダまたは／およびライタにより構成される伝送経路の全体の Q を通信帯域幅と電力伝送周波数との比に等しくするように該共振回路 3 および 4 の Q を設定する。

図 2



【特許請求の範囲】

【請求項1】リーダまたは／およびライタ装置とICカードとの間で電力または／および信号の伝送を非接触で行い、該リーダまたは／およびライタ装置と該ICカードとがそれぞれ該電力または／および該信号を送信するアンテナコイルと該電力を送信する電力伝送周波数に同調するように設定した容量と該アンテナコイルの駆動インピーダンスからなる共振回路を備えた非接触ICカードシステムであって、

該リーダまたは／およびライタ装置と該ICカードからなる通信経路全体のQを用いることで、該リーダまたは／およびライタ装置の有する共振回路と該ICカードの有する共振回路のそれぞれのQを設定したことを特徴とする非接触ICカードシステム。

【請求項2】前記ICカードに設けた共振回路のQを3～4.2の範囲に設定し、前記リーダまたは／およびライタ装置に設けた共振回路のQを3～4.0の範囲に設定したことを特徴とする請求項1記載の非接触ICカードシステム。

【請求項3】前記通信経路全体のQを前記ICカードに設けた共振回路と前記リーダまたは／およびライタ装置に設けた共振回路とのインピーダンスをほぼ等しくなるようにして算出したことを特徴とする請求項1又は請求項2記載の非接触ICカードシステム。

【請求項4】リーダまたは／およびライタ装置とICカードとの間で電力または／および信号の伝送を非接触で行う非接触ICカードシステムであって、該リーダまたは／およびライタ装置のアンテナ駆動インピーダンスを該リーダまたは／およびライタ装置のアンテナから該ICカードを見込んだインピーダンスにほぼ等しく設定して導き出した伝送経路全体のQの特性から、該信号の伝送速度に対して所望の帯域幅を得ることが可能となるQ3を算出し、該算出したQ3と該リーダまたは／およびライタ装置から該ICカードへの電力伝送効率を最大となる該リーダまたは／およびライタ装置のQ1と該ICカードのQ2との関係とを用いることで、該リーダまたは／およびライタ装置と該ICカードの有する共振回路のそれぞれのQ1、Q2を設定したことを特徴とする非接触ICカードシステム。

【請求項5】リーダまたは／およびライタ装置とICカードとの間で電力または／および信号の伝送を非接触で行う非接触ICカードシステムであって、該リーダまたは／およびライタ装置と該ICカードからなる通信経路全体のQを用いることで、該リーダまたは／およびライタ装置と該ICカードそれぞれのQを設定したことを特徴とする非接触ICカードシステム。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、例えばキャッシュ、ディスペンサ、電子マネー、自動改札システム、入退室

管理システム、公衆電話器等におけるキャッシュカード、クレジットカード、乗車券、定期券、回数券、管理カード、IDカード、免許証、テレホンカード等の非接触ICカードとリーダまたは／およびライタ装置との間において近接無線動作電力伝送及び通信を行う非接触ICカードシステムに関する。

【0002】

【従来の技術】従来、光または磁界を用いて電力供給側から近接無線カード(ICカード)に対して非接触で電力を供給することは知られている。

【0003】例えば、駅の改札口やバスや入退口等において使用するキャッシュカード、クレジットカード、乗車券や定期券等をICカード化し、このICカードを使用者が駅の改札口やバスや入退口等に備えられたリーダ／ライタに対して非接触で通過させたとき、リーダ／ライタとカードとの間での電磁結合方式または電磁誘導方式等により電力または／および信号の授受を行う非接触ICカードシステム(近接無線カードシステム)である。

【0004】一般に、このような非接触ICカードシステムは、リーダ／ライタ側からICカード側へ電力伝送波及びデータ通信変調波を高効率に伝送できるように、リーダ／ライタとICカードとをそれぞれ別個に設計していた。

【0005】具体的には、図4に示すような周波数特性から導かれる $Q (= f_0 / BW)$ 、 f_0 ：中心周波数、 BW ：中心周波数 f_0 の有する利得から-3dBとなる帯域幅)を考慮してリーダ／ライタとICカードとを設計していた。

【0006】

【発明が解決しようとする課題】しかし、リーダ／ライタが電力伝送波にデータ信号(データ通信変調波)を重ねて送受信を行う場合、非接触ICカードシステムでは、以下の条件を満足しなければならない。

【0007】(1) ICカード側において、あらゆるデータ通信変調波を全て確実に受信できるように、利得がある値以上となるような帯域幅 BW をなるべく広くするように設計しなければならない。すなわち、 Q が小さくなるように設計しなければならない。

【0008】(2) ICカード側に十分な電力を供給できるように、電力伝送周波数、例えば前述の中心周波数の利得をなるべく大きくしなければならない。この場合、一般には、 Q が大きくなるように設計しなければならない。なお、単にリーダ／ライタ側から送信される電力伝送波を大きくしただけでは、電力伝送波は法規制のないISMバンドを使用するので問題はないが、その電力伝送波に重畳されるデータ通信変調波が、使用する周波数帯域(ISMバンド外)において法規制値を満足できなくなることとも考慮しなければならない。

【0009】このように(1)、(2)の条件は、一方では Q を小さくすることが、他方では Q を大きくすること

が条件となり、両者を満足するようなリーダ/ライタとICカードのQをそれぞれ決定することは非常に困難な作業となる。

【0010】例えば、リーダ/ライタおよびICカードのそれぞれのアンテナ部の共振回路のQを高くしてリーダ/ライタとカードとで構成される伝送経路全体のQを高く設定すると、カードでの受信誘起電力は増加するが、リーダ/ライタとカードとの間での目標とする通信速度に対して十分な信号レベルを確保するための必要な帯域幅が得られないと言った事態となってしまう。

【0011】本発明は、上記問題点を解決すべくなされたものであり、リーダまたは/およびライタ装置と近接無線カード（ICカード）の共振回路に対して、該リーダまたは/およびライタ装置から該近接無線カード（ICカード）への電力伝送効率を最大とし、かつ目標とする通信速度に対して必要な帯域幅を容易に与える全く新規な方法を提供することを目的とする。

【0012】

【課題を解決するための手段】そこで、我々は、非接触ICカードシステム全体のQを用いてリーダ/ライタとICカードそれぞれのQを割り振り、設計することで上記目的を達成することとした。

【0013】具体的には、リーダまたは/およびライタ装置とICカードとの間で電力または/および信号の伝送を非接触で行い、該リーダまたは/およびライタ装置と該ICカードとがそれぞれ該電力または/および該信号を送るアンテナコイルと該電力を送る電力伝送周波数に同調するように設定した容量と該アンテナコイルの駆動インピーダンスからなる共振回路を備えた非接触式ICカードシステムであって、該リーダまたは/およびライタ装置と該ICカードからなる通信経路全体のQを用いることで、該リーダまたは/およびライタ装置の有する共振回路と該ICカードの有する共振回路のそれぞれのQを設定したものである。

【0014】もしくは、リーダまたは/およびライタ装置とICカードとの間で電力または/および信号の伝送を非接触で行う非接触式ICカードシステムであって、該リーダまたは/およびライタ装置のアンテナ駆動インピーダンスを該リーダまたは/およびライタ装置のアンテナから該ICカードを見込んだインピーダンスにほぼ等しく設定して導き出した伝送経路全体のQの特性から、該信号の伝送速度に対して所望の帯域幅を得ることが可能となるQ3を算出し、該算出したQ3と該リーダまたは/およびライタ装置から該ICカードへの電力伝送効率を最大となる該リーダまたは/およびライタ装置のQ1と該ICカードのQ2との関係を用いることで、該リーダまたは/およびライタ装置と該ICカードの有する共振回路のそれぞれのQ1、Q2を設定したものである。

【0015】もしくは、リーダまたは/およびライタ装

置とICカードとの間で電力または/および信号の伝送を非接触で行う非接触ICカードシステムであって、該リーダまたは/およびライタ装置と該ICカードからなる通信経路全体のQを用いることで、該リーダまたは/およびライタ装置と該ICカードそれぞれのQを設定したものである。

【0016】このような構成にすることで、近接されるICカードに対して電磁結合方式または電磁誘導方式等により電力および信号の授受を行うリーダまたは/およびライタとICカードからなる非接触ICカードシステム（近接無線カードシステム）において、目標とする通信距離においてICカードでの受信効率を最大とし、しかも目標とする通信速度に対して十分な信号レベルを確保するため必要な帯域幅を容易に得ることができる。

【0017】

【発明の実施の形態】本発明に係る実施の形態について図を用いて説明する。

【0018】図1は、本発明に係る例えば改札口やバスや入退口や所定の場所に備えられたリーダまたは/およびライタユニット（装置）1から非接触で通過または近接される非接触カード（近接無線カード：ICカード）2に対して電磁結合方式または電磁誘導方式等により電力を送ると共に通信を行う電力伝送および通信方式の概略構成を示す図である。非接触カード（近接無線カード：ICカード）2は、使用者が保持して改札口やバスや入退口に備えられたリーダまたは/およびライタユニット1に対して非接触で例えば10cm位までの距離を離して通過させることによって電磁結合方式または電磁誘導方式等によりキャッシュカード、クレジットカード、乗車券、定期券等の情報を送受信してキャッシュカード、クレジットカード、乗車券、定期券等の役目をするものである。

【0019】図2は、図1に示すリーダまたは/およびライタユニット（装置）1と該非接触カード（近接無線カード：ICカード）2の構成を等価回路により表したものである。なお、非接触カード（近接無線カード：ICカード）2を簡素化するために、単一のアンテナ（リーダライタアンテナ）101により電力伝送および情報の送受信するように構成した。従って、図2では、リーダまたは/およびライタユニット1に設けられたリーダライタアンテナ101と近接無線カード2に形成されたカードアンテナコイル201との間で、図3に示す電力伝送波およびデータ通信変調波からなる電磁波（無線）を使って電力の伝送および通信の送受信の両方を行う。なお、図3から分かるように、ASK変調方式における電力伝送波と信号波は、周波数領域で見ると異なる周波数成分であるが、時間領域で見ると電力伝送波の振幅が信号速度に応じて変化するだけである。つまり、電力伝送波に信号波を掛け合わせた変調波は時間領域では、電力伝送波の波形振幅が上下変動しているようにしか見え

ない。

【0020】さて、図2に示す非接触カードシステム（近接無線カードシステム）は、周波数 f_0 で発振するOSC（発振器）304と、該OSC304によってアンテナコイル301を駆動する際のアンテナコイル駆動インピーダンス303と、該アンテナコイル301と周波数 f_0 で直列共振するように設定したアンテナコイル同調容量302とで構成されるリーダ／ライタ300と、アンテナコイル401と周波数 f_0 で並列共振するように設定したアンテナコイル同調容量402とカード負荷低抗403とで構成されるICカード400とにより構成されている。そして、リーダ／ライタのアンテナコイル301とICカードのアンテナコイル401とは電磁誘導または電磁結合によりアンテナ結合係数 k をも

って結合している。この該アンテナ結合係数 k はリーダ／ライタのアンテナコイル301とICカードのアンテナコイル401との距離に応じて変化する。ここでは説明のため、リーダ／ライタ側の共振回路を直列共振回路とし、ICカード側の共振回路を並列共振回路としているが、共振回路の組み合わせはこれに限らず種々の態様をとることができる。

【0021】ここで、上記のようなリーダまたは／およびライタユニット（装置）1、非接触カード（近接無線カード：ICカード）2からなる非接触ICカードシステム全体の Q の近似式を求めると数1のようになる。

【0022】

【数1】

$$Q3 = \frac{1}{\left| \sqrt{\frac{\delta}{4 \cdot \epsilon} + \frac{\lambda}{2} + \frac{\sqrt{\mu + \nu}}{2}} - \sqrt{\frac{\delta}{4 \cdot \epsilon} + \frac{\lambda}{2} - \frac{\sqrt{\mu + \nu}}{2}} \right|} \quad (\text{数1})$$

ただし

$$\nu = \frac{\frac{\delta^3}{\epsilon^3} + \frac{4 \cdot \gamma \cdot \delta}{\epsilon^3} + \frac{8 \cdot \beta}{\epsilon}}{4 \sqrt{\lambda}}$$

$$\mu = \frac{\frac{\delta^2}{2 \cdot \epsilon^2} + \frac{4 \cdot \gamma}{3 \cdot \epsilon} - \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \epsilon} - \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \epsilon}}$$

$$\lambda = \frac{\frac{\delta^2}{4 \cdot \epsilon^2} + \frac{2 \cdot \gamma}{3 \cdot \epsilon} + \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \epsilon} + \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \epsilon}}$$

$$\kappa = \gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \epsilon$$

$$\theta = \tau + \sqrt{-4 \cdot \zeta + \tau^2}$$

$$\tau = -2 \cdot \gamma^3 + 9 \cdot \beta \cdot \gamma \cdot \delta - 27 \cdot \alpha \cdot \delta^2 + 27 \cdot \beta^2 \cdot \epsilon - 72 \cdot \alpha \cdot \gamma \cdot \epsilon$$

$$\zeta = (\gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \epsilon)^3$$

$$\epsilon = Q2^2 \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2})^2$$

$$\delta = 2 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2}) - (-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2))^2$$

$$\gamma = -(1 + 2 \cdot Q1 \cdot Q2)^2 \cdot (1 + Q2^2)^2 - 2 \cdot Q1 \cdot Q2^2 \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2}) - 2 \cdot (Q1 + Q2) \cdot (1 + Q2^2) \cdot (-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2)) + 2 \cdot \{2 + 4 \cdot Q2^2 + 2 \cdot Q2^4 + 2 \cdot \sqrt{1 + Q2^2} \cdot (Q2 + Q2^3)\}$$

$$\beta = -(Q1 + Q2)^2 \cdot (1 + Q2^2)^2 + 2 \cdot Q1 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2)^2$$

$$\alpha = -Q1^2 \cdot Q2^2 \cdot (1 + Q2^2)^2$$

【0023】これは図2に示す等価回路に基づいた回路方程式から求めた結果であり、非接触ICカードシステム全体のQ3をリーダまたは／およびライタユニットのQ1と非接触ICカードのQ2との関係で求めたものである。

なお、リーダまたは／およびライタユニット（装置）1、非接触カード（近接無線カード：ICカード）2の構成によって等価回路や数1の内容が当然異なるが、いずれの場合であっても非接触ICカードシステム全体のQ3をリーダまたは／およびライタユニットのQ1と非接触ICカードのQ2との関係で求めたものであれば良い。

【0024】次に、数1に示すような非接触ICカードシステム全体のQ3をリーダまたは／およびライタユニットのQ1と非接触ICカードのQ2とで表した関係を用いてリーダまたは／およびライタユニットのQ1と非接触ICカードのQ2とを決定する方法（Q1、Q2の割り振り）を図5を用いて説明する。

【0025】図5は、数1を用いて、該ICカード4のQ（Q2）と該リーダ／ライタ3と該ICカード4で構成される伝送経路全体のQ（Q3）との関係、および該ICカード4のQ（Q2）と該リーダ／ライタ3のQ（Q1）との関係についてシミュレーションした結果である。この場合、数2を数1に代入することでシミュレーションしている。

【0026】

【数2】

$$Q1 = \frac{1}{k^2 \cdot \sqrt{1+Q2^2}} \quad (\text{数2})$$

【0027】数2は、図2に示す回路において目標とする通信距離でのICカードの受信効率が最大となるよう、リーダ／ライタのアンテナ駆動インピーダンス303を目標とする通信距離におけるリーダ／ライタの端子a-a' 305からICカード4を見たインピーダンスZc 306に等しくしてインピーダンスマッチングをとることで導いたものである。

【0028】また、図5では、リーダ／ライタ3のアンテナコイル301を、ターン数[T]が3のスパイラル形状で外周を100[mm]×100[mm]とし、ICカード4のアンテナコイル401をターン数[T]が4のスパイラル形状で外周を77[mm]×42[mm]とし、該リーダ／ライタ3と該ICカード4の距離d=30[mm]（この時結合係数kの値はk=0.0998）をシミュレーションしている。

【0029】このようなシミュレーション結果に対して、目標とする通信速度における非接触ICカードシステムで必要となる帯域幅と、使用する電力伝送周波数とから伝送経路全体のQ3を設定することができる。そして設定したQ3から図5に示す関数を用いて、Q1Q2を一義的に設定することができる。

【0030】例えば、目標とする通信速度に対して必要

な帯域幅から伝送経路全体のQであるQ3を10以下とすると、該リーダ／ライタ3のQはQ1=4.5～22.2で、該ICカード4のQはQ2=4.4～22.0とすればよいことがわかる。

【0031】前述の如く、図5では、電力伝送が最大となる場合の関係式（数2）を用いてシミュレーションした結果であるので、設定したQ1、Q2は電力伝送が最大となるような値となる。すなわち、ICカード4での受信効率が最大にし、しかも目標とする通信速度に対して十分な帯域幅を得ることが可能なリーダ／ライタ3とICカード4それぞれの共振回路のQを設定することができる。

【0032】このように設定されたそれぞれのQから、例えば数3、数4等を用いてL1、L2、Rs、RL等を導けば、ICカード4での受信効率が最大にし、しかも目標とする通信速度に対して十分な帯域幅を得ることが可能なリーダ／ライタ3とICカード4を構成することができる。

【0033】

【数3】

$$Rs = k^2 \cdot 2 \cdot \pi \cdot f_0 \cdot L1 \cdot \sqrt{1+Q2^2} \quad (\text{数3})$$

【0034】

【数4】

$$Q2 = \frac{RL}{2 \cdot \pi \cdot f_0 \cdot L2} \quad (\text{数4})$$

【0035】なお、数2～数4やその他の構成要素C1、C2等は図2に示す等価回路に基づいた回路方程式から算出することができるのは言うまでもない。

【0036】一方、上述の説明においては、リーダ／ライタ3のアンテナコイル301をターン数[T]が3のスパイラル形状で外周を100[mm]×100[mm]とし、ICカード4のアンテナコイル401をターン数[T]が4のスパイラル形状で外周を77[mm]×42[mm]とし、該リーダ／ライタ3と該ICカード4の距離をd=30[mm]で伝送経路全体のQであるQ3を10以下とした場合について述べたが、本発明はこれに限らず種々の形態のものを適用できる。

【0037】例えば、上記のリーダ／ライタおよびICカードのアンテナを用いて目標とする通信距離を5cm以下で伝送経路全体のQを20以下とした場合、該リーダ／ライタ3のQはQ1=3～40の範囲で、該ICカード4のQはQ2=3～42の範囲で値を設定すればよい。また、リーダ／ライタおよびICカードのアンテナ形状を変えた場合であっても、アンテナ間の結合係数kと伝送経路全体のQまたは／および通信帯域幅と該通信信号の搬送波周波数との比とを用いて本発明を適用できる。

【0038】さらに、電力伝送の効率を最大とすることによる条件：数2の代わりに、既知のQ1とQ2の関係を用

いて図5のような関係をシミュレーションしても良い。

【0039】また、リーダ／ライタ3とICカード4で構成される伝送経路全体のQであるQ3を用いているが、通信帯域幅と該通信信号の搬送波周波数との比をQ3として用いてもよい。

【0040】次に本発明に係るリーダまたは／およびライタユニット（装置）1と非接触カード（近接無線カード：ICカード）2との間において電磁結合方式または電磁誘導方式等により電力伝送および情報の送受信（通信）を行う装置（システム）の一実施の形態に本発明を適用した例について説明する。

【0041】図6は、13.56MHzの高周波数の電圧を発生するOSC（発振器）105と、近接無線カード2へ送信するための入力された送信データ（DATA）106を符号化する符号化回路107と、上記OSC105から発生した13.56MHzの高周波数の電圧を上記符号化回路107の出力信号に従って変調する変調回路108と、該変調回路の出力信号に従ってアンテナコイルを駆動するアンテナコイル駆動回路109と、該アンテナコイル駆動回路で増幅された信号をインダクタンス結合103により結合させ、コンデンサ104とアンテナ駆動インピーダンス120とを有してインピーダンスをマッチングさせるための整合回路（給電回路）102と、該整合回路102の出力に応じて電力の伝送およびデータの送信を行うべく電磁波を発生し、近接無線カード2のカードアンテナコイル201から電磁波によって送信されてきたデータを受信するR/Wアンテナコイル101と、該R/Wアンテナコイル101で受信した信号を整合回路102で整合させてインダクタンス結合103により生じた信号からノイズ成分を取り除くフィルタ回路110と、該フィルタ回路110を通して得られる信号を増幅する受信アンプ111と、該受信アンプ111で増幅された信号を復調する復調回路112と、該復調回路112で復調された信号を復号化して受信データ（DATA）114として出力する復号化回路113とを備えている。そして、送信データ106および受信データ114はネットワークを介してホストコンピュータ115に接続されている。

【0042】近接無線カード（非接触カード：ICカード）2には、R/Wユニット1のR/Wアンテナコイル101から電力の伝送およびデータの送信を行うべく発生した電磁波を受信し、ロードスイッチング変調された送信データに応じた電磁波を発生するカードアンテナコイル201と、該カードアンテナコイル201で受信した13.56MHzの電力については整流し、送受信信号についてはコンデンサ221と抵抗220を用いてインピーダンスをマッチングさせて整合する整合／整流回路203と該整合／整流回路203から整流された誘起電圧から5mW程度で2～5V程度の一定の直流電圧電源205として供給する電源回路204と上記整合／整

流回路203から得られる受信信号からクロックを抽出するクロック抽出回路206と上記整合／整流回路203から得られる受信信号からノイズ成分を取り除くLPF回路207と該LPF回路207から得られる受信信号を波形整形する波形整形回路208と送信信号をロードスイッチング変調させて上記整合／整流回路203に与えて整合させてカードアンテナコイル201に供給するロードスイッチング変調回路とを有する無線チップ202と、該無線チップ202のクロック抽出回路206で抽出されたクロック信号に基づいて分周してマイコン214を働かせる信号を生成する分周回路211と無線チップ202の波形整形回路208から得られる信号を復号化して復号化データ（受信データ）としてマイコン（CPU）214へ入力する復号化回路212とマイコン214から得られる送信データを符号化して無線チップ202のロードスイッチング回路209へ入力する符号化回路213カードとしての情報を記憶するメモリを内蔵して送受信データの処理およびメモリとの間のデータの転送等を行うマイコン（CPU）214とを有し、上記無線チップ202の電源回路204から安定した電源205の供給を受けるCPU等（CPU+インタフェース）のチップ210とを備えている。

【0043】上記リーダまたは／およびライタユニット（装置）1では、コンデンサ104とアンテナ駆動インピーダンス120とR/Wアンテナコイル101とを用いて共振回路を構成しており、また上記近接無線カード（非接触カード：ICカード）2では、カードアンテナコイル201とコンデンサ221と抵抗220とを用いて共振回路を構成している。上記システムであっても、前記の実施例と同様にして、目標とする通信距離において該近接無線カード（非接触カード：ICカード）2での受信効率を最大とするように該アンテナ駆動インピーダンス120を設定し、かつ目標とする通信速度に対して十分な信号レベルを確保するための必要な帯域幅を得るようにこれら共振回路のそれぞれのQをそれぞれ設定することができる。

【0044】最後に、従来はリーダまたは／およびライタ装置のQと、近接無線カードのQとを別々に設計・設定していたので、非接触ICカードシステムの性能は両者の性能だけでなく両者の相性にも依存していたが、本発明を用いて非接触ICカードシステムの有するQを基準とした製品設計を行えば、その値から必要となるリーダまたは／およびライタ装置のQ、近接無線カードのQを一義的に決定・設定できるので（リーダまたは／およびライタ装置と、近接無線カードとの相性を設定できるので）、従来に比べて製品個々の性能のみを考慮した製品設計が可能となるといった効果もある。すなわち、非接触ICカードシステムの有するQを基準として、リーダまたは／およびライタ装置のQ、近接無線カードのQを割り振ることで、リーダまたは／およびライタ装置、近接無線カー

ドを標準化する上で非常に統一のとりやすい条件になるといった効果を有する。

【0045】

【発明の効果】以上説明したように、本発明によれば、リーダまたは／およびライタ装置と近接無線カード（ICカード）の共振回路に対して、該リーダまたは／およびライタ装置から該近接無線カード（ICカード）への電力伝送効率を最大とし、かつ目標とする通信速度に対して必要な帯域幅となるそれぞれのQを全く新規な方法により設定した非接触ICカードシステムを提供することができる。

【図面の簡単な説明】

【図1】本発明に係るリーダまたは／およびライタ装置と近接無線カード（ICカード）との間において電磁結合方式または電磁誘導方式等によって電力伝送および通信を行うことを示した概略構成斜視図である。

【図2】本発明に係るリーダまたは／およびライタ装置と近接無線カード（ICカード）との間において電磁結合方式または電磁誘導方式等によって電力伝送および通信を行う装置（システム）を等価回路に置き換えた基本概念図である。

【図3】本発明に係る電力伝送波とデータ通信変調波との関係を示す図である。

【図4】Qの原理を示した図である。

【図5】本発明に係るリーダまたは／およびライタ装置の共振回路のQと近接無線カード（ICカード）の共振回路のQと該リーダまたは／およびライタ装置と該近接

無線カード（ICカード）とで構成される伝送経路全体のQとの関係を示す図である。

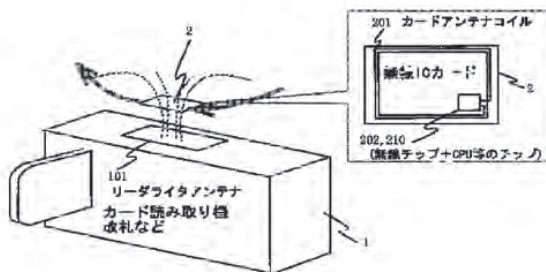
【図6】本発明に係るリーダまたは／およびライタ装置と近接無線カード（ICカード）の実施の形態における一実施例を示す図である。

【符号の説明】

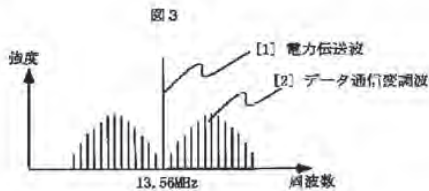
1…リーダ／ライタユニット、2…近接無線カード（ICカード：非接触カード）、101…リーダライタアンテナ、102…整合回路（給電回路）、104…コンデンサ、105…電源、107…符号化回路、108…変調器、109…送信アンプ、110…フィルタ回路、111…受信アンプ、112…復調器、113…復号化回路、115…ホストコンピュータ、120…アンテナ駆動インピーダンス、201…カードアンテナ、202…無線チップ、203…整合・整流回路、204…電源回路、206…クロック抽出回路、207…LPF回路、208…波形整形回路、209…ロードスイッチング回路、210…CPU等のチップ（CPU+インターフェースチップ）、211…分周回路、212…復号化回路、213…符号化回路、214…マイコン（CPU）、220…抵抗、221…コンデンサ、300…リーダ／ライタ、301…アンテナコイル、302…アンテナコイル同調容量、303…アンテナコイル駆動インピーダンス、304…OSC（発信器）、400…ICカード、401…アンテナコイル、402…アンテナコイル同調容量、403…カード負荷抵抗

【図1】

図1

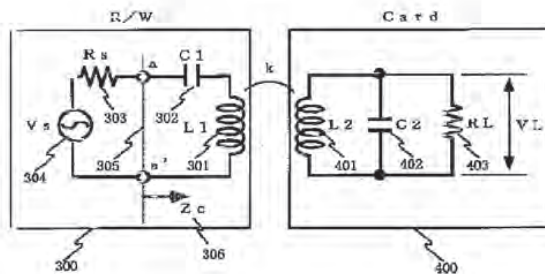


【図3】



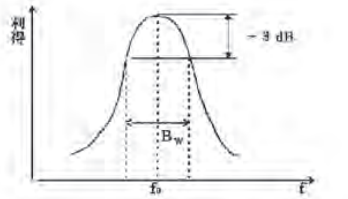
【図2】

図2



【 図 4 】

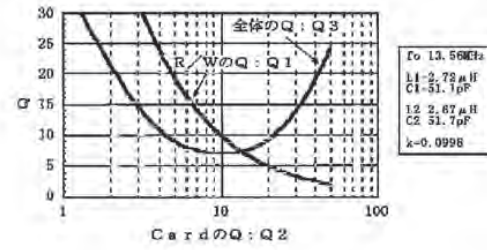
図 4



$Q = f_0 / B_w$
 f_0 : 中心周波数
 B_w : 帯域幅

【 図 5 】

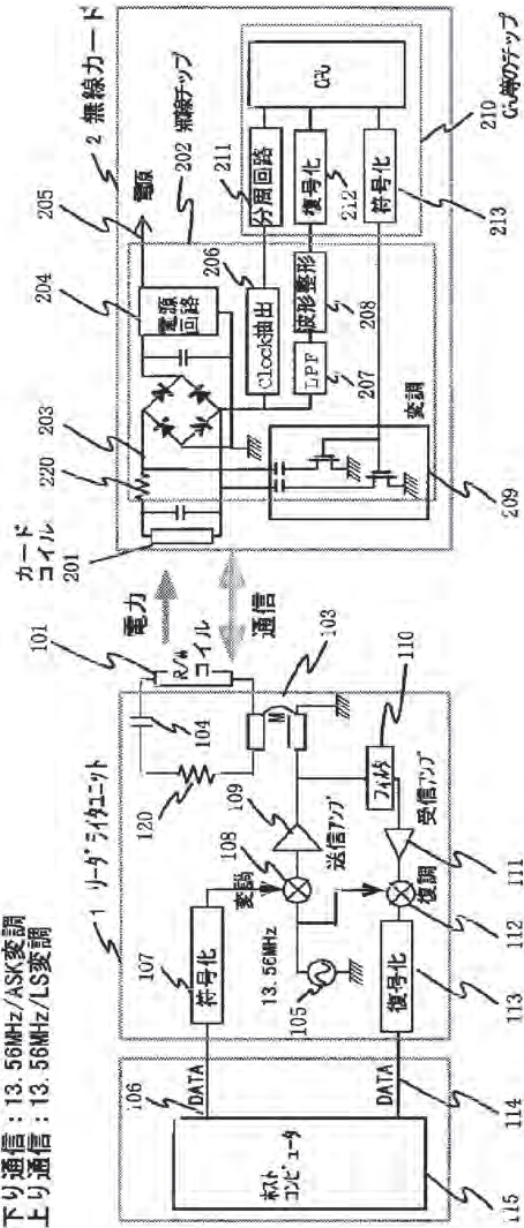
図 5



【図6】

図6

電力伝送周波数：13.56MHz
 下り通信：13.56MHz/ASK変調
 上り通信：13.56MHz/LS変調



フロントページの続き

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

[Claim(s)]

[Claim 1] Transmission of electric power or/and a signal is performed by non-contact between a reader or/and writer equipment, and an IC card, So that it may align with transfer-of-power frequency which transmits an antenna coil in which this reader or/and writer equipment, and this IC card transmit this electric power or/and this signal, respectively, and this electric power. By using Q of the whole communication path which is the non-contact IC card system provided with a resonant circuit which consists of capacity and drive impedance of this antenna coil which were set up, and consists of this reader or/and writer equipment, and this IC card, A non-contact IC card system setting up each Q of a resonant circuit which this reader or/and writer equipment have, and a resonant circuit which this IC card has.

[Claim 2] The non-contact IC card system according to claim 1 having set Q of a resonant circuit provided to the aforementioned IC card as the range of 3-42, and setting Q of a resonant circuit provided to the aforementioned reader or/and writer equipment as the range of 3-40.

[Claim 3] The non-contact IC card system according to claim 1 or 2 computing impedance with a resonant circuit which provided Q of the aforementioned whole communication path to a resonant circuit, the aforementioned reader, or/and writer equipment which were provided to the aforementioned IC card as it became substantially equal.

[Claim 4] It is a non-contact IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, From the characteristic of Q of the whole transmission route which set up substantially equally to impedance which expected this IC card antenna drive impedance of this reader or/and writer equipment, and drew it from an antenna of this reader or/and writer equipment, Q3 it becomes possible to obtain desired bandwidth to access speed of this signal is computed, By using a relation of Q2 of Q1 and this IC card of this Q3 computed and this reader, or/and writer equipment to this reader that serves as the maximum in transfer-of-power efficiency to this IC card or/and writer equipment, A non-contact IC card system setting each Q1 of a resonant circuit which this IC card has, and Q2 to this reader or/and writer equipment.

[Claim 5] It is a non-contact IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, A non-contact IC card system characterized by setting Q of each of this IC card to this reader or/and writer equipment by using Q of the whole communication path which consists of this reader or/and writer equipment, and this IC card.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]The present invention, for example A cash dispenser, electronic money, an automatic wicket system, The ATM card in a physical access control system, a public telephone machine, etc., a credit card, It is related with the non-contact IC card system which performs transfer of power for contiguity radio operation, and communication between noncontact IC cards, such as a ticket, a commuter pass, a coupon ticket, a management card, an ID card, a license, and a telephone card, a reader, or/and writer equipment.

[0002]

[Description of the Prior Art]Supplying electric power from a power supply side by non-contact to a contiguity wireless card (IC card) conventionally using light or a magnetic field is known.

[0003]For example, the ATM card used in the wicket and bus of a station, a gateway, etc., When a credit card, a ticket, a commuter pass, etc. are IC-card-ized and a user passes this IC card by non-contact to the reader/writer with which the wicket and bus of a station, the gateway, etc. were equipped, It is a non-contact IC card system (contiguity radio card system) which performs transfer of electric power or/and a signal with an electromagnetic coupling type or an electromagnetic induction type between reader/writer and a card, etc.

[0004]Generally, such a non-contact IC card system was designing reader/writer and an IC card separately, respectively to transmit a transfer-of-power wave and a data-communications modulated wave to the IC card side efficient from the reader/writer side.

[0005]Reader/writer and an IC card were designed in consideration of $Q (=f_0/BW)$, f_0 :center frequency, BW : bandwidth set to -3 dB from the gain which the center frequency f_0 has) specifically drawn from a frequency characteristic as shown in Fig.4.

[0006]

[Problem to be solved by the invention]However, when reader/writer transmits and receives by superimposing a data signal (data-communications modulated wave) on a transfer-of-power wave, it must be satisfied with a non-contact IC card system of the following conditions.

[0007](1) It must design to, make wide bandwidth BW which becomes more than a value with a gain if possible so that all data-communications modulated waves of all can be reliably received to the IC card side. That is, it must design so that Q may become small.

[0008](2) If possible, the gain of transfer-of-power frequency, for example, the above-mentioned center frequency, must be enlarged so that sufficient electric power for the IC card side can be supplied. In this case, generally, it must design so that Q may become largely. Only by enlarging the transfer-of-power wave only transmitted from the reader/writer side, Since a transfer-of-power wave uses an ISM band without laws and regulations, it is satisfactory, but it must take into consideration that it also becomes impossible for the superimposed data-communications modulated wave carried out to be satisfied with the transfer-of-power wave of a laws-and-regulations value in the frequency band (outside of an ISM band) to be used.

[0009]Thus, it becomes very difficult work that (1) or (2) condition determines Q of reader/writer which satisfies both on the other hand by it becoming conditions that making Q small enlarges Q on the other hand, and an IC card, respectively.

[0010]For example, if Q of the whole transmission route which makes high Q of the resonant circuit of each antenna section of reader/writer and an IC card, and comprises reader/writer and a card is set up highly, the reception induction electric power in a card will increase, but. It will be

the situation referred to as that the required bandwidth for securing sufficient signal level to the communication speed made into the target between reader/writer and a card is not obtained.
[0011]The present invention is made that the above-mentioned problem should be solved, and is a thing.

The purpose receives the resonant circuit of writer equipment and a contiguity wireless card (IC card). It is providing a completely new method of making transfer-of-power efficiency from this reader or/and writer equipment to this contiguity wireless card (IC card) into the maximum, and giving required bandwidth easily to a target communication speed.

[0012]

[Means for solving problem]Then, we decided to attain the above-mentioned purpose by assigning and designing Q of reader/writer and each IC card using Q of the whole non-contact IC card system.

[0013]Transmission of electric power or/and a signal is specifically performed by non-contact between a reader or/and writer equipment, and an IC card, So that it may align with the transfer-of-power frequency which transmits the antenna coil in which this reader or/and writer equipment, and this IC card transmit this electric power or/and this signal, respectively, and this electric power. By using Q of the whole communication path which is the noncontact type IC card system provided with the resonant circuit which consists of the capacity and the drive impedance of this antenna coil which were set up, and consists of this reader or/and writer equipment, and this IC card, Each Q of the resonant circuit which this reader or/and writer equipment have, and the resonant circuit which this IC card has is set up.

[0014]Or it is a noncontact type IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, From the characteristic of Q of the whole transmission route which set up substantially equally to the impedance which expected this IC card the antenna drive impedance of this reader or/and writer equipment, and drew it from the antenna of this reader or/and writer equipment, Q3 it becomes possible to obtain desired bandwidth to the access speed of this signal is computed, By using the relation of Q2 of Q1 and this IC card of this Q3 computed and this reader, or/and writer equipment to this reader that serves as the maximum in the transfer-of-power efficiency to this IC card or/and writer equipment, Each Q1 of the resonant circuit which this IC card has, and Q2 are set to this reader or/and writer equipment.

[0015]Or it is a non-contact IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, By using Q of the whole communication path which consists of this reader or/and writer equipment, and this IC card, Q of each of this IC card is set to this reader or/and writer equipment.

[0016]In the non-contact IC card system (contiguity radio card system) which consists of the reader or/and writer which perform transfer of electric power and a signal with an electromagnetic coupling type or an electromagnetic induction type by having such composition to the approaching IC card, and an IC card, Receiving efficiency in an IC card is made into the maximum in a target communication range, and since sufficient signal level is moreover secured to a target communication speed, required bandwidth can be obtained easily.

[0017]

[Mode for carrying out the invention]It describes using figures about the embodiment concerning the present invention.

[0018]Fig.1, As opposed to the non-contact card (contiguity wireless card: IC card) 2 which passes or approaches by non-contact from the reader with which the wicket, the bus, the gateway, and the predetermined place were equipped for example, it started the present invention, or/and the writer unit (equipment) 1. It is a figure showing the schematic structure of the transfer of power which electric power is transmitted with an electromagnetic coupling type or an electromagnetic induction type, and communicates, and a communication method. The non-contact card (contiguity wireless card: IC card) 2, By detaching the distance of an about [10 cm] and making it pass by non-contact to the reader or/and the writer unit 1 with which the user held and the wicket, the bus, and the gateway were equipped, with an electromagnetic coupling type or an electromagnetic induction type An ATM card, a credit card, a ticket, The information on a commuter pass etc. is transmitted and received and tasks, such as an ATM card, a credit card, a ticket, and a commuter pass, are carried out.

[0019]Fig.2 expresses the composition of the reader or/and the writer unit (equipment) 1 which are shown in Fig.1, and this non-contact card (contiguity wireless card: IC card) 2 by an equivalent circuit. In order to simplify the non-contact card (contiguity wireless card: IC card) 2, it constituted so that transfer of power and information might transmit and receive with the single antenna (reader/writer antenna) 101. Therefore, between the reader/writer antenna 101 provided by the reader or/and the writer unit 1 in Fig.2, and the card antenna coil 201 formed in the contiguity wireless card 2, Both transmission and reception of transmission of electric power and communication are performed using the electromagnetic waves (radio) which consist of the transfer-of-power wave and data-communications modulated wave which are shown in Fig.3. As Fig.3 shows, it is a frequency component which is different when the transfer-of-power wave and signal wave in an ASK modulation system are seen in a frequency domain, but if it sees by a segment of time, transfer-of-power wave amplitude will only change according to a signal speed. That is, by a segment of time, the modulated wave which multiplied the signal wave by the transfer-of-power wave is visible as the waveform amplitude of a transfer-of-power wave is only carrying out up-and-down change.

[0020]Now, the non-contact card system (contiguity radio card system) shown in Fig.2, OSC(oscillator) 304 oscillated on the frequency f_0 , and the antenna coil drive impedance 303 at the time of driving the antenna coil 301 by this OSC304, The reader/writer 300 which comprises the antenna coil tuning capacitance 302 set up to carry out series resonance to this antenna coil 301 on the frequency f_0 , It is constituted by IC card 400 which comprises the antenna coil tuning capacitance 402 set up to carry out parallel resonance to the antenna coil 401 on the frequency f_0 , and the card load resistance 403. And the antenna coil 301 of reader/writer and the antenna coil 401 of an IC card are combined with the antenna-coupler-control coefficient k by electromagnetic induction or inductive coupling. This antenna-coupler-control coefficient k changes according to the distance of the antenna coil 301 of reader/writer, and the antenna coil 401 of an IC card. Although the resonant circuit by the side of reader/writer is made into a series resonant circuit and the resonant circuit by the side of an IC card is used as the parallel resonant circuit here for the description, the combination of a resonant circuit can take not only this but various modes.

[0021]Here, if the approximate expression of Q of the whole non-contact IC card system consisting of above readers or/and the writer units (equipment) 1, and the non-contact card (contiguity wireless card: IC card) 2 is searched for, it will become like several 1.

[0022]

[Mathematical formula 1]

$$Q3 = \frac{1}{\left| \sqrt{\frac{\delta}{4 \cdot \varepsilon} + \frac{\lambda}{2} + \frac{\sqrt{\mu + \nu}}{2}} - \sqrt{\frac{\delta}{4 \cdot \varepsilon} + \frac{\lambda}{2} - \frac{\sqrt{\mu + \nu}}{2}} \right|} \quad (\text{数 } 1)$$

ただし

$$\nu = \frac{\frac{\delta^3}{\varepsilon^3} + \frac{4 \cdot \gamma \cdot \delta}{\varepsilon^3} + \frac{8 \cdot \beta}{\varepsilon}}{4 \sqrt{\lambda}}$$

$$\mu = \frac{\frac{\delta^2}{2 \cdot \varepsilon^2} + \frac{4 \cdot \gamma}{3 \cdot \varepsilon} - \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \varepsilon} - \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \varepsilon}}{1}$$

$$\lambda = \frac{\frac{\delta^2}{4 \cdot \varepsilon^2} + \frac{2 \cdot \gamma}{3 \cdot \varepsilon} + \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \varepsilon} + \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \varepsilon}}{1}$$

$$\kappa = \gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \varepsilon$$

$$\theta = \tau + \sqrt{-4 \cdot \zeta + \tau^2}$$

$$\tau = -2 \cdot \gamma^3 + 9 \cdot \beta \cdot \gamma \cdot \delta - 27 \cdot \alpha \cdot \delta^2 + 27 \cdot \beta^2 \cdot \varepsilon - 72 \cdot \alpha \cdot \gamma \cdot \varepsilon$$

$$\zeta = (\gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \varepsilon)^3$$

$$\varepsilon = Q2^2 \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2})^2$$

$$\delta = 2 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2}) - \{-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2)\}^2$$

$$\gamma = -(1 + 2 \cdot Q1 \cdot Q2)^2 \cdot (1 + Q2^2)^2 - 2 \cdot Q1 \cdot Q2^2 \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2 - \sqrt{1 + Q2^2}) - 2 \cdot (Q1 + Q2) \cdot (1 + Q2^2) \cdot \{-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2)\} + 2 \cdot \{2 + 4 \cdot Q2^2 + 2 \cdot Q2^4 + 2 \cdot \sqrt{1 + Q2^2} \cdot (Q2 + Q2^3)\}$$

$$\beta = -(Q1 + Q2)^2 \cdot (1 + Q2^2)^2 + 2 \cdot Q1 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2)^2$$

$$\alpha = -Q1^2 \cdot Q2^2 \cdot (1 + Q2^2)^2$$

[0023] This is the result of asking from the circuit equation based on the equivalent circuit shown in Fig.2, and calculates Q3 of the whole non-contact IC card system by the relation of Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit. Although an equivalent circuit and the several 1 contents naturally change with composition of a reader or/and the writer unit (equipment) 1, and the non-contact card (contiguity wireless card: IC card) 2, What is necessary is just to calculate Q3 of the whole non-contact IC card system by the relation of Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit, even if it is which case.

[0024] Next, Q3 of the whole non-contact IC card system as shown in several 1. The method (assignment of Q1 and Q2) of determining Q2 of Q1 and the noncontact IC card of a reader

or/and a writer unit using the relation expressed with Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit is described using Fig.5.

[0025]Fig.5 is the result of carrying out a simulation using several 1 about the relation between Q (Q2) of this IC card 4, this reader/writer 3, and Q (Q3) of the whole transmission route which comprises this IC card 4, and the relation between Q (Q2) of this IC card 4, and Q (Q1) of this reader/writer 3. In this case, the simulation of several 2 is carried out by substituting for several 1.

[0026]

[Mathematical formula 2]

$$Q1 = \frac{1}{k^2 \cdot \sqrt{1+Q2^2}} \quad (\text{数 } 2)$$

[0027]Several two so that the receiving efficiency of the IC card in a target communication range may serve as the maximum in the circuit shown in Fig.2. It leads by making it equal to impedance Zc306 which looked at IC card 4 from terminal a-a'305 of the reader/writer in the communication range aiming at the antenna drive impedance 303 of reader/writer, and taking impedance matching.

[0028]In Fig.5, a turn number [T] sets a periphery to 100[mm] x 100 [mm] for the antenna coil 301 of the reader/writer 3 with the spiral shape of 3, A turn number [T] sets a periphery to 77[mm] x 42 [mm] for the antenna coil 401 of IC card 4 with the spiral shape of 4, and the simulation of the distance d= 30 of this IC card 4 [mm] (the value of the coupling coefficient k is k= 0.0998 at this time) is carried out to this reader/writer 3.

[0029]Q3 of the whole transmission route can be set to the bandwidth which is needed with the non-contact IC card system at a target communication speed to such a simulation result from the transfer-of-power frequency to be used. And Q1Q2 can be uniquely set up using the function shown in Fig.5 from Q3 set up.

[0030]For example, when Q3 which is Q of the whole transmission route is made or less into ten from required bandwidth to a target communication speed, Q of this reader/writer 3 is Q1=4.5-22.2, and it turns out that Q of this IC card 4 should just set to Q2=4.4 - 22.0.

[0031]Since it is the result of carrying out a simulation in Fig.5 using an expression of relations (several 2) in case transfer of power serves as the maximum like the above-mentioned, Q1 set up and Q2 become the value that transfer of power serves as the maximum. namely, the reader/writer 3 which receiving efficiency in IC card 4 is made into the maximum, and can moreover obtain sufficient bandwidth to a target communication speed and IC card 4 -- Q of each resonant circuit can be set up.

[0032]If L1, L2, Rs, RL, etc. are drawn from each Q set up in this way, for example using several 3, several 4, etc., Receiving efficiency in IC card 4 can be made into the maximum, and the reader/writer 3 and IC card 4 which can moreover obtain sufficient bandwidth to a target communication speed can be constituted.

[0033]

[Mathematical formula 3]

$$Rs = k^2 \cdot 2 \cdot \pi \cdot f_0 \cdot L1 \cdot \sqrt{1+Q2^2} \quad (\text{数 } 3)$$

[0034]

[Mathematical formula 4]

$$Q2 = \frac{RL}{2 \cdot \pi \cdot f_0 \cdot L2} \quad (\text{数 } 4)$$

[0035]It cannot be overemphasized that several 2 - the component C1 of a four number or others, C2, etc. are computable from the circuit equation based on the equivalent circuit shown in Fig.2.
[0036]On the other hand in an above-mentioned description, a turn number [T] sets a periphery to 100[mm] x100 [mm] for the antenna coil 301 of the reader/writer 3 with the spiral shape of 3, Although the turn number [T] set the periphery to 77[mm] x42 [mm] for the antenna coil 401 of IC card 4 with the spiral shape of 4 and the case where Q3 which is Q of the whole transmission route in $d=30$ [mm] about the distance of this reader/writer 3 and this IC card 4 was made or less into ten was described, The present invention can apply the thing of not only this but various forms.

[0037]For example, when Q of the whole transmission route is made or less into 20 for a target communication range at 5 cm or less using the above-mentioned reader/writer and the antenna of an IC card, the ranges of Q of this reader/writer 3 are $Q1=3 - 40$, and Q of this IC card 4 should just set up a value in $Q2=3 - 42$. Even if it is a case where reader/writer and the antenna form of an IC card are changed, the present invention is applicable using Q of the coupling coefficient k between antennas, and the whole transmission route, or/and the ratio of communication band width and the carrier frequency of this signal transmission.

[0038]The conditions by making efficiency of transfer of power into the maximum: Instead of a two number, the relation of known Q1 and Q2 may be used, and the simulation of a relation like Fig.5 may be carried out.

[0039]Although Q3 which is Q of the whole transmission route which comprises the reader/writer 3 and IC card 4 is used, the ratio of communication band width and the carrier frequency of this signal transmission may be used as Q3.

[0040]Next, between the reader or/and the writer unit (equipment) 1 concerning the present invention, and the non-contact card (contiguity wireless card: IC card) 2. It describes about the example which applied the present invention to the 1 embodiment of equipment (system) which sets and performs transmission and reception (communication) of transfer of power and information with an electromagnetic coupling type or an electromagnetic induction type.

[0041]OSC(oscillator) 105 in which Fig.6 generates voltage with a high frequency of 13.56 MHz, The coding circuit 107 which codes send data (DATA)106 into which it input for transmitting to the contiguity wireless card 2, The modulation circuit 108 which modulates voltage with a high frequency of 13.56 MHz generated from the above-mentioned OSC105 according to the output signal of the above-mentioned coding circuit 107, The antenna coil drive circuit 109 which drives an antenna coil according to the output signal of this modulation circuit, The signal amplified in this antenna coil drive circuit is combined by the inductance combination 103, The matching circuit (feeder circuit) 102 for having the capacitor 104 and the antenna drive impedance 120, and making impedance match, Electromagnetic waves are generated in order to perform transmission of electric power, and transmission of data according to the output of this matching circuit 102, The R/W antenna coil 101 which receives the data transmitted by electromagnetic waves from the card antenna coil 201 of the contiguity wireless card 2, The filter circuit 110 which removes a noise component from the signal which was made to adjust the signal received with this R/W antenna coil 101 in the matching circuit 102, and was produced by the inductance combination 103, The receiving amplifier 111 which amplifies the signal acquired through this filter circuit 110, It has the demodulator circuit 112 which restores to the signal amplified with this receiving amplifier 111, and the decoding circuit 113 which decrypts the signal to which it restored in this demodulator circuit 112, and is outputted as received-data

(DATA)114. And the send data 106 and the received data 114 are connected to the host computer 115 via the network.

[0042]In the contiguity wireless card (non-contact card: IC card) 2, The card antenna coil 201 which receives the electromagnetic waves generated in order to perform transmission of electric power, and transmission of data from the R/W antenna coil 101 of the R/W unit 1, and generates the electromagnetic waves according to the send data by which Rhodes itching modulation was carried out, About the 13.56-MHz electric power received with this card antenna coil 201, a ready sink, From the induced voltage rectified from the consistency / rectification circuit 203 which is made to match impedance using the capacitor 221 and the resistance 220, and is adjusted about transmission and reception signals, and this the consistency/rectification circuit 203, at about 5 mW as the about [2-5V] fixed direct-current-voltage power supply 205. The input signal acquired from the power supply circuit 204 to supply, the clock extraction circuit 206 which extracts a clock from the input signal acquired from above-mentioned consistency / rectification circuit 203, the LPF circuit 207 which removes a noise component from the input signal acquired from above-mentioned consistency / rectification circuit 203, and this LPF circuit 207. The wireless chip 202 which has a Rhodes itching modulation circuit which carries out Rhodes itching modulation of the waveform shaping circuit 208 and sending signal which shape in waveform, gives and adjusts in above-mentioned consistency / rectification circuit 203, and is supplied to the card antenna coil 201, Dividing is carried out based on the clock signal extracted in the clock extraction circuit 206 of this radio chip 202. The signal acquired from the frequency divider 211 which generates the signal which uses the microcomputer 214, and the waveform shaping circuit 208 of the wireless chip 202 is decrypted. The decoding circuit 212 input into the microcomputer (CPU) 214 as decoding data (received data) and the send data obtained from the microcomputer 214 are coded. It has the microcomputer (CPU) 214 which contains the memory which memorizes the information as coding circuit 213 card input into the Rhodes itching circuit 209 of the wireless chip 202, and performs processing of transmitted and received data, transmission of the data between memories, etc., It has the chips 210, such as CPU (CPU+ interface) which receives supply of the power supply 205 stable from the power supply circuit 204 of the above-mentioned radio chip 202.

[0043]In the above-mentioned reader or/and the writer unit (equipment) 1, The resonant circuit is constituted using the capacitor 104, the antenna drive impedance 120, and the R/W antenna coil 101, The resonant circuit consists of the above-mentioned contiguity wireless cards (non-contact card: IC card) 2 using the card antenna coil 201, the capacitor 221, and the resistance 220. Even if it is the above-mentioned system, this antenna drive impedance 120 is set up like the aforementioned working example to make receiving efficiency in this contiguity wireless card (non-contact card: IC card) 2 into the maximum in a target communication range, And each Q of these resonant circuits can be set up, respectively to obtain the required bandwidth for securing sufficient signal level to a target communication speed.

[0044]Finally, since Q of a reader or/and writer equipment and Q of the contiguity wireless card were designed and set up independently conventionally, depended for the performance of the non-contact IC card system not only on both performance but on both affinity, but. If the product design on the basis of Q which a non-contact IC card system has using the present invention is performed, Since Q of the reader or/and writer equipment which are needed from the value, and Q of a contiguity wireless card can be determined and set up uniquely (with a reader or/and writer equipment) Since affinity with a contiguity wireless card can be set up, it is effective in the product design which took only the performance of product each into consideration

compared with the former becoming possible. That is, by assigning Q of a reader or/and writer equipment, and Q of a contiguity wireless card on the basis of Q which a non-contact IC card system has, when standardizing a reader or/and writer equipment, and a contiguity wireless card, it has the effect of becoming the conditions unification is very apt to take.

[0045]

[Effect of the Invention]As described above, according to the present invention, the resonant circuit of a reader or/and writer equipment, and a contiguity wireless card (IC card) is received, The non-contact IC card system which set up each Q which makes the maximum transfer-of-power efficiency from this reader or/and writer equipment to this contiguity wireless card (IC card), and becomes required bandwidth to a target communication speed by the completely new method can be provided.

TECHNICAL FIELD

[Field of the Invention]The present invention, for example A cash dispenser, electronic money, an automatic wicket system, The ATM card in a physical access control system, a public telephone machine, etc., a credit card, It is related with the non-contact IC card system which performs transfer of power for contiguity radio operation, and communication between noncontact IC cards, such as a ticket, a commuter pass, a coupon ticket, a management card, an ID card, a license, and a telephone card, a reader, or/and writer equipment.

PRIOR ART

[Description of the Prior Art]Supplying electric power from a power supply side by non-contact to a contiguity wireless card (IC card) conventionally using light or a magnetic field is known.

[0003]For example, the ATM card used in the wicket and bus of a station, a gateway, etc., When a credit card, a ticket, a commuter pass, etc. are IC-card-ized and a user passes this IC card by non-contact to the reader/writer with which the wicket and bus of a station, the gateway, etc. were equipped, It is a non-contact IC card system (contiguity radio card system) which performs transfer of electric power or/and a signal with an electromagnetic coupling type or an electromagnetic induction type between reader/writer and a card, etc.

[0004]Generally, such a non-contact IC card system was designing reader/writer and an IC card separately, respectively to transmit a transfer-of-power wave and a data-communications modulated wave to the IC card side efficient from the reader/writer side.

[0005]Reader/writer and an IC card were designed in consideration of $Q (=f_0/BW)$, f_0 :center frequency, BW: bandwidth set to -3 dB from the gain which the center frequency f_0 has) specifically drawn from a frequency characteristic as shown in Fig.4.

EFFECT OF THE INVENTION

[Effect of the Invention]As described above, according to the present invention, the resonant circuit of a reader or/and writer equipment, and a contiguity wireless card (IC card) is received, The non-contact IC card system which set up each Q which makes the maximum transfer-of-power efficiency from this reader or/and writer equipment to this contiguity wireless card (IC card), and becomes required bandwidth to a target communication speed by the completely new method can be provided.

TECHNICAL PROBLEM

[Problem to be solved by the invention]However, when reader/writer transmits and receives by superimposing a data signal (data-communications modulated wave) on a transfer-of-power wave, it must be satisfied with a non-contact IC card system of the following conditions.

[0007](1) It must design to, make wide bandwidth BW which becomes more than a value with a gain if possible so that all data-communications modulated waves of all can be reliably received to the IC card side. That is, it must design so that Q may become small.

[0008](2) If possible, the gain of transfer-of-power frequency, for example, the above-mentioned center frequency, must be enlarged so that sufficient electric power for the IC card side can be supplied. In this case, generally, it must design so that Q may become largely. Only by enlarging the transfer-of-power wave only transmitted from the reader/writer side, Since a transfer-of-power wave uses an ISM band without laws and regulations, it is satisfactory, but it must take into consideration that it also becomes impossible for the superimposed data-communications modulated wave carried out to be satisfied with the transfer-of-power wave of a laws-and-regulations value in the frequency band (outside of an ISM band) to be used.

[0009]Thus, it becomes very difficult work that (1) or (2) condition determines Q of reader/writer which satisfies both on the other hand by it becoming conditions that making Q small enlarges Q on the other hand, and an IC card, respectively.

[0010]For example, if Q of the whole transmission route which makes high Q of the resonant circuit of each antenna section of reader/writer and an IC card, and comprises reader/writer and a card is set up highly, the reception induction electric power in a card will increase, but. It will be the situation referred to as that the required bandwidth for securing sufficient signal level to the communication speed made into the target between reader/writer and a card is not obtained.

[0011]The present invention is made that the above-mentioned problem should be solved, and is a thing.

The purpose receives the resonant circuit of writer equipment and a contiguity wireless card (IC card). It is providing a completely new method of making transfer-of-power efficiency from this reader or/and writer equipment to this contiguity wireless card (IC card) into the maximum, and giving required bandwidth easily to a target communication speed.

MEANS

[Means for solving problem]Then, we decided to attain the above-mentioned purpose by assigning and designing Q of reader/writer and each IC card using Q of the whole non-contact IC card system.

[0013]Transmission of electric power or/and a signal is specifically performed by non-contact between a reader or/and writer equipment, and an IC card, So that it may align with the transfer-of-power frequency which transmits the antenna coil in which this reader or/and writer equipment, and this IC card transmit this electric power or/and this signal, respectively, and this electric power. By using Q of the whole communication path which is the noncontact type IC card system provided with the resonant circuit which consists of the capacity and the drive impedance of this antenna coil which were set up, and consists of this reader or/and writer equipment, and this IC card, Each Q of the resonant circuit which this reader or/and writer equipment have, and the resonant circuit which this IC card has is set up.

[0014]Or it is a noncontact type IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, From the characteristic of Q of the whole transmission route which set up substantially equally to the impedance which expected this IC card the antenna drive impedance of this reader or/and writer

equipment, and drew it from the antenna of this reader or/and writer equipment, Q3 it becomes possible to obtain desired bandwidth to the access speed of this signal is computed, By using the relation of Q2 of Q1 and this IC card of this Q3 computed and this reader, or/and writer equipment to this reader that serves as the maximum in the transfer-of-power efficiency to this IC card or/and writer equipment, Each Q1 of the resonant circuit which this IC card has, and Q2 are set to this reader or/and writer equipment.

[0015]Or it is a non-contact IC card system which performs transmission of electric power or/and a signal by non-contact between a reader or/and writer equipment, and an IC card, By using Q of the whole communication path which consists of this reader or/and writer equipment, and this IC card, Q of each of this IC card is set to this reader or/and writer equipment.

[0016]In the non-contact IC card system (contiguity radio card system) which consists of the reader or/and writer which perform transfer of electric power and a signal with an electromagnetic coupling type or an electromagnetic induction type by having such composition to the approaching IC card, and an IC card, Receiving efficiency in an IC card is made into the maximum in a target communication range, and since sufficient signal level is moreover secured to a target communication speed, required bandwidth can be obtained easily.

[0017]

[Mode for carrying out the invention]It describes using figures about the embodiment concerning the present invention.

[0018]Fig.1, As opposed to the non-contact card (contiguity wireless card: IC card) 2 which passes or approaches by non-contact from the reader with which the wicket, the bus, the gateway, and the predetermined place were equipped for example, it started the present invention, or/and the writer unit (equipment) 1. It is a figure showing the schematic structure of the transfer of power which electric power is transmitted with an electromagnetic coupling type or an electromagnetic induction type, and communicates, and a communication method. The non-contact card (contiguity wireless card: IC card) 2, By detaching the distance of an about [10 cm] and making it pass by non-contact to the reader or/and the writer unit 1 with which the user held and the wicket, the bus, and the gateway were equipped, with an electromagnetic coupling type or an electromagnetic induction type An ATM card, a credit card, a ticket, The information on a commuter pass etc. is transmitted and received and tasks, such as an ATM card, a credit card, a ticket, and a commuter pass, are carried out.

[0019]Fig.2 expresses the composition of the reader or/and the writer unit (equipment) 1 which are shown in Fig.1, and this non-contact card (contiguity wireless card: IC card) 2 by an equivalent circuit. In order to simplify the non-contact card (contiguity wireless card: IC card) 2, it constituted so that transfer of power and information might transmit and receive with the single antenna (reader/writer antenna) 101. Therefore, between the reader/writer antenna 101 provided by the reader or/and the writer unit 1 in Fig.2, and the card antenna coil 201 formed in the contiguity wireless card 2, Both transmission and reception of transmission of electric power and communication are performed using the electromagnetic waves (radio) which consist of the transfer-of-power wave and data-communications modulated wave which are shown in Fig.3. As Fig.3 shows, it is a frequency component which is different when the transfer-of-power wave and signal wave in an ASK modulation system are seen in a frequency domain, but if it sees by a segment of time, transfer-of-power wave amplitude will only change according to a signal speed. That is, by a segment of time, the modulated wave which multiplied the signal wave by the transfer-of-power wave is visible as the waveform amplitude of a transfer-of-power wave is only carrying out up-and-down change.

[0020]Now, the non-contact card system (contiguity radio card system) shown in Fig.2, OSC(oscillator) 304 oscillated on the frequency f_0 , and the antenna coil drive impedance 303 at the time of driving the antenna coil 301 by this OSC304, The reader/writer 300 which comprises the antenna coil tuning capacitance 302 set up to carry out series resonance to this antenna coil 301 on the frequency f_0 , It is constituted by IC card 400 which comprises the antenna coil tuning capacitance 402 set up to carry out parallel resonance to the antenna coil 401 on the frequency f_0 , and the card load resistance 403. And the antenna coil 301 of reader/writer and the antenna coil 401 of an IC card are combined with the antenna-coupler-control coefficient k by electromagnetic induction or inductive coupling. This this antenna-coupler-control coefficient k changes according to the distance of the antenna coil 301 of reader/writer, and the antenna coil 401 of an IC card. Although the resonant circuit by the side of reader/writer is made into a series resonant circuit and the resonant circuit by the side of an IC card is used as the parallel resonant circuit here for the description, the combination of a resonant circuit can take not only this but various modes.

[0021]Here, if the approximate expression of Q of the whole non-contact IC card system consisting of above readers or/and the writer units (equipment) 1, and the non-contact card (contiguity wireless card: IC card) 2 is searched for, it will become like several 1.

[0022]

[Mathematical formula 1]

$$Q3 = \frac{1}{\left| \sqrt{\frac{\delta}{4 \cdot \varepsilon} + \frac{\lambda}{2} + \frac{\sqrt{\mu + \nu}}{2}} - \sqrt{\frac{\delta}{4 \cdot \varepsilon} + \frac{\lambda}{2} - \frac{\sqrt{\mu + \nu}}{2}} \right|} \quad (\text{数 } 1)$$

ただし

$$\nu = \frac{\frac{\delta^3}{\varepsilon^3} + \frac{4 \cdot \gamma \cdot \delta}{\varepsilon^3} + \frac{8 \cdot \beta}{\varepsilon}}{4 \sqrt{\lambda}}$$

$$\mu = \frac{\frac{\delta^2}{2 \cdot \varepsilon^2} + \frac{4 \cdot \gamma}{3 \cdot \varepsilon} - \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \varepsilon} - \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \varepsilon}}$$

$$\lambda = \frac{\frac{\delta^2}{4 \cdot \varepsilon^2} + \frac{2 \cdot \gamma}{3 \cdot \varepsilon} + \frac{\theta^{1/3}}{3 \cdot 2^{1/3} \cdot \varepsilon} + \frac{2^{1/3} \cdot \kappa}{3 \cdot \theta^{1/3} \cdot \varepsilon}}$$

$$\kappa = \gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \varepsilon$$

$$\theta = \tau + \sqrt{-4 \cdot \zeta + \tau^2}$$

$$\tau = -2 \cdot \gamma^3 + 9 \cdot \beta \cdot \gamma \cdot \delta - 27 \cdot \alpha \cdot \delta^2 + 27 \cdot \beta^2 \cdot \varepsilon - 72 \cdot \alpha \cdot \gamma \cdot \varepsilon$$

$$\zeta = (\gamma^2 - 3 \cdot \beta \cdot \delta - 12 \cdot \alpha \cdot \varepsilon)^3$$

$$\varepsilon = Q2^2 \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2})^2$$

$$\delta = 2 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2^2 - \sqrt{1 + Q2^2}) - \{-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2)\}^2$$

$$\gamma = -(1 + 2 \cdot Q1 \cdot Q2)^2 \cdot (1 + Q2^2)^2 - 2 \cdot Q1 \cdot Q2^2 \cdot (1 + Q2^2) \cdot (Q1 + Q1 \cdot Q2 - \sqrt{1 + Q2^2}) - 2 \cdot (Q1 + Q2) \cdot (1 + Q2^2) \cdot \{-Q2 - Q2^3 + \sqrt{1 + Q2^2} - Q1 \cdot (1 + Q2^2)\} + 2 \cdot \{2 + 4 \cdot Q2^2 + 2 \cdot Q2^4 + 2 \cdot \sqrt{1 + Q2^2} \cdot (Q2 + Q2^3)\}$$

$$\beta = -(Q1 + Q2)^2 \cdot (1 + Q2^2)^2 + 2 \cdot Q1 \cdot Q2 \cdot (1 + 2 \cdot Q1 \cdot Q2) \cdot (1 + Q2^2)^2$$

$$\alpha = -Q1^2 \cdot Q2^2 \cdot (1 + Q2^2)^2$$

[0023] This is the result of asking from the circuit equation based on the equivalent circuit shown in Fig.2, and calculates Q3 of the whole non-contact IC card system by the relation of Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit. Although an equivalent circuit and the several 1 contents naturally change with composition of a reader or/and the writer unit (equipment) 1, and the non-contact card (contiguity wireless card: IC card) 2, What is necessary is just to calculate Q3 of the whole non-contact IC card system by the relation of Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit, even if it is which case.

[0024] Next, Q3 of the whole non-contact IC card system as shown in several 1. The method (assignment of Q1 and Q2) of determining Q2 of Q1 and the noncontact IC card of a reader

or/and a writer unit using the relation expressed with Q2 of Q1 and the noncontact IC card of a reader or/and a writer unit is described using Fig.5.

[0025]Fig.5 is the result of carrying out a simulation using several 1 about the relation between Q (Q2) of this IC card 4, this reader/writer 3, and Q (Q3) of the whole transmission route which comprises this IC card 4, and the relation between Q (Q2) of this IC card 4, and Q (Q1) of this reader/writer 3. In this case, the simulation of several 2 is carried out by substituting for several 1.

[0026]

[Mathematical formula 2]

$$Q1 = \frac{1}{k^2 \cdot \sqrt{1+Q2^2}} \quad (\text{数 } 2)$$

[0027]Several two so that the receiving efficiency of the IC card in a target communication range may serve as the maximum in the circuit shown in Fig.2. It leads by making it equal to impedance Zc306 which looked at IC card 4 from terminal a-a'305 of the reader/writer in the communication range aiming at the antenna drive impedance 303 of reader/writer, and taking impedance matching.

[0028]In Fig.5, a turn number [T] sets a periphery to 100[mm] x 100 [mm] for the antenna coil 301 of the reader/writer 3 with the spiral shape of 3, A turn number [T] sets a periphery to 77[mm] x 42 [mm] for the antenna coil 401 of IC card 4 with the spiral shape of 4, and the simulation of the distance d= 30 of this IC card 4 [mm] (the value of the coupling coefficient k is k= 0.0998 at this time) is carried out to this reader/writer 3.

[0029]Q3 of the whole transmission route can be set to the bandwidth which is needed with the non-contact IC card system at a target communication speed to such a simulation result from the transfer-of-power frequency to be used. And Q1Q2 can be uniquely set up using the function shown in Fig.5 from Q3 set up.

[0030]For example, when Q3 which is Q of the whole transmission route is made or less into ten from required bandwidth to a target communication speed, Q of this reader/writer 3 is Q1=4.5-22.2, and it turns out that Q of this IC card 4 should just set to Q2=4.4 - 22.0.

[0031]Since it is the result of carrying out a simulation in Fig.5 using an expression of relations (several 2) in case transfer of power serves as the maximum like the above-mentioned, Q1 set up and Q2 become the value that transfer of power serves as the maximum. namely, the reader/writer 3 which receiving efficiency in IC card 4 is made into the maximum, and can moreover obtain sufficient bandwidth to a target communication speed and IC card 4 -- Q of each resonant circuit can be set up.

[0032]If L1, L2, Rs, RL, etc. are drawn from each Q set up in this way, for example using several 3, several 4, etc., Receiving efficiency in IC card 4 can be made into the maximum, and the reader/writer 3 and IC card 4 which can moreover obtain sufficient bandwidth to a target communication speed can be constituted.

[0033]

[Mathematical formula 3]

$$Rs = k^2 \cdot 2 \cdot \pi \cdot f_0 \cdot L1 \cdot \sqrt{1+Q2^2} \quad (\text{数 } 3)$$

[0034]

[Mathematical formula 4]

$$Q2 = \frac{RL}{2 \cdot \pi \cdot f_0 \cdot L2} \quad (\text{数 } 4)$$

[0035]It cannot be overemphasized that several 2 - the component C1 of a four number or others, C2, etc. are computable from the circuit equation based on the equivalent circuit shown in Fig.2.
[0036]On the other hand in an above-mentioned description, a turn number [T] sets a periphery to 100[mm] x100 [mm] for the antenna coil 301 of the reader/writer 3 with the spiral shape of 3, Although the turn number [T] set the periphery to 77[mm] x42 [mm] for the antenna coil 401 of IC card 4 with the spiral shape of 4 and the case where Q3 which is Q of the whole transmission route in $d=30$ [mm] about the distance of this reader/writer 3 and this IC card 4 was made or less into ten was described, The present invention can apply the thing of not only this but various forms.

[0037]For example, when Q of the whole transmission route is made or less into 20 for a target communication range at 5 cm or less using the above-mentioned reader/writer and the antenna of an IC card, the ranges of Q of this reader/writer 3 are $Q1=3 - 40$, and Q of this IC card 4 should just set up a value in $Q2=3 - 42$. Even if it is a case where reader/writer and the antenna form of an IC card are changed, the present invention is applicable using Q of the coupling coefficient k between antennas, and the whole transmission route, or/and the ratio of communication band width and the carrier frequency of this signal transmission.

[0038]The conditions by making efficiency of transfer of power into the maximum: Instead of a two number, the relation of known Q1 and Q2 may be used, and the simulation of a relation like Fig.5 may be carried out.

[0039]Although Q3 which is Q of the whole transmission route which comprises the reader/writer 3 and IC card 4 is used, the ratio of communication band width and the carrier frequency of this signal transmission may be used as Q3.

[0040]Next, between the reader or/and the writer unit (equipment) 1 concerning the present invention, and the non-contact card (contiguity wireless card: IC card) 2. It describes about the example which applied the present invention to the 1 embodiment of equipment (system) which sets and performs transmission and reception (communication) of transfer of power and information with an electromagnetic coupling type or an electromagnetic induction type.

[0041]OSC(oscillator) 105 in which Fig.6 generates voltage with a high frequency of 13.56 MHz, The coding circuit 107 which codes send data (DATA)106 into which it input for transmitting to the contiguity wireless card 2, The modulation circuit 108 which modulates voltage with a high frequency of 13.56 MHz generated from the above-mentioned OSC105 according to the output signal of the above-mentioned coding circuit 107, The antenna coil drive circuit 109 which drives an antenna coil according to the output signal of this modulation circuit, The signal amplified in this antenna coil drive circuit is combined by the inductance combination 103, The matching circuit (feeder circuit) 102 for having the capacitor 104 and the antenna drive impedance 120, and making impedance match, Electromagnetic waves are generated in order to perform transmission of electric power, and transmission of data according to the output of this matching circuit 102, The R/W antenna coil 101 which receives the data transmitted by electromagnetic waves from the card antenna coil 201 of the contiguity wireless card 2, The filter circuit 110 which removes a noise component from the signal which was made to adjust the signal received with this R/W antenna coil 101 in the matching circuit 102, and was produced by the inductance combination 103, The receiving amplifier 111 which amplifies the signal acquired through this filter circuit 110, It has the demodulator circuit 112 which restores to the signal amplified with this receiving amplifier 111, and the decoding circuit 113 which decrypts the signal to which it restored in this demodulator circuit 112, and is outputted as received-data

(DATA)114. And the send data 106 and the received data 114 are connected to the host computer 115 via the network.

[0042]In the contiguity wireless card (non-contact card: IC card) 2, The card antenna coil 201 which receives the electromagnetic waves generated in order to perform transmission of electric power, and transmission of data from the R/W antenna coil 101 of the R/W unit 1, and generates the electromagnetic waves according to the send data by which Rhodes itching modulation was carried out, About the 13.56-MHz electric power received with this card antenna coil 201, a ready sink, From the induced voltage rectified from the consistency / rectification circuit 203 which is made to match impedance using the capacitor 221 and the resistance 220, and is adjusted about transmission and reception signals, and this the consistency/rectification circuit 203, at about 5 mW as the about [2-5V] fixed direct-current-voltage power supply 205. The input signal acquired from the power supply circuit 204 to supply, the clock extraction circuit 206 which extracts a clock from the input signal acquired from above-mentioned consistency / rectification circuit 203, the LPF circuit 207 which removes a noise component from the input signal acquired from above-mentioned consistency / rectification circuit 203, and this LPF circuit 207. The wireless chip 202 which has a Rhodes itching modulation circuit which carries out Rhodes itching modulation of the waveform shaping circuit 208 and sending signal which shape in waveform, gives and adjusts in above-mentioned consistency / rectification circuit 203, and is supplied to the card antenna coil 201, Dividing is carried out based on the clock signal extracted in the clock extraction circuit 206 of this radio chip 202. The signal acquired from the frequency divider 211 which generates the signal which uses the microcomputer 214, and the waveform shaping circuit 208 of the wireless chip 202 is decrypted. The decoding circuit 212 input into the microcomputer (CPU) 214 as decoding data (received data) and the send data obtained from the microcomputer 214 are coded. It has the microcomputer (CPU) 214 which contains the memory which memorizes the information as coding circuit 213 card input into the Rhodes itching circuit 209 of the wireless chip 202, and performs processing of transmitted and received data, transmission of the data between memories, etc., It has the chips 210, such as CPU (CPU+ interface) which receives supply of the power supply 205 stable from the power supply circuit 204 of the above-mentioned radio chip 202.

[0043]In the above-mentioned reader or/and the writer unit (equipment) 1, The resonant circuit is constituted using the capacitor 104, the antenna drive impedance 120, and the R/W antenna coil 101, The resonant circuit consists of the above-mentioned contiguity wireless cards (non-contact card: IC card) 2 using the card antenna coil 201, the capacitor 221, and the resistance 220. Even if it is the above-mentioned system, this antenna drive impedance 120 is set up like the aforementioned working example to make receiving efficiency in this contiguity wireless card (non-contact card: IC card) 2 into the maximum in a target communication range, And each Q of these resonant circuits can be set up, respectively to obtain the required bandwidth for securing sufficient signal level to a target communication speed.

[0044]Finally, since Q of a reader or/and writer equipment and Q of the contiguity wireless card were designed and set up independently conventionally, depended for the performance of the non-contact IC card system not only on both performance but on both affinity, but. If the product design on the basis of Q which a non-contact IC card system has using the present invention is performed, Since Q of the reader or/and writer equipment which are needed from the value, and Q of a contiguity wireless card can be determined and set up uniquely (with a reader or/and writer equipment) Since affinity with a contiguity wireless card can be set up, it is effective in the product design which took only the performance of product each into consideration

compared with the former becoming possible. That is, by assigning Q of a reader or/and writer equipment, and Q of a contiguity wireless card on the basis of Q which a non-contact IC card system has, when standardizing a reader or/and writer equipment, and a contiguity wireless card, it has the effect of becoming the conditions unification is very apt to take.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a schematic structure perspective view showing performing transfer of power and communication with an electromagnetic coupling type or an electromagnetic induction type between the reader or/and writer equipment concerning the present invention, and a contiguity wireless card (IC card).

[Drawing 2]It is the fundamental concept figure which replaced the equipment (system) which performs transfer of power and communication with an electromagnetic coupling type or an electromagnetic induction type between the reader or/and writer equipment concerning the present invention, and a contiguity wireless card (IC card) to the equivalent circuit.

[Drawing 3]It is a figure showing the relation of the transfer-of-power wave and data-communications modulated wave concerning the present invention.

[Drawing 4]It is a figure showing the principle of Q.

[Drawing 5]It is a figure showing a relation with Q of the whole transmission route which comprises a reader concerning the present invention, Q of the resonant circuit of writer equipment, Q of the resonant circuit of a contiguity wireless card (IC card) and this reader or/and writer equipment, and this contiguity wireless card (IC card).

[Drawing 6]It is a figure showing one working example in the embodiment of the reader or/and writer equipment concerning the present invention, and a contiguity wireless card (IC card).

[Explanations of letters or numerals]

1 -- a reader/writer unit, 2 -- contiguity wireless card (IC card: non-contact card), 101 -- reader/writer antenna, 102 -- matching circuit (feeder circuit), 104 -- capacitor, 105 -- power supply, 107 -- coding circuit, 108 -- modulator, 109 -- transmission amplifier, 110 -- filter circuit, 111 -- receiving amplifier, 112 -- demodulator, 113 -- decoding circuit, 115 -- host computer, 120 -- antenna drive impedance, 201 -- card antenna, 202 -- wireless chip, 203 -- consistency and rectification circuit, 204 -- power supply circuit, 206 -- clock extraction circuit, 207 -- LPF circuit, 208 -- waveform shaping circuit, 209 -- Rhodes itching circuit, 210 -- chips (CPU+ interface chip), such as CPU, 211 -- frequency divider, 212 -- decoding circuit, 213 -- coding circuit, 214 -- microcomputer (CPU), 220 -- resistance, 221 -- capacitor, 300 -- reader/writer, 301 -- antenna coil, 302 -- antenna coil tuning capacitance, 303 -- antenna coil drive impedance, 304 -- OSC (transmitter), 400 -- IC card, 401 -- antenna coil, 402 -- antenna coil tuning capacitance, 403 -- card load resistance



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NON-CONTACT COMMUNICATION SYSTEM, AND AUXILIARY DEVICE AND METHOD FOR NON-CONTACT COMMUNICATION

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Classification: - **international:** G06K17/00; H01Q7/00; H04B5/02; (IPC1-7): G06K17/00; H01Q7/00; H04B5/02
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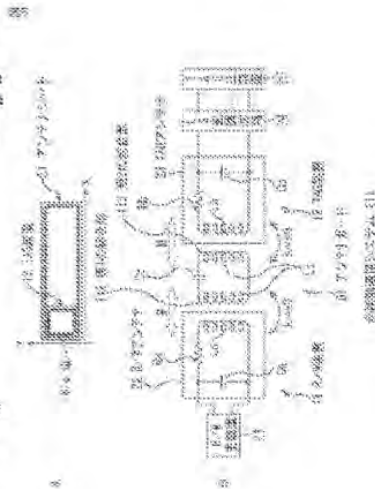
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Abstract of JP2003179526 (A)

PROBLEM TO BE SOLVED: To extend a communication range. ; **SOLUTION:** A non-contact communication system comprises an RW device 11 provided with an RW antenna 22 resonating with a communication carrier frequency, a TAG device 12 provided with a TAG antenna 23 resonating with the communication carrier frequency, and an antenna sheet 61 operating as an antenna resonating with the communication carrier frequency. The RW antenna 22 is electromagnetically coupled with a first coupling part 112 of the antenna sheet 61, and a second coupling part 113 is electromagnetically coupled with the TAG antenna 23 by a circulating magnetic field around a lead of the second coupling part 113 or the TAG antenna 23 produced by a line current flowing through the lead. The RW device 11 and the TAG device 12 carry out non-contact communication with each other via the electromagnetically coupled RW antenna 22, the antenna sheet 61, and the TAG antenna 23. ; **COPYRIGHT:** (C)2003,JPO



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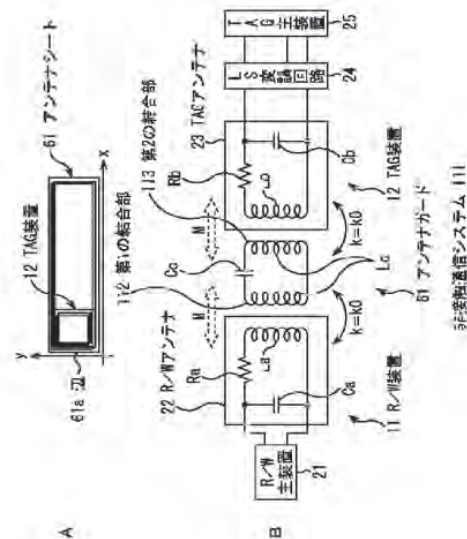
(54) 【発明の名称】 非接触通信システム、並びに非接触通信補助装置および方法

(57) 【要約】

【課題】 通信距離を延長することができるようにする。

【解決手段】 非接触通信システム111は、通信搬送周波数に共振するR/Wアンテナ22を備えるR/W装置11と、通信搬送周波数に共振するTAGアンテナ23を備えるTAG装置12と、通信搬送周波数に共振するアンテナとして動作するアンテナシート61とからなり、R/Wアンテナ22とアンテナシート61の第1の結合部112とが電磁結合するとともに、第2の結合部113またはTAGアンテナ23の導線に流れる線電流が導線の周辺に生成した循環磁界により、第2の結合部113とTAGアンテナ23とが電磁結合し、R/W装置11とTAG装置12は、電磁結合されたR/Wアンテナ22、アンテナシート61、およびTAGアンテナ23を介して相互に非接触通信する。

図8



【特許請求の範囲】

【請求項1】 通信搬送周波数に共振する第1のアンテナを備える第1の非接触通信装置と、
前記通信搬送周波数に共振する第2のアンテナを備える第2の非接触通信装置と、
前記通信搬送周波数に共振する第3のアンテナを備える非接触通信補助装置とからなり、
前記第1および前記第3のアンテナが電磁結合するとともに、前記第2または前記第3のアンテナの導線に流れる線電流が前記導線の周辺に生成した循環磁界により、前記第2および前記第3のアンテナが電磁結合し、
前記第1および前記第2の非接触通信装置は、電磁結合した前記第1および前記第3のアンテナ、並びに前記第3および前記第2のアンテナを介して相互に非接触通信することの特徴とする非接触通信システム。

【請求項2】 前記第1乃至第3のアンテナは、ループアンテナであり、
前記第2のアンテナのループ面積は、前記第1および前記第3のアンテナのループ面積よりも小さいことを特徴とする請求項1に記載の非接触通信システム。

【請求項3】 前記第2のアンテナは、前記第3のアンテナの前記導線に近接して配置されることを特徴とする請求項2に記載の非接触通信システム。

【請求項4】 前記第2のアンテナは、前記第3のアンテナの前記ループ面上に配置されることを特徴とする請求項3に記載の非接触通信システム。

【請求項5】 前記第2のアンテナは、前記第2のアンテナの法線方向と前記第3のアンテナの法線方向が垂直となるように配置されることを特徴とする請求項3に記載の非接触通信システム。

【請求項6】 前記第1および前記第3のアンテナが電磁結合する場合における幾何学的結合係数の第1の値を、前記第1および前記第3のアンテナ間の第1の距離で調整するとともに、
前記第2および前記第3のアンテナが電磁結合する場合における幾何学的結合係数の第2の値を、前記第2および前記第3のアンテナのループ面積比、並びに前記第1の距離より短い前記第2および前記第3のアンテナ間の第2の距離で調整し、
前記幾何学的結合係数の前記第1および前記第2の値を、所定の値にマッチングさせることを特徴とする請求項1に記載の非接触通信システム。

【請求項7】 前記第1の非接触通信装置は、
前記通信搬送周波数の搬送信号を生成する生成手段と、
前記生成手段により生成された前記搬送信号に第1の情報を重畳して送信する搬送信号送信手段とをさらに備えることを特徴とする請求項1に記載の非接触通信システム。

【請求項8】 前記第2の非接触通信装置は、
前記第1の非接触通信装置の前記搬送信号送信手段によ

り送信された前記搬送信号を、前記第1乃至前記第3のアンテナを介して受信する受信手段と、
前記受信手段により受信された前記搬送信号から電力を取得する電力取得手段と、
前記受信手段により受信された前記搬送信号に重畳されている前記第1の情報を取得する第1の情報取得手段と、
第2の情報を出力する情報出力手段と、
前記情報出力手段により出力された前記第2の情報に基づいて、前記第2のアンテナの受端インピーダンスを変化させる変調手段とをさらに備えることを特徴とする請求項7に記載の非接触通信システム。

【請求項9】 前記第1の非接触通信装置は、
前記第2の非接触通信装置の前記変調手段により変化された前記第2のアンテナの前記受端インピーダンスの変化量を、前記第1乃至前記第3のアンテナを介して検出する検出手段と、
前記検出手段により検出された前記第2のアンテナの前記受端インピーダンスの変化量に基づいて、前記第2の非接触通信装置の前記情報出力手段により出力された前記第2の情報を取得する第2の情報取得手段とをさらに備えることを特徴とする請求項8に記載の非接触通信システム。

【請求項10】 通信搬送周波数に共振する第1のアンテナを備える第1の非接触通信装置と、
前記通信搬送周波数に共振する第2のアンテナを備える第2の非接触通信装置とからなり、
前記第1または前記第2のアンテナの導線に流れる線電流が前記導線の周辺に生成した循環磁界により、前記第1のアンテナと前記第2のアンテナとが電磁結合し、
前記第1および前記第2の非接触通信装置は、電磁結合した前記第1および前記第2のアンテナを介して相互に非接触通信することの特徴とする非接触通信システム。

【請求項11】 前記第1および前記第2のアンテナは、
それぞれ異なるループ面積を有するループアンテナであることを特徴とする請求項10に記載の非接触通信システム。

【請求項12】 前記第1および前記第2のアンテナは、前記第1のアンテナの法線方向と前記第2のアンテナの法線方向とが垂直となるようにそれぞれ配置されることを特徴とする請求項11に記載の非接触通信システム。

【請求項13】 通信搬送周波数に共振する中継アンテナを備え、
前記中継アンテナは、
前記通信搬送周波数に共振する他の第1のアンテナと電磁結合されるとともに、前記中継アンテナの導線または前記通信搬送周波数に共振する他の第2のアンテナの導線に流れる線電流が前記導線の周辺に生成した循環磁界

により、前記第2のアンテナと電磁結合され、前記第1および前記第2のアンテナ間で通信される情報および電力を非接触で中継することを特徴とする非接触通信補助装置。

【請求項14】 前記中継アンテナは、前記通信搬送周波数に共振する共振回路を構成するキャパシタ、およびインダクタンスを有し、

前記アンテナコイルは、

前記第1のアンテナと電磁結合する第1の結合部と、前記第2のアンテナと電磁結合する第2の結合部とを有することを特徴とする請求項13に記載の非接触通信補助装置。

【請求項15】 シート状の基材をさらに備え、前記アンテナコイルと前記キャパシタとは、前記基材の面上にパターンで形成されることを特徴とする請求項16に記載の非接触通信補助装置。

【請求項16】 前記第1および前記第2の結合部は、同一の前記アンテナコイルの前記パターンとして構成されることを特徴とする請求項15に記載の非接触通信補助装置。

【請求項17】 前記基材の面は、第1の面と、前記第1の面と平行でない第2の面から構成されており、前記アンテナコイルの前記パターンは、前記第1および前記第2の面上にわたって循環していることを特徴とする請求項15に記載の非接触通信補助装置。

【請求項18】 前記第1の面の法線方向と前記第2の面の法線方向とが垂直であることを特徴とする請求項17に記載の非接触通信補助装置。

【請求項19】 前記第2のアンテナは、前記第1または前記第2の面上に配置されるとともに、配置された前記第1または前記第2の面上に形成されている前記アンテナコイルの前記パターンに近接して配置されることを特徴とする請求項18に記載の非接触通信補助装置。

【請求項20】 通信搬送周波数に共振する中継アンテナを備える非接触通信補助装置の非接触通信補助方法において、

前記中継アンテナと、前記通信搬送周波数に共振する他の第1のアンテナとを電磁結合させるとともに、

前記中継アンテナの導線または前記通信搬送周波数に共振する他の第2のアンテナの導線に流れる線電流が前記導線の周辺に生成した循環磁界により、前記中継アンテナと前記第2のアンテナとを電磁結合させ、

前記第1および前記第2のアンテナにそれぞれ電磁結合された前記中継アンテナにより、前記第1および前記第2のアンテナ間で通信される情報および電力を非接触で中継することを特徴とする非接触通信補助方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、非接触通信システム、並びに非接触通信補助装置および方法に関し、特

に、通信距離を延長することができるようにした非接触通信システム、並びに非接触通信補助装置および方法に関する。

【0002】

【従来の技術】非接触通信技術が応用されたIC (Integrated Circuit) カードシステムは、携帯可能なICカード、および、そのICカードに記憶されている情報を非接触で読み出すとともに、所定の情報をそのICカードに非接触で記憶させることが可能ないわゆるリーダライタ装置（以下、R/W装置と記述する）から構成されている。

【0003】即ち、ICカードシステムは、非接触で情報の読み書きが可能な利便性の高いシステムであり、近年、定期券や認証カードに代表される従来の磁気式カードシステムの代替システム、または物流システム等として使用されている。

【0004】また、ランダムアクセスが不可能なテープ系の記憶装置（例えば、ビデオカセットテープ）には、所定の情報をインディックス的にICメモリに記憶させ、記憶媒体へのアクセスなしに、かつ非接触で容易にその所定の情報を把握できるようにした非接触通信システムが使用されている。

【0005】このような非接触通信システムは、R/W装置が発生する磁界内にICカード等のトランスポンダ装置（以下、TAG装置と記述する）をかざすだけで瞬時に動作することが実用上不可欠である。

【0006】従って、非接触通信システムの実用化においては、その瞬時動作が可能な距離（R/W装置とTAG装置との間の距離）、即ち実用的な通信距離が確保される必要がある。

【0007】一方、非接触通信技術の有用性からその応用範囲は大きく広がり、さまざまなTAG装置が考案されている。例えば、通常のカードサイズのTAG装置に比較して、非常に小型のTAG装置が考案されている。

【0008】

【発明が解決しようとする課題】しかしながら、この超小型のTAG装置が使用される非接触通信システムにおいては、通信距離が非常に短距離に限定され、実用的な通信距離の確保が困難であるという課題があった。

【0009】本発明は、このような状況に鑑みてなされたものであり、通信距離を延長することができるようにするものである。

【0010】

【課題を解決するための手段】本発明の第1の非接触通信システムは、通信搬送周波数に共振する第1のアンテナを備える第1の非接触通信装置と、通信搬送周波数に共振する第2のアンテナを備える第2の非接触通信装置と、通信搬送周波数に共振する第3のアンテナを備える非接触通信補助装置とからなり、第1および第3のアンテナが電磁結合するとともに、第2または第3のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁

界により、第2および第3のアンテナが電磁結合し、第1および第2の非接触通信装置は、電磁結合した第1および第3のアンテナ、並びに第3および第2のアンテナを介して相互に非接触通信することを特徴とする。

【0011】第1乃至第3のアンテナは、ループアンテナであり、第2のアンテナのループ面積は、第1および第3のアンテナのループ面積よりも小さいようにすることができる。

【0012】第2のアンテナは、第3のアンテナの導線に近接して配置されるようにすることができる。

【0013】第2のアンテナは、第3のアンテナのループ面上に配置されるようにすることができる。

【0014】第2のアンテナは、第2のアンテナの法線方向と第3のアンテナの法線方向が垂直となるように配置されるようにすることができる。

【0015】第1および第3のアンテナが電磁結合する場合における幾何学的結合係数の第1の値を、第1および第3のアンテナ間の第1の距離で調整するとともに、第2および第3のアンテナが電磁結合する場合における幾何学的結合係数の第2の値を、第2および第3のアンテナのループ面積比、並びに第1の距離より短い第2および第3のアンテナ間の第2の距離で調整し、幾何学的結合係数の第1および第2の値を所定の値にマッチングさせるようにすることができる。

【0016】第1の非接触通信装置は、通信搬送周波数の搬送信号を生成する生成手段と、生成手段により生成された搬送信号に第1の情報を重畳して送信する搬送信号送信手段とをさらに備えるようにすることができる。

【0017】第2の非接触通信装置は、第1の非接触通信装置の搬送信号送信手段により送信された搬送信号を、第1乃至第3のアンテナを介して受信する受信手段と、受信手段により受信された搬送信号から電力を取得する電力取得手段と、受信手段により受信された搬送信号に重畳されている第1の情報を取得する第1の情報取得手段と、第2の情報を出力する情報出力手段と、情報出力手段により出力された第2の情報に基づいて、第2のアンテナの受端インピーダンスを変化させる変調手段とをさらに設けるようにすることができる。

【0018】第1の非接触通信装置は、第2の非接触通信装置の変調手段により変化した第2のアンテナの受端インピーダンスの変化量を、第1乃至第3のアンテナを介して検出する検出手段と、検出手段により検出された第2のアンテナの受端インピーダンスの変化量に基づいて、第2の非接触通信装置の出力手段により出力された第2の情報を取得する第2の情報取得手段とをさらに設けるようにすることができる。

【0019】本発明の第1の非接触通信システムにおいては、通信搬送周波数に共振する第1の非接触通信装置の第1のアンテナと、通信搬送周波数に共振する非接触通信補助装置の第3のアンテナとが電磁結合されると

もに、通信搬送周波数に共振する第2の非接触通信装置の第2のアンテナ、または第3のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、第2および第3のアンテナが電磁結合され、電磁結合された第1および第3のアンテナ、並びに第3および第2のアンテナを介して、第1および第2の非接触通信装置間で相互に非接触通信される。

【0020】本発明の第2の非接触通信システムは、通信搬送周波数に共振する第1のアンテナを備える第1の非接触通信装置と、通信搬送周波数に共振する第2のアンテナを備える第2の非接触通信装置とからなり、第1または第2のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、第1のアンテナと第2のアンテナとが電磁結合し、第1および第2の非接触通信装置は、電磁結合した第1および第2のアンテナを介して相互に非接触通信することを特徴とする。

【0021】第1および第2のアンテナは、それぞれ異なるループ面積を有するループアンテナであるようにすることができる。

【0022】第1および第2のアンテナは、第1のアンテナの法線方向と第2のアンテナの法線方向が垂直となるようにそれぞれ配置されるようにすることができる。

【0023】本発明の第2の非接触通信システムにおいては、通信搬送周波数に共振する第1の非接触通信装置の第1のアンテナ、または通信搬送周波数に共振する第2の非接触通信装置の第2のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、第1および第2のアンテナが電磁結合され、電磁結合された第1および第2のアンテナを介して、第1および第2の非接触通信装置間で相互に非接触通信される。

【0024】本発明の非接触通信補助装置は、通信搬送周波数に共振する中継アンテナを備え、中継アンテナは、通信搬送周波数に共振する他の第1のアンテナと電磁結合されるとともに、中継アンテナの導線または通信搬送周波数に共振する他の第2のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、第2のアンテナと電磁結合され、第1および第2のアンテナ間で通信される情報および電力を非接触で中継することを特徴とする。

【0025】中継アンテナは、通信搬送周波数に共振する共振回路を構成するキャパシタ、およびインダクタンスとして作用するアンテナコイルを有し、アンテナコイルは、第1のアンテナと電磁結合する第1の結合部と、第2のアンテナと電磁結合する第2の結合部とを有するようにすることができる。

【0026】シート状の基材をさらに設け、アンテナコイルとキャパシタは、基材の面上にパターンで形成されるようにすることができる。

【0027】第1および第2の結合部は、同一のアンテナコイルのパターンとして構成されるようにすることが

できる。

【0028】基材の面は、第1の面と、第1の面と平行でない第2の面から構成されており、アンテナコイルのパターンは、第1および第2の面上にわたって循環しているようにすることができる。

【0029】第1の面の法線方向と第2の面の法線方向とが垂直であるようにすることができる。

【0030】第2のアンテナは、第1または第2の面上に配置されるとともに、配置された第1または第2の面上に形成されているアンテナコイルのパターンに近接して配置されるようにすることができる。

【0031】本発明の非接触通信補助方法は、通信搬送周波数に共振する中継アンテナと、通信搬送周波数に共振する他の第1のアンテナとを電磁結合させるとともに、中継アンテナの導線または通信搬送周波数に共振する他の第2のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、中継アンテナと第2のアンテナとを電磁結合させ、第1および第2のアンテナにそれぞれ電磁結合された中継アンテナにより、第1および第2のアンテナ間で通信される情報および電力を非接触で中継することを特徴とする。

【0032】本発明の非接触通信補助装置および方法においては、通信搬送周波数に共振する中継アンテナと、通信搬送周波数に共振する他の第1のアンテナとが電磁結合されるとともに、中継アンテナの導線または通信搬送周波数に共振する他の第2のアンテナの導線に流れる線電流が導線の周辺に生成した循環磁界により、中継アンテナと第2のアンテナとが電磁結合され、第1および第2のアンテナとそれぞれ電磁結合された中継アンテナにより、第1および第2のアンテナ間で通信される情報および電力が非接触で中継される。

【0033】

【発明の実施の形態】図1は、本発明が適用される非接触通信基礎システム1の構成例を表している。

【0034】図1に示されるように、非接触通信基礎システム1は、R/W主装置21およびR/Wアンテナ22からなるR/W装置11と、TAGアンテナ23、LS (Load Switching) 変調回路24、およびTAG主装置25からなるTAG装置25とが、相互に非接触通信するシステムである。

【0035】R/W主装置21には、図示はしないが、通信を制御する為のマイコン、マンチェスター符号等へ符号化する符号化回路、マンチェスター符号等を復号するための復号回路、所定の通信搬送周波数の搬送波（搬送信号）を生成する搬送波生成回路、ASK (Amplitude Shift Keying) 変調回路、ASK復調回路、および電力増幅回路等が設けられている。なお、R/W主装置21として、従来のR/W主装置が使用されることができる。従って、R/W主装置21の構成要素の構成や動作は当業者に容易に理解できるため詳しい説明は省略する。

【0036】R/Wアンテナ22は、抵抗Ra、コイルLa、およびキャパシタCaから構成される共振回路を有している。即ち、R/Wアンテナ22は、そのコイルLaの部分がループアンテナとして動作するとともに、かつ所定の通信搬送周波数に共振するLCR共振回路としても動作する。

【0037】TAGアンテナ23は、R/Wアンテナ22と同様に、抵抗Rb、コイルLb、およびキャパシタCbから構成される共振回路を有している。即ち、TAGアンテナ23は、そのコイルLb部分がR/Wアンテナ22と相互インダクタンスMで電磁結合するためのループアンテナとして動作するとともに、かつ所定の通信搬送周波数に共振するLCRC共振回路としても動作する。

【0038】TAG主装置25には、図示はしないが、IC用電源生成回路、クロック抽出回路、ロジック回路、ASK復調回路、およびデータを記憶する為のメモリ等が設けられている。なお、TAG主装置25として、従来のTAG主装置が使用されることができる。従って、TAG主装置25の構成要素の構成や動作は当業者に容易に理解できるため詳しい説明は省略する。

【0039】LS変調回路25は、負荷抵抗RcとMOS (Metal Oxide Semiconductor) スイッチ38とが直列に接続された回路である。

【0040】次に、非接触通信基礎システム1の動作を説明する。

【0041】TAG装置12のTAGアンテナ23が、R/W装置11のR/Wアンテナ22に所定の距離（通信距離）で対向されて配置されると、TAGアンテナ23とR/Wアンテナ22とは、R/Wアンテナ22の法線方向に発生された磁界により相互インダクタンスMで電磁結合するとともに、R/W主装置21より出力された通信搬送信号の通信搬送周波数にそれぞれ共振する。これにより、R/W装置11とTAG装置12とは、R/Wアンテナ22およびTAGアンテナ23を介して、相互に非接触通信することができるようになる。

【0042】R/W主装置21より送信されるデータ（以下、第1の情報と称する）は、例えば、R/W主装置21において、符号化されるとともにASK変調され、ASK変調信号（第1の情報が重畳された通信搬送信号）として、電磁結合しているR/Wアンテナ22およびTAGアンテナ23、並びにLS変調回路24を介して、TAG主装置25に供給される。

【0043】TAG主装置25において、供給されたASK変調信号は、復調されるとともに復号されて元の第1の情報となり、この第1の情報がメモリに記憶されるデータであった場合、第1の情報はメモリに記憶され、一方、この第1の情報が情報読み出し指示データであった場合、第1の情報に基づいて、メモリより所定の情報が読み出される。

【0044】なお、ASK変調信号が復調された際に除去

された直流成分の信号はIC（図示せず）等の電源となる。

【0045】これらのレスポンスまたはメモリから読み出されたデータ（以下、第2の情報と称する）は、以下のようにTAG装置12からR/W装置11に供給される。

【0046】即ち、LS変調回路24において、第2の情報（0または1のデータ）に応じてスイッチ38がスイッチングされ、R/Wアンテナ22からみたTAG装置12のアンテナの等価的な負荷（TAGアンテナ23とLS変調回路24（抵抗Rc）とからなる回路の負荷）が変動される。

【0047】この負荷変動は、R/W装置11においては、R/Wアンテナ22とTAGアンテナ23との間の非接触な電磁結合により、R/Wアンテナ22の負荷変動として現れる。従って、R/W装置11は、この負荷変動を、通信搬送信号の振幅変動成分、即ちASK変調信号（第2の情報が重畳された通信搬送信号）として検出し、これを復調するとともに復号することで、第2の情報を取得する。

【0048】このように、非接触通信基礎システム1は、電磁結合を利用して非接触通信を行うシステムであ

$$k0 = \frac{1}{\sqrt{Q_1 \cdot Q_2}}$$

【0053】ただし、Q1は、R/Wアンテナ22のQ値を表しており、また、Q2は、TAGアンテナ23のQ値を表している。

【0054】一方、幾何学的結合係数kは、上述したように、両者のアンテナの幾何学的な配置に対応する係数である。

【0055】一方のアンテナから発生された全ての磁束がもう一方のアンテナを横切るとき、即ち、同じ大きさの2つのアンテナがそれぞれ対抗して接し合わせられた

$$k(x) = \frac{r_1^2 \cdot r_2^2}{\sqrt{r_1 \cdot r_2 \cdot (\sqrt{x^2 + r_2^2})^3}}$$

【0057】ただし、図2Aに示されるように、r1は、R/Wアンテナ22の径（コイルLaのループ径）を、r2は、TAGアンテナ23の径（コイルLbのループ径）を、xは、R/Wアンテナ22とTAGアンテナ23との間の距離を、それぞれ表している。即ち、k(x)は、R/Wアンテナ22とTAGアンテナ23との間の距離xにおける幾何学的結合係数kを表している。

【0058】R/Wアンテナ22とTAGアンテナ23との間の距離xと、この式（2）により演算された幾何学的結合係数k(x)との対応関係が、図2Bに示されている。

【0059】ただし、曲線（アンテナ径3.6mm）41は、R/Wアンテナ22とTAGアンテナ23の径がそれぞれ3.6mmである場合（両アンテナの径がそれぞれ小さい場合）の幾何学的結合係数k(x)を表している。

り、この電磁結合の強さが、非接触通信基礎システム1の通信距離に密接に関連している。

【0049】そこで、本出願人は、上述したようなR/Wアンテナ22とTAGアンテナ23との間の電磁結合の様相をいわゆる複同調として解析した。以下、その解析結果について説明する。

【0050】即ち、これらのアンテナ間の電磁結合には、それぞれのアンテナ回路の損失Q（Quality Factor）により物理的に決定される臨界時の結合係数（以下、臨界結合係数k0と称する）が存在し、これがちょうどアンテナ形状、距離等の幾何学的要因で決定される結合係数（以下、幾何学的結合係数kと称する）と一致した時点で最大の伝達ゲインとなることを利用して、本出願人は、R/Wアンテナ22とTAGアンテナ23との間の電磁結合の様相を解析した。

【0051】具体的には、臨界結合係数k0は、それぞれのアンテナ回路のQ値によって次式（1）に示されるように求められるアンテナの電気的特性を表す係数である。

【0052】

【数1】

・・・（1）

ときに、幾何学的結合係数kの値は最大値である1をとり、また、図2Aに示されるように、2つのアンテナが1つの軸上の真中に並べられたとき（2つのアンテナのそれぞれの幾何学的センターが一致したとき）、幾何学的結合係数kの値は、次式（2）に示されるように概算される。

【0056】

【数2】

・・・（2）

【0060】曲線（アンテナ径10mm）42は、R/Wアンテナ22とTAGアンテナ23の径がそれぞれ10mmである場合（両アンテナの径がそれぞれ大きい場合）の幾何学的結合係数k(x)を表している。

【0061】曲線（アンテナ径3.6mmと10mmの組合せ）43は、R/Wアンテナ22およびTAGアンテナ23のうち、一方の径が3.6mmであり、もう一方の径が10mmである場合（大きい径と小さい径とが組合せられた場合）の幾何学的結合係数k(x)を表している。

【0062】さて、R/Wアンテナ22およびTAGアンテナ23のような共振系アンテナのQ値は一般的に高い値であるため、その結果、式（1）に示されるように、臨界結合係数k0の値は小さい値となる。従って、非接触通信基礎システム1においては、最適な通信状態となる幾何

学的結合係数 k の値として、小さい値が適用されることができる。例えば、R/Wアンテナ22およびTAGアンテナ23のQ値がそれぞれ10とされた場合、臨界結合係数 k_0 の値は0.1となり、非接触通信基礎システム1は、幾何学的結合係数 k の値が0.1のとき最適な通信状態となる。

【0063】このように、非接触通信基礎システム1が使用される場合（共振系が構成されているシステムが使用される場合）、共振系が構成されていないシステムが使用される場合に比べて、臨界結合係数 k_0 の値は小さくなり、その結果、最適な通信状態となる幾何学的結合係数 k の値も小さい値が適用されることができる。

【0064】なお、幾何学的結合係数 $k(x)$ と2つのアンテナ間の距離 x との関係の様相は、曲線（アンテナ径3.6mmと10mmの組合せ）43と曲線（アンテナ径3.6mm）41とでは大差がない。即ち、いずれか一方（片方）のアンテナのみが大きくされても、最適な通信状態となる幾何学的結合係数 k の値が得られる通信距離（2つのアンテナ間の距離） x はさほど延長されない。

【0065】一方、最適な通信状態となる幾何学的結合係数 k の値が大きい場合（例えば、曲線43と曲線41との比較では、幾何学的結合係数 k が0.15以上の場合）、片方のアンテナのみが大きくされると、最適な通信状態となる幾何学的結合係数 k が得られる通信距離 x はむしろ短くなる。

【0066】このように（図2Bに示されるように）、超小型のTAG装置12が使用される非接触通信システム1においては、即ち、TAGアンテナ23が通常のそれより小さい場合、通信に十分な幾何学的結合係数 k の値が得られるように、R/W装置11と超小型のTAG装置12とが通常より近距離に配置される（R/Wアンテナ22とTAGアンテナ23との間の距離 x が短くされる）必要がある。

【0067】そこで、本出願人は、中継アンテナ（通信範囲を広げることが目的とされたアンテナ）として、例えば、図3に示されるようなアンテナシート61を採用した。

【0068】即ち、アンテナシート61とは、例えば、アンテナコイル L_c とキャパシタ C_c とがシート状の基板71にパターンとして形成されたものである。

【0069】なお、キャパシタ C_c は、薄型のものであればその形式は限定されない。例えば、チップ部品などでもよい。

【0070】このアンテナシート61は、アンテナコイル L_c の部分がループアンテナとして動作するとともに、図3Bに示されるように、アンテナコイル L_c およびキャパシタ C_c から構成される閉回路、即ち、所定の通信搬送周波数に共振するLC共振回路としても動作する。

【0071】なお、この例においては、アンテナシート61の大きさ（コイル L_c のループ径（ループ面積））は、R/Wアンテナ22の大きさ（コイル L_a のループ径

（ループ面積））とほぼ等しいものとされる。

【0072】また、この例においては、アンテナシート61は、シートとして構成されているが、上述した2つの動作（ループアンテナとしての動作、およびLC共振回路としての動作）が可能な構成であれば、その構成は限定されない。

【0073】ところで、仮にTAGアンテナ23とR/Wアンテナ22の大きさ（それぞれのコイル L_b と L_a のループ径（ループ面積））がほぼ等しい場合、即ち、アンテナシート61とTAGアンテナ23の大きさ（それぞれのコイル L_c と L_b のループ径（ループ面積））がほぼ等しい場合であれば、アンテナシート61は、図4に示されるように配置されることが理論上可能である。

【0074】即ち、アンテナシート61、TAGアンテナ23、およびR/Wアンテナ22（それぞれのコイル L_c 、 L_b 、および L_a のループ面）が平行になるとともに、それぞれのアンテナの幾何学的センター（それぞれのコイル L_c 、 L_b 、および L_a のループの中心）からのそれぞれの法線が一致されるように、アンテナシート61が、TAGアンテナ23とR/Wアンテナ22の間に配置されることで、アンテナシート61は理論上中継アンテナの機能を果たすことができる。

【0075】しかしながら、超小型のTAG装置12が使用される非接触通信基礎システム1は、上述したように、TAGアンテナ23とR/Wアンテナ22の大きさ（それぞれのコイル L_b と L_a のループ径（ループ面積））が甚だ異なる。

【0076】従って、超小型のTAG装置12が使用される非接触通信基礎システム1にアンテナシート61が適用された場合、アンテナシート61とTAGアンテナ23との大きさ（それぞれのコイル L_c と L_b のループ径（ループ面積））は甚だ異なることになり、図2Bの曲線（アンテナ径3.6mmと10mmの組合せ）43に示されるように、アンテナシート61が図4に示されるように配置されても、十分な幾何学的結合係数 k の値は得られない。

【0077】即ち、超小型のTAG装置12が使用される非接触通信システム1に対して、アンテナシート61が図4に示されるように配置された場合、アンテナシート61は、中継アンテナとしての機能を十分に発揮することができない。

【0078】なお、図4に示されるような配置は、実際には、R/Wアンテナ22とTAGアンテナ23との間の空間に、アンテナシート61が配置されることを意味している。即ち、仮に図4に示される配置が実用性のある配置だとされても、製造者等は、アンテナシート61を図4に示されるように実際に配置することは困難である。

【0079】そこで、本出願人は、幾何学的結合係数 k を臨界結合係数 k_0 にマッチングさせるという観点から、TAGアンテナ23とアンテナシート61との大きさが甚だ異なる場合のアンテナシート61の配置位置について

解析し、アンテナシート61の適切な配置位置を解明した。以下、この解析結果、即ち、アンテナシート61の適切な配置位置について説明する。

【0080】なお、前提条件として、上述したように、TAGアンテナ23に対して、R/Wアンテナ22が甚だ大きいものとされ、アンテナシート61は、R/Wアンテナ22に対して十分な幾何学的結合係数 k の値が得られることを目的として、R/Wアンテナ22と同等程度の大きさを持つものとされる。

【0081】なお、R/Wアンテナ22とTAGアンテナ23とは双対の関係にあることから、R/Wアンテナ22とTAGアンテナ23とが置き換えられても以下の議論は成立する。

【0082】それぞれの大きさが甚だ異なるTAGアンテナ23とアンテナシート61とが使用される場合、システムが非共振系であると臨界結合係数 k_0 の値は大きな値となるため、十分な幾何学的結合係数 k の値が得られない。

【0083】そこで、システムが共振系となるように、ここでは、TAGアンテナ23とアンテナシート61とが、図5Aに示されるように、それぞれ配置されるものとする。

【0084】即ち、アンテナシート61とTAGアンテナ23とのそれぞれの中心軸（幾何学的センター）が合わせられて配置された位置（TAGアンテナ23の中心が、 $(0, 0, 0)$ に配置された位置）が基準とされた場合、TAGアンテナ23が、 x 軸方向に $x1$ だけ、または z 軸方向に $z1$ だけシフトされて配置される（TAGアンテナ23の中心が、座標 $(x1, 0, 0)$ 、または $(0, 0, z1)$ に配置される）ものとする。

【0085】図5Bは、このようにアンテナシート61とTAGアンテナ23とが配置された場合におけるアンテナシート61とTAGアンテナ23との幾何学的結合係数 k の様相を表している。

【0086】図5Bにおいて、曲線（ x シフト）81は、TAGアンテナ23が x 軸方向に $x1$ だけシフトされて配置された場合におけるアンテナシート61とTAGアンテナ23との幾何学的結合係数 $k(x1)$ （ $x1$ は、0乃至30mm）を表しており、一方、曲線（ z シフト）82は、TAGアンテナ23が z 軸方向に $z1$ だけシフトされて配置された場合におけるアンテナシート61とTAGアンテナ23との幾何学的結合係数 $k(z1)$ （ $z1$ は、0乃至30mm）を表している。

【0087】曲線（ z シフト）82に示されるように、TAGアンテナ23が z 軸方向にシフトされて配置された場合、または、曲線（ x シフト）81に示されるように、TAGアンテナ23が x 軸方向にさほどシフトされずに配置された場合（TAGアンテナ23がアンテナシートの幾何学的センター付近に配置された場合）、十分な幾何学的結合係数 k の値は得られない。

【0088】一方、81-1点に示されるように、TAGアンテナ23が、 x 軸方向に約17mmシフトされて配置されたとき、即ち、アンテナシート61の同一平面上、かつアンテナシート61の導線の近傍に配置されたとき、比較的大きな幾何学的結合係数 k の値（ $k(17) = 0.08$ ）が得られる。

【0089】このように配置されると、TAGアンテナ23は、アンテナシート61の導線の周囲に発生されるループ磁界の影響をより強く受けることができるようになる。即ち、TAGアンテナ23の平面（TAGアンテナ23のコイル Lb のループ面）が、アンテナシート61の導線に流れる線電流により生成された磁束ループをより多く横切るように、TAGアンテナ23が配置されれば、電磁結合がより強くなる。

【0090】具体的には、図6Aに示されるように、アンテナシート61（アンテナコイル Lc ）は、R/Wアンテナ22からの磁界 H_r を受け、電圧が誘起され、誘導電流 i_r を発生する。この誘導電流 i_r が、アンテナシート61の導線の周囲にループ磁界 H_a をつくる。

【0091】従って、図5において、TAGアンテナ23とアンテナシート61とが同一平面上である場合の解析のみが行われたが、上述したように、アンテナシート61のアンテナコイル Lc の導線周囲のループ磁界 H_a の利用が可能な位置であれば、TAGアンテナ23の配置位置は限定されない。即ち、TAGアンテナ23とアンテナシート61とが同一平面に配置される必要はない。

【0092】例えば、図6Bに示されるように、TAGアンテナ23は、アンテナシート61の長方形のアンテナパターン（アンテナコイル Lc ）のうち、いずれかの一边に接するとともに、その一边の周囲に発生されるループ磁界 H_a に大きく作用されるように設置されるとよい。この場合、アンテナシート61とTAGアンテナ23との幾何学的結合係数 k の値が最も高められる。

【0093】またこのようなTAGアンテナ23の配置（図6Bに示されるような配置）は、図6Cに示されるように、逆にTAGアンテナ23からの磁界 H_t が、アンテナシート61に効率良く伝達される。

【0094】なお、上述したように（図5Bの曲線（ x シフト）81に示されるように）、TAGアンテナ23とアンテナシート61とが、図6Bに示されるように配置され（例えば、TAGアンテナ23の中心が、座標 $(17, 0, 0)$ に配置され）、幾何学的結合係数 k の値が最大値となった場合（81-1点に示されるように、 $k(17) = 0.08$ となった場合）であっても、幾何学的結合係数 k の値は遥か1には満たないが、TAGアンテナ23とアンテナシート61とが共振系を有することで比較的小さな結合係数においても十分な誘起電圧が得られることができる。

【0095】一方、TAGアンテナ23がアンテナシート61の幾何学的センターに配置されていた場合（TAGア

ンテナ23の中心が(0, 0, 0)に配置されていた場合)、アンテナシート61の導線周囲に発生されるループ磁界 H_a のTAGアンテナ23に対する影響、およびTAGアンテナ23からの磁界 H_t のアンテナシート61に対する影響が非常に小さくなり、その結果、幾何学的結合係数 k の値はむしろ小さくなる($k(0) \approx 0.015$ となる)。

【0096】これはTAGアンテナ23とアンテナシート61との大きさが非常に異なる場合において特徴的なことである。

【0097】ところで、非接触通信技術は非常に応用範囲が広く、様々な応用技術が提案されているが、上述したように、いったん設計された非接触通信システムにおいては、R/Wアンテナ22、またはTAGアンテナ23の仕様が決定された時点でシステムの通信距離が規定されてしまう。

【0098】即ち、TAGアンテナ23が小さく設計された非接触通信システムにおいては、その後いくらR/Wアンテナ22が大きく設計されたとしても、図2Bの曲線(アンテナ径3.6mmと10mmの組合せ)43に示されるように、TAGアンテナ23が小さい限り通信距離はTAGアンテナ23に見合って非常に短くなってしまう。逆も同様であり、図2Bの曲線(アンテナ径3.6mm)41と曲線(アンテナ径10mm)42とに示されるように、通信距離が拡大されるためには、双方のアンテナが大型化される必要がある。

【0099】しかしながら、R/W装置11は機器の設計自由度があり、大きなアンテナを有することも可能であるが、一方、規格化されたカセットなどのTAG装置12は、機器の設計自由度が小さく、大きなアンテナを有することは困難である。

【0100】そこで、上述したように、共振現象を利用したアンテナシート61が非接触通信基礎システム1に用いられるとともに、かつそれが適切にTAGアンテナ23の近傍に配置されることによって、R/Wアンテナ21とTAGアンテナ23とが、アンテナシート61を介して十分な通信距離で通信することが可能になる。

【0101】また、アンテナシート61がTAGアンテナ23の近傍に配置されることによって、TAGアンテナ23とアンテナシート61と一緒に取り扱われることができる。

【0102】ただし、アンテナシート61が中継アンテナとして有効に利用されるためには、アンテナシート61とR/Wアンテナ22との幾何学的結合係数 k の値と、アンテナシート61とTAGアンテナ23との幾何学的結合係数 k の値とがそれぞれ適切に調整される必要がある。

【0103】この例においては、これら2つの幾何学的結合係数 k の値は、それぞれ臨界結合係数 k_0 の値にマッチングされるものとする。このアンテナシート61による臨界結合係数 k と幾何学的結合係数 k_0 のマッチングの様子が、図7に示されている。

【0104】なお、図7Bは、上述した図5Bに対応し、一方、図7Cは、上述した図2Bに対応している。

【0105】図7Cの曲線 $k(z)$ 102に示されるように、共振の効果によって下げられた臨界結合係数 k_0 の値に対して、R/Wアンテナ22とアンテナシート61とでは遠距離 z_1 において幾何学的結合係数 $k(z)$ がマッチングされ、一方、図7Bの曲線 $k(x)$ 101に示されるように、アンテナシート61とTAGアンテナ23とでは甚だ異なるアンテナ径の大きさの差異が利用されて、アンテナシート61の導線の近傍において幾何学的結合係数 $k(x)$ がマッチングされている。

【0106】ところで、アンテナシート61とTAGアンテナ23との大きさが同程度である場合、アンテナシート61とTAGアンテナ23とが近傍に配置されると、両者は密結合の状態となり、共振周波数が通信搬送周波数から外れてしまい、通信搬送周波数において十分な共振が得られないという現象が起こる。即ち、アンテナシート61とTAGアンテナ23との近傍におけるマッチングに関しては、両者の大きさの違いが非常に効果的であることがわかる。

【0107】このようにしてマッチングされたそれぞれのアンテナは、実際には、例えば、図7Aに示されるように配置される。

【0108】即ち、アンテナシート61が基準とされた場合、R/Wアンテナ22は、その中心とアンテナシート61の中心との距離が z_1 となるとともに、その面(コイル L_a のループ面)とアンテナシート61の面(コイル L_c のループ面)とが平行になるように配置される(R/Wアンテナ22とアンテナシート61とは、距離 z だけ離れて、対向するようにそれぞれ配置される)。

【0109】また、TAGアンテナ23は、アンテナシート61の中心との距離が x_1 に、即ち、アンテナシート61のアンテナパターン(コイル L_c)の任意の一辺の近傍に配置されるとともに、そのアンテナパターンの一辺(導線)の周囲のループ磁界に大きく作用されるように配置される。

【0110】具体的には、図8Aに示されるように、例えば、TAG装置12は、アンテナシート61の辺61aに接するように同一平面上に配置されることができる。

【0111】このように、図1の非接触通信基礎システム1にアンテナシート61が付加された非接触通信システム11は、図8Bに示されるように構成される。なお、図8Bにおいて、図1の非接触通信基礎システム1に対応する部分には、対応する符号が付してある。

【0112】この構成例においては、上述したように、中継アンテナであるアンテナシート61が、R/W装置11のR/Wアンテナ22とTAG装置12のTAGアンテナ23との間に配置されている。

【0113】アンテナシート61は、上述したように、コイル L_c およびキャパシタ C_c からなる閉回路として形成

されている。即ち、アンテナシート61は、そのコイルLcの第1の結合部112がR/Wアンテナ22と相互インダクタンスMで電磁結合するためのループアンテナとして動作するとともに、そのコイルLcの第2の結合部113がTAGアンテナ23と相互インダクタンスMで電磁結合するためのアンテナとして動作し、さらに所定の通信搬送周波数に共振するLC共振回路としても動作する。

【0114】第1の結合部112は、図8Aでは、アンテナシート61のアンテナパターン(コイルLc)のループ全体に相当し、一方、第2の結合部113は、主にアンテナシート61のアンテナパターンの1つの辺61aに相当する。即ち、上述したように、第2の結合部113の導線に流れる線電流が生成するループ磁界により、第2の結合部113とTAGアンテナ23(コイルLb)とが電磁結合される。

【0115】その他の構成は、図1と同様である。

【0116】アンテナシート61の動作は、上述した通りであり、また、非接触通信システム111の動作は、基本的に図1の非接触通信基礎システム1の動作と同様であるので、それらの説明は省略する。

【0117】なお、アンテナシート61とTAGアンテナ12とは、上述した条件、即ち、アンテナシート61のアンテナパターン(コイルLc)の任意の辺の導線、またはTAGアンテナ12のコイルLbの導線に流れる電流がこれらの導線の周辺に生成した循環磁界により、アンテナシート61とTAGアンテナ12が相互インダクタンスMで電磁結合されるという条件が満たされれば、自在に配置されることができる。

【0118】例えば、アンテナシート61とTAGアンテナ12とはそれぞれ、図9に示されるように配置されることができる。

【0119】図9Aは、TAG装置12とアンテナシート61-1がそれぞれ独立した平面上に配置された例である。ただし、図8Bの第2の接続部113は、主にアンテナパターン(コイルLc)の辺61-1aに相当する。

【0120】図9Bは、アンテナシート61-2の基板(シート)71が、L字型の平面、即ち、x-y平面に平行な面61-2aとx-z平面に平行な面61-2bとから構成される平面状のシートにより形成された例である。TAG装置12は、例えば、面61-2b上、かつアンテナパターン(コイルLc)の辺61-2cに接するように配置される。即ち、図8Bの第2の接続部113は、主にアンテナパターン(コイルLc)の辺61-2cに相当する。

【0121】図9Cは、図9Bと同様に、アンテナシート61-3の基板(シート)71が、L字型の平面、即ち、x-y平面に平行な面61-3aとx-z平面に平行な面61-3bとから構成される平面状のシートにより形成された例である。ただし、面61-3bは、図9Bの面61-2bよりも小さく、例えば、TAG装置12

が丁度収まる程度の大きさに構成される。即ち、TAG装置12は、例えば、面61-3b上、かつアンテナパターン(コイルLc)の辺61-3c、辺61-3d、および辺61-3eの3辺に接するように配置される。即ち、図8Bの第2の接続部113は、主にアンテナパターン(コイルLc)の辺61-3c、辺61-3d、および辺61-3eに相当する。

【0122】このように、アンテナシート61とTAGアンテナ12とは、実装される場所や大きさ、または製造における工程などが考慮された様々な形で配置が可能であり、非常に近接して配置されることができることから、アンテナシート61とTAG装置12とは必要に応じて同一の装置として運用されることができる。

【0123】換言すると、アンテナシート61とTAGアンテナ23とは一体のアンテナとしてみなすことができる。即ち、アンテナシート61が使用されれば、TAGアンテナ23が変更されなくても、容易に通信範囲の拡大が達成されることができる。

【0124】ただし、上述したように、アンテナシート61とTAGアンテナ23との大きさの差は甚だ異なる必要がある。なぜならば、仮にアンテナシート61とTAGアンテナ23との大きさがほぼ等しい場合、幾何学的結合係数kが低い臨界結合係数k0にマッチングされるためには、アンテナシート61とTAGアンテナ23とが離されて配置される必要があり、これでは実用上、容易に通信範囲の拡大が達成されたとは言いがたいからである。

【0125】また、特に、図9Aに示されるような配置方法、即ち、アンテナシート61-1の法線方向とTAG装置12のTAGアンテナ23の法線方向とが垂直となるように配置させるという配置方法は、2つのアンテナを対向させて通信するという従来の通信システムでは適用不可能であり、上述したアンテナ導線周囲のループ磁界が利用される方式が採用されて初めて可能になったものである。この配置方法は、以下の応用例においてもその効果を十分に発揮している。

【0126】即ち、図10は、図8の非接触通信システム111が適用されたビデオカセットシステムの構成例を表している。

【0127】現在、図10Aに示されるような小型のTAG装置12が埋め込まれたビデオカセット121と、R/Wアンテナ22が取り付けられたビデオカセットプレーヤ122とから構成されるビデオカセットシステムが商品化されている。

【0128】このシステムにおいては、ビデオカセット121がビデオカセットプレーヤ122内に装着された場合、ビデオカセット121に埋め込まれたTAG装置12(TAGアンテナ23)と、ビデオデッキに取り付けられたR/Wアンテナ22とが近距離において対向して、ビデオカセットプレーヤ122内で非接触通信が行われる。

【0129】このTAGアンテナ23は、ビデオデッキカセット121の形状に合わせて超小型に製作されており、主に近接距離（ビデオデッキカセットプレーヤ122内）での通信が目的とされたアンテナである。

【0130】このようなビデオカセット121に関しても、ビデオカセット121本体のTAG装置12が変更されことなく、図10Bに示されるように、アンテナシート61が追加されるだけで、容易にその通信距離が変更されることができる。

【0131】即ち、図10Bに示されるように、シート状に形成されたアンテナシート61が、ビデオカセット121と一緒にビデオカセットケース122に収められると、アンテナシート61とTAGアンテナ23とが最適な位置関係で配置されたことになり、その結果、TAGアンテナ23の通信距離が、見かけ上、延長される。

【0132】換言すると、TAGアンテナ23の大きさは、見かけ上、アンテナシート61の大きさに拡張されたことになり、それに応じたR/W装置（ビデオカセットプレーヤ122に搭載されているR/W装置11とは別のR/W装置）が使用されることで、遠距離での通信が可能となる。

【0133】このようにして、本来、近距離通信が目的とされた非接触通信基礎システム1において、アンテナシート61が追加されるだけで、TAG装置12本体が変更されことなく通信距離が延長されることができる。例えば、ユーザは、ビデオカセットケース122をアンテナシート61とともにビデオカセット121に挿入し、それをその他のR/W装置にかざすだけで、非接触通信を行わせることができる。

【0134】さらに、アンテナシート61が例えば図9Aのような形状の場合、アンテナシート61は、上述したように（図10Bに示されるように）、1枚のシート状に形成される他、例えば、図9Bのような形状の場合、カセットインデックスシート状（L字型）に形成されることができる。

【0135】このように、対応するR/Wアンテナ22にあわせてアンテナシート61の大きさが変更されることによって、通信距離の決定要因がR/Wアンテナ22とTAGアンテナ23の組み合わせではなく、R/Wアンテナ22とアンテナシート61の組み合わせになる。これはちょうどR/Wアンテナ22からは、TAG装置12のアンテナがアンテナシート61になったようにみなされることを意味している。

【0136】即ち、アンテナシート61は、小さなTAGアンテナ23の近傍に適切に設置されることにより、TAGアンテナ23が変更されたときと同じ効果を奏することができる。従って、製造者等は、TAGアンテナ23の大きさによらず、新たなR/Wアンテナを設計し、TAG装置12の通信距離を延長することができる。

【0137】さらに、アンテナシート61はTAGアンテナ

23に接して使用されるために、両者は一体に扱われることができ、実際の利用において非常に利便性の高いものとなる。

【0138】さらにまた、アンテナシート61は、アンテナパターン（コイルlc）と、共振を調整するための少ない容量のキャパシタCとの2つ素子のみといった非常に簡素な構成で実現可能であり、非常に少ないコストで製造が可能であるとともに、配置上の自由度が比較的高いアンテナ装置である。

【0139】従って、アンテナシート61が適用された非接触通信システム111は、スペース上の理由からやむを得ずTAGアンテナ23が小さく設計されたが、用途に応じてTAG装置12の通信距離の延長が要求される場合等において、特に有効なシステムである。

【0140】また、非接触通信システム111は、1つのTAGアンテナ23に対して、R/Wアンテナ22以外の複数のR/Wアンテナを対応させることができる。即ち、製造者等は、配置スペースや用途に見合った通信距離に応じて複数のR/Wアンテナを設計することができ、その結果、上述したようなビデオカセットシステムの他、様々な非接触通信技術が利用されるシステムまたは装置等を製造することができる。

【0141】このように、非接触通信システム111は、アンテナの導線周囲のループ磁界を利用することを特徴としており、従来のアンテナパターン平面（コイルのループ平面）の法線方向に発生する磁界を利用する非接触通信システムとは明らかに異なるシステムである。

【0142】ところで、このアンテナの導線周囲のループ磁界を利用するという手法は、アンテナシート61が使用されない場合であって、二つのアンテナの大きさが非常に異なるようなときにおいて、同様に適用されることができる。

【0143】即ち、図1の非接触通信基礎システム1において、例えば、R/Wアンテナ22がTAGアンテナ23に比較して甚だ大きい場合、図11に示されるように、TAGアンテナ23が、その法線方向とR/Wアンテナ22の法線方向とが一致されるように、アンテナシート61の中心位置131付近に配置されたとき、R/W装置11は、TAG装置12から情報を読み取ることが困難となる。

【0144】一方、R/Wアンテナ22の導線の周りに発生されるループ磁界を受けるような淵、即ち、エッジ位置132付近に、TAGアンテナ23が配置されたとき、R/W装置11は、TAG装置12から情報を読み取ることが可能となる。

【0145】このように、上述した手法（アンテナの導線周囲のループ磁界を利用する手法）は、R/Wアンテナの淵にTAGアンテナを配置して通信する様な非接触通信システムに適用されることができる。

【0146】なお、図11においては、R/Wアンテナ22がTAGアンテナ23に比較して甚だ大きい場合につい

て図示されているが、R/Wアンテナ22がTAGアンテナ23に比較して甚だ小さい場合についても、上述した手法（アンテナの導線周囲のループ磁界を利用する手法）は適用されることができる。

【0147】また、本明細書において、システムとは、処理手段、および複数の装置により構成される装置全体を表すものである。

【0148】

【発明の効果】以上のごとく、本発明の非接触通信システム、並びに非接触通信補助装置および方法によれば、通信距離を延長することができる。

【図面の簡単な説明】

【図1】本発明が適用される非接触通信基礎システムの構成例を示す図である。

【図2】図1の非接触通信基礎システムのR/WアンテナとTAGアンテナの、それぞれの間の距離、径、および幾何学的結合係数の関係例を示す図である。

【図3】本発明が適用されるアンテナシートの構成例を示す図である。

【図4】図3のアンテナシートの配置の構成例を示す図である。

【図5】図3のアンテナシートと図1の非接触通信基礎システムのTAGアンテナとの配置位置、および幾何学的結合係数の関係例を示す図である。

【図6】図3のアンテナシートの原理、および図3のアンテナシートと図1の非接触通信基礎システムのTAGア

ンテナの配置位置の関係例を説明する図である。

【図7】図3のアンテナシートと図1の非接触通信基礎システムのTAGアンテナとの幾何学的結合係数のマッチング、および、図3のアンテナシートと図1の非接触通信基礎システムのR/Wアンテナとの幾何学的結合係数のマッチングの例を模式的に示す図である。

【図8】図3のアンテナシートが図1の非接触通信基礎システムに搭載された本発明が適用される非接触通信システムの構成例を示す図である。

【図9】図8の非接触通信システムのアンテナシートとTAGアンテナの実装例の構成を示す図である。

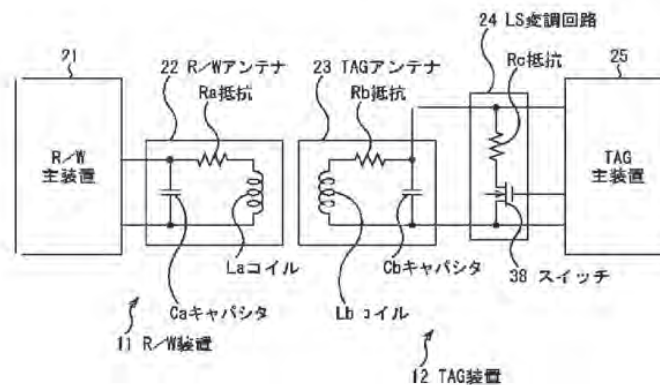
【図10】図8の非接触通信システムが適用されたビデオカセットシステムの構成例を示す図である。

【図11】図1の非接触通信基礎システムのTAGアンテナとR/Wアンテナの配置の応用例の構成を示す図である。

【符号の説明】

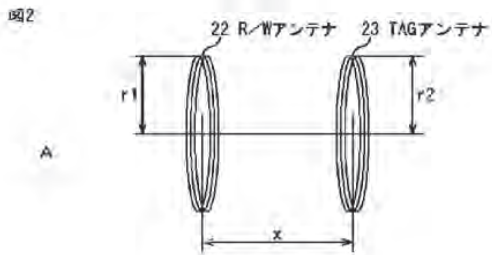
1 非接触通信基礎システム、 11 R/W装置、 12 TAG装置、 21 R/W主装置、 22 R/Wアンテナ、 23 TAGアンテナ、 24 LS変調回路、 25 TAG主装置、 61 アンテナシート、 71 基板、 111 非接触通信装置、 112 第1の結合部、 113 第2の結合部、 Ra、Rb、Rc 抵抗、 La、Lb コイル、 Lc アンテナコイル、 Ca、Cb、Cc キャパシタ、 Ha、Hr、Ht 磁界、 ir、it 誘導電流

【図1】

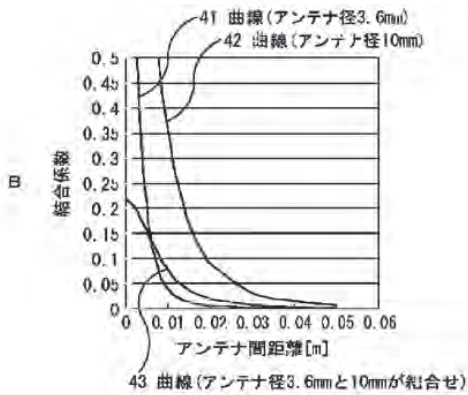
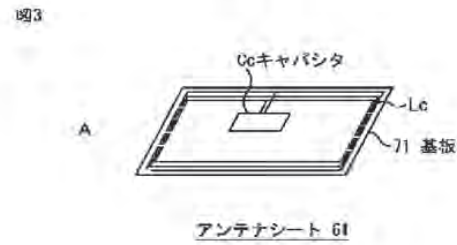


非接触通信基礎システム 1

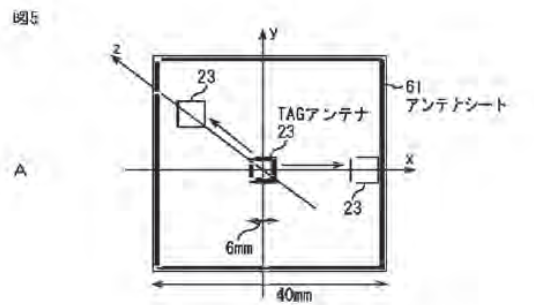
【図2】



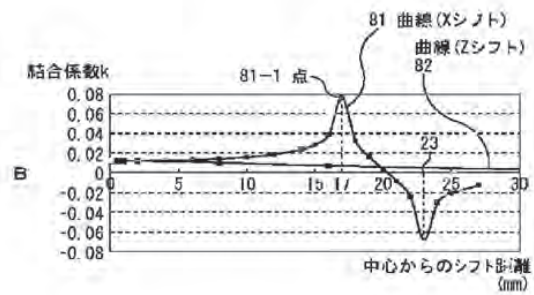
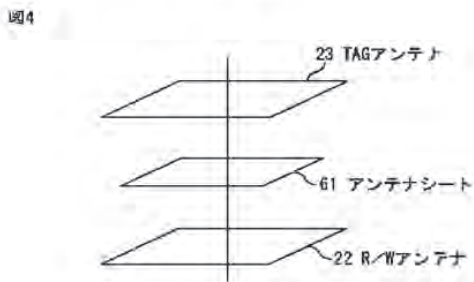
【図3】



【図5】

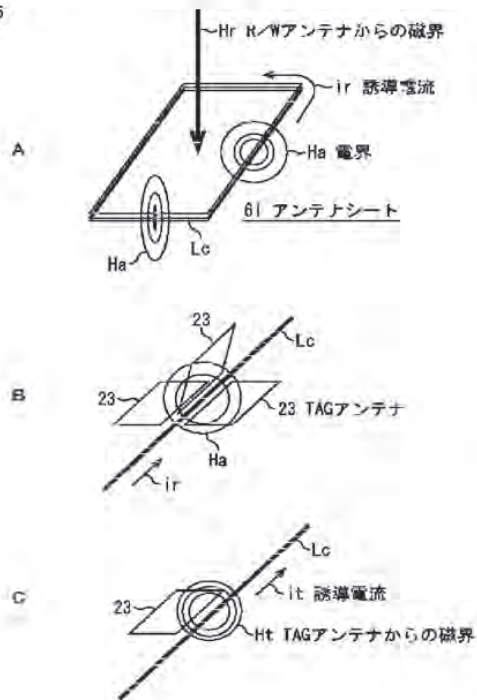


【図4】



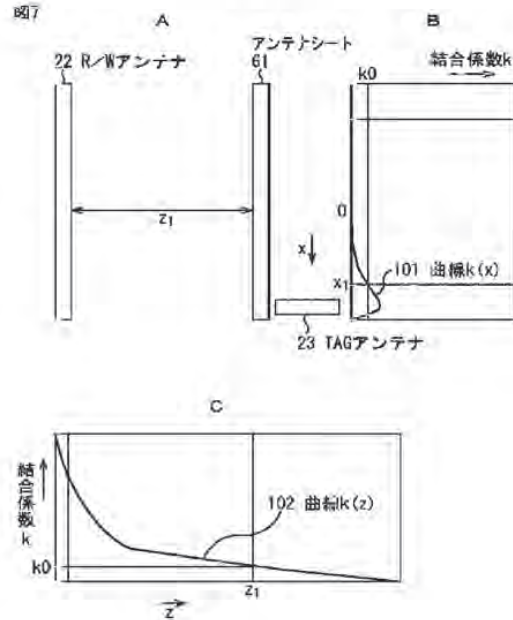
【図6】

図6



【図7】

図7



【図8】

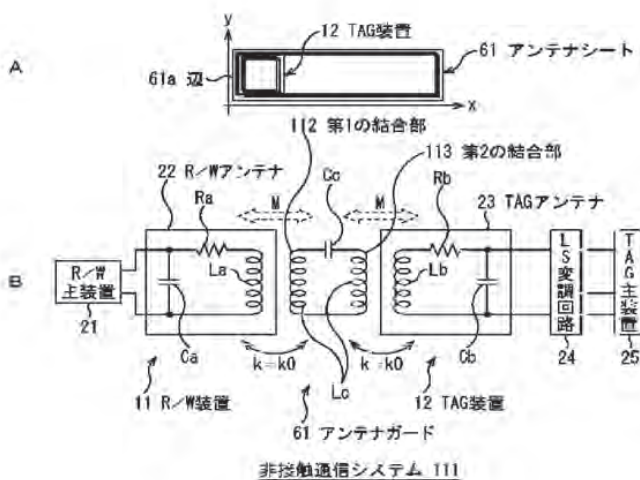
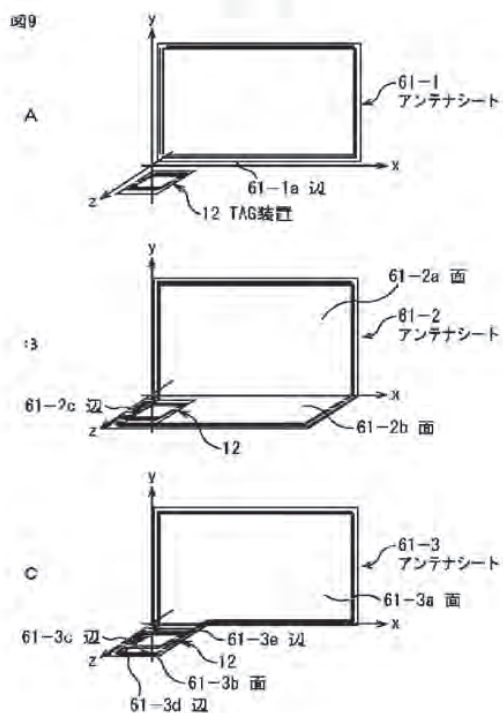
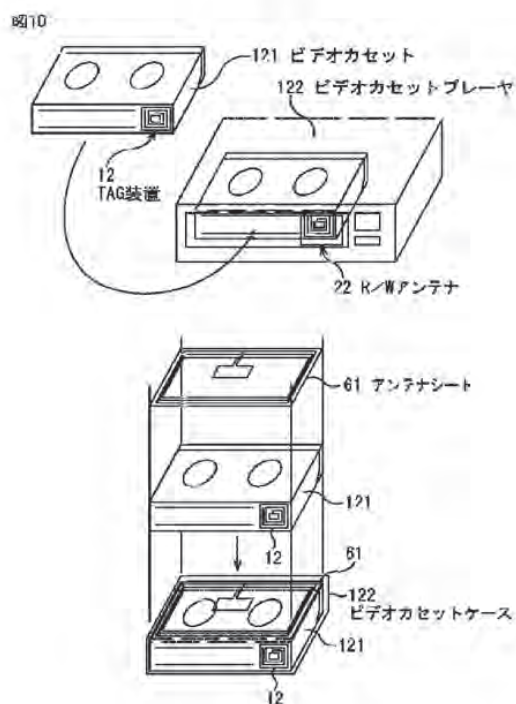


図8

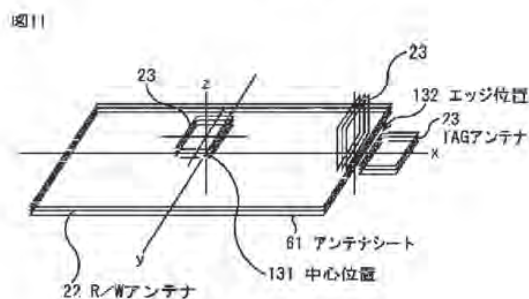
【図9】



【図10】



【図11】



フロントページの続き

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ー株式会社内

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5K012 AA03 AB03 AC06 AC08 AC10
BA02

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Thursday, May 2 2013

THOMSON INNOVATION

Patent/Publication: JP2003179526A**Bibliography****DWPI Title**

Non-contact communication system for integrated circuit card system, has read/write apparatus and tag apparatus which perform non-contact communication by inductive coupling of respective antenna with antenna sheet

Original Title

NON-CONTACT COMMUNICATION SYSTEM, AND AUXILIARY DEVICE AND METHOD FOR NON-CONTACT COMMUNICATION

A non-contact communication system, a non-contact communication auxiliary|assistance apparatus, and a method (*Translation from Thomson Reuters*)

English Title

NON-CONTACT COMMUNICATION SYSTEM, AND AUXILIARY DEVICE AND METHOD FOR NON-CONTACT COMMUNICATION

Assignee/Applicant

Standardized: **SONY CORP**

Original: SONY CORP

DWPI Assignee/Applicant

SONY CORP (SONY-C)

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DWPI Inventor

HOSOMI H; KANEKO M; KOBAYASHI M

Publication Date (Kind Code)

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Priority Number / Date / Country

JP2001377599A / 2001-12-11 / JP

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

Abstract**DWPI Abstract**

(JP2003179526A_)

Novelty

A read/write (R/W) antenna (22) and a tag antenna carry out inductive coupling with respective coupling portion (112, 113) of an antenna sheet (61) due to circulation magnetic field. A R/W apparatus (11) and a tag apparatus (12) perform non-contact communication by the inductive coupling of the respective antennas with the antenna sheet.

Detailed Description

INDEPENDENT CLAIMS are also included for the following:

1. non-contact communication auxiliary equipment; and
2. non-contact communication assisting method.

Use

For Integrated circuit card system.

Advantage

Enables to extend communication distance by mounting an antenna sheet between the apparatus.

Drawing Description

The figure shows the structure of the non-contact communication system. (Drawing includes non- English language text).

11 - R/W apparatus.

12 - tag apparatus.

22 - R/W antenna.

23 - tag antenna.

112, 113 - coupling portions of antenna sheet.

Abstract

PROBLEM TO BE SOLVED: To extend a communication range.

SOLUTION: A non-contact communication system comprises an R/W device 11 provided with an R/W antenna 22 resonating with a communication carrier frequency, a TAG device 12 provided with a TAG antenna 23 resonating with the communication carrier frequency, and an antenna sheet 61 operating as an antenna resonating with the communication carrier frequency. The R/W antenna 22 is electromagnetically coupled with a first coupling part 112 of the antenna sheet 61, and a second coupling part 113 is

electromagnetically coupled with the TAG antenna 23 by a circulating magnetic field around a lead of the second coupling part 113 or the TAG antenna 23 produced by a line current flowing through the lead. The R/W device 11 and the TAG device 12 carry out non-contact communication with each other via the electromagnetically coupled R/W antenna 22, the antenna sheet 61, and the TAG antenna 23.

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SUBJECT of the Invention It enables it to extend communication distance.

PROBLEM to be solved The non-contact communication system 111 consists of the R/W apparatus 11 equipped with the R/W antenna 22 which resonates to a communication carrier frequency, the TAG apparatus 12 equipped with the TAG antenna 23 which resonates to a communication carrier frequency, and the antenna sheet|seat 61 operate|moved as an antenna which resonates to a communication carrier frequency,

And

While the R/W antenna 22 and the 1st coupling|bond part 112 of the antenna sheet|seat 61 carry out an inductive coupling, the 2nd coupling|bond part 113 and the TAG antenna 23 carry out an inductive coupling by the circulation magnetic field which the line current which flows into the conducting wire of the 2nd coupling|bond part 113 or the TAG antenna 23 produced|generated around conducting wire,

Non-contact communication of the R/W apparatus 11 and the TAG apparatus 12 is mutually carried out through the R/W antenna 22 by which the inductive coupling was carried out, the antenna sheet|seat 61, and the TAG antenna 23.

[MAT_IMAGE 000002]

(Translation from Thomson Reuters)

Classes/Indexing

IPC

IPC Code(1-7) **H04B 5/02** G06K 17/00 H01Q 7/00

(7)

Current IPC	Invention	Version	Additional	Version
Full	G06K 17/00 H01Q 7/00 H04B 5/02	20060101 20060101 20060101	-	-
Main Group	-	-	-	-
Subclass	-	-	-	-

Original IPC	Invention	Version	Additional	Version
Advanced/Full	G06K 17/00 H01Q 7/00 H04B 5/02	20060101 20060101 20060101	-	-
Core/Main Group	G06K 17/00 H01Q 7/00 H04B 5/02	20060101 20060101 20060101	-	-
Subclass	-	-	-	-

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

JP FI Codes

G06K 17/00 F; H01Q 7/00 ; H04B 5/02

JP F Terms

5B058: CA15; KA24

5J048

5K012: AA03; AB03; AC06; AC08; AC10; BA02

DWPI Class

T04 W02

DWPI Manual Codes

Expand DWPI Manual Codes

Legal Status**INPADOC Legal Status**

Gazette Date	Code	Description
2010-03-25	FPAY +	RENEWAL FEE PAYMENT PAYMENT UNTIL: 20130319
2010-03-18	A61 +	FIRST PAYMENT OF ANNUAL FEES (DURING GRANT PROCEDURE) JAPANESE INTERMEDIATE CODE: A61 2010-03-15
2010-03-11	A01 +	WRITTEN DECISION TO GRANT A PATENT OR TO GRANT A REGISTRATION (UTILITY MODEL) JAPANESE INTERMEDIATE CODE: A01
2010-02-02	A521	WRITTEN AMENDMENT JAPANESE INTERMEDIATE CODE: A523 2010-02-01

Get Family Legal Status

Family**Family**

INPADOC Family (2)

Publication Number	Publication Date	Inventor	Assignee/Applicant	Title
JP2003179526A	2003-06-27	KOBAYASHI MIYUKI	SONY CORP	NON-CONTACT COMMUNICATION SYSTEM
JP04478366B2	2010-06-09	-	SONY CORP	-

DWPI Family (2); Countries (1)

Publication	DWPI Update	Publication Date	IPC Code	Language
JP2003179526A	200363	2003-06-27	H04B000502	Japanese

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

Local Applications: JP2001377599A filed 2001-12-11

JP04478366B2

201038

2010-06-09

H04B000502

Japanese

Local Applications: JP2001377599A filed 2001-12-11

Claims

Claims

All Claims (20)

Claims (English)

1. A 1st non-contact communication apparatus equipped with the 1st antenna which resonates to a communication carrier frequency,

A 2nd non-contact communication apparatus equipped with the 2nd antenna which resonates to said communication carrier frequency,

It consists of a non-contact communication auxiliary|assistance apparatus equipped with the 3rd antenna which resonates to said communication carrier frequency,

And

While said 1st and said 3rd antenna carries out an inductive coupling, said 2nd and said 3rd antenna carries out an inductive coupling by said 2nd or the circulation magnetic field which the line current which flows into the conducting wire of said 3rd antenna produced|generated around said conducting wire,

Non-contact communication of said 1st and said 2nd non-contact communication apparatus is mutually carried out through said 1st and said 3rd antenna which carried out the inductive coupling, and said 3rd and said 2nd antenna.

The non-contact communication system characterized by the above-mentioned.

2. A said 1st thru|or 3rd antenna is a loop antenna,

The loop area of said 2nd antenna is smaller than the loop area of said 1st and said 3rd antenna.

The non-contact communication system of Claim 1 characterized by the above-mentioned.

3. Said 2nd antenna is adjoined and arranged at said conducting wire of said 3rd antenna.

The non-contact communication system of Claim 2 characterized by the above-mentioned.

4. Said 2nd antenna is arranged on said loop surface of said 3rd antenna.

The non-contact communication system of Claim 3 characterized by the above-mentioned.

5. Said 2nd antenna is arranged so that the normal-line direction of said 2nd antenna and the normal-line direction of said 3rd antenna may become perpendicular|vertical.

The non-contact communication system of Claim 3 characterized by the above-mentioned.

6. When said 1st and said 3rd antenna carries out an inductive coupling, while adjusting the 1st value of the geometric coupling coefficient in in a 1st distance between said 1st and said 3rd antennas,

When said 2nd and said 3rd antenna carries out an inductive coupling, the 2nd value of the geometric coupling coefficient in is adjusted in a 2nd distance between the loop area ratio of said 2nd and said 3rd antenna, and said 2nd and said 3rd antenna shorter than said 1st distance,

The said 1st and said 2nd value of said geometric coupling coefficient is matched with predetermined value.

The non-contact communication system of Claim 1 characterized by the above-mentioned.

7. Said 1st non-contact communication apparatus,

A production|generation means to produce|generate the conveyance signal of said communication carrier frequency,

A conveyance signal transmitting means to superimpose 1st information on said conveyance signal

produced|generated by said production|generation means, and to transmit to it
These are further provided.

The non-contact communication system of Claim 1 characterized by the above-mentioned.

8. Said 2nd non-contact communication apparatus,

A receiving means to receive said conveyance signal transmitted by said conveyance signal transmitting means of said 1st non-contact communication apparatus through said 1st thru|or said 3rd antenna,

An electric power acquisition means to acquire electric power from said conveyance signal received by said receiving means,

A 1st information acquisition means to acquire said 1st information currently superimposed on said conveyance signal received by said receiving means,

An information output means to output 2nd information,

A modulation|irregularity means to change the receiving end impedance of said 2nd antenna based on said 2nd information output by said information output means

These are further provided.

The non-contact communication system of Claim 7 characterized by the above-mentioned.

9. Said 1st non-contact communication apparatus,

A detection means to detect the variation of said receiving end impedance of said 2nd antenna which changed with said modulation|irregularity means of said 2nd non-contact communication apparatus through said 1st thru|or said 3rd antenna,

A 2nd information acquisition means to acquire said 2nd information output by said information output means of said 2nd non-contact communication apparatus based on the variation of said receiving end impedance of said 2nd antenna detected by said detection means

These are further provided.

The non-contact communication system of Claim 8 characterized by the above-mentioned.

10. A 1st non-contact communication apparatus equipped with the 1st antenna which resonates to a communication carrier frequency,

It consists of a 2nd non-contact communication apparatus equipped with the 2nd antenna which resonates to said communication carrier frequency,

And

By said 1st or the circulation magnetic field which the line current which flows into the conducting wire of said 2nd antenna produced|generated around said conducting wire, said 1st antenna and said 2nd antenna carry out an inductive coupling,

Non-contact communication of said 1st and said 2nd non-contact communication apparatus is mutually carried out through said 1st and said 2nd antenna which carried out the inductive coupling.

The non-contact communication system characterized by the above-mentioned.

11. A said 1st and said 2nd antenna,

It is the loop antenna which has a mutually different loop area.

The non-contact communication system of Claim 10 characterized by the above-mentioned.

12. A said 1st and said 2nd antenna is each arranged so that the normal-line direction of said 1st antenna and the normal-line direction of said 2nd antenna may become perpendicular|vertical.

The non-contact communication system of Claim 11 characterized by the above-mentioned.

13. The relay antenna which resonates to a communication carrier frequency is provided,

A said relay antenna,

While an inductive coupling is carried out to the another 1st antenna which resonates to said communication carrier frequency, the inductive coupling of the line current which flows into the conducting wire of the another 2nd antenna which resonates to the conducting wire or said communication carrier frequency of said relay antenna is carried out to said 2nd antenna by the circulation magnetic field produced|generated around said conducting wire,

It is non-contact and the information and electric power which communicate between said 1st and said 2nd antennas are relayed.

The non-contact communication auxiliary|assistance apparatus characterized by the above-mentioned.

14. A said relay antenna has the capacitor which comprises the resonance circuit which resonates to said communication carrier frequency, and an inductance,
A said antenna coil,
The 1st coupling|bond part which carries out an inductive coupling to said 1st antenna,
It has the 2nd coupling|bond part which carries out electromagnetic joining with said 2nd antenna.
The non-contact communication auxiliary|assistance apparatus of Claim 13 characterized by the above-mentioned.

15. A sheet-like base material is further provided,
A said antenna coil and said capacitor are formed by a pattern on the surface of said base material.
The non-contact communication auxiliary|assistance apparatus of Claim 16 characterized by the above-mentioned.

16. A said 1st and said 2nd coupling|bond part is comprised as said pattern of the same said antenna coil.
The non-contact communication auxiliary|assistance apparatus of Claim 15 characterized by the above-mentioned.

17. The surface of said base material is a 1st surface,
It is comprised from the 2nd surface which is not parallel to said 1st surface,
It circulates through said pattern of said antenna coil over said 1st and said 2nd surface top.
The non-contact communication auxiliary|assistance apparatus of Claim 15 characterized by the above-mentioned.

18. It is perpendicular|vertical in the normal-line direction of said 1st surface, and the normal-line direction of said 2nd surface.
The non-contact communication auxiliary|assistance apparatus of Claim 17 characterized by the above-mentioned.

19. Said 2nd antenna is adjoined and arranged at said pattern of said 1st or said antenna coil which was arranged while arranging on said 2nd surface and which is formed on said 1st or said 2nd surface.
The non-contact communication auxiliary|assistance apparatus of Claim 18 characterized by the above-mentioned.

20. In the non-contact communication auxiliary|assistant method of a non-contact communication auxiliary|assistance apparatus equipped with the relay antenna which resonates to a communication carrier frequency,
A said relay antenna,
While carrying out the inductive coupling of the another 1st antenna which resonates to said communication carrier frequency,
By the circulation magnetic field which the line current which flows into the conducting wire of the another 2nd antenna which resonates to the conducting wire or said communication carrier frequency of said relay antenna produced|generated around said conducting wire, the inductive coupling of said relay antenna and said 2nd antenna is carried out,
With said relay antenna by which the inductive coupling was each carried out to said 1st and said 2nd antenna, it is non-contact and the information and electric power which communicate between said 1st and said 2nd antennas are relayed.
The non-contact communication auxiliary|assistant method characterized by the above-mentioned.

(Translation From Thomson Reuters)

Description

DWPI Drawing Description

The figure shows the structure of the non-contact communication system. (Drawing includes non- English language text).

11 - R/W apparatus.

12 - tag apparatus.

22 - R/W antenna.

23 - tag antenna.

112, 113 - coupling portions of antenna sheet.

Drawing Description

Drawing Description

Description

Description

TECHNICAL FIELD of the Invention

This invention is related to a non-contact communication system, a non-contact communication auxiliary|assistance apparatus, and a method.

Specifically,

It relates to the non-contact communication system which enabled it to extend communication distance, a non-contact communication auxiliary|assistance apparatus, and a method.

PRIOR ART

IC(Integrated Circuit) card system by which the non-contact communication technique was applied is comprised what is called from a reader-writer apparatus (It describes as a R/W apparatus hereafter) which it is non-contact to the IC card, and can store predetermined information in it while it is non-contact and reads a portable IC card and the information currently stored in the IC card.

That is, it is the convenient high system [IC card system is non-contact and] which can read/write information,

It uses as the alternative system of the conventional magnetic-type card system represented by a season ticket and the authentication card in recent years, or a physical distribution system etc.

Moreover, an IC memory is made to store predetermined information in the memory|storage device (For example, videocassette tape) of the tape type|system|group which cannot do a random access in in ディスクス.

The non-contact communication system which enabled it to grasp|ascertain the predetermined information without the access to a storage medium non-contactly and easily is used.

It is indispensable practically to instantaneously operate|move such a non-contact communication system only by holding up the transponder units (It describes as a TAG apparatus hereafter), such as an IC card, in the magnetic field which a R/W apparatus generate|occur|produces.

Therefore, in utilization of a non-contact communication system, the distance in which the instantaneous operation|movement is possible (distance between a R/W apparatus and a TAG apparatus), i.e., a practical communication distance, needs to be ensured.

On the other hand, the application range spreads greatly from the usefulness of a non-contact

communication technique, and various TAG apparatus are devised.

For example, compared with the TAG apparatus of usual card|card size, the small-sized TAG apparatus is devised very much.

PROBLEM to be solved by the Invention

However

In the non-contact communication system with which this micro TAG apparatus is used, communication distance was limited very much to short distance, and the task that ensuring of a practical communication distance was difficult occurred.

This invention was comprised in view of such a situation,
It enables it to extend communication distance.

MEANS to solve the Problem

The non-contact communication system of this invention 1 consists of a 1st non-contact communication apparatus equipped with the 1st antenna which resonates to a communication carrier frequency, a 2nd non-contact communication apparatus equipped with the 2nd antenna which resonates to a communication carrier frequency, and a non-contact communication auxiliary|assistance apparatus equipped with the 3rd antenna which resonates to a communication carrier frequency,

And

While a 1st and 3rd antenna carries out an inductive coupling, a 2nd and 3rd antenna carries out an inductive coupling by the circulation magnetic field which the line current which flows into the conducting wire of a 2nd or 3rd antenna produced|generated around conducting wire,

Non-contact communication of the 1st and 2nd non-contact communication apparatus is mutually carried out through the 1st and 3rd antenna which carried out the inductive coupling, and a 3rd and 2nd antenna,

It is characterized by the above-mentioned.

A 1st thru|or 3rd antenna is a loop antenna,

A 2nd loop area of an antenna can be smaller than the loop area of a 1st and 3rd antenna.

A 2nd antenna adjoins to the conducting wire of a 3rd antenna, and can be arranged,

A 2nd antenna can be arranged on the loop surface of a 3rd antenna.

A 2nd antenna can be arranged so that the normal-line direction of a 2nd antenna and the normal-line direction of a 3rd antenna may become perpendicular|vertical.

When a 1st and 3rd antenna carries out an inductive coupling, while adjusting the 1st value of the geometric coupling coefficient in a 1st distance between 1st and 3rd antennas, when a 2nd and 3rd antenna carries out an inductive coupling, the 2nd value of the geometric coupling coefficient in is adjusted in a 2nd distance between 2nd and 3rd antennas shorter than the loop area ratio of a 2nd and 3rd antenna, and a 1st distance,

The 1st and 2nd value of a geometric coupling coefficient can be matched with predetermined value.

A 1st non-contact communication apparatus is a production|generation means to produce|generate the conveyance signal of a communication carrier frequency,

A conveyance signal transmitting means to superimpose 1st information on the conveyance signal produced|generated by the production|generation means, and to transmit to it

These can further be provided.

A 2nd non-contact communication apparatus is a receiving means to receive the conveyance signal transmitted by the conveyance signal transmitting means of a 1st non-contact communication apparatus through a 1st thru|or 3rd antenna,

An electric power acquisition means to acquire electric power from the conveyance signal received by the receiving means,

A 1st information acquisition means to acquire the 1st information currently superimposed on the conveyance signal received by the receiving means,

An information output means to output 2nd information,

A modulation|irregularity means to change the receiving end impedance of a 2nd antenna based on the 2nd information output by the information output means

These can further be provided.

A 1st non-contact communication apparatus is a detection means to detect the variation of the receiving end impedance of the 2nd antenna which changed with the modulation|irregularity means of a 2nd non-contact communication apparatus through a 1st thru|or 3rd antenna,

A 2nd information acquisition means to acquire the 2nd information output by the output means of a 2nd non-contact communication apparatus based on the variation of the receiving end impedance of the 2nd antenna detected by the detection means

These can further be provided.

In the non-contact communication system of this invention 1

While the inductive coupling of the 1st antenna of the 1st non-contact communication apparatus which resonates to a communication carrier frequency, and the 3rd antenna of the non-contact communication auxiliary|assistance apparatus which resonates to a communication carrier frequency is carried out

By the circulation magnetic field which the line current which flows into the conducting wire of the 2nd antenna of the 2nd non-contact communication apparatus which resonates to a communication carrier frequency, or a 3rd antenna produced|generated around conducting wire

The inductive coupling of the 2nd and 3rd antenna is carried out, and non-contact communication is mutually carried out between 1st and 2nd non-contact communication apparatus through the 1st and 3rd antenna by which the inductive coupling was carried out, and a 3rd and 2nd antenna.

The non-contact communication system of this invention 2 consists of a 1st non-contact communication apparatus equipped with the 1st antenna which resonates to a communication carrier frequency, and a 2nd non-contact communication apparatus equipped with the 2nd antenna which resonates to a communication carrier frequency,

And

By the circulation magnetic field which the line current which flows into the conducting wire of a 1st or 2nd antenna produced|generated around conducting wire, a 1st antenna and a 2nd antenna carry out an inductive coupling,

Non-contact communication of the 1st and 2nd non-contact communication apparatus is mutually carried out through the 1st and 2nd antenna which carried out the inductive coupling,

It is characterized by the above-mentioned.

A 1st and 2nd antenna can be a loop antenna which has a mutually different loop area.

A 1st and 2nd antenna can each be arranged so that the normal-line direction of a 1st antenna and the normal-line direction of a 2nd antenna may become perpendicular|vertical.

In the non-contact communication system of this invention 2, the inductive coupling of the 1st and 2nd antenna is carried out by the circulation magnetic field which the line current which flows into the conducting wire of the 1st antenna of the 1st non-contact communication apparatus which resonates to a communication carrier frequency, or the 2nd antenna of the 2nd non-contact communication apparatus which resonates to a communication carrier frequency produced|generated around conducting wire, and non-contact communication is mutually carried out between 1st and 2nd non-contact communication apparatus through the 1st and 2nd antenna by which the inductive coupling was carried out.

The non-contact communication auxiliary|assistance apparatus of this invention is equipped with the relay antenna which resonates to a communication carrier frequency, an inductive coupling is carried out to a 2nd antenna by the circulation magnetic field which the line current which flows into the conducting wire of the another 2nd antenna which resonates to the conducting wire or the communication carrier

frequency of a relay antenna while the inductive coupling of the relay antenna is carried out to the another 1st antenna which resonates to a communication carrier frequency produced/generated around conducting wire, it is non-contact and the information and the electric power which communicate between 1st and 2nd antennas act as intermediary, It is characterized by the above-mentioned.

A relay antenna has the capacitor which comprises the resonance circuit which resonates to a communication carrier frequency, and the antenna coil which acts as an inductance, An antenna coil can have the 1st coupling/bond part which carries out an inductive coupling to a 1st antenna, and the 2nd coupling/bond part which carries out electromagnetic joining with a 2nd antenna.

A sheet-like base material is further provided and an antenna coil and a capacitor can be formed by a pattern on the surface of a base material.

A 1st and 2nd coupling/bond part can be comprised as a pattern of the same antenna coil.

The surface of a base material is comprised from the 1st surface and the 2nd surface which is not parallel to a 1st surface, It can circulate through the pattern of an antenna coil over a 1st and 2nd surface top.

The normal-line direction of a 1st surface and the normal-line direction of a 2nd surface can be perpendicular/verticals.

A 2nd antenna adjoins to the pattern of the antenna coil formed on the arranged 1st or 2nd surface, and can be arranged while arranging on a 1st or 2nd surface.

While the non-contact communication auxiliary/assistant method of this invention carries out the inductive coupling of the relay antenna which resonates to a communication carrier frequency, and the another 1st antenna which resonates to a communication carrier frequency, the inductive coupling of a relay antenna and the 2nd antenna is carried out by the circulation magnetic field which the line current which flows into the conducting wire of the another 2nd antenna which resonates to the conducting wire or the communication carrier frequency of a relay antenna produced/generated around conducting wire, With the relay antenna by which the inductive coupling was each carried out to the 1st and 2nd antenna, it is non-contact and the information and electric power which communicate between 1st and 2nd antennas are relayed, It is characterized by the above-mentioned.

In the non-contact communication auxiliary/assistance apparatus and method of this invention While the inductive coupling of the relay antenna which resonates to a communication carrier frequency, and the another 1st antenna which resonates to a communication carrier frequency is carried out By the circulation magnetic field which the line current which flows into the conducting wire of the another 2nd antenna which resonates to the conducting wire or the communication carrier frequency of a relay antenna produced/generated around conducting wire By the relay antenna by which the inductive coupling of a relay antenna and the 2nd antenna was carried out, and the inductive coupling was each carried out to the 1st and 2nd antenna, the information and electric power which communicate between 1st and 2nd antennas are non-contact, and are relayed.

EMBODIMENT of the Invention

FIG. 1 shows the example of a structure of the non-contact communication basic system 1 by which this invention is applied.

As FIG. 1 shows, the non-contact communication basic system 1 is a system in which the R/W apparatus 11 which consists of a R/W main apparatus 21 and a R/W antenna 22, and the TAG apparatus 25 which consists of the TAG antenna 23, the LS (Load Switching) modulation circuit 24, and the TAG main apparatus 25 carry out non-contact communication mutually.

Illustration is not carried out to the R/W main apparatus 21,
However

The decoding circuit for decoding a coding network, a Manchester code, etc. which are encoded to the microcomputer for controlling communication, a Manchester code, etc., the carrier-wave generating circuit which produces|generates the carrier wave (conveyance signal) of a predetermined communication carrier frequency, ASK(Amplitude Shift Keying) modulation circuit, an ASK demodulation circuit, and a power-amplification circuit, etc. are provided.

In addition, the conventional R/W main apparatus can be used as a R/W main apparatus 21.

Therefore, since he can understand easily a structure and operation|movement of the component of the R/W main apparatus 21 to an expert, detailed description is abbreviate|omitted.

The R/W antenna 22 has the resonance circuit comprised from resistance Ra, coil La, and capacitor Ca. That is, the R/W antenna 22 is operate|moved also as a LCR resonance circuit which resonates to a predetermined communication carrier frequency while the part of the coil La operate|moves as a loop antenna.

The TAG antenna 23 has the resonance circuit comprised from resistance Rb, Coil Lb, and Capacitor Cb like the R/W antenna 22.

That is, the TAG antenna 23 is operate|moved also as a 共振す LCRC resonance circuit to a predetermined communication carrier frequency while operate|moving it as a loop antenna for the coil Lb part to carry out an inductive coupling to the R/W antenna 22 by mutual-inductance M.

Illustration is not carried out to the TAG main apparatus 25,
However

The memory for storing the power-supply generating circuit for IC, a clock extraction circuit, a logic circuit, an ASK demodulation circuit, and data etc. is provided.

In addition, the conventional TAG main apparatus can be used as a TAG main apparatus 25.

Therefore, since he can understand easily a structure and operation|movement of the component of the TAG main apparatus 25 to an expert, detailed description is abbreviate|omitted.

The LS modulation circuit 25 is a circuit where a load resistance Rc and MOS(Metal Oxide Semiconductor) switch 38 were connected in series.

Next, operation|movement of the non-contact communication basic system 1 is demonstrated.

When the TAG antenna 23 of the TAG apparatus 12 can oppose the R/W antenna 22 of the R/W apparatus 11 predetermined distance (communication distance) and is arranged at it, they will each resonate to the communication carrier frequency of the communication conveyance signal output from the R/W main apparatus 21 while carrying out the inductive coupling of the TAG antenna 23 and the R/W antenna 22 by mutual-inductance M by the magnetic field generate|occur|produced by the normal-line direction of the R/W antenna 22.

Thereby, non-contact communication of the R/W apparatus 11 and the TAG apparatus 12 can be mutually carried out now through the R/W antenna 22 and the TAG antenna 23.

While encoding in the R/W main apparatus 21, an ASK modulation|irregularity is carried out, and data (1st information is called hereafter) transmitted from the R/W main apparatus 21 is supplied to the TAG main apparatus 25 through the R/W antenna 22 which is carrying out the inductive coupling, the TAG antenna 23, and the LS modulation circuit 24 as an ASK modulating signal (communication conveyance signal on which 1st information was superimposed) (for example).

The ASK modulating signal supplied in the TAG main apparatus 25 is decoded while demodulating, and it becomes the original 1st information,

When this 1st information is the data stored in a memory, 1st information is stored in a memory, and on the other hand, when this 1st information is information read-out instructions data, based on 1st information, predetermined information is read from a memory.

In addition, the signal of the direct current|flow component removed when an ASK modulating signal

demodulated becomes power supplies, such as IC (not shown).

The data (2nd information is called hereafter) read from these responses or memories are supplied to the R/W apparatus 11 from the TAG apparatus 12 as follows.

That is, in the LS modulation circuit 24, switch 38 is switched according to 2nd information (data of 0 or 1), and the equivalent load (A load of the circuit which consists of a TAG antenna 23 and a LS modulation circuit 24 (resistance R_c)) of the antenna of the TAG apparatus 12 seen from the R/W antenna 22 is fluctuated.

This load fluctuation appears as a load fluctuation of the R/W antenna 22 in the R/W apparatus 11 by the non-contact inductive coupling between the R/W antenna 22 and the TAG antenna 23. Therefore, the R/W main apparatus 21 detects this load fluctuation as the amplitude fluctuation component (communication conveyance signal on which 2nd information was superimposed), i.e., the ASK modulating signal, of a communication conveyance signal, 2nd information is acquired by decoding, while demodulating to this.

Thus, the non-contact communication basic system 1 is a system which performs non-contact communication using an inductive coupling, The strength of this inductive coupling relates to the communication distance of the non-contact communication basic system 1 at the intimate contact.

Then, the present applicant analyzed the aspect of the inductive coupling between the above-mentioned R/W antenna 22 and the TAG antenna 23 as what is called double synchronization. Hereafter, the analysis result is demonstrated.

That is, in the inductive coupling between these antennas, the coupling coefficient (The critical-coupling coefficient k_0 is called hereafter) at the time of the threshold physically determined by the loss Q of each antenna circuit (Quality Factor) exists, When this is in agreement with the coupling coefficient (The geometric coupling coefficient k is called hereafter) exactly determined by geometric factors, such as an antenna shape and distance, it utilizes becoming the greatest transmission gain, The present applicant analyzed the aspect of the inductive coupling between the R/W antenna 22 and the TAG antenna 23.

Specifically, the critical-coupling coefficient k_0 is a coefficient showing the electrical property of the antenna require|calculated as Q value of each antenna circuit shows at following Formula (1).

[EQUATION 1]
[MAT_IMAGE 000003]

However, Q_1 shows Q value of the R/W antenna 22, Moreover, Q_2 shows Q value of the TAG antenna 23.

On the other hand, the geometric coupling coefficient k is a coefficient which respond|corresponds to the geometric arrangement of both antenna as above-mentioned.

When all the magnetic flux generate|occur|produced from the one antenna transverses another antenna, Namely, when two antennas of the same magnitude|size each confront and are touched As the value of the geometric coupling coefficient k takes 1 which is the maximum value and is shown by FIG. 2A, when two antennas are arranged in the middle on one axis|shaft, the value of (When each geometric center of two antennas is in agreement) and the geometric coupling coefficient k is estimated as following Formula (2) shows.

[EQUATION 2]
[MAT_IMAGE 000004]

However, as FIG. 2A shows, r_1 shows the diameter (diameter of a loop of coil La) of the R/W antenna 22, r_2 shows the diameter (diameter of a loop of Coil Lb) of the TAG antenna 23, and x each shows the distance between the R/W antenna 22 and the TAG antenna 23. That is, $k(x)$ shows the geometric coupling coefficient k in the distance x between the R/W antenna 22 and the TAG antenna 23.

Distance x between the R/W antenna 22 and the TAG antenna 23
Correspondence with geometric coupling-coefficient $k(x)$ calculated by this Formula (2) is shown by FIG. 2B.

However, curve (3.6 mm of diameters of an antenna) 41 shows geometric coupling-coefficient $k(x)$ in case the diameter of the R/W antenna 22 and the TAG antenna 23 is respectively 3.6 mm (when the diameter of both antennas is small respectively).

Curve (10 mm of diameters of an antenna) 42 shows geometric coupling-coefficient $k(x)$ in case the diameter of the R/W antenna 22 and the TAG antenna 23 is respectively 10 mm (when the diameter of both antennas is large respectively).

The diameter of one of a curve (the diameter of an antenna of 3.6 mm and combination of 10 mm) 43 is 3.6 mm among the R/W antenna 22 and the TAG antenna 23, Geometric coupling-coefficient $k(x)$ in case another diameter is 10 mm (when a large diameter and a small diameter are put together) is shown.

Now, since Q value of a resonance type|system|group antenna like the R/W antenna 22 and the TAG antenna 23 is generally a high value as a result, as Formula (1) shows, the value of the critical-coupling coefficient k_0 turns into a small value.

Therefore, in the non-contact communication basic system 1, a small value can be applied as a value of the geometric coupling coefficient k used as an optimal communication state.

For example, when Q value of the R/W antenna 22 and the TAG antenna 23 is each set to 10, the value of the critical-coupling coefficient k_0 is set to 0.1,

The non-contact communication basic system 1 will be in an optimal communication state, when the value of the geometric coupling coefficient k is 0.1.

Thus, when the non-contact communication basic system 1 is used, compared with the case where the system by which (When the system by which the resonance type|system|group is comprised is used) and a resonance type|system|group are not comprised is used, a value also with a small value of the geometric coupling coefficient k which the value of the critical-coupling coefficient k_0 will become smaller, as a result will be in an optimal communication state can be applied.

In addition, the aspect of a relationship with the distance x between geometric coupling-coefficient $k(x)$ and two antennas does not have great difference with a curve (the diameter of an antenna of 3.6 mm, and combination of 10 mm) 43, and curve (3.6 mm of diameters of an antenna) 41.

That is, even if only the antenna of any one (one side) is enlarged, the communication distance (distance between the antennas whose number is two) x from which the value of the geometric coupling coefficient k used as an optimal communication state is acquired is not extended so much.

When the value of the geometric coupling coefficient k which will be in an optimal communication state on the other hand is large and only the antenna of (For example, when the geometric coupling coefficient k is 0.15 or more in a comparison with curve 43 and curve 41) and one side is enlarged, the communication distance x from which the geometric coupling coefficient k used as an optimal communication state is obtained will become short rather.

Thus, (FIG. 2B shows -- as --) -- in the non-contact communication system 1 with which the micro TAG apparatus 12 is used, when the TAG antenna 23 is smaller than usual it, there exists (Distance x between the R/W antenna 22 and the TAG antenna 23 is shortened.) need that the R/W apparatus 11 and the micro TAG apparatus 12 are arranged at a short distance from usual so that the value of sufficient geometric coupling coefficient k for communication may be acquired.

Then, the present applicant employed the antenna sheet|seat 61 as is shown by FIG. 3 as a relay antenna (The antenna with which to extend the communication range was made into the objective), for example.

That is, the antenna coil Lc and Capacitor Cc are formed at the sheet-like board|substrate 71 as a pattern in the antenna sheet|seat 61 (for example).

In addition, the format will not be limited if Capacitor Cc is slim profile.
For example, a chip component etc. may be sufficient.

Also as the closed circuit comprised from the antenna coil Lc and Capacitor Cc, i.e., a LC resonance circuit which resonates to a predetermined communication carrier frequency, as FIG. 3B shows, this antenna sheet|seat 61 is operate|moved, while the part of the antenna coil Lc operate|moves as a loop antenna.

In addition, let the magnitude|size (diameter of a loop of Coil Lc (loop area)) of the antenna sheet|seat 61 be a thing substantially equal to the magnitude|size (diameter of a loop of coil La (loop area)) of the R/W antenna 22 in this example.

Moreover, in this example, the antenna sheet|seat 61 is comprised as a sheet|seat.
The structure will not be limited if it is the structure in which two above-mentioned operation|movement (Operation|movement as a loop antenna, and operation|movement as a LC resonance circuit) is possible.

By the way, if it is when the magnitude|size (The diameter of a loop of each coil Lb and La (loop area)) of the TAG antenna 23 and the R/W antenna 22 is substantially equal (i.e., when the magnitude|size (The diameter of a loop of each coil Lc and Lb (loop area)) of the antenna sheet|seat 61 and the TAG antenna 23 is substantially equal), the theory top of the antenna sheet|seat 61 is possible for arranging, as FIG. 4 shows.

That is, while the antenna sheet|seat 61, the TAG antenna 23, and R/W antenna 22 (The loop surface of each coil Lc, Lb, and La) become parallel, the antenna sheet|seat 61 can achieve the function of a relay-on theory antenna by the antenna sheet|seat 61 being arranged between the TAG antenna 23 and the R/W antenna 22 so that each normal line from the geometric center (The center of the loop of each coil Lc, Lb, and La) of each antenna may be in agreement.

However

As above-mentioned, the non-contact communication basic system 1 by which the micro TAG apparatus 12 is used differs in the magnitude|size (The diameter of a loop of each coil Lb and La (loop area)) of the TAG antenna 23 and the R/W antenna 22 very much.

Therefore, when the antenna sheet|seat 61 is applied to the non-contact communication basic system 1 by which the micro TAG apparatus 12 is used, the magnitude|sizes (The diameter of a loop of each coil Lc and Lb (loop area)) of the antenna sheet|seat 61 and the TAG antenna 23 will differ very much, Even if it arranges as the curve (the diameter of an antenna of 3.6 mm and combination of 10 mm) 43 of FIG. 2B shows, and the antenna sheet|seat 61 is shown by FIG. 4, the value of sufficient geometric coupling coefficient k is not acquired.

That is, as the antenna sheet|seat 61 is shown by FIG. 4 to the non-contact communication system 1 with which the micro TAG apparatus 12 is used, when it arranges, the antenna sheet|seat 61 cannot fully exhibit the function as a relay antenna.

In addition, the arrangement as is shown by FIG. 4 is meaning in fact that the antenna sheet|seat 61 is arranged at the space between the R/W antenna 22 and the TAG antenna 23.

That is, even if [the arrangement shown by FIG. 4] it is a practical arrangement, a manufacturer etc. will be difficult to actually arrange the antenna sheet|seat 61, as FIG. 4 shows.

Then, it analyzes about the arrangement position of the antenna sheet|seat 61 in case the magnitude|sizes of the TAG antenna 23 and the antenna sheet|seat 61 differ very much from a viewpoint that the present applicant matches the geometric coupling coefficient k with the critical-coupling coefficient k_0 .

The appropriate arrangement position of the antenna sheet|seat 61 was elucidated.

Hereafter, the appropriate arrangement position of this analysis result 61, i.e., an antenna sheet|seat, is demonstrated.

In addition, the R/W antenna 22 is used as a very large thing, and the antenna sheet|seat 61 has a magnitude|size about the R/W antenna 22 and equivalent held to the TAG antenna 23 as above-mentioned as a precondition for the purpose of the value of sufficient geometric coupling coefficient k being acquired with respect to the R/W antenna 22.

In addition, the R/W antenna 22 and the TAG antenna 23 have a dual relation, From this, even if the R/W antenna 22 and the TAG antenna 23 are replaced, the following arguments are established.

Since the value of the critical-coupling coefficient k_0 becomes that a system is a non-resonating type|system|group with a big value when the TAG antenna 23 which differs in each magnitude|size very much, and the antenna sheet|seat 61 are used, the value of sufficient geometric coupling coefficient k is not acquired.

Then, as FIG. 5A shows, the TAG antenna 23 and the antenna sheet|seat 61 shall each be arranged here, so that a system may become a resonance type|system|group.

That is, when position (The position by which the center of the TAG antenna 23 was arranged at (0, 0, 0)) at which it matched and each center axis|shaft (geometric center) of the antenna sheet|seat 61 and the TAG antenna 23 was arranged is made into reference(standard), the TAG antenna 23 sets it as (The center of the TAG antenna 23 is arranged at a coordinate (x1,0,0) or (0,0, z1).) thing by which only z1 is shifted and arranged at x axial direction by x1 or z axial direction.

FIG. 5B shows the aspect of the geometric coupling coefficient k of the antenna sheet|seat 61 and the TAG antenna 23 in, when the antenna sheet|seat 61 and the TAG antenna 23 are arranged in this way.

When only x1 is shifted to x axial direction and the TAG antenna 23 is arranged at it as for a curve (x shift) 81 in FIG. 5B, the geometric coupling coefficient k of the antenna sheet|seat 61 and the TAG antenna 23 in (x1) (x1 is 0 thru|or 30 mm) is shown,

On the other hand, the curve (z shift) 82 shows the geometric coupling coefficient k of the antenna sheet|seat 61 and the TAG antenna 23 in (z1) (z1 is 0 thru|or 30 mm), when only z1 is shifted to z axial direction and the TAG antenna 23 is arranged at it.

As a curve (z shift) 82 shows, when the TAG antenna 23 is shifted and arranged at z axial direction, or when [as a curve (x shift) 81 shows,] the TAG antenna 23 is arranged without shifting to x axial direction so much, the value of (When the TAG antenna 23 is arranged at geometric center vicinity of an antenna sheet|seat) and sufficient geometric coupling coefficient k is not acquired.

As 81 to one point shows on the other hand, when the TAG antenna 23 is shifted to x axial direction about 17 mm and arranged at it (i.e., when it arranges at the same plane top of the antenna sheet|seat 61, and the vicinity of the conducting wire of the antenna sheet|seat 61), the value ($k(17)=0.08$) of the comparatively big geometric coupling coefficient k is acquired.

Thus, when it arranges, the TAG antenna 23 can receive strongerly the influence of the loop magnetic field generate|occur|produced around the conducting wire of the antenna sheet|seat 61.

That is, an inductive coupling will become stronger, if the TAG antenna 23 is arranged so that planar (The loop surface of the coil Lb of the TAG antenna 23) of the TAG antenna 23 may transverse more magnetic flux loops produced|generated by the line current which flows into the conducting wire of the antenna sheet|seat 61.

Specifically, as FIG. 6A shows, the magnetic field H_r from the R/W antenna 22 is received, a voltage is induced, and the antenna sheet|seat 61 (antenna coil L_c) generate|occur|produces an induced current i_r .

This induced current i_r makes the loop magnetic field H_a around the conducting wire of the antenna sheet|seat 61.

Therefore, in FIG. 5, only the analysis in case the TAG antenna 23 and the antenna sheet|seat 61 are on the same plane was carried out,

However

As above-mentioned, if it is the position which can utilize the loop magnetic field H_a around [conducting wire] the antenna coil L_c of the antenna sheet|seat 61, the arrangement position of the TAG antenna 23 will not be limited.

That is, the TAG antenna 23 and the antenna sheet|seat 61 do not need to be arranged at the same plane.

For example, as FIG. 6B shows, it is good [the antenna] to install so that the loop magnetic field H_a generate|occur|produced around the one side may effect|act greatly while the TAG antenna 23 touches the one side of any one among the rectangular antenna patterns (antenna coil L_c) of the antenna sheet|seat 61.

In this case, the value of the geometric coupling coefficient k of the antenna sheet|seat 61 and the TAG antenna 23 is raised most.

Moreover, as the arrangement (arrangement as is shown by FIG. 6B) of such a TAG antenna 23 is shown by FIG. 6C, the magnetic field H_t from the TAG antenna 23 is conversely transmitted to the antenna sheet|seat 61 efficiently.

In addition, when (The curve (x shift) 81 of FIG. 5B shows.), the TAG antenna 23, and the antenna sheet|seat 61 are arranged as above-mentioned as FIG. 6B shows, and the value of (For example, the center of the TAG antenna 23 is arranged at coordinate (17, 0, 0).) and the geometric coupling coefficient k turns into the maximum value, even if it (81 to one point shows,

When set to $k(17)=0.08$), 1 is not far filled with the value of the geometric coupling coefficient k ,

However

Also in a comparatively small coupling coefficient, sufficient induced voltage can be obtained because the TAG antenna 23 and the antenna sheet|seat 61 have a resonance type|system|group.

On the other hand, when the TAG antenna 23 is arranged at the geometric center of the antenna sheet|seat 61, the influence with respect to the TAG antenna 23 of the loop magnetic field H_a generate|occur|produced around [conducting wire] (When the center of the TAG antenna 23 is arranged at (0, 0, 0)) and the antenna sheet|seat 61 and the influence with respect to the antenna sheet|seat 61 of the magnetic field H_t from the TAG antenna 23 become smaller very much, as a result the value of the geometric coupling coefficient k becomes smaller rather ($k(0)$ = set to about 0.015).

This is a characteristic thing when the magnitude|sizes of the TAG antenna 23 and the antenna sheet|seat 61 differ very much.

By the way, a non-contact communication technique has the very wide application range, and various applied technologies are proposed,

However

As above-mentioned, in the once designed non-contact communication system, when the specification of the R/W antenna 22 or the TAG antenna 23 is determined, the communication distance of a system will be prescribed.

That is, in the non-contact communication system with which the TAG antenna 23 was designed small, even if the R/W antenna 22 is designed greatly how much after that, as curve (3.6 mm of diameters of an antenna and 10 mm -- put together) 43 of FIG. 2B shows, as long as the TAG antenna 23 is small, communication distance will meet the TAG antenna 23 and will become very short.

A contrary is also the same,

Both antennas need to be expanded in order to enlarge communication distance, as curve (3.6 mm of diameters of an antenna) 41 and curve (10 mm of diameters of an antenna) 42 of FIG. 2B show.

However

The R/W apparatus 11 has the degree of freedom in design of an apparatus,
It is also possible to have a big antenna,

However

The TAG antenna 12, such as a cassette normalized on the other hand, have the small degree of freedom in design of an apparatus, and it is difficult to have a big antenna.

Then, while the antenna sheet|seat 61 using a resonance phenomenon is used for the non-contact communication basic system 1 as above-mentioned, the R/W antenna 21 and the TAG antenna 23 can communicate in sufficient communication distance through the antenna sheet|seat 61 by arranging it at the vicinity of the TAG antenna 23 appropriately.

Moreover, the TAG antenna 23 and the antenna sheet|seat 61 can be dealt with together by arranging the antenna sheet|seat 61 at the vicinity of the TAG antenna 23.

However, in order to utilize the antenna sheet|seat 61 effectively as a relay antenna, the value of the geometric coupling coefficient k of the antenna sheet|seat 61 and the R/W antenna 22 and the value of the geometric coupling coefficient k of the antenna sheet|seat 61 and the TAG antenna 23 each need to be adjusted appropriately.

In this example, the value of these two geometric coupling coefficients k shall each be matched with the value of the critical-coupling coefficient k_0 .

The mode of a matching of the critical-coupling coefficient k by this antenna sheet|seat 61 and the geometric coupling coefficient k_0 is shown by FIG. 7.

In addition, FIG. 7B respond|corresponds to above-mentioned FIG. 5B,
On the other hand, FIG. 7C is corresponding to above-mentioned FIG. 2B.

The curve k of FIG. 7C -- as shown in 102, to the value of the critical-coupling coefficient k_0 lowered by the effect of a resonance, in long distance z_1 , geometric coupling-coefficient $k(z)$ is matched with the R/W antenna 22 and the antenna sheet|seat 61, and as curve $k(x)$ 101 of FIG. 7B shows, on the other hand, the difference in the magnitude|size of a diameter of an antenna which is very different with the antenna sheet|seat 61 and the TAG antenna 23 is utilized
Geometric coupling-coefficient $k(x)$ is matched in the vicinity of the conducting wire of the antenna sheet|seat 61.

By the way, when the magnitude|size of the antenna sheet|seat 61 and the TAG antenna 23 is comparable and the antenna sheet|seat 61 and the TAG antenna 23 are arranged at vicinity, both will be in the state of a tight coupling.

The resonant frequency removes from a communication carrier frequency, and the phenomenon in which sufficient resonance is not acquired in a communication carrier frequency happens.

That is, it relates to the matching in the vicinity of the antenna sheet|seat 61 and the TAG antenna 23, and it turns out that the difference of both magnitude|size is very effective.

Thus, in fact (for example), each matched antenna is arranged, as FIG. 7A shows.

That is, when the antenna sheet|seat 61 is made into reference(standard), the R/W antenna 22 is arranged so that the surface (loop surface of coil La) and surface (loop surface of Coil Lc) of the antenna sheet|seat 61 may become parallel, while the distance of the center and center of the antenna sheet|seat 61 is set to z_1 .

(The R/W antenna 22 and the antenna sheet|seat 61 leave only distance z_1 ,
It each arranges so that it may oppose.)

Moreover, the TAG antenna 23 is arranged so that the loop magnetic field around the one side

(conducting wire) of the antenna pattern may effect|act greatly, while distance with the center of the antenna sheet|seat 61 is arranged at $x1$, i.e., the vicinity of the arbitrary one side of the antenna pattern (coil Lc) of the antenna sheet|seat 61.

Specifically, as FIG. 8A shows (for example), the TAG apparatus 12 can be arranged on the same plane so that it may touch edge 61a of the antenna sheet|seat 61.

Thus, the non-contact communication system 111 with which the antenna sheet|seat 61 was added to the non-contact communication basic system 1 of FIG. 1 is comprised as FIG. 8B shows. In addition, the code which respond|corresponds is attached to the part which respond|corresponds to the non-contact communication basic system 1 of FIG. 1 in FIG. 8B.

As above-mentioned in this example of a structure, the antenna sheet|seat 61 which is a relay antenna is arranged between the R/W antenna 22 of the R/W apparatus 11, and the TAG antenna 23 of the TAG apparatus 12.

As above-mentioned, the antenna sheet|seat 61 is formed as a closed circuit which consists of a coil Lc and a capacitor Cc .

That is, the antenna sheet|seat 61 is operate|moved as an antenna for the 2nd coupling|bond part 113 of the coil Lc to carry out an inductive coupling to the TAG antenna 23 by mutual-inductance M while operate|moving as a loop antenna for the 1st coupling|bond part 112 of the coil Lc to carry out an inductive coupling to the R/W antenna 22 by mutual-inductance M . Furthermore, it operate|moves also as a LC resonance circuit which resonates to a predetermined communication carrier frequency.

The 1st coupling|bond part 112 corresponds to the loop whole of the antenna pattern (coil Lc) of the antenna sheet|seat 61 in FIG. 8A,

On the other hand, the 2nd coupling|bond part 113 mainly corresponds one edge 61a of the antenna pattern of the antenna sheet|seat 61.

That is, the inductive coupling of the 2nd coupling|bond part 113 and the TAG antenna 23 (coil Lb) is carried out by the loop magnetic field which the line current which flows into the conducting wire of the 2nd coupling|bond part 113 as above-mentioned produces|generates.

The other structure is the same as that of FIG. 1.

Operation|movement of the antenna sheet|seat 61 is as above-mentioned,

Moreover, operation|movement of the non-contact communication system 111 is the same as that of operation|movement of the non-contact communication basic system 1 of FIG. 1 fundamentally,

Therefore

Those description is abbreviate|omitted.

In addition, the antenna sheet|seat 61 and the TAG antenna 12 can freely be arranged, if the conditions that the inductive coupling of the antenna sheet|seat 61 and the TAG antenna 12 is carried out by mutual-inductance M are satisfy|filled by the circulation magnetic field which the electric current which flows into the above-mentioned conditions, i.e., the conducting wire of the arbitrary edges of the antenna pattern (coil Lc) of the antenna sheet|seat 61, and the conducting wire of the coil Lb of the TAG antenna 12 produced|generated around these conducting wire.

For example, as FIG. 9 respectively shows as the antenna sheet|seat 61 and the TAG antenna 12, it can arrange.

FIG. 9A is the example arranged on the plane in which the TAG apparatus 12 and the antenna sheet|seat 61-1 were respectively independent.

However, the 2nd connection part 113 of FIG. 8B mainly corresponds to edge 61-1a of an antenna pattern (coil Lc).

FIG. 9B is the example formed with the sheet|seat of the planar shape comprised from surface 61-2b

with the board|substrate (sheet|seat) 71 of the antenna sheet|seat 61-2 parallel to surface 61-2a and x-z plane parallel to the plane, i.e., the x-y plane, of a L-shape.

The TAG apparatus 12 (for example) is arranged so that edge 61-2c of an antenna pattern (coil Lc) may be touched on surface 61-2b.

That is, the 2nd connection part 113 of FIG. 8B mainly corresponds to edge 61-2c of an antenna pattern (coil Lc).

FIG. 9C is the example formed like FIG. 9B with the sheet|seat of the planar shape comprised from surface 61-3b with the board|substrate (sheet|seat) 71 of the antenna sheet|seat 61-3 parallel to surface 61-3a and x-z plane parallel to the plane, i.e., the x-y plane, of a L-shape.

However, surface 61-3b is smaller than surface 61-2b of FIG. 9B (for example), and comprises the magnitude|size which is the extent in which the TAG apparatus 12 is settled exactly.

That is, the TAG apparatus 12 (for example) is arranged so that surface 61-b [3] top, edge 61-3c of an antenna pattern (coil Lc) and a 61 to 3 d edge, and the 3 side of edge 61-3e may be touched.

That is, the 2nd connection part 113 of FIG. 8B mainly corresponds to edge 61-3c of an antenna pattern (coil Lc), a 61 to 3 d edge, and edge 61-3e.

Thus, the antenna sheet|seat 61 and the TAG antenna 12 can perform the arrangement in various forms where the place mounted, the magnitude|size, or the process in manufacture was considered into consideration, adjoin very much and can be arranged,

From this, it can operate|use as an apparatus with as required same the antenna sheet|seat 61 and the TAG apparatus 12.

I.e., it can regard as an antenna with integral antenna sheet|seat 61 and TAG antenna 23.

That is, if the antenna sheet|seat 61 is used, even if the TAG antenna 23 is not changed, enlargement of the communication range can be achieved easily.

However, as above-mentioned, the differences of the magnitude|size of the antenna sheet|seat 61 and the TAG antenna 23 need to differ very much.

Because, when the magnitude|size of the antenna sheet|seat 61 and the TAG antenna 23 is substantially equal temporarily, in order to match the geometric coupling coefficient k with the low critical-coupling coefficient k₀, the antenna sheet|seat 61 and the TAG antenna 23 need to be released and arranged,

It is for being hard to say that enlargement of the communication range was achieved easily practically this.

Moreover, it comes to be able to do in the conventional communication system of making two antennas opposing and communicating, in particular the arrangement method, i.e., arrangement method of making it arrange so that the normal-line direction of the antenna sheet|seat 61-1 and the normal-line direction of the TAG antenna 23 of the TAG apparatus 12 may become perpendicular|vertical, as is shown by FIG. 9A, only after being unable to apply and employing the system with which the loop magnetic field of the above-mentioned circumference|surroundings of antenna conducting wire is utilized.

This arrangement method is fully exhibiting that effect also in the following application examples.

That is, FIG. 10 shows the example of a structure of the videocassette system by which the non-contact communication system 111 of FIG. 8 was applied.

Now, the videocassette system comprised from videocassette 121 on which the small-sized TAG apparatus 12 as is shown by FIG. 10A was embedded, and the videocassette player 122 to which the R/W antenna 22 was attached is commercialized.

In this system, when videocassette 121 is mounted in the videocassette player 122, the TAG apparatus 12 (TAG antenna 23) embedded on videocassette 121 and the R/W antenna 22 attached to the video recorder oppose in a short distance,

Non-contact communication is performed within the videocassette player 122.

This TAG antenna 23 is manufactured micro according to the shape of the video-recorder cassette 121,

Communication in proximity|contact distance (inside of the video deca set player 122) is mainly the antenna made into the objective.

Without also relating to such videocassette 121 and changing the TAG apparatus 12 of videocassette 121 main body, as FIG. 10B shows, the communication distance can be easily changed only by the antenna sheet|seat 61 being added.

That is, as FIG. 10B shows, when the antenna sheet|seat 61 formed at sheet type is stored in the videocassette case 122 together with videocassette 121, it means that the antenna sheet|seat 61 and the TAG antenna 23 were arranged by optimal positional relationship.

As a result, the communication distance of the TAG antenna 23 is extended seemingly.

It means that the magnitude|size of the TAG antenna 23 had been i.e. extend|expanded by the magnitude|size of the antenna sheet|seat 61 seemingly.

Communication in a long distance can be performed by the R/W apparatus (The R/W apparatus different from the R/W apparatus 11 mounted on the videocassette player 122) according to it being used.

Thus, communication distance can be extended only by the antenna sheet|seat 61 being added in the non-contact communication basic system 1 by which original and short-distance communication were made into the objective, without changing TAG apparatus 12 main body.

For example, a user inserts the videocassette case 122 in videocassette 121 with the antenna sheet|seat 61,

Non-contact communication can be performed only by holding it up to another R/W apparatus.

Furthermore, when the antenna sheet|seat 61 is a shape like FIG. 9A, as above-mentioned (FIG. 10B shows -- as), it forms at one sheet of sheet type, and also (for example), in the case of a shape like FIG. 9B, the antenna sheet|seat 61 can be formed in the shape of a cassette index sheet (L-shape).

Thus, the determinant of communication distance becomes the combination of the R/W antenna 22 and the antenna sheet|seat 61 instead of the combination of the R/W antenna 22 and the TAG antenna 23 by changing the magnitude|size of the antenna sheet|seat 61 in accordance with the R/W antenna 22 which respond|corresponds.

This is meaning exactly that it is considered that the antenna of the TAG apparatus 12 became the antenna sheet|seat 61 from the R/W antenna 22.

That is, the antenna sheet|seat 61 can have the same effect as the time of the TAG antenna 23 being changed by installing appropriate for the vicinity of the small TAG antenna 23.

Therefore, a manufacturer etc. is not based on the magnitude|size of the TAG antenna 23, but designs a new R/W antenna,

The communication distance of the TAG apparatus 12 is extensible.

Furthermore, since the antenna sheet|seat 61 is used in contact with the TAG antenna 23, both can integrally be treated and it becomes a very convenient high thing in actual utilization.

Furthermore, the antenna sheet|seat 61 is an antenna apparatus whose degrees of freedom on an arrangement is comparatively high while being able to implement|achieve by very simple structure called only 2 elements of an antenna pattern (coil Lc) and the capacitor Cc of the small capacity|capacitance for adjusting a resonance and being able to manufacture it at very few|small cost.

Therefore, as for the non-contact communication system 111 with which the antenna sheet|seat 61 was applied, the TAG antenna 23 was unavoidably designed small from the reasons of a space,

However

In the case where extension of the communication distance of the TAG apparatus 12 is required according to a use etc., it is an in particular effective system.

Moreover, the non-contact communication system 111 can make several R/W antennas other than R/W antenna 22 respond|correspond to one TAG antenna 23.

That is, a manufacturer etc. can manufacture a system or an apparatus etc. with which several R/W antennas can be designed according to the communication distance corresponding to an arrangement space or a use, as a result various non-contact communication technique other than the above-mentioned videocassette system is utilized.

Thus, the non-contact communication system 111 utilizes the loop magnetic field around [conducting wire] an antenna,
It is characterized by the above-mentioned,
The non-contact communication system using the magnetic field generate|occur|produced in the conventional normal-line direction of antenna-pattern plane (loop plane of a coil) is a clearly different system.

By the way, the method of utilizing the loop magnetic field around [conducting wire] this antenna is the case where the antenna sheet|seat 61 is not used,
Comprising:
At the time so that the magnitude|sizes of a two antenna may differ very much
WHEREIN:
It can apply similarly.

That is, when the TAG antenna 23 is arranged at center position 131 vicinity of the antenna sheet|seat 61 so that the normal-line direction and normal-line direction of the R/W antenna 22 may be in agreement as FIG. 11 shows in the non-contact communication basic system 1 of FIG. 1, when very large [the R/W antenna 22] compared with the TAG antenna 23, the R/W apparatus 11 becomes difficult [it / to read information in the TAG apparatus 12].

As for the R/W apparatus 11, information can be read in the TAG apparatus 12 when the TAG antenna 23 is arranged at an edge which, on the other hand, receives the loop magnetic field generate|occur|produced around the conducting wire of the R/W antenna 22, i.e., edge position 132 vicinity.

Thus, above-mentioned method (The method using the loop magnetic field around [conducting wire] an antenna) can be applied to a non-contact communication system which arranges a TAG antenna at the edge of a R/W antenna, and communicates.

In addition, in FIG. 11, the R/W antenna 22 is illustrated about the case of being very large, compared with the TAG antenna 23,
However

The method (The method using the loop magnetic field around [conducting wire] an antenna) which the R/W antenna 22 above-mentioned also about the case of being very small, compared with the TAG antenna 23 can be applied.

Moreover, in this specification, a system is a processing means,
And the apparatus whole comprised by several apparatus is shown.

ADVANTAGE of the Invention

As mentioned above, according to the non-contact communication system, non-contact communication auxiliary|assistance apparatus, and method of this invention, communication distance is extensible.

BRIEF DESCRIPTION OF THE DRAWINGS

[FIG. 1]

It is the figure which shows the example of a structure of the non-contact communication basic system by which this invention is applied.

[FIG. 2]

It is the figure which shows the distance between each of the R/W antenna of the non-contact communication basic system of FIG. 1, and a TAG antenna, a diameter, and the related example of a

geometric coupling coefficient.

[FIG. 3]

It is the figure which shows the example of a structure of the antenna sheet|seat with which this invention is applied.

[FIG. 4]

It is the figure which shows the example of a structure of the arrangement of the antenna sheet|seat of FIG. 3.

[FIG. 5]

It is the figure which shows an arrangement position with the antenna sheet|seat of FIG. 3, and the TAG antenna of the non-contact communication basic system of FIG. 1, and the related example of a geometric coupling coefficient.

[FIG. 6]

It is a figure explaining the related example of the arrangement position of the principle of the antenna sheet|seat of FIG. 3, and the TAG antenna of the antenna sheet|seat of FIG. 3, and the non-contact communication basic system of FIG. 1.

[FIG. 7]

It is the figure which shows typically the example of a matching of the geometric coupling coefficient of the antenna sheet|seat of FIG. 3, and the TAG antenna of the non-contact communication basic system of FIG. 1, and a matching of the geometric coupling coefficient of the antenna sheet|seat of FIG. 3, and the R/W antenna of the non-contact communication basic system of FIG. 1.

[FIG. 8]

It is the figure which shows the example of a structure of the non-contact communication system with which this invention by which the antenna sheet|seat of FIG. 3 was mounted on the non-contact communication basic system of FIG. 1 is applied.

[FIG. 9]

It is the figure which shows a structure of the example of mounting of the antenna sheet|seat of the non-contact communication system of FIG. 8, and a TAG antenna.

[FIG. 10]

It is the figure which shows the example of a structure of the videocassette system by which the non-contact communication system of FIG. 8 was applied.

[FIG. 11]

It is the figure which shows a structure of the application example of the arrangement of the TAG antenna of the non-contact communication basic system of FIG. 1, and a R/W antenna.

Description of Symbols

1 Non-contact communication basic system,
 11 R/W apparatus,
 12 TAG apparatus,
 21 R/W main apparatus,
 22 R/W antenna,
 23 TAG antenna,
 24LS modulation circuit,
 25 TAG main apparatus,
 61 Antenna sheet|seat,
 71 Board|substrate,
 111 Non-contact communication apparatus,
 112 1st coupling|bond part,
 113 2nd coupling|bond part,
 Ra,
 Rb,
 Rc Resistance,
 La,
 Lb Coil,
 Lc Antenna coil,
 Ca,
 Cb,
 Cc capacitor,
 Ha,

Hr,
Ht Magnetic field,
Ir,
It Induced current
[FIG. 1]
[MAT_IMAGE 000005]
[FIG. 2]
[MAT_IMAGE 000006]
[FIG. 3]
[MAT_IMAGE 000007]
[FIG. 4]
[MAT_IMAGE 000008]
[FIG. 5]
[MAT_IMAGE 000009]
[FIG. 6]
[MAT_IMAGE 000010]
[FIG. 7]
[MAT_IMAGE 000011]
[FIG. 8]
[MAT_IMAGE 000012]
[FIG. 9]
[MAT_IMAGE 000013]
[FIG. 10]
[MAT_IMAGE 000014]
[FIG. 11]
[MAT_IMAGE 000015]

(Translation from Thomson Reuters)

Citations

Citation Record level

 Expand Citing Patents (25)

 Expand Cited Patents (12)

 Cited Non-patents (0)

Other

DWPI Title Terms

NON CONTACT COMMUNICATE SYSTEM INTEGRATE CIRCUIT CARD READ WRITING APPARATUS TAG
PERFORMANCE INDUCTIVE COUPLE RESPECTIVE ANTENNA SHEET

DWPI Related Accession Numbers

-

Custom Fields

Test

-

Relevance

^

Product Name

^

Docket number

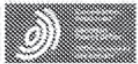
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Notes

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NON-CONTACT FEEDING DEVICE

Inventor(s): YAMAMOTO KITAO; SASAKI MANABU ± (YAMAMOTO KITAO ; SASAKI MANABU)

Applicant(s): MITSUI SHIPBUILDING ENG ± (MITSUI ENG & SHIPBUILD CO LTD)

Classification: - **International:** **B60L5/00; H01F38/14; H01M10/44; H02J17/00; H02J7/00;** (IPC1-7): B60L5/00; H01F38/14; H01M10/44; H02J17/00; H02J7/00

- **cooperative:** **Y02E60/12**

Application number: JP20020332448 20021115

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Abstract of JP2004166459 (A)

PROBLEM TO BE SOLVED: To provide a non-contact feeding device that can feed power only when a gap between a feeding position and a receiving one is within a prescribed value. ; **SOLUTION:** A secondary battery mounted device 3 that uses a secondary battery (not shown) as a power source is provided with a feeding control portion 12. This feeding control portion 12 starts feeding power when proximity sensors 13 detect that the facing surfaces of the feeding portion 2-1 of a power supply 2 that comes close to the device 3 and feeds power by an electromagnetic induction means in a non-contact way to charge the secondary battery and of the receiving portion 3-1 of the device 3 are close to each other with a little gap. Feeding is stopped when a receiving detection sensor 11 does not detect within a certain period of time that the receiving portion 3-1 has reached a chargeable position. ; **COPYRIGHT:** (C)2004,JPO



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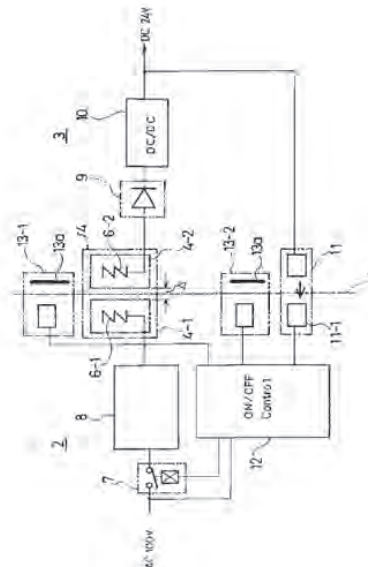
(54) 【発明の名称】 非接触給電装置

(57) 【要約】

【課題】 給電部位と受電部位との間隔が所定値内にあるときのみ給電可能となる非接触型給電装置を提供する。

【解決手段】 2次電池（図示せず）を動力源とする2次電池搭載装置3に、接近して電磁誘導手段により非接触的に給電して2次電池に充電する電源装置2の給電部2-1と、2次電池搭載装置3の受電部3-1とが僅かな隙間を開けて相対する面が接近したことを近接センサ13が検知すると給電を開始し、受電検知センサ11が一定時間内に受電部3-1が充電可能状態に達したことを検知しないと給電を停止する給電制御部12を設けた。

【選択図】 図1



【特許請求の範囲】

【請求項1】

2次電池を動力源として作動する2次電池搭載装置と、前記2次電池に充電する電源装置とが、充電時にいずれかまたは相互に、また自動的にまたは遠隔操作により接近して電磁誘導手段により非接触的に給電する給電装置において、前記電源装置の給電部と、前記2次電池搭載装置の受電部とが接近し給電可能状態となると、少なくとも僅かな隙間を開けて相対する面が生じるように前記両装置を形成し、前記相対する面が予め定められた間隔以内に接近すると給電開始信号を出力する近接センサと、前記受電部が充電可能状態に達したことを検知する受電検知センサとを設け、前記近接センサが前記接近を検知すると、給電を開始し、給電開始後一定時間内に前記受電検知センサが受電開始信号を検知すると給電を継続し、何らかの原因で前記一定時間内に前記受電開始信号を検知しないと給電を停止する給電制御部を設けた非接触給電装置。

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【請求項2】

前記近接センサが、交流電流により励磁する電磁コイルと、前記2次電池搭載装置に取り付けた透磁率の高い金属体とからなり、前記電磁コイルによる励磁で前記金属板に発生する渦電流により生じる前記電磁コイルの負荷変動を検知して前記隙間の大きさを検知することからなる請求項1記載の非接触給電装置。

【請求項3】

前記受電検知センサが、前記2次電池搭載装置が受電して発生する電圧が所定値に達すると光を発する発光素子と、前記電源装置に設けられ、前記発光により作動する受光素子とで構成することからなる請求項1～2のいずれかに記載の非接触給電装置。

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【請求項4】

前記受電検知センサが、前記2次電池搭載装置が受電して発生する電圧が所定値に達すると超音波を発信する超音波発信素子と、前記電源装置に設けられ、前記超音波を受信する超音波受信素子とで構成することからなる請求項1～2のいずれかに記載の非接触給電装置。

【請求項5】

前記近接センサの励磁を間 断 的に行なうようにした請求項1～4のいずれかに記載の非接触給電装置。

【請求項6】

前記2次電池を動力源として作動する装置が水中に敷設された装置であり、前記給電装置の給電部を水中走行ロボットに設けたことからなる請求項1～5記載の非接触給電装置。

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【請求項7】

前記2次電池を動力源として作動する装置が自走式作業ロボットであり、前記給電装置は該作業ロボットの待機中に充電するようにしたことからなる請求項1～5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、電磁誘導作用を利用して給電する非接触給電装置に関し、更に詳細には、例えば海中施設などに搭載する2次電池に給電装置を搭載した水中ロボットを使用して給電する際に、前記施設の受電部位にロボットの給電部位が正しく配置されたことを自動的に確認して給電を行なう非接触給電装置に関するものである。

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【0002】

【従来の技術】

リチウム電池など、高性能、軽量、且つ密閉型2次電池が開発されたため、長時間電源から切り離して機器を作動させることが可能となり、またコードレス電話器、電気髭剃り器、電気自動車など各種分野で、それぞれの必要性からコンセントなどの電気接点を使用しないで充電できる非接触型給電装置、即ち電磁誘導方式を用いた給電装置が提案され、また実際に使用されるに至っている。

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【0003】

前記電磁誘導方式による給電上の問題として、何らかの原因で受電部位に金属が置かれると、電磁誘導作用により発熱し、装置が加熱されて故障の原因となったり、最悪の場合火災を起こすなどのおそれが生じる。

【0004】

その対策として、電気髭剃り器（以下シェーバーという）の非接触充電器の小型化技術を開示した「小型高効率共振トランスを用いた非接触充電器」（松下電工技報（D.E.C. 2001）88～92ページ）には、充電器上にシェーバーが置かれているか否かの識別を行なう手段として、トランス1次側コアおよびトランス2次側コアにそれぞれ電力伝達用1次、2次巻線の外に、本体検知・充電制御信号用巻線および間発振用巻線を設け、電力伝達時以外は間発振用巻線により励磁高周波電流を供給し、シェーバー本体側から受電したことを知らせる本体検知信号が出力されない限り充電操作を行なわないようにすることで、シェーバー以外の対象に電力を供給しないようにしたものである。

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【0005】

【非特許文献1】

桂 嘉志、山下 幹広、安部 秀明共著「小型高効率共振トランスを用いた非接触充電器」松下電工技報（2001年12月、P. 88～92）

【0006】

【発明が解決しようとする課題】

ところで、例えば海水の水質などを長期間継続的に定点観測する要望が高まっている。そのため動力源として各種一次電池を使用すると設備費は安価となるが使い捨てであるため環境保全重視の社会的要望に反し好ましくなく、各種二次電池に太陽電池や波動発電機を組み合わせる方法は気象・海象の影響を受けるため作動の確実性に欠け、10ワット程度の小電力用としてのみ可能性があると思われれる。また燃料電池は開発中の技術であり、また商用電力を直接供給するには海底ケーブルの敷設工事が必要となり経済上の問題が生じる。

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【0007】

したがって各種二次電池を水中施設に取り付け、水中ロボットにより充電するという組み合わせが最も現実的であると考えられる。例えば、50ワット負荷を7日間（158時間）使用すると消費電力量は8.4kWhとなり、これを仮に2kWで充電すると約4時間で充電できる。したがって水中ロボットによる充電方式は、長期定点観測の実現性に最も高い方式の一つと考えられる。

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【0008】

このような場合、給電方式は水中であるから当然非接触型給電方式となるが、給電装置に鉄などの透磁率の高い異物が近づいた場合、これを誘導加熱してしまうおそれがある。かかる事態の回避と、視界が十分でない海中での遠隔操縦により確実に給電側と受電側の鉄心が正確に一定範囲内に接近させる必要があるという問題がある。

【0009】

本発明は、以上の問題に着目してなされたものであり、経済的理由などで送電ケーブルの敷設が困難な海中設備などに装備した2次電池に給電する給電装置において、給電部位と受電部位との間隔が所定値内にあるときに給電可能となる非接触型給電装置を提供することを目的としている。

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【0010】

【課題を解決するための手段】

上記目的を達成するための本発明の非接触型給電装置は、2次電池を動力源として作動する2次電池搭載装置と、前記2次電池に充電する電源装置とが、充電時にいずれかまたは相互に、また自動的にまたは遠隔操作により接近して電磁誘導手段により非接触的に給電する給電装置において、前記電源装置の給電部と、前記2次電池搭載装置の受電部とが接近し給電可能状態となると、少なくとも僅かな隙間を開けて相対する面が生じるように前記両装置を形成し、前記相対する面が予め定められた間隔以内に接近すると給電開始信号を出

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力する近接センサと、前記受電部が充電可能状態に達したことを検知する受電検知センサとを設け、前記近接センサが前記接近を検知すると、給電を開始し、給電開始後一定時間内に前記受電検知センサが受電開始信号を検知すると給電を継続し、何らかの原因で前記一定時間内に前記受電開始信号を検知しないと給電を停止する給電制御部を設けたものである。

【0011】

前記何らかの原因とは、例えば近接センサが2次電池搭載装置以外の物体に反応し、誤作動した場合、前記受電部が故障している場合などである。

【0012】

前記近接センサには特に限定は無く、光を利用するもの、静電容量の変化を利用するもの、超音波を利用するもの、空気圧を利用するもの、電磁誘導によるうず電流による励磁コイルの入力インピーダンス変化を利用するものなど、一般に知られたものの中から適宜選択できる。水中ロボットに適用するものとしては、前記うず電流方式、即ち交流電流により励磁する電磁コイルと、前記2次電池搭載装置に取り付けた透磁率の高い金属体とからなり、前記電磁コイルによる励磁で前記金属板に発生するうず電流により生じる前記電磁コイルの負荷変動を検知して前記隙間の大きさを検知する方法の採用が好ましい。

【0013】

前記受電検知センサには特に限定はないが、例えば前記2次電池搭載装置が受電して発生する電圧が所定値に達すると光を発する発光素子と、前記電源装置に設けられ、前記発光により作動する受光素子とで構成する方法、前記2次電池搭載装置が受電して発生する電圧が所定値に達すると超音波を発信する超音波発信素子と、前記電源装置に設けられ、前記超音波を受信する超音波受信素子とで構成する方法などを採用することができる。さらに、前記発光、超音波などの信号がノイズの影響を受けないようにするために、受電検知センサに変調・復調手段を設けることができる。

【0014】

前記近接センサの励磁を間断的に行なうと、うず電流による発熱により、装置が加熱をされることを少なくできるので、一般的に好ましいが、本発明はこれに限定されない。

【0015】

本発明の非接触型給電装置を適用する装置には特に限定はないが、前記2次電池を動力源として作動する装置が水中に敷設された装置であり、前記給電装置の給電部を水中走行ロボットに設けたもの、前記2次電池を動力源として作動する装置が掃除ロボット、巡回監視ロボットなどの自走式作業ロボットであり、前記給電装置は該作業ロボットの待機中に充電するようにしたものなどを適用対象として例示することができる。

【0016】

【発明の実施の形態】

以下添付の図面を参照する一実施の形態を示し本発明の非接触型給電装置を具体的に説明する。

【0017】

図1に示す回路は、本発明の非接触型給電装置の基本回路を説明するものであり、中央に示す破線1の左側が電源装置2の回路部分であり、右側が2次電池搭載装置3の回路部分であり、ギャップ結合トランス4は電源装置2側と2次電池搭載装置3側とに跨って設けられている。

【0018】

ギャップ結合トランス4は、トランス1次側4-1とトランス2次側4-2とに分割されており、その鉄心5は、図2に示すように、互いに開口部分が向き合っていないU状の1次側鉄心5-1および2次側鉄心5-2からなり、それぞれ1次コイル6-1および2次コイル6-2を巻きつけ、1次側鉄心5-1および2次鉄心5-2の合わせ部分のギャップΔを所定値以下とすることで過大な励磁無効電力が生じないように設計されている。

【0019】

なお一例として、250～300W、周囲温度を-10～40℃とした場合のギャップ結

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合トランス 4 として、鉄心にフェライトを使用し、鉄心の幅を 20 mm、積層厚みを 50 mm、両側の腕状部の鉄心長さを 40 mm、リッツ線コイルを巻く辺の鉄心長さを 120 mm とし、全体を絶縁性樹脂で水密とした容器内に、ギャップ Δ が 5 mm 以下とすることができ、

【0020】

図 1 の説明に戻り、トランス 1 次側 4-1 の 1 次コイル 6-1 と電源との間にはリレーがらなる電源スイッチ 7 および周波数変換器 8 を介して AC 100 V などの交流電源（以下電源 E）に接続した。なお周波数変換器 8 は低周波電源を高周波に変換するものであり、例えば A/D 変換器とインバータとを組み合わせたものを使用することができる。

【0021】

トランス 2 次側 4-2 の 2 次コイル 6-2 は、発生した高周波電圧を整流器 9 によって直流に変換し、直流電圧安定化回路 10 を介して 2 次電池（図示せず）と受電検知センサ 11 とに与えるようにした。

【0022】

電源装置 2 の電源 E に対し、電源スイッチ 7 および周波数変換器 8 と並列的にマイクロコンピュータからなる給電制御部 12 を設け、これに受電検知センサ 11 および近接センサ 13-1 および 13-2（以下総称するときは 13 を表す）の出力信号を入力し、電源スイッチ 7 をオン・オフ制御するように構成し、近接センサ 13-1 および 13-2 から接近完了信号が出力されると、電源スイッチ 7 をオンすると共に計時プログラム（タイマー）を作動させ、一定時間内に受電検知センサ 11 から受電検知信号が出力されない、給電制御部 12 は電源スイッチ 7 をオフするようにプログラムした。

【0023】

次に受電検知センサ 11 および近接センサ 13 を、図 3～5 に示す第 2 実施の形態によって、より具体的に説明する。図 3 は第 2 実施の形態による非接触型給電装置を海中 14 に敷設した昇降式水質計測ブイ 15 用の水中ステーション 16 と充電兼データ回収用水中ロボット（以下単に水中ロボットという）17 とによって実施したものである。なお本発明は上記水質計測用以外の水中施設に利用できることは説明を要しないことは明らかである。

【0024】

第 2 実施の形態による非接触型給電装置のギャップ型結合トランス 4 のトランス 1 次側 4-1（図 4）は、水中ロボット 17 の給電部 3-1 に設け、信号伝送、索条などの機能を有する電源ケーブル 19 によって母船 18 に搭載した発電機（図示せず）を電源とし給電制御部（図 3 および 4 に図示せず）に接続した。またトランス 2 次側 4-2（図 4）を収容する受電部 3-2 は、水中ステーション 16（図 3）に設けた電源部（2 次電池）20 と一体的に取り付けた。図 4 に示すギャップ結合トランス 4 のギャップ Δ は、図 4 に示す 2 箇所の間隔 δ_1 および δ_2 の和の $1/2$ （ $\delta_1 / 2 + \delta_2 / 2$ ）に一致する。

【0025】

ここで図 3 に示す水中ステーション 16 および水中ロボット 17 に図示されている部材について説明する。水中ステーション 16 に付した符号 16a は昇降式水質計測ブイ 15 を水中ステーション 16 に係留し、且つブイ 16 内の機器を作動させる電源用リード線、観測に必要とする信号を伝達する信号線等を組み込んだケーブル、16b はケーブル 16a を巻き取り・繰り出す電動機内臓のドラム、16c は観測用電子機器容器、16d は水中ロボット 17 にデータを伝送する音響リンク、16e は海底の岩盤等に固定するための脚部である。

【0026】

また水中ロボット 17 に付した符号 17a はスラストであり前進・後退用スラストが 3 機、上昇・下降用スラストが 2 機、側方移動用スラストが 1 機使用されており、17b は水中ロボット本体、17c は前記本体 17b の端部を覆う透明アクリル樹脂製のドームであり、その中心軸上に操縦用 CCD カメラを備えている。17d はヘッドライト、17e は超音波ソナー、17f は保護用フレームである。また図 4 に示す符号 4a は水密とした

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樹脂製容器である。

【0027】

第2実施の形態のギャップ結合トランス4は、結合されると図2に示したギャップ結合トランス4と同じであるが、1次側鉄心5-1は、図4に示すように鉄心の1辺の一部を切り出した形状とし、したがって1次コイル6-1も幅を狭く、分厚く巻き付け、外見上は平板状に形成した。2次コイル6-2は、図1に示したものと同様にした。2点鎖線で示した2次側鉄心5-2および2次コイル6-2は、水中ロボット17に設けた給電部2-1が受電部3-1に結合すると図1で示した非接触型給電装置の基本回路が形成され、前記説明の手順に従って充電できることを示している。

【0028】

ところで、第2の実施の形態で使用した受電検知センサ11の信号出力素子11-2には発光素子、例えば発光ダイオードを使用し、光による受電検知信号回路11-1にはフォトトランジスタを使用したか、フォトダイオードなどの受光素子を使用することもできる。更に超音波を使用することもでき、これらの信号を変調し、ノイズによる作動ミスを防止することもできる。また近接センサ13の金属板13aにうず電流を発生させる電磁コイル13bの鉄心13cにはコナールU状鉄心を使用した。但し、棒状鉄心を使用することもできる。

【0029】

なお第2実施の形態による近接センサ13が検出する隙間は、第1実施の形態のギャップΔではなく、1次側鉄心5-1の軸心と、これと向き合う2次側鉄心5-2の軸心5a(図4)との不一致の許容範囲である。したがって、受電部3-1に給電部2-1を結合させるには、最終段階で給電部2-1を前進・後退のみの動きとする必要がある。したがって、前進後退のみの動きとする場合近接センサ13は少なくとも1個設けるのでもよい。なお、図4に示す符号11aは光透過用の窓である。

【0030】

そのために、例えば図5に示すような先端が拡開した鞘状ガイド21-1と挿入棒21-2を、受電検知センサ11および近接センサ13それぞれの給電部2-1および受電部3-1に設ける前面22の複数箇所、例えば4箇所に突き出し状に設けるとよい。但し本発明はこのガイドに限定されず、水中ロボット17を正確に誘導できるものであればいずれのものも使用できる。

【0031】

【発明の効果】

以上説明したように本発明の非接触型給電装置は、ギャップ結合トランスが許容範囲内に接近したことを検知すると給電を開始し、一定時間内に受電したことが確認されないと給電を停止するようにしたので、受電装置以外の金属体などに給電し、過熱による事故の発生を無くすることができるし、異物が間にはさまって給電できない場合も検知することができる。

【図面の簡単な説明】

【図1】本発明の第1の実施の形態による非接触型給電装置の基本回路図である。

【図2】図1に示す給電装置に使用したギャップ結合トランスの鉄心形状を示す平面説明図である。

【図3】本発明の第2の実施の形態による非接触型給電装置の全体の構成を示す説明図である。

【図4】図3に示すギャップ結合トランスの構成を示す説明図である。

【図5】図3に示す給電装置の給電部および受電部に設けたガイドの一例を示す側面図である。

【符号の説明】

- 2 電源装置(例えば水中ロボット17)
- 2-1 給電部
- 3 2次電池搭載装置(例えば水中ステーション16)

10

20

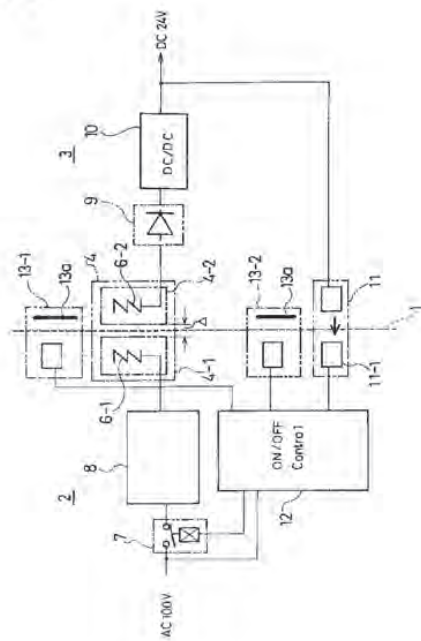
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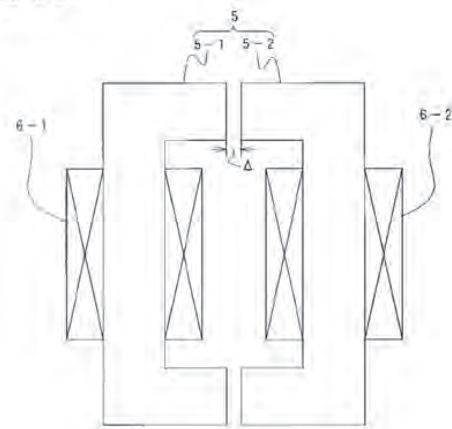
50

- | | | |
|---|-------|---------|
| 3 | - 1 | 受電部 |
| 1 | 1 | 受電検知センサ |
| 1 | 2 | 給電制御部 |
| 1 | 3 - 1 | 近接センサ |
| 1 | 3 - 2 | 近接センサ |

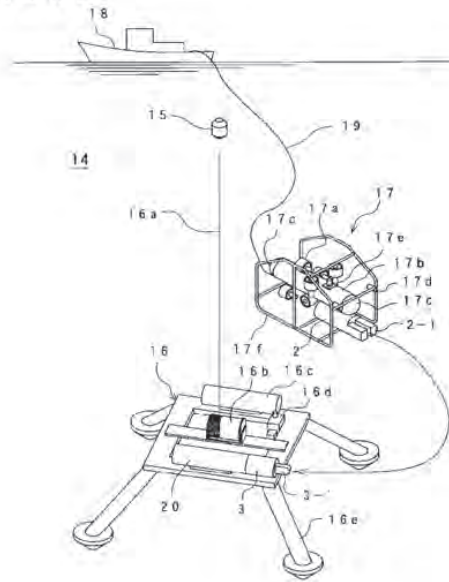
【图 1】



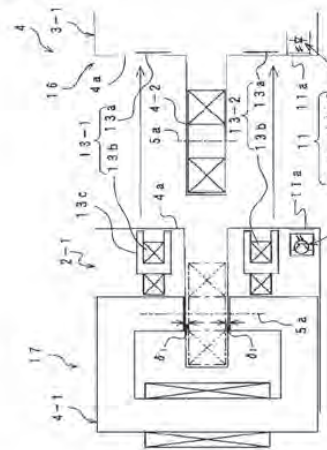
【图 2】



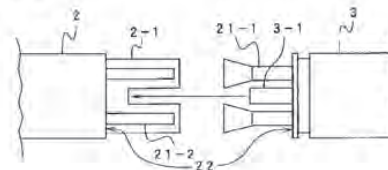
【図 3】



【図 4】



【図 5】



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5H105 AA01 BA09 BB10 DD10 GG04 GG15

* 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 rechargeable battery mounting apparatus which operates as the source of power, and an electric power unit which charges the aforementioned rechargeable battery a rechargeable battery, In a feeder system which approaches either or mutual by remote control automatically again, and supplies electric power to it in non-contact by an electromagnetic guiding means at the time of charge, If a feed part of the aforementioned electric power unit and a receiving part of the aforementioned rechargeable battery mounting apparatus approach and it will be in a state for which electric power can be supplied, A proximity sensor which will output an electric supply start signal if it approaches within an interval which a surface which forms both the aforementioned equipment and carries out the aforementioned relativity defined previously so that a surface which opens a slight gap at least and faces may produce, If a power receiving detection sensor which detects that the aforementioned receiving part reached a state which can be charged is provided and the aforementioned proximity sensor detects the aforementioned approach, electric supply is started -- a non-contact feeder system which provided a power feeding control part which will stop electric supply if electric supply will be continued if the aforementioned electricity-receiving detecting sensor detects a power receiving start signal in fixed time after an electric supply start, and the aforementioned power receiving start signal is not detected in said fixed time by a certain cause.

[Claim 2]

A non-contact feeder system comprising:

A magnet coil which the aforementioned proximity sensor excites by alternating current.

It consists of a metal body with high amplitude permeability attached to the aforementioned rechargeable battery mounting apparatus, a load change of the aforementioned magnet coil produced by an eddy current generated in the aforementioned metal plate in excitation by the aforementioned magnet coil is detected, and a size of the aforementioned gap is detected.

[Claim 3]

A non-contact feeder system comprising:

A light emitting device which will emit light if voltage which the aforementioned rechargeable battery mounting apparatus receives and the aforementioned power receiving detection sensor generates reaches a specified value.

It constitutes from a photo detector which is provided by the aforementioned electric power unit and operates by the aforementioned luminescence.

[Claim 4]

A non-contact feeder system comprising:

An ultrasonic dispatch element which will send an ultrasonic wave if voltage which the aforementioned rechargeable battery mounting apparatus receives and the aforementioned power receiving detection sensor generates reaches a specified value.

It constitutes from an ultrasonic wave receiving element which is provided by the aforementioned electric power unit and receives the aforementioned ultrasonic wave.

[Claim 5]

The non-contact feeder system according to any one of claims 1 to 4 which was made to excite the aforementioned proximity sensor intermittently.

[Claim 6]

The non-contact feeder system according to claim 1 to 5 which equipment which operates considering the aforementioned rechargeable battery as the source of power is the equipment laid underwater, and consists of having provided a feed part of the aforementioned feeder system to an underwater traveling robot.

[Claim 7]

The non-contact feeder system according to claim 1 to 5 which equipment which operates considering the aforementioned rechargeable battery as the source of power is a self-propelled working robot, and consists of this working robot having charged the aforementioned feeder system waiting.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention about the non-contact feeder system which supplies electric power using an electromagnetic induction action more particularly, For example, when supplying electric power using the underwater robot which mounted the feeder system on the rechargeable battery mounted on a sea institution etc., it is related with the non-contact feeder system which supplies electric power to the power receiving part of the aforementioned institution by checking automatically that the electric supply part of a robot has been arranged correctly.

[0002]

[Description of the Prior Art]

Become possible to separate from a power supply for a long time, and to operate apparatus, since high performance, a light weight, and encapsulated type rechargeable batteries, such as a lithium cell, were developed, and in various fields, such as a cordless telephone and electric shaver machine and an electric vehicle, The noncontact feeder system which can be charged without using electric contact, such as an electric socket, from each necessity, i.e., the feeder system using an electromagnetic induction type, is proposed, and it has actually come to be used.

[0003]

As a problem of electric supply by the aforementioned electromagnetic induction type, if metal is put on a power receiving part by a certain cause, it generates heat by an electromagnetic

induction action, and equipment will be heated and fear, such as becoming a cause of failure, or starting a fire, when the worst, will arise.

[0004]

As the measure, to "the noncontact charger using a small efficient resonant transformer" (88-92 pages of Matsushita Electric Works technical reports (DEC.2001)) which disclosed the miniaturization technology of the noncontact charger of an electric shaver machine (henceforth a shaver), As a means to identify whether the shaver is placed on the battery charger, To the primary transformer side core and a transformer secondary core, respectively 1 order for power transmission, Besides secondary winding, main part detection, the winding for charging control signals, and the winding for an intermittent oscillation are provided, The excitation high frequency current is supplied with the winding for an intermittent oscillation except the time of power transmission, and it is made not to supply electric power to objects other than Javor because it is made not to perform charge operation unless the main part detection signal which tells having received transmitted electricity from the main part side of a shaver is outputted.

[0005]

[Nonpatent literature 1]

Katsura ****, Yamashita Mikihiro, Abe The Hideaki collaboration "noncontact charger using small efficient resonant transformer" Matsushita Electric Works technical report (December, 2001, p.88-92)

[0006]

[Problem to be solved by the invention]

By the way, the requests which make the fixed point observation of the water quality of sea water, etc. continuously for a long period of time, for example are mounting. Since it will become inexpensive [an installation cost] if various primary batteries are used as the source of power for that, but it is throwing away, it is contrary to the social request focused on environmental protection, and is not preferable. It is admitted that it lacks in the certainty of an operation since the method of combining a solar cell and a wave-motion generator with various rechargeable batteries is affected by the influence of the weather and a hydrographic condition, and it is possible only as an about 10-W object for small power. A fuel cell is the technology under development, and the laying work of a submarine cable is needed for carrying out direct supply of the commercial power, and the problem of economy arises.

[0007]

Therefore, various rechargeable batteries are attached to an underwater institution, and it is thought that combination of charging with an underwater robot is the most practical. for example, if 50-W load is used for seven days (158 hours), amount of used electricity will come out and will be set to 8.4 kWh, and if this is charged at 2 kW, it can charge in about 4 hours. Therefore, the charging system by an underwater robot is considered to be one of the highest systems by the implementability of a long-term fixed point observation.

[0008]

In such a case, since a feed system is underwater, naturally it becomes a noncontact feed system, but when a foreign matter with iron high amplitude permeability approaches a feeder system, there is a possibility of carrying out induction heating of this. There is a problem of the iron core by the side of electric supply and power receiving making it approach into a fixed range correctly reliably by evasion of this situation and remote control in the inside of the sea whose field of view is not sufficient.

[0009]

In the feeder system which supplies electric power to the rechargeable battery with which the present invention was made paying attention to the above problem, and laying of power transmission cables equipped difficult sea equipment etc. by the economic reason etc., It aims at providing the noncontact feeder system whose electric supply is attained when the interval of an electric supply part and a power receiving part is in a specified value.

[0010]

[Means for solving problem]

The noncontact feeder system of the present invention for attaining the above-mentioned purpose, The rechargeable battery mounting apparatus which operates as the source of power, and the electric power unit which charges the aforementioned rechargeable battery a rechargeable battery, In the feeder system which approaches either or mutual by remote control automatically again, and supplies electric power to it in non-contact by an electromagnetic guiding means at the time of charge, If the feed part of the aforementioned electric power unit and the receiving part of the aforementioned rechargeable battery mounting apparatus approach and it will be in the state for which electric power can be supplied, The proximity sensor which will output an electric supply start signal if it approaches within the interval which the surface which forms both the aforementioned equipment and carries out the aforementioned relativity defined previously so that the surface which opens a slight gap at least and faces may produce, If the power receiving detection sensor which detects that the aforementioned receiving part reached the state which can be charged is provided and the aforementioned proximity sensor detects the aforementioned approach, electric supply is started -- if the aforementioned electricity-receiving detecting sensor detects a power receiving start signal in the fixed time after an electric supply start, electric supply will be continued, and if the aforementioned power receiving start signal is not detected in the above-mentioned fixed time by a certain cause, the power feeding control part which stops electric supply will be provided.

[0011]

A proximity sensor reacts to objects other than a rechargeable battery mounting apparatus, for example, and a certain above-mentioned cause is a case where the aforementioned receiving part is out of order etc., when it malfunctions.

[0012]

What limitation in particular does not have in the aforementioned proximity sensor, and uses light, the thing using change of electrostatic capacitance, It can choose suitably from things generally known, such as a thing using an ultrasonic wave, a thing using pneumatic pressure, and a thing using input-impedance change of the exciting coil by the eddy current by electromagnetic induction. The magnet coil excited with the aforementioned eddy current system, i.e., alternating current, as what is applied to an underwater robot, Adoption of the method of consisting of a metal body with high amplitude permeability attached to the aforementioned rechargeable battery mounting apparatus, detecting the load change of the aforementioned magnet coil produced by the eddy current generated in the aforementioned metal plate in excitation by the aforementioned magnet coil, and detecting the size of the aforementioned gap is preferable.

[0013]

The light emitting device which will emit light if the voltage which the aforementioned rechargeable battery mounting apparatus receives and generates, for example reaches a specified value although there is no limitation in particular in the aforementioned power receiving detection sensor, The ultrasonic dispatch element which will send an ultrasonic wave if the

voltage which the method and the aforementioned rechargeable battery mounting apparatus which are constituted from a photo detector which is provided by the aforementioned electric power unit and operates by the aforementioned luminescence receive and generate reaches a specified value, The aforementioned electric power unit provides and the method of constituting from an ultrasonic wave receiving element which receives the aforementioned ultrasonic wave, etc. can be adopted. In order that signals, such as the aforementioned luminescence and an ultrasonic wave, may not be affected by the influence of a noise, modulation and a demodulation means can be provided in a power receiving detection sensor.

[0014]

Since it can lessen being heated in equipment by generation of heat by an eddy current if the aforementioned proximity sensor is excited intermittently, generally it is preferable, but the present invention is not limited to this.

[0015]

Although there is no limitation in particular in the equipment which applies the noncontact feeder system of the present invention, the equipment which operates considering the aforementioned rechargeable battery as the source of power is the equipment laid underwater, What provided the feed part of the aforementioned feeder system to the underwater traveling robot, and the equipment which operates as the source of power the aforementioned rechargeable battery A cleaning robot, It is self-propelled working robots, such as a round monitor robot, and the aforementioned feeder system can illustrate as an applied object what this working robot charged waiting.

[0016]

[Mode for carrying out the invention]

The 1 embodiment which refers to attached Drawings below is shown, and the noncontact feeder system of the present invention is described specifically.

[0017]

The circuit shown in Fig.1 is what describes the basic circuit of the noncontact feeder system of the present invention, The left-hand side of the dashed line 1 shown in the center is a circuit part of the electric power unit 2, right-hand side is a circuit part of the rechargeable battery mounting apparatus 3, and the gap junction transformer 4 is provided ranging over the electric power unit 2 side and the rechargeable battery mounting apparatus 3 side.

[0018]

The gap junction transformer 4 is divided into the transformer secondary 4-2 the primary transformer side 4-1, and the iron core 5, As shown in Fig.2, it consists of the primary side iron core 5-1 and the secondary side iron core 5-2 of KO thru/or the shape of U where the opening part faces mutually, The primary coil 6-1 and the secondary coil 6-2 are twisted, respectively, and it is designed so that excessive excitation reactive power may not arise because below a specified value carries out the gap delta of the doubling portions of the primary side iron core 5-1 and the secondary iron core 5-2.

[0019]

As an example, as the gap junction transformer 4 at the time of making 250-300W, and ambient air temperature into -10-40 degree C, a ferrite is used for an iron core -- the iron core length of the neighborhood which rolls 20 mm and lamination thickness for the width of an iron core, and rolls 40 mm and a litz wire coil for 50 mm and the iron core length of the brachial part of both sides can be 120 mm, and the gap delta is 5 mm or less into the container which made the whole watertight with insulating resin.

[0020]

It returned to the description of Fig.1 and connected with AC power supply (following power supply E), such as AC100V, via the electric power switch 7 and the frequency converter 8 which consist of relays between the primary coil 6-1 by the side of [4-1] the primary transformer, and a power supply. The frequency converter 8 can convert a low frequency power source to high frequency, and can use what combined the A/D converter and the inverter.

[0021]

The secondary coil 6-2 of the transformer secondary 4-2 converts the generated high frequency voltage to a direct current with the rectifier 9, and gave it to the rechargeable battery (not shown) and the electricity-receiving detecting sensor 11 via DC voltage stabilizing circuit 10.

[0022]

Power feeding control part 12 which becomes the electric power switch 7 and the frequency converter 8 from a microcomputer in parallel is provided to the power supply E of the electric power unit 2, The power receiving detection sensor 11, the proximity sensor 13-1, and the output signal of 13-2 (when naming generically below, it expresses with 13) are input into this, If it constitutes so that on-off control of the electric power switch 7 may be carried out, and an approach completion signal is outputted from the proximity sensor 13-1 and 13-2, while turning on the electric power switch 7 -- a time check -- when the program (timer) was operated and a power receiving detection signal was not outputted from the electricity-receiving detecting sensor 11 in fixed time, the power feeding control part 12 was programmed to turn off the electric power switch 7.

[0023]

next, a 2nd embodiment that shows the power receiving detection sensor 11 and the proximity sensor 13 to Fig.3 - 5 -- it describes more specifically. Fig.3 is carried out with the underwater station 16 for rise-and-fall-system water quality measurement buoy 15 which laid the noncontact feeder system by a 2nd embodiment to sea 14, and the robot 17 in charge and data recovery service water (only henceforth an underwater robot). It is clear use [the present invention / for underwater institutions other than for / above-mentioned / water quality measurement] not to require a description.

[0024]

The primary transformer side 4-1 (Fig.4) of the gap type coupling transformer 4 of the noncontact feeder system by a 2nd embodiment, It provided to the underwater robot's 17 feed part 3-1, and with the power cable 19 which has a function of a signal transmission, a wire rope, etc., the generator (not shown) mounted on the mother ship 18 was used as the power supply, and it connected with the power feeding control part (not shown to Fig.3 and 4). The receiving part 3-2 which accommodates the transformer secondary 4-2 (Fig.4) was integrally attached with the power supply section (rechargeable battery) 20 which provided to the underwater station 16 (Fig.3).The gap delta of the gap junction transformer 4 shown in Fig.4 corresponds to one half of the sums of two gap delta1 shown in Fig.4, and delta2 ($\text{delta1} / 2 + \text{delta2} / 2$).

[0025]

It describes about the component currently illustrated by the underwater station 16 and the underwater robot 17 which show Fig.3 here. The code 16a given to the underwater station 16 moors the rise-and-fall-system water quality measurement buoy 15 to the underwater station 16, And the cable incorporating the lead for power supplies which operates the apparatus in the buoy 16, the signal wire which transmits the signal needed for observation, etc., The sound link which 16b transmits the drum of winding and the electric motor internal organs which it lets out for the

cable 16a, and 16c transmits the electronic device container for observation, and transmits 16 d of data to the underwater robot 17, and 16e are the legs for fixing to submarine bedrock etc.

[0026]

The code 17a given to the underwater robot 17 is a thruster, and the thruster for advance / retreat Three sets, the thruster for a rise / descent -- two sets and lateral movement business -- one thruster is used -- 17b is an underwater robot main part, 17c is a dome made of wrap transparent acrylic resin about the end of the aforementioned main part 17b, and it has the CCD camera for operation on the medial axis. As for 17 d, an ultrasonic sonar and 17 f of a headlight and 17e are the frames for protection. The code 4a shown in Fig.4 is the resin made container made watertight.

[0027]

The gap junction transformer 4 of a 2nd embodiment is the same as the gap junction transformer 4 shown in Fig.2, if combined, but. The primary side iron core 5-1 was made into the form which cut out a part of one side of an iron core as shown in Fig.4, therefore the winding and appearance top formed width in plate-like also for the primary coil 6-1 thick narrowly. The secondary coil 6-2 was made to be the same as that of what was shown in Fig.1. If the feed part 2-1 provided to the underwater robot 17 combines with the receiving part 3-1, the basic circuit of the noncontact feeder system shown by Fig.1 will be formed, and the secondary side iron core 5-2 and the secondary coil 6-2 which were shown according to the two-dot chain line show that it can charge according to the procedure of the aforementioned description.

[0028]

By the way, although the light emitting device, for example, a light emitting diode, was used for the signal output element 11-2 of the power receiving detection sensor 11 used by the second embodiment and the photo-transistor was used for the power receiving detection signal circuit 11-1 by light, photo detectors of **, such as a photo-diode, can also be used. an ultrasonic wave can also be used -- the signal of these can be modulated and the operation mistake by a noise can also be prevented. KO thru/or U-like iron core were used for the iron core 13c of the magnet coil 13b which makes the metal plate 13a of the proximity sensor 13 generate an eddy current. However, a rod-like iron core can also be used.

[0029]

The gap which the proximity sensor 13 by a 2nd embodiment detects is the inharmonious tolerance level of not the gap delta of a 1st embodiment but the axial center of the primary side iron core 5-1, and the axial center 5a (Fig.4) of the secondary side iron core 5-2 which faces this. Therefore, in order to combine the feed part 2-1 with the receiving part 3-1, it is necessary to consider the feed part 2-1 as movement only toward advance and retreat in a culmination. Therefore, when considering it as movement only toward a moved back, what is provided may be sufficient as at least one proximity sensor 13. The code 11a shown in Fig.4 is a window for light transmission.

[0030]

therefore, the vaginate guide 21-1 and the driving post 21-2 which the tip as shown, for example in Fig.5 extended -- the power receiving detection sensor 11 and the proximity sensor 13 -- it is good for two or more places of the front face 22 provided to each feed part 2-1 and receiving part 3-1, for example, four places, to provide in the shape of ejection. However, the present invention is not limited to this guide, but if the underwater robot 17 can be derived correctly, it can use anything.

[0031]

[Effect of the Invention]

As described above, the noncontact feeder system of the present invention, Since it was made to stop electric supply when having started electric supply when it detected that the gap junction transformer approached into tolerance level, and having received transmitted electricity in fixed time was not checked, Electric power can be supplied to metal bodies other than power receiving equipment, etc., and the occurrence of the accident by overheating can be lost, and a foreign matter can detect, also when the way cannot supply electric power in between.

[Brief Description of the Drawings]

[Drawing 1]It is a basic circuit figure of the noncontact feeder system by the first embodiment of the present invention.

[Drawing 2]It is a plane explanatory view showing the iron core form of the gap junction transformer used for the feeder system shown in Fig.1.

[Drawing 3]It is an explanatory view showing the composition of the whole noncontact feeder system by the second embodiment of the present invention.

[Drawing 4]It is an explanatory view showing the composition of the gap junction transformer shown in Fig.3.

[Drawing 5]It is a side view showing an example of the guide provided to the feed part and receiving part of the feeder system which are shown in Fig.3.

[Explanations of letters or numerals]

2 Electric power unit (for example, underwater robot 17)

2-1 Feed part

3 Rechargeable battery mounting apparatus (for example, underwater station 16)

3-1 Receiving part

11 Power receiving detection sensor

12 Power feeding control part

13-1 Proximity sensor

13-2 Proximity sensor

TECHNICAL FIELD

[Field of the Invention]

The present invention about the non-contact feeder system which supplies electric power using an electromagnetic induction action more particularly, For example, when supplying electric power using the underwater robot which mounted the feeder system on the rechargeable battery mounted on a sea institution etc., it is related with the non-contact feeder system which supplies electric power to the power receiving part of the aforementioned institution by checking automatically that the electric supply part of a robot has been arranged correctly.

[0002]

PRIOR ART

[Description of the Prior Art]

Become possible to separate from a power supply for a long time, and to operate apparatus, since high performance, a light weight, and encapsulated type rechargeable batteries, such as a lithium cell, were developed, and in various fields, such as a cordless telephone and electric shaver machine and an electric vehicle, The noncontact feeder system which can be charged without using electric contact, such as an electric socket, from each necessity, i.e., the feeder system using an electromagnetic induction type, is proposed, and it has actually come to be used.

[0003]

As a problem of electric supply by the aforementioned electromagnetic induction type, if metal is put on a power receiving part by a certain cause, it generates heat by an electromagnetic induction action, and equipment will be heated and fear, such as becoming a cause of failure, or starting a fire, when the worst, will arise.

[0004]

As the measure, to "the noncontact charger using a small efficient resonant transformer" (88-92 pages of Matsushita Electric Works technical reports (DEC.2001)) which disclosed the miniaturization technology of the noncontact charger of an electric shaver machine (henceforth a shaver), As a means to identify whether the shaver is placed on the battery charger, To the primary transformer side core and a transformer secondary core, respectively 1 order for power transmission, Besides secondary winding, main part detection, the winding for charging control signals, and the winding for an intermittent oscillation are provided, The excitation high frequency current is supplied with the winding for an intermittent oscillation except the time of power transmission, and it is made not to supply electric power to objects other than Javor because it is made not to perform charge operation unless the main part detection signal which tells having received transmitted electricity from the main part side of a shaver is outputted.

[0005]

[Nonpatent literature 1]

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[0006]

EFFECT OF THE INVENTION

[Effect of the Invention]

As described above, the noncontact feeder system of the present invention, Since it was made to stop electric supply when having started electric supply when it detected that the gap junction transformer approached into tolerance level, and having received transmitted electricity in fixed time was not checked, Electric power can be supplied to metal bodies other than power receiving equipment, etc., and the occurrence of the accident by overheating can be lost, and a foreign matter can detect, also when the way cannot supply electric power in between.

TECHNICAL PROBLEM

[Problem to be solved by the invention]

By the way, the requests which make the fixed point observation of the water quality of sea water, etc. continuously for a long period of time, for example are mounting. Since it will become inexpensive [an installation cost] if various primary batteries are used as the source of power for that, but it is throwing away, it is contrary to the social request focused on environmental protection, and is not preferable, It is admitted that it lacks in the certainty of an operation since the method of combining a solar cell and a wave-motion generator with various rechargeable batteries is affected by the influence of the weather and a hydrographic condition, and it is possible only as an about 10-W object for small power. A fuel cell is the technology under development, and the laying work of a submarine cable is needed for carrying out direct supply of the commercial power, and the problem of economy arises.

[0007]

Therefore, various rechargeable batteries are attached to an underwater institution, and it is thought that combination of charging with an underwater robot is the most practical. for example, if 50-W load is used for seven days (158 hours), amount of used electricity will come out and will be set to 8.4 kWh, and if this is charged at 2 kW, it can charge in about 4 hours. Therefore, the charging system by an underwater robot is considered to be one of the highest systems by the implementability of a long-term fixed point observation.

[0008]

In such a case, since a feed system is underwater, naturally it becomes a noncontact feed system, but when a foreign matter with iron high amplitude permeability approaches a feeder system, there is a possibility of carrying out induction heating of this. There is a problem of the iron core by the side of electric supply and power receiving making it approach into a fixed range correctly reliably by evasion of this situation and remote control in the inside of the sea whose field of view is not sufficient.

[0009]

In the feeder system which supplies electric power to the rechargeable battery with which the present invention was made paying attention to the above problem, and laying of power transmission cables equipped difficult sea equipment etc. by the economic reason etc., It aims at providing the noncontact feeder system whose electric supply is attained when the interval of an electric supply part and a power receiving part is in a specified value.

[0010]

MEANS

[Means for solving problem]

The noncontact feeder system of the present invention for attaining the above-mentioned purpose, The rechargeable battery mounting apparatus which operates as the source of power, and the electric power unit which charges the aforementioned rechargeable battery a rechargeable battery, In the feeder system which approaches either or mutual by remote control automatically again, and supplies electric power to it in non-contact by an electromagnetic guiding means at the time of charge, If the feed part of the aforementioned electric power unit and the receiving part of the aforementioned rechargeable battery mounting apparatus approach and it will be in the state for which electric power can be supplied, The proximity sensor which will output an electric supply start signal if it approaches within the interval which the surface which forms both the aforementioned equipment and carries out the aforementioned relativity defined previously so that the surface which opens a slight gap at least and faces may produce, If the power receiving detection sensor which detects that the aforementioned receiving part reached the state which can be charged is provided and the aforementioned proximity sensor detects the aforementioned approach, electric supply is started -- if the aforementioned electricity-receiving detecting sensor detects a power receiving start signal in the fixed time after an electric supply start, electric supply will be continued, and if the aforementioned power receiving start signal is not detected in the above-mentioned fixed time by a certain cause, the power feeding control part which stops electric supply will be provided.

[0011]

A proximity sensor reacts to objects other than a rechargeable battery mounting apparatus, for example, and a certain above-mentioned cause is a case where the aforementioned receiving part is out of order etc., when it malfunctions.

[0012]

What limitation in particular does not have in the aforementioned proximity sensor, and uses light, the thing using change of electrostatic capacitance, It can choose suitably from things generally known, such as a thing using an ultrasonic wave, a thing using pneumatic pressure, and a thing using input-impedance change of the exciting coil by the eddy current by electromagnetic induction. The magnet coil excited with the aforementioned eddy current system, i.e., alternating current, as what is applied to an underwater robot, Adoption of the method of consisting of a metal body with high amplitude permeability attached to the aforementioned rechargeable battery mounting apparatus, detecting the load change of the aforementioned magnet coil produced by the eddy current generated in the aforementioned metal plate in excitation by the aforementioned magnet coil, and detecting the size of the aforementioned gap is preferable.

[0013]

The light emitting device which will emit light if the voltage which the aforementioned rechargeable battery mounting apparatus receives and generates, for example reaches a specified value although there is no limitation in particular in the aforementioned power receiving detection sensor, The ultrasonic dispatch element which will send an ultrasonic wave if the voltage which the method and the aforementioned rechargeable battery mounting apparatus which are constituted from a photo detector which is provided by the aforementioned electric power unit and operates by the aforementioned luminescence receive and generate reaches a specified value, The aforementioned electric power unit provides and the method of constituting from an ultrasonic wave receiving element which receives the aforementioned ultrasonic wave, etc. can be adopted. In order that signals, such as the aforementioned luminescence and an ultrasonic wave, may not be affected by the influence of a noise, modulation and a demodulation means can be provided in a power receiving detection sensor.

[0014]

Since it can lessen being heated in equipment by generation of heat by an eddy current if the aforementioned proximity sensor is excited intermittently, generally it is preferable, but the present invention is not limited to this.

[0015]

Although there is no limitation in particular in the equipment which applies the noncontact feeder system of the present invention, the equipment which operates considering the aforementioned rechargeable battery as the source of power is the equipment laid underwater, What provided the feed part of the aforementioned feeder system to the underwater traveling robot, and the equipment which operates as the source of power the aforementioned rechargeable battery A cleaning robot, It is self-propelled working robots, such as a round monitor robot, and the aforementioned feeder system can illustrate as an applied object what this working robot charged waiting.

[0016]

[Mode for carrying out the invention]

The 1 embodiment which refers to attached Drawings below is shown, and the noncontact feeder system of the present invention is described specifically.

[0017]

The circuit shown in Fig.1 is what describes the basic circuit of the noncontact feeder system of the present invention, The left-hand side of the dashed line 1 shown in the center is a circuit part of the electric power unit 2, right-hand side is a circuit part of the rechargeable battery mounting

apparatus 3, and the gap junction transformer 4 is provided ranging over the electric power unit 2 side and the rechargeable battery mounting apparatus 3 side.

[0018]

The gap junction transformer 4 is divided into the transformer secondary 4-2 the primary transformer side 4-1, and the iron core 5, As shown in Fig.2, it consists of the primary side iron core 5-1 and the secondary side iron core 5-2 of KO thru/or the shape of U where the opening part faces mutually, The primary coil 6-1 and the secondary coil 6-2 are twisted, respectively, and it is designed so that excessive excitation reactive power may not arise because below a specified value carries out the gap delta of the doubling portions of the primary side iron core 5-1 and the secondary iron core 5-2.

[0019]

As an example, as the gap junction transformer 4 at the time of making 250-300W, and ambient air temperature into -10-40 degree C, a ferrite is used for an iron core -- the iron core length of the neighborhood which rolls 20 mm and lamination thickness for the width of an iron core, and rolls 40 mm and a litz wire coil for 50 mm and the iron core length of the brachial part of both sides can be 120 mm, and the gap delta is 5 mm or less into the container which made the whole watertight with insulating resin.

[0020]

It returned to the description of Fig.1 and connected with AC power supply (following power supply E), such as AC100V, via the electric power switch 7 and the frequency converter 8 which consist of relays between the primary coil 6-1 by the side of [4-1] the primary transformer, and a power supply. The frequency converter 8 can convert a low frequency power source to high frequency, and can use what combined the A/D converter and the inverter.

[0021]

The secondary coil 6-2 of the transformer secondary 4-2 converts the generated high frequency voltage to a direct current with the rectifier 9, and gave it to the rechargeable battery (not shown) and the electricity-receiving detecting sensor 11 via DC voltage stabilizing circuit 10.

[0022]

Power feeding control part 12 which becomes the electric power switch 7 and the frequency converter 8 from a microcomputer in parallel is provided to the power supply E of the electric power unit 2, The power receiving detection sensor 11, the proximity sensor 13-1, and the output signal of 13-2 (when naming generically below, it expresses with 13) are input into this, If it constitutes so that on-off control of the electric power switch 7 may be carried out, and an approach completion signal is outputted from the proximity sensor 13-1 and 13-2, while turning on the electric power switch 7 -- a time check -- when the program (timer) was operated and a power receiving detection signal was not outputted from the electricity-receiving detecting sensor 11 in fixed time, the power feeding control part 12 was programmed to turn off the electric power switch 7.

[0023]

next, a 2nd embodiment that shows the power receiving detection sensor 11 and the proximity sensor 13 to Fig.3 - 5 -- it describes more specifically. Fig.3 is carried out with the underwater station 16 for rise-and-fall-system water quality measurement buoy 15 which laid the noncontact feeder system by a 2nd embodiment to sea 14, and the robot 17 in charge and data recovery service water (only henceforth an underwater robot). It is clear use [the present invention / for underwater institutions other than for / above-mentioned / water quality measurement] not to require a description.

[0024]

The primary transformer side 4-1 (Fig.4) of the gap type coupling transformer 4 of the noncontact feeder system by a 2nd embodiment, It provided to the underwater robot's 17 feed part 3-1, and with the power cable 19 which has a function of a signal transmission, a wire rope, etc., the generator (not shown) mounted on the mother ship 18 was used as the power supply, and it connected with the power feeding control part (not shown to Fig.3 and 4). The receiving part 3-2 which accommodates the transformer secondary 4-2 (Fig.4) was integrally attached with the power supply section (rechargeable battery) 20 which provided to the underwater station 16 (Fig.3). The gap delta of the gap junction transformer 4 shown in Fig.4 corresponds to one half of the sums of two gap delta1 shown in Fig.4, and delta2 ($\text{delta1} / 2 + \text{delta2} / 2$).

[0025]

It describes about the component currently illustrated by the underwater station 16 and the underwater robot 17 which show Fig.3 here. The code 16a given to the underwater station 16 moors the rise-and-fall-system water quality measurement buoy 15 to the underwater station 16, And the cable incorporating the lead for power supplies which operates the apparatus in the buoy 16, the signal wire which transmits the signal needed for observation, etc., The sound link which 16b transmits the drum of winding and the electric motor internal organs which it lets out for the cable 16a, and 16c transmits the electronic device container for observation, and transmits 16 d of data to the underwater robot 17, and 16e are the legs for fixing to submarine bedrock etc.

[0026]

The code 17a given to the underwater robot 17 is a thruster, and the thruster for advance / retreat Three sets, the thruster for a rise / descent -- two sets and lateral movement business -- one thruster is used -- 17b is an underwater robot main part, 17c is a dome made of wrap transparent acrylic resin about the end of the aforementioned main part 17b, and it has the CCD camera for operation on the medial axis. As for 17 d, an ultrasonic sonar and 17 f of a headlight and 17e are the frames for protection. The code 4a shown in Fig.4 is the resin made container made watertight.

[0027]

The gap junction transformer 4 of a 2nd embodiment is the same as the gap junction transformer 4 shown in Fig.2, if combined, but. The primary side iron core 5-1 was made into the form which cut out a part of one side of an iron core as shown in Fig.4, therefore the winding and appearance top formed width in plate-like also for the primary coil 6-1 thick narrowly. The secondary coil 6-2 was made to be the same as that of what was shown in Fig.1. If the feed part 2-1 provided to the underwater robot 17 combines with the receiving part 3-1, the basic circuit of the noncontact feeder system shown by Fig.1 will be formed, and the secondary side iron core 5-2 and the secondary coil 6-2 which were shown according to the two-dot chain line show that it can charge according to the procedure of the aforementioned description.

[0028]

By the way, although the light emitting device, for example, a light emitting diode, was used for the signal output element 11-2 of the power receiving detection sensor 11 used by the second embodiment and the photo-transistor was used for the power receiving detection signal circuit 11-1 by light, photo detectors of **, such as a photo-diode, can also be used, an ultrasonic wave can also be used -- the signal of these can be modulated and the operation mistake by a noise can also be prevented. KO thru/or U-like iron core were used for the iron core 13c of the magnet coil 13b which makes the metal plate 13a of the proximity sensor 13 generate an eddy current. However, a rod-like iron core can also be used.

[0029]

The gap which the proximity sensor 13 by a 2nd embodiment detects is the inharmonious tolerance level of not the gap delta of a 1st embodiment but the axial center of the primary side iron core 5-1, and the axial center 5a (Fig.4) of the secondary side iron core 5-2 which faces this. Therefore, in order to combine the feed part 2-1 with the receiving part 3-1, it is necessary to consider the feed part 2-1 as movement only toward advance and retreat in a culmination. Therefore, when considering it as movement only toward a moved back, what is provided may be sufficient as at least one proximity sensor 13. The code 11a shown in Fig.4 is a window for light transmission.

[0030]

therefore, the vaginate guide 21-1 and the driving post 21-2 which the tip as shown, for example in Fig.5 extended -- the power receiving detection sensor 11 and the proximity sensor 13 -- it is good for two or more places of the front face 22 provided to each feed part 2-1 and receiving part 3-1, for example, four places, to provide in the shape of ejection. However, the present invention is not limited to this guide, but if the underwater robot 17 can be derived correctly, it can use anything.

[0031]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a basic circuit figure of the noncontact feeder system by the first embodiment of the present invention.

[Drawing 2]It is a plane explanatory view showing the iron core form of the gap junction transformer used for the feeder system shown in Fig.1.

[Drawing 3]It is an explanatory view showing the composition of the whole noncontact feeder system by the second embodiment of the present invention.

[Drawing 4]It is an explanatory view showing the composition of the gap junction transformer shown in Fig.3.

[Drawing 5]It is a side view showing an example of the guide provided to the feed part and receiving part of the feeder system which are shown in Fig.3.

[Explanations of letters or numerals]

2 Electric power unit (for example, underwater robot 17)

2-1 Feed part

3 Rechargeable battery mounting apparatus (for example, underwater station 16)

3-1 Receiving part

11 Power receiving detection sensor

12 Power feeding control part

13-1 Proximity sensor

13-2 Proximity sensor



Espacenet

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TRANSFORMER FOR MULTIPLE-OUTPUT POWER SUPPLY

Inventor(s): KOJIMA HIDEKI ± (KOJIMA HIDEKI)

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Classification: - international: *H01F30/04; H02M3/28; H02M3/338*; (IPC1-7): H01F30/04; H02M3/28; H02M3/338
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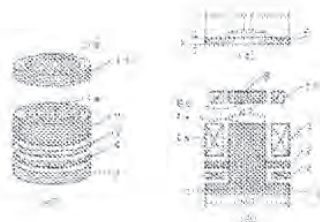
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Abstract of JP2004201458 (A)

PROBLEM TO BE SOLVED: To provide a transformer for multiple-output power supply wherein the output voltage/current characteristics are provided with a drooping characteristic and necessity for an overcurrent protection circuit is obviated.

SOLUTION: The transformer is for a multiple-output power supply. The transformer comprises a non-contact power supply which is provided with a primary coil for supplying power and a secondary coil for receiving power and transmits power with the primary coil, and the secondary coil opposed to each other; and a power supply which obtains a plurality of direct-current output voltages from a tertiary coil provided coaxially with the winding axis of the primary coil. The transformer comprises the primary coil, secondary coil, and tertiary coil. The windings of the primary coil and the tertiary coil are wound on the same core shaft. The winding of the secondary coil is wound on another core shaft. A partition plate made of the core material is provided between the primary coil and the tertiary coil. ; COPYRIGHT; (C)2004, JPO&NCIP)



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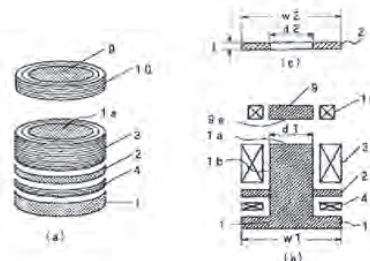
(54) 【発明の名称】 マルチ出力電源装置のトランス

(57) 【要約】

【課題】出力電圧電流特性に垂下特性をもたせ、過電流保護回路を不要としたマルチ出力電源装置のトランスを提供することを目的とする。

【解決手段】電力を供給する一次側コイルと電力を受電する二次側コイルを備え、一次側コイルと二次側コイルとを対向させて電力の伝達をおこなう非接触電源装置と、一次側コイルの巻線軸と同軸に設けた三次側コイルから複数の直流出力電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、トランスは一次側コイル、二次側コイル、三次側コイルを具備している。一次側コイルと三次側コイルは同一のコア軸に巻線が巻回されている。二次側コイルは他のコア軸に巻線が巻回されている。そして、一次側コイルと三次側コイルとの間にコア材の仕切り板を設けた。

【選択図】 図1



【特許請求の範囲】

【請求項1】

電力を供給する一次側コイルと電力を受電する二次側コイルを備え、該一次側コイルと該二次側コイルとを対向させて電力の伝達を行なう非接触電源装置と、該一次側コイルの巻線軸と同軸に設けた二次側コイルから複数の直流出力電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、

該トランスは一次側コイル、二次側コイル、三次側コイルを具備してなり、

該一次側コイルと該三次側コイルは同一のコア軸に巻線が巻回され、該二次側コイルは他のコア軸に巻線が巻回され、

該一次側コイルと該三次側コイルとの間にコア材の仕切り板を設けたことを特徴とするマルチ出力電源装置のトランス。

【請求項2】

電力を供給する一次側コイルと電力を受電する二次側コイルを備え、該一次側コイルと該二次側コイルとを対向させて電力の伝達を行なう非接触電源装置と、該一次側コイルの巻線軸と同軸に設けた二次側コイルから複数の直流出力電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、

該トランスは一次側コイル、二次側コイル、三次側コイルを具備してなり、

該一次側コイルと該三次側コイルは同一コア軸に並べて巻線が巻回され、

該二次側コイルは他のコア軸に巻線が巻回され、

該一次側コイルと該三次側コイルとの間にコア材の仕切り板を設けたことを特徴とするマルチ出力電源装置のトランス。

【請求項3】

電力を供給する一次側コイルと電力を受電する二次側コイルを備え、該一次側コイルと該二次側コイルとを対向させて電力の伝達を行なう非接触電源装置と、該一次側コイルの巻線軸と同軸に設けた二次側コイルから複数の直流出力電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、

該トランスは一次側コイル、二次側コイル、三次側コイルを具備してなり、

該一次側コイルと該三次側コイルは同一コア軸に重ねて巻線が巻回され、該二次側コイルは他のコア軸に巻線が巻回され、該一次側コイルと該三次側コイルとの間にコア材の仕切り板を設けたことを特徴とするマルチ出力電源装置のトランス。

【請求項4】

前記一次側コイルと三次側コイルを巻回するコアは仕切り板を一体にして成型したことを特徴とする請求項1、請求項2、請求項3記載のマルチ出力電源装置のトランス。

【請求項5】

前記仕切り板は一次側コイルと三次側コイルの結合係数を一次側コイルと二次側コイルの結合係数とほぼ同じになるように所定の大きさとしたことを特徴とする請求項1、請求項2、請求項3、請求項4記載のマルチ出力電源装置のトランス。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、非接触で電力を供給する電源装置と複数の直流出力電圧とを同時に得られるマルチ出力電源装置に用いるトランスに関する。

【0002】

【従来の技術】

【特許文献1】特開平9-121481号公報

【特許文献2】特開平6-169566号公報

【0003】

例えば、コードレス電話装置のように、子機はコードレスで親機から非接触で二次電池を充電する充電電池を備え、親機は子機に電力を供給する電源を備えたとともに、複数の回路に応じた直流電源を出力できるマルチ出力電源装置が用いられている。（例えば、特許文献1参照）

【0004】

部品点数が少なく、回路構成が簡単な自励発振型のマルチ出力電源装置の概略回路図を図5に示す。

図5に示すように、電力を供給する一次側は商用交流電源(AC100V 50/60Hz)から整流平滑回路を介して直流電圧を得る。その直流電圧を自励発振回路によりスイッチング素子をオンオフさせて、一次コイルL1に発生したエネルギーを、一次コイルL1と所定の間隔を隔てて対向させて配置した二次コイルL2に電力を供給し、非接触で出力端子CN2に所定の直流電圧を得る回路である。また、一次コイルL1のエネルギーを同じトランス内に設けられた三次コイルL3に伝え、出力端子CN3に所定の直流電圧を得る回路である。なお、回路図では、出力端子CN3は1出力であるが複数の出力を必要とする場合は三次コイルを複数設け、それぞれに応じた設定の直流電圧を得る。

【0005】

このような構成のマルチ出力電源装置における従来のトランスを図6に示す。

図6に示すように、図6(a)は説明のための模式図であり、図2(b)はその断面図である。

図6より、磁性材料から成る断面がT字状の一次側コア1に、巻線部1bに一次コイル3を巻回し、同じコア軸上に並べて、三次コイル4を巻回したものである。

二次コイルは磁性材料から成る断面がI字状の二次側コア9に二次コイル10を巻回したものである。そして、一次側コア(一次コイルの巻線面を含む)面1aと二次側コア(二次コイル巻線面を含む)面9aが所定の間隔を置いて、対向した状態で二次コイル10に電力を伝達する。

【0006】

このようなトランスにおける磁束の流れを図7に示す。

図7に示すとおり、一次コイル3で発生する磁束は一次側コアの面1aから対向する二次側コア9、二次コイル20を経て、一次側コアの鉤1cに入る磁束のループ ϕ_{1-2} と、一次側コア1から一次側コアの面1aを飛び出し鉤1cに入る磁束のループ ϕ_{1-3} が考えられる。

これらは、一次コイル3と二次コイル4の結合係数 k_{1-2} と一次コイルと三次コイルの結合係数 k_{1-3} を測定することにより、一次コイル、二次コイル、三次コイルの磁束の関係をあらわすことができる。

図6のトランスにおいて結合係数を測定した結果、一次コイルと二次コイルの結合係数 K_{1-2} は0.2～0.4であり、一次コイルと三次コイルの結合係数 K_{1-3} は0.5～0.8であった。

図5に示す回路図にこのトランスを用いた時、三次コイルの出力端子CN3の出力電圧電流特性は図4に示す曲線Bのようになった。

このような出力電圧電流特性では、外部負荷において短絡(ショート)した場合に過大な電流が流れ回路を焼損する恐れがある。これを防止するために保護回路を設けると回路が複雑となり大幅なコストアップとなる欠点があった。また、三次コイルに並列に共振コンデンサC6(図5 点線部)を挿入する方法があるが、一次コイルと三次コイルの結合係数 k_{1-3} が強くなりすぎて自励発振回路の発振が不安定となる。

【0007】

【発明が解決しようとする課題】

本発明は以上のような従来の欠点に鑑み、三次コイルの出力電圧電流特性に垂下特性をもたせ、過電流保護回路を不要としたマルチ出力電源装置のトランスを提供することを目的としている。

【0008】

【課題を解決するための手段】

上記目的を達成するために、本発明は、電力を供給する一次側コイルと電力を受電する二次側コイルを備え、一次側コイルと二次側コイルとを対向させて電力の伝達をおこなう非接触電源装置と、一次側コイルの巻線軸と同軸に設けた三次側コイルから複数の直流出力

電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、トランスは一次側コイル、二次側コイル、三次側コイルを具備している。一次側コイルと三次側コイルは同一のコア軸に巻線が巻回されている。二次側コイルは他のコア軸に巻線が巻回されている。そして、一次側コイルと三次側コイルとの間にコア材の仕切り板を設けた構成である。

【0009】

【発明の実施の形態】

電力を供給する一次側コイルと電力を受け取る二次側コイルを備え、一次側コイルと二次側コイルとを対向させて電力の伝達を行なう非接触電源装置と、一次側コイルの巻線軸と同軸に設けた三次側コイルから複数の直流出力電圧を得る電源装置とを併せ持つマルチ出力電源装置のトランスにおいて、トランスは一次側コイル、二次側コイル、三次側コイルを具備している。

一次側コイルと三次側コイルは同一のコア軸に並べて巻線を巻回したり、または、一次側コイルと三次側コイルを同一のコア軸に重ねて巻線を巻回する。二次側コイルは他のコア軸に巻線を巻回する。一次側コイルと三次側コイルとの間にコア材の仕切り板を設けて磁氣的結合を調整する。

仕切り板は一次側コイルと三次側コイルの結合係数を一次側コイルと二次側コイルの結合係数とほぼ同じ結合係数となるように所定の大きさとする。

または、一次側コアには、仕切り板を設けた形状のコアを一体にして形成したものをを用いると部品点数を削減すると共に作業が容易となる。

【0010】

【実施例】

本発明のマルチ出力電源装置のトランスの実施例を図1から図4を用いて説明する。

【0011】

図1は一次コイルと二次コイルを巻線軸に並べて、磁氣的結合を垂直方向に結合させたトランスで、図1 (a) は説明のための模式図であり、図1 (b) はその断面図であり、図1 (c) は仕切り板の断面図である。

図1に示すように、トランスにおいて、1は磁性材料で断面がT字状に成型された一次側コア、2は磁性材料でリング状に成型された平板状の仕切り板、3は一次コイル、4は三次コイル、9は磁性材料で断面がI字状に成型された二次側コア、10は二次コイルである。

【0012】

仕切り板は一次コイルと三次コイルの結合係数 k_{1-3} が一次コイルと二次コイルの結合係数 k_{1-2} とほぼ同じになるようにコアを所定の大きさに設定したもので、その大きさは内径 d_2 を一次側コア1の巻線部径 d_1 とほぼ同じとし、外径 w_2 を一次側コア1の外径 w_1 とほぼ同じ（やや小さめ）とし、厚み t を設けたものである。

なお、本願実施において一次コイルと三次コイルの結合係数 k_{1-3} を設定する際、仕切り板の外径 w_2 を変えると大きく結合が変わることより粗調整として予め行い、仕切り板の厚み t で微調整を行うことにより設定が容易に行なえる。なお、仕切り板の外径 w_2 を一次側コアの外形 w_1 より大きくすると、仕切り板2が出っ張ることになり、他の部品との接触およびトランスの配置に注意を要する。

また、一次側コアはコア1と仕切り板2を一体に形成したものでよい。

【0013】

このような構造のトランスの磁束の流れを図2に示す。

図2に示すように、一次コイル3で発生した磁束は一次側コア1から対向する二次側コア9、二次コイル10を経て、一次コイル3と三次コイル4間に設けた仕切り板2を通るループ ϕ_{1-2} を描く。また、一次コイルで発生した磁束 ϕ_1 は二次側コア面9aと対向する一次側コアの面1aから飛び出し、仕切り板2に入る磁束のループと三次コイル4を通り一次側コアの鏝1cに入る磁束 ϕ_{1-3} とが考えられる。

【0014】

このように、磁性体の仕切り板2を設けることにより、一次コイル3で発生した磁束の一部は仕切り板2を通るループと三次コイル4を通るループ $\phi_1 - \phi_3$ に分かれる。いいかえれば、仕切り板の大きさ(w_2 、 t)によって三次コイル4を通るループ $\phi_1 - \phi_3$ の磁束を調整することができる。

【0015】

図5の回路において、三次コイルと並列に共振コンデンサC_o(点線部)を接続した共振型のマルチ出力電源装置に本願発明のトランスを用いて、三次コイルの出力端子C N 3の出力電圧電流特性を測定した結果、図4の曲線Aで示す特性を得た。

図4の曲線Aに示すように垂下特性をもたせることができる。

このときの実施例である本願発明のトランスの各結合係数は、一次コイルと二次コイルの結合係数 k_{1-2} は0.25~0.35で、一次コイル三次コイルの結合係数 k_{1-3} は0.2~0.3であった。

【0016】

このように、本発明のマルチ出力電源装置のトランスを用いることにより、三次コイルの出力回路に保護回路が不要となり、コスト低減となる。また、三次コイルの出力端子C N 3が電力制限されるため、無負荷時の二次側出力電圧が跳ね上がらず安全である。

【0017】

次に、他の実施例であるマルチ出力電源装置のトランスを図3に示す。

図3は、一次コイルに二次コイルを重ねて巻回して高さを低く抑えた、磁気結合を水平方向に結合させたトランスで、図3(a)は説明のための模式図であり、図3(b)はその断面図であり、図3(c)は仕切り板の断面図である。

図3に示すように、トランスにおいて、1は磁性材料で断面がE字状に成型されたボット形の一次側コア、2は磁性材料で成型された筒状の仕切り板、3は一次コイル、4は三次コイル、9は磁性材料で断面がI字状に成型された二次側コア、10は二次コイルである。

仕切り板2は一次コイルと三次コイルの結合係数 k_{1-3} が一次コイルと二次コイルの結合係数 k_{1-2} より小さくなるように高さ h_2 をコア1の脚1cと同じ高さ h_1 寸法とし、厚み t を所定の厚みに設定する。

なお、一次側コア1は仕切り板2を一体にして形成したものでもよい。

【0018】

以上、本発明のマルチ出力電源装置のトランスの実施例を述べたが、これらの実施例に限られるものではない。例えば、コア形状を円筒で示したが、楕円、四角形、多角形を用いてもよい。一次コイル、二次コイル、三次コイルは予め巻線された空心コイルを用いてもよい。さらに、一次側コアと仕切り板の透磁率を異ならせた磁性材料を用いてもよい。さらに、自励型の共振回路を用いて説明したが他励の共振回路を用いても同様である。

【0019】

【発明の効果】

以上の説明から明らかなように、本発明のマルチ出力電源装置のトランスは、一次コイルと三次コイルを同一のコア軸に巻線が巻回されており、一次コイルと三次コイルとの間に仕切り板を設け、一次コイルと三次コイルの結合を一次コイルと二次コイルの結合をほぼ同じにすることにより、三次コイルの出力端子の出力電圧電流特性に垂下特性を持たせている。それによって過電流を回避するため、複雑な過電流保護回路を必要としない安価なマルチ出力電源装置を提供することができる。

【図面の簡単な説明】

【図1】本発明の一実施例であるマルチ出力電源装置のトランスの模式図(a)とその断面図(b)と仕切り板の断面図(c)

【図2】図1に示したトランスの磁束の流れ図

【図3】本発明の他の実施例であるマルチ出力電源装置のトランスの模式図(a)とその断面図(b)と仕切り板の断面図(c)

【図4】三次側の出力端子の出力電圧電流特性図

【図5】マルチ出力電源装置の概略回路図

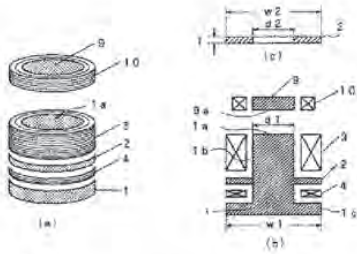
【図6】従来のマルチ出力電源装置のトランスの模式図(a)とその断面図(b)

【図7】図6に示したトランスの磁束の流れ図

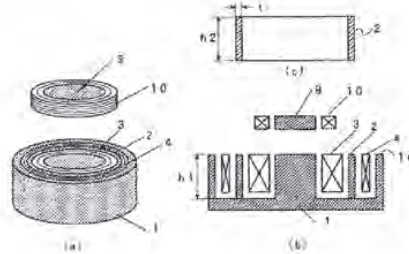
【符号の説明】

- 1 一次側コア
- 2 仕切り板
- 3 一次コイル
- 4 三次コイル
- 9 二次側コア
- 10 二次コイル

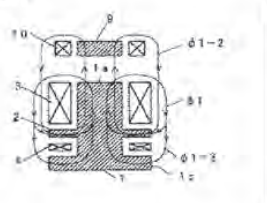
【図1】



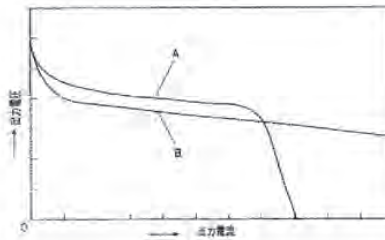
【図3】



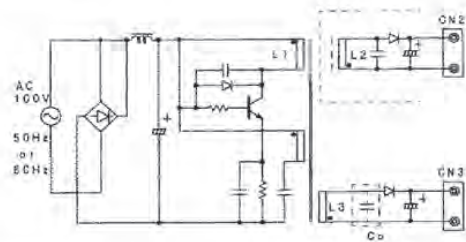
【図2】



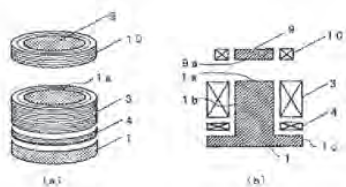
【図4】



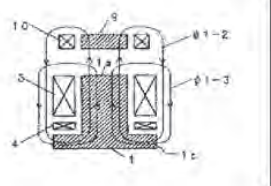
【図5】



【図6】



【図7】



(8)

特開2004-201458 (P2004-201458A)

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Thursday, May 2 2013

THOMSON INNOVATION

Patent/Publication: JP2004201458A**Bibliography****DWPI Title**

Transformer used in multioutput power supply, has primary and tertiary coils separated by partition plate, wound on same core, and secondary coil wound on separate core

Original Title

TRANSFORMER FOR MULTIPLE-OUTPUT POWER SUPPLY

The trans|transformer of a multi output power supply (*Translation from Thomson Reuters*)**English Title**

TRANSFORMER FOR MULTIPLE-OUTPUT POWER SUPPLY

Assignee/ApplicantStandardized: **TOKO INC**

Original: TOKO INC

DWPI Assignee/Applicant

TOKO KK (TOJK-C)

Inventor

KOJIMA HIDEKI,

DWPI Inventor

KOJIMA H

Publication Date (Kind Code)

2004-07-15 (A)

DWPI Accession / Update

2004-514382 / 200449

Application Number / Date

JP2002369380A / 2002-12-20

Priority Number / Date / Country

JP2002369380A / 2002-12-20 / JP

Abstract**DWPI Abstract**

(JP2004201458A_)

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

Novelty

A secondary coil (10) receives power from a primary coil (3), such that direct current (DC) voltages are output by the secondary coil. The primary coil and a tertiary coil (4) separated by a partition plate (2), are wound in the same core, and the secondary coil is wound on a separate core (9).

Use

In multioutput power supply.

Advantage

Enables to provide a dropping characteristics to the voltage-current characteristic curve of the tertiary coil, by separating the tertiary coil and the primary coil using the partition plate. By preventing over current generation, the need for providing an expensive protective circuit is eliminated.

Drawing Description

The figure shows the perspective and sectional views of the transformer and the partition plate.

- 1 - primary side core.
- 2 - partition plate.
- 3 - primary coil.
- 4 - tertiary coil.
- 9 - secondary side core.
- 10 - secondary coil.

Abstract

PROBLEM TO BE SOLVED: To provide a transformer for multiple-output power supply wherein the output voltage/current characteristics are provided with a drooping characteristic and necessity for an overcurrent protection circuit is obviated.

SOLUTION: The transformer is for a multiple-output power supply. The transformer comprises a non-contact power supply which is provided with a primary coil for supplying power and a secondary coil for receiving power and transmits power with the primary coil, and the secondary coil opposed to each other; and a power supply which obtains a plurality of direct-current output voltages from a tertiary coil provided coaxially with the winding axis of the primary coil. The transformer comprises the primary coil, secondary coil, and tertiary coil. The windings of the primary coil and the tertiary coil are wound on the same core shaft. The winding of the secondary coil is wound on another core shaft. A partition plate made of the core material is provided between the primary coil and the tertiary coil.

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SUBJECT of the Invention A drooping characteristic is given to an output-voltage electric-current characteristic,

It aims at providing the trans|transformer of the multi output power supply which made the overcurrent protective circuit unnecessary.

PROBLEM to be solved The trans|transformer of the multi output power supply having the non-contact power supply which have the primary side coil which supplies electric power, and the secondary side coil which receives electric power, and a primary side coil and a secondary side coil are made to oppose, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the third order side coil provided coaxial as the coil|winding axis|shaft of a primary side coil

WHEREIN:

The trans|transformer has comprised the primary side coil, the secondary side coil, and the third order side coil.

The coil|winding is wound by the core axis|shaft with same primary side coil and third order side coil.

As for the secondary side coil, the coil|winding is wound by another core axis|shaft.

And the partition plate of a core material was provided between the primary side coil and the third order side coil.

SELECTED DRAWINGS FIG. 1

[MAT_IMAGE 000002]

(Translation from Thomson Reuters)

Classes/Indexing

IPC

IPC Code(1-7) **H02M 3/28** H01F 30/04 H02M 3/338

(7)

Current IPC	Invention	Version	Additional	Version
Full	H01F 30/04 H02M 3/28 H02M 3/338	20060101 20060101 20060101	-	-
Main Group	-	-	-	-
Subclass	-	-	-	-

Original IPC	Invention	Version	Additional	Version
Advanced/Full	H01F 30/04 H02M 3/28 H02M 3/338	20060101 20060101 20060101	-	-
Core/Main Group	H01F 30/00 H02M 3/24	20060101 20060101	-	-
Subclass	-	-	-	-

JP FI Codes

H01F 31/04 ; H02M 3/28 C; H02M 3/28 L; H02M 3/28 V; H02M 3/338 A

JP F Terms

5E068

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

5H730; AA14; AA17; AA20; BB43; BB52; CC04; DD02; DD23; EE02; EE07; EE73; FD24; FG08; XX03; XX15; XX47; ZZ16

DWPI Class

U24 V02 X12

DWPI Manual Codes

 Expand DWPI Manual Codes

Legal Status**INPADOC Legal Status**

Gazette Date	Code	Description
2012-02-07	FPAY +	RENEWAL FEE PAYMENT PAYMENT UNTIL: 20140204
2012-02-02	FPAY +	RENEWAL FEE PAYMENT PAYMENT UNTIL: 20120204
2010-02-02	FPAY +	RENEWAL FEE PAYMENT PAYMENT UNTIL: 20120204
2010-01-28	FPAY +	RENEWAL FEE PAYMENT PAYMENT UNTIL: 20100204

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Family**Family**

INPADOC Family (2)

Publication Number	Publication Date	Inventor	Assignee/Applicant	Title
JP2004201458A	2004-07-15	KOJIMA HIDEKI	TOKO INC	TRANSFORMER FOR MULTIPLE-OUTPUT POWER SUPPLY
JP03643581B2	2005-04-27	-	-	-

DWPI Family (2); Countries (1)

Publication	DWPI Update	Publication Date	IPC Code	Language
JP2004201458A	200449	2004-07-15	H02M000328	Japanese
Local Applications: JP2002369380A filed 2002-12-20				
JP03643581B2	200528	2005-04-27	H02M000328	Japanese
Local Applications: JP2002369380A filed 2002-12-20				

Claims**Claims**

All Claims (5)

<https://www.thomsoninnovation.com/tip-innovation/printRecView.do?ResultSetId=409676...> 5/2/2013

Claims (English)

1. The trans|transformer of the multi output power supply having the non-contact power supply which have the primary side coil which supplies electric power, and the secondary side coil which receives electric power, and this primary side coil and this secondary side coil are made to oppose, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the secondary side coil provided coaxial as the coil|winding axis|shaft of this primary side coil

WHEREIN:

This trans|transformer comprises a primary side coil, a secondary side coil, and an third order side coil, A coil|winding is wound by the core axis|shaft with same this primary side coil and this third order side coil,

As for this secondary side coil, a coil|winding is wound by another core axis|shaft,

The partition plate of a core material was provided between this primary side coil and this third order side coil.

The trans|transformer of the multi output power supply characterized by the above-mentioned.

2. The trans|transformer of the multi output power supply having the non-contact power supply which have the primary side coil which supplies electric power, and the secondary side coil which receives electric power, and this primary side coil and this secondary side coil are made to oppose, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the secondary side coil provided coaxial as the coil|winding axis|shaft of this primary side coil

WHEREIN:

This trans|transformer comprises a primary side coil, a secondary side coil, and an third order side coil, This primary side coil and this third order side coil are arranged in the same core axis|shaft, and a coil|winding is wound,

As for this secondary side coil, a coil|winding is wound by another core axis|shaft,

The partition plate of a core material was provided between this primary side coil and this third order side coil.

The trans|transformer of the multi output power supply characterized by the above-mentioned.

3. The trans|transformer of the multi output power supply having the non-contact power supply which have the primary side coil which supplies electric power, and the secondary side coil which receives electric power, and this primary side coil and this secondary side coil are made to oppose, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the secondary side coil provided coaxial as the coil|winding axis|shaft of this primary side coil

WHEREIN:

This trans|transformer comprises a primary side coil, a secondary side coil, and an third order side coil, As for this primary side coil and this third order side coil, a coil|winding is wound in piles by the same core axis|shaft,

As for this secondary side coil, a coil|winding is wound by another core axis|shaft,

The partition plate of a core material was provided between this primary side coil and this third order side coil.

The trans|transformer of the multi output power supply characterized by the above-mentioned.

4. The core which winds said primary side coil and an third order side coil made the partition plate integral, and shape|molded it.

The trans|transformer of the multi output power supply of Claim 1, 2, 3 characterized by the above-mentioned.

5. Said partition plate made the predetermined size the coupling coefficient of a primary side coil and an third order side coil so that it might become substantially the same as the coupling coefficient of a primary side coil and a secondary side coil.

The trans|transformer of the multi output power supply of Claim 1, 2, 3, 4 characterized by the above-mentioned.

(Translation from Thomson Reuters)

Description

DWPI Drawing Description

The figure shows the perspective and sectional views of the transformer and the partition plate.

- 1 - primary side core.
- 2 - partition plate.
- 3 - primary coil.
- 4 - tertiary coil.
- 9 - secondary side core.
- 10 - secondary coil.

Drawing Description

Drawing Description

Description

Description

TECHNICAL FIELD of the Invention

This invention is non-contact and relates the power supply which supplies electric power, and some direct current|flow output voltages to the trans|transformer used for the multi output power supply which can be obtained simultaneously.

PRIOR ART

For example, like a cordless-telephone apparatus, a sub-station|mobile_unit is cordless, and it is non-contact from a main|base_station, and has the charging battery which charges a secondary battery, and while a main|base_station is equipped with the power supply which supplies electric power to a sub-station|mobile_unit, the multi output power supply which can output the DC power according to some circuits is used.

(For example, patent-documents 1 reference)

There are few number of parts and a circuit structure shows the outline circuit diagram of the multi output power supply of a simple self-excitation oscillation type|mold in FIG. 5.

As shown in FIG. 5, the primary side which supplies electric power obtains a DC voltage from a mains AC power supply (AC100V 50 / 60Hz) via a rectification smoothing circuit.

A switching element is turned on-off for the DC voltage by a self-excitation oscillation circuit,

Electric power is supplied to the secondary coil L2 which the energy generate|occur|produced in the primary coil L1 was made to oppose at predetermined intervals with a primary coil L1, and arranged it, It is non-contact and is the circuit which obtains a predetermined DC voltage to an output terminal CN2.

Moreover, it is the circuit which imparts the energy of a primary coil L1 to the tertiary coil L3 provided in the same trans|transformer, and obtains a predetermined DC voltage to an output terminal CN3.

In addition, with a circuit diagram, although it is one output, in a required case, some output are provided plurality of a tertiary coil, and an output terminal CN3 obtains the DC voltage of a setting according to each.

The conventional trans|transformer in the multi output power supply of such a structure is shown in FIG. 6.

As shown in FIG. 6, FIG.6(a) is the model for description,

FIG.2(b) is the sectional drawing.

From FIG. 6, the cross-section which consists of a magnetic material winds a primary coil 3 to the T-shaped primary side core 1 at coil|winding part 1b,

It arranges on the same core axis|shaft and a tertiary coil 4 is wound.

A secondary coil winds a secondary coil 10 to the secondary side core 9 whose cross-section which consists of a magnetic material is I character-like.

And primary side core (coil|winding surface of primary coil is contained) surface 1a and secondary side core (secondary-coil coil|winding surface is contained) surface 9a -- with a given interval

Electric power is transmitted to a secondary coil 10 in the state where it opposed.

The flow of the magnetic flux in such a trans|transformer is shown in FIG. 7.

The magnetic flux generate|occur|produced in a primary coil 3 can consider loop $(\phi)_{1-2}$ of the magnetic flux which put|enters in collar 1c of a primary side core, and loop $(\phi)_{1-3}$ of the magnetic flux which put|enters surface 1a of the primary side core 1 to a primary side core in jump-out|protrusion collar 1c passing through the secondary side core 9 which opposes from surface 1a of a primary side core, and a secondary coil 20 as shown in FIG. 7.

These can express the relationship of the magnetic flux of a primary coil, a secondary coil, and a tertiary coil by measuring coupling-coefficient k_{1-3} of coupling-coefficient k_{1-2} of a primary coil 3 and a secondary coil 4, a primary coil, and a tertiary coil.

Coupling-coefficient K_{1-2} of the result and primary coil which measured the coupling coefficient in the trans|transformer of FIG. 6, and a secondary coil is 0.2-0.4,

Coupling-coefficient K_{1-3} of a primary coil and a tertiary coil was 0.5-0.8.

When this trans|transformer was used for the circuit diagram shown in FIG. 5, the output-voltage electric-current characteristic of the output terminal CN3 of a tertiary coil became like the curve B shown in FIG. 4.

In such an output-voltage electric-current characteristic, when it short-circuits in an external load (short), there exists a possibility of an excessive electric current flowing and burning a circuit.

In order to prevent this, when the protective circuit was provided, there existed a fault which a circuit becomes complicated and serves as a large cost increase.

Moreover, there exists the method of inserting the resonance capacitor|condenser Co (FIG. 5 point line part) in a tertiary coil in parallel,

However, coupling-coefficient k_{1-3} of a primary coil and a tertiary coil becomes too strong, and it becomes unstable oscillating [of a self-excitation oscillation circuit] It.

PROBLEM to be solved by the Invention

This invention gives a drooping characteristic to the output-voltage electric-current characteristic of a tertiary coil in view of the above conventional faults,

It aims at providing the trans|transformer of the multi output power supply which made the overcurrent protective circuit unnecessary.

MEANS to solve the Problem

It is the trans|transformer of the multi output power supply having the non-contact power supply which this invention is equipped with the primary side coil which supplies electric power, and the secondary side coil which receives electric power, and a primary side coil and a secondary side coil are made to oppose in order to achieve said objective, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the third order side coil provided coaxial as the coil|winding axis|shaft of a primary side coil.

WHEREIN:

The trans|transformer has comprised the primary side coil, the secondary side coil, and the third order side coil.

The coil|winding is wound by the core axis|shaft with same primary side coil and third order side coil.

As for the secondary side coil, the coil|winding is wound by another core axis|shaft.
And it is the structure which provided the partition plate of a core material between the primary side coil and the third order side coil.

EMBODIMENT of the Invention

The trans|transformer of the multi output power supply having the non-contact power supply which have the secondary side coil which receives the primary side coil which supplies electric power, and electric power, and a primary side coil and a secondary side coil are made to oppose, and transmits electric power, and the power supply which obtains some direct current|flow output voltages from the third order side coil provided coaxial as the coil|winding axis|shaft of a primary side coil

WHEREIN:

The trans|transformer has comprised the primary side coil, the secondary side coil, and the third order side coil.

A primary side coil and an third order side coil are arranged in the same core axis|shaft, and a coil|winding is wound,

Or a coil|winding is wound for a primary side coil and an third order side coil in piles on the same core axis|shaft.

A secondary side coil winds a coil|winding on another core axis|shaft.

The partition plate of a core material is provided between a primary side coil and an third order side coil, and magnetic binding|bond|coupling is adjusted to it.

A partition plate makes a predetermined size the coupling coefficient of a primary side coil and an third order side coil so that it may become the coupling coefficient of a primary side coil and a secondary side coil, and a substantially the same coupling coefficient.

Or operation becomes easy while reducing a number of parts, when what made integral the core of the shape which provided the partition plate, and formed it at the primary side core is used.

EXAMPLES

The Example of the trans|transformer of the multi output power supply of this invention is demonstrated using FIGS. 1-4.

It is the trans|transformer which FIG. 1 arranged [trans|transformer] the primary coil and the secondary coil in the coil|winding axis|shaft, and combined magnetic binding|bond|coupling with the orthogonal|vertical direction, and FIG.1(a) is the model for description,

FIG.1(b) is the sectional drawing,

FIG.1(c) is sectional drawing of a partition plate.

As shown in FIG. 1, it is a trans|transformer.

WHEREIN:

1 is the primary side core by which the cross-section was shape|molded T-shaped with the magnetic material,

2 is the flat partition plate shape|molded in a ring shape with the magnetic material,

3 is a primary coil,

4 is a tertiary coil,

9 is the secondary side core by which the cross-section was shape|molded in the shape of I character with the magnetic material,

10 is a secondary coil.

A partition plate is what set the core in the predetermined size so that coupling-coefficient k_{1-3} of a primary coil and a tertiary coil may become substantially the same as coupling-coefficient k_{1-2} of a primary coil and a secondary coil, and the size makes an internal diameter d2 substantially the same as the diameter d1 of a volume line part of the primary side core 1,

An outer diameter w2 -- the outer diameter w1 of the primary side core 1 -- being substantially the same (it being slightly smallish) -- carrying out Thickness t is provided.

In addition, when setting coupling-coefficient k_{1-3} of a primary coil and a tertiary coil in this-application implementation, and the outer diameter w2 of a partition plate is changed, it will carry out beforehand

as a coarse control from binding|bond|coupling changing a lot,
 Thickness t of a partition plate -- fine-adjustment 行 $\bar{\omega}$ -- it can set easily by things.
 In addition, when the outer diameter w_2 of a partition plate is enlarged from the external shape w_1 of a primary side core, a partition plate 2 will protrude,
 The arrangement of a contact and a trans|transformer with another component requires a caution.
 Moreover, what integrally formed core 1 and the partition plate 2 is sufficient as a primary side core.

The flow of the magnetic flux of the trans|transformer of such structure is shown in FIG. 2.
 As shown in FIG. 2, the magnetic flux generate|occur|produced in the primary coil 3 draws loop $(\phi)_{1-2}$ which passes along the partition plate 2 provided between the primary coil 3 and the tertiary coil 4 passing through the secondary side core 9 which opposes from the primary side core 1, and a secondary coil 10.
 Moreover, the magnetic flux $(\phi)_{1-3}$ generate|occur|produced in the primary coil protrudes|jumps out from surface 1a of the primary side core opposing secondary side core surface 9a,
 Magnetic flux $(\phi)_{1-3}$ which put|enters in collar 1c of a primary side core through the loop and tertiary coil 4 of magnetic flux which put|enter in a partition plate 2 can be considered.

Thus, one part of the magnetic flux generate|occur|produced in the primary coil 3 is divided into loop $(\phi)_{1-3}$ which passes along the loop which passes along a partition plate 2, and a tertiary coil 4 by providing the partition plate 2 of a magnetic substance.
 In other words, the magnetic flux of loop $(\phi)_{1-3}$ which passes along a tertiary coil 4 with the size (w_2, t) of a partition plate can be adjusted.

The circuit of FIG. 5

WHEREIN:

The trans|transformer of this invention is used for the multi output power supply of the resonance type|mold which connected the resonance capacitor|condenser C_o (point line part) to the tertiary coil and the parallel,

The result which measured the output-voltage electric-current characteristic of the output terminal CN3 of a tertiary coil, and the characteristic shown with the curve A of FIG. 4 were acquired.

A drooping characteristic can be given as shown in the curve A of FIG. 4.

Coupling-coefficient k_{1-2} of a primary coil and a secondary coil of each coupling coefficient of the trans|transformer of this invention which is an Example at this time was 0.25-0.35, and coupling-coefficient k_{1-3} of a primary-coil tertiary coil was 0.2-0.3.

Thus, the thing for which the trans|transformer of the multi output power supply of this invention is used,

A protective circuit becomes unnecessary in the output circuit of a tertiary coil,

It becomes a cost reduction.

Moreover, since the power restrictions of the output terminal CN3 of a tertiary coil are carried out, the secondary-side output voltage at the time of a no load leaps up and is safe.

Next, the trans|transformer of the multi output power supply which is another Example is shown in FIG. 3.

FIG. 3 is the trans|transformer which wound the secondary coil in piles to the primary coil, and restrained height low and which combined magnetic coupling with the horizontal direction, and FIG.3(a) is the model for description,

FIG.3(b) is the sectional drawing,

FIG.3(c) is sectional drawing of a partition plate.

As shown in FIG. 3, it is a trans|transformer.

WHEREIN:

1 is the primary side core of the pot type by which the cross-section was shape|molded by the E-shape with the magnetic material,

2 is the cylindrical partition plate shape|molded with the magnetic material,

3 is a primary coil,

4 is a tertiary coil,

9 is the secondary side core by which the cross-section was shape|molded in the shape of I character with the magnetic material,
10 is a secondary coil.

A partition plate 2 makes height h_2 the height h_1 same dimension as leg 1c of core 1 so that coupling-coefficient K_{1-3} of a primary coil and a tertiary coil may become smaller from coupling-coefficient k_{1-2} of a primary coil and a secondary coil,

Thickness t is set in predetermined thickness.

In addition, what made the partition plate 2 integral and formed it is sufficient as the primary side core 1.

In the above, the Example of the trans|transformer of the multi output power supply of this invention was described,

However, it is not restricted to these Examples.

For example, it was cylindrical and the core shape was shown,

However, it may use an ellipse, a square, and a polygon.

A primary coil, a secondary coil, and a tertiary coil may use the air core coil wound beforehand.

Furthermore, it may use the magnetic material which varied the permeability of a primary side core and a partition plate.

Furthermore, it is the same even if it uses the resonance circuit of a separate excitation, although demonstrated using the resonance circuit of a self-excitation type|mold.

ADVANTAGE of the Invention

As for the trans|transformer of the multi output power supply of this invention, the coil|winding is clearly wound by the same core axis|shaft in the primary coil and the tertiary coil from the above description, The drooping characteristic is given to the output-voltage electric-current characteristic of the output terminal of a tertiary coil by providing a partition plate between a primary coil and a tertiary coil, and making binding|bond|coupling of a primary coil and a secondary coil substantially the same for binding|bond|coupling of a primary coil and a tertiary coil.

Since an overcurrent is avoided by it, the cheap multi output power supply with which a complicated overcurrent protective circuit is not required can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[FIG. 1]

Sectional-drawing (c) of model (a) and sectional-drawing (b) of the trans|transformer of the multi output power supply which is one Example of this invention, and a partition plate

[FIG. 2]

The flowchart of the magnetic flux of the trans|transformer shown in FIG. 1

[FIG. 3]

Sectional-drawing (c) of model (a) and sectional-drawing (b) of the trans|transformer of the multi output power supply which is another Example of this invention, and a partition plate

[FIG. 4]

The output-voltage electric-current characteristic view of the output terminal of the third order side

[FIG. 5]

The outline circuit diagram of a multi output power supply

[FIG. 6]

Conventional model (a) and its conventional sectional-drawing (b) of a trans|transformer of a multi output power supply

[FIG. 7]

The flowchart of the magnetic flux of the trans|transformer shown in FIG. 6

Description of Symbols

1 Primary side core

2 Partition plate

3 Primary coil

4 Tertiary coil
9 Secondary side core
10 Secondary coil
[FIG. 1]
[MAT_IMAGE 000003]
[FIG. 2]
[MAT_IMAGE 000004]
[FIG. 3]
[MAT_IMAGE 000005]
[FIG. 4]
[MAT_IMAGE 000006]
[FIG. 5]
[MAT_IMAGE 000007]
[FIG. 6]
[MAT_IMAGE 000008]
[FIG. 7]
[MAT_IMAGE 000009]

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Citations

Citation Record level

Citing Patents (0)



Expand Cited Patents (4)

Cited Non-patents (0)

Other

DWPI Title Terms

TRANSFORMER POWER SUPPLY PRIMARY TERTIARY COIL SEPARATE PARTITION PLATE WOUND CORE
SECONDARY

DWPI Related Accession Numbers

-

Custom Fields

Test

-

Relevance

-

Product Name

~

Docket number

~

Notes

~

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SMALL-SIZED HIGH-SENSITIVITY ANTENNA

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Classification: - international: **H01Q7/08**; (IPC1-7): H01Q7/08
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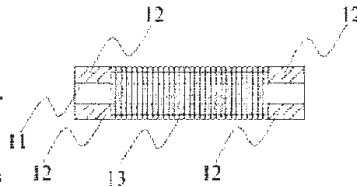
Application number: JP20030285350 20030801

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Abstract of JP2005057444 (A)

PROBLEM TO BE SOLVED: To improve transmission/reception sensitivity of an antenna core by improving an L value and a Q value without varying the length of an antenna or to make the antenna thinner and more small-sized without varying the sensitivity. ; SOLUTION: The antenna having its core material wound with a conductive wire material coated with an insulator is provided with a gate at an end of an area where the conductive wire material is wound. The gate is formed of a composite material made of a composition consisting of 5 to 60 vol.% metal magnetic powder and resin and a flat nano-crystal magnetic metal material is preferably used as the metal magnetic powder. ; COPYRIGHT: (C)2005,JPO&NCIPI



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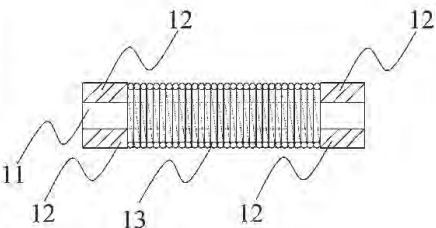
(54) 【発明の名称】 小型高感度アンテナ

(57) 【要約】

【課題】 アンテナの長さ寸法を変えずに、L値、Q値を向上させ、アンテナコアの送受信感度の向上を実現すること、或いは感度を変えずに更なる薄型化、小型化を実現する

【解決手段】 芯材に絶縁体で被覆された導電性線材が巻回されているアンテナにおいて、該導電性線材が巻回されている領域の端部に堰が設けられていることを特徴とするアンテナを用いる。堰は、金属磁性粉末5～60V o l %と樹脂とからなる組成物により形成されている複合体から成り、前記金属磁性粉末は、扁平上のナノ結晶磁性金属材料を用いることが好ましい。

【選択図】 図1



【特許請求の範囲】

【請求項 1】

芯材に絶縁体で被覆された導電性線材が巻回されているアンテナにおいて、該導電性線材が巻回されている領域の端部に堰が設けられていることを特徴とするアンテナ。

【請求項 2】

前記堰が、金属磁性粉末を含む組成物から成ることを特徴とする前記請求項 1 記載のアンテナ。

【請求項 3】

前記堰が、金属磁性粉末と樹脂とからなる組成物を含む複合体から成ることを特徴とする前記請求項 1 記載のアンテナ。

【請求項 4】

前記金属磁性粉末が、ナノ結晶磁性金属材料であることを特徴とする請求項 1～3 記載のアンテナ。

【請求項 5】

前記金属磁性粉末の形状が扁平状であることを特徴とする前記請求項 1～4 記載のアンテナ。

【請求項 6】

金属磁性粉末 5～60 vol % と樹脂 95～40 vol % とからなる組成物を含む前記請求項 3 の複合体を製造するための組成物。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、電波を電気信号に変換するアンテナ素子のうち、棒状アンテナに関するものである。例えば、電波を受信、送信、送受信するアンテナであり、RFID 用アンテナ、車載イモビライザー用アンテナ、電子キー用アンテナ、電波時計用アンテナ、ラジオ、携帯機器用小型アンテナ等が挙げられる。これらの棒状アンテナの感度をさらに向上させるために、棒状アンテナの片側もしくは両端に付加する金属磁性粉末ブロック体及び金属磁性粉末ブロックを付与したアンテナに関するものである。

【背景技術】

【0002】

電子・通信分野の目覚ましい発展に伴い、電気・電子機器に用いられる磁気応用製品の需要の拡大、これに伴う製品形態の多様化が急速に進んでおり、特に携帯機器の普及に伴って、薄型化、小型化、高効率化の要求が高まっている。これらの機器に用いられる、電波を電気信号に変換するアンテナ素子はより薄型化、小型化、高効率化が望まれている。

【0003】

従来このようなアンテナとして特開平 7-278763（特許文献 1）では、図 3 に示すように、磁気特性が特に優れる非晶質金属薄帯材料を棒状のアンテナコア材料として用い、棒状コアに巻線を施すことで、100 kHz 以上で Q 値が高く高感度な、アンテナが提案されている。また、この技術の改善策として、特開 2001-337181（特許文献 2）の方法が提案されている。この方法によれば、アンテナの棒状心材の両端にフランジが形成され、そのフランジの間にコイルが巻回されている。このフランジを付加することにより、アンテナの受信感度を向上させることが可能となる。しかし、機器の小型化に伴いさらなる薄型化、小型化、高性能アンテナが要望されている。

【特許文献 1】特開平 7-278763

【特許文献 2】特開 2002-278763

【発明の開示】

【発明が解決しようとする課題】

【0004】

近年の電波を利用した情報通信が、例えば防犯用の施錠システム、ID カード、タグ等のトランスポンダに使用される RFID の情報の送受信、または、電波時計、ラジオ等に

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用いられている。これらの用途では、携帯するタグ、キー等に用いられることから、さらなる薄型化、カード化の市場要求がある。こうした用途のアンテナもさらなる小型化を図るために、アンテナコアの厚み、長さをさらに低減する必要がある。

【0005】

しかしながら、アンテナの体積減少に伴い、アンテナのL値またはQ値が低下し、L値とQ値の積に比例するアンテナ感度が低下する。その結果、実用上十分な電波受信感度が得られなくなることがある。

【0006】

そこで本発明はこれらの問題を解決するために、本発明ではアンテナの長さ寸法を変えずに、L値、Q値を向上させ、アンテナコアの送受信感度の向上を実現すること、或いは感度を変えずに更なる薄型化、小型化を実現することを課題とする。 10

【課題を解決するための手段】

【0007】

このような課題を解決するために鋭意研究の結果以下のことを見出した。

【0008】

本発明は、芯材に絶縁体で被覆された導電性線材が巻回されているアンテナにおいて、該導電性線材が巻回されている領域の端部に堰が設けられていることを特徴とするアンテナを提供する。

【0009】

前記アンテナに設けられている堰は、金属磁性粉末を含む組成物から成ることを特徴とする。 20

【0010】

前記アンテナに設けられている堰は、金属磁性粉末と樹脂とからなる組成物を含む複合体から成ることを特徴とする。

【0011】

前記金属磁性粉末が、ナノ結晶磁性金属材料を用いることは本発明の好ましい態様の1つである。

【0012】

前記金属磁性粉末の形状は扁平状であることを特徴とする前記請求項1～4記載のアンテナ。 30

【0013】

本発明は、堰を作るための金属磁性粉末5～60vol%と樹脂95～40vol%とからなる組成物を提供する。

【発明の効果】

【0014】

絶縁体で被覆された導電性線材が巻回されているアンテナにおいて、該導電性線材が巻回されている領域の端部に堰が設けられることにより、アンテナのL値が向上し小型高感度アンテナを得ることができた。その結果、L値が一定で良い場合は、アンテナコイルの銅巻線数が減らせる、その結果、銅損が減り、Q値が向上でき、アンテナの送受信感度が大幅に向上する。また銅巻線を減らした分、アンテナの幅、高さが小さくなり、アンテナの小型化、薄型化が可能となった。 40

【発明を実施するための最良の形態】

【0015】

次に本発明の実施の形態について具体的に説明する。

(アンテナ)

本発明のアンテナの例を図1に示す。本発明は、アンテナの芯材11、堰12、被覆導電性線材が巻回されている領域13の3つの要素から構成される。

【0016】

アンテナの芯材は、磁性体からなり、アンテナの芯材の中央部を含む領域に銅線からなる巻線コイルがアンテナの芯材に巻回されている。被覆導電性線材が巻回されている領域 50

は、堰に接していることが好ましい。堰は、磁性金属粉末と樹脂の組成物により形成されている。本願において、この組成物により形成されている堰のことを単に複合体と呼ぶ場合がある。

(アンテナの芯材)

本発明のアンテナの芯材について説明する。

【0017】

アンテナの芯材の形状は円柱、角柱等の種々の形状のが可能である。その中でも、直方体もしくは角柱が、積層体を切断加工して容易に作製できるため好ましい。

【0018】

アンテナの芯材は磁性体からなり、磁性体の形態は板状もしくは粉末状である。材料としては、例えば、珪素鋼板、パーマロイ、センダスト、軟磁性フェライト、アモルファス磁性金属、ナノ結晶磁性金属等が挙げられる。珪素鋼板、パーマロイなどは打抜き等でアンテナの芯材形状に加工する。またセンダストなどは水ガラスや樹脂等と混合して一体成形しアンテナの芯材形状とする。

【0019】

このなかでもC o系アモルファス磁性金属薄帯や、F e系アモルファス磁性金属薄帯、ナノ結晶磁性金属薄帯などは、透磁率が高く、損失が低い小型薄型用アンテナコア材料として好適である。但し、1枚が10 μm～30 μmと薄いため、必要な性能を得るために、実際には複数枚を積層して、アンテナの芯材形状とする。ポリイミド等の耐熱樹脂とC o系アモルファス磁性金属薄帯や、F e系アモルファス磁性金属薄帯、ナノ結晶磁性金属薄帯が交互に積層された積層体からなるアンテナの芯材は、この中でも、C o系アモルファス磁性金属薄帯や、F e系アモルファス磁性金属薄帯とポリイミド等の耐熱樹脂からなる積層体が最も好ましい。またこれらの積層体が積層後、非晶質金属の磁気特性向上に必要な熱処理ができ、さらにその後、機械加工が出来る。

【0020】

この非晶質金属と耐熱樹脂からなる積層体は以下の方法で作製することができる。

(非晶質合金薄帯)

本発明のアンテナに使用される非晶質金属薄帯に用いられる磁性材料としては、F e系、C o系の非晶質金属薄帯が用いられる。これらの非晶質金属薄帯は、通常熔融金属を急冷ロールを用いて、急冷して得られる。通常は10～50 μmの厚さであり、好ましくは10～30 μmの厚さの薄帯が用いられる。

【0021】

F e系非晶質金属材料としては、F e - S i - B系、F e - B系、F e - P - C系などのF e - 半金属系非晶質金属材料や、F e - Z r系、F e - H f系、F e - T i系などのF e - 遷移金属系非晶質金属材料を挙げることができる。C o系非晶質金属材料としてはC o - S i - B系、C o - B系などの非晶質金属材料が例示できる。これらの中でも、アンテナ特性としてのQ値が高い材料としては、以下の組成のものがより好ましい。

【0022】

非晶質金属薄帯の組成が、一般式 $(Co_{1-c}Fe_c)_{1-a-b}X_aY_b$ (式中のXは、S i, B, C, G eから選ばれる少なくとも1種類以上の元素を表し、YはZ r, N b, T i, H f, T a, W, C r, M o, V, N i, P, A l, P t, P h, R u, S n, S b, C u, M n, 希土類元素から選ばれる少なくとも1種類以上の元素で表される。c, a, bは、それぞれ、 $0 \leq c \leq 0.2$ 、 $0 < a \leq 0.35$ 、 $0 \leq b \leq 0.3$ ここでa, bは原子%)で表される組成が好ましい。上記非晶質金属薄帯のC oのF e置換は非晶質合金の飽和磁化の増加に寄与する傾向にある。このため、置換量cは $0 \leq c \leq 0.2$ であることが好ましく、 $0 \leq c \leq 0.1$ であることがさらに好ましい。

【0023】

X元素は本発明に用いる非晶質金属薄帯を製造する上で、非晶質化のために結晶化速度

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を低減するために有効な元素である。X元素が10原子%より少ないと、非晶質化が低下して一部結晶質が混在し、また、35原子%を超えると、非晶質構造は得られるものの合金薄帯の機械的強度が低下し、連続的な薄帯が得られなくなる。したがって、X元素の量aは、 $10 < a \leq 35$ であることが好ましく、さらに好ましくは、 $12 \leq a \leq 30$ である。

【0024】

Y元素は、本発明に用いる非晶質金属薄帯の耐食性に効果がある。この中で特に有効な元素は、Zr, Nb, Mn, W, Mo, Cr, V, Ni, P, Al, Pt, Ph, Ru 元素である。Y元素の添加量は30%以上になると、耐食性の効果はあるが、薄帯の機械的強度が脆弱になるため、 $0 \leq b \leq 30$ であることが好ましい。さらに好ましい範囲は、 $0 \leq b \leq 20$ である。

【0025】

また、前記非晶質金属薄帯は、例えば、所望組成の金属を調合したものを高周波溶解炉等を用いて熔融し、均一な溶融体としたものを、不活性ガス等でフローして、急冷ロールに吹き付けて、急冷して得られる。通常は厚さは5～50 μ mであり、好ましくは10～30 μ mの薄帯が用いられる。本発明に用いられる非晶質金属薄帯は、液体急冷方法などによりシート状に作製された非晶質金属材料が使用できる。または、粉末状の非晶質金属材料をプレス成形などによりシート状にしたものを使用することができる。また、本発明に使用される非晶質金属薄帯は、単一非晶質金属薄帯を用いても良いし、複数および多種類の非晶質金属薄帯を重ねたものを用いることができる。

(塗工基材および積層体)

本発明のアンテナの芯材が耐熱樹脂を表面にコートした非晶質金属薄帯とからなる場合、非晶質金属薄帯の原反からロールコータなどのコーティング装置で、非晶質金属薄帯上に液状樹脂の塗膜を作り、これを乾燥させて非晶質金属薄帯に耐熱性樹脂を付与する方法で作製することができる。

【0026】

非晶質金属薄帯に耐熱性樹脂を付与した多層構造の磁性基材を作製する場合、例えば熱プレスや熱ロールなどにより積層一体化することができる。加圧時の温度は耐熱樹脂の種類により異なるが、概ね、耐熱樹脂硬化物のガラス転移温度以上で軟化もしくは熔融する温度近傍で積層接着することが好ましい。

(アンテナの作製方法)

アンテナの芯材は、目的とする磁性コアに使用されるように所望の形状に加工される。形状加工方法としては、ダイサー加工、打抜き加工、エッチング加工、レーザー加工、放電ワイヤー加工、ウォータージェット等により加工される。この中でも、アンテナの芯材形状が矩形の場合はダイサー加工が好ましい。また矩形以外の形状の場合は打抜き加工もしくはエッチング加工することが好ましい。

【0027】

アンテナの芯材が非晶質金属材料からなる場合、さらに形状加工を施した磁性積層体もしくは一枚の磁性基材のうち、非晶質金属の磁気特性発現に必要な200℃から500℃の熱処理を施す。

(堰)

本発明の堰は、被覆された導電性線材が巻回されている領域の両端に配置される。通常、巻回されている線材と堰は接している。

【0028】

本発明の堰の形状は、具体的には図1に示すように貫通孔のあいたキャップ状のバルク体を棒状アンテナコアで貫通したり、図2に示すような金属磁性粉末21からなるケース構造でも良い。ケース21で棒状アンテナをカバーすることで、巻線時に棒状アンテナのエッジで、巻線コイルの被覆が剥がれ絶縁破壊に至る可能性が大幅に減る。しかしながら、ケース分の厚みが増えるため、薄型化が必要な場合は不利となる。また、堰と堰は連結されていてもよく、例えば、棒状アンテナの表面を磁性複合体のペーストで覆って図2の

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ケースのような形状にしても良い。

【0029】

図1のように堰に貫通孔があいている場合、貫通孔の形状は、アンテナの芯材の断面形状にほぼ一致し、アンテナの芯材に嵌めたときに空隙が無いことが望ましい。また磁性複合体の長手方向の長さは、アンテナの芯材の長手長の2%~30%の比率であることが良く、さらに好ましくは、長手長の5%~20%が良い。

(構成材料)

本発明の磁性複合体は、磁性金属粉末と樹脂とを複合して構成される。

【0030】

以下に磁性金属粉末と樹脂及び複合方法について述べる。

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(磁性金属粉末)

本発明に用いられる磁性粉末は、ナノ結晶磁性金属粉、アモルファス磁性金属粉、パーマロイ粉末、センダスト粉末、珪素鋼板粉末などが挙げられる。この中でもアモルファス磁性金属粉とナノ結晶磁性金属粉がアンテナのL値及びQ値向上に著しい改善効果があることを見出した。その中でもナノ結晶非晶質金属粉が好ましく、さらに好ましくは扁平状のナノ結晶非晶質金属粉がアンテナのL値及びQ値向上に著しい改善効果を有している。

(ナノ結晶磁性粉末)

本発明に用いられるナノ結晶磁性材料は組織が粒径100nm以下のナノ結晶粒を主成分とする磁性材料であり、非晶質合金を結晶化温度以上で熱処理し、ナノ結晶粒を析出させることで得られる。

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【0031】

ナノ結晶磁性材料の組成としては、ナノ結晶磁性材料として代表的なFe-Cu-Nb-Si-B系でもよいが、下記組成に限らないが、最も望ましくは、一般式 $(Fe_{1-x}M_x)_{100-a-b-c-d}Si_aAl_bB_cM'_d$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Y、Pd、Ru、Ga、Ge、C、Pから選ばれる1種類以上の元素を表わす。xは原子比を、a、b、c、dは原子%を示し、それぞれ $0 \leq x \leq 0.5$ 、 $0 \leq a \leq 24$ 、 $1 \leq b \leq 20$ 、 $4 \leq c \leq 30$ 、 $0 \leq d \leq 10$ を満たすものとする)で表わされる組成が望ましい。

【0032】

望ましくは、以下の一般式A、B、C、D、Eの5通りで表現される金属粉末が望ましい。

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【0033】

一般式Aは $(Fe_{1-x}M_x)_{100-a-b-c-d}Si_aAl_bB_cM'_d$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Pd、Ru、Ge、C、P、希土類元素から選ばれる1種類以上の元素を表わす。xは原子比を、a、b、c、dは原子%を示し、それぞれ $0 \leq x \leq 0.5$ 、 $0 \leq a \leq 24$ 、 $0.1 < b \leq 20$ 、 $4 \leq c \leq 30$ 、 $0 \leq d \leq 20$ を満たすものとする)で表わされる組成である。

【0034】

一般式Bは $(Fe_{1-x}M_x)_{100-a-b-c-d}Cu_aSi_bB_cM'_d$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Pd、Ru、Ge、C、P、希土類元素から選ばれる1種類以上の元素を表わす。xは原子比を、a、b、c、dは原子%を示し、それぞれ $0 \leq x \leq 0.4$ 、 $0.1 \leq a \leq 3$ 、 $b \leq 19$ 、 $5 \leq c \leq 25$ 、 $0 < d \leq 20$ 、 $15 \leq b + c \leq 30$ を満たすものとする)で表わされる組成である。

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【0035】

一般式Cは $(Fe_{1-x}M_x)_{100-a-b}BaM'_b$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Pd、Ru、Ga、Ge、C、希土類元素から選ばれる1種類以上の元素を表わす。xは原子比を、a、bは原子%を示し、それぞれ $0 \leq x \leq 0.5$ 、 $0 < a \leq 20$ 、 $2 \leq b \leq 20$ を満たすものとする)で表わされる組成である。

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のとする)で表わされる組成である。

【0036】

一般式Dは $(Fe_{1-x}M_x)_{100-a-b-c}P_aM'_bCu_c$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Pd、Ru、Ga、Ge、Al、C、希土類元素から選ばれる1種類以上の元素を表わす。xは原子比を、a、b、c、dは原子%を示し、それぞれ $0 \leq x \leq 0.5$ 、 $0 < a \leq 20$ 、 $2 \leq b \leq 20$ 、 $0 \leq c \leq 3$ を満たすものとする)で表わされる組成で表される。

【0037】

一般式Eは $(Fe_{1-x}M_x)_{100-a-b}M_aM'_b$ (式中、MはCo及び/又はNi、M'はTa、Zr、Hf、Ti、Nb、Mo、W、V、Cr、Mn、Pd、Ru、Ga、Ge、Si、Al、P、Cu、希土類元素から選ばれる1種類以上の元素を表わす。M'はC、N、Oから選ばれる1種類以上の元素を表わす。xは原子比を、a、bは原子%を示し、それぞれ $0 \leq x \leq 0.5$ 、 $2 < a \leq 30$ 、 $4 \leq b \leq 30$ を満たすものとする)で表わされる組成で表される。

【0038】

なお、上記組成の合金において、これらの構成元素以外に合金を作製する上で使用母材に含まれるSなどの不純物は不可避である。

【0039】

磁性材料に含まれるナノ結晶粒は、100nm以下、望ましくは50nm以下、更に望ましくは、30nm以下が望ましい。磁性材料にこれらナノ結晶粒が含まれることで、保磁力の低減等の軟磁気特性の向上が見られる。ナノ結晶粒は、実験的には、X線回折を測定し、ピーク半値幅より結晶粒のサイズを測定することができる。

【0040】

一方、本発明に用いられる非晶質磁性材料は、熱処理後も非晶質構造を維持しており、非晶質磁性材料の組成としては、これに制限を受けないが、一般式 $(Fe_{1-x}M_x)_{100-a-b-c}Si_aB_bM'_c$ (式中、MはCo及び/又はNi、M'はNb、Mo、Zr、W、Ta、Hf、Ti、V、Cr、Mn、Y、Pd、Ru、Ga、Ge、C、Pから選ばれる1種類以上の元素を表わす。xは原子比を、a、b、cは原子%を示し、それぞれ $0 \leq x < 1$ 、 $0 \leq a \leq 24$ 、 $4 \leq b \leq 30$ 、 $0 \leq c \leq 10$ を満たすものとする)が望ましいが、これに限定されるものではない。

【0041】

本発明に用いられる磁性粉末の厚み、粒径は厚み5ミクロン以下の扁平状の形状を有しているものが良く、更に望ましくは、厚み5ミクロン以下、粒径300ミクロン以下が望ましい。更に望ましくは、厚み3ミクロン以下、粒径200ミクロン以下が望ましい。

【0042】

本発明に用いられる磁性粉末の厚み、粒径は厚み5ミクロン以下の扁平状の形状を有しているものが良いが、円盤型、楕円回転体型、球型、針状、不定形などであっても良いが、厚みが5ミクロン以下であるような薄型の磁性粉末がアンテナのL値、Q値を向上する上で望ましい。

【0043】

本発明に用いられる磁性粉末は、上記の扁平状磁性粉末の単独でも良いが、球状磁性粉末や他の形状の磁性粉末と混合で用いても良い。

【0044】

本発明の磁性粉末の製造方法であるが、合金溶湯を急冷し得られた非晶質リボンを作成した後、粉末砕し粉末末を得る方法があるが、粉碎する方法は粉碎時の応力により磁気特性の低下が起こりやすいため、水アトマイズ方法やガスアトマイズ方法等の直接磁性粉が得られる方法が望ましい。

【0045】

本発明に用いられる磁性材料は、上記非晶質磁性材料、ナノ結晶磁性材料それぞれ単独でも良いが、ナノ結晶磁性材料と非晶質金属材料とを混合させても良い。更に、他の磁性

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材料、例えば、フェライトやセンダストなどとの混合して用いても良い。

(樹脂材料)

本発明の堰の成形に金属粉末とともに用いられる樹脂材料の目的は、磁性複合体間の電氣的絶縁と、磁性金属粉間の結着である。このような材料として、無機系材料では水ガラス、セラミックス、有機系材料としては熱可塑性樹脂、熱硬化性樹脂など種々の樹脂が挙げられるが、特に磁気特性向上に200℃以上の熱処理が必要な場合は、熱可塑性、弾性率の低い耐熱樹脂を混ぜることが、優れた性能を発揮する上で効果的である。

【0046】

本発明に用いられる耐熱性樹脂は、非晶質金属薄帯の磁気特性を向上させる最適熱処理温度で熱処理される場合があるので、当該熱処理温度で熱分解の少ない材料を選定することが必要になる。非晶質金属薄帯の熱処理温度は、非晶質金属薄帯を構成する組成および目的とする磁気特性により異なるが、良好な磁気特性を向上させる温度は概ね200～600℃の範囲にあり、さらに好ましくは300℃～500℃の範囲である。

【0047】

本発明に用いられる耐熱性樹脂としては、熱可塑性、非熱可塑性、熱硬化性樹脂を挙げることができる。中でも熱可塑性樹脂を用いるのが好ましい。また、本発明においてバインダーとして用いられる熱可塑性樹脂は、ガラス転移温度T_gが420℃以下が良く、更に、望ましくは、ガラス転移温度T_gが50℃以上420℃以下のものが良く、更に望ましくは、ガラス転移温度T_gが60℃以上350℃以下のものが良い。更に望ましくは、ガラス転移温度T_gが100℃以上300℃以下のものが良い。

【0048】

この製造方法により、耐熱性樹脂を樹脂化しているため、室温でタック性がなく、また安定であるため、取り扱いが簡便であり、積層時の作業性がよく工程の歩留まりが向上できるメリットがある。

【0049】

本発明に用いられる耐熱性樹脂としては、前処理として120℃で4時間乾燥を施し、その後、窒素雰囲気下、300℃で2時間保持した際の重量減少量を、DTA-TGを用いて測定され、通常1%以下、好ましくは0.5%以下であるものが用いられる。具体的な樹脂としては、ポリイミド系樹脂、ケイ素含有樹脂、ケトン系樹脂、ポリアミド系樹脂、液晶ポリマー、ニトリル系樹脂、チオエーテル系樹脂、ポリエステル系樹脂、アリレート系樹脂、サルホン系樹脂、イミド系樹脂、アミドイミド系樹脂を挙げることができる。これらのうちポリイミド系樹脂、スルホン系樹脂、アミドイミド系樹脂を用いるのが好ましい。

【0050】

また本発明において200℃以上の耐熱性を必要としない場合、これに限定されないが、本発明に用いられる熱可塑性樹脂を具体的に挙げるとすれば、ポリエーテルサルホン、ポリエーテルイミド、ポリエーテルケトン、ポリエチレンテレフタレート、ナイロン、ポリブチレンテレフタレート、ポリカーボネート、ポリフェニレンエーテル、ポリフェニレンスルフィド、ポリサルホン、ポリアミド、ポリアミドイミド、ポリ乳酸、ポリエチレン、ポリプロピレン等々あるが、この中でも、望ましくは、ポリエーテルサルホン、ポリエーテルイミド、ポリエーテルケトン、ポリエチレン、ポリプロピレン、エポキシ樹脂、シリコン樹脂、ゴム系樹脂(クロロブレンゴム、シリコンゴム)等を用いることができる。

【0051】

(堰を形成する組成物)

本発明の堰を形成する組成物の作成方法としては、磁性金属粉末と、樹脂粉末を粉碎粉を混練する方法や、磁性粉末と樹脂粉末を溶媒を用いず乾式で混合後、ホットプレスする方法や、ジメチルアセトアミドのような有機溶媒に樹脂を溶かし、磁性粉末を混合し、ペーストを作成し、金型に中で乾燥させ磁性複合体を作成する方法等がある。この中でも、磁性粉末と樹脂を乾式で混合し、直接ホットプレスをする方法で磁性複合体を作製することが好ましい。

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【0052】

本発明の磁性複合材料の金属粉末と樹脂の配合比は、好ましくは5V o l % ~ 50V o l %用いるのが好ましく、さらに好ましくは10V o l % ~ 30V o l %用いることが好ましく、さらに好ましくは15V o l % ~ 25V o l %用いることが好ましい。この範囲にあると本発明の効果であるアンテナのL値Q値が大幅に向上できることを見出した。

(形状加工方法)

材料の複合化の後、アンテナの芯材に付加できるように形状加工を施す。成形方法は、磁性複合材料がペレット状の場合は射出成形または押出し成形が好適である。また溶剤を含まない混合粉の場合は、熱プレス等の方法が挙げられる。射出成形や押出し成形は量産時に低コストで製造できるため好ましい。

【実施例1】

【0053】

アンテナの芯材は、ハネウエル社製、Metglas: 2714A (商品名)、幅約50mm、厚み約15 μ mであるCo₆₆Fe₄Ni₁(BSi)₂₉(原子%)の組成を持つ非晶質金属薄帯を使用した。この薄帯の片面全面にE型粘度計で測定(25℃)し、約0.3Pa・sの粘度のポリアミド酸溶液を付与し、140℃で乾燥後、260℃でキュアし、非晶質金属薄帯の片面に約6ミクロンの耐熱樹脂(ポリイミド樹脂)を付与した。ポリイミド樹脂は、3,3'-ジアニソジフェニルエーテルと3,3',4,4'-ビフェニルテトラカルボン酸二無水物を1:0.98の割合で混合し、ジメチルアセトアミド溶媒中で室温にて縮重合して得られたものである。通常は、ポリアミド酸としてジアセチルアミド溶液として用いる。この基材を、40枚積み重ねて熱プレスすることにより大気中260℃30分、5MPaで、厚み1.0mmの積層体を作製した。磁気特性を発現するためこれをさらに、400℃1hr窒素雰囲気中で加圧、加熱し、ダイサーにより長さ15mm、幅1mm、厚さ1mmのアンテナの芯材とした。

【0054】

次に堰の作製方法を示す。堰は磁性金属粉体と樹脂粉体とを混合して作製される。まず磁性金属粉体の組成はFe₆₆Ni₄Si₁₄B₉Al₄Nb₃の合金を高周波溶解炉で1300℃の溶湯とし、溶解炉の底に取り付けたノズルを通して溶湯を流下させ、ノズル先に取り付けたガスアトマイズ部より75kg/cm²の高圧ガスで溶湯を微粒化し、更にこの微粒化させた溶湯をロール径190mm、円錐角度80度、回転数7200rpmの回転冷却体に衝突させ、Fe₆₆Ni₄Si₁₄B₉Al₄Nb₃(at%)の組成を有する平均長径150ミクロン、平均短径55ミクロン、平均厚み2ミクロンの扁平状磁性粉を作製した。磁性粉の熱処理前のX線回折を測定した結果、磁性粉は典型的な非晶質のハローパターンを示し、完全な非晶質であることが明らかになった。得られた磁性粉を580℃で1時間熱処理を行った。磁性粉の熱処理後のX線回折を測定した結果、熱処理後の磁性粉は微結晶化しており、ピーク半値幅よりほぼ20nmの微結晶が析出していることが明らかになった。

【0055】

堰を作製するための樹脂としてポリエーテルサルホン(以下PES)(三井化学社製)粉末を用いた。ポリエーテルサルホンのペレットをボールミルで粉碎し、ポリエーテルサルホンの粒径100ミクロンの粉末を作製した。そして、得られたナノ結晶磁性粉を20V o l %、バインダーとして前記のポリエーテルサルホンの粉末を80V o l %を混合し、ハイブリッドミキサー(キーエンス社製)にて10分攪拌し、均一な磁性粉と樹脂からなる混合粉末を得た。

【0056】

そして、得られたナノ結晶磁性粉を20V o l %、樹脂粉末として前記のポリエーテルサルホンの粉末を80体積%を混合し、ハイブリッドミキサー(キーエンス社製)にて10分攪拌し、均一な磁性粉と樹脂からなる混合粉末を得た。更に、この複合粉末を、300℃、15MPaにて10分間熱プレスを行い、厚さ4mmの複合材シートを作製した。その後NC工作機により3×3×4mmのブロックに成形した。さらに中心部に1×1角

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(mm)のアンテナの芯材を貫通させるための穴を設けた。

【0057】

本方法で作製した磁性複合体コアに棒状アンテナの両端に嵌めた後、 $\phi 0.1$ mmのポリウレタン被覆銅線を600ターン巻回した。

【0058】

アンテナ特性を評価するため、インダクタL値と性能指数Q値を測定し、比透磁率を算出した。測定にはヒューレットパッカード製LCRメータ4024Aにより測定した。結果を下表に示す。その結果、本発明による実施例1のアンテナは、従来技術に比べて、大幅な磁気特性の向上が可能ながわかった。

【実施例2】

【0059】

実施例1とは堰を構成する組成物中の金属粉末形状が球状であることのみ異なる。球状金属粉末の作製方法は、実施例1と同様に磁性金属粉末の組成はFe66Ni4Si14B9Al4Nb3の合金を高周波溶解炉で1300℃の溶湯とし、溶解炉の底に取り付けたノズルを通して溶湯を流下させ、ノズル先に取り付けたガスアトマイズ部より75kg/cm²の高圧ガスで溶湯を微粒化する。その後、冷却固体させ、球状磁性粉体とする。それ以外は全て実施例1と同様の材料、および工程でアンテナを作製した。

【0060】

アンテナ特性を評価するため、インダクタL値と性能指数Q値を測定し、比透磁率を算出した。測定にはヒューレットパッカード製LCRメータ4024Aにより測定した。結果を下表に示す。その結果、本発明による実施例2のアンテナは、さらに大幅な磁気特性の向上が可能ながわかった。

【実施例3】

【0061】

本発明のアンテナの実施例の構成を図1に示す。実施例1とは金属粉末組成が、Co系非晶質金属であることのみ異なる。Co系非晶質金属は以下の通り（後で記入）。それ以外は全て実施例1と同様の材料、および工程でアンテナを作製した。

【0062】

アンテナ特性を評価するため、インダクタL値と性能指数Q値を測定し、比透磁率を算出した。測定にはヒューレットパッカード製LCRメータ4024Aにより測定した。結果を下表に示す。その結果、本発明による実施例2のアンテナは、さらに大幅な磁気特性の向上が可能ながわかった。

【比較例】

【0063】

本発明の薄型インダクタの比較例の構成を図3に示す。実施例1とは、磁性複合体の構成材料および金属粉末材料だけが異なる。それ以外は全て実施例1と同様の材料、および工程でアンテナを作製した。

【0064】

アンテナ特性を評価するため、インダクタL値と性能指数Q値を測定し、比透磁率を算出した。測定にはヒューレットパッカード製LCRメータ4024Aにより測定した。結果を下表に示す。

【0065】

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【表 1】

	堰の材料				コイルの 線径 × 巻数	アンテナの L×Q値
	磁性粉末 の種類	磁性粉末 の形状	磁性粉末 の体積比 率(%)	樹脂		
実施例1	ナノ結晶磁 性粉	りん片	20	PES	0.1×600	13×108
実施例2	ナノ結晶磁 性粉	球形	20	PES	0.1×600	12×105
実施例3	アモルファス 磁性粉	りん片	20	PES	0.1×600	14×110
比較例1	Fe-Si-Cr 系粒状磁 性粉末	粒状	95	ナイロン	0.1×670	10×90

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【図面の簡単な説明】

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【0066】

【図1】本発明のアンテナの構成を示す図である。

【0067】

【図2】本発明の小型高感度アンテナの斜視図（巻線コイルなし）

【0068】

【図3】比較例のアンテナの構成を示す図である。

【符号の説明】

【0069】

11 アンテナの芯材

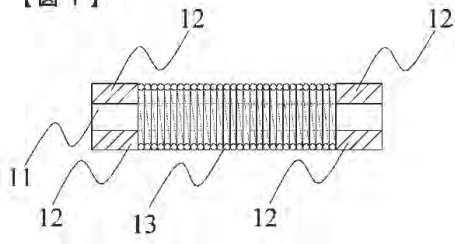
12 堰

13 被覆導線線材が巻回されている領域

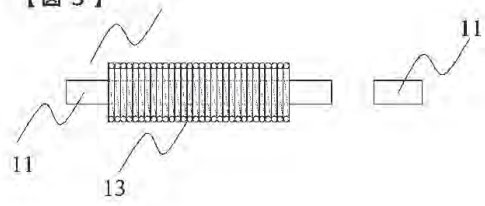
21 磁性粉末複合体からなるケース

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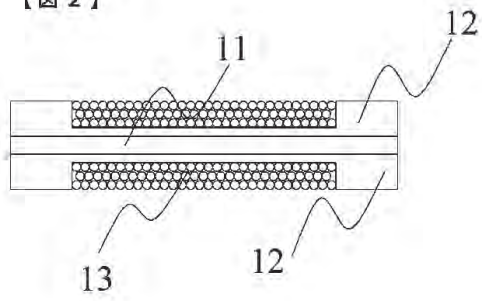
【図 1】



【図 3】



【図 2】



* NOTICES *

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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]

An antenna, wherein a weir is provided by end of a region around which this conductive wire rod is wound in an antenna with which a conductive wire rod covered with an insulator is wound around a core material.

[Claim 2]

Said antenna according to claim 1, wherein the aforementioned weir comprises a constituent containing magnetic metal powder.

[Claim 3]

Said antenna according to claim 1, wherein the aforementioned weir comprises a complex containing a constituent consisting of magnetic metal powder and resin.

[Claim 4]

The antenna according to claim 1 to 3, wherein the aforementioned magnetic metal powder is a nano crystal magnetic metal material.

[Claim 5]

Said antenna according to claim 1 to 4, wherein form of the aforementioned magnetic metal powder is flat state.

[Claim 6]

A constituent for manufacturing a complex of aforementioned Claim 3 containing a constituent which consists of the magnetic metal powder 5 - 60Vol%, and the resin 95 - 40Vol%.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Field of the Invention]

[0001]

The present invention relates to a stick antenna among the antenna elements which convert an electric wave to an electrical signal. For example, it is an antenna which receives, transmits, transmits and receives an electric wave, and is RFID. The ** antenna, the antenna for in-vehicle immobilizers, the antenna for electronic keys, the antenna for wave clocks, radio, the miniaturized antenna for portable devices, etc. are mentioned. In order to improve the sensitivity of these stick antennas further, it is related with the antenna which gave the magnetic-metal-powder block body and magnetic-metal-powder block which are added to one side or the both ends of a stick antenna.

[Background of the Invention]

[0002]

Diversification of the types of products accompanying expansion of the demand of the magnetic application products used for the electrical and electric equipment and this is progressing quickly with remarkable development of an electron and a telecommunications sector, and the demand of slimming down, a miniaturization, and efficient-izing is increasing especially with the spread of portable devices. As for the antenna element which is used for these apparatus and which converts an electric wave to an electrical signal, slimming down, a miniaturization, and efficient-ization are desired more.

[0003]

As such [conventionally] an antenna, in JP,7-278763,A (Patent document 1), As shown in Fig.3, the antenna with it is proposed by giving winding to a rod-like core, using the amorphous metal thin band material which is excellent in especially magnetic properties as a cylindrical antenna core material. [high Q value and] [high sensitivity / above 100 kHz] The method of JP,2001-337181,A (Patent document 2) is proposed as a remedy of this technology. According to this method, a flange is formed in the both ends of the rod-like heartwood of an antenna, and the coil is wound between that flange. By adding this flange, it becomes possible to improve the receiving sensitivity of an antenna. However, the further slimming down, the miniaturization, and the highly efficient antenna are demanded with the miniaturization of apparatus.

[Patent document 1] JP,7-278763,A

[Patent document 2] JP,2002-278763,A

[Description of the Invention]

[Problem to be solved by the invention]

[0004]

The information and telecommunications using an electric wave in recent years are used for transmission and reception of the information on RFID used, for example for transponders, such as a locking system for crime prevention, an ID card, and a tag, or a wave clock, radio, etc. In these uses, since it is used for a tag, a key, etc. to carry, the market demand of the further slimming down and card-izing occurs. In order for the antenna of such a use to also attain the further miniaturization, it is necessary to reduce the thickness of an antenna core, and length further.

[0005]

However, in connection with the volume decrease of an antenna, L value or Q value of an antenna is deteriorated, and the antenna sensitivity proportional to the product of L value and Q value is deteriorated. As a result, practically sufficient electric wave receiving sensitivity may not no longer be obtained.

[0006]

Then, in order that the present invention may solve these problems, in the present invention, without changing the linear dimension of an antenna, L value and Q value are improved and let it be problem to realize improvement in the transmission and reception sensitivity of an antenna core, or to realize the further slimming down and a miniaturization, without changing sensitivity.

[Means for solving problem]

[0007]

In order to solve such problem, the following things were intensively found out as a result of research.

[0008]

In the antenna with which the conductive wire rod covered with the insulator is wound around the core material, the present invention provides an antenna, wherein the weir is provided by the end of a region around which this conductive wire rod is wound.

[0009]

The weir currently provided by the aforementioned antenna comprises the constituent containing magnetic metal powder.

[0010]

The weir currently provided by the aforementioned antenna comprises the complex containing the constituent consisting of magnetic metal powder and resin.

[0011]

It is one of the preferable modes of the present invention that the aforementioned magnetic metal powder uses a nano crystal magnetic metal material.

[0012]

Said antenna according to claim 1 to 4, wherein the form of the aforementioned magnetic metal powder is flat state.

[0013]

The present invention provides the constituent which consists of the magnetic metal powder 5 for making a weir - 60Vol%, and the resin 95 - 40Vol%.

[Effect of the Invention]

[0014]

In the antenna around which the conductive wire rod covered with the insulator is wound, when a weir was provided by the end of a region around which this conductive wire rod is wound, L value of the antenna was able to improve and the small high sensitivity antenna was able to be obtained. As a result, when L value may be constant, as a result it can reduce the number of copper winding of an antenna coil, copper loss decreases, Q value can be improved and the transmission and reception sensitivity of an antenna improves substantially. The part which reduced copper winding, the width of an antenna, and height became small, and the miniaturization of an antenna and slimming down of them were attained.

[Best Mode of Carrying Out the Invention]

[0015]

Next, it describes specifically about an embodiment of the invention.

(Antenna)

The example of the antenna of the present invention is shown in Fig.1. The present invention comprises three elements, the core material 11 of an antenna, the weir 12, and the region 13 where the covering conductive wire rod is wound.

[0016]

The winding coil which the core material of an antenna consists of magnetic bodies, and becomes a region including the central part of the core material of an antenna from copper wire is wound around the core material of the antenna. As for the region where the covering conductive wire rod is wound, it is preferable that it is in contact with the weir. The weir is formed with the constituent of magnetic metal powder and resin. In an application concerned, the weir currently formed with this constituent may only be called a complex.

(Core material of an antenna)

It describes about the core material of the antenna of the present invention.

[0017]

That of various form, such as a pillar and a square pillar, is possible for the form of the core material of an antenna. Since a rectangular parallelepiped or a square pillar carries out cut processing of the laminated body and can produce it easily also in it, it is preferable.

[0018]

The core material of an antenna consists of magnetic bodies, and the form of a magnetic body is plate-like or powdered. As a material, a silicon steel, permalloy, Sendust, soft magnetism ferrite, amorphous magnetic metal, and nano crystal magnetic metal etc. are mentioned, for example. Silicon steel, a permalloy, etc. process the core material form of an antenna by die cutting etc. Sendust is mixed with water glass, resin, etc., forms integrally, and is taken as the core material form of an antenna.

[0019]

Also in this, their amplitude permeability is high, and since Co system amorphous magnetic metal thin band, Fe system amorphous magnetic metal thin band, a nano crystal magnetic metal thin band, etc. have the low loss, they are preferable as an antenna core material for small thin shapes. However, 10 micrometers - 30 micrometers, since it is thin, in order to obtain required performance, one sheet laminates two or more sheets actually, and considers it as the core material form of an antenna. The core material of the antenna with which heat-resistant resin, such as polyimide, Co system amorphous magnetic metal thin band, and Fe system amorphous magnetic metal thin band and a nano crystal magnetic metal thin band consist of a laminated body laminated alternately, Also in this, the laminated body which consists of heat-resistant resin, such as Co system amorphous magnetic metal thin band, Fe system amorphous magnetic metal thin band, polyimide, is the most preferable. Heat treatment required for the improvement in magnetic properties of an amorphous metal can be performed after these laminated bodies' laminating, and machining is further possible after that.

[0020]

The laminated body which consists of this amorphous metal and heat-resistant resin is producible by the following methods.

(Amorphous alloy thin band)

As a magnetic material used for the amorphous metal thin band used for the antenna of the present invention, it is Fe. A system and Co The amorphous metal thin band of a system is used. These amorphous metal thin bands are obtained by usually quickly cooling molten metal using a quenching roll. Usually, it is the thickness of 10 - 50 μm , and the thin band of the thickness of 10 - 30 μm is used preferably.

[0021]

Fe [A system and Fe -Hf / A system and Fe -Ti / Fe - transition metal system amorphous metals, such as a system, can be mentioned.] As system amorphous metals, it is Fe -Si -B. A system and Fe -B Fe - semimetal system amorphous metals, such as a system and a Fe -P -C system, and Fe - Zr Co As system amorphous metals, it is Co -Si -B. A system and Co -B Amorphous metals, such as a system, can be illustrated. Also in these, the thing of the following composition is more preferable as a material with high Q value as an antenna characteristic.

[0022]

Composition of an amorphous metal thin band is general formula $(\text{Co}_1\text{-CFeC})^{1-a-b}\text{XaYb}$ (X in a formula). The element beyond at least 1 kind chosen from Si, B, C, and germanium is expressed, Y It is expressed by the element beyond at least 1 kind chosen from ** Zr, Nb, and Ti, Hf, Ta, W, Cr, Mo, V, nickel, P, aluminum, Pt, Ph, Ru, Sn, Sb, Cu, Mn, and a rare earth element. c a and b -- respectively -- $0 \leq c \leq 0.2$, $10 < a \leq 35$, and $0 \leq b \leq 30$ -- a and b have here

the preferable composition expressed by the atom %. Fe of Co of the above-mentioned amorphous metal thin band Substitution tends to contribute to the increase in the saturation magnetization of an amorphous alloy. For this reason, as for the substitution volume c, it is preferable that it is $0 \leq c \leq 0.2$, and it is still more preferable that it is $0 \leq c \leq 0.1$.

[0023]

When an X element manufactures the amorphous metal thin band used for the present invention, in order to reduce a crystallization rate for amorphous-izing, it is an effective element. If amorphous-ization is deteriorated, a crystalline substance is intermingled in part, if there are few X elements than ten atom %, and 35 atom % is exceeded, the mechanical strength of the alloy thin band of that from which amorphous structure is acquired will be deteriorated, and a continuous thin band will no longer be obtained. Therefore, X It is preferable still more preferable that it is $10 < a \leq 35$, and the quantity a of an element is $12 \leq a \leq 30$.

[0024]

Y element has an effect in the corrosion resistance of the amorphous metal thin band used for the present invention. The especially effective elements in this are Zr, Nb, Mn, W, Mo, Cr, V, nickel, P, aluminum, Pt, Ph, and Ru. It is an element. When the addition amount of Y element will be not less than 30%, there is a corrosion-resistant effect, but since the mechanical strength of a thin band becomes vulnerable, it is preferable that it is $0 \leq b \leq 30$. The still more preferable range is $0 \leq b \leq 20$.

[0025]

The aforementioned amorphous metal thin band carries out melting of what prepared the metal of request composition using a high frequency smelter etc., for example, carries out the flow of what was used as the uniform melting object with inactive gas etc., is sprayed on a quenching roll, and is quickly cooled and obtained. Usually, thickness is 5-50 micrometers and is 10-30 micrometers preferably. A thin band is used. The amorphous metals produced by the sheet shaped by the liquid quick cooling method etc. can be used for the amorphous metal thin band used for the present invention. Or what made powdered amorphous metals the sheet shaped by press forming etc. can be used. A single amorphous metal thin band may be used for the amorphous metal thin band used for the present invention, and what piled up plurality and a various kinds of amorphous metal thin band can be used for it.

(A coating base material and a laminated body)

When the core material of the antenna of the present invention consists of an amorphous metal thin band which carried out the coat of the heat-resistant resin to the surface, with coating devices, such as a roll coater, from the original fabric of an amorphous metal thin band, The coating film of liquefied resin can be made on an amorphous metal thin band, and it can produce by the method of drying this and giving heat resistant resin to an amorphous metal thin band.

[0026]

When producing the magnetic substrate of the multilayer structure which gave heat resistant resin to the amorphous metal thin band, laminate integration can be carried out, for example with heat pressing, a hot calender roll, etc. Although the temperature at the time of application of pressure changes with kinds of heat-resistant resin, it is preferable to carry out lamination adhesion softening or near [which carries out melting] the temperature above the glass transition temperature of a heat-resistant resin curing thing in general.

(Manufacturing method of an antenna)

The core material of an antenna is processed into desired form so that it may be used for the target magnetic core. It is processed by dicer processing, stamping, etching processing, laser

processing, discharge wire processing, water jet, etc. as the shape working method. Dicer processing is preferable when the core material form of an antenna is rectangular also in this. In the case of the form except rectangular, it is preferable stamping or to carry out etching processing.

[0027]

When the core material of an antenna consists of amorphous metals, 200 to 500 required for the magnetic-properties manifestation of an amorphous metal among the magnetic laminated body which performed shape working further, or the magnetic substrate of one sheet degrees C heat treatment is performed.

(Weir)

The weir of the present invention is arranged to the both ends of the region where the covered conductive wire rod is wound. Usually, the wire rod and weir which are wound have touched.

[0028]

The case structure which consists of the magnetic metal powder 21 as penetrates by a rod-like antenna core or shows the bulk body of the cap shape in which the through-hole opened as shown in Fig.1 to Fig.2 specifically may be sufficient as the form of the weir of the present invention. A possibility of covering of a winding coil separating and resulting in a dielectric breakdown with the edge of a stick antenna with covering a stick antenna in the case 21 at the time of winding decreases substantially. However, since the thickness for a case increases, it becomes disadvantageous when slimming down is required. The weir and the weir may be connected, for example, may cover the surface of a stick antenna with the paste of a magnetic complex, and may make it form like the case of Fig.2.

[0029]

As for the form of a through-hole, when the through-hole has opened in the weir like Fig.1, when it corresponds to the sectional shape of the core material of an antenna substantially and inserts in the core material of an antenna, it is desirable for there to be no gap. As for the length of the longitudinal direction of a magnetic complex, it is good that it is the Nagate chief's of the core material's of an antenna's ratio of 2% - 30%. 5% - 20% of the Nagate chief is good still more preferably.

(Component)

The magnetic complex of the present invention compounds magnetic metal powder and resin, and is constituted.

[0030]

Magnetic metal powder, resin, and the compound method are described below.

(Magnetic metal powder)

As for the magnetic powder used for the present invention, nano crystal magnetic metal powder, amorphous magnetic metal powder, permalloy powder, Sendust powder, silicon steel powder, etc. are mentioned. It found out that there was an improvement effect with amorphous magnetic metal powder and nano crystal magnetic metal powder remarkable to L value of an antenna and the improvement in Q value also in this. The flat state nano crystal amorphous metal powder in which nano crystal amorphous metal powder is preferable still more preferable has L value of an antenna, and an improvement effect remarkable to the improvement in Q value also in it.

(Nano crystal magnetic powder)

The nano crystal magnetic material used for the present invention is obtained because an organization is a magnetic material which carries out the main component of the nano crystal

grains with a particle diameter of 100 nm or less, heat-treats an amorphous alloy above crystallization temperature and deposits nano crystal grains.

[0031]

Although a Fe-Cu-Nb-Si-B system typical as a nano crystal magnetic material may be sufficient as composition of a nano crystal magnetic material, and not restricted to the following composition, most desirably, General formula $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b-c-d}\text{Si}_a\text{Al}_b\text{B}_c\text{M}'_d$ (among a formula) M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Y, Pd, Ru, Ga, germanium, C, and P. what x shows an atomic ratio, and a, b, c, and d show the atom %, and fills $0 \leq x \leq 0.5$, $0 \leq a \leq 24$, $1 \leq b \leq 20$, $4 \leq c \leq 30$, and $0 \leq d \leq 10$, respectively -- carrying out -- the composition expressed is desirable.

[0032]

The metal powder which is five kinds of the following general formulas A, B, and C, D, and E, and is expressed desirably is desirable.

[0033]

The general formula A is $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b-c-d}\text{Si}_a\text{Al}_b\text{B}_c\text{M}'_d$ (among a formula). M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Pd, Ru, germanium, C, P, and a rare earth element. what x shows an atomic ratio, and a, b, c, and d show the atom %, and fills $0 \leq x \leq 0.5$, $0 \leq a \leq 24$, $0.1 \leq b \leq 20$, $4 \leq c \leq 30$, and $0 \leq d \leq 20$, respectively -- carrying out -- it is the composition expressed.

[0034]

The general formula B is $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b-c-d}\text{Cu}_a\text{Si}_b\text{B}_c\text{M}'_d$ (among a formula). M -- Co, and/or nickel and M -- ' -- one or more kinds of elements chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Pd, Ru, germanium, C, P, and a rare earth element are expressed. what x shows an atomic ratio, and a, b, c, and d show the atom %, and fills $0 \leq x \leq 0.4$, $0.1 \leq a \leq 3$, $b \leq 19$, $5 \leq c \leq 25$, $0 \leq d \leq 20$, and $15 \leq b+c \leq 30$, respectively -- carrying out -- it is the composition expressed.

[0035]

The general formula C is $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b}\text{BaM}'_b$ (among a formula). M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Pd, Ru, Ga, germanium, C, and a rare earth element. what x shows an atomic ratio, and a and b show the atom %, and fills $0 \leq x \leq 0.5$, $0 \leq a \leq 20$, and $2 \leq b \leq 20$, respectively -- carrying out -- it is the composition expressed.

[0036]

The general formula D is $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b-c}\text{PaM}'_b\text{Cu}_c$ (among a formula). M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Pd, Ru, Ga, germanium, aluminum, C, and a rare earth element. what x shows an atomic ratio, and a, b, c, and d show the atom %, and fills $0 \leq x \leq 0.5$, $0 \leq a \leq 20$, $2 \leq b \leq 20$, and $0 \leq c \leq 3$, respectively -- carrying out -- it is expressed with the composition expressed.

[0037]

The general formula E is $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b}\text{MaM}'_b$ (among a formula). M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Ta, Zr, Hf, Ti, Nb, Mo, W, V, Cr, Mn, Pd, Ru, Ga, germanium, Si, aluminum, P, Cu, and a rare earth element. M' expresses one or more kinds of elements chosen from C, N, and O. what x shows an atomic ratio, and a and b show the atom %, and fills $0 \leq x \leq 0.5$, $2 \leq a \leq 30$, and $4 \leq b \leq 30$, respectively -- carrying out -- it is expressed with the composition expressed.

[0038]

In the alloy of the above-mentioned composition, when producing an alloy in addition to these composing elements, impurities, such as S contained in the base metal used, are inescapable.
[0039]

As for the nano crystal grains contained in a magnetic material, 30 nm or less is desirably desirable still more desirably 50 nm or less 100 nm or less. By these nano crystal grains being contained in a magnetic material, improvement in soft magnetic characteristics, such as reduction of coercive force, is found. Experimentally, nano crystal grains can measure X-ray diffraction, and can measure the size of a crystal grain from peak-mesial-magnitude width.

[0040]

On the other hand, the amorphous magnetic material used for the present invention, After heat treatment is maintaining amorphous structure and it as composition of an amorphous magnetic material, Although restriction is not received in this, it is general formula $(\text{Fe}_{1-x}\text{M}_x)_{100-a-b-c}\text{Si}_a\text{B}_b\text{M}'_c$ (among a formula). M expresses Co and/or nickel, and one or more kinds of elements in which M' is chosen from Nb, Mo, Zr, W, Ta, Hf, Ti, V, Cr, Mn, Y, Pd, Ru, Ga, germanium, C, and P. what x shows an atomic ratio, and a, b, and c show the atom %, and fills $0 \leq x < 1$, $0 \leq a \leq 24$, $4 \leq b \leq 30$, and $0 \leq c \leq 10$, respectively -- carrying out -- although it is desirable, it is not limited to this.

[0041]

What has the form of 5 microns or less-thick flat shape is at best still more desirable, and the thickness of the magnetic powder used for the present invention and particle diameter have 5 microns or less in thickness, and the desirable particle diameter of 300 microns or less. 3 microns or less in thickness and the particle diameter of 200 microns or less are desirable desirably.

[0042]

Although what has the form of 5 microns or less-thick flat shape is good as for the thickness of the magnetic powder used for the present invention, and particle diameter, Although it may be a disk type, an elliptical solid-of-revolution type, a ball type, a needle, an infinite form, etc., when the magnetic powder of the thin shape of as [whose thickness is 5 microns or less] improves L value of an antenna, and Q value, it is desirable.

[0043]

the magnetic powder used for the present invention -- the above-mentioned flat shape magnetic powder -- being independent -- although -- spherical magnetic powder and others -- it may use by the magnetic powder of form, and mixing.

[0044]

Although it is a manufacturing method of the magnetic powder of the present invention, after creating the amorphous ribbon which may have had the molten metal quickly cooled, there is a method of ***** (ing) and obtaining the end of powder, but. Since deterioration of magnetic properties takes place easily with the stress at the time of grinding, the method of grinding has a desirable method by which magnetic powder, such as the water atomization method and the gas atomization method, is obtained directly.

[0045]

the magnetic material used for the present invention -- the above-mentioned amorphous magnetic material and a nano crystal magnetic material -- although it may be [each] independent, a nano crystal magnetic material and amorphous metals may be mixed. It may mix with other magnetic materials, for example, a ferrite, Sendust, etc., and may use.

(Resin material)

The purposes of the resin material used for molding of the weir of the present invention with a metal powder object are the electric insulation between magnetic complexes, and binding between magnetic metal powder. Although various resin, such as thermoplastics and thermosetting resin, is mentioned as water glass, ceramics, and an organic system material with an inorganic system material as such a material, When mixing thermoplasticity and heat-resistant resin with a low elastic modulus especially with the improvement in magnetic properties when not less than 200 degrees C needs to be heat-treated exerts the outstanding performance, it is effective.

[0046]

Since the heat resistant resin used for the present invention may be heat-treated with the optimal heat treatment temperature which improves the magnetic properties of an amorphous metal thin band, it is necessary to select material with few pyrolyses with the heat treatment temperature concerned. Although the heat treatment temperature of an amorphous metal thin band changes with magnetic properties made into composition and the purpose of constituting an amorphous metal thin band, the temperature which improves good magnetic properties is in the range of 200-600 degrees C in general, and the ranges of it are 300 degrees C - 500 degrees C still more preferably.

[0047]

Thermoplasticity, non-thermoplasticity, and thermosetting resin can be mentioned as heat resistant resin used for the present invention. It is preferable to use thermoplastics especially. As for the glass transition temperature Tg, 420 degrees C or less are good, it is still more desirable, not less than 50 degree-C a thing of 420 degrees C or less is [the glass transition temperature Tg] at best still more desirable, and the thermoplastics used as a binder in the present invention has [the glass transition temperature Tg] good not less than 60 degree-C thing of 350 degrees C or less. Not less than 100 degree-C a thing of 300 degrees C or less has the good glass transition temperature Tg desirably.

[0048]

There is a merit to which does not have tack properties at a room temperature, and it is simple, the workability at the time of lamination is good, and the handling of yield of a process can improve with this manufacturing method since it is stable since heat resistant resin is resinified.

[0049]

As heat resistant resin used for the present invention, drying is performed at 120 degrees C as pretreatment for 4 hours, the amount of weight loss at the time of holding at 300 degrees C under a nitrogen atmosphere after that for 2 hours is measured using DTA-TG, and what is 0.5% or less preferably is usually used 1% or less. As specific resin, polyimide system resin, silicon content resin, ketone system resin, polyamide system resin, a liquid crystal polymer, nitrile system resin, thioether series resin, polyester system resin, arylate system resin, Sal Hong system resin, imide system resin, and amide imide system resin can be mentioned. It is preferable to use polyimide system resin, sulfone series resin, and amide imide system resin among these.

[0050]

Supposing it mentions specifically the thermoplastics used for the present invention although not limited to this when you do not need the heat resistance of not less than 200 degrees C in the present invention, Polyether sulphone, polyether imide, polyether ketone, Although there are polyethylene terephthalate, nylon, polybutylene terephthalate, polycarbonate, polyphenylene ether, a polyphenylene sulfide, poly SARUHON, polyamide, polyamidoimide, polylactic acid, polyethylene, polypropylene, etc., Also in this, polyether sulphone, polyether imide, polyether

ketone polyethylene, polypropylene, an epoxy resin, silicon resin, rubber system resin (chloroprene rubber, silicone rubber), etc. can be used desirably.

[0051]

(Constituent which forms a weir)

As a preparation method of the constituent which forms the weir of the present invention, Not using a solvent, magnetic metal powder, the method of mulling a pulverized powder for resin powder and magnetic powder, and resin powder by dry type After mixing, There are a method of carrying out a hotpress, the method of melting resin in an organic solvent like dimethylacetamide, mixing magnetic powder, and creating a paste, and drying a mold in inside and creating a magnetic complex, etc. It is preferable to produce a magnetic complex by the method of mixing resin with magnetic powder by dry type, and carrying out a hotpress directly also in this.

[0052]

the metal powder of the magnetic composite material of the present invention, and the compounding ratio of resin -- preferable -- 5Vol% - 50Vol% -- using -- preferable -- further -- preferable -- 10Vol% - 30Vol% -- using -- preferable -- further -- preferable -- 15Vol% - 25%Vol% -- using is preferable. When it was in this range, it found out that L value Q value of the antenna which is an effect of the present invention could improve substantially.

(The shape working method)

After combining of material, shape working is performed so that it can add to the core material of an antenna. When the magnetic composite material of a forming method is a pellet type, injection moulding or extrusion molding is preferable. In the case of the mixed powder which does not contain a solvent, methods, such as heat pressing, are mentioned. Since injection moulding and extrusion molding can be manufactured by low cost at the time of mass production, they are preferable.

[Work example 1]

[0053]

The amorphous metal thin band with composition of Co₆₆Fe₄nickel₁ (BSi) 29 (atom %) which is the Honeywell, Inc. make, Metglas:2714A (trade name), about 50 mm in width, and about 15 micrometers in thickness was used for the core material of an antenna. It measured with E type viscosity meter all over one side of this thin band (25 degrees C), and the polyamide acid solution of the viscosity of about 0.3 Pa and s was given, the cure was carried out at 260 degrees C after drying at 140 degrees C, and about 6-micron heat-resistant resin (polyimide resin) was given to one side of the amorphous metal thin band. Polyimide resin mixes a 3,3,4,4'-biphenyl ***** anhydride with 3,3'-diaminodiphenyl ether at a ratio of 1:0.98, and it is obtained by carrying out condensation polymerization of it at a room temperature in a dimethylacetamide solvent. Usually, it uses as a diacetyl amide solution as polyamide acid. The 1.0-mm-thick laminated body was produced by 260 degree-C30 minutes and 5MPa in the atmosphere by accumulating 40 sheets of this base material and carrying out heat pressing. In order to reveal magnetic properties, further, this was pressurized and heated in a 400 degree-C1hr nitrogen atmosphere, and was made into the core material of an antenna (15 mm in length, 1 mm in width, and 1 mm in thickness) by the dicer.

[0054]

Next, the manufacturing method of a weir is shown. A weir mixes magnetic metal powder and resin powder, and is produced. Composition of magnetic metal powder makes the alloy of Fe₆₆Ni₄Si₁₄B₉Al₄Nb₃ first a 1300 degrees C molten metal with a high frequency smelter,

Make it flow down a molten metal through the nozzle attached to the bottom of a smelter, and a molten metal is atomized with 75 kg/cm² of high pressure gas from the gas atomization part attached to the nozzle tip, This molten metal made to atomize The roll diameter of 190 mm, 80 cone angles, It was made to collide with a rotary cooling body with a rotational speed of 7200 rpm, and the diameter of average length of 150 microns, 55 microns of average minor axes, and the flat shape magnetic powder with an average thickness of 2 microns which have composition of Fe₆₆Ni₄Si₁₄B₉Al₄Nb₃ (at%) were produced. As a result of measuring the X-ray diffraction before heat treatment of magnetic powder, magnetic powder showed the typical amorphous halo pattern, and the perfect amorphous thing became clear. Heat treatment was performed for the obtained magnetic powder at 580 degrees C for 1 hour. As a result of measuring the X-ray diffraction after heat treatment of magnetic powder, magnetic powder after heat treatment was micro-crystallite-ized, and it became clear that about 20-nm micro crystallite deposits from peak-mesial-magnitude width.

[0055]

Polyether sulphone (henceforth, PES) (made by Mitsui Chemicals, Inc.) powder was used as resin for producing a weir. The ball mill ground the pellet of polyether sulphone and powder with a particle diameter of 100 microns of polyether sulphone was produced. And the powder mixture which mixes 80Vol%, stirs the powder of the aforementioned polyether sulphone by a hybrid mixer (made by KEYENCE CORP.) as a binder 20Vol% for 10 minutes, and consists the obtained nano crystal magnetic powder of uniform magnetic powder and resin was obtained.

[0056]

And the powder mixture which mixes the 80 volume %, stirs the powder of the aforementioned polyether sulphone by a hybrid mixer (made by KEYENCE CORP.) as resin powder 20Vol% for 10 minutes, and consists the obtained nano crystal magnetic powder of uniform magnetic powder and resin was obtained. Heat pressing was performed for this compound powder for 10 minutes in 300 degrees C and 15MPa, and the 4-mm-thick composite sheet was produced. It molded into a 3x3x4-mm block with the NC machine after that. The hole for making the central part penetrate the core material of the antenna of 1x1 angle (mm) furthermore was provided.

[0057]

After inserting in the magnetic complex core produced by this method to the both ends of a stick antenna, 600 *****s of phi0.1mm polyurethane coat copper wire were wound.

[0058]

In order to evaluate an antenna characteristic, an inductor L value and performance-index Q value were measured, and relative permeability was computed. For measurement, it measured with Hewlett Packard LCR meter 4024A. A result is shown in the following table. As a result, the antenna of the working example 1 by the present invention was understood that improvement in large magnetic properties is possible compared with the prior art.

[Work example 2]

[0059]

It differs that the working example 1 only has the spherical metal powder form in the constituent which constitutes a weir. As for the manufacturing method of spherical metal powder, composition of magnetic metal powder makes the alloy of Fe₆₆nickel₄Si₁₄B₉aluminum₄Nb₃ a 1300 degrees C molten metal with a high frequency smelter like the working example 1, It is made to flow down a molten metal through the nozzle attached to the bottom of a smelter, and a molten metal is atomized with 75 kg/cm² of high pressure gas from the gas atomization part attached to the nozzle tip. Then, a cooling solid is carried out and it is considered as spherical

magnetic powder. The antenna was produced at the same material as the working example 1, and a process except [all] it.

[0060]

In order to evaluate an antenna characteristic, an inductor L value and performance-index Q value were measured, and relative permeability was computed. For measurement, it measured with Hewlett Packard LCR meter 4024A. A result is shown in the following table. As a result, the antenna of the working example 2 by the present invention was understood that improvement in still larger magnetic properties is possible.

[Work example 3]

[0061]

The composition of the working example of the antenna of the present invention is shown in Fig.1. It only differs that metal powder composition is Co system amorphous metal in the working example 1. The passage of the following [amorphous metal / Co system] (it enters later). The antenna was produced at the same material as the working example 1, and a process except [all] it.

[0062]

In order to evaluate an antenna characteristic, an inductor L value and performance-index Q value were measured, and relative permeability was computed. For measurement, it measured with Hewlett Packard LCR meter 4024A. A result is shown in the following table. As a result, the antenna of the working example 2 by the present invention was understood that improvement in still larger magnetic properties is possible.

[Comparative Example(s)]

[0063]

The composition of the comparative example of the thin inductor of the present invention is shown in Fig.3. In the working example 1, only the component and metallic powder material of a magnetic complex differ from each other. The antenna was produced at the same material as the working example 1, and a process except [all] it.

[0064]

In order to evaluate an antenna characteristic, an inductor L value and performance-index Q value were measured, and relative permeability was computed. For measurement, it measured with Hewlett Packard LCR meter 4024A. A result is shown in the following table.

[0065]

[Table 1]

	堰の材料				コイルの 線径 × 巻数	アンテナの L×Q値
	磁性粉末 の種類	磁性粉末 の形状	磁性粉末 の体積比 率(%)	樹脂		
実施例1	ナノ結晶磁 性粉	りん片	20	PES	0.1×600	13×108
実施例2	ナノ結晶磁 性粉	球形	20	PES	0.1×600	12×105
実施例3	アモルファス 磁性粉	りん片	20	PES	0.1×600	14×110
比較例1	Fe-Si-Cr 系粒状磁 性粉末	粒状	95	ナイロン	0.1×670	10×90

[Brief Description of the Drawings]

[0066]

[Drawing 1]It is a figure showing the composition of the antenna of the present invention.

[0067]

[Drawing 2]The perspective view of the small high sensitivity antenna of the present invention (with no winding coil)

[0068]

[Drawing 3]It is a figure showing the composition of the antenna of a comparative example.

[Explanations of letters or numerals]

[0069]

11 The core material of an antenna

12 Weir

13 The region where the covered conductor wire rod is wound

21 The case consisting of a magnetic powder complex

TECHNICAL FIELD

[Field of the Invention]

[0001]

The present invention relates to a stick antenna among the antenna elements which convert an electric wave to an electrical signal. For example, it is an antenna which receives, transmits, transmits and receives an electric wave, and is RFID. The ** antenna, the antenna for in-vehicle immobilizers, the antenna for electronic keys, the antenna for wave clocks, radio, the miniaturized antenna for portable devices, etc. are mentioned. In order to improve the sensitivity of these stick antennas further, it is related with the antenna which gave the magnetic-metal-powder block body and magnetic-metal-powder block which are added to one side or the both ends of a stick antenna.

PRIOR ART

[Background of the Invention]

[0002]

Diversification of the types of products accompanying expansion of the demand of the magnetic application products used for the electrical and electric equipment and this is progressing quickly with remarkable development of an electron and a telecommunications sector, and the demand of slimming down, a miniaturization, and efficient-izing is increasing especially with the spread of portable devices. As for the antenna element which is used for these apparatus and which converts an electric wave to an electrical signal, slimming down, a miniaturization, and efficient-ization are desired more.

[0003]

As such [conventionally] an antenna, in JP,7-278763,A (Patent document 1), As shown in Fig.3, the antenna with it is proposed by giving winding to a rod-like core, using the amorphous metal thin band material which is excellent in especially magnetic properties as a cylindrical antenna core material. [high Q value and] [high sensitivity / above 100 kHz] The method of JP,2001-337181,A (Patent document 2) is proposed as a remedy of this technology. According to this method, a flange is formed in the both ends of the rod-like heartwood of an antenna, and the coil is wound between that flange. By adding this flange, it becomes possible to improve the receiving sensitivity of an antenna. However, the further slimming down, the miniaturization, and the highly efficient antenna are demanded with the miniaturization of apparatus.

[Patent document 1] JP,7-278763,A

[Patent document 2] JP,2002-278763,A

EFFECT OF THE INVENTION

[Effect of the Invention]

[0014]

In the antenna around which the conductive wire rod covered with the insulator is wound, when a weir was provided by the end of a region around which this conductive wire rod is wound, L value of the antenna was able to improve and the small high sensitivity antenna was able to be obtained. As a result, when L value may be constant, as a result it can reduce the number of copper winding of an antenna coil, copper loss decreases, Q value can be improved and the transmission and reception sensitivity of an antenna improves substantially. The part which reduced copper winding, the width of an antenna, and height became small, and the miniaturization of an antenna and slimming down of them were attained.

TECHNICAL PROBLEM

[Problem to be solved by the invention]

[0004]

The information and telecommunications using an electric wave in recent years are used for transmission and reception of the information on RFID used, for example for transponders, such as a locking system for crime prevention, an ID card, and a tag, or a wave clock, radio, etc. In these uses, since it is used for a tag, a key, etc. to carry, the market demand of the further slimming down and card-izing occurs. In order for the antenna of such a use to also attain the further miniaturization, it is necessary to reduce the thickness of an antenna core, and length further.

[0005]

However, in connection with the volume decrease of an antenna, L value or Q value of an antenna is deteriorated, and the antenna sensitivity proportional to the product of L value and Q value is deteriorated. As a result, practically sufficient electric wave receiving sensitivity may not no longer be obtained.

[0006]

Then, in order that the present invention may solve these problems, in the present invention, without changing the linear dimension of an antenna, L value and Q value are improved and let it be problem to realize improvement in the transmission and reception sensitivity of an antenna core, or to realize the further slimming down and a miniaturization, without changing sensitivity.

MEANS

[Means for solving problem]

[0007]

In order to solve such problem, the following things were intensively found out as a result of research.

[0008]

In the antenna with which the conductive wire rod covered with the insulator is wound around the core material, the present invention provides an antenna, wherein the weir is provided by the end of a region around which this conductive wire rod is wound.

[0009]

The weir currently provided by the aforementioned antenna comprises the constituent containing magnetic metal powder.

[0010]

The weir currently provided by the aforementioned antenna comprises the complex containing the constituent consisting of magnetic metal powder and resin.

[0011]

It is one of the preferable modes of the present invention that the aforementioned magnetic metal powder uses a nano crystal magnetic metal material.

[0012]

Said antenna according to claim 1 to 4, wherein the form of the aforementioned magnetic metal powder is flat state.

[0013]

The present invention provides the constituent which consists of the magnetic metal powder 5 for making a weir - 60Vol%, and the resin 95 - 40Vol%.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[0066]

[Drawing 1]It is a figure showing the composition of the antenna of the present invention.

[0067]

[Drawing 2]Perspective view of the small high sensitivity antenna of the present invention (with no winding coil)

[0068]

[Drawing 3]It is a figure showing the composition of the antenna of a comparative example.

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Title of Invention:		WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-Q RESONATORS		
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Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
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Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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

Electronic Acknowledgement Receipt	
EFS ID:	15816082
Application Number:	12649635
International Application Number:	
Confirmation Number:	5891
Title of Invention:	WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-Q RESONATORS
First Named Inventor/Applicant Name:	John D. Joannopoulos
Customer Number:	26161
Filer:	Marc M. Wefers/Cheryl Forrest
Filer Authorized By:	Marc M. Wefers
Attorney Docket Number:	01997-0359015 / MIT 11757
Receipt Date:	20-MAY-2013
Filing Date:	30-DEC-2009
Time Stamp:	13:10:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$180
RAM confirmation Number	11095
Deposit Account	061050
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1		359015-IDS.pdf	141074 6ca50deb0f8b2c3a1f81a13588a76ad7f1a813d9d	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Foreign Reference	FA1.pdf	874797 2f1c62391e79436c078035003e7f0885d66d8fa	no	28
Warnings:					
Information:					
3	Foreign Reference	FA2.pdf	1638865 0fa5c30217026770b004e10526cc9831bf080ff1	no	41
Warnings:					
Information:					
4	Foreign Reference	FA3.pdf	789738 3724und0610e5a2b7b300408107a0108108773d1	no	24
Warnings:					
Information:					
5	Foreign Reference	FA4.pdf	841204 60a9ee2d7d1bd205651b69612104062f549aac	no	21
Warnings:					
Information:					
6	Foreign Reference	FA5.pdf	689910 a7ceee0db291409f8f142376330c4099caad95	no	28
Warnings:					
Information:					
7	Non Patent Literature	NPL1.pdf	8453557 6e2a64fb25d99a41c4ff07d8b61101d1293e1a1ee	no	23
Warnings:					
Information:					
8	Non Patent Literature	NPL2.pdf	709211 0de602e2abc10550478482942042d1101d19dc71	no	12

Warnings:					
Information:					
9	Non Patent Literature	NPL3.pdf	149163 b7e27d9a3c35668ea11dc9b30ce91e7699 68ec1	no	3
Warnings:					
Information:					
10	Non Patent Literature	NPL4.pdf	1334461 12862141b241b5a34037402ed87b267ed3 a53028	no	15
Warnings:					
Information:					
11	Fee Worksheet (SB06)	fee-info.pdf	30759 a914275bc3a2ac10ce800b6d72ad64eda7 42081	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			15652739		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : John D. Joannopoulos et al. Art Unit : 2836
Serial No. : 12/649,635 Examiner : Fritz Fleming
Filed : December 30, 2009 Conf. No. : 5891
Title : WIRELESS ENERGY TRANSFER TO A MOVING DEVICE BETWEEN HIGH-
Q RESONATORS

MAIL STOP AMENDMENT

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

INFORMATION DISCLOSURE STATEMENT

Please consider the references listed on the enclosed PTO-1449 form. Foreign patent documents and non-patent literature are enclosed; cited U.S. patents and patent application publications will be provided on request.

This statement is being filed after a first Office action on the merits, but before receipt of a final Office action or a Notice of Allowance. The fees in the amount of \$180 in payment of the late submission fee of 37 CFR §1.17(p) are being paid concurrently herewith. In addition, please apply any other necessary charges or credits to Deposit Account 06-1050, referencing the above attorney docket number.

Respectfully submitted,

Date: _____

5/20/13



Marc M. Wefers
Reg. No. 56,842

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Telephone: (617) 542-5070
Facsimile: (877) 769-7945

23031206.doc



UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,635	12/30/2009	John D. Joannopoulos	01997-0359015 / MIT 11757	5891
26161 7590 06/20/2013 FISH & RICHARDSON P.C. (BO) P.O. BOX 1022 MINNEAPOLIS, MN 55440-1022			EXAMINER FLEMING, FRITZ M	
			ART UNIT 2836	PAPER NUMBER
			NOTIFICATION DATE 06/20/2013	DELIVERY MODE ELECTRONIC

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

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

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

PATDOCTC@fr.com

<i>Applicant-Initiated Interview Summary</i>	Application No. 12/649,635	Applicant(s) JOANNOPOULOS ET AL.	
	Examiner FRITZ M. FLEMING	Art Unit 2836	

All participants (applicant, applicant's representative, PTO personnel):

(1) FRITZ M. FLEMING. (3) _____

(2) Mr. Marc Wefers. (4) _____

Date of Interview: 24 January 2013.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____

Issues Discussed ☐ 101 ☐ 112 ☐ 102 ☒ 103 ☒ Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1-36.

Identification of prior art discussed: Laue, iC-Haus, Schuder.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Discussed proposed amendments that would overcome the rejection of record. Discussed double patenting rejections over multiple similar applications. The proposed amendments would overcome the rejection of record, but further search and consideration would be needed to determine if other references would be applicable.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/FRITZ M FLEMING/ Primary Examiner, Art Unit 2836	
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Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135, (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiner's Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner.
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Office Action Summary	Application No. 12/649,635	Applicant(s) JOANNOPOULOS ET AL.	
	Examiner FRITZ M. FLEMING	Art Unit 2836	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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 25 January 2013.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

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

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

Disposition of Claims

5) ☒ Claim(s) 1-3,5-7 and 9-44 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☒ Claim(s) 1-3,5-7 and 9-44 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 25 January 2013 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.

Interim copies:

a) ☐ All b) ☐ Some c) ☐ None of the: Interim copies of the priority documents have been received.

Attachment(s)

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

2) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 1/25/13, 3/7/13, 4/18/13, 5/20/13

3) ☒ Interview Summary (PTO-413)
Paper No(s)/Mail Date: attached

4) ☐ Other: _____

DETAILED ACTION

Response to Arguments

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

Applicants' arguments regarding the specification and drawings are persuasive, given the breadth of the claim and commensurate description.

The independent claims have been amended to include subject matter not previously claimed. Therefore it is proper to reject these amended claims on new art in a FINAL rejection. The "secondary considerations" are presented without any mention of claim language. Applicants (applicants have not specified the type of secondary consideration the articles indicate) bear the burden of proof of establishing a nexus between the claimed invention and the evidence of commercial success. Applicants merely mention "abundant acclaim" and then assert that this is "evidence", without pointing to anything in particular in any of the numerous articles mentioned. Applicants need to clearly explain what the secondary considerations are, and make a clear connection between the claims and the articles.

Turning to the claim language, the independent claims have been amended to recite that the resonator has a resonant frequency, an intrinsic loss rate, and is capable of storing electromagnetic energy with an intrinsic quality factor Q greater than 100, without setting forth any particular structure of the resonator itself. Various examples of "resonators" are given by applicants, one of which is a capacitively loaded conducting

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wire loop, which appears to not be shown. None the less, the claim is given its broadest reasonable interpretation in that a "resonator" is not limited to a "cavity resonator", but is also applicable to "resonator circuits", as explained in section 8.4 of the Staelin et al. reference supplied by applicants. In this section, the Q of a series RLC is found directly from equation 8.3.3 and 8.3.7, where one finds that Q is the total energy divided by the energy lost per radian. Page 359 also states that Q is the total energy stored divided by the power dissipated, and that $Q = \omega / 2\alpha$, which basically corresponds to applicants' claimed relationship of Q, as α appears to be an "intrinsic loss/loss rate", as α is proportional to R, which is the lossy element where power is dissipated (again page 359). Page 361 then goes on to state that when $\alpha \ll \omega$, the circuit is a high quality resonator. Therefore, for purposes of an art rejection, a "high-Q" resonant circuit is reasonably construed to be a "resonator" to the extent claimed, as per the above, the discrete element resonator circuits of the references would exhibit the same capability to store electromagnetic energy by virtue of the "high-Q". Thus once something is determined to be a "resonator" it will inherently show the intrinsic quality factor with the attendant capability to store electromagnetic energy and the intrinsic loss rate and resonant frequency.

Double Patenting

1. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory

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obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

2. Claims 1-3,5-7,9-44 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-30 and 1-26 and 1-9,14-18,25-30 of copending Application No. 12/649,777 and 12/649,852 and 12/649,813. Although the conflicting claims are not identical, they are not patentably distinct from each other because the pending claims broadly recite near field transfer of

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electromagnetic energy with first and second resonators, Q's greater than 100, and other features. The co-pending applications claim similar subject matter in different combinations, thus provisional obviousness type double patenting exists across numerous applications. Regarding claims 4 and 8 acoustic near field region, I take official notice that such is a known method. Thus to substitute one known method of power transfer for another is the mere substitution of parts to achieve the desired outcome with a reasonable expectation of success.

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

Claim Rejections - 35 USC § 103

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

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

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of

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the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1-3,5-7,9-19,21-33,35-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dayan et al. (Dayan, WO2004/015885A1) in view of Schuermann (5,374,930) and Matsuda et al. (Matsuda 4,180,795) and Schuder (Powering an Artificial Heart: Birth of the Inductively Coupled Radio Frequency System in 1960). Dayan sets forth the basic principle of narrow band resonance coupling (abstract). Technical features are a pad 100 with a coil 101, which coil is driven by a power oscillator 102 connected to a not shown energy source with the near field shown to be 110 and on the order of 5 inches determined to be within the geometry size of the coil itself. Thus is shown a source coil, not disclosed to be a resonator with the high-Q. Also shown in Figure 2 is a second device in the form of a notebook computer 200 with a coil 201 and an RF-DC converter 202. Figure 3 ties the two together with use in 900MHz, 13.5MHz, or 2.4GHz range. The regulator 103 can control frequency, frequency spread, and total power pushed into the antenna. The recipient inductor 201 has a capacitor 201a to form a narrowly tuned, resonance antenna wherein the higher the Q, the narrower the power band, and the better the coupling even if the mechanical situation is not ideal. Per page 4, multiple devices can be controlled by slightly skewing

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the resonance frequencies of the different devices. Figures 5 and 6 show how multiple devices are accommodated, such that there is wireless electromagnetic energy transferred from a source coil to multiple recipient higher-Q resonant coil and capacitor devices, devices that are free to move and located a distance (i.e. within the near field) from the source coil. Dayan lacks the resonator terminology.

Schuermann teaches the use of "high-Q" resonant circuits in both the interrogator and transponder (bottom of column 2), as it is known in prior art devices that optimal power transfer is achieved by the use of highly tuned, high-Q factor resonant circuits (top of column 2).

Matsuda teaches that a resonator 5 with a series resonance coil and a capacitor.

Operation can be over a broad range of 20KHz-10MHz. Thus this type of resonator has a resonance circuit.

Finally, Schuder quantifies what a "high-Q" is. Q values are shown to be slightly more than 200 and 180 depending on the size of the coil.

Therefore it would have been obvious to one having ordinary skill in the art at the time that the invention was made to modify Dayan by the teachings of Schuermann (use highly tuned high-Q resonant circuits for both sides), Matsuda (a resonator has a resonance circuit), and Schuder (Qs over 100 are effective to transfer wireless electromagnetic energy) in order to benefit from optimal power transfer by the use of highly tuned high-Q factor resonant circuits at the source and device sides, such that the resonant circuits are in fact resonators. As the circuits are considered to be resonators, they inherently exhibit the claimed resonant frequency, intrinsic loss rate,

and a capability to store electromagnetic energy with a high intrinsic Q, as was explained in detail above. Note that the combined references then teach a source resonator wirelessly transmitting energy to second and third device resonators located a distance from the source, all with highly tuned, high-Q resonant circuit resonators. Claims 2,3 are met when the system described above is in operation, as the fields generated are magnetic and electromagnetic in the near field. Dayan and Schuermann have power sources coupled to the source resonator. The method of claim 5 parallels the apparatus of claim 1, as do 6,7 parallel 2,3. Claims 9,10 recite a different numerical expression for the Q product, which is met when both are in the range of Schuder. Claim 11 is shown by Schuermann and Dayan showing energy drains at the devices themselves. Claim 12 is met by Dayan and the computer and cell phone examples. Claim 13/14 is met by Dayan providing power to multiple devices, as the multiple devices will also show mutual coupling amongst each other to some degree. Also the choice of the third resonator to be a source or drain is a matter of design need if more sources or drains are needed, noting that the drain/supply coupling is optional. Claim 15 is met in that all resonant circuits are tunable by the choice of the components (L and C). Dayan and Schuermann show the devices being freely movable over a range of distances (say within the illustrated near field). Claims 16-18 are met by Dayan's exemplary 5 inch coil and near field, as the near field is determined by the size of the antenna per Dayan, thus a bigger antenna means for a bigger near field. Claims 21,22 are met in that Schuder addresses coefficient of coupling "k" such that the kQ product is large in order to decrease losses (910). Since Q is inversely proportional to the intrinsic

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loss rate, then the kQ product is proportional to k divided by the loss rate. While the claim "k" is called a "wireless energy transfer rate", Schuder's "k" is a similar term to describe the coefficient of coupling, applicants also call "k" a coupling coefficient. For claim 19, Schuder teaches 4% transmission losses, better than a 20% efficiency. Dayan teaches at least 5MHz with skewed resonant frequencies for each device, so that the source and two devices can each have a different resonant frequency. For claims 21 and 22, note that Schuermann teaches how both the interrogator and transponder can change Q in order to affect efficient data transfer based upon the transmission of data. The change in Q optimizes the communications and then also the power during phases A-D, and thus the adjustable tuning of each Q allows for an increase in the useful-lost power during the various phases. Claims 23-33 and 35-36 parallel above claims and are rejected for the same reasons. Newly added claims are met as follow. Claims 37 and 41 recite energy provision based on a rate of wireless energy transfer. Dayan teaches regulator 103 and regulation based upon the amount of power drawn. As the amount of power drawn varies, then Dayan would also provide for a "configured to" functionality as claimed, noting that the claims only recite a functional outcome met by Dayan's regulation. Claims 38,39,42,43 represent the optimization of the parameters of the combined references, as the overall goal of the system is to operate as efficiently as possible. For claims 40/44, Schuder teaches the 200 range and thus to go above this would ensure better power transfer due to a higher Q . Claims 20 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dayan et al. (Dayan, WO2004/015885A1) in view of Schuermann (5,374,930) and

Matsuda et al. (Matsuda 4,180,795) and Schuder (Powering an Artificial Heart: Birth of the Inductively Coupled Radio Frequency System in 1960) as applied to Claims 1-3,5-7,9-19,21-33,35-44 above, and further in view of Bradin (6,650,227).

Claims 20 and 34 add a feedback mechanism to adjust for resonant frequency detuning. Bradin does this with a feedback circuit 22 and an adjustment circuit 44 to retune the resonant frequency with applicability where the system is subject to disruptive elements in the operating environment (column 7). Detuning is mentioned in column 2. Therefore it would have been obvious to one having ordinary skill in the art at the time that the invention was made to modify the teachings of Dayan, Schuermann, Matsuda and Schuder by the teachings of Bradin so as to be able to compensate for detuning and thereby improve performance.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hochstein teaches high-Q in a magnetic field power transfer. Fujimoto et al. teach a k-detecting circuit.

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

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

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mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRITZ M. FLEMING whose telephone number is (571)272-4145. The examiner can normally be reached on M-F, 0900-1730.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jared Fureman can be reached on 571-272-2391. 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.

FRITZ M FLEMING
Primary Examiner
Art Unit 2836

/FRITZ M FLEMING/
Primary Examiner, Art Unit 2836

Notice of References Cited	Application/Control No. 12/649,635		Applicant(s)/Patent Under Reexamination JOANNOPOULOS ET AL.	
	Examiner FRITZ M. FLEMING		Art Unit 2836	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,703,573	12-1997	Fujimoto et al.	340/10.3
*	B	US-4,450,431	05-1984	Hochstein, Peter A.	340/447
*	C	US-5,374,930	12-1994	Schuermann, Josef H.	342/42
*	D	US-4,180,795	12-1979	Matsuda et al.	340/448
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
*	N	WO 2004015885 A1	02-2004	World Intellect	DAYAN et al.	
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
*	U	John C. Schuder, Powering an Artificial Heart: Birth of the Inductively Coupled-Radio Frequency System in 1960, Artificial Organ, 2002.
	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: 04/18/2013

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Sheet 1 of 1

Substitute Disclosure Form	U.S. Department of Commerce Patent and Trademark Office	Attorney Docket No. 01997-0359015	Application No. 12/649,635
Information Disclosure Statement by Applicant (Use several sheets if necessary)		Applicant John D. Joannopoulos et al.	
		Filing Date December 30, 2009	Group Art Unit 2836
(37 CFR §1.98(b))			

U.S. Patent Documents							
Examiner Initial	Desig. ID	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate
	1	8,178,995	5/15/2012	Amano et al.			
	2	2005/0125093	6/9/2005	Kikuchi et al.			
	3						

Foreign Patent Documents or Published Foreign Patent Applications								
Examiner Initial	Desig. ID	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation	
							Yes	No
	4	EP 1 521 206	04/06/2005	Europe				
	5							

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Desig. ID	Document
	6	Copy of European Search Report with regard to Application Serial No. 11184066.6 by Examiner Konstantin Kanelis dated March 20, 2013
	7	

Examiner Signature /Fritz Fleming/ (06/17/2013)	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Substitute Disclosure Form

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /F.F./