AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-413	10/21/2022	Eastern District of Texas

PLAINTIFF	DEFENDANT
FRACTUS, S.A.	VIVINT, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	7,907,092	3/15/2011	FRACTUS, S.A.
2	8,738,103	5/27/2014	FRACTUS, S.A.
3	8,994,604	3/31/2015	FRACTUS, S.A.
4	10,135,138	11/20/2018	FRACTUS, S.A.
5	10,468,770	11/5/2019	FRACTUS, S.A.

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-413	10/21/2022	Eastern District of Texas

PLAINTIFF	DEFENDANT
FRACTUS, S.A.	VIVINT, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	11,349,200	5/31/2022	FRACTUS, S.A.
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	03/31/2015	8994604	0690.0026CON	7241

27896 7590 03/11/2015

EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 543 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Carles Puente Baliarda, San Cugat del Valles (Barcelona), SPAIN;
Jaume Anguera Pros, Vinaros (Castellon), SPAIN;
Jordi Soler Castany, Mataro (Barcelona), SPAIN;
Antonio Condes Martinez, Esplugues de Llobregat (Barcelona), SPAIN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PTO/SB/08a (08-06)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5,966,097 ~~6500882~~		1999-10-12	Fukasawa et al	
Change(s) applied to document, /A.E.M./ 2/4/2015	2	6337667		2002-01-08	Ayala et al	
	3	6,509,882 ~~5966097~~		2003-01-21	McKivergan	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] ¡	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

EFS Web 2.0

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

ALTERNATIVE TO PTO/SB/08A/B
(Based on PTO 01-08 version)

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA*	US-4,628,322	12-09-1986	Marko et al.	
	AB*	US-5,365,246	11-15-1994	Rasinger et al.	
	AC*	US-6,337,667	01-08-2002	Ayala et al.	
	AD*	US-5,966,097	10-12-1999	Fukasawa et al.	
	AE*	US-20020075187-A1	~~01-21-2003~~ 06/2002	McKivergan	
	AF*	US-6,466,176	10-15-2002	Maoz et al.	
	AG*	US-5,990,838	11-23-1999	Burns et al.	
	AH*	US-6,509,882	01-21-2003	McKivergan	

Change(s) applied to document,
/A.E.M./
2/4/2015

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BA**	EP-0 942 488	09-15-1999	Murata Manufacturing Co., Ltd.		
	BB**	JP-56-12102	02-06-1981	Nippon Teleghraph & Telephone et al.		√
	BC**	WO-96/38881	12-05-1996	Ericsson Inc.		
	BD**	WO-01/78192	10-18-2001	Research In Motion Limited		
	BE**	WO-01/22528	03-29-2001	Fractus S.A.		√
	BF**	WO-01/54225	07-26-2001	Fractus, S.A.		

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

*EXAMINER: Initial if information considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA**	Hisamatsu Nakano et al., "Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas", IEEE Transactions on Antennas and Propagation, vol. 46, no. 6, June 1998, pages 788-793	
	CB**	Constantine A. Balanis, "Antenna Theory: Analysis and Design", Hamilton Printing, 1982 & 1997, pages 498-502.	
	CC**	C. Puente et al., "Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition", Electronics Letters, December 5, 1996, vol. 32, no. 25, pages 2298-2299	
	CD**	Jaume Anguera et al., "Miniature WideBand Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry", IEEE, 2000, pages 1700-1703	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27896 7590 01/08/2015
EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	0690.0026CON	7241

TITLE OF INVENTION: COUPLED MULTIBAND ANTENNAS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/08/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
KARACSONY, ROBERT	2845	343-803000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Edell, Shapiro & Finnan LLC
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Fractus, S.A.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Barcelona, Spain

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☒ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 05-0460 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Patrick J. Finnan/ Date February 20, 2015

Typed or printed name Patrick J. Finnan Registration No. 39189

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Patrick J. Finnan
Attorney Docket Number:	0690.0026CON

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	21558707
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	27896
Filer:	Patrick J. Finnan/Janet Dorgan
Filer Authorized By:	Patrick J. Finnan
Attorney Docket Number:	0690.0026CON
Receipt Date:	20-FEB-2015
Filing Date:	05-DEC-2007
Time Stamp:	16:54:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$960
RAM confirmation Number	3740
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	2015-02-20_IssueFeeTransmittal_Part-B.pdf	206871 4d83177815ab13ca79d623cdca918a769fdfb950	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30200 9ce653d68cd5392662b10f773a0b75ee20b2942a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	237071		

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

27896 7590 01/08/2015

EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

EXAMINER
KARACSONY, ROBERT

ART UNIT	PAPER NUMBER
2845	

DATE MAILED: 01/08/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	0690.0026CON	7241

TITLE OF INVENTION: COUPLED MULTIBAND ANTENNAS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/08/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27896 7590 01/08/2015
EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	0690.0026CON	7241

TITLE OF INVENTION: COUPLED MULTIBAND ANTENNAS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/08/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
KARACSONY, ROBERT	2845	343-803000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	0690.0026CON	7241

27896 7590 01/08/2015

EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

EXAMINER	
KARACSONY, ROBERT	

ART UNIT	PAPER NUMBER
2845	

DATE MAILED: 01/08/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 11/950,835	Applicant(s) BALIARDA ET AL.	
	Examiner ROBERT KARACSONY	Art Unit 2845	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the communication filed August 18, 2014*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *20-55*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ROBERT KARACSONY/
Primary Examiner, Art Unit 2845

DETAILED ACTION

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

Allowable Subject Matter

Claims 20-55 are allowed.

The following is an examiner's statement of reasons for allowance:

Claims 20-31 are allowable because prior art fails to teach, nor render obvious, an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna system to operate in the multiple frequency bands, in combination with all of the other limitations recited in the independent claim.

Claims 32-43 are allowable because prior art fails to teach, nor render obvious, an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands, in combination with all of the other limitations recited in the independent claim.

Claims 44-50 are allowable because prior art fails to teach, nor render obvious, an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide an impedance bandwidth

required by the antenna system to operate in the multiple frequency bands, in combination with all of the other limitations recited in the independent claim.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 9:00 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sue Purvis can be reached on 571-272-1236. 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.

/ROBERT KARACSONY/
Primary Examiner, Art Unit 2845

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	**Art Unit**
	ROBERT KARACSONY	2845

CPC								
Symbol							**Type**	**Version**
H01Q		9	/	42			F	2013-01-01
H01Q		1	/	36			I	2013-01-01
H01Q		1	/	362			I	2013-01-01
H01Q		1	/	40			I	2013-01-01
H01Q		5	/	0062			I	2013-01-01
H01Q		9	/	0414			I	2013-01-01
H01Q		9	/	0421			I	2013-01-01
H01Q		9	/	26			I	2013-01-01
H01Q		9	/	36			I	2013-01-01
H01Q		9	/	40			I	2013-01-01
			/					
			/					
			/					
			/					
			/					

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	36	
/ROBERT KARACSONY/ Primary Examiner.Art Unit 2845	12/14/2014	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	15

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	**Art Unit**
	ROBERT KARACSONY	2845

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
343	803	H 0 1 Q 9 / 26 (2006.01.01)	

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	36	
/ROBERT KARACSONY/ Primary Examiner.Art Unit 2845	12/14/2014	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	15

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	**Art Unit**
	ROBERT KARACSONY	2845

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17	14	33	30	49								
	2		18	15	34	31	50								
	3		19	16	35	32	51								
	4	1	20	17	36	33	52								
	5	2	21	18	37	34	53								
	6	3	22	19	38	35	54								
	7	4	23	20	39	36	55								
	8	5	24	21	40										
	9	6	25	22	41										
	10	7	26	23	42										
	11	8	27	24	43										
	12	9	28	25	44										
	13	10	29	26	45										
	14	11	30	27	46										
	15	12	31	28	47										
	16	13	32	29	48										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	36	
/ROBERT KARACSONY/ Primary Examiner.Art Unit 2845	12/14/2014	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	15

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

CPC- SEARCHED		
Symbol	Date	Examiner
H01Q5/0062	3/24/2014	RK
H01Q5/0062	12/14/2014	RK

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK
343	803	9/10/2010	RK
343	893	6/20/2011	RK

SEARCH NOTES		
Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK
Class/Subclass, Text, Assignment data, Inventor name and Backward/Forward search	9/10/2010	RK
Updated search	6/20/2011	RK
Updated search	5/10/2012	RK
Updated search	3/24/2014	RK
Updated search	12/14/2014	RK

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
PGPub text search	See Interference search printout	12/14/2014	RK

	/ROBERT KARACSONY/ Primary Examiner.Art Unit 2845

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	312802	parasitic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S2	6682	inverted$1f PIFA	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S3	824	S1 and S2 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S4	70	S3 and clam$1shell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S5	0	("2008/0129630").URPN.	USPAT	OR	OFF	2014/12/14 20:58
S6	13	("20020075187" | "20040212545" | "4628322" | "4907006" | "5365246" | "5838285" | "5903239" | "5966097" | "5990838" | "6337667" | "6373447" | "6466176" | "6509882").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S7	754	S3 not S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S8	721	S7 and ground$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S9	13	("20010050636" | "20010050643" |	US-PGPUB;	OR	OFF	2014/12/14

		"20020019247" | "20020163470" | "20030210188" | "5966097" | "6323810" | "6456249" | "6657593" | "6680705" | "6788257" | "6958730" | "7046196").PN.	USPAT; USOCR			20:58
S10	15	("20030169209" | "20050285596" | "20060022889" | "20070057849" | "20070069958" | "20080168384" | "4742359" | "5966097" | "6707428" | "6795028" | "7026996" | "7026999" | "7084813" | "7173567" | "7215289").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S11	6	("20050110692" | "5583521" | "5966097" | "6657595" | "6765536" | "6876331").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S12	5	("7215289").URPN.	USPAT	OR	OFF	2014/12/14 20:58
S13	9	("20040212542" | "20060044196" | "20070182651" | "20080094303" | "6339402" | "6850196" | "6914565" | "7289064" | "7477201").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S14	9	("7701401").URPN.	USPAT	OR	OFF	2014/12/14 20:58
S15	22	("20030103010" | "20030201942" | "20040090366" | "20050184914" | "20070229358" | "20080309562" | "20090189815" | "6081242" | "6366243" | "6538607" | "6611235" | "6856294" | "6917335" | "6956534" | "7053844" | "7084813" | "7088299" | "7136019" | "7170450" | "7183982" | "7319432" | "7701401").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S16	13	("7825863").URPN.	USPAT	OR	OFF	2014/12/14 20:58
S17	12	("20070057849" | "6326921" | "6614400" | "6714162" | "7136022" | "7205942" | "7319432" | "7477199" | "7495620" | "7619572" | "7652633" | "7701401").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S18	4	("4138681" | "5598169" | "6734825" | "6861986").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S19	9	("7701401").URPN.	USPAT	OR	OFF	2014/12/14 20:58
S20	5	("20010050643" | "5319378" | "6114996" | "6195048" | "6326921").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S21	4	("5585807" | "5760745" | "5966097" | "6225951").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S22	5	("4491843" | "5847682" | "5912647" | "6025805" | "6127979").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S23	8	("20100060528" | "6781546" | "20070120745" | "20090189815" | "20100328182" | "20080246665" | "20090073059" | "20080180333").PN.	US-PGPUB; USPAT	OR	OFF	2014/12/14 20:58
S24	4	("8378898" | "7701401" | "6380903" |	US-PGPUB;	OR	OFF	2014/12/14

		"6225951").PN.	USPAT			20:58
S25	7	("6917338" | "20050128162" | "20090278750" | "20100127944" | "7058434" | "7486975" | "7701401").PN.	US-PGPUB; USPAT	OR	OFF	2014/12/14 20:58
S26	5	("20070115188" | "7136022" | "7358906" | "20060017629" | "6498586").PN.	US-PGPUB; USPAT	OR	OFF	2014/12/14 20:58
S27	9	("20020018020" | "20020190903" | "20030169209" | "6130651" | "6239765" | "6252550" | "6452556" | "7068230" | "7183983").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S28	4	("4138681" | "5598169" | "6734825" | "6861986").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S29	44	(US-20080129630-$ or US-20040212545-$ or US-20070057849-$ or US-20060022889-$ or US-20030201942-$ or US-20090322285-$ or US-20080278398-$ or US-20050104783-$ or US-20070120745-$ or US-20050128162-$).did. or (US-8138981-$ or US-7315289-$ or US-6509882-$ or US-5966097-$ or US-5365246-$ or US-4907006-$ or US-4628322-$ or US-6680705-$ or US-7733271-$ or US-7215289-$ or US-7084813-$ or US-7026999-$ or US-7026996-$ or US-6795028-$ or US-6876331-$ or US-6765536-$ or US-7701401-$ or US-8063827-$ or US-7825863-$ or US-7136019-$ or US-7477199-$ or US-7136022-$ or US-7457650-$ or US-7447530-$ or US-7289072-$ or US-7119748-$).did. or (US-7119743-$ or US-7113135-$ or US-7061430-$ or US-6943733-$ or US-6917339-$ or US-6795027-$ or US-6552686-$ or US-7358906-$).did.	US-PGPUB; USPAT	OR	OFF	2014/12/14 20:58
S30	0	h01q5/0062.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S31	2899	h01q5/0062.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S32	125	h01q5/0062.cpc. and coplanar	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S33	18	("20020190905" | "4367475" |	US-PGPUB;	OR	OFF	2014/12/14

		"5184144" | "5337065" | "5626666" | "5677698" | "5754143" | "5790080" | "5903240" | "5936590" | "5943020" | "6011519" | "6034638" | "6307520" | "6339400" | "6456243" | "6774850" | "7081854").PN.	USPAT; USOCR			20:58
S34	2774	S31 not S32	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S35	564	S34 and multi$1band	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S36	2210	S34 not S35	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S37	328	S36 and dual adj (band bandwidth frequency)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S38	2	("5696517" | "6323811").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S39	1882	S36 not S37	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S40	28	("20010020335" | "20020169010" | "20030184494" | "20030210206" | "20040001022" | "20050183242" | "4313119" | "5246374" | "5561437" | "5649306" | "5760747" | "5903821" | "5991643" | "5995052" | "6075500" | "6255996" | "6272356" | "6307511" | "6307520" | "6625469" | "6819295" | "6839569" | "6861989" | "6885880" | "6963310" | "7084919" | "7096046" | "7271772").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S41	2	("6995719" | "7009567").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S42	11	("20020021250" | "20020149525" | "20030137459" | "20030179143" | "20040027298" | "20040125029" |	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58

		"6011519" | "6031503" | "6466176" | "6693604" | "6806835").PN.				
S43	6682	inverted$1f PIFA	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S44	486	hinge and S43	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S45	330	hinge and S43 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 20:58
S46	8	("4751513" | "5420596" | "5777581" | "6147652" | "6218991" | "6222496" | "6282433" | "6297776").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/12/14 20:58
S47	5	(("20020075187") or ("5365246") or ("4628322") or ("5966097") or ("6337667")).PN.	US-PGPUB; USPAT	OR	OFF	2014/12/14 21:22
S48	2899	h01q5/0062.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 21:36
S49	506	S48 and (bent bend$4 fold$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 21:36
S50	506	S48 and (bent bend$4 fold$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 21:37
S51	2393	S48 not S49	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 21:58
S52	419	S51 and parasitic$4	US-PGPUB; USPAT; USOCR;	OR	OFF	2014/12/14 21:58

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S53	1974	S51 not S52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/14 22:08

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S54	524803	antenna	US-PGPUB; USPAT; UPAD	OR	OFF	2014/12/14 22:30
S55	515	close adj proximity adj region	US-PGPUB; USPAT; UPAD	OR	OFF	2014/12/14 22:30
S56	65	S54 and S55	US-PGPUB; USPAT; UPAD	OR	OFF	2014/12/14 22:30
S57	0	S54 and S55 and line adj segment	US-PGPUB; USPAT; UPAD	OR	OFF	2014/12/14 22:30
S58	2	S54 and S55 and orthogonal adj projection	US-PGPUB; USPAT; UPAD	OR	OFF	2014/12/14 22:31

12/14/2014 10:33:16 PM
C:\Users\rkaracsony\Documents\EAST\Workspaces\Cases\Coupled Multiband Antennas 11950835\Coupled Multiband Antennas 12-2014.wsp

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1

CONFIRMATION NO. 7241

POWER OF ATTORNEY NOTICE

61060
WINSTEAD PC
P.O. BOX 131851
DALLAS, TX 75313

OC000000070333134

Date Mailed: 08/25/2014

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/18/2014.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/nfissha/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/950,835	12/05/2007	Carles Puente Baliarda	0690.0026CON

CONFIRMATION NO. 7241

POA ACCEPTANCE LETTER

27896
EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg, MD 20878

OC00000070333162

Date Mailed: 08/25/2014

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/18/2014.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/nfissha/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	11/950,835
First Named Inventor	:	Carles Puente Baliarda
Confirmation No.	:	7241
Filed	:	December 5, 2007
TC/A.U.	:	2845
Examiner	:	Karacsony, Robert
Customer No.	:	27896
Docket No.	:	0690.0026CON
Title	:	Coupled Multiband Antennas

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

REVOCATION AND NEW POWER BY ASSIGNEE AND STATEMENT UNDER 37 C.F.R. §3.73(c)

The Assignee of the entire right, title, and interest in the above-identified application hereby revokes all previously granted powers of attorney and grants the registered practitioners of EDELL, SHAPIRO & FINNAN, LLC included in the Customer Number provided below power to act, prosecute, and transact all business in the U.S. Patent and Trademark Office in connection with this application, any applications claiming priority to this application, and any patents issuing therefrom.

The assignee certifies that to the best of its knowledge and belief it is the owner of the entire right, title, and interest in and to the above-identified application as evidenced by:

☐ An assignment document, a copy of which is enclosed herewith;

☒ An assignment previously recorded in the U.S. Patent and Trademark Office at Reel 023628, Frame 0642.

☒ Please direct all correspondence concerning this application to:

EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd., Suite 750
Gaithersburg, MD 20878
(301) 424-3640

CUSTOMER NUMBER: 27896

The undersigned (whose title is supplied below) is empowered to sign this statement on behalf of the assignee.

Date: July 28th, 2014 Signature: _____

Name: CARMEN GOROA

Title: IPR MANAGER

Company: Fractus, S.A.

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Patrick J. Finnan
Attorney Docket Number:	47005-P015WUSC1

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:				
Extension - 2 months with $0 paid	1252	1	600	600

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**600**

Electronic Acknowledgement Receipt

EFS ID:	19888529
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Patrick J. Finnan/Janet Dorgan
Filer Authorized By:	Patrick J. Finnan
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	18-AUG-2014
Filing Date:	05-DEC-2007
Time Stamp:	15:53:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$600
RAM confirmation Number	2277
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Extension of Time	EOTxml.pdf	70042 1e0d05e80a5a00d8e5a8cc510ee58096cacf9a53	no	1
Warnings:					
Information:					
2		Amendment_20140818.pdf	159664 7d8b2b64a910ef51049705ad4e52dabcbf4150b6	yes	20

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	10
	Applicant Arguments/Remarks Made in an Amendment	11	20

Warnings:					
Information:					
3	Power of Attorney	ExecutedPOA-.pdf	482494 e83509c824fa3fb0b014213fd990389551f4377b	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30524 73607d9bd81721c3dd64aa7ea56390353c521bbd	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	742724	

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	11/950,835
First Named Inventor	:	Carles Puente Baliarda
Confirmation No.	:	7241
Filed	:	December 5, 2007
TC/A.U.	:	2845
Examiner	:	Karacsony, Robert
Customer No.	:	27896
Docket No.	:	0690.0026CON
Title	:	Coupled Multiband Antennas

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application. The applicant herewith petitions the Director of the United States Patent and Trademark Office to extend the time for reply to the Office action dated March 31, 2014 for 2 month(s) from July 1, 2014 to August 31, 2014.

The requested extension and fee are as follows:

- ☐ One month (37 CFR 1.17(a)(1); $200/$100/$50)
- ☒ Two months (37 CFR 1.17(a)(2); $600/$300/$150)
- ☐ Three months (37 CFR 1.17(a)(3); $1400/$700/$350)
- ☐ Four months (37 CFR 1.17(a)(4); $2200/$1100/$550)
- ☐ Five months (37 CFR 1.17(a)(5); $3000/$1500/$750)

Total Fee Due: $600.00. Credit card payment has been submitted concurrently with the filing of this transmittal.

The Director is hereby authorized to charge any additional appropriate fees that may be required for the above-identified application, and to credit any overpayment, to Deposit Account No. **05-0460**.

Dated: August 18, 2014

Respectfully submitted by:

/Patrick J. Finnan/
Patrick J. Finnan
Reg. No. 39189

EDELL, SHAPIRO & FINNAN, LLC
CUSTOMER NO. 27896
9801 Washingtonian Blvd., Suite 750
Gaithersburg, MD 20878
(301) 424-3640

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	11/950,835
First Named Inventor	:	Carles Puente Baliarda
Confirmation No.	:	7241
Filed	:	December 5, 2007
TC/A.U.	:	2845
Examiner	:	Karacsony, Robert
Customer No.	:	27896
Docket No.	:	0690.0026CON
Title	:	Coupled Multiband Antennas

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

AMENDMENT

Madam:

In response to the Office Action mailed March 31, 2014, please amend the above-identified application as follows:

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

Remarks begin on page 11 of this paper.

Amendments to the Claims:

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

Listing of Claims:

1-19. (Canceled)

20. (Currently Amended) A ~~handheld terminal~~ wireless portable device comprising:

~~at least one~~ a printed circuit board comprising a ground plane structure;

an antenna ~~element~~ system operating ~~at~~ in multiple frequency bands, the antenna ~~element~~ system comprising:

a first radiating arm comprising a first-radiating-arm first tip, ~~end and~~ a first-radiating-arm second tip, ~~end~~ and a feeding terminal connected to the first-radiating-arm first ~~end being a feeding point~~ tip, wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal; and

a second radiating arm ~~not in ohmic contact with the first radiating arm and~~ comprising a second-radiating-arm first tip, ~~end and~~ a second-radiating-arm second tip ~~end~~, and a grounding terminal connected to the second-radiating-arm ~~second end~~ first tip, wherein the second radiating arm does not include a contact point with first radiating arm, wherein: ~~being connected to the ground plane;~~

~~a feeding port defined between the feeding point of the first radiating arm and at least one point on of the ground plane;~~

~~wherein~~ the first radiating arm and the second radiating arm are coupled through a close proximity region from a first specific ~~region~~ portion of the first radiating arm and from a second specific ~~region~~ portion of the second radiating arm;

~~wherein the first radiating arm comprises a substantially planar structure;~~

~~wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;~~

~~wherein~~ a length of a line segment between a point of the first specific portion ~~first radiating arm~~ and a point of the second specific portion ~~second radiating arm~~ is ~~less~~

shorter than a distance between the feeding ~~point~~ terminal and the ~~second radiating arm second end~~ grounding terminal;

~~wherein the line segment does not intersect a projection~~ an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect ~~to~~ the ground plane structure; and

~~wherein~~ the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna ~~element~~ system to operate in the multiple frequency bands.

21. (Currently Amended) The wireless portable device ~~handheld terminal~~ of claim 20, wherein ~~the handheld terminal comprises a cell phone~~ a folding of the first radiating arm is formed by a 90-degree angle.

22. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 21~~ claim 20, wherein the close proximity region is located at a distance from the feeding terminal that is longer than 1/40 of the longest free-space operating wavelength of the antenna system ~~cell phone comprises a clamshell body~~.

23. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 22~~ claim 20, wherein~~: the clamshell body comprises: a first body portion; a second body portion; and a hinge interposed between the first body portion and the second body portion; and~~ the first specific portion of the first radiating arm includes the first-radiating-arm second tip ~~and the second radiating arm are mounted adjacent to the hinge~~.

24. (Currently Amended) The wireless portable device ~~handheld terminal~~ of claim 23, wherein[[:]] the first radiating arm and the second radiating arm form an open loop configuration

~~the feeding port is located on a first side of the hinge;~~

~~the second radiating arm second end is coupled to the ground plane on a second side of the hinge;~~

~~the second side is opposite the first side~~.

25. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 21~~ claim 24, wherein ~~the cell phone comprises a candybar body~~ a folding of the second radiating arm is formed by a 90-degree angle.

26. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 21~~ claim 25, wherein ~~the first radiating arm and the second radiating arm are substantially coplanar~~ a folding of the first radiating arm is formed by a 90-degree angle.

27. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 25~~ claim 20, wherein the ~~line segment is coplanar with the ground plane~~ first radiating arm comprises at least one inductive stub.

28. (Currently Amended) The wireless portable device ~~handheld terminal~~ of claim 20, wherein the first radiating arm comprises a portion formed by ten or more connected segments, each of the connected segments forming an angle with its neighboring connected segment, the angle being smaller than 180 degrees, and the segments being ~~and the second radiating arm define a coupling region in which the length of the line segment is~~ shorter than 1/8 ~~a tenth~~ of ~~a~~ the longest free-space operating wavelength of the antenna system.

29. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 26~~ claim 20, wherein the first radiating arm and the second radiating arm are substantially coplanar ~~with the ground plane~~.

30. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 21~~ claim 20, wherein the ~~first radiating arm and~~ second radiating arm ~~protrude beyond an edge of the ground plane~~ comprises at least one inductive stub.

31. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 30~~ claim 20, wherein the first specific portion of the first radiating arm and the second specific portion of the second radiating arm-are-substantially ~~perpendicular to the ground plane~~ coplanar.

32. (Currently Amended) ~~The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane~~ A wireless portable device comprising:

a printed circuit board comprising a ground plane structure;

an antenna system operating in multiple frequency bands and included within the wireless portable device, the antenna system comprising:

a first radiating arm comprising a first-radiating-arm first tip, a first-radiating-arm second tip, a feeding terminal connected to the first-radiating-arm first tip, and a first-radiating-arm first point; and

a second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip, wherein:

the second radiating arm does not include a contact point with the first radiating arm;

the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip;

a length of a line segment between the first-radiating-arm first point and the second-radiating-arm second tip is shorter than a distance between a point of the feeding terminal and a point of the grounding terminal;

an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and

the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands.

33. (Currently Amended) The ~~handheld terminal~~ wireless portable device of claim 32, wherein the second-radiating-arm ~~second end is coupled to the ground plane on a second corner of the ground plane~~ comprises at least one inductive stub.

34. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 33~~ claim 32, wherein the close proximity region is located at a distance from the feeding terminal that is longer than 1/40 of the longest free-space wavelength of the antenna system

~~: the ground plane is substantially rectangular; and~~

~~the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane~~.

35. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the ~~handheld terminal comprises a personal digital assistant~~ first radiating arm and the second radiating arm form an open loop configuration.

36. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the ~~handheld terminal comprises a cordless telephone~~ second radiating arm comprises at least one inductive stub.

37. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 36, wherein ~~the handheld terminal comprises a pager~~ the first radiating arm comprises at least one inductive stub.

38. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the ~~handheld terminal comprises an electronic gaming device~~ first radiating arm comprises at least a portion formed by ten or more connected segments, each of the connected segments forming an angle with its neighboring connected segment, the angle being less than 180 degrees, and the segments being shorter than 1/8 of the longest free-space operating wavelength of the antenna system.

39. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the ~~handheld terminal comprises a remote control device~~ first radiating arm and the second radiating arm substantially coplanar.

40. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the first radiating arm comprises a sub-branch

~~: the handheld terminal is operative at multiple frequency bands; and~~

~~at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) or Universal Mobile Telecommunications System (UMTS) communication service~~.

41. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 40~~ claim 32, wherein a folding of the first radiating arm is formed by a 90 degree angle

~~: the handheld terminal is operative at multiple frequency bands;~~

~~a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service~~.

42. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein ~~the handheld terminal is operative at least at four frequency bands~~ a folding of the second radiating arm is formed by a 90-degree angle.

43. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 32, wherein the ~~handheld terminal is operative at least at five frequency bands~~ second radiating arm comprises a sub-branch.

44. (Currently Amended) ~~The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS),~~

~~GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS1900), and Digital Cellular System (DCS)~~

A wireless portable device comprising:

a printed circuit board comprising a ground plane structure;

an antenna system configured to operate in multiple frequency bands and included within the wireless portable device, the antenna system comprising:

a first radiating arm comprising a first-radiating-arm first tip, a feeding terminal connected to the first-radiating-arm first tip, a first-radiating-arm second tip, and a first-radiating-arm first point located at a distance from the feeding terminal shorter than 1/40 times the longest free-space operating wavelength of the antenna system; and

a second radiating arm comprising a second-radiating-arm first tip, a grounding terminal connected to the second-radiating-arm first tip, a second-radiating-arm second tip, a second-radiating arm first point, and a second-radiating-arm second point located at a distance from the grounding terminal shorter than 1/40 times the longest free-space operating wavelength of the antenna system, wherein:

the second radiating arm does not include a contact point with the first radiating arm;

the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion comprising the first-radiating-arm second tip and the second-radiating-arm first point;

the close proximity region is located at a distance from the feeding terminal longer than 1/40 times the longest free-space operating wavelength of the antenna system;

a spacing between the first-radiating-arm second tip and the second-radiating-arm first point is less than a distance between the first-radiating-arm first point and the second-radiating-arm second point;

the close proximity region comprises a line segment between the first-radiating-arm second tip and the second-radiating-arm first point;

an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure; and

the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide an impedance bandwidth required by the antenna system to operate in the multiple frequency bands.

45. (Currently Amended) The wireless portable device ~~handheld terminal~~ of ~~claim 21~~ claim 44, wherein ~~the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS~~ a folding of the first radiating arm is formed by a 90° angle.

46. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 21~~ claim 44, wherein ~~the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS~~ a folding of the second radiating arm is formed by a 90 degree angle.

47. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 44, wherein ~~at least one of~~ the first radiating arm and the second radiating arm ~~comprises a monopole~~ form an open loop configuration.

48. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 47~~ claim 44, wherein ~~each of the first radiating arm and the second radiating arm comprises a monopole~~ a length of the line segment is shorter than a tenth of the longest free-space operating wavelength of the antenna system.

49. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 44, wherein ~~at least one of~~ the first radiating arm ~~and the second radiating arm~~ comprises ~~an IFA structure~~ at least one inductive stub.

50. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 47~~ claim 49, wherein the ~~monopole comprises an IFA structure~~ second radiating arm comprises at least an inductive stub.

51. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 47~~ claim 44, wherein the close proximity region forms a substantially planar structure

~~: one of the first radiating arm and the second radiating arm comprises a monopole; and~~

~~the other of the first radiating arm and the second radiating arm comprises a microstrip structure~~.

52. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 44, wherein ~~at least one of~~ the first radiating arm ~~and the second radiating arm~~ comprises a sub-branch ~~microstrip structure~~.

53. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 52~~ claim 44, wherein ~~each of the first radiating arm and~~ the second radiating arm comprises a sub-branch ~~microstrip structure~~.

54. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 52~~ claim 51, wherein ~~the microstrip structure comprises a PIFA structure~~ the first radiating arm and the second radiating arm are substantially coplanar.

55. (Currently Amended) The ~~handheld terminal~~ wireless portable device of ~~claim 20~~ claim 44, wherein ~~at least one of~~ the first radiating arm and the second radiating arm ~~comprises a PIFA structure~~ are substantially coplanar.

REMARKS

Claims 20-55 have been examined: claims 20-23 and 25-55 stand rejected, and dependent claim 24 is indicated as containing allowable subject matter. By the above amendments, claims 20-55 have been amended. Accordingly, claims 20-55 remain pending in the subject application. Favorable reconsideration of the application and allowance of all of the pending claims are respectfully requested in view of the above amendments and the following remarks.

Drawings

The drawings are objected to under 37 CFR 1.83(a) as failing to show every feature claimed. The amendments to claims 20, 29, and 34 obviate this objection. Applicant notes that the features of claims 20, 29, and 34 are shown, for example, in configuration 70 of Fig. 15. Accordingly, the Examiner is respectfully requested to reconsider and withdraw this objection.

Indefiniteness Rejections

Claims 27 and 29 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The amendments to claims 20, 27, and 29 obviate this rejection, and the Examiner is respectfully requested to reconsider and withdraw this rejection. Nevertheless, Applicant notes that amended claim 20 does not exclude implementations in which the claimed line segment is coplanar with the claimed ground plane structure. For example, if the first and second radiating elements are coplanar with the ground plane structure, i.e., they lie in the same plane, as shown in configuration 70 of Fig. 15, the line segment between the radiating elements will be coplanar as well and no intersection of the line segment with ground plane structure will occur (note that, in this example, since the line segment actually lies in the same plane as the ground plane structure, the orthogonal projection of the line segment coincides with the line segment itself). By way of further clarification, structures like those shown in configuration 60 of Fig. 12 are planar structures where the first radiating arm 143 and the second radiating arm 144 are not coplanar with the ground plane structure. However, the first radiating arm 143 and the second radiating arm 144 could be arranged to be coplanar with the ground plane structure if arranged, for instance, like the radiating arms shown in configuration 70 of Fig. 15.

Rejections Over Pedersen

Claims 20, 21, 25-34, 40, 41, and 47-55 stand rejected under 35 U.S.C. § 102(a) as being anticipated by EP Patent No. 1,067,627 to Pedersen. Further, claims 22, 23, 35-39, and 42-46 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pedersen. Applicant respectfully traverses these rejections insofar as they apply to the amended claims.

Independent Claim 20

Amended independent claim 20 sets forth a wireless portable device comprising a printed circuit board and an antenna system operating in multiple frequency bands. The printed circuit board comprises a ground plane structure and the antenna system comprising a first radiating arm and a second radiating arm that does not include a contact point with the first radiating arm. The first radiating arm comprises a feeding terminal connected to the first-radiating-arm first tip, and the second radiating arm comprises a grounding terminal connected at the second-radiating-arm second tip, wherein the first radiating arm is not connected to the ground plane structure through a grounding terminal. The first radiating arm and the second radiating arm are coupled through a close proximity region from a first specific portion of the first radiating arm and from a second specific portion of the second radiating arm, and a length of a line segment between a point of the first specific portion and a point of the second specific portion is shorter than a distance between the feeding terminal and the grounding terminal. In other words, at least one portion on each radiating arm is placed in close proximity to each other to allow electromagnetic fields in one arm to be transferred to the other through the specific close proximity regions (see Pat. App. Publ., par. [0024]). Further, an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure, and the first radiating arm, the second radiating arm, and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands.

Pedersen relates to a radio apparatus, particularly for mobile use, comprising an antenna arrangement with at least a first antenna element and a second antenna element, the radio device being operational in at least two different frequency bands (see Pedersen, par. [0001]). The first

antenna element comprises a first connecting means in the form of a shorting pin at a first end of the first antenna element, and further comprises a feeding element close to the first connecting means (see Pedersen, par. [0028], [0034]). The second antenna element comprises a coupling element providing capacitive coupling between the first antenna element and the second antenna element, and a second connecting means electrically connected to the ground plate (see Pedersen, par. [0032]).

Applicant respectfully submits that Pedersen fails to disclose at least the following distinguishing features from amended independent claim 20: *the first radiating arm is not connected to the ground plane structure through a grounding terminal; the second radiating arm comprising a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip*; and *an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure*.

Pedersen teaches a first antenna element 20 electrically connected to the ground plate 10 by first connecting means 50, provided near one of the corners of the rectangularly shaped first antenna element 20. As the first antenna element 20 has an oblong form, the location of the first connecting means 50 defines a first end of the first antenna element 20. The first connecting means 50 is provided in the form of a shorting pin and is therefore also referred to as the first shorting pin 50 (see Pedersen, par. [0028]). The first antenna element 20 also comprises a feeding element 22, provided relatively close to the first connecting means 50 in order to form a planar inverted F antenna (see Pedersen, par. [0034], Figs. 1-7).

Amended independent claim 20 requires that the first radiating arm comprises a feeding terminal connected at a first-radiating-arm first tip, and that the arm is not connected to the ground plane through a grounding terminal. In direct contrast to this requirement of claim 20, Pedersen discloses that the first antenna element includes a shorting pin at a first end so as to provide an inverted F antenna.

Pedersen also discloses a second antenna element comprising a second connecting means 60, wherein the second connecting means electrically connects the second antenna element to the ground plate 10. The second connecting means 60 is provided at the most distant corner of the coupling element 40 relative to the first connecting means 50. Thus, at best, the second

connecting means is relatively close to a second end or tip of the first antenna element (see Pedersen, par. [0032]). In contrast, amended independent claim 20 requires that the second radiating arm comprises a grounding terminal connected at the second-radiating-arm first tip. Applicant respectfully disagrees that Pedersen's arrangement with connection means 60 constitutes a second-radiating arm first tip connected to a ground plane. It is clear from Pedersen's Figs. 1-7 that the second connecting means 60 is not at a tip of the second antenna element. Moreover, Pedersen teaches that the specific position of the second connecting means 60 (asymmetrical with respect to the two sub-elements 30, 31 of the second antenna element, and at the most distant corner of the coupling element 40 relative to the first connecting means 50) provides an enlargement of the frequency band of operation of the antenna arrangement, especially with respect to the frequency band to which the second antenna element is tuned. Pedersen teaches that it is advantageous to provide a second shorting pin common to the two sub-elements 30, 31 and that the common second shorting pin is provided asymmetrically with respect to the centerline of the first antenna element. In this manner, it is possible to place the resonances of the sub-elements slightly apart in order to obtain a greater bandwidth of the resonance bands where the antenna arrangement 75 is operational (see Pedersen, pars. [0007-0008]). In other words, Pedersen's second connecting means is located in the middle of the two sub-elements of the second antenna element, not at any tip of the second antenna element. Thus, Pedersen teaches away from arranging the second connecting means 60 at a tip of the second radiating arm, as required by amended independent claim 20, because it would not achieve the effect of bandwidth enlargement by using a common shorting pin for two sub-elements that advantageously adjusts the resonance of each of the sub-elements.

Further, Pedersen does not teach a line segment whose orthogonal projection onto a plane of a ground plane structure does not intersect the ground plane structure, as required by claim 20. If a line segment is drawn between the first antenna element and the second antenna element in Pedersen's close proximity region (the region between coupling element 40 and the first antenna element 20), since this region has a ground plane structure underneath, an orthogonal projection of the line segment will always intersect the ground plane structure. Specifically, such a line segment's orthogonal projection onto a plane of the ground plane structure will be within the

footprint of the ground plane structure. In fact, the entirety of Pedersen's first and second antenna elements lies directly above the ground plane structure (see, e.g., Figs. 4 and 9); thus, any line extending between any points on these two antenna elements must have an orthogonal projection onto the ground plane structure beneath. Pedersen neither teaches nor suggests placing the coupling element or the antenna elements beyond the ground plane such that an orthogonal projection of the line segment onto a plane containing the ground plane structure does not intersect the ground plane structure. Since Pedersen fails to disclose or suggest all of these requirements of claim 20, the Examiner is respectfully requested to reconsider and withdraw the rejections of claim 20 and its dependent claims over Pedersen.

Independent Claim 32

Independent claim 32 relates to a wireless portable device comprising a printed circuit board comprising a ground plane structure and an antenna system operating in multiple frequency bands and comprising first and second radiating arms. The second radiating arm does not include a contact point with the first radiating arm. The first radiating arm comprises a first-radiating-arm first tip, a first-radiating-arm second tip, and a feeding terminal connected to the first-radiating-arm first tip. The second radiating arm comprises a second-radiating-arm first tip, a second-radiating-arm second tip, and a grounding terminal connected to the second-radiating-arm first tip. The first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip, wherein a length of a line segment between the first-radiating-arm first point and the second-radiating-arm second tip is shorter than a distance between a point of the feeding terminal and a point of the grounding terminal. Further, an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure, and the first radiating arm, the second radiating arm, and the close proximity region are configured to simultaneously provide a bandwidth required for the antenna system to operate in the multiple frequency bands. Support for the amendments to independent claim 32 can be found in the specification of the published application at least in paragraphs [0009], [0010], [0011], [0012], [0014], [0025], [0048], and [0062], and configurations 19-23 from Figs. 3 and 6.

Pedersen fails to teach the following requirement of claim 32: *"the first radiating arm and the second radiating arm are coupled through a close proximity region formed by a portion including the first-radiating-arm first point and the second-radiating-arm second tip."* Pedersen discloses a close proximity region between the first and second antenna elements arranged between coupling element 40 and one end of the first antenna element 20. In contrast, new independent claim 32 requires that the close proximity region includes the first-radiating-arm first point and the second-radiating-element second tip. The two tips in the second antenna element in Pedersen (formed by sub-elements 30, 31, first and second bonding elements 35, 36 and coupling element 40) are at the end of sub-elements 30, 31 farthest away from the coupling element 40. It is clear that no tip of the sub-elements is included in the close proximity region.

Further, claim 32 requires that an orthogonal projection of the line segment between the first and second radiating arms onto a plane of the ground plane structure does not intersect the ground plane structure. As explained above in relation to claim 20, since Pedersen's first and second antenna elements lie entirely above the ground plane structure, any line segment extending between points of the two antenna elements necessarily has an orthogonal projection onto the plane of the ground plane structure that intersects the ground plane structure, in violation of the requirement of claim 32. For this and for similar reasons to those stated above regarding amended independent claim 20, Applicant respectfully submits that independent claim 32 is patentably distinguishable from Pedersen and is in condition for allowance.

Independent Claim 44

Independent claim 44 sets forth a wireless portable device comprising a printed circuit board that comprises a ground plane structure and an antenna system configured to operate in multiple frequency bands. The antenna system comprises first and second radiating arms, wherein the second radiating arm does not include a contact point with the first radiating arm. The first radiating arm comprises a feeding terminal connected to the first-radiating-arm first tip, and the second radiating arm comprises a grounding terminal connected to the second-radiating-arm first tip. The first radiating arm and the second radiating arm are coupled through a close proximity region formed by a porting comprising the first-radiating-arm second tip and the

second-radiating-arm first point. A spacing between the first-radiating-arm second tip and the second-radiating-arm first point is shorter than a distance between the first-radiating-arm first point and the second-radiating-arm second point. Further, the close proximity region is located at a distance from the feeding terminal that is longer than 1/40 times a longest free-space operating wavelength of the antenna system. The close proximity region comprises a line segment between the first-radiating-arm second tip and the second-radiating-arm first point, and an orthogonal projection of the line segment onto a plane of the ground plane structure does not intersect the ground plane structure. Further, the first radiating arm, the second radiating arm, and the close proximity region are configured to simultaneously provide an impedance bandwidth required by the antenna system to operate in the multiple frequency bands.

Support for the amendments to independent claim 44 can be found in the specification of the published application at least in paragraphs [0009], [0010], [0011], [0012], [0014], [0025], [0048], [0062], Fig. 2, and configurations 6 and 8-11 from Figs. 3, 5, and 6.

For similar reasons to those stated above with respect to amended independent claim 20, Applicant respectfully submits that new independent claim 44 is patentably distinguishable from Pedersen and is in condition for allowance.

Additional Remarks

Applicant respectfully does not acquiesce with some of the Examiner's interpretations in relation to Pedersen's disclosed features. Applicant submits that Pedersen does not teach that *"the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane"* (previously presented dependent claim 30), because that would require the first and second antenna elements to be substantially outside the footprint of the ground plane so as to protrude beyond one of its edges. The plan view shown in Fig. 4 of Pedersen clearly illustrates that this is not the case.

Regarding that *"the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane"* (previously presented dependent claim 31), Applicant submits that Pedersen teaches the first and second antenna elements lying on planes that are substantially parallel to each other and to the ground plane (see Pedersen, par. [0009]). While it

may be possible to change the inclination of sub-elements 30, 31 of the second antenna element (see Pedersen, par. [0050]), they would not be placed perpendicular to the ground plane due to degradation of the radioelectric performance and due to apparent physical space limitations in the radio apparatus (see Pedersen, Fig. 9) that would make the antenna system not to be *"included within the wireless portable device"* as required by amended independent claim 32 and 44.

Further, Pedersen does not teach *"the feeding port is located on a first corner (corner closest to 22) of the ground plane, the second-radiating-arm second end is coupled to the ground plane on a second corner (corner closest to 60) of the ground plane"* (previously presented dependent claims 32-33) as asserted by the Examiner. As clearly seen in Figs. 1 and 4 of Pedersen, which are the only representations that do not depict cut out ground planes, the feeding point of the first antenna element (22) and the grounding point of the second antenna element (60) are nowhere near the first and second corners of the ground plane (10). Applicant respectfully disagrees with the assertions: *"the first corner and the second corner are opposite corners of a short edge"* (previously presented dependent claim 34) and *"the Examiner interprets the long edge of ground 10 as the claimed 'short edge' of the substantially rectangular ground plane,"* and submits that 'short edges' of the ground plane (10) in Figs. 1 and 4 of Pedersen would be the left and right-most edges.

Amendments – Dependent Claims

Support for the amendments to depend claims 21, 25, 26, 41, 42, 45 and 46 can be found in the specification of the published application at least in paragraphs [0049] and [0051].

Support for the amendments to depend claims 22 and 34 can be found in the specification of the published application at least in paragraphs [0009].

Support for the amendments to depend claims 23 can be found in the specification of the published application at least in paragraphs [0010] and [0048].

Support for the amendments to depend claims 24, 35 and 47 can be found in the specification of the published application at least in paragraphs [0032] and [0053].

Support for the amendments to depend claims 27, 30, 33, 36, 37, 49 and 50 can be found in the specification of the published application at least in paragraphs [0032] and [0052].

Support for the amendments to depend claims 28 and 38 can be found in the specification of the published application at least in paragraphs [0015], [0045], and [0048]. The features of claims 28 and 38 were previously presented in claim 9 in the published application.

Support for the amendments to depend claims 29, 31, 39, 51, 54, and 55 can be found in the specification of the published application at least in paragraphs [0010], [0015], [0048], [0056], [0058], [0059], and [0064]. The features of claims 29, 54, and 55 were previously presented in claim 26.

Support for the amendment to depend claim 48 can be found in the specification of the published application at least in paragraph [0009]. This feature was previously presented in claim 28.

Support for the amendments to depend claims 40, 43, 52, and 53 can be found in the specification of the published application at least in paragraphs [0035] and [0056].

Closing

In view of the foregoing, Applicant respectfully requests the Examiner to find the application to be in condition for allowance with claims 20-55. However, if for any reason the Examiner feels that the application is not now in condition for allowance, the Examiner is respectfully requested to call the undersigned attorney to discuss any unresolved issues and to expedite the disposition of the application.

Filed concurrently herewith is a Petition (with payment) for an Extension of Time of Two Months. Applicant hereby petitions for any extension of time that may be necessary to maintain the pendency of this application. The Commissioner is hereby authorized to charge payment of any additional fees required for the above-identified application or credit any overpayment to Deposit Account No. 05-0460.

Dated: August 18, 2014

Respectfully submitted by:

EDELL, SHAPIRO & FINNAN, LLC
CUSTOMER NO. 27896
9801 Washingtonian Blvd., Suite 750
Gaithersburg, MD 20878
(301) 424-3640

/Patrick J. Finnan/

Patrick J. Finnan
Reg. No. 39189

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

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 11/950,835	Filing Date 12/05/2007	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **08/18/2014**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

LIE
/PAUL STANBACK/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 03/31/2014

WINSTEAD PC
P.O. BOX 131851
DALLAS, TX 75313

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	PAPER NUMBER
2845	

MAIL DATE	DELIVERY MODE
03/31/2014	PAPER

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

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

Office Action Summary	Application No. 11/950,835	Applicant(s) BALIARDA ET AL.	
	Examiner ROBERT KARACSONY	Art Unit 2845	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *10/18/2012*.

☐ 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) *20-55* 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) *20-23 and 25-55* is/are rejected.

8)☒ Claim(s) *24* 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 *12/05/2007* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

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

4) ☐ Other: _____.

DETAILED ACTION

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

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on October 18, 2012 has been entered.

Response to Arguments

Applicant's arguments with respect to claim 20 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Drawings

The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "wherein the first radiating arm comprises a substantially planar structure and wherein the first radiating arm and the second radiating arm are coplanar with the ground plane" (see claim 20 and 29); and "wherein the first radiating arm comprises a substantially planar structure and the ground plane is substantially rectangular; and the first corner and the second corner are opposite corners of a short edge of the

substantially rectangular ground plane" (see claims 20 and 34) must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 27 and 29 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 27: The limitation "the line segment is coplanar with the ground plane" is unclear since claim 20 limits the invention to have "the line segment does not intersect a projection orthogonal to the ground plane." These two conditions are mutually exclusive. The Examiner interpret claim 27 as wherein the line segment is not coplanar with the ground plane.

Claim 29: The limitation "the first radiating arm and the second radiating arm are coplanar with the ground plane" is unclear since claim 20 limits the invention to have "the first radiating arm comprises a substantially planar structure." The Examiner interprets claim 29 as the first radiating arm and the second radiating arm are not coplanar with the ground plane.

Claim Rejections - 35 USC § 102

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

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 20, 21, 25-34, 40, 41 and 47-55 are rejected under pre-AIA 35 U.S.C. 102(a) as being anticipated by Petersen et al. (EP 1067627, hereinafter Pedersen).

Claims 20, 21, 25-34, 40, 41 and 47-55: Pedersen teaches a handheld terminal (figs. 1-9) comprising: at least one printed circuit board (fig. 9 shows ground plane 10. It is implied by this

illustration that the a pcb is inherent) comprising a ground plane (10); an antenna element (5) operating at multiple frequency bands (¶[0001]), the antenna element comprising: a first radiating arm (20) comprising a first-radiating-arm first end and a first- radiating-arm second end, the first-radiating-arm first end being a feeding point (22); a second radiating arm (30, 35, 40, 36, 31) not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second- radiating-arm second end being connected (60) to the ground plane; a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane; wherein the first radiating arm and the second radiating arm are coupled through a close proximity region (region between 40 and 20) from a specific region of the first radiating arm and from a specific region of the second radiating arm; wherein the first radiating arm comprises a substantially planar structure; wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board; wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second- radiating-arm second end; wherein the line segment does not intersect a projection orthogonal to the ground plane; and wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands (Abstract), the handheld terminal comprises a cell phone (¶[0013]), the cell phone comprises a candybar body, the first radiating arm and the second radiating arm are substantially coplanar, the line segment is not coplanar with the ground plane, the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space

operating wavelength, the first radiating arm and the second radiating arm are not coplanar with the ground plane, the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane, the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane, the feeding port is located on a first comer (corner closest to 22) of the ground plane, the second-radiating-arm second end is coupled to the ground plane on a second corner (corner closest to 60) of the ground plane, the ground plane is substantially rectangular; and the first corner and the second corner are opposite corners of a short edge (the term "short edge" is a relative term. The Examiner interprets the long edge of ground 10 as the claimed "short edge") of the substantially rectangular ground plane, the handheld terminal is operative at multiple frequency bands; and at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) or Universal Mobile Telecommunications System (UMTS) communication service (¶[0013]), the handheld terminal is operative at multiple frequency bands; a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service (¶[0013]), at least one of the first radiating arm and the second radiating arm comprises a monopole, each of the first radiating arm and the second radiating arm comprises a monopole, at least one of the first radiating arm and the second radiating arm comprises an IFA structure, the monopole comprises an IFA structure, one of the first radiating arm and the second radiating arm comprises a monopole; and the other of the first radiating arm and the second radiating arm comprises a microstrip structure, at least one of the first radiating arm and the second radiating arm comprises a microstrip structure, each of the first radiating arm and the second radiating arm comprises a microstrip structure, the microstrip structure comprises

a PIFA structure, at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

Claim Rejections - 35 USC § 103

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

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

Claims 22, 23, 35-39 and 42-46 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Pedersen.

Claims 22 and 23: Pedersen fails to teach the cell phone comprises a clamshell body, the clamshell body comprises: a first body portion; a second body portion; and a hinge interposed between the first body portion and the second body portion; and the first radiating arm and the second radiating arm are mounted adjacent to the hinge. The Examiner takes official notice that cell phone comprising a clamshell body, comprising a first body portion; a second body portion; and a hinge interposed between the first body portion and the second body portion; and mounting the antenna adjacent to the hinge was well known at the time of the invention. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used the antenna of Pedersen in within a clamshell body in order to have reduced the size of the cell phone which is attributed to the clamshell design.

Claims 35-39: Pedersen fails to teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device, or a remote control device.

The Examiner takes office notice that all of these devices were known at the time of the invention to have wireless capabilities. The claim would have been obvious because the substitution of one known element for another equivalent would have yielded predictable results to one of ordinary skill in the art. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have substituted the antenna of Pederson for the antenna of each of the above devices in order to have yielded the predictable result of wireless functionality.

Claims 42-46: Pedersen fails to teach the handheld terminal is operative at least at four frequency bands, the handheld terminal is operative at least at five frequency bands, the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS), GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS 1900), and Digital Cellular System (DCS), the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS, and the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS. The Examiner takes official notice that it was well known at the time of the invention to provide handheld terminals with multi-functionality, i.e. the above operating bands. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to have combined the claimed operating bands above in order to have provided a handheld terminal with multi-functionality.

Allowable Subject Matter

Claim 24 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacob Y. Choi can be reached on 571-272-2367. 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.

/ROBERT KARACSONY/
Primary Examiner, Art Unit 2845

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	291816	parasitic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:34
S2	6003	inverted$1f PIFA	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:34
S3	743	S1 and S2 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:34
S4	67	S3 and clam$1shell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:34
S5	0	("2008/0129630").URPN.	USPAT	OR	OFF	2014/03/23 23:35
S6	13	("20020075187" | "20040212545" | "4628322" | "4907006" | "5365246" | "5838285" | "5903239" | "5966097" | "5990838" | "6337667" | "6373447" | "6466176" | "6509882").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:35
S7	676	S3 not S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:36
S8	648	S7 and ground$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/23 23:36
S9	13	("20010050636" | "20010050643" |	US-PGPUB;	OR	OFF	2014/03/23

		"20020019247" | "20020163470" | "20030210188" | "5966097" | "6323810" | "6456249" | "6657593" | "6680705" | "6788257" | "6958730" | "7046196").PN.	USPAT; USOCR			23:39
S10	15	("20030169209" | "20050285596" | "20060022889" | "20070057849" | "20070069958" | "20080168384" | "4742359" | "5966097" | "6707428" | "6795028" | "7026996" | "7026999" | "7084813" | "7173567" | "7215289").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:43
S11	6	("20050110692" | "5583521" | "5966097" | "6657595" | "6765536" | "6876331").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:46
S12	5	("7215289").URPN.	USPAT	OR	OFF	2014/03/23 23:47
S13	9	("20040212542" | "20060044196" | "20070182651" | "20080094303" | "6339402" | "6850196" | "6914565" | "7289064" | "7477201").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:48
S14	7	("7701401").URPN.	USPAT	OR	OFF	2014/03/23 23:49
S15	22	("20030103010" | "20030201942" | "20040090366" | "20050184914" | "20070229358" | "20080309562" | "20090189815" | "6081242" | "6366243" | "6538607" | "6611235" | "6856294" | "6917335" | "6956534" | "7053844" | "7084813" | "7088299" | "7136019" | "7170450" | "7183982" | "7319432" | "7701401").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:49
S16	10	("7825863").URPN.	USPAT	OR	OFF	2014/03/23 23:51
S17	12	("20070057849" | "6326921" | "6614400" | "6714162" | "7136022" | "7205942" | "7319432" | "7477199" | "7495620" | "7619572" | "7652633" | "7701401").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:51
S18	4	("4138681" | "5598169" | "6734825" | "6861986").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/23 23:52
S19	7	("7701401").URPN.	USPAT	OR	OFF	2014/03/23 23:53
S20	5	("20010050643" | "5319378" | "6114996" | "6195048" | "6326921").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:02
S21	4	("5585807" | "5760745" | "5966097" | "6225951").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:03
S22	5	("4491843" | "5847682" | "5912647" | "6025805" | "6127979").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:08
S23	8	("20100060528" | "6781546" | "20070120745" | "20090189815" | "20100328182" | "20080246665" | "20090073059" | "20080180333").PN.	US-PGPUB; USPAT	OR	OFF	2014/03/24 00:24
S24	4	("8378898" | "7701401" | "6380903" |	US-PGPUB;	OR	OFF	2014/03/24

		"6225951").PN.	USPAT			00:27
S25	7	("6917338" | "20050128162" | "20090278750" | "20100127944" | "7058434" | "7486975" | "7701401").PN.	US-PGPUB; USPAT	OR	OFF	2014/03/24 00:28
S26	5	("20070115188" | "7136022" | "7358906" | "20060017629" | "6498586").PN.	US-PGPUB; USPAT	OR	OFF	2014/03/24 00:32
S27	9	("20020018020" | "20020190903" | "20030169209" | "6130651" | "6239765" | "6252550" | "6452556" | "7068230" | "7183983").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:32
S28	4	("4138681" | "5598169" | "6734825" | "6861986").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:33
S29	44	(US-20080129630-$ or US-20040212545-$ or US-20070057849-$ or US-20060022889-$ or US-20030201942-$ or US-20090322285-$ or US-20080278398-$ or US-20050104783-$ or US-20070120745-$ or US-20050128162-$).did. or (US-8138981-$ or US-7315289-$ or US-6509882-$ or US-5966097-$ or US-5365246-$ or US-4907006-$ or US-4628322-$ or US-6680705-$ or US-7733271-$ or US-7215289-$ or US-7084813-$ or US-7026999-$ or US-7026996-$ or US-6795028-$ or US-6876331-$ or US-6765536-$ or US-7701401-$ or US-8063827-$ or US-7825863-$ or US-7136019-$ or US-7477199-$ or US-7136022-$ or US-7457650-$ or US-7447530-$ or US-7289072-$ or US-7119748-$).did. or (US-7119743-$ or US-7113135-$ or US-7061430-$ or US-6943733-$ or US-6917339-$ or US-6795027-$ or US-6552686-$ or US-7358906-$).did.	US-PGPUB; USPAT	OR	OFF	2014/03/24 00:42
S30	0	h01q5/0062.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:43
S31	2576	h01q5/0062.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:43
S32	104	h01q5/0062.cpc. and coplanar	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:43
S33	18	("20020190905" | "4367475" |	US-PGPUB;	OR	OFF	2014/03/24

		"5184144" | "5337065" | "5626666" | "5677698" | "5754143" | "5790080" | "5903240" | "5936590" | "5943020" | "6011519" | "6034638" | "6307520" | "6339400" | "6456243" | "6774850" | "7081854").PN.	USPAT; USOCR			00:44
S34	2472	S31 not S32	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:49
S35	497	S34 and multi$1band	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:49
S36	1975	S34 not S35	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:54
S37	307	S36 and dual adj (band bandwidth frequency)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 00:55
S38	2	("5696517" | "6323811").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2014/03/24 00:59
S39	1668	S36 not S37	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/03/24 01:02

EAST Search History (Interference)

<This search history is empty>

3/24/2014 11:57:55 AM
C:\Users\rkaracsony\Documents\EAST\Workspaces\Cases\Coupled Multiband Antennas 11950835\Coupled Multiband Antennas 03-2014.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

CPC- SEARCHED		
Symbol	Date	Examiner
H01Q5/0062	3/24/2014	RK

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK
343	803	9/10/2010	RK
343	893	6/20/2011	RK

SEARCH NOTES		
Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK
Class/Subclass, Text, Assignment data, Inventor name and Backward/Forward search	9/10/2010	RK
Updated search	6/20/2011	RK
Updated search	5/10/2012	RK
Updated search	3/24/2014	RK

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

	/ROBERT KARACSONY/ Primary Examiner.Art Unit 2845

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: October 18, 2012
Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

Docket No. 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles PUENTE BALIARDA et al.

Application No. 11/950,835 Confirmation No. 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

SUPPLEMENTAL AMENDMENT AFTER FINAL ACTION

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

Dear Madam:

INTRODUCTORY COMMENTS

In further response to the Final Office Action dated May 23, 2012, for which a one-month extension of time was previously submitted and a Request for Continued Examination was previously requested, please amend the above-identified U.S. patent application as indicated herein.

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

Remarks/Arguments begin on page 7 of this paper.

AMENDMENTS TO THE CLAIMS

1-19. (CANCEL)

20. (CURRENTLY AMENDED) A handheld terminal comprising:

at least one printed circuit board comprising a ground plane;

an antenna element operating at multiple frequency bands, the antenna element comprising:

a first radiating arm comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point; ~~and~~

a second radiating arm not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being connected ~~coupled~~ to the ground plane;

a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane;

wherein the first radiating arm and the second radiating arm are coupled through a close proximity region from a specific region of the first radiating arm and from a specific region of the second radiating arm;

wherein the first radiating arm comprises a substantially planar structure;

wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;

wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end;

wherein the line segment does not intersect a projection orthogonal to the ground plane; and

wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for ~~tune~~ the antenna element to operate in the ~~at a plurality of operating frequencies in~~ multiple frequency bands.

21. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cell phone.

22. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a clamshell body.

23. (PREVIOUSLY PRESENTED) The handheld terminal of claim 22, wherein: the clamshell body comprises:

a first body portion;

a second body portion; and

a hinge interposed between the first body portion and the second body portion; and

the first radiating arm and the second radiating arm are mounted adjacent to the hinge.

24. (PREVIOUSLY PRESENTED) The handheld terminal of claim 23, wherein:

the feeding port is located on a first side of the hinge;

the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge;

the second side is opposite the first side.

25. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a candybar body.

26. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm are substantially coplanar.

27. (PREVIOUSLY PRESENTED) The handheld terminal of claim 25, wherein the line segment is coplanar with the ground plane.

28. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength.

29. (PREVIOUSLY PRESENTED) The handheld terminal of claim 26, wherein the first radiating arm and the second radiating arm are coplanar with the ground plane.

30. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane.

31. (PREVIOUSLY PRESENTED) The handheld terminal of claim 30, wherein the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane.

32. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane.

33. (PREVIOUSLY PRESENTED) The handheld terminal of claim 32, wherein the second-radiating-arm second end is coupled to the ground plane on a second corner of the ground plane.

34. (PREVIOUSLY PRESENTED) The handheld terminal of claim 33, wherein:

the ground plane is substantially rectangular; and

the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane.

35. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a personal digital assistant.

36. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cordless telephone.

37. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a pager.

38. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises an electronic gaming device.

39. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a remote control device.

40. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein:

the handheld terminal is operative at multiple frequency bands; and

at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) or Universal Mobile Telecommunications System (UMTS) communication service.

41. (PREVIOUSLY PRESENTED) The handheld terminal of claim 40, wherein:

the handheld terminal is operative at multiple frequency bands;

a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service.

42. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at four frequency bands.

43. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at five frequency bands.

44. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS), GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS1900), and Digital Cellular System (DCS).

45. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

46. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

47. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a monopole.

48. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein each of the first radiating arm and the second radiating arm comprises a monopole.

49. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises an IFA structure.

50. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein the monopole comprises an IFA structure.

51. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein:

one of the first radiating arm and the second radiating arm comprises a monopole; and

the other of the first radiating arm and the second radiating arm comprises a microstrip structure.

52. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a microstrip structure.

53. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein each of the first radiating arm and the second radiating arm comprises a microstrip structure.

54. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein the microstrip structure comprises a PIFA structure.

55. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

REMARKS

Reconsideration of the application is respectfully requested. Claims 20-55 are pending. Claim 20 has been amended. Applicant respectfully submits that no new matter has been added by the amendments presented herein.

I. Response to Interview Summary

In response to the Interview Summary dated October 10, 2012, Applicant provides this Statement reporting the substance of the interview held with the Examiner on October 3, 2012. In the interview, Applicant discussed independent claim 20 and U.S. Patent No. 6,765,536 to Phillips et al. ("Phillips"). Applicant respectfully submits that the substance of the interview, as shown on the Interview Summary sheet, is accurate.

II. Rejections Under 35 U.S.C. § 112

Claims 20-55 stand rejected under 35 U.S.C. § 112, first and second paragraphs. In response, Applicant has amended independent claim 20 to comply with 35 U.S.C. § 112. In addition, Applicant respectfully submits that claims 20-55 are fully supported by the written description thereby complying with the written description requirement. Applicant respectfully submits that support for claims 20-55 may be found throughout the specification and particularly on paragraphs 0009, 0023, 0044, 0047-0048, 0050, 0055, and 0064 of the published application.

For example, paragraph 0009 of the published application recites "The present invention consists of an antenna comprising ***at least two radiating structures***, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms ***being coupled to each other through a region*** on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, ***a multiband behavior*** or a combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the

shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna."

Paragraph 0023 of the published application recites "The skilled in the art will notice that, obviously, such advantages can be combined with other features, for instance, a multiband response. The skilled in the art will notice that such ***a multiband response can be obtained within the present invention by adjusting the length and size of the several-coupled arms, together with the spacing and size of the proximity region defined between the several arms***. Another way of combining said advantages with a multiband behavior consists of shaping at least one of the arms as a multiband antenna, for instance by means of a multilevel structure or a space-filling structure."

Paragraph 0044 of the published application recites "In order to construct a coupled antenna system according to embodiments of the invention, a suitable antenna design is required. Any number of possible configurations exists, and ***the actual choice of antenna is dependent, for instance, on the operating frequency and bandwidth, among other antenna parameters***. Several possible examples of embodiments are listed hereinafter. However, in view of the foregoing description, it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. In particular, different materials and fabrication processes for producing the coupled antenna system may be selected, which still achieve the desired effects."

Paragraph 0047 of the published application recites "Drawing 3 from FIG. 1 shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole

arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the ***close proximity region*** to reduce the antenna size yet providing a broadband or ***multiband behavior***."

Paragraph 0048 of the published application recites "Unlike the prior art structures illustrated in FIG. 1, the newly disclosed coupled antenna system shown in FIG. 2, Drawing 4, is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, Ws<Wd. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). ***Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency*** of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in Drawing 5. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that Ws<Wd. It is clear to those skilled in the art that these configurations in FIG. 2 could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat ground plane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the ground planes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other ground plane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling ground planes, or Electromagnetic Band-Gap (EBG) ground planes, or Photonic Band-Gap (PBG) ground planes, or high-impedance (Hi-Z) ground planes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by using a conductive ink."

Paragraph 0050 of the published application recites "Some embodiments, like the ones being showed in FIG. 4, where space-filling curves are coupled, are preferred when a ***multiband*** or broadband ***behavior is to be enhanced***. Said space-filling arrangement allows ***multiple resonant frequencies which can be used as separate bands*** or as a broadband if they are properly coupled together. Also, ***said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure***. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of generality, particular configurations are being showed in this figure, where the active elements (that is, the radiating arms) are straight, whereas the space-filling properties have been utilized in the parasitic elements. However, the same space-filling principle could have been used to the radiating elements, as it will be shown in other preferred embodiments described later in this document."

Paragraph 0055 of the published application recites "Some embodiments, like the ones being showed in FIG. 8, where space-filling curves are coupled, are preferred when ***a multiband or broadband behavior is to be enhanced***. Said space-filling arrangement allows multiple resonant frequencies which can be used as separate bands or as a broadband if they are properly coupled together. ***Also, said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure***. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of generality, particular configurations are being showed in this figure, where the both the active elements (that is, the radiating arms) and the parasitic elements are being formed by means of space-filling curves."

Paragraph 0064 of the published application recites "FIG. 17, Drawing 74 shows a PIFA structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In Drawing 74 it can be clearly seen that the close proximity region is formed by elements (178)

and (179). PIFA antennas have become a hot topic lately due to having a form that can be integrated into the per se known type of handset cabinets. Preferably, for this type of antenna system, the antenna, the ground-plane or both are disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by printing the antenna and the ground-plane onto the substrate using a conductive ink. A low-loss dielectric substrate (such as glass-fibre, a Teflon substrate such as Cuclad® or other commercial materials such as Rogers® 4003 well-known in the art) can be placed between said patches and ground-plane. Other dielectric materials with similar properties may be substituted above without departing from the intent of the present invention. As an alternative way to etching the antenna and the ground-plane out of copper or any other metal, it is also possible to manufacture the antenna system by printing it using conductive ink. The antenna feeding scheme can be taken to be any of the well-known schemes used in prior art patch or PIFA antennas as well, for instance: a coaxial cable with the outer conductor connected to the ground-plane and the inner conductor connected to the patch at the desired input resistance point; a microstrip transmission line sharing the same ground-plane as the antenna with the strip capacitively coupled to the patch and located at a distance below the patch, or in another embodiment with the strip placed below the ground-plane and coupled to the patch through a slot, and even a microstrip transmission line with the strip co-planar to the patch. All these mechanisms are well known from prior art and do not constitute an essential part of the present invention. ***The essential part of the present invention is the shape of the proximity close region***, which contributes to reducing the size with respect to prior art configurations, ***as well as enhancing antenna bandwidth, VSWR, and radiation efficiency***."

Applicant respectfully submits that by taking into account the above-identified sections of the present application, a person of ordinary skill in the art receives the teaching that key elements to achieve a multiband behavior, a broadband behavior or a combination of both effects are a first radiating arm, a second radiating arm and a close proximity region. Thus, a person of ordinary skill in the art, after reading the present application understands that, to obtain the multiband behavior, the first radiating arm, the second radiating arm and the close proximity region have to be configured. For example, a length and size of several-coupled arms together

with a spacing and size of the proximity region and/or the shape and dimensions of the first and second radiating elements have to be adjusted to obtain the multiband behavior.

In other words, the person of ordinary skill in the art receives the teaching of "*simultaneously tune*" the antenna element at a plurality of operating frequencies in multiple frequencies bands. Applicant respectfully submits that the term "*simultaneously*" in the context of the present patent application has the meaning known in the art, that is, "*at the same time*" while the term "*tune*" has the meaning know in the field of antennas as a process of adjusting the input and radiation parameters of the antenna element to achieve the desired behavior. As such, a person of ordinary skill in the art receives the teaching of configuring the antenna element to provide at the same time ("*simultaneously*") the bandwidth, the VSWR and the radiation efficiency for operating in multiple frequency bands ("*tune*").

In addition, according to the present application, the multiband behavior, the broadband behavior or a combination of both effects is not achieved through a variable tuning circuit, that is, the present application refers to antenna elements which do not require a variable tuning circuit. As disclosed in the above-identified sections of the present application, the first radiating element, the second radiating element and the close proximity region are the ***key*** elements that provide the multiband behavior, the broadband behavior or a combination of both effects. Therefore, an antenna element according to the present invention provides ***at the same time*** the bandwidth, VSWR and radiation efficiency required to operate at multiple frequency bands (multiband behavior).

Furthermore, Applicant respectfully submits that due to the fact that the present application does not disclose an antenna element with a variable tuning circuit for tuning the antenna element at a given time at just one frequency band of the multiple frequency bands, the term multiband behavior in the present application means that the antenna element (i.e., first radiating element, second radiating element and the close proximity region) is configured to provide***, at the same time,*** the bandwidth, VSRW and antenna efficiency required to operate at multiple frequency bands (multiband behavior).

For at least the reasons presented above, Applicant respectfully submits that claims 20-55 are fully supported by the written description. Withdrawal of the § 112 rejection of claims 20-55 is respectfully requested.

III. Rejections Under 35 U.S.C. § 102/103

Claims 20-25, 27, 30-34, and 40-55 stand rejected under 35 U.S.C. § 102 (e) as being anticipated by U.S. Patent No. 6,765,536 to Phillips ("Phillips"). Claims 26, 28-29, and 35-39 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Phillips.

Independent claim 20 relates to a handheld terminal. Applicant respectfully submits that Phillips fails to disclose at least one of the distinguishing features of amended independent claim 20, namely, that a first radiating arm, a second radiating arm and a close proximity region are configured to simultaneously provide the bandwidth required for an antenna element to operate in the multiple frequency bands.

In rejecting independent claim 20, the Office Action asserts that "wherein the first radiating arm, the second radiating arm and the close proximity region are configured to provide broadband behavior."[1] However, independent claim 20, prior to the current amendment, recited "wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands." Applicant respectfully submits that, in rejecting independent claim 20, the Office Action failed to address all the claimed features. More specifically, the Office Action failed to address the claimed feature of *simultaneously tuning the antenna element at a plurality of operating frequencies in multiple frequency bands*.

[1] *See* Office Action pages 4-5.

Applicant respectfully submits that Phillips fails to disclose the features disclosed in the claims. In particular, amended independent claim 20 recites components that are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands and that the first radiating arm, the second radiating arm, and the close proximity region are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands. In contrast, in Phillips, increased bandwidth to cover different frequency bands is accomplished by coupling an electrically-driven antenna element with an active, variably tuned, parasitic element.[2] Phillips utilizes at least one conductor, in close proximity to a transmitting and/or receiving directly connected (driven) antenna, to electromagnetically couple a tunable load to perturb the antenna's resonant frequency. In particular, a parasitic element (12) is coupled to a tuning circuit (20), where the function of the tuning circuit (20) is to provide a variable load to be mutually coupled to a driven antenna element (10) through the parasitic element (12).[3] Applicant respectfully submits that even if it is assumed, for the sake of argument, that a first radiating arm, a second radiating arm, and a close proximity region as in amended independent claim 20 are disclosed in Phillips, no such elements are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands since Phillips requires a variable tuning circuit (20).

Amended independent claim 20 recites components that are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands and that the first radiating element, the second radiating element, and the close proximity region are configured for such purpose. In contrast, in Phillips, increased bandwidth to cover different frequency bands is accomplished by coupling an electrically-driven antenna element with an active, variably tuned, parasitic element. Phillips utilizes at least one conductor, in close proximity to a transmitting and/or receiving directly connected (driven) antenna, to electromagnetically couple a tunable load to perturb the antenna's resonant frequency. In particular, a parasitic element (12) is coupled to a tuning circuit (20), where the function of the

[2] *See* Phillips, col. 2, lns. 15–28, 34–36.
[3] *See* Phillips, Fig. 2, col. 4, lns. 15–21.

tuning circuit (20) is to provide a variable load to be mutually coupled to a driven antenna element (10) through the parasitic element (12).

The tuning circuit (20) connected to the parasitic element (12) utilizes an RF switching device to enable a variety of capacitive or inductive tuning components to be selected or combined in order to adjust the reactive load on the parasitic element (12). The tuning circuit (20) includes a plurality of switches to synthesize different tuning loads. By selectively turning these switches ON and OFF, different tuning states are defined to tune the antenna to different frequencies. According to Phillips, this arrangement permits more tuning states, more frequency bands, or broader bandwidth to be achieved.

In Phillips, the tuning circuit (20) is variable to adjust a parasitic load on an antenna element to provide variable operating frequencies and bandwidths for the communication device. That being said, the antennas disclosed in Phillips do not anticipate or render obvious amended independent claim 20 at least because Phillips fails to teach or suggest a first radiating arm, a second radiating arm, and a close proximity region that are configured to simultaneously provide the bandwidth required for the antenna element to operate in the multiple frequency bands. In contrast, in Phillips, the required bandwidth is achieved by the variable tuning circuit (20) at a given time at just one frequency band of the multiple frequency bands.

For at least the reasons set forth above, amended claim 20 distinguishes over Phillips. Withdrawal of the rejection thereof is respectfully requested.

Dependent claims 21-55 depend from and further restrict independent claim 20 in a patentable sense. Applicant respectfully submits that, for at least the reasons set forth above with respect to the rejection of independent claim 20, dependent claims 21-55 distinguish over Phillips and are in condition for allowance. Withdrawal of the rejection of dependent claims 21-55 is respectfully requested.

In view of the above, Applicant respectfully submits that the present application is in condition for allowance. Applicant authorizes the Office to debit any required fees from Deposit Account 23-2426. A Notice to that effect is respectfully requested.

Dated: October 18, 2012

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 131851
Dallas, Texas 75313
(214) 745-5400
Attorneys For Applicant

Electronic Acknowledgement Receipt

EFS ID:	14020029
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Shoaib Amirali Mithani
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	18-OCT-2012
Filing Date:	05-DEC-2007
Time Stamp:	15:52:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Supplemental Response or Supplemental Amendment	47005P015Amendment.pdf	69186 0551c614b070fb58bc452ca39fcd98713534082e	no	16

Warnings:	
Information:	

Total Files Size (in bytes):	69186

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	10/18/2012	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $ =		OR	X $62=	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $250=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/CAROLYN COFER/

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 10/10/2012

WINSTEAD PC
P.O. BOX 131851
DALLAS, TX 75313

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	**PAPER NUMBER**
2821	

MAIL DATE	DELIVERY MODE
10/10/2012	PAPER

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

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

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

All participants (applicant, applicant's representative, PTO personnel):

(1) *ROBERT KARACSONY*. (3)_____.

(2) *Shoaib A. Mithani*. (4)_____.

Date of Interview: *03 October 2012*.

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: *20*.

Identification of prior art discussed: *Phillips et al. (US 6,765,536)*.

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...)

Applicants representative went over the response dated September 18, 2012 to emphasize some of the key points. Regarding the 112 rejections made in the previous Office action dated May 23, 2012, Applicants have amended the claims to clarify the rejected issues and used language verbatim with the original Specification. It was noted by the Examiner that language verbatim with the Specification would resolve all 112 issues.
Further, Applicants have amended the limitation "an antenna element" to now be limited to "a passive antenna element," see claim 1, line 3 of the amended claim set submitted September 18, 2012. The Examiner noted that this amendment would be considered New Matter and would be rejected under 112 2nd para. as being indefinite. The indefinite arraises from the fact that the claim first radiating arm, which makes up part of the passive antenna element, having a feeding point, see lines 5-6, claim 1. Since a passive element does not, by definition, have a feeding point, the new amendment "a passive antenna element" is indefinite .

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

/Robert Karacsony/ Examiner, Art Unit 2821	

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 Examiners 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.

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles PUENTE BALIARDA
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. [ ] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. [ ] Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
      ii. [ ] Other _____

   b. [x] Enclosed
      i. [x] Amendment/Reply
      ii. [ ] Affidavit(s)/Declaration(s)
      iii. [ ] Information Disclosure Statement (IDS)
      iv. [ ] Other _____

2. Miscellaneous

   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. [ ] Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. [x] The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any Overpayments, to Deposit Account No. 23-2426 .
      i. [x] RCE fee required under 37 CFR 1.17(e)
      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)
      iii. [ ] Other _____

   b. [ ] Check in the amount of $ _____ enclosed

   c. [ ] Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Shoaib A. Mithani/	Date	September 18, 2012
Name (Print/Type)	Shoaib A. Mithani	Registration No.	61,654

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: September 18, 2012 Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: September 18, 2012
Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

Docket No. 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles PUENTE BALIARDA et al.

Application No. 11/950,835 — Confirmation No. 7241

Filed: December 5, 2007 — Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS — Examiner: R. Karacsony

AMENDMENT AFTER FINAL ACTION

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

Dear Madam:

INTRODUCTORY COMMENTS

In response to the Final Office Action dated May 23, 2012 for which a one-month extension of time accompanies this amendment, please amend the above-identified U.S. patent application as indicated herein.

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

Remarks/Arguments begin on page 7 of this paper.

AMENDMENTS TO THE CLAIMS

1-19. (CANCEL)

20. (CURRENTLY AMENDED) A handheld terminal comprising:

at least one printed circuit board comprising a ground plane;

[[an]] a passive antenna element operating at multiple frequency bands, the passive antenna element comprising:

a first radiating arm comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point; ~~and~~

a second radiating arm not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane;

a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane;

wherein the first radiating arm and the second radiating arm are coupled through a close proximity region from a specific region of the first radiating arm and from a specific region of the second radiating arm;

wherein the first radiating arm comprises a substantially planar structure;

wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;

wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end;

wherein the line segment does not intersect a projection orthogonal to the ground plane; and

wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for ~~tune~~ the passive antenna element to operate in the ~~at a plurality of operating frequencies in~~ multiple frequency bands.

21. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cell phone.

22. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a clamshell body.

23. (PREVIOUSLY PRESENTED) The handheld terminal of claim 22, wherein: the clamshell body comprises:

a first body portion;

a second body portion; and

a hinge interposed between the first body portion and the second body portion; and

the first radiating arm and the second radiating arm are mounted adjacent to the hinge.

24. (PREVIOUSLY PRESENTED) The handheld terminal of claim 23, wherein:

the feeding port is located on a first side of the hinge;

the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge;

the second side is opposite the first side.

25. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a candybar body.

26. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm are substantially coplanar.

27. (PREVIOUSLY PRESENTED) The handheld terminal of claim 25, wherein the line segment is coplanar with the ground plane.

28. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength.

29. (PREVIOUSLY PRESENTED) The handheld terminal of claim 26, wherein the first radiating arm and the second radiating arm are coplanar with the ground plane.

30. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane.

31. (PREVIOUSLY PRESENTED) The handheld terminal of claim 30, wherein the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane.

32. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane.

33. (PREVIOUSLY PRESENTED) The handheld terminal of claim 32, wherein the second-radiating-arm second end is coupled to the ground plane on a second corner of the ground plane.

34. (PREVIOUSLY PRESENTED) The handheld terminal of claim 33, wherein:

the ground plane is substantially rectangular; and

the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane.

35. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a personal digital assistant.

36. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cordless telephone.

37. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a pager.

38. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises an electronic gaming device.

39. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a remote control device.

40. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein:

the handheld terminal is operative at multiple frequency bands; and

at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) or Universal Mobile Telecommunications System (UMTS) communication service.

41. (PREVIOUSLY PRESENTED) The handheld terminal of claim 40, wherein:

the handheld terminal is operative at multiple frequency bands;

a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service.

42. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at four frequency bands.

43. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at five frequency bands.

44. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS), GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS1900), and Digital Cellular System (DCS).

45. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

46. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

47. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a monopole.

48. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein each of the first radiating arm and the second radiating arm comprises a monopole.

49. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises an IFA structure.

50. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein the monopole comprises an IFA structure.

51. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein:

one of the first radiating arm and the second radiating arm comprises a monopole; and

the other of the first radiating arm and the second radiating arm comprises a microstrip structure.

52. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a microstrip structure.

53. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein each of the first radiating arm and the second radiating arm comprises a microstrip structure.

54. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein the microstrip structure comprises a PIFA structure.

55. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

REMARKS

Reconsideration of the application is respectfully requested. Claims 20-55 are pending. Claim 20 has been amended. Applicant respectfully submits that no new matter has been added by the amendments presented herein.

I. Rejections Under 35 U.S.C. § 112

Claims 20-55 stand rejected under 35 U.S.C. § 112, first and second paragraphs. In response, Applicant has amended independent claim 20 to comply with 35 U.S.C. § 112. In addition, Applicant respectfully submits that claims 20-55 are fully supported by the written description thereby complying with the written description requirement. Applicant respectfully submits that support for claims 20-55 may be found throughout the specification and particularly on paragraphs 0009, 0023, 0044, 0047-0048, 0050, 0055, and 0064 of the published application.

For example, paragraph 0009 of the published application recites "The present invention consists of an antenna comprising ***at least two radiating structures***, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms ***being coupled to each other through a region*** on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, ***a multiband behavior*** or a combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna."

Paragraph 0023 of the published application recites "The skilled in the art will notice that, obviously, such advantages can be combined with other features, for instance, a multiband response. The skilled in the art will notice that such ***a multiband response can be obtained within the present invention by adjusting the length and size of the several-coupled arms, together with the spacing and size of the proximity region defined between the several arms***. Another way of combining said advantages with a multiband behavior consists of shaping at least one of the arms as a multiband antenna, for instance by means of a multilevel structure or a space-filling structure."

Paragraph 0044 of the published application recites "In order to construct a coupled antenna system according to embodiments of the invention, a suitable antenna design is required. Any number of possible configurations exists, and ***the actual choice of antenna is dependent, for instance, on the operating frequency and bandwidth, among other antenna parameters***. Several possible examples of embodiments are listed hereinafter. However, in view of the foregoing description, it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. In particular, different materials and fabrication processes for producing the coupled antenna system may be selected, which still achieve the desired effects."

Paragraph 0047 of the published application recites "Drawing 3 from FIG. 1 shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the ***close proximity region*** to reduce the antenna size yet providing a broadband or ***multiband behavior***."

Paragraph 0048 of the published application recites "Unlike the prior art structures illustrated in FIG. 1, the newly disclosed coupled antenna system shown in FIG. 2, Drawing 4, is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this

configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, Ws<Wd. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). ***Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency*** of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in Drawing 5. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that Ws<Wd. It is clear to those skilled in the art that these configurations in FIG. 2 could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat ground plane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the ground planes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other ground plane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling ground planes, or Electromagnetic Band-Gap (EBG) ground planes, or Photonic Band-Gap (PBG) ground planes, or high-impedance (Hi-Z) ground planes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by using a conductive ink."

Paragraph 0050 of the published application recites "Some embodiments, like the ones being showed in FIG. 4, where space-filling curves are coupled, are preferred when a ***multiband*** or broadband ***behavior is to be enhanced***. Said space-filling arrangement allows ***multiple resonant frequencies which can be used as separate bands*** or as a broadband if they are properly coupled together. Also, ***said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure***. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of

generality, particular configurations are being showed in this figure, where the active elements (that is, the radiating arms) are straight, whereas the space-filling properties have been utilized in the parasitic elements. However, the same space-filling principle could have been used to the radiating elements, as it will be shown in other preferred embodiments described later in this document."

Paragraph 0055 of the published application recites "Some embodiments, like the ones being showed in FIG. 8, where space-filling curves are coupled, are preferred when ***a multiband or broadband behavior is to be enhanced***. Said space-filling arrangement allows multiple resonant frequencies which can be used as separate bands or as a broadband if they are properly coupled together. ***Also, said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure***. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of generality, particular configurations are being showed in this figure, where the both the active elements (that is, the radiating arms) and the parasitic elements are being formed by means of space-filling curves."

Paragraph 0064 of the published application recites "FIG. 17, Drawing 74 shows a PIFA structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In Drawing 74 it can be clearly seen that the close proximity region is formed by elements (178) and (179). PIFA antennas have become a hot topic lately due to having a form that can be integrated into the per se known type of handset cabinets. Preferably, for this type of antenna system, the antenna, the ground-plane or both are disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by printing the antenna and the ground-plane onto the substrate using a conductive ink. A low-loss dielectric substrate (such as glass-fibre, a Teflon substrate such as Cuclad® or other commercial materials such as Rogers® 4003 well-known in the art) can be placed between said patches and ground-plane.

Other dielectric materials with similar properties may be substituted above without departing from the intent of the present invention. As an alternative way to etching the antenna and the ground-plane out of copper or any other metal, it is also possible to manufacture the antenna system by printing it using conductive ink. The antenna feeding scheme can be taken to be any of the well-known schemes used in prior art patch or PIFA antennas as well, for instance: a coaxial cable with the outer conductor connected to the ground-plane and the inner conductor connected to the patch at the desired input resistance point; a microstrip transmission line sharing the same ground-plane as the antenna with the strip capacitively coupled to the patch and located at a distance below the patch, or in another embodiment with the strip placed below the ground-plane and coupled to the patch through a slot, and even a microstrip transmission line with the strip co-planar to the patch. All these mechanisms are well known from prior art and do not constitute an essential part of the present invention. ***The essential part of the present invention is the shape of the proximity close region***, which contributes to reducing the size with respect to prior art configurations, ***as well as enhancing antenna bandwidth, VSWR, and radiation efficiency***."

Applicant respectfully submits that by taking into account the above-identified sections of the present application, a person of ordinary skill in the art receives the teaching that key elements to achieve a multiband behavior, a broadband behavior or a combination of both effects are a first radiating arm, a second radiating arm and a close proximity region. Thus, a person of ordinary skill in the art, after reading the present application understands that, to obtain the multiband behavior, the first radiating arm, the second radiating arm and the close proximity region have to be configured. For example, a length and size of several-coupled arms together with a spacing and size of the proximity region and/or the shape and dimensions of the first and second radiating elements have to be adjusted to obtain the multiband behavior.

In other words, the person of ordinary skill in the art receives the teaching of "*simultaneously tune*" the antenna element at a plurality of operating frequencies in multiple frequencies bands. Applicant respectfully submits that the term "*simultaneously*" in the context of the present patent application has the meaning known in the art, that is, "*at the same time*"

while the term "*tune*" has the meaning know in the field of antennas as a process of adjusting the input and radiation parameters of the antenna element to achieve the desired behavior. As such, a person of ordinary skill in the art receives the teaching of configuring the antenna element to provide at the same time ("*simultaneously*") the bandwidth, the VSWR and the radiation efficiency for operating in multiple frequency bands ("*tune*").

In addition, according to the present application, the multiband behavior, the broadband behavior or a combination of both effects is not achieved through a variable tuning circuit, that is, the present application refers to passive antenna elements. As disclosed in the above-identified sections of the present application, the first radiating element, the second radiating element and the close proximity region are the ***key*** elements that provide the multiband behavior, the broadband behavior or a combination of both effects. Therefore, an antenna element according to the present invention provides ***at the same time*** the bandwidth, VSWR and radiation efficiency required to operate at multiple frequency bands (multiband behavior).

Furthermore, Applicant respectfully submits that due to the fact that the present application does not disclose an antenna element with a variable tuning circuit for tuning the antenna element at a given time at just one frequency band of the multiple frequency bands, the term multiband behavior in the present application means that the antenna element (i.e., first radiating element, second radiating element and the close proximity region) is configured to provide***, at the same time,*** the bandwidth, VSRW and antenna efficiency required to operate at multiple frequency bands (multiband behavior).

For at least the reasons presented above, Applicant respectfully submits that claims 20-55 are fully supported by the written description. Withdrawal of the § 112 rejection of claims 20-55 is respectfully requested.

II. Rejections Under 35 U.S.C. § 102/103

Claims 20-25, 27, 30-34, and 40-55 stand rejected under 35 U.S.C. § 102 (e) as being anticipated by U.S. Patent No. 6,765,536 to Phillips ("Phillips"). Claims 26, 28-29, and 35-39 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Phillips.

Independent claim 20 relates to a handheld terminal. Applicant respectfully submits that Phillips fails to disclose at least one of the distinguishing features of amended independent claim 20, namely, a passive antenna element operating at multiple frequency bands. In addition, Phillips fails to disclose that the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously provide the bandwidth required for the passive antenna element to operate in the multiple frequency bands.

In rejecting independent claim 20, the Office Action asserts that "wherein the first radiating arm, the second radiating arm and the close proximity region are configured to provide broadband behavior." [1] However, independent claim 20, prior to the current amendment, recited "wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands." Applicant respectfully submits that, in rejecting independent claim 20, the Office Action failed to address all the claimed features. More specifically, the Office Action failed to address the claimed feature of *simultaneously tuning the antenna element at a plurality of operating frequencies in multiple frequency bands*.

Applicant respectfully submits that Phillips fails to disclose the features disclosed in the Office Action. In particular, amended independent claim 20 recites components that are configured to simultaneously provide the bandwidth required for the passive antenna element to operate in the multiple frequency bands and that the first radiating arm, the second radiating arm, and the close proximity region are configured for providing the bandwidth required for the

[1] *See* Office Action pages 4-5.

passive antenna element to operate in the multiple frequency bands. In contrast, in Phillips, increased bandwidth to cover different frequency bands is accomplished by coupling an electrically-driven antenna element with an active, variably tuned, parasitic element.[2] Phillips utilizes at least one conductor, in close proximity to a transmitting and/or receiving directly connected (driven) antenna, to electromagnetically couple a tunable load to perturb the antenna's resonant frequency. In particular, a parasitic element (12) is coupled to a tuning circuit (20), where the function of the tuning circuit (20) is to provide a variable load to be mutually coupled to a driven antenna element (10) through the parasitic element (12).[3] Applicant respectfully submits that even if it is assumed, for the sake of argument, that a first radiating arm, a second radiating arm, and a close proximity region as in amended independent claim 20 are disclosed in Phillips, no such elements are configured to simultaneously provide the bandwidth required for the passive antenna element to operate in the multiple frequency bands since Phillips requires a variable tuning circuit (20).

In addition, Phillips refers to an active antenna since it requires an active, variably tuned parasitic element with a variable tuning circuit (20) coupled to the parasitic element (12).[4] In contrast, amended independent claim 20 requires, among other things, a passive antenna element operating at multiple frequency bands but does not require a variable tuning circuit to achieve the multiband behavior, the broadband behavior or a combination of both effects as required by Phillips. Such a feature of the passive antenna element operating at multiple frequency bands is not disclosed by Phillips.

Amended independent claim 20 recites components that are configured to simultaneously provide the bandwidth required for the passive antenna element to operate in the multiple frequency bands and that the first radiating element, the second radiating element, and the close proximity region are configured for such purpose. In contrast, in Phillips, increased bandwidth to cover different frequency bands is accomplished by coupling an electrically-driven antenna element with an active, variably tuned, parasitic element. Phillips utilizes at least one conductor,

[2] *See* Phillips, col. 2, lns. 15–28, 34–36.
[3] *See* Phillips, Fig. 2, col. 4, lns. 15–21.
[4] *See* Phillips, Fig. 2, col. 4, lns. 15–21.

in close proximity to a transmitting and/or receiving directly connected (driven) antenna, to electromagnetically couple a tunable load to perturb the antenna's resonant frequency. In particular, a parasitic element (12) is coupled to a tuning circuit (20), where the function of the tuning circuit (20) is to provide a variable load to be mutually coupled to a driven antenna element (10) through the parasitic element (12).

The tuning circuit (20) connected to the parasitic element (12) utilizes an RF switching device to enable a variety of capacitive or inductive tuning components to be selected or combined in order to adjust the reactive load on the parasitic element (12). The tuning circuit (20) includes a plurality of switches to synthesize different tuning loads. By selectively turning these switches ON and OFF, different tuning states are defined to tune the antenna to different frequencies. According to Phillips, this arrangement permits more tuning states, more frequency bands, or broader bandwidth to be achieved.

In Phillips, the tuning circuit (20) is variable to adjust a parasitic load on an antenna element to provide variable operating frequencies and bandwidths for the communication device. That being said, the antennas disclosed in Phillips do not anticipate or render obvious amended independent claim 20 at least because Phillips fails to teach or suggest a first radiating arm, a second radiating arm, and a close proximity region that are configured to simultaneously provide the bandwidth required for the passive antenna element to operate in the multiple frequency bands. In contrast, in Phillips, the required bandwidth is achieved by the variable tuning circuit (20) at a given time at just one frequency band of the multiple frequency bands.

Dependent claims 21-55 depend from and further restrict independent claim 20 in a patentable sense. Applicant respectfully submits that, for at least the reasons set forth above with respect to the rejection of independent claim 20, dependent claims 21-55 distinguish over Phillips and are in condition for allowance. Withdrawal of the rejection of dependent claims 21-55 is respectfully requested.

For at least the reasons set forth above, amended claim 20 distinguishes over Phillips. Withdrawal of the rejection thereof is respectfully requested.

In view of the above, Applicant respectfully submits that the present application is in condition for allowance. A Notice to that effect is respectfully requested.

Dated: September 18, 2012

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 131851
Dallas, Texas 75313
(214) 745-5400
Attorneys For Applicant

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Shoaib Amirali Mithani
Attorney Docket Number:	47005-P015WUSC1

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:				
Extension - 1 month with $0 paid	1251	1	150	150

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	1801	1	930	930
		Total in USD ($)		**1080**

Electronic Acknowledgement Receipt

EFS ID:	13773637
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Shoaib Amirali Mithani
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	18-SEP-2012
Filing Date:	05-DEC-2007
Time Stamp:	13:30:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1080
RAM confirmation Number	10268
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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

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

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	**Document Description**	**File Name**	**File Size(Bytes)/ Message Digest**	**Multi Part /.zip**	**Pages (if appl.)**
1	Request for Continued Examination (RCE)	47005RCE.pdf	26736 459d63fccb930fb847629a3f5836734c7eb6da6e	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2	Amendment After Final	47005Response.pdf	69375 7adb92dc5f45ffa94dd47a49e40352e919deb234	no	16
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32271 7292a2adb1e05f34e3499975ba0be612807efd43	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	128382		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	09/18/2012	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $ =		OR	X $60=	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $250=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/Theresa Dawkins/

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 05/23/2012

WINSTEAD PC
P.O. BOX 131851
DALLAS, TX 75313

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	PAPER NUMBER
2821	

MAIL DATE	DELIVERY MODE
05/23/2012	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

-- 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 *23 December 2011*.

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) *20-55* 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) *20-55* is/are rejected.

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

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

Application Papers

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

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

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

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

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

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

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *12/28/2011, 06/22/2011*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

The following Office Action is in response to the Request for Reconsideration received December 28, 2011. Claims 20-55 are currently pending.

Information Disclosure Statement

The information disclosure statements (IDS) submitted on June 22, 2011 and December 28, 2011 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements are being considered by the examiner.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 20-55 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claim 20: In the last two lines, the limitation "simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands" is not disclosed in the Original Specification.

Claims 21-55 are rejected for at least depending on claim 20, as discussed above.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 20-55 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 20: In the last two lines, the limitation "simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands" is indefinite as it fails to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Based on the written description, "said two arms being coupled to each other through a region on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, a multiband behavior or a combination of both effects," (see page 4, lines 12-17). For examination purposes, the said limitation will be interpreted accordingly.

Claim Rejections - 35 USC § 102

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

A person shall be entitled to a patent unless –

> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 20-25, 27, 30-34, and 40-55 are rejected under 35 U.S.C. 102(e) as being anticipated by *Phillips et al.* (US 6,765,536, hereinafter *Phillips*).

Claim 20: *Phillips* teaches a handheld terminal comprising: at least one printed circuit board (14, fig. 1) comprising a ground plane (col. 3, lines 53-58); an antenna element comprising: a first radiating arm (10, fig. 1) comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point (point that connects to transceiver, see fig. 2); a second radiating arm (12, fig. 1) not in ohmic contact (col. 3, lines 45-47) with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane (end that couples to ground via tuning circuit 20, see fig. 2); a feeding port (transceiver, see fig. 2) defined between the feeding point of the first radiating arm and at least one point on the ground plane; wherein the first radiating arm and the second radiating arm are coupled through a close proximity region (region that provides capacitive coupling, see col. 3, lines 45-47) from a specific region of the first radiating arm and from a specific region of the second radiating arm; wherein the first radiating arm comprises a substantially planar structure (col. 8, lines 59-62); wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board (col. 3, lines 53-54); wherein a length of a line segment (vertical line that orthogonally projects from horizontal segment of radiator 12 onto radiator 10) between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second- radiating-arm second end (fig. 1); wherein the line segment does not intersect a projection orthogonal to the ground plane (fig. 1 illustrates the line segment being parallel to the projection), wherein the first radiating arm, the second

radiating arm and the close proximity region are configured to provide broadband behavior (col. 2, lines 29-32).

Claim 21: *Phillips* teaches the handheld terminal comprises a cell phone (col. 2, lines 54-56).

Claim 22: *Phillips* teaches the cell phone comprises a clamshell body (fig. 11).

Claim 23: *Phillips* teaches the clamshell body comprises: a first body portion (132, fig. 11); a second body portion (130, fig. 11); and a hinge (134, fig. 11) interposed between the first body portion and the second body portion; and the first radiating arm and the second radiating arm are mounted adjacent to the hinge (fig. 11).

Claim 24: *Phillips* teaches the feeding port is located on a first side of the hinge (fig. 11); the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge (fig. 11); the second side is opposite the first side (fig. 11).

Claim 25: *Phillips* teaches the cell phone comprises a candy bar body (fig. 11, the Examiner interprets the shape of the phone in the closed state as a candy bar).

Claim 27: *Phillips* teaches the line segment is coplanar with the ground plane (fig. 1).

Claim 30: *Phillips* teaches the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane (fig. 1).

Claim 31: *Phillips* teaches the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane (fig. 1).

Claim 32: *Phillips* teaches the feeding port is located on a first comer (left corner of ground plane, see fig. 1) of the ground plane.

Claim 33: *Phillips* teaches the second-radiating-arm second end is coupled to the ground plane on a second comer (right corner of ground plane, see fig. 1) of the ground plane.

Claim 34: *Phillips* teaches the ground plane is substantially rectangular (fig. 1); and the first comer and the second comer are opposite comers of a short edge of the substantially rectangular ground plane (fig. 1).

Claim 40: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); and at least one of the multiple frequency bands is used by a GSM or UMTS communication service (col. 1, lines 38-42).

Claim 41: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service (col. 1, lines 38-42).

Claim 42: *Phillips* teaches the handheld terminal is operative at least at four frequency bands (col. 1, lines 38-42).

Claim 43: *Phillips* teaches the handheld terminal is operative at least at five frequency bands (col. 1, lines 38-42).

Claim 44: *Phillips* teaches the handheld terminal is operative according to at least three of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 45: *Phillips* teaches the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 46: *Phillips* teaches the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS 1900, and DCS (col. 1, lines 38-42).

Claim 47: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 48: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 49: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises an IFA structure (col. 8, lines 59-62).

Claim 50: *Phillips* teaches the monopole comprises an IFA structure (col. 8, lines 59-62).

Claim 51: *Phillips* teaches one of the first radiating arm and the second radiating arm comprises a monopole; and the other of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 52: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 53: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 54: *Phillips* teaches the microstrip structure comprises a PIFA structure (col. 8, lines 59-62).

Claim 55: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a PIFA structure (col. 8, lines 59-62).

Claim Rejections - 35 USC § 103

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 negatived by the manner in which the invention was made.

Claims 26, 28, 29, and 35-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Phillips*.

Claim 26: *Phillips* teaches all of the limitations of claim 21, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm are substantially coplanar. However, *Phillips* teaches that either the antenna element and the parasitic element can be a straight wire (col. 3, lines 61-62) and that they each can be shared therebetween (col. 8, lines 41-48). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a straight wire for both the antenna element and the parasitic element, thereby having them coplanar, as suggested by *Phillips*, since it was known to one having ordinary skill in the art at the time of the invention.

Claim 28: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength. However, *Phillips* teaches that the coupling between the antenna element and the parasitic element can be varied by controlling the diameter of the parasitic element (col. 4, lines 10-14). Therefore, it would have been obvious to one of ordinary skill in the art at the

time the invention was made to have set the length of the coupling region to that of the claimed invention in order to have varied the coupling between the antenna element and the parasitic element.

Claim 29: The modified invention of *Phillips* teaches the first radiating arm and the second radiating arm are coplanar with the ground plane (fig. 1).

Claims 35-39: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Response to Arguments

Applicant's arguments filed December 23, 2011 have been fully considered but they are not persuasive.

In light of the rejections to independent claim 20 under 112 1st and 2nd paragraphs, Applicant's arguments are considered moot.

Conclusion

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

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacob Y. Choi can be reached on 571-272-2367. 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.

/R. K./
Examiner, Art Unit 28213

/JACOB Y CHOI/
Supervisory Patent Examiner, Art Unit 2821

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

SEARCHED			
Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK
343	803	9/10/2010	RK
343	893	6/20/2011	RK

SEARCH NOTES		
Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK
Class/Subclass, Text, Assignment data, Inventor name and Backward/Forward search	9/10/2010	RK
Updated search	6/20/2011	RK
Updated search	5/10/2012	RK

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/R.K./ Examiner.Art Unit 2821	

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda et al.
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5767810		1998-06-16	HAGIWARA ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1231404	JP		1989-09-14	TOYOTA CENTRAL RES & DEV		☒
	2	0655797	EP		1995-05-31	MOTOROLA		☐

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

NON-PATENT LITERATURE DOCUMENTS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

Receipt date: 12/28/2011

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835 11950835 - GAU: 2821
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda et al.
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Li, R. L. et al, Broadband semiloop antenna, Microwave and Optical Technology Letters, dated on August 20, 2002	☐
	2	Risco, S. , Coupled monopole antenna techniques for handset devices, Fractus / Universitat Ramon Llull, May 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	05/10/2012

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

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

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010	06/20/2011	05/10/2012				
	1	✓	-	-	-	-				
	2	✓	-	-	-	-				
	3	✓	-	-	-	-				
	4	✓	-	-	-	-				
	5	✓	-	-	-	-				
	6	✓	-	-	-	-				
	7	✓	-	-	-	-				
	8	✓	-	-	-	-				
	9	✓	-	-	-	-				
	10	✓	-	-	-	-				
	11	✓	-	-	-	-				
	12	✓	-	-	-	-				
	13	✓	-	-	-	-				
	14	✓	-	-	-	-				
	15	✓	-	-	-	-				
	16	✓	-	-	-	-				
	17	✓	-	-	-	-				
	18	✓	-	-	-	-				
	19	✓	-	-	-	-				
	20		✓	✓	✓	✓				
	21		✓	✓	✓	✓				
	22		✓	✓	✓	✓				
	23		✓	✓	✓	✓				
	24		✓	✓	✓	✓				
	25		✓	✓	✓	✓				
	26		✓	✓	✓	✓				
	27		✓	✓	✓	✓				
	28		✓	✓	✓	✓				
	29		✓	✓	✓	✓				
	30		✓	✓	✓	✓				
	31		✓	✓	✓	✓				
	32		✓	✓	✓	✓				
	33		✓	✓	✓	✓				
	34		✓	✓	✓	✓				
	35		✓	✓	✓	✓				
	36		✓	✓	✓	✓				

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010	06/20/2011	05/10/2012				
	37		✓	✓	✓	✓				
	38		✓	✓	✓	✓				
	39		✓	✓	✓	✓				
	40		✓	✓	✓	✓				
	41		✓	✓	✓	✓				
	42		✓	✓	✓	✓				
	43		✓	✓	✓	✓				
	44		✓	✓	✓	✓				
	45		✓	✓	✓	✓				
	46		✓	✓	✓	✓				
	47		✓	✓	✓	✓				
	48		✓	✓	✓	✓				
	49		✓	✓	✓	✓				
	50		✓	✓	✓	✓				
	51		✓	✓	✓	✓				
	52		✓	✓	✓	✓				
	53		✓	✓	✓	✓				
	54		✓	✓	✓	✓				
	55		✓	✓	✓	✓				

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5363114		1994-11-08	Shoemaker	
	2	4751513		1988-06-14	Daryoush et al	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

Receipt date: 06/22/2011

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835 11950835 - GAU: 2821
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Mushiake , Y. , Self-complementary antennas , Antennas and Propagation Magazine, IEEE , Vol. 34 , No. 6 , December 1, 1992.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	05/10/2012

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	0	("("4751513" | "5363114").PN.").PN.	US-PGPUB; USPAT	OR	OFF	2012/05/10 18:24
S2	2	("4751513" | "5363114").PN.	US-PGPUB; USPAT	OR	ON	2012/05/10 18:24
S3	1	("5767810").PN.	US-PGPUB; USPAT	OR	ON	2012/05/10 18:25
S4	150	((CARLES) near2 (BALIARDA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:27
S5	36	((JAUME) near2 ("ANGUERA PROS")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:27
S6	46	((JORDI) near2 ("SOLER CASTANY")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:27
S7	4	((ANTONIO) near2 ("CONDES MARTINEZ")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:27
S8	156	S4 S5 S6 S7	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:27
S9	144	S8 and "343".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:28
S10	60	S8 and coupl$4 near7 region	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:28
S11	96	S8 not coupl$4 near7 region	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:30
S12	1	"7315289".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:31
S13	24	("5966097" | "5990838" | "6337677" | "6456243" | "6573867" | "6765536" | "20020075187" | "5365246" | "6262495" | "5363114" | "5767810" | "6337667" | "20030020661" | "5838285" | "5903239" | "20020075187" | "6466176" | "6281848" | "4907006" | "6373447" | "20020149527" | "6943730" | "4751513" | "4628322" | "6509882").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:48
S14	1	(10/205364).APP.	USPAT; USOCR	OR	ON	2012/05/10 18:55
S15	3	("6864844").URPN.	USPAT	OR	ON	2012/05/10 18:55

S16	15	("2003/0020661").URPN.	USPAT	OR	ON	2012/05/10 18:55
S17	6	("20030020661" | "20060017635" | "6515625" | "6903688" | "7336239" | "7420511").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2012/05/10 18:55
S18	233472	parasitic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/05/10 18:56
S19	27446	mutli$1band multi$1bandwidth multi$1frequency	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/05/10 18:57
S20	46461	multi$1band multi$1bandwidth multi$1frequency	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/05/10 18:57
S21	2538	S18 and S20	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/05/10 18:57
S22	359	S18 and S20 and 343/702.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/05/10 18:57

EAST Search History (Interference)

< This search history is empty>

5/ 10/ 2012 7:26:52 PM
C:\ Users\ rkaracsony\ Documents\ EAST\ Workspaces\ Cases\ Coupled Multiband Antennas 11950835\ Coupled Multiband Antennas 05-10-2012.wsp

All search listings have been considered by the Examiner. /RK/

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: January 6, 2012
Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 | Confirmation No.: 7241

Filed: December 5, 2007 | Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS | Examiner: R. Karacsony

STATEMENT REPORTING INTERVIEW SUMMARY

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

Dear Sir:

In response to the Interview Summary dated December 21, 2011, Applicant provides this Statement reporting the substance of the telephone interview held with the Examiner on December 16, 2011.

In the telephone interview, Applicant discussed claim 20. Applicant respectfully submits that the substance of the interview, as shown on the Interview Summary sheet, is accurate.

Dated: January 6, 2012

Respectfully submitted,
Electronic signature: /Shoaib A. Mithani/

Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys for Applicant

Electronic Acknowledgement Receipt

EFS ID:	11774020
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Shoaib Amirali Mithani
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	06-JAN-2012
Filing Date:	05-DEC-2007
Time Stamp:	11:17:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	47005Interview.pdf	20887 e2b3e3130c741afc8ab0cdd3c86978ea54225dbc	no	1

Warnings:	
Information:	

Total Files Size (in bytes):	20887

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda et al.
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5767810		1998-06-16	HAGIWARA ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1231404	JP		1989-09-14	TOYOTA CENTRAL RES & DEV		☒
	2	0655797	EP		1995-05-31	MOTOROLA		☐

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda et al.
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Li, R. L. et al, Broadband semiloop antenna, Microwave and Optical Technology Letters, dated on August 20, 2002	☐
	2	Risco, S. , Coupled monopole antenna techniques for handset devices, Fractus / Universitat Ramon Llull, May 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 28, 2011
Electronic Signature for Brenda I. Brown: /Brenda I. Brown/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed more than three months after the U.S. filing date, OR more than three months after the date of entry of the national stage of a PCT application, AND after the mailing date of the first Office Action on the merits, whichever occurs first, but before the mailing date of a Final Office Action or Notice of Allowance, as far as is known to the undersigned (37 CFR 1.97(c)).

A summary/abstract translation of the non-English language references is enclosed.

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

Please charge our Deposit Account No. 23-2426 in the amount of $180.00 covering the fee set forth in 37 CFR 1.17(p). The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1.

Dated: December 28, 2011

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 655 797 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94117751.1**

(51) Int. Cl.[6]: **H01Q 19/00**, H01Q 1/24

(22) Date of filing: **10.11.94**

(30) Priority: **26.11.93 US 157250**

(43) Date of publication of application:
31.05.95 Bulletin 95/22

(84) Designated Contracting States:
DE FR GB

(71) Applicant: **MOTOROLA, INC.**
1303 East Algonquin Road
Schaumburg, IL 60196 (US)

(72) Inventor: **Burrell, Dennis**
9873 Lawrence Road B-20
Boynton Beach,
Florida 33436 (US)

(74) Representative: **Spaulding, Sarah Jane et al**
Motorola
European Intellectual Property
Midpoint
Alencon Link
Basingstoke,
Hampshire RG21 1PL (GB)

(54) Quarter-wave gap-coupled tunable strip antenna.

(57) An antenna has a quarter wave resonant strip (10) and first and second parasitically excited strips (12 and 14) resonant at a lower and upper frequency, respectively, of the antenna bandwidth. The strips (10, 12 and 14) have trim tabs (20, 22 and 24) for adjusting the resonant frequency of each strip. The location of a feed (30) is set to provide a desired impedance match for use by a radio (60) such as a pager. A ground plane (40) provides a grounding for the strips (10, 12 and 14) and inhibits undesirable radio frequency interaction between the radio (60) and the strips (10, 12 and 14).

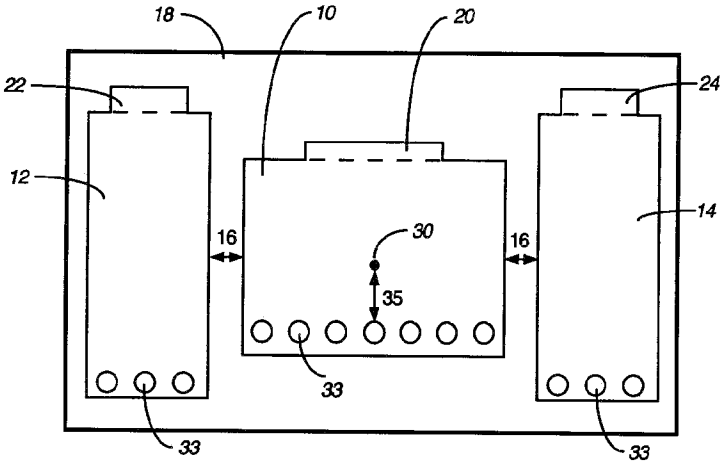


FIG. 1

EP 0 655 797 A1

FIELD OF THE INVENTION

This invention relates generally to antennas for receiving and transmitting UHF radio frequency signals ranging between 800 MHz and 3,000 MHz, and more particularly to such antennas for use in miniature portable devices.

BACKGROUND OF THE INVENTION

With the advent of new paging systems operating in the radio frequency range between substantially 800 MHz and 3,000 MHz, a new problem arises in designing a miniature antenna having the bandwidth necessary for such systems. Conventional pager antennas have a bandwidth limited to about 1% of the receive frequency. This does not provide for frequency hopping in the 902 to 928 MHz band. Furthermore, a single conventional loop antennas cannot both transmit in the 901 to 902 MHz band while receiving in the 929 to 932 or 940 to 941 MHz paging channels as is necessary for new ack-back paging systems.

Thus, what is needed is an antenna for use in a miniature paging device which has a wider bandwidth.

SUMMARY OF THE INVENTION

In accordance with the invention, a miniature radio device has an antenna which comprises a driven resonant strip and at least one parasitic strip.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a top view of an antenna in accordance with the preferred embodiment of the invention.

FIG. 2 shows a side view of the antenna in accordance with the preferred embodiment of the invention.

FIG. 3 shows a Smith chart representation of the input impedance resulting from experimental characterization of the antenna of the preferred embodiment.

FIG. 4 shows a plot of the standing wave ratio (SWR) resulting from experimental characterization of the antenna of the preferred embodiment.

FIG. 5 shows a top view of an alternate embodiment of the present invention.

FIG. 6 shows a cross sectional view of the alternate embodiment of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a top view of an antenna in accordance with the preferred embodiment of the invention. The antenna comprises a driven resonant strip, 10, a first parasitically excited strip, 12, and a second parasitically excited strip 14. Parasitically excited strips, 12 and 14, are separated from the resonant strip, 10, by a predetermined distance 16. The strips 10, 12 and 14 are affixed to a first surface of a low loss dielectric substrate 18.

FIG. 1 also shows three trim tabs, 20, 22 and 24, for adjusting a resonant frequency of each strip of the antenna, wherein a first of the three trim tabs, 20, is attached the resonant strip, 10, a second of said three trim tabs, 22, is attached to the first parasitically excited strip, 12, and a third of the three trim tabs, 24, is attached to the second parasitically excited strip, 14. A feed, 30, is coupled at a first end to the resonant strip, 10, and is for coupling the antenna to an electronic radio frequency device such as an ack-back pager. An ack-back pager is capable of receive and transmit functions and has both receiver and transmitter circuits. A multiplicity of ground posts, 33, electrically ground one end of the strips, 10, 12 and 14. The feed, 30 is, located a predetermined distance, 35, from its nearest ground post, 33. In the preferred embodiment seven ground posts, 33, are attached to the resonant strip, 10, three of ground posts, 33, are attached to the first parasitically excited strip, 12, and three ground posts, 33, are attached to the second parasitically excited strip, 14. In an alternate embodiment, only one ground post 33 per strip may be used.

FIG. 2 shows a side view of the antenna in accordance with the preferred embodiment of the invention. A ground plane, 40, is affixed to the second side of the substrate, 18. At a second end of the feed, 30, is attached to a RF connector, 50, for interfacing the antenna with a radio receiver circuit such as a receive only selective call receiver paging circuit or an ack-back transceiving paging circuit, 60. The circuit, 60, may be affixed to the ground plane, 40. The ground plane, 40, being substantially parallel and in close proximity to the strips, provides both a ground reference for the antenna strips 10, 12 and 14, and a radio frequency shield to prevent undesirable interference between the antenna and the circuit 60. The second end of each ground post, 33, is attached to the ground plane, 40.

In the preferred embodiment, the substrate, 18, has a length of substantially 84.8 mm, a width of substantially 55.9 mm and a thickness of substantially 3.2 mm and consists of a dielectric material such as FR4 (a flame retardant classification) or

other glass/epoxy material. The resonator strip, 10, has a length of substantially 35.6 mm, a width of substantially 45.0 mm, with the trim tab, 20, having a length of substantially 1.3 mm, a width of substantially 7.6 mm. The first parasitically excited strip, 12, has a length of substantially 40.8 mm, and a width of substantially 12.7 mm, with the respective trim tab, 22, having a length of substantially 1.3 mm, and a width of substantially 7.6 mm.

The second parasitically excited strip, 14, has a length of substantially 39.5 mm, and a width of substantially 12.7 mm, with the respective trim tab, 24, having a length of substantially 1.3 mm, and a width of substantially 7.6 mm. The strips, 10, 12 and 14, and the trim tabs, 20, 22 and 24 consisting substantially of copper. The strips, 10, 12 and 14, are centered about a common axis relative to each other. The distance, 18, between the strips is substantially 0.10 mm. The distance, 35, between the feed and its nearest ground post is substantially 17.8 mm. The ground posts are located substantially 2.4 mm from an edge of a strip and have a diameter of substantially 2.3 mm. The feed, 30, and resonator strip, 10, are centered about a common axis perpendicular to the ground posts, 33.

FIG. 3 shows a Smith chart representation of the input impedance resulting from experimental characterization of the antenna of the preferred embodiment. The Smith chart shows that the reflection coefficient does not exceed 0.33 over the frequency range between substantially 896 MHz and 956 MHz.

FIG. 4 shows a plot of the standing voltage wave ratio (SWR) resulting from experimental characterization of the antenna of the preferred embodiment. FIG. 4 shows that between 896 MHz and 956 MHz, the SWR is below 2:1. Thus, the useful bandwidth of the antenna is more than 60 MHz, or about 6.5% of the center frequency of operation.

Furthermore, the overall dimensions of the antenna, 84.8 mm x 55.9 mm x substantially 3.2 mm, make the antenna suitable for a miniature paging receiver implemented in a common credit card sized form factor.

In the preferred embodiment, the driven resonant strip, 10, has a quarter-wave resonant length at the center frequency of operation, which is preferably 916 MHz. The distance, 35, between the feed, 30, and its nearest ground post, 33, is set to provide a match to a nominally fifty ohm impedance with a standing wave ratio of 2:1 or less across the operating band. The two parasitically excited strips, 12 and 14, have quarter wave resonant lengths at the upper and lower frequencies of operation, which are preferably 901 and 930 MHz. The distances between the strips, 16, are set to cause capacitive coupling between the strips thereby producing the desired impedance bandwidth of the antenna. The trim tabs, 20, 22 and 24, allow the resonant frequency of each strip, 10, 12 and 14, to be individually adjusted by removing metalization from the respective strip.

Thus, the antenna provides for constructing a miniature pager operating on new paging systems operating in the radio frequency range between substantially 800 MHz and 3000 MHz. The antenna has a bandwidth of about 6.5% of the receive frequency. This provides for frequency hopping in the 902 to 928 MHz band, and can both transmit in the 901 to 902 MHz band and receive in the 929 to 932 or 940 to 941 MHz paging channels. In alternate embodiments, the dimensions of the antenna of FIG. 1 may be scaled in proportion to provide operation at other frequencies, including the frequencies in the 800 MHz to 3,000 MHz range.

Thus, what is provided is an antenna for use in a miniature paging device which has a bandwidth than the bandwidth provided by conventional miniature antenna structures.

FIG. 5 shows a top view of an alternate embodiment of the present invention. FIG. 6 shows a cross sectional view of the embodiment of FIG. 5. There is one driven resonant strip, 110, and one parasitically excited resonant strip, 112, each having trim tabs 120 and 122. In this embodiment, the bandwidth is determined by the resonant frequency of the two strips 110 and 112. Since ground posts 133 are in the middle of each strip, the strips are half wave resonant rather than quarter wave resonant as shown in the antenna of FIG. 1. Feed 130 is placed similar to the method of placing feed 30 to obtain a desired impedance match to the antenna. Substrate 118 and ground plane 140 perform similar functions to 18 and 40 respectively. Also, a paging receiver or transceiver circuit may be attached to ground plane 140. It should be appreciated that similar half wave resonant lengths could be implemented with strips 10, 12, and 14 of FIG. 1.

Insulator substrate 150 and plate 160 form an alternate means for coupling strip 110 to strip 120. In stead of relying only on the separation 16 between the strips of FIG. 1, where the coupling is primarily due to fringe fields coupling between the strips, since a portion of plate 160 is overlapping and parallel to strip 110 and another portion of plate 160 is overlapping and parallel to strip 120, plate 160 directly couples strip 120 to strip 110. This results in a substantially improved electrical coupling mechanism between the strips. It should be appreciated that similar coupling could be implemented between strips 10, 12, and 14 of FIG. 1.

Claims

1. In a miniature radio device capable of receiving signals in a first frequency band, transmitting signals in a second frequency band, an antenna comprising:

   a substrate having a first planar surface and a second planar surface;

   a ground plane affixed to the second planar surface of the substrate;

   a driven resonant strip affixed to the first planar surface;

   at least a first parasitic strip affixed to the first planar surface and spaced a predetermined distance from the driven resonant strip;

   the predetermined distance being such that the first parasitic strip is capacitively coupled to the driven resonant strip to such a degree that the bandwidth of the antenna for transmission and reception encompasses the first and second frequency bands.

2. The antenna of claim 1, and further comprising:

   a second parasitic strip affixed to said first planar surface and spaced from the driven resonant strip by said predetermined distance;

   the predetermined distance separating the driven resonant strip and both parasitic strips being such that the first and second parasitic strips are capacitively coupled to the driven resonant strip to such a degree that the bandwidth of the antenna for transmission and reception encompasses the first and second frequency bands.

3. The antenna of claim 2, wherein the first and second parasitic strips have quarter wave resonant lengths at upper and lower frequencies of operation of the antenna.

4. The antenna according to claim 1 wherein said driven resonant strip and said first parasitic strip are quarter wave resonant.

5. The antenna according to claim 1 wherein said driven resonant strip and said first parasitic strip are half wave resonant.

6. The antenna according to claim 1 further comprising:

   a plurality of trim tabs for adjusting a resonant frequency of the antenna, wherein

   a first of said plurality trim tabs is attached to said driven resonant strip, and

   a second of said plurality of trim tabs is attached to said first parasitic strip.

7. The antenna according to claim 6 wherein

   said driven resonant strip is substantially rectangular and has a first side, and

   said first parasitic resonant strip is adjacent to the first side and spaced from the first side by the predetermined distance.

8. The antenna according to claim 7 further comprising:

   a plate for coupling said driven resonant strip to said first parasitic strip, said plate overlapping and parallel to both said driven resonant strip and said first parasitic strip; and

   an insulator substrate interposed between said plate and said driven resonant strip and said first parasitic strip.

9. The antenna according to claim 1 wherein said driven resonant strip and said first parasitic strip are substantially rectangular and have a first end adjacent to a first edge of said substrate, the antenna further comprising:

   a grounding means for electrically coupling the first end of each of said driven resonant strip and said first resonant strip to said ground screen.

10. The antenna according to claim 9 further comprising

    a feed coupled at a first end to said driven resonant strip and having a second end for coupling to a radio receiver circuit affixed to said ground screen.

11. The device according to claim 1 further comprising:

    a radio receiver circuit coupled to the antenna for receiving radio frequency signals received by the antenna.

12. The device according to claim 11 wherein said radio receiver circuit is a selective call receiver.

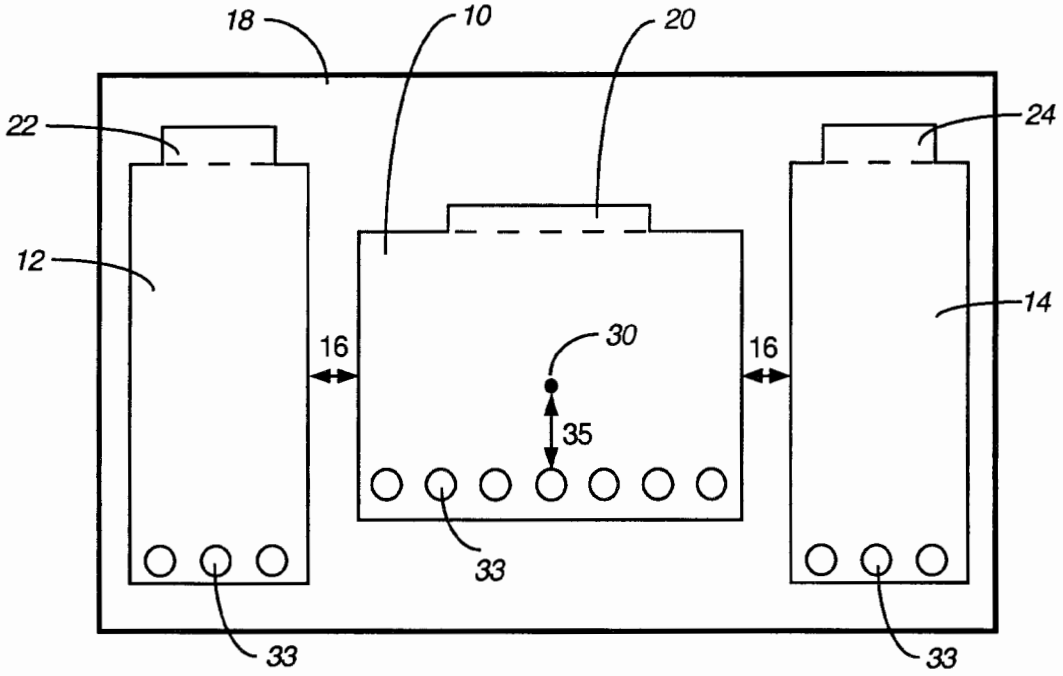

18
10
20
22
24
12
14
16
16
30
35
33
33
33

FIG. 1

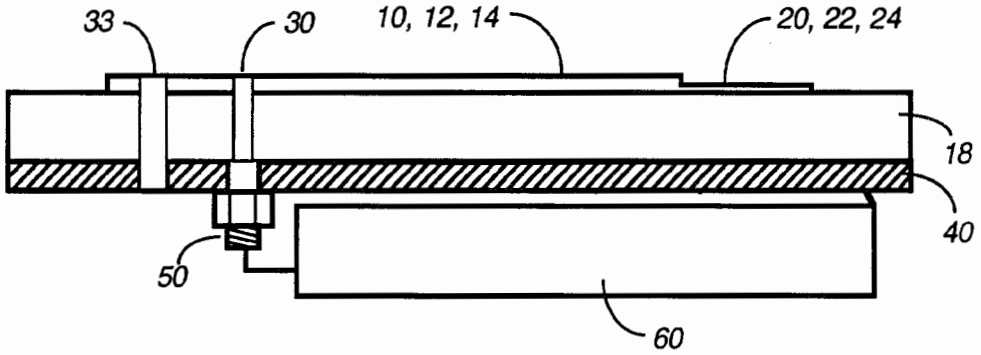

33
30
10, 12, 14
20, 22, 24
18
40
50
60

FIG. 2

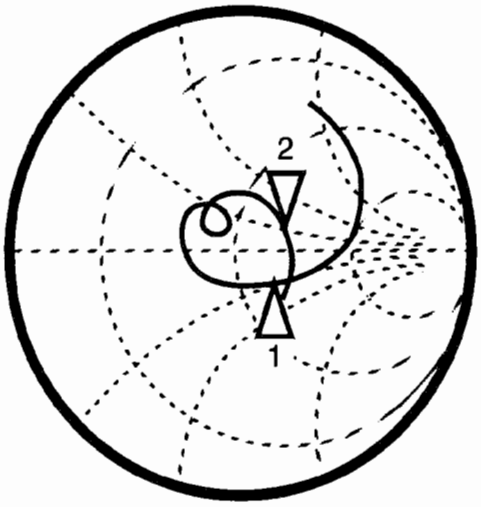


FIG. 3

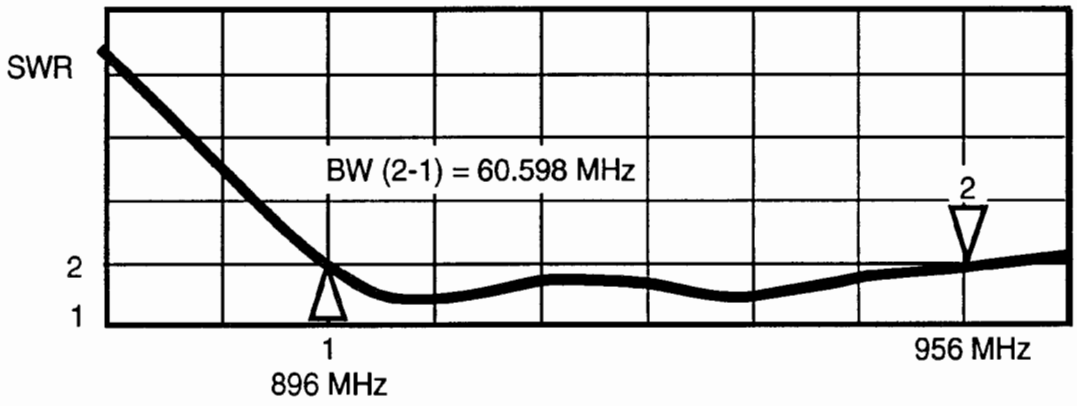


FIG. 4

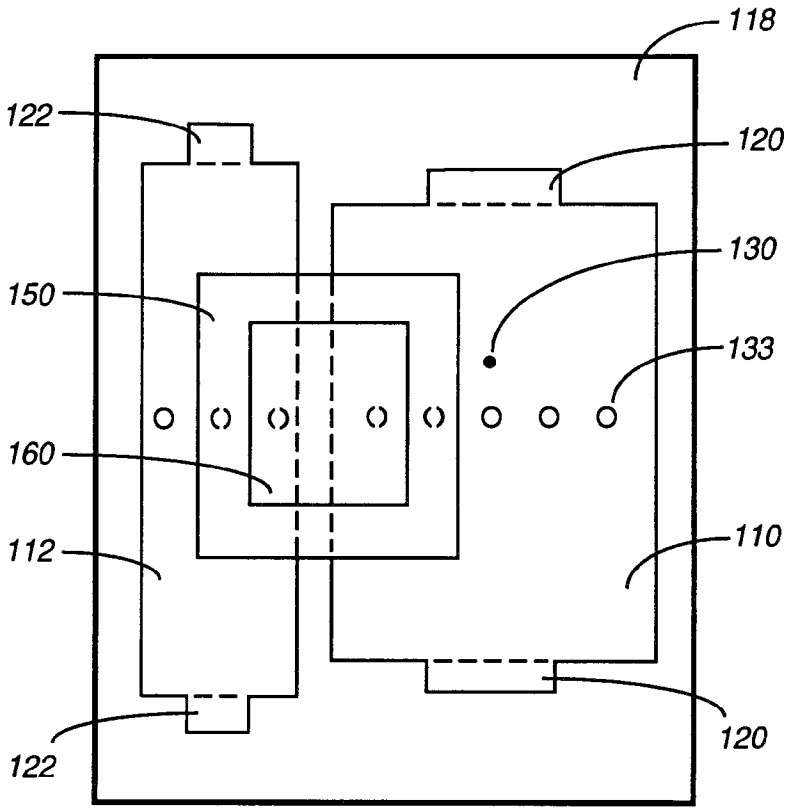

118
122
120
130
150
133
160
110
112
120
122

FIG. 5

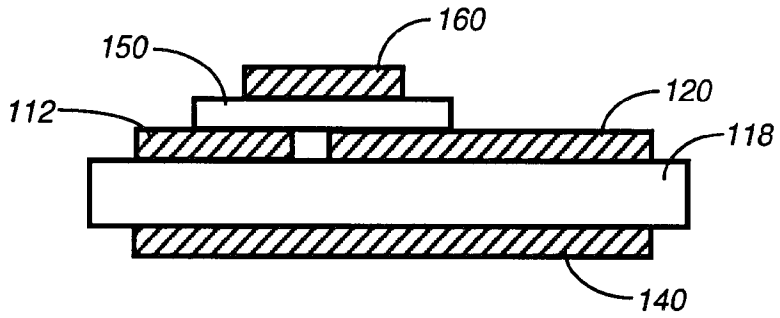

160
150
120
112
118
140

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 7751

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	GB-A-2 067 842 (THE SECRETARY OF STATE FOR DEFENCE)	1	H01Q19/00 H01Q1/24
A	* abstract * * page 2, line 79 - page 2, line 29; figures 1-5 *	2-12	
Y	EP-A-0 516 485 (NEC) * abstract; claims 1,8; figures 1-6 *	1	
A	EP-A-0 361 417 (HUGHES AIRCRAFT) * column 11, line 6 - column 15, line 17; figures 8-10 *	1-12	
A	WO-A-91 12637 (BRITISH TELECOMMUNICATIONS) * page 2 - page 3; figures 1,2 * * page 8, paragraph 3 *	1-12	
A	US-A-4 940 963 (GUTMAN ET AL.) * column 3, line 29 - column 4, line 25; figures 1-4 *	1,11,12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	IEICE TRANSACTIONS, vol. e74, no.10, October 1991 TOKYO JP, pages 3241-3245, XP 000279305 EBINET ET AL. 'A Wide Beamwidth and Broad Bandwidth Microstrio Antenna with a Pair of Short Circuit Patches' * page 3241 - page 3242; figures 1,4 *	1,8	H01Q
A	EP-A-0 525 726 (MURATA) * abstract; figures 1-13 *	1,6	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 March 1995	Angrabeit, F

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

EPO FORM 1503 03.82 (P04C01)

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **01-231404**
(43)Date of publication of application : **14.09.1989**

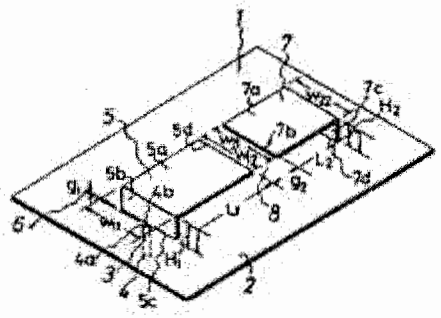
(51)Int.Cl. H01Q 13/08
H01Q 1/32
H01Q 9/30

(21)Application number : **63-057206**
(22)Date of filing : **10.03.1988**

(71)Applicant : **TOYOTA CENTRAL RES & DEV LAB INC**
(72)Inventor : **NISHIKAWA KUNITOSHI**
FUJIMOTO YOSHITOSHI

(54) ANTENNA FOR MOBILE BODY

(57)Abstract:
PURPOSE: To provide a broad and stable resonance matching band and to attain the transmission reception with a high degree of freedom by opposing an open end of a radiation guide plate to an open end of an added conductor plate and using a current induced in the added conductor plate so as to adjust the impedance of the radiation conductor plate and to form a dual resonance band.
CONSTITUTION: The open end 5d of the radiation conductor plate 5 on a ground conductor plate 2 and the open end 7b of the added conductor plate 7 are opposed to each other with a prescribed gap 8. Thus, the impedance of the radiation conductor plate 5 is adjusted by a current induced in the added conductor plate 7 to widen the frequency band. Moreover, a prescribed gap 6 is provided between the lower end 5c of the radiation conductor 5 connecting to a feeder 4 and a flat face of the grounded conductor plate 2. Thus, the resonance matching band is widened by adjusting the said gap. Thus, a stable and wide resonance matching band is provided to attain transmission reception with a high degree of freedom.



⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平1−231404

⑤Int.Cl.⁴	識別記号	庁内整理番号	㊸公開　平成1年(1989)9月14日
H 01 Q 13/08		7741−5J	
1/32		Z−6658−5J	
9/30		7210−5J	審査請求　未請求　請求項の数 2　(全6頁)

㊹発明の名称　移動体用アンテナ

㉑特　願　昭63−57206
㉒出　願　昭63(1988)3月10日

㉒発明者　西川　訓利　愛知県愛知郡長久手町大字長湫字横道41番地の1　株式会社豊田中央研究所内
㉒発明者　藤元　美俊　愛知県愛知郡長久手町大字長湫字横道41番地の1　株式会社豊田中央研究所内
㉑出願人　株式会社豊田中央研究所　愛知県愛知郡長久手町大字長湫字横道41番地の1
㉔代理人　弁理士　高橋　克彦　外1名

明　細　書

1．発明の名称

移動体用アンテナ

2．特許請求の範囲

(1)　平坦面を有する接地導体板と、

該接地導体板に外導体を接続し、中心導体を非接続とした給電用の同軸線と、

L字形状とした導体板の一面を前記接地導体板に平行にし、他面を垂直とするとともに該他面の下端部と前記接地導体板の平坦面との間に一定の狭い間隙を形成して、前記端部のほぼ中央には前記同軸線の中心導体を接続してなる放射導体板と、

前記接地導体板上で、前記放射導体板に近接する位置に、L字形状とした導体板の一面を前記接地導体板に平行とし、該一面の端部を前記放射導体板の一面の端部と一定間隙をおいて相対向させるとともに、前記接地導体板に垂直な他面の端部は前記接地導体板に接続してなる広帯域性を生じさせる付加導体板と、

よりなることを特徴とする移動体用アンテナ。

(2)　前記放射導体板および前記付加導体板と前記接地導体板との間に介挿された高周波特性のよい誘電体材料を具備することを特徴とする請求項(1)記載の移動体用アンテナ。

3．発明の詳細な説明

本発明は移動体に装着するアンテナに関するものである。

〔従来技術〕

通信技術の発達によって、有線のみならず無線による通信が行われ、その需要も急激に増してきた。

同時送受信を行う移動無線通信ではアンテナの有する周波数帯域(共振整合帯)内で、送信用および受信用とそれぞれ異なる周波数を用いて送受信を行う。

しかして、無線通信用アンテナの性能を評価する条件の一つに送受信を行う二つの周波数の送受

信電波が干渉しないように十分離した状態に設定できること、さらにこの二つの周波数帯を含む共振整合帯が十分に広い帯域を有することである。

従来移動体に装着する無線通信用アンテナは一辺が接地導体板に接続した逆L字状の放射導体板と、整合をとるために折り曲げた位置から若干離れた点で給電（オフセット給電）する第6図に示す板状逆Fアンテナがよく使用される。

ところで、該アンテナは共振整合帯が数%程度と非常に狭いのである。よって該アンテナは外部の要因により、共振整合帯がシフトすると、設定した送受信用の周波数帯が、該共振整合帯から外れてしまうことになり、しかして送受信が不通となることがしばしばあった。

従来でも上記欠点を改善すべく工夫がなされ、その例としては、アンテナの放射導体板だけでなく共振周波数が僅かに異なった無給電の付加導体板を2段に積み上げたもの（第7図）、また付加導体板を放射導体板に並列に並べたもの（第8図）がある。これは各導体板によって生じる共振整合帯を重ねならべ合わせることにより、より広い共振整合帯をもたせ送受信用の周波数帯が外部要因によって共振整合帯から外れないようにしたものである。

さらに、該アンテナの給電線にインピーダンス補償素子を付加してアンテナの共振整合帯を広くもたせて、給電線とのインピーダンス整合をはかり、前述した効果を得るようにしたもの（第9図）がある。

しかしながら、上述したいずれのアンテナも給電線とのインピーダンス整合をとるための共振整合帯を広くとれるように設計することが非常に難しい。その上できたアンテナの共振整合帯は反射減衰量が所定の電圧定在波比（VRWR＜2.0）を満足する－10dB以下となる範囲が7～9%と期待するほど余り大きくはとれなかった（第10図）。このように従来のアンテナは共振整合帯を充分広くとることができる自由度のある改善手段ではなかったのである。

特に、本発明が課題とした自動車用の同時送受話方式の移動通信方式では、搭載するアンテナの装着位置の周囲には、該アンテナに悪影響を及ぼす要因が数多く存在する。このような条件下でも安定した送受信ができる自由度のある広い共振整合帯を有する無線用アンテナが要望されていた。

〔発明が解決しようとする問題点〕

本発明は上述の従来の課題に鑑みなされたものであり、その目的は、放射導体板と付加導体板とにより生じた複共振帯を利用して、広い安定した共振整合帯を持たせて、自由度のある送受信ができるようにすること、さらにその構造が車載用として適用できる小型であって、その上容易に製作できる移動体用アンテナを提供することにある。

〔発明の説明〕

（構成）

前記目的を達成するために本願発明の移動体用アンテナは、平坦面を有する接地導体板と、該接地導体板に外導体を接続し、中心導体を非接続した給電用の同軸線と、L字形状とした導体板の一面を前記接地導体板に平行にし、他面を垂直にするとともに該他面の下端部と前記接地導体板の平坦面との間に一定の狭い間隙を形成して、前記端部のほぼ中央には前記同軸線の中心導体を接続してなる放射導体板と、前記接地導体板上で、前記放射導体板に近接する位置に、L字形状とした導体板の一面を前記接地導体板に平行とし、該一面の端部を前記放射導体板の一面の端部と一定間隙をおいて相対向させるとともに、前記接地導体板に垂直な他面の端部は前記接地導体板に接続してなる広帯域性を生じさせる付加導体板と、よりなることを特徴とする。

上記構成において、接地導体板上で、放射導体板の開放端と、付加導体板の開放端とを一定の間隙をおいて相対向させて設定した。これは付加導体板に誘起する電流で放射導体板のインピーダンスが調整できることを利用して共振状態（インピーダンスの虚数部が零のとき）での該アンテナのインピーダンスの実数部が周波数変化に対して給電線のインピーダンス（通常50Ω）と同一又はこれに極めて近い値で維持できる周波数帯域を極

めて広く取れるようにしたものである。

さらに、本発明の移動体用アンテナにおいて、給電線に接続する放射導体板の下端部と接地導体板の平坦面との間に一定の間隙を設けた。これは、この間隙により生じるキャパシタンスが該アンテナの有するインピーダンス成分の虚数部にあたるリアクタンス成分を打ち消す役目を果たさせるためである。この間隙の調整によりインピーダンスの虚数部を広い周波数帯域でほぼ零又はこれに近い状態（共振）に維持することができた。

けだし、上記発明の移動体用アンテナを上記構成にしたときの周波数に対する該アンテナ給電端インピーダンスの実数部と虚数部との関係を第2図に示す。図より給電線のインピーダンス（50Ω）と整合がとれる周波数帯（共振整合帯）が十分に広くとれていることがわかる。

（作用）

本発明の移動体用アンテナは、放射導体板の開放端と付加導体板の開放端とを相対向させ、該付加導体板に誘起される電流で該放射導体板のインピーダンスを調整し、複共振帯を形成したことにより、異なった周波数帯を有する送受信帯が十分に包括できる自由度のある広い周波数帯域（共振整合帯域）にすることができた。したがって、アンテナが外部の影響を受けて共振整合帯がずれても十分に送受信ができる。

すなわち送信する場合、送信信号を同軸線を介して給電点に発生した電圧により、放射導体板および付加導体板に共振電流が流れ、そして電波が空間に放射される。一方受信する場合、外部より所定の電波が到達すると、放射導体板および付加導体板に共振電流が流れ、電圧が給電点に発生することにより送受信が可能になるのである。

（効果）

しかして、本発明の移動体用アンテナは給電線のインピーダンスと整合できる周波数帯域幅を30％以上と広い範囲にすることができた。

しかも、本発明の移動体用アンテナの構造は、非常に簡単であって、寸法、形状を変えることにより所望の周波数帯域での整合を容易に実現することができた。

しかして、本発明の移動体用アンテナの用途は広く、特に自動車等の移動体に装着する送受信用無線アンテナとしては最適のものである。

〔他の発明の説明〕

請求項(2)記載の移動体用アンテナは該アンテナ自体を小型化することを目的とした。すなわち、放射導体板および付加導体板と接地導体板との間に介挿された高周波特性のよい誘電体材料を具備することを特徴とする。

放射導体板および付加導体板と接地導体板との間に高周波特性のよい誘電体材料を用いた。該アンテナに挿入する誘電体材料の比誘電率をε_rとするとアンテナ上での波長短縮率は約$\frac{1}{\sqrt{\varepsilon_r}}$となる。このことから、誘電体材料の比誘電率の大きい材料を用いるとアンテナの共振寸法を短くすることができる。

本発明では誘電体材料としてエポキシ樹脂、テフロン、ガラス等の比誘電率の大きい材料を選んで用いた。

〔実施例〕

次に本発明の好適な実施例を図面に基づき説明する。

実施例1の移動体用アンテナ1は、自動車に装着され基地局との無線通信の際、電波を送受するもので、その態様を第1図に示す。

該アンテナは平坦な導体で形成された接地導体板2と該接地導体板2の一部に穴3を開け、該穴3には給電用同軸線4の外導体4aを接続する。中心導体4bは非接続とする。

該接地導体板2上には、送受信用の放射導体板5を置く。該放射導体板5はL字形状で該導体板5の一面5aを前記接地導体板3に平行とする。そして垂直となる他面5bの端部5cは前記接地導体板2から一定の狭い間隙6をおき、該他面の端部5cのほぼ中央部には前記給電用同軸線4の中心導体4bと接続する。

さらに、広帯域性を生じさせる付加導体板7は、前記放射導体板5の近接する位置で、L字形状と

した導体板の一面7aを前記接地導体板2に平行とするとともに、該一面の端部7bを前記放射導体板5の一面の端部5bと一定間隙8を保って相対向させて置く。そして該導体板7の垂直な他面7cの端部7dは前記接地導体板2に接続した。

前記放射導体板5の同軸線4の給電点端4bから面端5dまでの長さL_1は使用波長のλ／4より若干長くし、また前記付加導体板7の長さL_2は使用波長のλ／4より若干短く設定する。

車載用実用移動体アンテナとして1GHz帯域用に設定したものの寸法は以下の通りである。

放射導体板の長さL_1＝70㎜、幅$W_{11}=W_{12}$＝50㎜、縦H_1＝20㎜、接地導体板と放射導体板との間隙g_1＝1㎜、

付加導体板の長さL_2＝45㎜、幅$W_{21}=W_{22}$＝50㎜、縦H_2＝20㎜、接地導体板と放射導体板との間隙g_2＝22㎜。

上記寸法を有する移動体用アンテナの周波数特性を第3図に示す。

第3図より上記実施例1では比帯域が20％を越えることを示している。ちなみに、放射導体板の縦H_1および付加導体板の縦H_2をそれぞれ30㎜程度まで高くすると比帯域は40％まで改善することができた。

実施例2の移動体用アンテナは放射導体板の幅W_{11}、W_{12}および付加導体板の幅W_{21}、W_{22}を調整することによりさらに広帯域幅が得られるものを実現した。

上記実施例2のその寸法は以下の通りである。

放射導体板の一方の幅W_{11}＝50㎜、他方の幅W_{12}＝20㎜、付加導体板と放射導体板との間隙g_2＝12㎜、他の寸法は放射導体および付加導体とも前記実施例1と同じである。

上記の寸法を有する移動体用アンナテの周波数特性を第4図に示す。

第4図より上記実施例2の比帯域は30％以上にもなることを示す。

してみると、上記実施例1、2から、該アンテナの寸法、形状を変えることにより、自由度のある広い周波数帯域幅（共振整合帯幅）のあるものが種々得ることができる。

実施例3の移動体用アンテナ1は、前記実施例1、2に比べ移動体に載置用として、さらに小型で機械強度的にも十分に耐えることができるようにしたもので、その態様を第5図に示した。

接地導体板2上の放射導体板5および付加導体板7と接地導体板2との間に高周波特性のよいテフロン9を挿入した。この場合、該テフロン9は比誘電率が$\varepsilon_r=2.6$である。これにより該アンテナの全体の大きさを20％程度短縮することができた。しかも、誘電体材料を挿入したことにより移動体からの振動に対しても十分に耐えることができるものとなった。

4．図面の簡単な説明

第1図は本発明の実施例を示す概要図、第2図は周波数に対するアンテナ給電端インピーダンスの実数部及び虚数部の変化を示す線図、第3図は実施例1の周波数に対する反射減衰量を示す線図、第4図は実施例2の周波数に対する反射減衰量を示す線図、第5図は実施例3の概要図、第6図、第7図、第8図、第9図は従来のアンテナを示した概要図、第10図は従来アンテナの周波数に対する反射減衰量を示す線図である。

1･･･移動体用アンテナ、2･･･接地導体板、3･･･穴、4･･･同軸線、5･･･放射導体板、6･･･間隙、7･･･付加導体板、8･･･間隙、9･･･テフロン

特許出願人

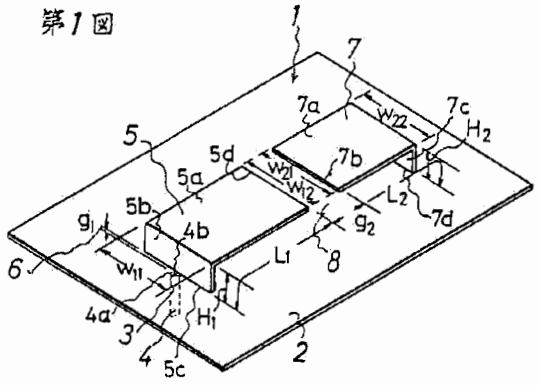
株式会社豊田中央研究所

代理人

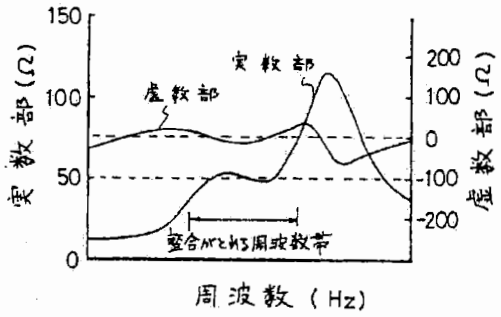
弁理士　高橋克彦

（外1名）

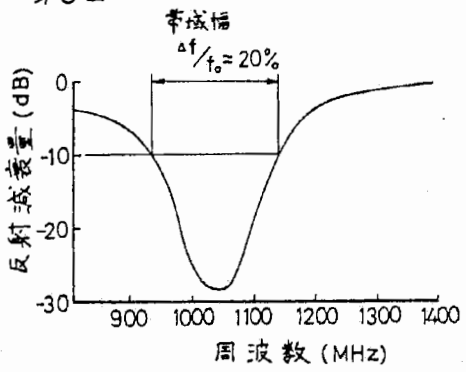
第1図



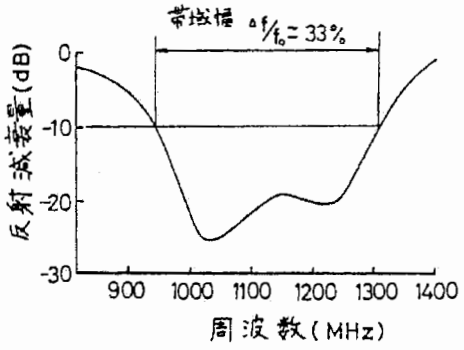
第2図



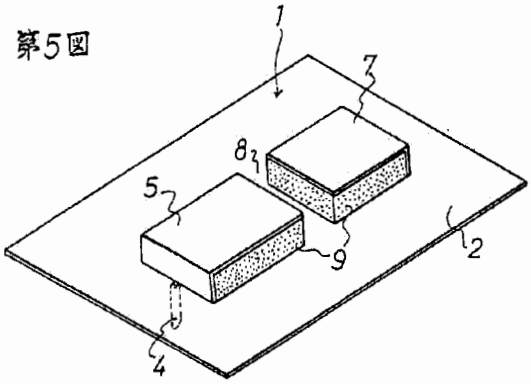
第3図



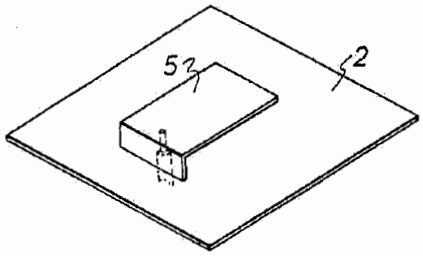
第4図



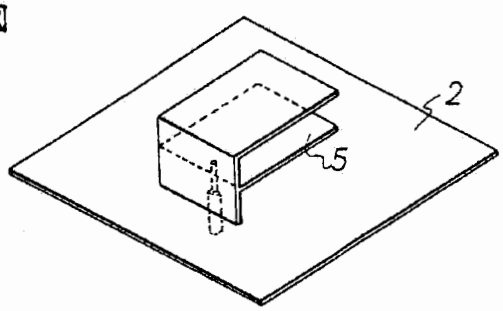
第5図



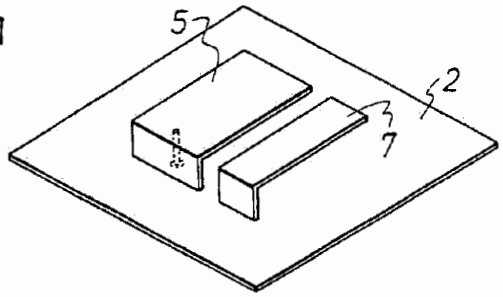
第6図



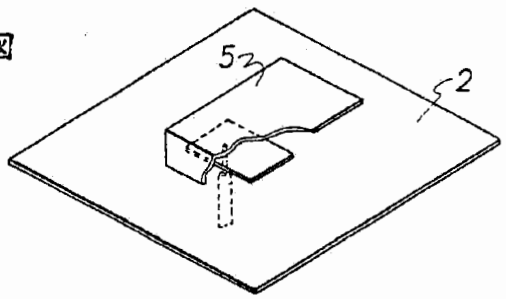
第7図



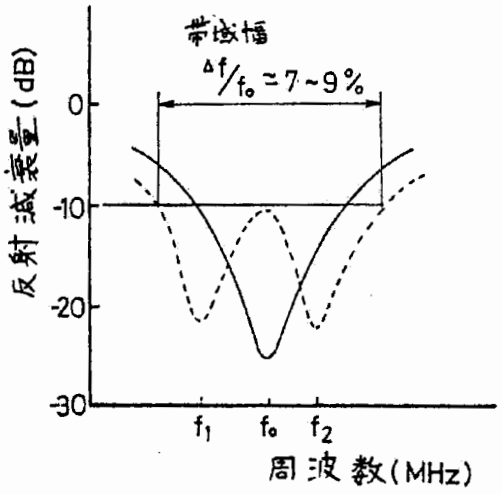
第8図



第9図



第10図



Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson/Brenda Brown
Attorney Docket Number:	47005-P015WUSC1

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:	11716620
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson/Brenda Brown
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	28-DEC-2011
Filing Date:	05-DEC-2007
Time Stamp:	11:34:03
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	7291
Deposit Account	232426
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	LI.pdf	2584855 6a9ae69829f167a2e0fd00a91c861dc378be6435	no	2
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IDSStatementByApplicant47005P015WUSC1.pdf	238462 be00638f04840e4051012d3ce34ba7e62764caae	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Transmittal Letter	IDS47005P015WUSC1.pdf	211603 d829ba2d59408d7d07c7045391e7e8215ab0b803	no	2
Warnings:					
Information:					
4	Non Patent Literature	RISCO.pdf	4415531 79d173a9cae910e36eef51126450ddddc060e342	no	29
Warnings:					
Information:					
5	Foreign Reference	EP0655797.pdf	4689502 0f7ac27524711df4b72eb95c172d069c23b9c6d9	no	8
Warnings:					
Information:					
6	Foreign Reference	JP1231404.pdf	975259 79f1f4c38b7349e9d23e1f33285739e281611567	no	7
Warnings:					
Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	30366 502d34f49ea48785d78edd9aeb0ce59999327e88	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	13145578		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 23, 2011
Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Docket No. 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No. 11/950,835 | Confirmation No. 7241

Filed: December 5, 2007 | Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS | Examiner: R. Karacsony

AMENDMENT IN RESPONSE TO NON-FINAL OFFICE ACTION

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

Dear Sir:

INTRODUCTORY COMMENTS

In response to the Office Action dated June 28, 2011, please amend the above-identified U.S. patent application as follows:

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

Remarks/Arguments begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

1-19. (CANCEL)

20. (CURRENTLY AMENDED) A handheld terminal comprising:

at least one printed circuit board comprising a ground plane;

an antenna element ~~capable of simultaneous operation at multiple frequency bands, the antenna element~~ comprising:

a first radiating arm comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point; and

a second radiating arm not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane;

a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane;

wherein the first radiating arm and the second radiating arm are coupled through a close proximity region from a specific region of the first radiating arm and from a specific region of the second radiating arm;

wherein the first radiating arm comprises a substantially planar structure;

wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;

wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end;

wherein the line segment does not intersect a projection orthogonal to the ground plane; and

wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands.

21. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cell phone.

22. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a clamshell body.

23. (PREVIOUSLY PRESENTED) The handheld terminal of claim 22, wherein:
the clamshell body comprises:

a first body portion;

a second body portion; and

a hinge interposed between the first body portion and the second body portion; and

the first radiating arm and the second radiating arm are mounted adjacent to the hinge.

24. (PREVIOUSLY PRESENTED) The handheld terminal of claim 23, wherein:

the feeding port is located on a first side of the hinge;

the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge;

the second side is opposite the first side.

25. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a candybar body.

26. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm are substantially coplanar.

27. (PREVIOUSLY PRESENTED) The handheld terminal of claim 25, wherein the line segment is coplanar with the ground plane.

28. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength.

29. (PREVIOUSLY PRESENTED) The handheld terminal of claim 26, wherein the first radiating arm and the second radiating arm are coplanar with the ground plane.

30. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane.

31. (PREVIOUSLY PRESENTED) The handheld terminal of claim 30, wherein the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane.

32. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane.

33. (PREVIOUSLY PRESENTED) The handheld terminal of claim 32, wherein the second-radiating-arm second end is coupled to the ground plane on a second corner of the ground plane.

34. (PREVIOUSLY PRESENTED) The handheld terminal of claim 33, wherein:

the ground plane is substantially rectangular; and

the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane.

35. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a personal digital assistant.

36. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cordless telephone.

37. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a pager.

38. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises an electronic gaming device.

39. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a remote control device.

40. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein:

the handheld terminal is operative at multiple frequency bands; and

at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) or Universal Mobile Telecommunications System (UMTS) communication service.

41. (PREVIOUSLY PRESENTED) The handheld terminal of claim 40, wherein:

the handheld terminal is operative at multiple frequency bands;

a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service.

42. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at four frequency bands.

43. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at five frequency bands.

44. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS), GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS1900), and Digital Cellular System (DCS).

45. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

46. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

47. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a monopole.

48. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein each of the first radiating arm and the second radiating arm comprises a monopole.

49. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises an IFA structure.

50. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein the monopole comprises an IFA structure.

51. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein:

one of the first radiating arm and the second radiating arm comprises a monopole; and

the other of the first radiating arm and the second radiating arm comprises a microstrip structure.

52. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a microstrip structure.

53. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein each of the first radiating arm and the second radiating arm comprises a microstrip structure.

54. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein the microstrip structure comprises a PIFA structure.

55. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

REMARKS

Petition for Extension of Time

Applicant petitions for a three-month extension of time and authorizes the Office to debit the required fee from Deposit Account 23-2426.

Reconsideration of the application is respectfully requested. Claims 20-55 are pending. Claim 21 has been amended. No claims have been added. No claims have been canceled. Applicant respectfully submits that no new matter has been added by the amendments presented herein.

Claims 20-25, 27, 30-34, and 40-55 stand rejected under 35 U.S.C. 102 as being anticipated by U.S. Patent No. 6,765,536 to Phillips ("Phillips"). Claims 26, 28-29, and 35-39 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Phillips.

Independent claim 20 has been amended such that it recites, among other things, the following features: 1) *wherein the first radiating arm and the second radiating arm are coupled through a close proximity region from a specific region of the first radiating arm and from a specific region of the second radiating arm*; and 2) *wherein the first radiating arm, the second radiating arm and the close proximity region are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands*. Applicant respectfully submits that even if it is assumed, for the sake of argument, that a first radiating arm, a second radiating arm, and a close proximity region as in claim 20 are disclosed in Phillips, no such elements are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands as required by claim 20.

Amended claim 20 recites components that are configured to simultaneously tune the antenna element at a plurality of operating frequencies in multiple frequency bands and that the first radiating element, the second radiating element, and the close proximity region are configured for such tuning. In contrast, in Phillips, increased bandwidth to cover different frequency bands is accomplished by coupling an electrically-driven antenna element with an

active, variably tuned, parasitic element.[1] Phillips utilizes at least one conductor, in close proximity to a transmitting and/or receiving directly connected (driven) antenna, to electromagnetically couple a tunable load to perturb the antenna's resonant frequency. In particular, a parasitic element (12) is coupled to a tuning circuit (20), where the function of the tuning circuit (20) is to provide a variable load to be mutually coupled to a driven antenna element (10) through the parasitic element (12).[2]

The tuning circuit (20) connected to the parasitic element (12) utilizes an RF switching device to enable a variety of capacitive or inductive tuning components to be selected or combined in order to adjust the reactive load on the parasitic element (12).[3] The tuning circuit (20) includes a plurality of switches[4] to synthesize different tuning loads. By selectively turning these switches ON and OFF, different tuning states are defined to tune the antenna to different frequencies.[5] According to Phillips, this arrangement permits more tuning states, more frequency bands, or broader bandwidth to be achieved.[6]

In Phillips, the tuning circuit (20) is variable to adjust a parasitic load on an antenna element to provide variable operating frequencies and bandwidths for the communication device. That being said, the antennas disclosed in Phillips do not anticipate or render obvious claim 20 at least because Phillips fails to teach or suggest a first radiating arm, a second radiating arm, and a close proximity region that are configured to simultaneously tune an antenna element at a plurality of operating frequencies in multiple frequency bands as claimed in amended claim 20. In contrast, in Phillips, tuning is performed by the tuning circuit (20) that includes a plurality of switches. Any tuning so performed is not accomplished simultaneously as required by claim 20.

For at least the reasons set forth above, amended claim 20 distinguishes over Phillips. Withdrawal of the rejection thereof is respectfully requested.

---

[1] *See* Phillips, col. 2, lns. 15–28, 34–36.
[2] *See* Phillips, Fig. 2, col. 4, lns. 15–21.
[3] *See* Phillips, Fig. 2, col. 4, lns. 33–37.
[4] *See*, *e.g.*, Phillips' PIN diodes, Fig. 3.
[5] *See* Phillips col. 4, lns. 51–60.
[6] *Id.*

Each of the remaining pending claims depends either directly or indirectly from independent claim 20. As such, each is also deemed to distinguish over Phillips. Withdrawal of the rejections thereof is respectfully requested.

In view of the above, Applicant respectfully submits that the present application is in condition for allowance. A Notice to that effect is respectfully requested.

Dated: December 23, 2011

Respectfully submitted,

Electronic signature: /Ross T. Robinson/
Ross T. Robinson
Registration No.: 47,031
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1

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:				
Extension - 3 months with $0 paid	1253	1	1270	1270

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**1270**

Electronic Acknowledgement Receipt

EFS ID:	11698174
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	23-DEC-2011
Filing Date:	05-DEC-2007
Time Stamp:	10:06:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1270
RAM confirmation Number	11335
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	amendment.pdf	43095 2d51382ccf4bf7b4164384fb2d7603fd0f267cf8	no	10
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30467 d44dcbf9e9d704cc130efd3a6f20f57f17d5e0be	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	73562		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT	12/23/2011	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $ =		OR	X $60=	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $250=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/WANDA BARNES/

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 12/21/2011

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	**PAPER NUMBER**
2821	

MAIL DATE	DELIVERY MODE
12/21/2011	PAPER

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

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

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

All participants (applicant, applicant's representative, PTO personnel):

(1) *ROBERT KARACSONY*. (3)_____.

(2) *Ross T. Robinson*. (4)_____.

Date of Interview: *16 December 2011*.

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: *20*.

Identification of prior art discussed: *N/A*.

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 the Examiner's position on the limitation "capable of simultaneous operation at multiple frequency bands".

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

/Robert Karacsony/ Examiner, Art Unit 2821	

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 Examiners 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.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	11/950,835	BALIARDA ET AL.	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 4/4/11	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
Janice Ford

U.S. Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 06/28/2011

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	**PAPER NUMBER**
2821	

MAIL DATE	DELIVERY MODE
06/28/2011	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

-- 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 *04 April 2011*.

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

3)☐ 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

4)☒ Claim(s) *20-55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20-55* is/are rejected.

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

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

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

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

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

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *04/18/2011*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

The following Office Action is in response to the Request for Reconsideration received April 04, 2011. Claims 20-55 are currently pending.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on April 04, 2011 has been entered.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on April 18, 2011 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 102

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

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 20-25, 27, 30-34, and 40-55 are rejected under 35 U.S.C. 102(e) as being anticipated by *Phillips et al.* (US 6,765,536, hereinafter *Phillips*).

Claim 20: *Phillips* teaches a handheld terminal comprising: at least one printed circuit board (14, fig. 1) comprising a ground plane (col. 3, lines 53-58); an antenna element capable of (The Examiner notes that the limitation "capable of" does not require that the antenna element be "configured for," "adapted for" or "operable for" simultaneous operation. Therefore, the Examiner broadly interprets the antenna element of *Phillips* as "capable of" simultaneous operation.) simultaneous operation at multiple frequency bands, the antenna element comprising: a first radiating arm (10, fig. 1) comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point (point that connects to transceiver, see fig. 2); a second radiating arm (12, fig. 1) not in ohmic contact (col. 3, lines 45-47) with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane (end that couples to ground via tuning circuit 20, see fig. 2); a feeding port (transceiver, see fig. 2) defined between the feeding point of the first radiating arm and at least one point on the ground plane; wherein the first radiating arm comprises a substantially planar structure (col. 8, lines 59-62); wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board (col. 3, lines 53-54); wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second- radiating-arm second end (fig. 1); wherein the line segment does not intersect a projection orthogonal to the ground plane (fig. 1).

Claim 21: *Phillips* teaches the handheld terminal comprises a cell phone (col. 2, lines 54-56).

Claim 22: *Phillips* teaches the cell phone comprises a clamshell body (fig. 11).

Claim 23: *Phillips* teaches the clamshell body comprises: a first body portion (132, fig. 11); a second body portion (130, fig. 11); and a hinge (134, fig. 11) interposed between the first body portion and the second body portion; and the first radiating arm and the second radiating arm are mounted adjacent to the hinge (fig. 11).

Claim 24: *Phillips* teaches the feeding port is located on a first side of the hinge (fig. 11); the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge (fig. 11); the second side is opposite the first side (fig. 11).

Claim 25: *Phillips* teaches the cell phone comprises a candy bar body (fig. 11, the Examiner interprets the shape of the phone in the closed state as a candy bar).

Claim 27: *Phillips* teaches the line segment is coplanar with the ground plane (fig. 1).

Claim 30: *Phillips* teaches the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane (fig. 1).

Claim 31: *Phillips* teaches the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane (fig. 1).

Claim 32: *Phillips* teaches the feeding port is located on a first comer (left corner of ground plane, see fig. 1) of the ground plane.

Claim 33: *Phillips* teaches the second-radiating-arm second end is coupled to the ground plane on a second comer (right corner of ground plane, see fig. 1) of the ground plane.

Claim 34: *Phillips* teaches the ground plane is substantially rectangular (fig. 1); and the first comer and the second comer are opposite comers of a short edge of the substantially rectangular ground plane (fig. 1).

Claim 40: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); and at least one of the multiple frequency bands is used by a GSM or UMTS communication service (col. 1, lines 38-42).

Claim 41: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service (col. 1, lines 38-42).

Claim 42: *Phillips* teaches the handheld terminal is operative at least at four frequency bands (col. 1, lines 38-42).

Claim 43: *Phillips* teaches the handheld terminal is operative at least at five frequency bands (col. 1, lines 38-42).

Claim 44: *Phillips* teaches the handheld terminal is operative according to at least three of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 45: *Phillips* teaches the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 46: *Phillips* teaches the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS 1900, and DCS (col. 1, lines 38-42).

Claim 47: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 48: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 49: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises an IFA structure (col. 8, lines 59-62).

Claim 50: *Phillips* teaches the monopole comprises an IFA structure (col. 8, lines 59-62).

Claim 51: *Phillips* teaches one of the first radiating arm and the second radiating arm comprises a monopole; and the other of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 52: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 53: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 54: *Phillips* teaches the microstrip structure comprises a PIFA structure (col. 8, lines 59-62).

Claim 55: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a PIFA structure (col. 8, lines 59-62).

Claim Rejections - 35 USC § 103

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 negatived by the manner in which the invention was made.

Claims 26, 28, 29, and 35-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Phillips*.

Claim 26: *Phillips* teaches all of the limitations of claim 21, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm are substantially coplanar. However, *Phillips* teaches that either the antenna element and the parasitic element can be a straight wire (col. 3, lines 61-62) and that they each can be shared therebetween (col. 8, lines 41-48). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a straight wire for both the antenna element and the parasitic element, thereby having them coplanar, as suggested by *Phillips*, since it was known to one having ordinary skill in the art at the time of the invention.

Claim 28: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength. However, *Phillips* teaches that the coupling between the antenna element and the parasitic element can be varied by controlling the diameter of the parasitic element (col. 4, lines 10-14). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have set the length of the coupling region to that of the claimed invention in order to have varied the coupling between the antenna element and the parasitic element.

Claim 29: The modified invention of *Phillips* teaches the first radiating arm and the second radiating arm are coplanar with the ground plane (fig. 1).

Claims 35-39: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Response to Arguments

Applicant's arguments filed April 4, 2011 have been fully considered but they are not persuasive.

Regarding the arguments on page 7, paragraph 4 of the Remarks, the Examiner respectfully disagrees with Applicant's. Particularly, Applicant's argue that "no antenna is disclosed in *Phillips* as capable of simultaneous operation in multiple frequency bands."

In response, the Examiner notes that the limitation "capable of" does not require that the antenna element be "configured for," "adapted for" or "operable for" simultaneous operation in multiple frequency bands. Therefore, the Examiner broadly interprets the antenna element of *Phillips* as "capable of" simultaneous operation in multiple frequency bands.

Regarding the arguments on page 8, paragraph 2 of the Remarks, the Examiner respectfully disagrees with Applicant's. Particularly, Applicant's submit that "no radiating arm having a feeding point is disclosed that includes any substantially planar structure."

In response, the Examiner notes that *Phillips* discloses that "…the antenna is equally applicable to other antenna structures like printed wire antennas or planar inverted F antennas…" Therefore, the Examiner submits that *Phillips* does in fact disclose the limitation "wherein the first radiating arm comprises a substantially planar structure," as recited in independent claim 20.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacob Y. Choi can be reached on 571-272-2367. 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.

/R. K./
Examiner, Art Unit 2821

/JACOB Y CHOI/
Supervisory Patent Examiner, Art Unit 2821

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	**Art Unit**
	ROBERT KARACSONY	2821

SEARCHED

Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK
343	803	9/10/2010	RK
343	893	6/20/2011	RK

SEARCH NOTES

Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK
Class/Subclass, Text, Assignment data, Inventor name and Backward/Forward search	9/10/2010	RK
Updated search	6/20/2011	RK

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010	06/20/2011					
	1	✓	-	-	-					
	2	✓	-	-	-					
	3	✓	-	-	-					
	4	✓	-	-	-					
	5	✓	-	-	-					
	6	✓	-	-	-					
	7	✓	-	-	-					
	8	✓	-	-	-					
	9	✓	-	-	-					
	10	✓	-	-	-					
	11	✓	-	-	-					
	12	✓	-	-	-					
	13	✓	-	-	-					
	14	✓	-	-	-					
	15	✓	-	-	-					
	16	✓	-	-	-					
	17	✓	-	-	-					
	18	✓	-	-	-					
	19	✓	-	-	-					
	20		✓	✓	✓					
	21		✓	✓	✓					
	22		✓	✓	✓					
	23		✓	✓	✓					
	24		✓	✓	✓					
	25		✓	✓	✓					
	26		✓	✓	✓					
	27		✓	✓	✓					
	28		✓	✓	✓					
	29		✓	✓	✓					
	30		✓	✓	✓					
	31		✓	✓	✓					
	32		✓	✓	✓					
	33		✓	✓	✓					
	34		✓	✓	✓					
	35		✓	✓	✓					
	36		✓	✓	✓					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010	06/20/2011					
	37		✓	✓	✓					
	38		✓	✓	✓					
	39		✓	✓	✓					
	40		✓	✓	✓					
	41		✓	✓	✓					
	42		✓	✓	✓					
	43		✓	✓	✓					
	44		✓	✓	✓					
	45		✓	✓	✓					
	46		✓	✓	✓					
	47		✓	✓	✓					
	48		✓	✓	✓					
	49		✓	✓	✓					
	50		✓	✓	✓					
	51		✓	✓	✓					
	52		✓	✓	✓					
	53		✓	✓	✓					
	54		✓	✓	✓					
	55		✓	✓	✓					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	744	343/893.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:35
S2	216769	parasitic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:36
S3	79	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:36
S4	665	S1 not S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:40
S5	50492	multi$1band multiple near3 band dual adj band	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:54
S6	3270	S2 and S5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:54
S7	2357	S2 and S5 and ground$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:55

S8	937	S7 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:55
S9	228	S8 and simultaneous$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/06/17 19:57

EAST Search History (Interference)

< This search history is empty>

6/20/2011 1:48:49 AM
C:\Documents and Settings\rkaracsony\My Documents\EAST\Workspaces\Cases\Coupled Multiband Antennas 11950835\Coupled Multiband Antennas 06-17-2011.wsp

*** All search listings have been considered by the Examiner. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	56-12102	JP		1981-02-06	Mishima		☐

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

NON-PATENT LITERATURE DOCUMENTS

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

Receipt date: 04/18/2011	Application Number	11950835 11950835 - GAU: 2821
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2007-12-05
(Not for submission under 37 CFR 1.99)	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Karacsony, Robert
	Attorney Docket Number	47005-P015WUSC1

	1	Jaggard , D. L. Rebuttal expert report of Dr. Dwight L. Jaggard (redacted version) Fractus 20110216	☐
	2	Jaggard , D. L. Expert report of Dwight L. Jaggard (redacted) - expert witness retained by Fractus Fractus 20110118	☐
	3	Long , S. A. Rebuttal expert report of Dr. Stuart A. Long (redacted version) Fractus 20110216	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	06/20/2011

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5363114		1994-11-08	Shoemaker	
	2	4751513		1988-06-14	Daryoush et al	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Mushiake , Y. , Self-complementary antennas , Antennas and Propagation Magazine, IEEE , Vol. 34 , No. 6 , December 1, 1992.	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

Electronic Acknowledgement Receipt

EFS ID:	10358403
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson/Brenda Brown
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	22-JUN-2011
Filing Date:	05-DEC-2007
Time Stamp:	10:16:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS47005P015WUSC1.pdf	64755 c555cd5379614c97543dbb5fa9ab3b6b6bbab3e1	no	2

Warnings:	
Information:	

2	Non Patent Literature	MushiakeYSelfComplementaryAntennasDec11992.pdf	515779 774ec48f5867ce770289d8022a07784b28f88532	no	7
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	IDSStatementbyApplicant47005P015WUSC1.pdf	73293 479968d58c2f8f32c5061329b36d0dd52b2feeb5a	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
		Total Files Size (in bytes):	653827		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: June 22, 2011
Electronic Signature for Brenda I. Brown; /Brenda I. Brown/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action after the filing of a Request for Continued Examination under 37 CFR 1.114, as far as is known to the undersigned (37 CFR 1.97(b)(4)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1.

Dated: June 22, 2011

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	56-12102	JP		1981-02-06	Mishima		☐

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

NON-PATENT LITERATURE DOCUMENTS

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Karacsony, Robert
	Attorney Docket Number	47005-P015WUSC1

	1	Jaggard , D. L. Rebuttal expert report of Dr. Dwight L. Jaggard (redacted version) Fractus 20110216	☐
	2	Jaggard , D. L. Expert report of Dwight L. Jaggard (redacted) - expert witness retained by Fractus Fractus 20110118	☐
	3	Long , S. A. Rebuttal expert report of Dr. Stuart A. Long (redacted version) Fractus 20110216	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

⑲ 日本国特許庁（JP）　　⑪特許出願公開

⑫公開特許公報（A）　　昭56—12102

⑤Int. Cl.³	識別記号	庁内整理番号	⑬公開　昭和56年(1981)2月6日
H 01 Q 1/36		7125—5 J	
9/30		7190—5 J	
			発明の数　1
			審査請求　有

（全 3 頁）

⑭広帯域逆L形アンテナ

⑳特　　願　昭54—86862
㉒出　　願　昭54(1979)7月11日

㉑発 明 者　三島発
横須賀市武1丁目2356番地日本電信電話公社横須賀電気通信研究所内
㉑発 明 者　小坂和弘
東京都千代田区丸の内3丁目3番1号電気興業株式会社内
㉑発 明 者　鈴田豊次
東京都千代田区丸の内3丁目3番1号電気興業株式会社内
㉓出 願 人　日本電信電話公社
㉓出 願 人　電気興業株式会社
東京都千代田区丸の内3丁目3番1号
㉔代 理 人　弁理士　白水常雄　　外1名

明　　細　　書

1. 発明の名称　　広帯域逆L形アンテナ

2. 特許請求の範囲

1/4波長ヘリポールアンテナの放射導体を適当な角度で垂直に折り曲げて給電部に並列な伝送線路型先端開放共振回路を構成し、かつ給電部に並列に伝送線路型先端開放整合回路を接続した先端開放逆L形アンテナにおいて、上記共振回路の開放端側の適当な位置に集積素子を配置し、給電部にインピーダンス補償素子を挿入したことを特徴とする広帯域逆L形アンテナ。

3. 発明の詳細な説明

本発明は移動体に装着する小形の広帯域逆L形アンテナに関するものである。

従来、航空機など移動体の通信用アンテナとして1/4波長ホイップ逆L形アンテナが用いられている。第1図は先端開放整合逆L形アンテナ、(a)は集積素子を付加した先端開放整合逆L形アンテナ、(b)は集積素子を付加した先端開放整合逆L形アンテナ、(c)は集積素子を付加した先端開放整合逆L形アンテナである。(a)に示したものは、基板裏面に近接して集積素子2が装着されるためインピーダンスの再現性が極めて困難である。また基板厚の大きさによってインピーダンス特性が変化するため非常に大きな基板厚を必要とし、さらに大形で地板の影響もより受け易い欠点があった。第1図(b)、(c)およびこれ以上の欠点を補なうべく対策を施したもので、基板裏面としては集積素子を付加して機械的強度を増すと共に、アンテナに並列にインピーダンスを付加してある程度の広帯域性を得たものである。

しかし、同軸式受信方式の移動通信方式等においては、非常に広帯域な送受信用アンテナが必要であり、上記のいずれの構造の場合でも帯域特性としては充分でなく、帯域幅の広域に亘って安定した特性を維持するには難点があった。

本発明は、これらの欠点を解決し、広帯域通信

るいは再放送情報の伝送が受ける無線通信に利用できる小形の広帯域受信用アンテナを提供するものである。

以下図面により本発明を詳細に説明する。

第1図は本発明の実施例であって、1は入力端子、2は放射素子、3は無給電素子、4は並列素子、5は無給電素子、7は終端素子である。

入力端子1より給電すると、電波は放射素子2および並列素子4に分岐し、空間に電磁波が放射されるが、一部の電磁波は近接した無給電素子3に結合して無給電素子3上に誘導電流が励振され、その一部は再放射される。

従って、受信アンテナの近傍に無給電素子を配置すると相互干渉によって受信アンテナの入力インピーダンスが変化し、無給電素子上に流れる電流によって指向性も変化する。

以上の動作については入力アンテナ等の論文によって説明できるものであるが、本発明者はインピーダンスの広帯域化を行なうために無給電素子3を利用する事に着目し、該受信アンテナの指向

入力インピーダンス、Z_{11}は放射素子2と入力端子間に存在する無線路のインピーダンス、Z_{22}は放射素子2のインピーダンス、Z_{44}は並列素子4のインピーダンス、Z_{55}は無給電素子5のインピーダンス、M_{12}は受信アンテナと無給電素子3との結合量、L_3およびL_5は終端素子7のインダクタンス及び容量性リアクタンスである。第1図ではL_3及びL_5を受信アンテナからの結合量を1/3の1以下となるように選定し、終端素子7のL_3及びL_5を調整すれば、指向性に影響を与えずに広帯域に設定して整合がとれる。

第4図は1/3の1波長受信アンテナの入力インピーダンス特性の実施例を示したもので、Sは従来より使用されているアンテナ、Tは本発明によるアンテナ、Uは無給電素子のみを受信アンテナに付加した時の実施例である。

第2図の放射素子2，並列素子4および無給電素子3は丸棒の例を示しているが、同等以上の強、角材又は板状としてもその効果は変らない。また、無給電素子3は必ずしも放射素子2の同等以上

度を得るために無給電素子3においてインピーダンスを正常値にすることを実験により確認した。受信アンテナと無給電素子3との結合量が1/3の1以上となると、指向性への影響が大きくなるため、結合をさらに弱くしなければならない。しかしながら、結合を弱くすれば相互干渉が少なくなって入力インピーダンスへの影響も小さくなり、そのままではインピーダンスの広帯域化は出来ない。

そこで、第2図に示す如く終端素子7を付加し、受信アンテナの入力インピーダンスを変化させ、無給電素子3を適当な状態で結合させる入力インピーダンスの広帯域化を行なわしめたものである。

終端素子7には数オームから数十オームと数千オームのものを分布定数で形成し、適当に選択したものを受信アンテナに並列に接続したものである。

第3図は、受信アンテナの電気的等価回路を示したもので、(a)は本発明によるアンテナの等価回路、(b)は第1図(a)に示す従来のアンテナの等価回路である。1～1は入力端子、2は2にアンテナの

に設置されているが、必ずしも同軸上に設ける必要はなく、L形に曲げずに直線状のものを使用するに直立させてもまた斜めに立てても効果は変らない。

以上説明したように、本発明によれば小形の受信装置の一部を受信アンテナで共用出来る上に2:1の帯域幅特性を定常波比1.5以下とすることが出来るから、きわめて広帯域な各局の伝送やテレメータの信号を1台のアンテナで受信することも可能であるばかりでなく、広帯域特性により雑音等の気象変化の影響を受け難く、電気的特性が安定する利点がある。

また、アンテナの大きさを例えば1/3の1波長以下として小形化しても、本発明による整合方法を用いれば、広帯域特性を容易に実現出来る。実施例では船舶等の移動体の通信に用いる場合に、電気的性能が安定でしかも小形軽量のものが要望されており、本発明によるアンテナはその要求を満足するものである。

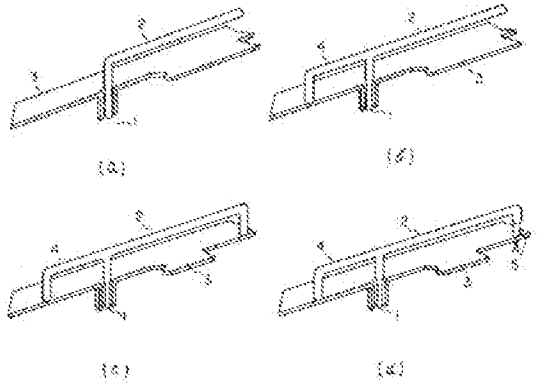
4. 図面の簡単な説明

第1図は従来の逆L形アンテナの斜視図、第2図は本発明の一実施例の斜視図、第3図(a)(b)は本発明および従来のアンテナの電気的等価回路図、第4図は従来のアンテナと本発明によるアンテナの入力インピーダンスの実数成分を示す特性図である。

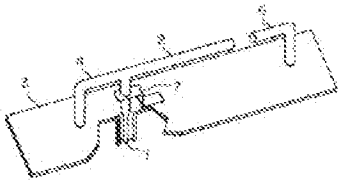
1…入力端子、2…放射素子、3…短絡板、4…並列素子、5…負荷容量、6…短絡板素子、7…給電素子、8…従来のアンテナの定在波比、9…本発明によるアンテナの定在波比、10…短絡板素子そのものを付加したアンテナの定在波比。

特許出願人　日本電信電話公社
同　電気興業株式会社
代理人　弁理士　木村孝雄

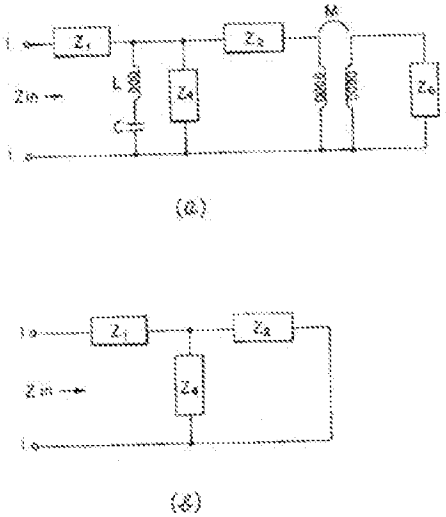
第1図



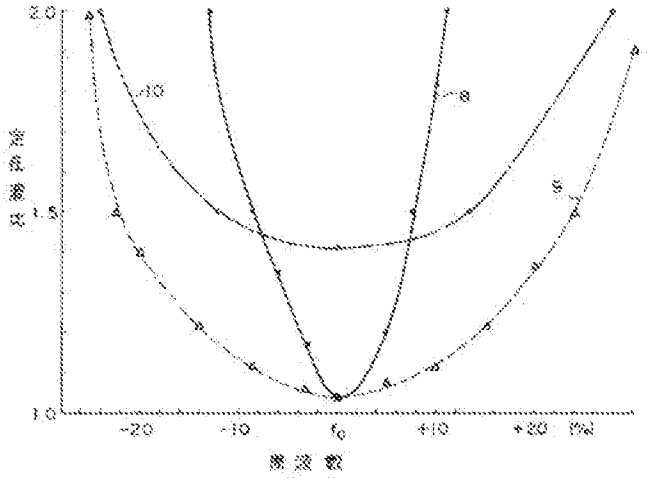
第2図



第3図



第4図



(19) Japan Patent Office (JP)

(12) **Publication of Unexamined Patent Application** (A)

(11) Kokai number
S56-12102 (1981)

(51) Int.Cl.³	Identification symbol	JPO file number
H01Q 1/36		7125-5J
9/30		7150-5J

(43) Publication date: 6 February 1981

Number of inventions: 1
Request for examination: Requested

(3 pages total)

(54) Inverted L-shaped broadband antenna

(21) Application number: S54-86862

(22) Application date: 11 July 1979

(72) Inventor: Hatsu MISHIMA
NTT Yokosuka Research and Development Center
1-2356 Take, Yokosuka-shi

(72) Inventor: Kazuhiro KOSAKA
Denki Kogyo Co., Ltd.
3-3-1 Marunouchi, Chiyoda-ku, Tokyo

(72) Inventor: Toyoji SUZUTA
Denki Kogyo Co., Ltd.
3-3-1 Marunouchi, Chiyoda-ku, Tokyo

(71) Applicant: Nippon Telegraph and Telephone Corporation

(71) Applicant: Denki Kogyo Co., Ltd.
3-3-1 Marunouchi, Chiyoda-ku, Tokyo

(74) Representative: Tomeo SHIROMIZU, Patent Attorney (and 1 other)

SPECIFICATION

1. TITLE OF THE INVENTION

Inverted L-shaped broadband antenna

2. CLAIMS

What is claimed is:

An inverted L-shaped broadband antenna comprising an open-ended inverted L-shaped antenna with a 1/4 wavelength unipole antenna radiation conductor perpendicularly bent to an appropriate height and a parallel transmission line open-ended resonant circuit on the feed end, wherein: a parasitic element is arranged in an appropriate position on the open end of said resonant circuit; and an impedance compensation element is inserted into the feed end.

3. DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a compact inverted L-shaped broadband antenna installed on a mobile object.

Inverted L-shaped antennas like those shown in FIG. 1 have conventionally been used as communication antennas on mobile objects, such as airplanes and the like. FIG. 1(a) is an open-ended inverted L-shaped antenna, (b) is an open-ended inverted L-shaped antenna to which a parallel element has been added, (c) is an end-grounded inverted L-shaped antenna to which a parallel element has been added, and (d) is an end-capacitance-loaded inverted L-shaped antenna to which a parallel element has been added. The antenna shown in (a) comprises a radiation element 2 installed in proximity to a ground plane 3, so it is an antenna with ultra narrow band impedance frequency characteristics. Its impedance characteristics also change depending on the size of the ground plane 3, making an extremely large ground plane necessary, and it is also affected by rain and vibration. The antennas shown in (b), (c), and (d) were developed with countermeasures to compensate for the deficiencies described above. A parallel element 4 was added as a grounding feed, increasing mechanical strength and allowing for broadband characteristics with added parallel impedance.

However, in simultaneous transmission/reception mobile communication systems and so on, an antenna capable of extreme broadband transmission/reception is required, and none of the structures described above are sufficient in terms of their band characteristics, making it difficult to maintain stable characteristics throughout the frequency spectrum.

The present invention has resolved the deficiencies described above, and provides a compact inverted L-shaped broadband antenna that can be utilized for broadband communication or wireless communication, in which the transmission of high-quality information is desired.

The present invention will now be described in detail with reference to the drawings.

FIG. 2 is a working example of the present invention. 1 is an input terminal, 2 is a radiation element, 3 is a ground plane, 4 is a parallel element, 6 is a parasitic element, and 7 is a compensation element.

When power is fed from the input terminal 1, the current is distributed to the radiation element 2 and parallel element 4. Although electromagnetic waves are radiated into the spaces, some of the electromagnetic waves are coupled to the proximal parasitic element 6. Current is generated in the parasitic element 6, proportional to the coupled amount of electromagnetic waves, and is re-radiated.

Consequently, if a parasitic element is arranged in proximity to the inverted L-shaped antenna, the inverted L-shaped antenna's input impedance changes due to the mutual interference, and the directivity also changes due to the current flowing through the parasitic element.

The operation above was described based on Yagi antenna theory

and the like, but the present invention focused on using a passive element is to make to realize a wider impedance bandwidth, and continued through experimentation that realizing a wider impedance bandwidth is possible within a range where the directivity of the inverted L-shaped antenna is not harmed. The directivity is largely affected if the amount of coupling between the inverted L-shaped antenna and the parasitic element 6 is 10% or more, so loose coupling is necessary. However, if the coupling is made loose, the mutual interference decreases and there is little effect on the input impedance, making it impossible to realize a wider impedance bandwidth.

By adding a compensation element 7, as shown in FIG. 2, the input impedance of the inverted L-shaped antenna is changed, and as overall wider impedance bandwidth is realized in a state where the inverted L-shaped antenna is loosely coupled with the parasitic element 6.

The compensation element 7 is formed with a distributed constant with a small inductance L and small capacitance C, and these connected in series are connected to the inverted L-shaped antenna in parallel.

FIG. 3 shows selected equivalent circuits of inverted L-shaped antennas. (a) Shows an equivalent circuit of an antenna according to the present invention, and (b) shows an equivalent circuit of the conventional antenna shown in FIG. 1(b). 1-1 is an input terminal. Zin is the antenna's input impedance, Z_1 is the vertical impedance between the radiation element 2 and input terminal, Z_2 is the impedance of the radiation element 2, Z_3 is the impedance of the parasitic element 4, Z_4 is the impedance of the parasitic element 6, M is the amount of coupling between the inverted L-shaped antenna and the parasitic element 6, and L and C are the impedance and capacitive reactance of the compensation element 7, respectively. In FIG. 3(a), Z_2 and M are selected such that the amount of coupling from the inverted L-shaped antenna is 10% or less and the L and C of the compensation element 7 are timely adjusted, matching throughout the broadband spectrum without allowing directivity is possible.

FIG. 4 shows the measured values of the input impedance characteristics of ¼ wavelength inverted L-shaped antennas. 8 is the measured values with a conventionally used antenna, 9 is the measured values with an antenna according to the present invention, and 10 is the measured values when a parasitic element has been added to an inverted L-shaped antenna.

The radiation element 2, parallel element 4, and parasitic element 6 in FIG. 2 are round bar examples, but the effects are no different if they are circular tubes, square, or plates. Further, the parasitic element 6 is bent into an L shape and is installed along the same axis as the radiation element 2, but it does not necessarily have to be placed along the same axis. The effects are no different if it is bent (not bent into an L shape) and installed upright or on an angle on the ground plane 3.

As described above, according to the present invention, it is possible to make the 2Pth frequency band of the centre frequency have a standing wave ratio of 1.5 or less, even with a ¼ wavelength, compact inverted L-shaped antenna. Thus, not only is it possible to transmit extreme broadband signals and feed multichannel signals to an antenna, but the broadband characteristics are also not easily affected by changes in the weather, such as rain and snow, and the electrical characteristics are also stabilized.

Further, even if the size of the antenna is compacted to ¼ wavelength or less, for example, if the matching method according to the present invention is employed, broadband characteristics can be realized easily. If used for communication on a mobile object, such as an airplane or automobile, stable electrical performance and a compact, lightweight design are desired, and an antenna according to the present invention satisfies these requirements.

4. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is perspective views of conventional inverted L-shaped antennas.

FIG. 2 is a perspective view of one working example of the present invention.

FIG. 3(a) and 3(b) are drawings of electrical equivalent circuits of an antenna according to the present invention and a conventional antenna, respectively.

FIG. 4 is a characteristics diagram showing the measured values of the input impedance of a conventional antenna and an antenna according to the present invention.

EXPLANATION OF THE SYMBOLS

1: Input terminal
2: Radiation element
3: Ground plane
4: Parallel element
5: Load capacitance
6: Parasitic element
7: Compensation element
8: Standing wave ratio of a conventional antenna
9: Standing wave ratio of an antenna according to the present invention
10: Standing wave ratio of an antenna to which only a parasitic element 6 has been added

Patent applicant: Nippon Telegraph and Telephone Corporation
Patent applicant: Daidō Kogyo Co., Ltd.
Representative: Tsuneo SUMIOKIZE
Representative: Akemichi OTSUKA

FIG. 1

FIG. 2

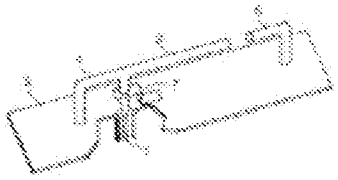
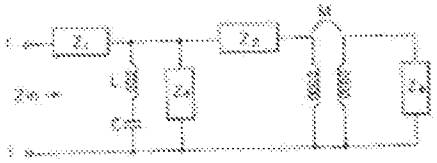
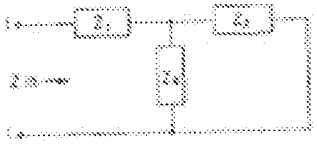


FIG. 3

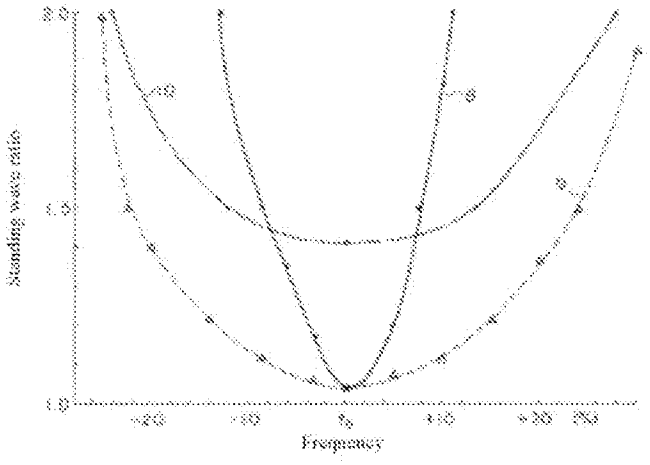


(a)



(b)

FIG. 4



Electronic Acknowledgement Receipt

EFS ID:	9896751
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson/Brenda Brown
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	18-APR-2011
Filing Date:	05-DEC-2007
Time Stamp:	10:39:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS47005P015WUSC1.pdf	66563 faf59a6526ad0f5241407f26033f16162b145e0c	no	2

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Filed (SB/08)	IDSStatementbyApplicant47005P015WUSC1.pdf	78298 91cc1508fb5cff9e89cff01051e058fc12c332f3	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	JP5612102.pdf	843244 c22941ac1ca09cb7173b5fc47bc78838ae593d50	no	6
Warnings:					
Information:					
4	NPL Documents	Jaggardrebuttalexpert.pdf	23924049 5205f33e2afd5eef5d84ab410b29ace304d4d2ed	no	177
Warnings:					
Information:					
5	NPL Documents	Jaggardexportreport.pdf	24394244 5f08bc0e8eb4abe8df1591a6cb7d9530d32c36b7	no	167
Warnings:					
Information:					
6	NPL Documents	Longrebuttal.pdf	18771161 f3efb3c372a0690afd5f4d27a307aa270611fe46	no	140
Warnings:					
Information:					
		Total Files Size (in bytes):	68077559		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: April 18, 2011
Electronic Signature for Brenda I. Brown: /Brenda I. Brown/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action after the filing of a Request for Continued Examination under 37 CFR 1.114, as far as is known to the undersigned (37 CFR 1.97(b)(4)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1.

Dated: April 18, 2011

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. [ ] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. [ ] Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
      ii. [ ] Other _____

   b. [x] Enclosed
      i. [x] Amendment/Reply
      ii. [ ] Affidavit(s)/Declaration(s)
      iii. [ ] Information Disclosure Statement (IDS)
      iv. [x] Other Terminal Disclaimer to Obviate a Double Patentitng Rejection over a "Prior" Patent

2. Miscellaneous
   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)
   b. [ ] Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.
   a. [x] The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any Overpayments, to Deposit Account No. 23-2426 .
      i. [x] RCE fee required under 37 CFR 1.17(e)
      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)
      iii. [ ] Other _____
   b. [ ] Check in the amount of $ _____ enclosed
   c. [ ] Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Ross T. Robinson/	Date	April 4, 2011
Name (Print/Type)	Ross T. Robinson	Registration No.	47,031

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: April 4, 2011 Electronic Signature for Ross T. Robinson: /Ross T. Robinson /

PTO/SB/26 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 47005-P015WUSC1

In re Application of: Carles Puente Baliarda et al.

Application No.: 11/950,835-Conf. #7241

Filed: December 5, 2007

For: COUPLED MULTIBAND ANTENNAS

The owner*, Fractus, S.A., of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 7,315,289 as the term of said prior patent is defined in 35 U.S.C. 154 and 173, and as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☒ The undersigned is an attorney or agent of record. Reg. No. 47,031

/Ross T. Robinson/ — Signature
April 4, 2011 — Date

Ross T. Robinson — Typed or printed name

(214) 745-5185 — Telephone Number

☒ Terminal disclaimer fee under 37 CFR 1.20(d) is included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: April 4, 2011 — Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1

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($)
Miscellaneous:				
Request for continued examination	1801	1	810	810
		Total in USD ($)		**810**

Electronic Acknowledgement Receipt

EFS ID:	9800767
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	04-APR-2011
Filing Date:	05-DEC-2007
Time Stamp:	13:55:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$810
RAM confirmation Number	185
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment After Final	response.pdf	44874 9a81a4b445d0e65f3120380d10c524230b778fca	no	9
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	RCE.pdf	29250 5bd30d2296dd7c9a3eb7b1ac5054b1799332e772	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
3	Terminal Disclaimer Filed	terminaldisclaimer.pdf	22555 d3d742828f5861fc56cdc26b1d1c25a4525afe71	no	1
Warnings:					
Information:					
4	Fee Worksheet (PTO-875)	fee-info.pdf	30299 739e533f0adeccb3632568c4da1faddf11b2cfc0	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	126978		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: April 4, 2011
Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Docket No. 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No. 11/950,835 Confirmation No. 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

AMENDMENT IN RESPONSE TO FINAL OFFICE ACTION

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

Dear Sir:

INTRODUCTORY COMMENTS

In response to the Office Action dated January 4, 2011, finally rejecting claims 20-55, please amend the above-identified U.S. patent application as follows:

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

Remarks/Arguments begin on page 7 of this paper.

AMENDMENTS TO THE CLAIMS

1-19. (CANCEL)

20. (CURRENTLY AMENDED) A handheld terminal comprising:

at least one printed circuit board comprising a ground plane;

an antenna element capable of simultaneous operation at multiple frequency bands, the antenna element comprising:

a first radiating arm comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point; and

a second radiating arm not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane;

a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane;

wherein the first radiating arm comprises a substantially planar structure;

wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;

wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end;

wherein the line segment does not intersect a projection orthogonal to the ground plane.

21. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cell phone.

22. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a clamshell body.

23. (PREVIOUSLY PRESENTED) The handheld terminal of claim 22, wherein: the clamshell body comprises:

a first body portion;

a second body portion; and

a hinge interposed between the first body portion and the second body portion; and

the first radiating arm and the second radiating arm are mounted adjacent to the hinge.

24. (PREVIOUSLY PRESENTED) The handheld terminal of claim 23, wherein:

the feeding port is located on a first side of the hinge;

the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge;

the second side is opposite the first side.

25. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the cell phone comprises a candybar body.

26. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm are substantially coplanar.

27. (PREVIOUSLY PRESENTED) The handheld terminal of claim 25, wherein the line segment is coplanar with the ground plane.

28. (CURRENTLY AMENDED) The handheld terminal of claim 20, wherein the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength.

29. (PREVIOUSLY PRESENTED) The handheld terminal of claim 26, wherein the first radiating arm and the second radiating arm are coplanar with the ground plane.

30. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane.

31. (PREVIOUSLY PRESENTED) The handheld terminal of claim 30, wherein the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane.

32. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane.

33. (PREVIOUSLY PRESENTED) The handheld terminal of claim 32, wherein the second-radiating-arm second end is coupled to the ground plane on a second corner of the ground plane.

34. (PREVIOUSLY PRESENTED) The handheld terminal of claim 33, wherein:

the ground plane is substantially rectangular; and

the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane.

35. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a personal digital assistant.

36. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a cordless telephone.

37. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a pager.

38. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises an electronic gaming device.

39. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal comprises a remote control device.

40. (CURRENTLY AMENDED) The handheld terminal of claim 20, wherein:

the handheld terminal is operative at multiple frequency bands; and

at least one of the multiple frequency bands is used by a Global System for Mobile Communications (GSM) ~~GSM~~ or Universal Mobile Telecommunications System (UMTS) ~~UMTS~~ communication service.

41. (PREVIOUSLY PRESENTED) The handheld terminal of claim 40, wherein:

the handheld terminal is operative at multiple frequency bands;

a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service.

42. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at four frequency bands.

43. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at five frequency bands.

44. (CURRENTLY AMENDED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of Advanced Mobile Phone Service (AMPS) ~~AMPS~~, GSM850, GSM900, GSM1800, UMTS, Personal Communications Services 1900 (PCS1900) ~~PCS1900~~, and Digital Cellular System (DCS) ~~DCS~~.

45. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

46. (PREVIOUSLY PRESENTED) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

47. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a monopole.

48. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein each of the first radiating arm and the second radiating arm comprises a monopole.

49. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises an IFA structure.

50. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein the monopole comprises an IFA structure.

51. (PREVIOUSLY PRESENTED) The handheld terminal of claim 47, wherein:

one of the first radiating arm and the second radiating arm comprises a monopole; and

the other of the first radiating arm and the second radiating arm comprises a microstrip structure.

52. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a microstrip structure.

53. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein each of the first radiating arm and the second radiating arm comprises a microstrip structure.

54. (PREVIOUSLY PRESENTED) The handheld terminal of claim 52, wherein the microstrip structure comprises a PIFA structure.

55. (PREVIOUSLY PRESENTED) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

REMARKS

Reconsideration of the application as amended is respectfully requested. Claims 20, 28, 40, and 44 have been amended. No claims have been added or canceled. Claims 20-55 are pending. Applicant respectfully submits that no new matter has been added by the amendments presented in this amendment.

Claims 28, 40-41, and 44-46 stand objected to for various informalities. Applicant has amended the objected-to claims in accordance with the examiner's suggestion and requests that the objections be withdrawn.

Claims 20-25, 27, 30-34, and 40-55 stand rejected under 35 USC 102(e) as anticipated by US Patent No. 6,675,536 to Phillips ("Phillips"). Claims 26, 28-29, and 35-39 stand rejected under 35 USC 103(a) as unpatentable over Phillips. Independent claim 20 has been amended herein to recite an antenna element capable of simultaneous operation in multiple frequency bands and that comprises the first and second radiating arms as claimed. Independent claim 20 has also been amended to recite that the first radiating arm comprises a substantially planar structure.

Applicant respectfully submits that no antenna is disclosed in Phillips as capable of simultaneous operation in multiple frequency bands. In Phillips, increased bandwidth to cover different frequency bands is disclosed to be accomplished by coupling an electrically-driven antenna element with an active variably tuned parasitic element.[1] The parasitic element is coupled to a tunable circuit.[2] In addition, the antennas disclosed in Phillips preferably also include a variable matching circuit coupled to the electrically-driven antenna element.[3]

Both the tunable circuit and the variable matching circuit of Phillips include a plurality of switches to synthesize different tuning loads. By selectively turning the switches ON and OFF,

[1] Phillips, col. 2, lns. 15–28, 34–36.
[2] Phillips, Fig. 2, col. 4, lns. 15–21.
[3] Phillips, Fig. 2, col. 4, lns. 22–32.

different tuning states may be defined to tune an antenna to different frequencies.[4] According to Phillips, the more tuning states, more frequency bands, or broader bandwidth, can be covered.[5] Thus, for at least the reason that the antennas disclosed in Phillips employ the switching scheme described above, Phillips does not disclose antennas capable of simultaneous operation at multiple frequency bands as claimed in amended claim 20.

In addition to the above, in the antennas disclosed in Phillips, no radiating arm having a feeding point is disclosed that includes any substantially planar structure as now claimed in amended claim 20.[6] In contrast to amended claim 20, Phillips discloses that either the antenna element or the parasitic element can be a helix or a straight wire.[7] In other words, Phillips discloses using wire-like structures for the antennas disclosed therein and does not disclose this additional distinguishing feature of amended claim 20.

Applicant respectfully submits that amended independent claim 20 distinguishes over Phillips for at least these reasons set forth above. Withdrawal of the rejection of claim 20 as anticipated by Phillips is respectfully requested.

All remaining pending claims depend from and further limit independent claim 20 in a patentable sense. Applicant respectfully submits that each of the dependent claims also distinguishes over Phillips for at least the same reasons as those set forth above with respect to the rejection of independent claim 20. Applicant accordingly respectfully requests that all anticipation and obviousness rejections of claims 21-55 be withdrawn.

Claims 20-34 and 40-48 stand rejected as unpatentable over various claims of US Patent No. 7,315,289 on the basis of obviousness-type double patenting. In response to the double-patenting rejection, Applicant submits herewith a terminal disclaimer. Applicant submits the terminal disclaimer in an effort to expedite prosecution and by so doing does not concede the correctness of the double-patenting rejection.

---

[4] Phillips. col. 4, lns. 51–60.
[5] Phillips. col. 4, lns. 51–60.
[6] Phillips, Figs. 1, 2, 4–9.
[7] Phillips, col. 3, lns. 61–62.

In view of the above amendments and remarks, Applicant respectfully submits that the present application is in condition for allowance. A Notice to that effect is respectfully requested.

Dated: April 4, 2011

Respectfully submitted,

Electronic signature: /Ross T. Robinson/
Ross T. Robinson
Registration No.: 47,031
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	04/04/2011	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $ =		OR	X $52=	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $220=	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/CHRISTINE MOLLISH/

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

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

Document code: WFEE

United States Patent and Trademark Office
Sales Receipt for Accounting Date: 04/05/2011

CMOLLISH SALE #00000002 Mailroom Dt: 04/04/2011 232426 11950835
01 FC : 1814 140.00 DA

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 01/04/2011

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	**PAPER NUMBER**
2821	

MAIL DATE	DELIVERY MODE
01/04/2011	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

-- 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 *13 December 2010*.

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

3)☐ 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

4)☒ Claim(s) *20-55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20-55* is/are rejected.

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

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

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

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

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

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *09/28/2010 and 12/13/2010*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. The following Office Action is in response to the Request for Reconsideration received December 13, 2010. Claims 20-55 are currently pending.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on December 13, 2010 has been entered.

Information Disclosure Statement

3. The information disclosure statements (IDS) submitted on September 28, 2010 and December 13, 2010 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements are being considered by the examiner.

Claim Objections

4. Claims 28, 40, 41 and 44-46 are objected to because of the following informalities:

5. In line 1, claim 28, please replace "first radiating arm" with --the first radiating arm-- to comply with antecedent basis rules.

6. Claims 40, 41 and 44-46: Please define the limitations "GSM," "UMTS," "AMPS," "DCS" and "PCS" at least once in the claims.

7. Appropriate correction is required.

Claim Rejections - 35 USC § 102

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

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

9. Claims 20-25, 27, 30-34, and 40-55 are rejected under 35 U.S.C. 102(e) as being anticipated by Phillips et al. (US 6,765,536, hereinafter Phillips).

Claim 20: Phillips teaches a handheld terminal comprising: at least one printed circuit board (14, fig. 1) comprising a ground plane (col. 3, lines 53-58); a first radiating arm (10, fig. 1) comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point (point that connects to transceiver, see fig. 2); a second radiating arm (12, fig. 1) not in ohmic contact (col. 3, lines 45-47) with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane (end that couples to ground via tuning circuit 20, see fig. 2); a feeding port (transceiver, see fig. 2) defined between the feeding point of the first radiating arm and at least one point on the ground plane; wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board (col. 3, lines 53-54); wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second- radiating-arm second end (fig. 1); wherein the line segment does not intersect a projection orthogonal to the ground plane (fig. 1).

Claim 21: Phillips teaches the handheld terminal comprises a cell phone (col. 2, lines 54-56).

Claim 22: Phillips teaches the cell phone comprises a clamshell body (fig. 11).

Claim 23: Phillips teaches the clamshell body comprises: a first body portion (132, fig. 11); a second body portion (130, fig. 11); and a hinge (134, fig. 11) interposed between the first body portion and the second body portion; and the first radiating arm and the second radiating arm are mounted adjacent to the hinge (fig. 11).

Claim 24: Phillips teaches the feeding port is located on a first side of the hinge (fig. 11); the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge (fig. 11); the second side is opposite the first side (fig. 11).

Claim 25: Phillips teaches the cell phone comprises a candy bar body (fig. 11, the Examiner interprets the shape of the phone in the closed state as a candy bar).

Claim 27: Phillips teaches the line segment is coplanar with the ground plane (fig. 1).

Claim 30: Phillips teaches the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane (fig. 1).

Claim 31: Phillips teaches the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane (fig. 1).

Claim 32: Phillips teaches the feeding port is located on a first comer (left corner of ground plane, see fig. 1) of the ground plane.

Claim 33: Phillips teaches the second-radiating-arm second end is coupled to the ground plane on a second comer (right corner of ground plane, see fig. 1) of the ground plane.

Claim 34: Phillips teaches the ground plane is substantially rectangular (fig. 1); and the first comer and the second comer are opposite comers of a short edge of the substantially rectangular ground plane (fig. 1).

Claim 40: Phillips teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); and at least one of the multiple frequency bands is used by a GSM or UMTS communication service (col. 1, lines 38-42).

Claim 41: Phillips teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service (col. 1, lines 38-42).

Claim 42: Phillips teaches the handheld terminal is operative at least at four frequency bands (col. 1, lines 38-42).

Claim 43: Phillips teaches the handheld terminal is operative at least at five frequency bands (col. 1, lines 38-42).

Claim 44: Phillips teaches the handheld terminal is operative according to at least three of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 45: Phillips teaches the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 46: Phillips teaches the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS 1900, and DCS (col. 1, lines 38-42).

Claim 47: Phillips teaches at least one of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 48: Phillips teaches each of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 49: Phillips teaches at least one of the first radiating arm and the second radiating arm comprises an IFA structure (col. 8, lines 59-62).

Claim 50: Phillips teaches the monopole comprises an IFA structure (col. 8, lines 59-62).

Claim 51: Phillips teaches one of the first radiating arm and the second radiating arm comprises a monopole; and the other of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 52: Phillips teaches at least one of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 53: Phillips teaches each of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 54: Phillips teaches the microstrip structure comprises a PIFA structure (col. 8, lines 59-62).

Claim 55: Phillips teaches at least one of the first radiating arm and the second radiating arm comprises a PIFA structure (col. 8, lines 59-62).

Claim Rejections - 35 USC § 103

10. 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 negatived by the manner in which the invention was made.

11. Claims 26, 28, 29, and 35-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Phillips.

Claim 26: Phillips teaches all of the limitations of claim 21, as discussed above. Phillips fails to explicitly teach the first radiating arm and the second radiating arm are substantially coplanar. However, Phillips teaches that either the antenna element and the parasitic element can be a straight wire (col. 3, lines 61-62) and that they each can be shared therebetween (col. 8, lines 41-48). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a straight wire for both the antenna element and the parasitic element, thereby having them coplanar, as suggested by Phillips, since it was known to one having ordinary skill in the art at the time of the invention.

Claim 28: Phillips teaches all of the limitations of claim 20, as discussed above. Phillips fails to explicitly teach the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength. However, Phillips teaches that the coupling between the antenna element and the parasitic element can be varied by controlling the diameter of the parasitic element (col. 4, lines 10-14). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have set the length of the coupling region to that of the claimed invention in order to have varied the coupling between the antenna element and the parasitic element.

Claim 29: The modified invention of Phillips teaches the first radiating arm and the second radiating arm are coplanar with the ground plane (fig. 1).

Claims 35-39: Phillips teaches all of the limitations of claim 20, as discussed above. Phillips fails to explicitly teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Response to Arguments

12. Applicant's arguments with respect to claims 20-55 have been considered but are moot in view of the new ground(s) of rejection.

Double Patenting

13. 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 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).

14. Claims 20-34 and 40-48 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1, 2, 14, 17, 22-24 and 35 of U.S. Patent No. 7,315,289, (hereinafter '289). Although the conflicting claims are not identical, they are not patentably distinct from each other because.

Claim 1 of '289 teaches the limitations of claims 20, 47 and 48 of the instant application.

Claim 2 of '289 teaches the limitations of claim 28 of the instant application.

Claim 14 of '289 teaches the limitations of claims 26 and 27 of the instant application.

Claim 17 of '289 teaches the limitations of claims 40-46 of the instant application.

Claim 22 of '289 teaches the limitations of claims 21 and 25 of the instant application.

Claim 23 of '289 teaches the limitations of claim 22 of the instant application.

Claim 24 of '289 teaches the limitations of claims 23 and 24 of the instant application.

Claim 35 of '289 teaches the limitations of claims 30-34 of the instant application.

15. Claims 35-39 and 49-55 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of '289 in view of Phillips.

Claims 35-39: Claim 1 of '289 teaches all of the limitations of claim 20 of the instant application, however, fails to teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Claims 49-55: Claim 1 of the instant application teaches all of the limitations of claim 20 and 47, however, fails to teach at least one of the first radiating arm and the second radiating arm comprises an IFA structure, the monopole comprises an IFA structure, one of the first radiating arm and the second radiating arm comprises a monopole and the other of the first radiating arm and the second radiating arm comprises a microstrip structure, at least one of the first radiating arm and the second radiating arm comprises a microstrip structure, each of the first radiating arm and the second radiating arm comprises a microstrip structure and the microstrip structure comprises a PIFA structure, or at least one of the first radiating arm and the second radiating arm comprises a PIFA structure. However, Phillips teaches any suitable type of antenna may be used such as printed wire antennas or PIFAs (col. 8, lines 59-62). The claim would have been obvious because the substitution of one known element for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention. Therefore, it would have

been obvious to one of ordinary skill in the art at the time the invention was made to have selected the antenna of '289 to be any one of IFA, monopole, microstrip or PIFA, with a reasonable expectation of success, since the substitution of one known element for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

Conclusion

16. All claims are drawn to the same invention claimed in the application prior to the entry of the submission under 37 CFR 1.114 and could have been finally rejected on the grounds and art of record in the next Office action if they had been entered in the application prior to entry under 37 CFR 1.114. Accordingly, **THIS ACTION IS MADE FINAL** even though it is a first action after the filing of a request for continued examination and the submission under 37 CFR 1.114. See MPEP § 706.07(b). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacob Y. Choi can be reached on 571-272-2367. 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.

/R. K./
Examiner, Art Unit 2821

/Jacob Y Choi/
Supervisory Patent Examiner, Art Unit 2821

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
1195083 5	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010						
	1	✓	-	-						
	2	✓	-	-						
	3	✓	-	-						
	4	✓	-	-						
	5	✓	-	-						
	6	✓	-	-						
	7	✓	-	-						
	8	✓	-	-						
	9	✓	-	-						
	10	✓	-	-						
	11	✓	-	-						
	12	✓	-	-						
	13	✓	-	-						
	14	✓	-	-						
	15	✓	-	-						
	16	✓	-	-						
	17	✓	-	-						
	18	✓	-	-						
	19	✓	-	-						
	20		✓	✓						
	21		✓	✓						
	22		✓	✓						
	23		✓	✓						
	24		✓	✓						
	25		✓	✓						
	26		✓	✓						
	27		✓	✓						
	28		✓	✓						
	29		✓	✓						
	30		✓	✓						
	31		✓	✓						
	32		✓	✓						
	33		✓	✓						

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
11950835	11950835	BALIARDA ET AL.
	Examiner	**Art Unit**
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010	12/31/2010						
	34		✓	✓						
	35		✓	✓						
	36		✓	✓						
	37		✓	✓						
	38		✓	✓						
	39		✓	✓						
	40		✓	✓						
	41		✓	✓						
	42		✓	✓						
	43		✓	✓						
	44		✓	✓						
	45		✓	✓						
	46		✓	✓						
	47		✓	✓						
	48		✓	✓						
	49		✓	✓						
	50		✓	✓						
	51		✓	✓						
	52		✓	✓						
	53		✓	✓						
	54		✓	✓						
	55		✓	✓						

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(**Not for submission under 37 CFR 1.99)**

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

Receipt date: 09/28/2010	Application Number	11950835 11950835 - GAU: 2821
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	R. Karacsony
	Attorney Docket Number	47005-P015WUSC1

	1	TAGUCHI, Yujiro. Aeronautical Low-Profile Yagi-Uda Antennas. Electronic and Comunications in Japan, Vol. 81, No. 12, 1998.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/31/2010

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-06)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6509882		1999-10-12	Fukasawa et al	
	2	6337667		2002-01-08	Ayala et al	
	3	5966097		2003-01-21	McKivergan	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] ¡	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

EFS Web 2.0

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

Receipt date: 12/13/2010	Application Number	11950835 11950835 - GAU: 2821
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2007-12-05
(Not for submission under 37 CFR 1.99)	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Karacsony, Robert
	Attorney Docket Number	47005-P015WUSC1

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Chen , S. C. Notice of Allowance of US patent application no. 11/075980 dated on June 1, 2007	☐
	2	Chen , S. C. Notice of Allowance of US patent application no. 11/075980 dated on September 19, 2007	☐
	3	Chen , S. C. Office Action of US patent application no. 11/075980 dated on January 29, 2007	☐
	4	Chen , S. C. Office Action of US patent application no. 11/075980 dated on July 12, 2006	☐
	5	Robinson , R. Response to Office Action dated January 29, 2007 of US patent application no. 11/075980	☐
	6	Mithani , S. Response to Office Action dated July 12, 2006 of US patent application no. 11/075980	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/31/2010

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. [ ] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. [ ] Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
      ii. [ ] Other _____

   b. [x] Enclosed
      i. [ ] Amendment/Reply
      ii. [ ] Affidavit(s)/Declaration(s)
      iii. [x] Information Disclosure Statement (IDS)
      iv. [ ] Other _____

2. Miscellaneous

   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. [ ] Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. [x] The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any Overpayments, to Deposit Account No. 23-2426 .
      i. [x] RCE fee required under 37 CFR 1.17(e)
      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)
      iii. [ ] Other _____

   b. [ ] Check in the amount of $ _____ enclosed

   c. [ ] Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Shoaib A. Mithani/	Date	December 13, 2010
Name (Print/Type)	Shoaib A. Mithani	Registration No.	61,654

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 13, 2010 Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6509882		1999-10-12	Fukasawa et al	
	2	6337667		2002-01-08	Ayala et al	
	3	5966097		2003-01-21	McKivergan	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] ¡	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Karacsony, Robert
Attorney Docket Number	47005-P015WUSC1

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Chen , S. C. Notice of Allowance of US patent application no. 11/075980 dated on June 1, 2007	☐
	2	Chen , S. C. Notice of Allowance of US patent application no. 11/075980 dated on September 19, 2007	☐
	3	Chen , S. C. Office Action of US patent application no. 11/075980 dated on January 29, 2007	☐
	4	Chen , S. C. Office Action of US patent application no. 11/075980 dated on July 12, 2006	☐
	5	Robinson , R. Response to Office Action dated January 29, 2007 of US patent application no. 11/075980	☐
	6	Mithani , S. Response to Office Action dated July 12, 2006 of US patent application no. 11/075980	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 13, 2010
Electronic Signature for Shoaib A. Mithani: /Shoaib A. Mithani/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement, pursuant to 37 CFR 1.114(c), accompanies the Request for Continued Examination (37 CFR 1.114) submitted herewith.

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information

as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1.

Dated: December 13, 2010

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Shoaib Amirali Mithani
Attorney Docket Number:	47005-P015WUSC1

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($)
Miscellaneous:				
Request for continued examination	1801	1	810	810
		Total in USD ($)		**810**

Electronic Acknowledgement Receipt

EFS ID:	9018616
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Shoaib Amirali Mithani
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	13-DEC-2010
Filing Date:	05-DEC-2007
Time Stamp:	13:20:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$810
RAM confirmation Number	9538
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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

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

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	RCE.pdf	29013 c5d6003094e05adddae22a7eae76befd1ae2c677	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2	Information Disclosure Statement (IDS) Filed (SB/08)	IDSbyapplicant.PDF	218780 f328680d220bf41b476968a38da168d851c1fb10	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Transmittal Letter	IDStrans.pdf	25189 a490a4b9f3a4e0dc8aeb38051527c7bca38dd6d2	no	2
Warnings:					
Information:					
4	NPL Documents	MithaniROA11075980.pdf	805433 877826dc7ef31d9ab6d884deb4e250c6a80d982f	no	17
Warnings:					
Information:					
5	NPL Documents	RobinsonROA11075980.pdf	590673 3a5c64b4d127db315cb990fa82289b28b7688c00	no	15
Warnings:					
Information:					
6	NPL Documents	ChenJuly2006OA11075980.pdf	436026 686eb72c03c97e7b925018b043436f2c549fcd18	no	12
Warnings:					
Information:					
7	NPL Documents	ChenOAJanuary200711075980.pdf	466618 f109080afe5d0d66df3cd5f7f0f392cf3f246a1c	no	12
Warnings:					
Information:					
8	NPL Documents	ChenNOA11075980September2007pdf.pdf	319825 58303b6ec916b7835301da5a26f2a1f8191cbcf6	no	6

Warnings:					
Information:					
9	NPL Documents	ChenNOAJune200711075980.pdf	354980 aa306678d4732093947c06b30c4a8d26c281c2bf	no	7
Warnings:					
Information:					
10	Fee Worksheet (PTO-875)	fee-info.pdf	30357 73d9d4ea66e45aec566396d95685bdebbb04e108	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3276894		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 12/13/2010

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	X $ =		OR	X $52=	0
Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $220=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/DOROTHY BELL/

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

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

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	R. Karacsony
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	R. Karacsony
	Attorney Docket Number	47005-P015WUSC1

	1	TAGUCHI, Yujiro. Aeronautical Low-Profile Yagi-Uda Antennas. Electronic and Comunications in Japan, Vol. 81, No. 12, 1998.	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	R. Karacsony
	Attorney Docket Number	47005-P015WUSC1

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☐ None

SIGNATURE

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

Signature		Date (YYYY-MM-DD)	
Name/Print		Registration Number	

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

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: September 28, 2010
Electronic Signature for Brenda I. Brown: /Brenda I. Brown/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed after the mailing date of a Final Office Action or Notice of Allowance, whichever occurred first, but on or before payment of the Issue Fee (37 CFR 1.97(d)). Applicant(s) hereby petition(s) that the Information Disclosure Statement be considered.

I hereby certify, pursuant to 37 CFR 1.97(e)(1), that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

Please charge our Deposit Account No. 23-2426 in the amount of $180.00 covering the fee set forth in 37 CFR 1.17(p). The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1.

Dated: September 28, 2010

Respectfully submitted,

Electronic signature: /Shoaib A. Mithani/
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson/Brenda Brown
Attorney Docket Number:	47005-P015WUSC1

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:	8513240
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson/Brenda Brown
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	28-SEP-2010
Filing Date:	05-DEC-2007
Time Stamp:	13:25:53
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	10402
Deposit Account	232426
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	IDSbyApplicant47005P015WUSC1.pdf	35589 6608c950bab7880220a8ab4c5b1d508596b091f9	no	4
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	Transmittal Letter	IDS47005P015WUSC1.pdf	26137 7d13fa7d4f023ebdead221c0a66aa4a10c3624e2	no	2
Warnings:					
Information:					
3	NPL Documents	TAGUCHI.pdf	419277 eae26df503268ffe0666a54ce1ddaf42fce8229f	no	11
Warnings:					
Information:					
4	Fee Worksheet (PTO-875)	fee-info.pdf	30366 1c9cc6b84b7cc4fdd6b1c43c2663edcc96479fb0	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	511369		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 09/14/2010

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

EXAMINER	
KARACSONY, ROBERT	

ART UNIT	PAPER NUMBER
2821	

MAIL DATE	DELIVERY MODE
09/14/2010	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

-- 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 June 2010*.

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

3)☐ 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

4)☒ Claim(s) *20-55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20-55* is/are rejected.

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

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

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

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

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

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. The following Office Action is in response to the Amendments received June 25, 2010. Claims 20-55 are currently pending.

Claim Objections

2. Claims 28, 40, 41 and 44-46 are objected to because of the following informalities:

3. In line 1, claim 28, please replace "first radiating arm" with --the first radiating arm-- to comply with antecedent basis rules.

4. Claims 40, 41 and 44-46: Please define the limitations "GSM," "UMTS," "AMPS," "DCS" and "PCS" at least once in the claims.

5. Appropriate correction is required.

Claim Rejections - 35 USC § 102

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

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claims 20-25, 27, 30-34, and 40-55 are rejected under 35 U.S.C. 102(e) as being anticipated by *Phillips et al.* (US 6,765,536, hereinafter *Phillips*).

Claim 20: *Phillips* teaches a handheld terminal comprising: at least one printed circuit board (14, fig. 1) comprising a ground plane (col. 3, lines 53-58); a first radiating arm (10, fig. 1) comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point (point that connects to transceiver, see fig. 2); a second

radiating arm (12, fig. 1) not in ohmic contact (col. 3, lines 45-47) with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane (end that couples to ground via tuning circuit 20, see fig. 2); a feeding port (transceiver, see fig. 2) defined between the feeding point of the first radiating arm and at least one point on the ground plane; wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board (col. 3, lines 53-54); wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second- radiating-arm second end (fig. 1); wherein the line segment does not intersect a projection orthogonal to the ground plane (fig. 1).

Claim 21: *Phillips* teaches the handheld terminal comprises a cell phone (col. 2, lines 54-56).

Claim 22: *Phillips* teaches the cell phone comprises a clamshell body (fig. 11).

Claim 23: *Phillips* teaches the clamshell body comprises: a first body portion (132, fig. 11); a second body portion (130, fig. 11); and a hinge (134, fig. 11) interposed between the first body portion and the second body portion; and the first radiating arm and the second radiating arm are mounted adjacent to the hinge (fig. 11).

Claim 24: *Phillips* teaches the feeding port is located on a first side of the hinge (fig. 11); the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge (fig. 11); the second side is opposite the first side (fig. 11).

Claim 25: *Phillips* teaches the cell phone comprises a candy bar body (fig. 11, the Examiner interprets the shape of the phone in the closed state as a candy bar).

Claim 27: *Phillips* teaches the line segment is coplanar with the ground plane (fig. 1).

Claim 30: *Phillips* teaches the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane (fig. 1).

Claim 31: *Phillips* teaches the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane (fig. 1).

Claim 32: *Phillips* teaches the feeding port is located on a first comer (left corner of ground plane, see fig. 1) of the ground plane.

Claim 33: *Phillips* teaches the second-radiating-arm second end is coupled to the ground plane on a second comer (right corner of ground plane, see fig. 1) of the ground plane.

Claim 34: *Phillips* teaches the ground plane is substantially rectangular (fig. 1); and the first comer and the second comer are opposite comers of a short edge of the substantially rectangular ground plane (fig. 1).

Claim 40: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); and at least one of the multiple frequency bands is used by a GSM or UMTS communication service (col. 1, lines 38-42).

Claim 41: *Phillips* teaches the handheld terminal is operative at multiple frequency bands (col. 2, lines 15-17); a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service (col. 1, lines 38-42).

Claim 42: *Phillips* teaches the handheld terminal is operative at least at four frequency bands (col. 1, lines 38-42).

Claim 43: *Phillips* teaches the handheld terminal is operative at least at five frequency bands (col. 1, lines 38-42).

Claim 44: *Phillips* teaches the handheld terminal is operative according to at least three of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 45: *Phillips* teaches the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS (col. 1, lines 38-42).

Claim 46: *Phillips* teaches the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS 1900, and DCS (col. 1, lines 38-42).

Claim 47: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 48: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a monopole (fig. 1).

Claim 49: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises an IFA structure (col. 8, lines 59-62).

Claim 50: *Phillips* teaches the monopole comprises an IFA structure (col. 8, lines 59-62).

Claim 51: *Phillips* teaches one of the first radiating arm and the second radiating arm comprises a monopole; and the other of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 52: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 53: *Phillips* teaches each of the first radiating arm and the second radiating arm comprises a microstrip structure (col. 8, lines 59-62).

Claim 54: *Phillips* teaches the microstrip structure comprises a PIFA structure (col. 8, lines 59-62).

Claim 55: *Phillips* teaches at least one of the first radiating arm and the second radiating arm comprises a PIFA structure (col. 8, lines 59-62).

Claim Rejections - 35 USC § 103

8. 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 negatived by the manner in which the invention was made.

9. Claims 26, 28, 29, and 35-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Phillips*.

Claim 26: *Phillips* teaches all of the limitations of claim 21, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm are substantially coplanar. However, *Phillips* teaches that either the antenna element and the parasitic element can be a straight wire (col. 3, lines 61-62) and that they each can be shared therebetween (col. 8, lines 41-48). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a straight wire for both the antenna element and the parasitic element, thereby having them coplanar, as suggested by *Phillips*, since it was known to one having ordinary skill in the art at the time of the invention.

Claim 28: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space

operating wavelength. However, *Phillips* teaches that the coupling between the antenna element and the parasitic element can be varied by controlling the diameter of the parasitic element (col. 4, lines 10-14). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have set the length of the coupling region to that of the claimed invention in order to have varied the coupling between the antenna element and the parasitic element.

Claim 29: The modified invention of *Phillips* teaches the first radiating arm and the second radiating arm are coplanar with the ground plane (fig. 1).

Claims 35-39: *Phillips* teaches all of the limitations of claim 20, as discussed above. *Phillips* fails to explicitly teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Double Patenting

10. 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 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).

11. Claims 20-34 and 40-48 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1, 2, 14, 17, 22-24 and 35 of U.S. Patent No. 7,315,289, (hereinafter '289). Although the conflicting claims are not identical, they are not patentably distinct from each other because.

Claim 1 of '289 teaches the limitations of claims 20, 47 and 48 of the instant application.

Claim 2 of '289 teaches the limitations of claim 28 of the instant application.

Claim 14 of '289 teaches the limitations of claims 26 and 27 of the instant application.

Claim 17 of '289 teaches the limitations of claims 40-46 of the instant application.

Claim 22 of '289 teaches the limitations of claims 21 and 25 of the instant application.

Claim 23 of '289 teaches the limitations of claim 22 of the instant application.

Claim 24 of '289 teaches the limitations of claims 23 and 24 of the instant application.

Claim 35 of '289 teaches the limitations of claims 30-34 of the instant application.

12. Claims 35-39 and 49-55 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of '289 in view of *Phillips*.

Claims 35-39: Claim 1 of '289 teaches all of the limitations of claim 20 of the instant application, however, fails to teach the handheld terminal comprises a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device. However, the use of the antenna in any of the above listed devices is merely a matter of intended use. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the antenna in a personal digital assistant, a cordless telephone, a pager, an electronic gaming device or a remote control device since all of them are wireless devices that require an antenna and it is merely a matter of intended use.

Claims 49-55: Claim 1 of the instant application teaches all of the limitations of claim 20 and 47, however, fails to teach at least one of the first radiating arm and the second radiating arm comprises an IFA structure, the monopole comprises an IFA structure, one of the first radiating arm and the second radiating arm comprises a monopole and the other of the first radiating arm and the second radiating arm comprises a microstrip structure, at least one of the first radiating arm and the second radiating arm comprises a microstrip structure, each of the first radiating arm and the second radiating arm comprises a microstrip structure and the microstrip structure

comprises a PIFA structure, or at least one of the first radiating arm and the second radiating arm comprises a PIFA structure. However, *Phillips* teaches any suitable type of antenna may be used such as printed wire antennas or PIFAs (col. 8, lines 59-62). The claim would have been obvious because the substitution of one known element for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have selected the antenna of '289 to be any one of IFA, monopole, microstrip or PIFA, with a reasonable expectation of success, since the substitution of one known element for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

Response to Arguments

13. Applicant's arguments with respect to claims 20-55 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

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

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacob Y. Choi can be reached on 571-272-2367. 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.

/R. K./
Examiner, Art Unit 2821

/Jacob Y Choi/
Supervisory Patent Examiner, Art Unit 2821

Notice of References Cited	Application/Control No. 11/950,835	Applicant(s)/Patent Under Reexamination BALIARDA ET AL.	
	Examiner ROBERT KARACSONY	Art Unit 2821	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,765,536	07-2004	Phillips et al.	343/702
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

SEARCHED			
Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK
343	803	9/10/2010	RK

SEARCH NOTES		
Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK
Class/Subclass, Text, Assignment data, Inventor name and Backward/Forward search	9/10/2010	RK

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010							
	1	✓	-							
	2	✓	-							
	3	✓	-							
	4	✓	-							
	5	✓	-							
	6	✓	-							
	7	✓	-							
	8	✓	-							
	9	✓	-							
	10	✓	-							
	11	✓	-							
	12	✓	-							
	13	✓	-							
	14	✓	-							
	15	✓	-							
	16	✓	-							
	17	✓	-							
	18	✓	-							
	19	✓	-							
	20		✓							
	21		✓							
	22		✓							
	23		✓							
	24		✓							
	25		✓							
	26		✓							
	27		✓							
	28		✓							
	29		✓							
	30		✓							
	31		✓							
	32		✓							
	33		✓							
	34		✓							
	35		✓							
	36		✓							

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009	09/10/2010							
	37		✓							
	38		✓							
	39		✓							
	40		✓							
	41		✓							
	42		✓							
	43		✓							
	44		✓							
	45		✓							
	46		✓							
	47		✓							
	48		✓							
	49		✓							
	50		✓							
	51		✓							
	52		✓							
	53		✓							
	54		✓							
	55		✓							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	5	("2004025778").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/09/09 16:04
S2	5	(("5966097") or ("20020075187") or ("6337667") or ("5365246") or ("4628322")).PN.	US-PGPUB; USPAT	OR	OFF	2010/09/09 16:06
S3	2	("20080129630").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/09/09 16:26
S4	687048	(cell cellular portable mobile) adj (device phone terminal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:28
S5	2225093	fold$3 flip$4 clamshell hinge	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:29
S6	772764	antenna antennae radiator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:29
S7	202637	parasitic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:29

S8	1325	S4 and S5 and S6 and S7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:29
S9	330	S4 and S5 and S6 and S7 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/09 16:30
S10	15	("20030169209" | "20050285596" | "20060022889" | "20070057849" | "20070069958" | "20080168384" | "4742359" | "5966097" | "6707428" | "6795028" | "7026996" | "7026999" | "7084813" | "7173567" | "7215289").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:31
S11	6	("20050110692" | "5583521" | "5966097" | "6657595" | "6765536" | "6876331").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:33
S12	2	("7215289").URPN.	USPAT	OR	ON	2010/09/09 16:35
S13	9	("20040212542" | "20060044196" | "20070182651" | "20080094303" | "6339402" | "6850196" | "6914565" | "7289064" | "7477201").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:37
S14	13	("20020075187" | "20040212545" | "4628322" | "4907006" | "5365246" | "5838285" | "5903239" | "5966097" | "5990838" | "6337667" | "6373447" | "6466176" | "6509882").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:44
S15	2	("6995719" | "7009567").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:46
S16	6	("20050007291" | "20050184914" | "20050212706" | "5914690" | "6674411" | "7180464").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:47
S17	2	("7215289").URPN.	USPAT	OR	ON	2010/09/09 16:48

S18	16	("20020105471" | "20060082514" | "2745102" | "4827266" | "5966097" | "6326921" | "6429818" | "6456249" | "6480155" | "6535170" | "6657593" | "6657595" | "6765536" | "6819287" | "7084831").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:49
S19	12	("4442438" | "4494122" | "4631546" | "4800395" | "4939525" | "5572223" | "5754146" | "5767807" | "5923305" | "6081700" | "6107970" | "6448942").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 16:51
S20	10	("4644361" | "5365246" | "6466170" | "6504511" | "6535170" | "6573867" | "6573869" | "6603429" | "6686886" | "6801168").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 17:12
S21	10	("4644361" | "5365246" | "6466170" | "6504511" | "6535170" | "6573867" | "6573869" | "6603429" | "6686886" | "6801168").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 17:17
S22	12	("4442438" | "4494122" | "4631546" | "4800395" | "4939525" | "5572223" | "5754146" | "5767807" | "5923305" | "6081700" | "6107970" | "6448942").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/09 17:18
S23	114	((CARLES) near2 (BALIARDA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/10 19:33
S24	32	((JAUME) near2 ("ANGUERA PROS")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/10 19:35
S25	36	((JORDI) near2 ("SOLER CASTANY")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/10 19:36
S26	3	((ANTONIO) near2 ("CONDES MARTINEZ")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/10 19:36
S27	182	fractus.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/10 19:37

S28	386	343/803.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/10 19:38
S29	9	candy$1bar adj phone	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/10 19:39
S30	5	"7315289"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/10 20:48

EAST Search History (Interference)

< This search history is empty>

9/10/2010 9:46:22 PM
C:\Documents and Settings\rkaracsony\My Documents\EAST\Workspaces\Cases\Coupled Multiband Antennas 11950835\Coupled Multiband Antennas 09-09-2010.wsp

*** All search listings have been considered by the Examiner. /RK/

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: June 25, 2010
Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Docket No. 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No. 11/950,835 Confirmation No. 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: R. Karacsony

AMENDMENT IN RESPONSE TO NON-FINAL OFFICE ACTION

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

Dear Sir:

INTRODUCTORY COMMENTS

In response to the Office Action dated December 30, 2009, please amend the above-identified U.S. patent application as follows:

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

Remarks/Arguments begin on page 6 of this paper.

AMENDMENTS TO THE CLAIMS

1-19. (CANCEL)

20. (NEW) A handheld terminal comprising:

at least one printed circuit board comprising a ground plane;

a first radiating arm comprising a first-radiating-arm first end and a first-radiating-arm second end, the first-radiating-arm first end being a feeding point;

a second radiating arm not in ohmic contact with the first radiating arm and comprising a second-radiating-arm first end and a second-radiating-arm second end, the second-radiating-arm second end being coupled to the ground plane;

a feeding port defined between the feeding point of the first radiating arm and at least one point on the ground plane;

wherein the first radiating arm and the second radiating arm are mounted on the at least one printed circuit board;

wherein a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end;

wherein the line segment does not intersect a projection orthogonal to the ground plane.

21. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises a cell phone.

22. (NEW) The handheld terminal of claim 21, wherein the cell phone comprises a clamshell body.

23. (NEW) The handheld terminal of claim 22, wherein:

the clamshell body comprises:

a first body portion;

a second body portion; and

a hinge interposed between the first body portion and the second body portion; and

the first radiating arm and the second radiating arm are mounted adjacent to the hinge.

24. (NEW) The handheld terminal of claim 23, wherein:

the feeding port is located on a first side of the hinge;

the second-radiating-arm second end is coupled to the ground plane on a second side of the hinge;

the second side is opposite the first side.

25. (NEW) The handheld terminal of claim 21, wherein the cell phone comprises a candybar body.

26. (NEW) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm are substantially coplanar.

27. (NEW) The handheld terminal of claim 25, wherein the line segment is coplanar with the ground plane.

28. (NEW) The handheld terminal of claim 20, wherein first radiating arm and the second radiating arm define a coupling region in which the length of the line segment is shorter than a tenth of a longest free-space operating wavelength.

29. (NEW) The handheld terminal of claim 26, wherein the first radiating arm and the second radiating arm are coplanar with the ground plane.

30. (NEW) The handheld terminal of claim 21, wherein the first radiating arm and the second radiating arm protrude beyond an edge of the ground plane.

31. (NEW) The handheld terminal of claim 30, wherein the first radiating arm and the second radiating arm are substantially perpendicular to the ground plane.

32. (NEW) The handheld terminal of claim 21, wherein the feeding port is located on a first corner of the ground plane.

33. (NEW) The handheld terminal of claim 32, wherein the second-radiating-arm second end is coupled to the ground plane on a second corner of the ground plane.

34. (NEW) The handheld terminal of claim 33, wherein:
the ground plane is substantially rectangular; and
the first corner and the second corner are opposite corners of a short edge of the substantially rectangular ground plane.

35. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises a personal digital assistant.

36. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises a cordless telephone.

37. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises a pager.

38. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises an electronic gaming device.

39. (NEW) The handheld terminal of claim 20, wherein the handheld terminal comprises a remote control device.

40. (NEW) The handheld terminal of claim 20, wherein:
the handheld terminal is operative at multiple frequency bands; and
at least one of the multiple frequency bands is used by a GSM or UMTS communication service.

41. (NEW) The handheld terminal of claim 40, wherein:
the handheld terminal is operative at multiple frequency bands;
a first one of said multiple frequency bands is used by a GSM communication service and a second one of said multiple frequency bands is used by a UMTS communication service.

42. (NEW) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at four frequency bands.

43. (NEW) The handheld terminal of claim 20, wherein the handheld terminal is operative at least at five frequency bands.

44. (NEW) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least three of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

45. (NEW) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least four of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

46. (NEW) The handheld terminal of claim 21, wherein the handheld terminal is operative according to at least five of AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, and DCS.

47. (NEW) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a monopole.

48. (NEW) The handheld terminal of claim 47, wherein each of the first radiating arm and the second radiating arm comprises a monopole.

49. (NEW) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises an IFA structure.

50. (NEW) The handheld terminal of claim 47, wherein the monopole comprises an IFA structure.

51. (NEW) The handheld terminal of claim 47, wherein:
one of the first radiating arm and the second radiating arm comprises a monopole; and

the other of the first radiating arm and the second radiating arm comprises a microstrip structure.

52. (NEW) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a microstrip structure.

53. (NEW) The handheld terminal of claim 52, wherein each of the first radiating arm and the second radiating arm comprises a microstrip structure.

54. (NEW) The handheld terminal of claim 52, wherein the microstrip structure comprises a PIFA structure.

55. (NEW) The handheld terminal of claim 20, wherein at least one of the first radiating arm and the second radiating arm comprises a PIFA structure.

REMARKS

Reconsideration of the application is respectfully requested. Claims 1-19 have been cancelled. No claims have been amended. New claims 20-55 have been added. Claims 20-55 are pending.

Claims 2, 8-10, 13, 15-16, and 18-19 stand objected to because of various informalities. These claims have been cancelled, thereby rendering the objections thereto moot.

Claims 1-3 and 6-7 stand rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent Publication No. 2003/0020661 to Sato ("Sato"). Claims 1 and 4-5 stand rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent Publication No. 2002/0149527 to Wen, et al. ("Wen"). Claims 1 and 8-11 stand rejected under 35 U.S.C. 102(b) as being anticipated by EP 1067627 to Pedersen ("Pedersen"). Claims 1, 13-15, 17, and 19 stand rejected under 35 U.S.C. 102(e) as anticipated by U.S. Patent No. 6,943,730 to Poilasne, et al. ("Poilasne"). Claims 1, 16, and 18 stand rejected under 35 U.S.C. 102(e) as anticipated by U.S. Patent No. 6,509,882 to McKivergan ("McKivergan"). Claim 12 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Sato. Claims 1-19 have been cancelled, thereby rendering the novelty and obviousness rejections referenced above moot.

Claims 1-19 stand rejected on the basis of non-statutory obviousness-type double patenting as being unpatentable over claims 1-17 of U.S. Patent No. 7,315,289. Claims 1-19 have been cancelled, thereby rendering the rejection thereof moot.

With regard to newly added independent claim 20, Applicant respectfully submits that this claim patentably distinguishes over the art cited in the Office Action of December 30, 2009 ("the cited art"), at least because the cited art fails to disclose a first radiating arm and a second radiating arm as claimed in which a length of a line segment between a point of the first radiating arm and a point of the second radiating arm is less than a distance between the feeding point and the second-radiating-arm second end and that the line segment does not intersect a projection orthogonal to a ground plane as claimed. Applicant respectfully submits that the claims dependent from claim 20 distinguish over the cited art for at least the same reasons as those noted with regard to claim 20.

In view of the above, Applicant respectfully submits that the present application is in condition for allowance. A Notice to that effect is respectfully requested.

Dated: June 25, 2010

Respectfully submitted,

Electronic signature: /Ross T. Robinson/
Ross T. Robinson
Registration No.: 47,031
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

Electronic Patent Application Fee Transmittal

Application Number:	11950835
Filing Date:	05-Dec-2007
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1

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:				
Claims in excess of 20	1202	16	52	832
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1110	1110
Miscellaneous:				
			Total in USD ($)	**1942**

Electronic Acknowledgement Receipt

EFS ID:	7899274
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	25-JUN-2010
Filing Date:	05-DEC-2007
Time Stamp:	19:27:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1942
RAM confirmation Number	5473
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	response.pdf	99179 57fadca67944fb5f5c04f888cb9aacc731140ba1	no	7
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	32391 a930ab619d1e96e5a22ca164b32bff0e68609dc6	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	131570		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/950,835	12/05/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 06/25/2010	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 36	Minus	** 20	= 16	X $ =		OR	X $52=	832
Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $220=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	**832**

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/DAVINA G. BUTLER/

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1

CONFIRMATION NO. 7241

61060
WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

POA ACCEPTANCE LETTER

OC000000039386861

Date Mailed: 12/31/2009

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/21/2009.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/tnnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

61060 7590 12/30/2009

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

EXAMINER	
KARACSONY, ROBERT	
ART UNIT	**PAPER NUMBER**
2821	

MAIL DATE	DELIVERY MODE
12/30/2009	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/950,835	BALIARDA ET AL.	
	Examiner	Art Unit	
	ROBERT KARACSONY	2821	

-- 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 *05 December 2007*.

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

3)☐ 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

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-19* is/are rejected.

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

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

Application Papers

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

10)☒ The drawing(s) filed on *11 February 2008* 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *See Continuation Sheet*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :01/22/2008, 04/08/2008, 06/09/2008, 06/09/2008, 09/02/2008, 11/05/2008.

DETAILED ACTION

Claim Objections

1. Claims 2, 8-10, 13, 15, 16, 18 and 19 are objected to because of the following informalities:

2. In line 6, claim 2, please replace "the longer free space operating wavelength" with --a longer free space operating wavelength--, to comply with proper antecedent basis rules. Claims 8, 9 and 13 are objected to for the same reasons as claim 2, as discussed above.

3. In line 7, claim 10, please replace "said conducting ground plane" with --a conducting ground plane--, to comply with proper antecedent basis rules. Claims 15, 16 and 19 are objected to for the same reasons as claim 10, as discussed above.

4. In line 9, claim 13, please replace "the same shorter edge of said ground plane" with --the same edge of said ground plane--, to comply with proper antecedent basis rules.

5. Appropriate correction is required.

Claim Rejections - 35 USC § 102

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

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claims 1-3, 6 and 7 are rejected under 35 U.S.C. 102(e) as being anticipated by *Sato* (US 2003/0020661, hereinafter *Sato*).

Claim 1: *Sato* teaches an antenna device characterized in that it includes two or more radiating arms (11c, 11d &11b, fig. 1), a first of these radiating arms including a feeding point (12, fig. 1), wherein at least two of these radiating arms are coupled by at least a close proximity region (14, fig. 1), said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm (fig. 18), and wherein the antenna does not include a contact point between said first arm and said second arm (fig. 1 and fig. 18).

Claim 2: *Sato* teaches at least a first (11d & 11b, fig. 1) and a second radiating arm (11c, fig. 1), said first arm including a feeding point (12, fig. 1), wherein the distance between at least a first point in said first arm and a second point in said second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm said distance between said first and second points being shorter than a tenth of a longer free-space operating wavelength (fig. 1 and fig. 18).

Claim 3: *Sato* teaches a first arm (11d and 11b, fig. 1) includes a feeding port (12, fig. 1), said feeding port being formed by at least a point in one of the tips of said first arm and at least a point on a ground-plane or ground counterpoise (13, fig. 1), and wherein a second arm has one of its tips connected to said ground-plane or ground counterpoise.

Claim 6: *Sato* teaches at least one of the tips in one of the arms is closer to at least a point on a second arm than the distance between the feeding point in one arm and the grounding point on the other arm (fig. 1).

Claim 7: *Sato* teaches at least one of the arms include one bend, said bend defining an angle smaller than 90° with respect to the normal direction to a plane, said plane including the feeding point in one arm and being orthogonal to the ground plane at the feeding point and said plane excluding the grounding point on a second arm of the antenna, said normal to said plane being described by a vector pointing to the semispace over said plane including said grounding point on said second arm (fig. 1).

8. Claims 1, 4 and 5 are rejected under 35 U.S.C. 102(e) as being anticipated by *Wen et al.* (US 2002/0149527, hereinafter *Wen*).

Claim 1: *Wen* teaches an antenna device characterized in that it includes two or more radiating arms (32 and 34, fig. 2), a first of these radiating arms including a feeding point (44, fig. 2), wherein at least two of these radiating arms are coupled by at least a close proximity region (42, fig. 2), said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm (fig. 2), and wherein the antenna does not include a contact point between said first arm and said second arm (fig. 2).

Claim 4: *Wen* teaches the antenna has a differential input between a first feeding point on a first arm and a second feeding point on a second arm such that said first and second arms define the two arms of a dipole antenna (paragraph [0010]).

Claim 5: *Wen* teaches the antenna includes a differential input between a first feeding point on a first arm and a second feeding point on a second arm, and wherein said first and second arms are coupled through two close regions that include said close first and second points

on each of said first and second arms respectively, such that said first arm, said second arm and the coupling region between both arms define a loop for the current flowing through the antenna structure (fig. 3).

9. Claims 1 and 8-11 are rejected under 35 U.S.C. 102(b) as being anticipated by *Pedersen et al.* (EP 1067627, hereinafter *Pedersen*).

Claim 1: *Pedersen* teaches an antenna device characterized in that it includes two or more radiating arms (20 and 30,35,40,36,31, see fig. 6), a first of these radiating arms including a feeding point (22, fig. 6), wherein at least two of these radiating arms are coupled by at least a close proximity region (gap between element 20 and element 30,35,40,36,31), said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm (fig. 6), and wherein the antenna does not include a contact point between said first arm and said second arm (fig. 6).

Claims 8 and 9: *Pedersen* teaches at least a portion of at least one arm (20, fig. 6) is formed after ten or more connected segments, each of said segments forming an angle with their neighboring connected segments, said angle being smaller than 180 degrees (fig. 6 illustrates element 20 with a meandering shape), said segments being shorter than 1/8 of a longer free-space operating wavelength.

Claim 10: *Pedersen* teaches at least a portion of at least one arm includes a set of conductor, superconductor or semiconductor polygons (the Examiner interprets the parasitic radiator to be made up of several rectangular polygons, see fig. 6), all of said polygons featuring

the same number of sides, wherein said polygons are electromagnetically coupled either by means of a capacitive coupling or ohmic contact, wherein the contact region between directly connected polygons is narrower than 50% of the perimeter of said polygons in at least 75% of said polygons defining a conducting ground-plane.

Claim 11: *Pedersen* teaches at least one of the arms is formed by a polygonal surface enclosing a conducting, superconducting or semi conducting material (the Examiner interprets the parasitic radiator to enclose element 20, see fig. 6).

10. Claims 1, 13-15, 17 and 19 are rejected under 35 U.S.C. 102(e) as being anticipated by *Poilasne et al.* (US 6,943,730, hereinafter *Poilasne*).

Claim 1: *Poilasne* teaches an antenna device characterized in that it includes two or more radiating arms (14 and 12, fig. 1), a first of these radiating arms including a feeding point (18, fig. 1), wherein at least two of these radiating arms are coupled by at least a close proximity region (24, fig. 1), said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm (fig. 1), and wherein the antenna does not include a contact point between said first arm and said second arm (fig. 1).

Claim 13: *Poilasne* teaches at least a portion (vertical portions of 14 and 12 that extend orthogonal to ground plane 18, see fig. 1) of said first and second arm have a substantially planar shape (fig. 1), said portions being mounted orthogonally to a rectangular or elongated ground plane at a distance smaller than 1/3 of a free-space operating wavelength from the shorter side or edge of said ground plane, said portions of said arms being substantially parallel to said edge of

said ground-plane, said first arm including a feeding point (18, fig. 1), said feeding point being located near the corner of said ground plane at a distance smaller than a tenth of a free-space operating wavelength, said second arm being connected to said ground plane near the opposite corner on the same edge of said ground plane at a distance smaller than a tenth of a free- space operating wavelength.

Claim 14: *Poilasne* teaches the planar portion of said first arm is closer to the edge of said ground plane than the planar portion of said second arm, and said first arm includes the feeding point, while the second arm is shorted to the ground plane (fig. 1).

Claim 15: *Poilasne* teaches in that said first and second arms are planar and parallel to the ground plane (fig. 1).

Claims 17 and 19 is considered a suggested use limitation and is not given any patentable weight. It has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex Parte Masham, 2 USPQ F.2d 1647 (1987).

11. Claims 1, 16 and 18 are rejected under 35 U.S.C. 102(e) as being anticipated by *McKivergan* (US 6,509,882, hereinafter *Mckivergan*).

Claim 1: *Mckivergan* teaches an antenna device characterized in that it includes two or more radiating arms (54 and 70, fig. 2), a first of these radiating arms including a feeding point (62, fig. 2), wherein at least two of these radiating arms are coupled by at least a close proximity region (fig. 2), said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the

second arm (fig. 2), and wherein the antenna does not include a contact point between said first arm and said second arm (fig. 2).

Claim 16: *Mckivergan* (see fig. 2) teaches said first and second arms are planar and parallel to a ground plane (32) and are printed (The method of forming a device is not germane to the issue of patentability of the device itself, therefore, these limitations have not been given patentable weight) in any of the layers of the sides of a single layer or a multilayer printed circuit board, said board including also said ground plane.

Claim 18: *Mckivergan* teaches said antenna is integrated inside the package of an integrated circuit or chip (see fig. 1), such that at least one of the arms (54, 70) of said antenna is printed in one of the layers of the substrate (50) supporting the semiconductor die.

Claim Rejections - 35 USC § 103

12. 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 negatived by the manner in which the invention was made.

13. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Sato*.

Claim 12: *Sato* teaches all of the limitations of claim 1, as discussed above. *Sato* fails to teach at least a portion of said first and second arms are lying on two parallel surfaces, said surfaces being spaced by a dielectric material. However, the Examiner takes official notes that it was well known to the skilled artisan at the time of the invention to position a dielectric member intermediate to the ends of a capacitor to vary the electrical characteristic of the capacitor. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention

was made to have used a dielectric member between the ends of the two radiating arms of *Sato* in order to have varied the electrical characteristic of the capacitance.

Double Patenting

14. 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 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).

15. Claims 1-19 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-17 of U.S. Patent No. 7,315,289. Although the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-19 are broad enough that they encompass the claimed inventions of claim 1-17 of Patent No. 7,315,289.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT KARACSONY whose telephone number is (571)270-1268. The examiner can normally be reached on M-F 7:30 am - 5:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas W. Owens can be reached on 571-272-1662. 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.

/R. K./
Examiner, Art Unit 2821

/Hoang V Nguyen/
Primary Examiner, Art Unit 2821

Notice of References Cited	Application/Control No. 11/950,835	Applicant(s)/Patent Under Reexamination BALIARDA ET AL.	
	Examiner ROBERT KARACSONY	Art Unit 2821	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,573,867	06-2003	Desclos et al.	343/700MS
*	B	US-6,456,243	09-2002	Poilasne et al.	343/700MS
*	C	US-6,509,882	01-2003	McKivergan, Patrick D.	343/818
*	D	US-2003/0020661	01-2003	Sato, Masahide	343/702
*	E	US-2002/0149527	10-2002	Wen et al.	343/727
*	F	US-6,943,730	09-2005	Poilasne et al.	343/700MS
	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	EP1067627A1	01-2001	EP	Pedersen, Gert	---
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

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

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

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 067 627 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.01.2001 Bulletin 2001/02

(51) Int Cl.[7]: **H01Q 9/04**, H01Q 5/00, H01Q 1/24, H01Q 19/00

(21) Application number: **99113329.9**

(22) Date of filing: **09.07.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(71) Applicant: **ROBERT BOSCH GMBH**
70442 Stuttgart (DE)

(72) Inventors:
- **Jagielski, Ole c/o Peder Aarup**
  9210 Aalborg S/O (DK)
- **Pedersen, Gert Frolund**
  9280 Storvorde (DK)

(54) Dual band radio apparatus

(57) The invention relates to a radio apparatus (1), particularly for mobile use, comprising an antenna arrangement (5) with at least the first antenna element (20) and a second antenna element, wherein said first antenna element (20) and said second antenna element are coupled so that said antenna arrangement (5) is operational in at least to difference frequency bands and wherein the two antenna elements are connected to a ground plate (10) by first and second connecting means (50 and 60).

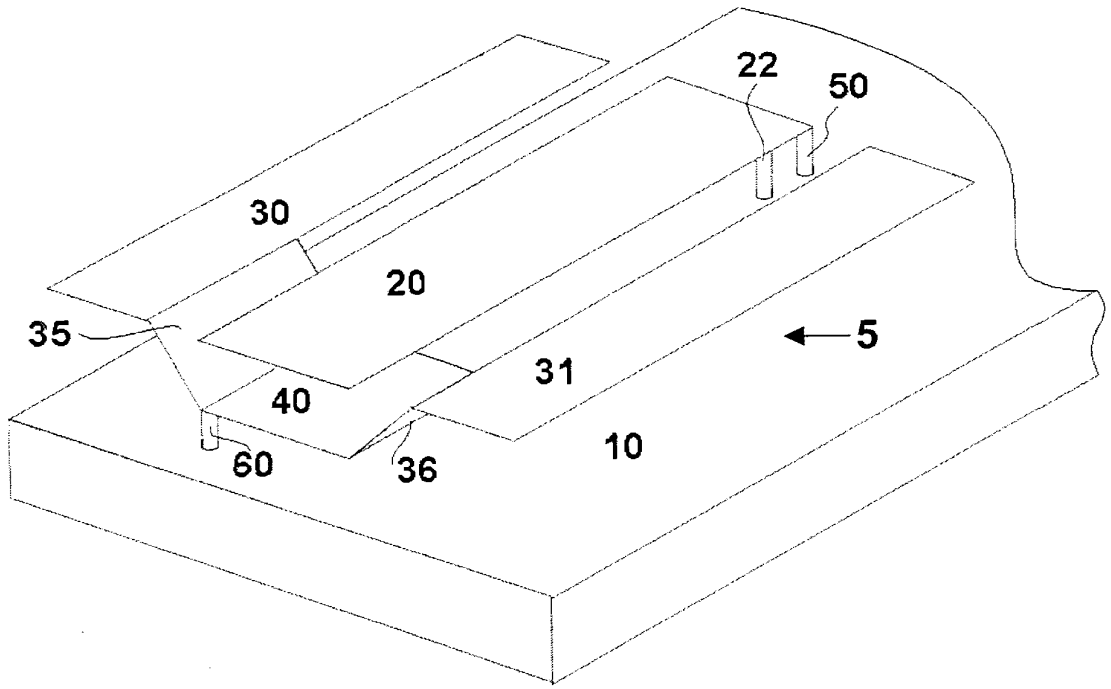


Fig 2

EP 1 067 627 A1

Printed by Jouve, 75001 PARIS (FR)

Description

Prior art

[0001] The invention relates to a radio apparatus, particularly for mobile use, comprising an antenna arrangement with at least a first antenna element and a second antenna element. From the international application WO 97/18601, a radio device is already known with a first antenna element and a second antenna element, this radio device being operational in at least two different frequency bands.

Advantages of the invention

[0002] The invention according to the features of the independent patent claim has the advantage that the volume of the antenna element is well used at all frequency bands of operation. Therefore, the radiation which is incident on the antenna arrangement or which is emitted from the antenna arrangement do not only originate from one point or a single part of the antenna arrangement but from several parts of the antenna arrangement. Therefore, it is possible to combine high efficiency of the antenna arrangement with a small size of the antenna arrangement. Furthermore, it is possible to build the antenna arrangement in a very compact way, as the maximum dimension required is only one eighth of the wavelength at the lowest frequency of operation.

[0003] The dependent patent claims comprise features that allow further useful improvements of the radio apparatus of the independent patent claim.

[0004] It is particularly advantageous that said first connecting means are provided substantially at a first end of the first antenna element. Thus, the first antenna element can be used together with the connecting ground plate substantially as a folded monopole antenna for emitting and/or receiving radio frequency radiation.

[0005] Furthermore, it is advantageous that the second antenna element includes a coupling element providing said capacitive coupling between said first antenna element and said second antenna element, said coupling element being provided close to a second end of said first antenna element so as to provide said electromagnetic interaction. Thus, the coupling between the first antenna element and the second antenna element can be implemented in a very simple manner. Especially, it is possible to conceive the antenna arrangement with a simple mechanical structure.

[0006] Furthermore, it is advantageous that said capacitive coupling between said first antenna element and said second antenna element is provided by interacting metallic surfaces, by a metallic surface interacting with a metallic wire and/or by interacting edges of metallic surfaces. This allows a variety of different possible designs of the antenna arrangement.

[0007] Furthermore, it is advantageous that said second antenna element includes two subelements and that said second connecting means are provided as a second shorting pin common to said two subelements. Thus, it is possible to combine high efficiency of the second antenna element and a small size of the two subelements.

[0008] Furthermore, it is advantageous that the two subelements are provided substantially symmetrically in respect of the centerline of that first antenna element and that said common second shorting pin is provided asymmetrically in respect of said centerline. Thus it is possible to place the resonances of the subelements slightly apart in order to obtain a greater band width of the resonance bands where the antenna arrangement is operational.

[0009] Furthermore, it is advantageous that said ground plate substantially defines a first plane, that said first antenna element and said second antenna element are provided substantially in a second plane and that the second plane is substantially parallel to the first plane. Thus, a better directionality of the antenna arrangement is possible. Furthermore, a good SAR-performance (specific absorption rate) is possible.

[0010] Furthermore, it is advantageous that said second plane and said third plane are substantially identical. Thus, the two antenna elements have almost the same characteristic in respect to space directionality.

[0011] Furthermore, it is advantageous that the first antenna element is provided as a capacitively coupled planar inverted F-antenna, a capacitively coupled patch antenna, an capacitively coupled inverted F-antenna or a capacitively coupled curled up inverted F-antenna. Thus, it is possible, to shape the first antenna element mechanically so that it fits into the form of a given design.

[0012] Furthermore, it is advantageous that the subelements are short circuit patch antennas. Thus, the second antenna element is easy to shape and to be adapted to a given design of the radio apparatus.

[0013] Furthermore, it is advantageous that the antenna arrangement operates at a first frequency band at a center frequency of about 900 MHz and that the antenna arrangement operates as well at a second frequency band, either at a center frequency of alternatively about 1800 MHz or 1900 MHz or at a center frequency comprised inbetween 1800 MHz and 1900 MHz. Thus, it is possible to use the radio apparatus in cellular radio telecommunication networks, as, for example, GSM-Networks, UMTS-Networks, GPRS-Networks and/or DECT-Networks.

Drawings

[0014] The invention is shown in the drawings and described in detail in the following description.

[0015] Figure 1 shows an antenna arrangement together with a ground plate of a radio apparatus in top view.

[0016] Figure 2 shows the antenna arrangement in perspective view together with a cutout of the ground plate.

[0017] Figure 3 shows a second embodiment of the antenna arrangement together with a cutout of the ground plate.

[0018] Figure 4 shows the second embodiment of the antenna arrangement together with the ground plate of the radio apparatus in top view

[0019] Figure 5 shows a third embodiment of the antenna arrangement together with a cutout of the ground plate.

[0020] Figure 6 shows a fourth embodiment of the antenna arrangement together with a cutout of the ground plate.

[0021] Figure 7 shows a fifth embodiment of the antenna arrangement together with a cutout of the ground plate.

[0022] Figure 8 shows a radio apparatus in front view.

[0023] Figure 9 shows the radio apparatus in side view including the ground plate and the antenna arrangement.

Description

[0024] For better understanding, the figures 8 and 9 are described first.

In figure 8, a radio apparatus 1 with a housing 2, input means 4 and output means 3 is depicted. The input means 4 are provided, for example, as keys, keyboards, microphones, touch screens and the like. The output means are provided, for example, as display means, loudspeakers and the like. The housing 2 has substantially a cuboidic form with a front side and with a back side, both shaped substantially as rectangles and with two lateral sides having a smaller surface than the front side. Figure 8 depicts the front side of the housing with the output means 3 in the upper portion of the front side and with the input means 4 in the lower portion of the front side.

[0025] Figure 9 depicts a side view of the radio apparatus 1 by showing a lateral side of the housing 2 with the output means 3 and the input means 4. In the interior of the housing 2 is provided a ground plate 10 and an antenna arrangement 5. The antenna arrangement 5 is connected to the ground plate by means of first and second connecting means 50, 60. The ground plate 10 is provided substantially elongated in two dimensions and therefore defines a first plane 11. The antenna arrangement 5 is also elongated in two dimensions and defines a second plane 21.

[0026] Figure 1 is a representation in top view of the ground plate 10 and of the antenna arrangement 5, the antenna arrangement 5 being connected to the ground plate 10. Figure 2 shows in perspective view said antenna arrangement 5 and a cut out of said ground plate 10. In the following, figure 1 and figure 2 are described together. The ground plate 10 has the form of a rectangle of conducting material and defines therefore the first plane 11. The antenna arrangement 5 comprises a first antenna element 20 and a second antenna element.

[0027] The first antenna element 20 is rectangularly shaped in an oblong manner and it is made of a conducting material, for example a metal. Furthermore the first antenna element 20 defines the second plane 21 which is parallel to the first plane 11. Therefore, the first antenna element 20 is provided at a certain distance of the ground plate 10. The second antenna element comprises a first subelement 30, a second subelement 31, a first bonding element 35, a second bonding element 36 and a coupling element 40, all these parts of the second antenna element being made of rectangular conducting plates of different size. The first and the second subelement 30, 31 have the same size and are shaped in an oblong manner. The coupling element 40 has substantially a quadratic form and the length of one of its sides is essentially the same as the width of the first antenna element 20. The first and second bonding elements 35, 36 have the same size; their length is essentially the same as the length of one side of the coupling element 40. The first bounding element 35 connects the first subelement 30 with the coupling element 40 and the second bounding element 36 connects the second subelement 31 with the coupling element 40, so that the second antenna element forms one piece. Particularly, the bonding elements 35, 36 provide an electrically conducting connection between the coupling element 40 and, respectively, the subelements 30, 31 of the second antenna element.

[0028] The first antenna element 20 is electrically connected to the ground plate 10 by first connecting means 50, provided near one of the corners of the rectangularly shaped first antenna element 20 or at a first of the small sides, i.e. at one end, of the first antenna element 20. As the first antenna element 20 has an oblong form, the location of the first connecting means 50 defines a first end of the first antenna element 20. The first connecting means 50 are provided in the form of a shorting pin and are therefore also referred to as the first shorting pin 50.

[0029] The subelements 30, 31 of the second antenna element are provided symmetrically relative to the first antenna element 20 and parallel to the first antenna element 20. Therefore, the subelements 30, 31 are provided in the same second plane 21 as the first antenna element 20. The symmetry of the location of the subelements 30, 31 is defined by the center line of the first antenna element 20 which is a symmetry axe parallel to the long side of the first antenna element 20. The width of the subelements 30, 31 is provided smaller than that of the first antenna element 20. The first subelement 30 is oriented parallel to the first antenna element 20. Furthermore, the subelements 30, 31 and the first antenna element 20 have substantially the same length and are provided side by side. The second subelement 31 is located identically relative to the first subelement 30 but symmetrically on the other side of the first antenna ele-

ment 20.

[0030] At one end of the first and the second subelement 30, 31 the two subelements 30, 31 are connected by means of the first and second bonding element 35, 36 to the coupling element 40, in order to form a single piece. The coupling element 40 has also rectangular form and is located parallel to the first and the second plane 11, 21 in a plane inbetween the first and the second plane 11, 21. To connect the coupling element 40 with the first subelement 30, the first bonding element 35 is located in a plane inclined relative to the first and the second plane 11, 21. Analogously, the second bonding element 36 is inclined relative to the first and the second plane 11, 21, as it connects the coupling element 40 with the second subelement 31. The coupling element 40 is provided so that an important portion of the coupling element 40 is situated near to a second end of the first antenna element 20 which is opposite to the first end where the first connecting means 50 are situated.

[0031] The antenna arrangement 5 is provided so that there is a relatively large coupling area where the coupling element 40 and the second end of the first antenna element 20 are fairly close to each other. The interaction of the antenna arrangement 5 with radio frequency radiation implies that the very narrowly spaced surfaces of the coupling element 40 and of the second end of the first antenna element 20 have the effect of a capacitive coupling between the first antenna element 20 and the second antenna element. The capacitive coupling between the two antenna elements is therefore provided like the coupling between the two plates of a condensator.

[0032] At the most distant corner of the coupling element 40 relative to the first connecting means 50 are provided second connecting means 60 which connect the coupling element 40 electrically to the ground plate 10. The second connecting means 60 are provided in the form of a shorting pin and are therefore also referred to as the second shorting pin 60. The second shorting pin 60 can be provided in the same manner as or differently to the first shorting pin 50, e.g. by means of a piece of wire or other connecting means.

[0033] Differently to the shape of the second antenna element, the second connecting means 60 are not provided symmetrically to the two subelements 30, 31 of the second antenna element. By providing this asymmetry in the location of the second connecting means 60, it is possible to provide an enlargement of the frequency band of operation of the antenna arrangement 5, especially in respect of the frequency band, the second antenna element is tuned to

[0034] A feeding element 22 is provided with the antenna arrangement 5 in order to connect the antenna arrangement 5 to reception and transmission circuitry provided with the radio apparatus 1. For these purposes, the feeding element 22 is connected, in an advantageous embodiment of the invention, to the first antenna element 20. In other embodiments of the invention the feeding element 22 may also be connected to the second antenna element. In figure 1 and 2 the feeding element 22 is provided relatively close to the first connecting means 50 in order to form a planar inverted F-antenna. Other locations of the feeding element 22 relative to the first antenna element 20 and relative to the second antenna element are possible according to the invention and are mainly dependent on the impedance required by a feeding circuit that is not shown. The feeding element 22 connects the feeding circuit and the antenna arrangement 5. The feeding circuit can also be replaced by a receiving circuit or by a combined feeding and receiving circuit.

[0035] Alternative embodiments of the described parts of the radio apparatus 1 or of the antenna arrangement 5 are mentioned in the following.

[0036] The feeding can be provided in different ways, for example by a slot feeding with a slot in the ground plate providing an electromagnetic coupling between the feeding element 22 and one of the antenna elements.

In other embodiments of the invention, a stub is provided to couple electromagnetically the feeding circuit to one of the antenna elements and to provide the feeding in this manner.

[0037] The first shorting pin 50 is a piece of wire connecting the first antenna element 20 with the ground plate 10. In an advantageous embodiment of the invention, these first connecting means 50 are provided as a shorting pin or as a shorting bridge made of conducting material which electrically connect the ground plate 10 with different parts of the antenna arrangement 5.

[0038] The ground plate 10 is a conducting ground plate, for example made of a metallic material. The ground plate 10 is, in a particular advantageous embodiment of the invention, fixed to a substrate which gives a mechanical stability to the conducting ground plate 10. The ground plate 10 can be provided as the circuit board of a radio apparatus 1 to be described together with figure 7. Naturally, it is possible to provide the ground plate 10 in such a manner that the mechanical stability is given by its own, for example by using as a conducting ground plate 10 a metallic panel of sufficient thickness. The conducting ground plate 10 is provided substantially in a first plane 11 which will be described together with figure 8. This means that the ground plate 10 is substantially flat. This does not exclude that some parts of the ground plate 10 are provided outside of the first plane 11.

[0039] The second antenna element is in an advantageous embodiment of the invention provided as a flat conductor, for example a metallic plate or a metallic layer on a mechanically fixing substrate. However, other embodiments, for example conductors in the form of a wire or layers in the form of a wire and being shaped, for example, in a helical way, are possible embodiments of the second antenna element.

[0040] Likewise, the first antenna element is, in the

embodiment of figure 1 and 2, a conducting plate but can be shaped in other ways, several of which are described in the following figures.

[0041] Furthermore, it is possible that the subelements 30,31 of the second antenna element are not in the same plane as the first antenna element 20. Thus the subelements can be located in a plane substantially parallel to the ground plate 10 but closer to or further from the ground plate 10 that the first antenna element 20.

[0042] Figure 3 depicts the antenna arrangement 5 together with a part of the ground plate 10 in a second embodiment. Likewise, figur 4 is a representation in topview of the ground plate 10 and of the second embodiment of the antenna arrangement 5. Therefore, figure 3 and 4 are described together. Identical reference numerals as in the preceding figures refer in figure 3 and 4 to the same parts or elements of the radio apparatus 1 or of the antenna arrangement 5. In the second embodiment, the first antenna element 20 is provided as a capacitively coupled patch antenna. The main portion of the first antenna element 20 is a metallic rectangle formed in an oblong manner, as described in connection with figures 1 and 2. At the first end of the first antenna element 20, there is an electrically conducting connection between the first antenna element 20 and the ground plate 10 along the entire small side of the first antenna element 20. This conducting connection can be called a connecting bridge and is another embodiment of the first connecting means 50. Another way to describe the second embodiment of the first connecting means 50 is that the small side of the metallic plate of which is formed the first antenna element 20 is bent by 90 degrees at a certain distance from one of its ends. This distance is equal to the distance of the first antenna element 20 and the ground plate 10. Thus, the bent end of the first antenna element 20 connects the first antenna element 20 to the ground plate 10 and forms the first connecting means 50 in a bridge-like manner. So, the first connecting means 50 are provided as a connecting bridge. In the embodiment of figure 3 and 4, the feeding element 22 is provided in a similar manner. The feeding element is realized as an electrically conductive connection between the first antenna element 20 and the feeding circuit. The feeding element 22 is provided near the first end of the first antenna element 20, i.e. near the first connecting means 50, and it is formed as a metallic plate, parallel to the small side of the first antenna element 20, that connects the first antenna element 20 with the feeding circuit. Thus, in the second embodiment, the feeding element 22 is provided as a connecting bridge between the first antenna element 20 and the feeding circuit.

[0043] Figure 5 depicts the antenna arrangement 5 in a third embodiment of the invention and furthermore, figure 5 shows a part of the ground plate 10. Identical reference numerals as in the preceding figures refer in figure 5 to the same parts or elements of the radio apparatus 1 or of the antenna arrangement 5. The first antenna element 20 is provided as a inverted F-antenna. The main portion of the first antenna element 20 has the form of an elongated wire, parallel to the first plane 11. At the first end of the first antenna element 20 the first shorting pin 50 connects the first antenna element 20 to the ground plate 10. Near the first shorting pin 50 the feeding element 22 is provided to connect the first antenna element 20 to the feeding circuitry of the radio apparatus 1. The first antenna element 20 is provided parallel to the first plane 11 at a certain distance to the ground plate 10. The second antenna element is provided in the same manner as described in figures 1 to 4. Therefore the coupling between the first antenna element 20 and the second antenna element is obtained by means of the interaction of the second or free end of the first antenna element 20, shaped as a wire, with the coupling element 40 of the second antenna element. The symmetry of the location of the subelements 30, 31 is defined by the center line of the first antenna element 20, which is, in the case of the third embodiment, parallel to the longest extension of the first antenna element 20.

[0044] Figure 6 depicts the antenna arrangement 5 together with a part of the ground plate 10 in a fourth embodiment of the invention. The first antenna element 20 is provided as a curled up inverted F-antenna. The first antenna element 20 is therefore shaped like a wire and the curled form of the first antenna element 20 is in the form of a meander. This allows a very small size of the antenna element for a given minimal frequency of operation of the first antenna element 20. The meander-shaped first antenna element 20 is again connected at its first end to the ground plate 10 by means of the shorting pin 50 and the second or free end of the first antenna element 20 interacts with the coupling element 40 of the second antenna element if radio frequency radiation is incident on or emitted from the antenna arrangement 5. The meander-shaped or curl-shaped first antenna element 20 defines the second plane 21. The feeding element 22 is again provided near the first connecting means 50 at the first end of the first antenna element 20, which is opposite of the second or free end, the second or free end being coupled to the coupling element 40 of the second antenna element. In case of an interaction of the antenna arrangement 5 with a radiofrequency radiation field, the coupling between the first and the second antenna element is realized by means of the interaction of the coupling element 40 and the wire-shaped second end of the first antenna element 20.

[0045] Figure 7 depicts a fifth embodiment of the antenna arrangement 5 and a part of the ground plate 10. In the embodiment of figure 7 the first antenna element 20 is again shaped as a planar inverted F-antenna, like it was described in figure 1 and 2. In figure 7, the second antenna element is shaped differently from the embodiments described with the above mentioned figures. In figure 7 the second antenna element comprises again the first subelement 30, the second subelement 31 and

the coupling element 40. These three parts of the second antenna element are again rectangularly shaped. At the difference of the above mentioned figures, however, the coupling element 40 is provided in the plane defined by the two subelements 30, 31. The coupling element therefore is parallel to the ground plate 10 at the same distance as the elements 30, 31. Since they are in the same plane, no bonding elements 35, 36 as in figures 1 to 6 are needed. Therefore, the first subelement 30 is directly connected to the coupling element 40 and the second subelement 31 is also directly connected to the coupling element 40. The coupling between the first antenna element 20 and the coupling element 40 is provided by a narrow distance between the second end of the first antenna element 20 and the coupling element 40. This distance is less than the distance between the first antenna element 20 and the subelements 30, 31.

[0046] The antenna arrangement 5 as it is described is operational with at least two different frequency bands. The exact value of the center frequency and the band width of the frequency bands is dependent on the dimensions and the shapes of the first antenna element 20, the second antenna element and the kind of coupling between these two antenna elements. The antenna arrangement 5 can be used to emit radio frequency radiation which means that the radio apparatus 1 is used as a transmitter. Furthermore, the antenna arrangement 5 can be used as a reception antenna which means that the radio apparatus 1 can be used as a receiver. It is also possible to use the antenna arrangement 5 both, as an emitting antenna, and as a receiving antenna, and likewise the radio apparatus 1 as a transceiver.

[0047] The antenna arrangement 5 according to the invention is very flexible concerning the tuning to particular frequency bands of operation. This feature is combined with the fact that the radiation not only originate from one point or a single part of the antenna arrangement but from several parts of the antenna arrangement 5. Analogously, for the receiving mode of the antenna arrangement 5, radiation is not only incident to one point or to a single part of the antenna arrangement 5 but to several parts of the antenna arrangement 5. The choice of dimensions on the first antenna element 20 will mainly affect the lower frequency band of operation of the antenna arrangement 5. The choice of dimensions on the second antenna element and especially on the first and second subelements 30, 31 will mainly effect the resonance in the higher frequency band. The minimum required length of the first antenna element 20 can be as low as substantially one eighth of the wavelength at the lowest frequency of operation.

[0048] The provided frequency bands of operation are especially: for the first frequency band, the 900 MHz band used in cellular radio networks, e.g. GSM-networks, and for the second frequency band the 1800 MHz and/or 1900 MHz band used in cellular and other radio networks, e.g. GSM-networks, UMTS-networks, GPRS-networks and DECT-networks.

[0049] The antenna arrangement 5 can be placed and shaped mechanically in order to obtain a large tolerance to, for example, the finger of an operator held very close to the antenna element 5. The center frequencies and the band widths of the frequency bands of operation of the antenna arrangement 5 are also dependent on the coupling scheme provided by the second end of the first antenna element 20 and by the coupling element 40 of the second antenna element. The embodiments of the invention described are only meant as examples for possible embodiments of the invention. For example, there can be corners cut out of elements or corners can be provided round, rectangular parts can be shaped differently and do not to be flat, and especially different coupling scenarios can be applied, which can be described as coupling schemes between the free end of the first antenna element 20 and the coupling element 40 mixing the coupling schemes described in the figures. For example a mixing of the coupling scheme in figure 2 and 7 is possible. In this way the antenna arrangement 5 as a whole can easily be fitted into a range of different designs. Nevertheless, other embodiments of a capacitive coupling are possible, for example, by means of a discrete capacitor between the first antenna element 20 and the second antenna element.

[0050] Furthermore the subelements 30, 31 of the second antenna element can be provided in another plane than the second plane. This other plane can be parallel to the ground plate 10 or it can be inclined. This means that it is possible to provide these subelements 30, 31 at a different distance from the ground plate 10 than the first antenna element 20. It is possible to provide one of the subelements 30, 31 in another plane, i. e. at another distance of the ground plate 10 than the other of the subelements 30, 31. Furthermore, it is also possible to provide a capacitive coupling between the ground plate 10 and one of the subelements 30, 31 or all of the subelements 30, 31 in order to lower the dimensions of the subelements 30, 31 needed for a given frequency of operation. This capacitive coupling can be provided, for example by lowering the distance between the ground plate 10 and the subelements 30, 31 or by providing a discrete capacitor between the ground plate 10 and the subelements 30, 31. Furthermore, it is possible that the subelements 30, 31 are provided with different length so that one of the subelements 30, 31 is operational at a different frequency of operation than the other subelement 30, 31. These different frequencies can be provided in different frequency bands in order to operate the antenna arrangement 5 in three or more frequency bands.

Claims

1. Radio apparatus (1), particularly for mobile use, comprising an antenna arrangement (5) with at

least a first antenna element (20) and a second antenna element, wherein a capacitive coupling provides an electromagnetic interaction between the first and the second antenna element when radio frequency radiation is incident on or emitted from said antenna arrangement (5), said interaction providing that the antenna arrangement (5) is operational in at least two frequency bands, characterized in that said radio apparatus (1) comprises a conducting ground plate (10), that said first antenna element (20) is electrically connected to said ground plate (10) by first connecting means (50) and that said second antenna element is electrically connected to said ground plate (10) by second connecting means (60).

2. Radio apparatus (1) according to claim 1, characterized in that said first connecting means (50) are provided substantially at a first end of said first antenna element (20).

3. Radio apparatus (1) according to claim 1 or 2, characterized in that the second antenna element includes a coupling element (40) providing said capacitive coupling between said first antenna element (20) and said second antenna element, said coupling element (40) being provided close to a second end of said first antenna element (20) so as to provide said electromagnetic interaction.

4. Radio apparatus (1) according to any of the preceding claims, characterized in that said capacitive coupling between said first antenna element (20) and said second antenna element is provided by interacting metallic surfaces, by a metallic surface interacting with a metallic wire and/or by interacting edges of metallic surfaces.

5. Radio apparatus according to any of the preceding claims, characterized in that said second antenna element includes two subelements (30, 31) and that said second connecting means (60) are provided as a second shorting pin common to said two subelements (30, 31).

6. Radio apparatus (1) according to claim 5, characterized in that the two subelements (30, 31) are provided substantially symmetrically in respect of the centerline of said first antenna element (20) and that said common second shorting pin (60) is provided asymmetrically in respect of said centerline.

7. Radio apparatus (1) according to any of the preceding claims, characterized in that said ground plate (10) substantially defines a first plane (11), that said first antenna element (20) and said second antenna element are provided substantially in a second plane (21) and that the second plane (21) is substantially parallel to the first plane (11).

8. Radio apparatus (1) according to any of the preceding claims, characterized in that the first antenna element (20) is provided as a capacitively coupled planar inverted F-antenna, a capacitively coupled patch antenna, an capacitively coupled inverted F-antenna or a capacitively coupled curled up inverted F-antenna.

9. Radio apparatus (1) according to any of the claims 5-8, characterized in that the subelements (30, 31) are short circuit patch antennas.

10. Radio apparatus (1) according to any of the preceding claims, characterized in that the antenna arrangement (5) operates at a first frequency band at a center frequency of about 900 MHz and that the antenna arrangement (5) operates as well at a second frequency band, either at a center frequency of alternatively about 1800 MHz or 1900 MHz or at a center frequency comprised inbetween 1800 MHz and 1900 MHz.

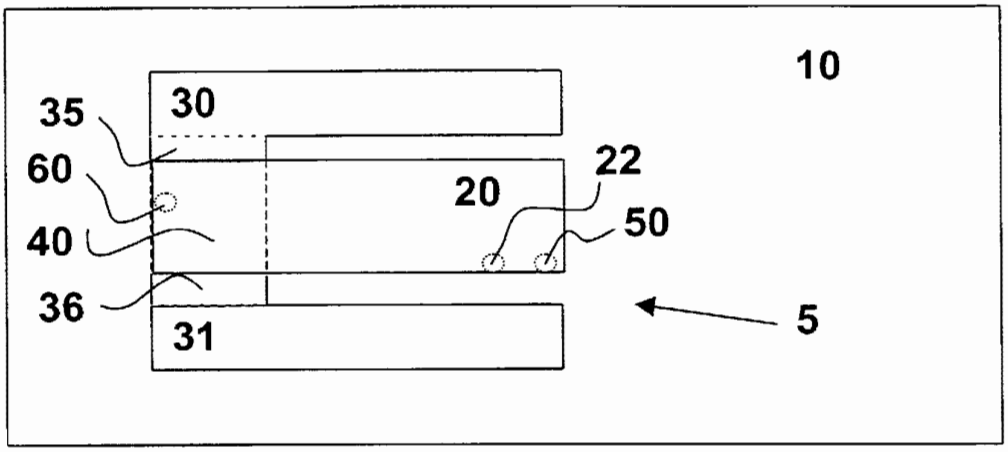


Fig 1

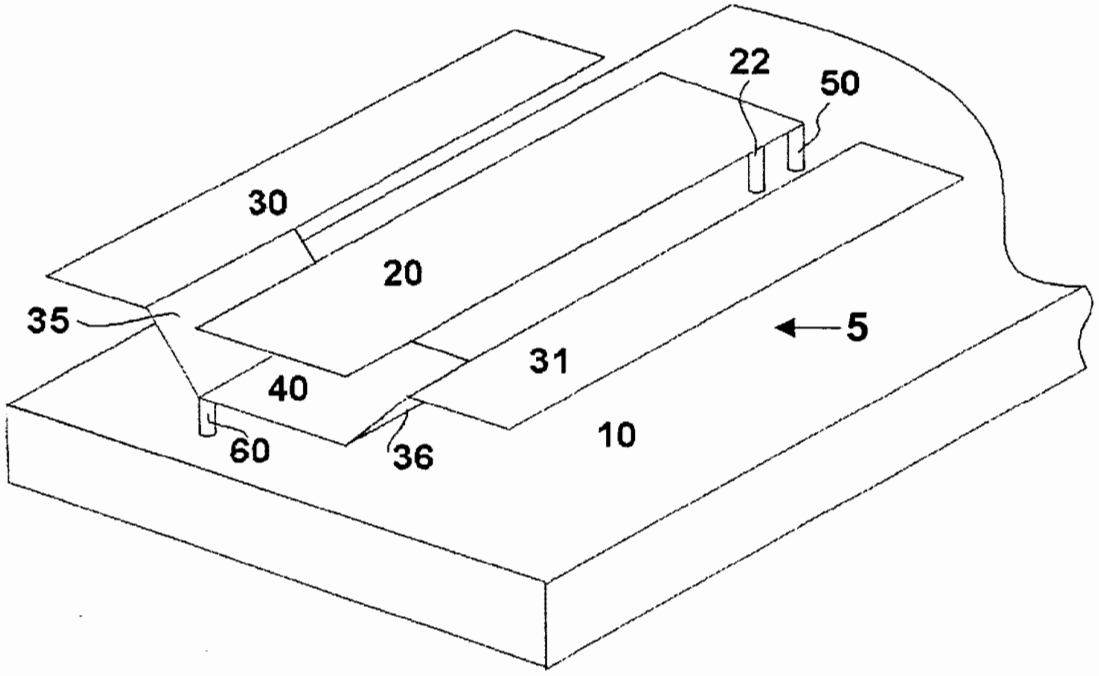


Fig 2

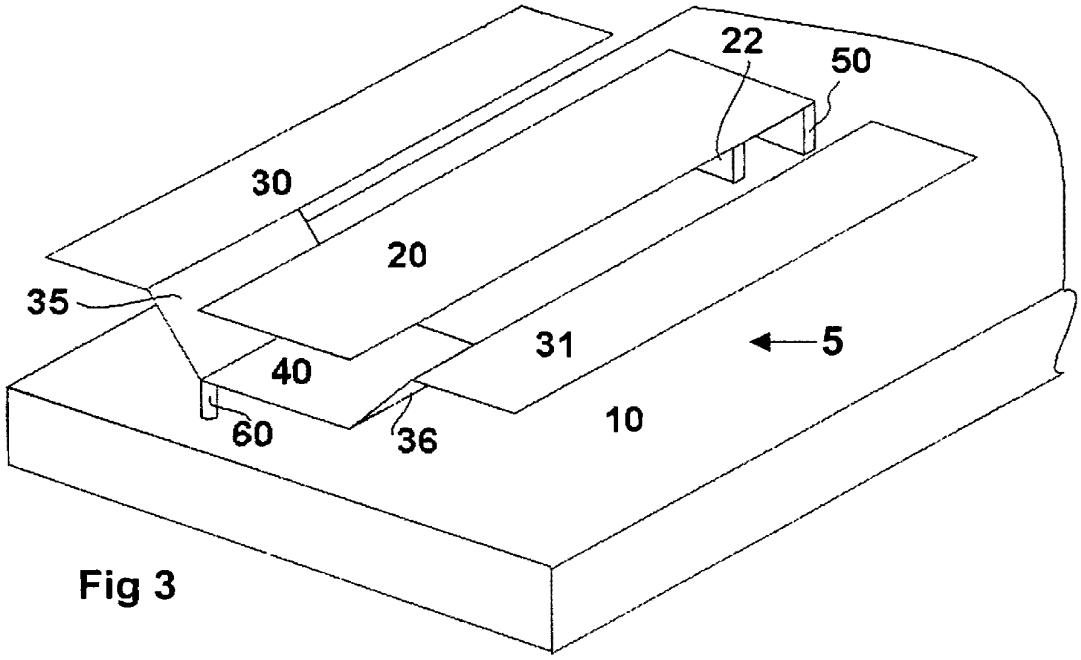


Fig 3

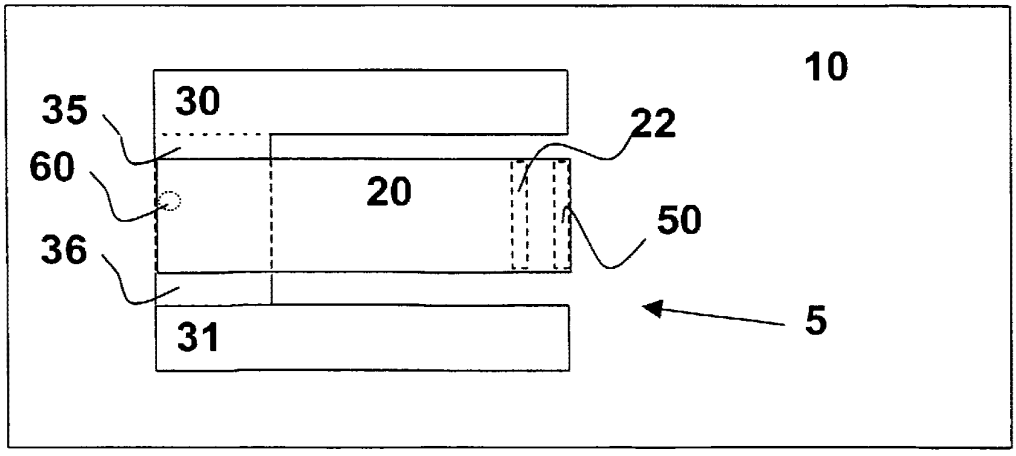


Fig 4

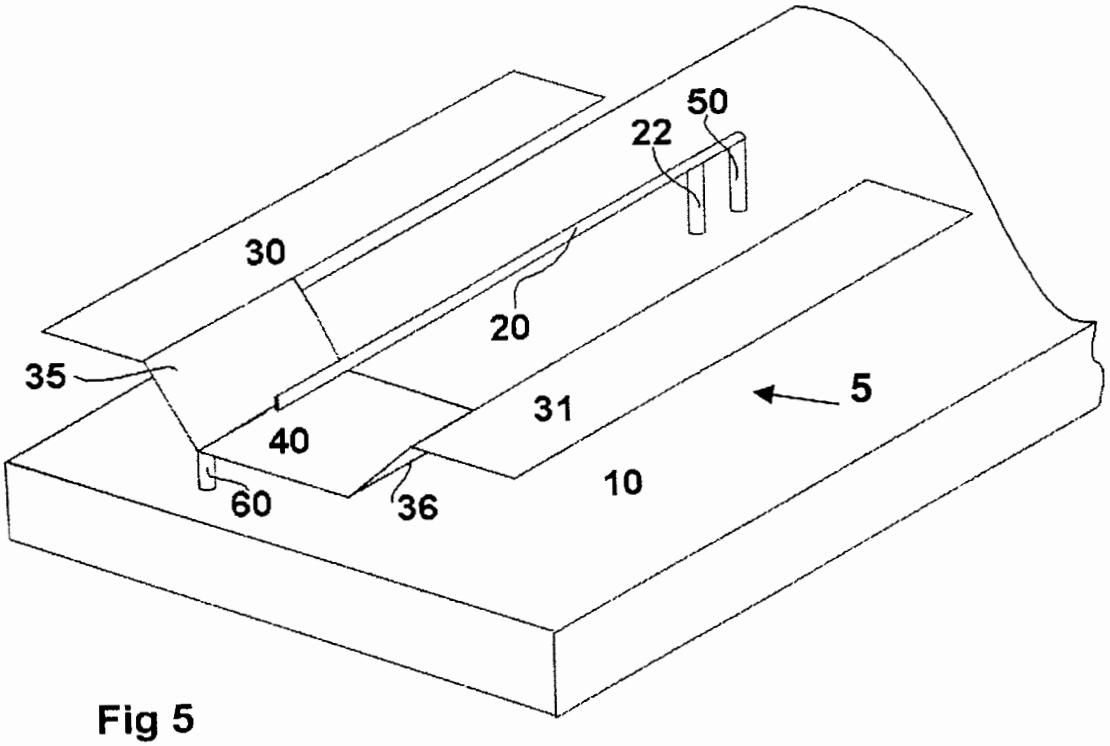


Fig 5

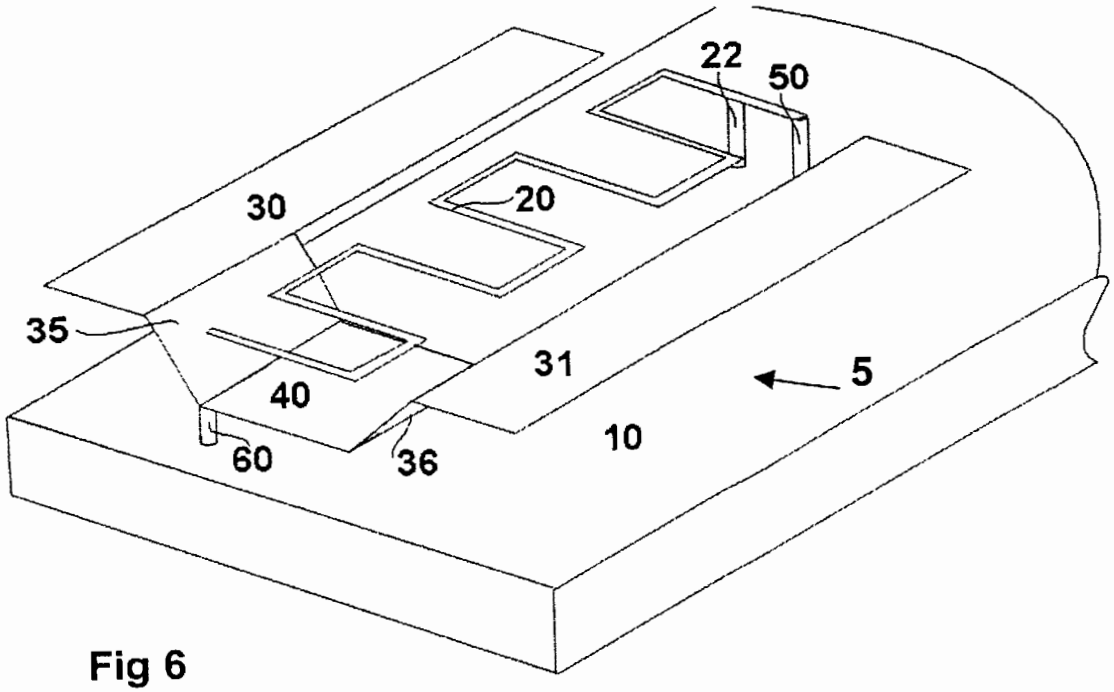


Fig 6

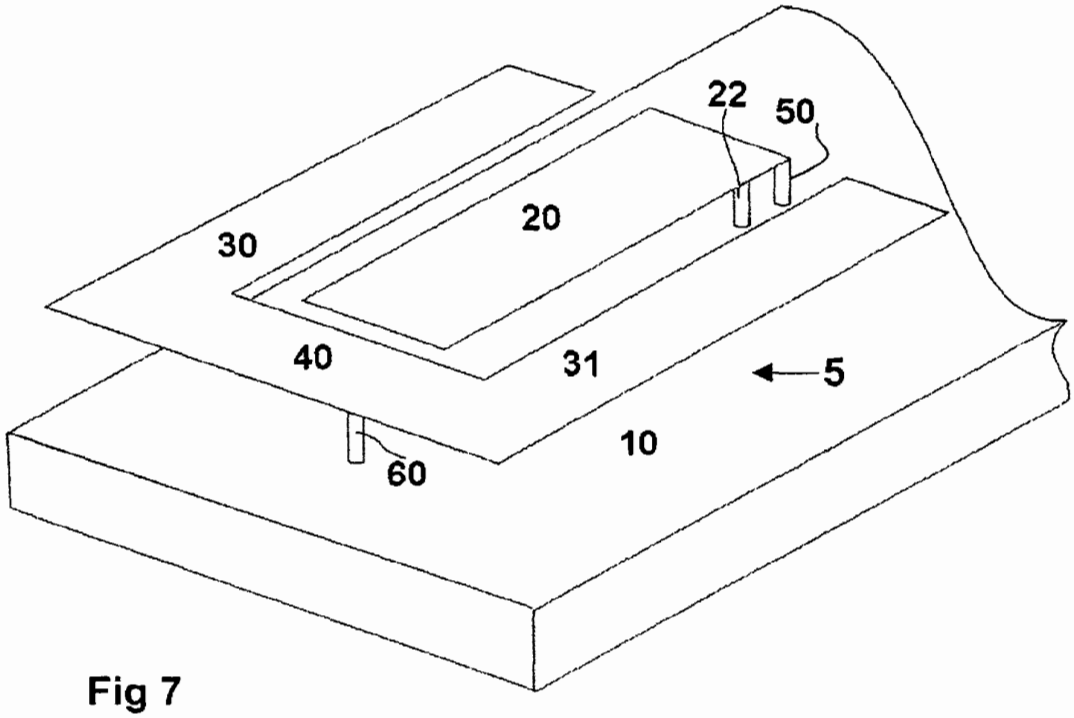


Fig 7

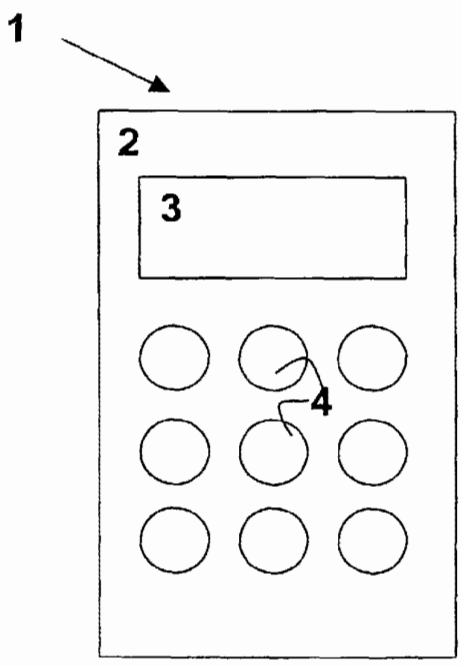


Fig 8

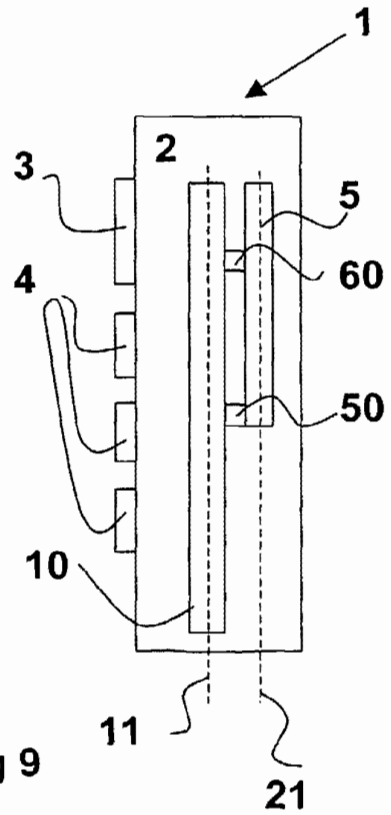


Fig 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 11 3329

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 91 02386 A (SIEMENS AG OESTERREICH ;SIEMENS AG (DE)) 21 February 1991 (1991-02-21) * page 7, line 21-28; figure 5 *	1-4,7-10	H01Q9/04 H01Q5/00 H01Q1/24 H01Q19/00
X	US 5 767 810 A (HAGIWARA SEIJI ET AL) 16 June 1998 (1998-06-16) * column 6, line 13-63; figure 5 *	1-4,8-10	
X	EP 0 332 139 A (TOYODA CHUO KENKYUSHO KK) 13 September 1989 (1989-09-13) * column 5, line 33 - column 6, line 51; figure 1 *	1	
X	EP 0 655 797 A (MOTOROLA INC) 31 May 1995 (1995-05-31) * column 2, line 4-36; figure 1 *	1	
X	EP 0 766 341 A (MURATA MANUFACTURING CO) 2 April 1997 (1997-04-02) * column 4, line 9-40; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
E	EP 0 942 488 A (MURATA MANUFACTURING CO) 15 September 1999 (1999-09-15) * claims 1,2; figure 1 *	1-4,7-10	H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 November 1999	Van Dooren, G

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 11 3329

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

25-11-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9102386 A	21-02-1991	AT 393054 B	12-08-1991
		AT 112421 T	15-10-1994
		DE 59007355 D	03-11-1994
		EP 0484454 A	13-05-1992
		JP 5500889 T	18-02-1993
		US 5365246 A	15-11-1994
US 5767810 A	16-06-1998	CA 2181887 A	25-10-1996
		WO 9634426 A	31-10-1996
EP 0332139 A	13-09-1989	JP 1231404 A	14-09-1989
		JP 1942242 C	23-06-1995
		JP 6059009 B	03-08-1994
		CA 1313408 A	02-02-1993
		DE 68909072 D	21-10-1993
		DE 68909072 T	24-03-1994
		US 4907006 A	06-03-1990
EP 0655797 A	31-05-1995	US 5420596 A	30-05-1995
		DE 69411355 D	06-08-1998
		DE 69411355 T	04-03-1999
EP 0766341 A	02-04-1997	JP 9098015 A	08-04-1997
		CA 2186808 A	30-03-1997
		DE 69601912 D	06-05-1999
		DE 69601912 T	26-08-1999
		US 5760746 A	02-06-1998
EP 0942488 A	15-09-1999	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	2	"US 20080129630"	US-PGPUB; USPAT; USOCR; DERWENT	OR	ON	2009/12/16 20:26
S2	15	("20020075187" | "20020075187" | "4628322" | "4907006" | "5365246" | "5838285" | "5903239" | "5966097" | "5990838" | "6262495" | "6281848" | "6337667" | "6337677" | "6373447" | "6466176" | "6509882").PN.	US-PGPUB; USPAT	OR	ON	2009/12/16 20:34
S3	105	((CARLES) near2 (BALIARDA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 20:35
S4	31	((JAUME) near2 ("ANGUERA PROS")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 20:36
S5	34	((JORDI) near2 ("SOLER CASTANY")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 20:37
S6	3	((ANTONIO) near2 ("CONDES MARTINEZ")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 20:38
S7	13	("20020075187" | "20040212545" | "4628322" | "4907006" | "5365246" | "5838285" | "5903239" | "5966097" | "5990838" | "6337667" | "6373447" | "6466176" | "6509882").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 20:38
S8	1	("7315289").URPN.	USPAT	OR	ON	2009/12/16 20:39
S9	5	("20030020661" | "20060017635" | "6515625" | "6903688" | "7420511").PN.	US-PGPUB; USPAT	OR	ON	2009/12/16 21:25

S12	64089	dipole	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/16 21:31
S13	478675	parasitic passive	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/16 21:31
S14	10723	S12 and S13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/16 21:31
S15	2327	S12 and S13 and "343".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/16 21:31
S16	857	S12 and S13 and "343".clas. and loop	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/16 21:32
S17	11	("3721990" | "4684952" | "5450090" | "5627550" | "5781158" | "5943020" | "6008762" | "6114996" | "6133880" | "6195051" | "6323810").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 21:44
S18	13	("6456243").URPN.	USPAT	OR	ON	2009/12/16 21:45

S19	38	("3707681" | "3721990" | "4450449" | "4598276" | "4684952" | "4749996" | "5114996" | "5245745" | "5304222" | "5309164" | "5348894" | "5410323" | "5450090" | "5627550" | "5764190" | "5781158" | "5835063" | "5943020" | "5966096" | "5986606" | "6002367" | "6010969" | "6040965" | "6046707" | "6133880" | "6147649" | "6157348" | "6181281" | "6195051" | "6211815" | "6246371" | "6323810" | "6339409" | "6369777" | "6388631" | "6417817" | "6639564" | "6759990").PN.	US-PGPUB; USPAT	OR	ON	2009/12/16 22:03
S20	6	("6356242" | "6580398" | "6650301" | "6664930" | "6717551" | "6781556").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/16 22:06
S21	775	343/793,803.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 13:23
S22	5	("20070132646" | "6870506" | "6963310" | "7034754" | "7253775").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 13:28
S23	7	("20060220869" | "3229298" | "3689929" | "3813674" | "6466178" | "6791500").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 13:34

S24	15	("20010007445" | "20010054979" | "5363114" | "5986606" | "6008762" | "6046700" | "6107967" | "6114996" | "6184833" | "6222494" | "6239753" | "6259407" | "6300908" | "6573867" | "6650294").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 13:35
S25	6	("6356242" | "6580398" | "6650301" | "6664930" | "6717551" | "6781556").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 13:41
S26	18	("3725943" | "4125839" | "4443800" | "4611212" | "4635065" | "4684953" | "4814777" | "5146232" | "5291210" | "5325403" | "5654724" | "5719794" | "5757333" | "5760747" | "5771025" | "5784032" | "5821902" | "5894287").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 13:47
S27	3	("2850734" | "3868689").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 14:04
S28	4	("20040070548" | "20040174316" | "6014107" | "6285336").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 14:06
S29	51	343/804.ccls.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 14:07
S30	5	("3827053" | "5936590" | "6008764" | "6366258" | "6529749").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/17 14:08
S31	375	343/803.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 14:08

S32	45	343/803.ccls. and switch$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 14:09
S33	20	("6697025").URPN.	USPAT	OR	ON	2009/12/17 14:10
S34	1403	folded adj dipole	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 14:14
S35	372	folded adj dipole and gap	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 14:14
S36	9	("20050093677" | "20050119035" | "20060208957" | "20060232382" | "7084769").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/17 14:17

EAST Search History (Interference)

< This search history is empty>

12/17/2009 2:48:15 PM
C:\ Documents and Settings\ rkaracsony\ My Documents\ EAST\ Workspaces\ Cases\ Coupled Multiband Antennas 11950835\ Coupled Multiband Antennas.wsp

UNITED STATES PATENT AND TRADEMARK OFFICE

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

BIB DATA SHEET

CONFIRMATION NO. 7241

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/950,835	12/05/2007	343	2821	47005-P015WUSC1

APPLICANTS

Carles Puente Baliarda, San Cugat del Valles (Barcelona), SPAIN;
Jaume Anguera Pros, Vinaros (Castellon), SPAIN;
Jordi Soler Castany, Mataro (Barcelona), SPAIN;
Antonio Condes Martinez, Esplugues de Llobregat (Barcelona), SPAIN;

**** CONTINUING DATA ***************************

This application is a CON of 11/075,980 03/09/2005 PAT 7,315,289 /RK/
which is a CON of PCT/EP02/11355 09/10/2002 /RK/

**** FOREIGN APPLICATIONS *************************** NONE /RK/

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
12/17/2007

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ROBERT KARACSONY/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		SPAIN	17	19	1

ADDRESS

WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201
UNITED STATES

TITLE

COUPLED MULTIBAND ANTENNAS

FILING FEE RECEIVED		
1030	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

SEARCHED			
Class	Subclass	Date	Examiner
343	793, 803	12/17/2009	RK

SEARCH NOTES		
Search Notes	Date	Examiner
EAST search	12/17/2009	RK
Inventor search	12/17/2009	RK

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11950835	BALIARDA ET AL.
	Examiner	Art Unit
	ROBERT KARACSONY	2821

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/17/2009								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

ALTERNATIVE TO PTO/SB/08A/B
(Based on PTO 01-08 version)

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA*	US-4,628,322	12-09-1986	Marko et al.	
	AB*	US-5,365,246	11-15-1994	Rasinger et al.	
	AC*	US-6,337,667	01-08-2002	Ayala et al.	
	AD*	US-5,966,097	10-12-1999	Fukasawa et al.	
	AE*	US-20020075187-A1	01-21-2003	McKivergan	
	AF*	US-6,466,176	10-15-2002	Maoz et al.	
	AG*	US-5,990,838	11-23-1999	Burns et al.	
	AH*	US-6,509,882	01-21-2003	McKivergan	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BA**	EP-0 942 488	09-15-1999	Murata Manufacturing Co., Ltd.		
	BB**	JP-56-12102	02-06-1981	Nippon Teleghraph & Telephone et al.		√
	BC**	WO-96/38881	12-05-1996	Ericsson Inc.		
	BD**	WO-01/78192	10-18-2001	Research In Motion Limited		
	BE**	WO-01/22528	03-29-2001	Fractus S.A.		√
	BF**	WO-01/54225	07-26-2001	Fractus, S.A.		

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

*EXAMINER: Initial if information considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA**	Hisamatsu Nakano et al., "Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas", IEEE Transactions on Antennas and Propagation, vol. 46, no. 6, June 1998, pages 788-793	
	CB**	Constantine A. Balanis, "Antenna Theory: Analysis and Design", Hamilton Printing, 1982 & 1997, pages 498-502.	
	CC**	C. Puente et al., "Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition", Electronics Letters, December 5, 1996, vol. 32, no. 25, pages 2298-2299	
	CD**	Jaume Anguera et al., "Miniature WideBand Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry", IEEE, 2000, pages 1700-1703	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

ALTERNATIVE TO PTO/SB/08A/B
(Based on PTO 01-08 version)

Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/950,835-Conf. #7241
				Filing Date	December 5, 2007
				First Named Inventor	Carles Puente Baliarda
				Art Unit	2821
(Use as many sheets as necessary)				Examiner Name	Not Yet Assigned
Sheet	2	of	2	Attorney Docket Number	47005-P015WUSC1

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

IPE JAN 22 2008 PATENT & TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5838285		1998-11-17	TAY	

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

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040212545	A1	2004-10-28	LI	

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835 ~~11950835 GAU: 2821~~
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	NA
	Examiner Name	NA
	Attorney Docket Number	47005-P015WUSC1

	1		☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

OIPE
JAN 22 2008
PATENT & TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5966097		1999-10-12	FUKASAWA	
	2	6337667	B1	2002-01-08	AYALA	
	3	4628322		1986-12-09	MARKO	
	4	5365246		1994-11-15	RASINGER	
	5	5903239		1999-05-11	TAKAHASHI	
	6	6373447	B1	2002-04-16	ROSTOKER	
	7	4907006		1990-03-06	NISHIKAWA	

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

U.S.PATENT APPLICATION PUBLICATIONS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835 ~~11950835 - GAU: 2821~~
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020075187	A1	2002-06-20	MCKIVERGAN	

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	03047025	WO	A1	2003-06-05	KONINKLIJKE PHILIPS ELECTRONICS N.V.		☐
	2	2387486	GB	A	2003-10-15	SAMSUNG ELECTRO-MECHANICS CO. LTD.		☐
	3	0131747	WO	A1	2001-05-03	FRACTUS SA		☐
	4	1195847	EP	A2	2002-04-10	E-TENNA DORPORATION LAUREL		☐
	5	9950929	WO	A1	1999-10-07	THE REGENTS OF THE UNIVERSITY OF CALIFORNIA		☐
	6	200250924	JP		2002-02-15	SANSEI ELECTRIC CORP		☐
	7	2002141726	JP	A	2002-05-17	YOKOWO SEISAKUSHO KK		☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

~~11950835 - GAU: 2821~~

OIPE
JAN 22 2008
PATENT & TRADEMARK OFFICE

	8	56012102	JP		1981-02-06	NIPPON TELEGR & TELEPH CORP <NTT> DENKI KOGYO KK		☐
	9	JP5275918	JP		1993-10-22	UNAVAILABLE		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	PAN et al. N anetnnas and their applications in portable handsets, IEEE Transactions on Antennas and Propagation, 1997, Vol. 45, No. 10	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

OIPE
JAN 22 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

11950835 - GAU: 2821

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

	1	CHOW et al., A dual-frequency-mode monopole-helical antenna with a parasitic normal-mode helix, Microwave and optical Technology Letters, February 2001,	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

USPTO
APR 08 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1011167	EP	A1	2000-06-21	Matsushita Electric Industrial		☐
	2	06334421	JP		1994-12-02	Mitsubishi Heavy Ind		☒

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

NON-PATENT LITERATURE DOCUMENTS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)



Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

OIPE IAP67 JUN 09 2008 PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-05-12
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6281848	B1	2001-08-21	NAGUMO ET AL	
	2	6262495	B1	2001-07-17	YABLONOVITCH ET AL	
	3	6509882	B2	2003-01-21	MCKIVERGAN ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	00/35048	WO	A1	2000-06-15	QUALCOMM INCORPORATED		☐

EFS Web 2.0

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-05-12
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	2	05-090824	JP		1993-04-09	MATSUSHITA ELECTRIC IND CO LTD		☒
	3	2001-007639	JP		2001-01-12	MURATA MFG CO LTD		☒

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	TAYLOR, C. D. ; ARONSON, E. A. ; HARRISON, C.W. JR., Theory of coupled monopoles, IEEE Transactions on antennas and propagation, Vol. AP-18, No. 3, May 1970	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

OIPE IAP67 JUN 09 2008 PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-05-12
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6281848	B1	2001-08-21	NAGUMO ET AL	
	2	6262495	B1	2001-07-17	YABLONOVITCH ET AL	
	3	6509882	B2	2003-01-21	MCKIVERGAN ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	00/35048	WO	A1	2000-06-15	QUALCOMM INCORPORATED		☐

EFS Web 2.0

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-05-12
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	2	05-090824	JP		1993-04-09	MATSUSHITA ELECTRIC IND CO LTD		☒
	3	2001-007639	JP		2001-01-12	MURATA MFG CO LTD		☒

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	TAYLOR, C. D. ; ARONSON, E. A. ; HARRISON, C.W. JR., Theory of coupled monopoles, IEEE Transactions on antennas and propagation, Vol. AP-18, No. 3, May 1970	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

EFS Web 2.0

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP79 SEP 0 2 2008 PATENT & TRADEMARK OFFICE

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1445821	EP	A1	2004-08-11	MATSUSHITA ELECTRIC INDUSTRIAL		☐
	2	1538694	EP	A1	2005-06-08	MATSUSHITA ELECTRIC INDUSTRIAL		☐

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

NON-PATENT LITERATURE DOCUMENTS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835 11950835 - GAU: 2821
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ANGUERA, J.; RISCO, S., Coupled monopoles on a handset / wireless PCB, Fractus, January 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-06)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP79 SEP 02 2008 PATENT & TRADEMARK OFFICE

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1445821	EP	A1	2004-08-11	MATSUSHITA ELECTRIC INDUSTRIAL		☐
	2	1538694	EP	A1	2005-06-08	MATSUSHITA ELECTRIC INDUSTRIAL		☐

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

NON-PATENT LITERATURE DOCUMENTS

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835 11950835 - GAU: 2821
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ANGUERA, J.; RISCO, S., Coupled monopoles on a handset / wireless PCB, Fractus, January 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

OIPE IAP84
NOV 05 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6337677		2002-01-08	HIGASHI	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	62-262502	JP		1987-11-14	YUNIDEN KK		☒
	2	9102386	WO		1991-02-21	SIEMENS		☒
	3	5500889	JP		1993-02-18	N/A		☒

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835 11950835 - GAU: 2821
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	4	2001267841	JP		2001-09-28	SONY		☒
	5	02000811U	JP		2008-10-29	N/A		☐
	6	1223637	EP		2005-03-30	FRACTUS		☐
	7	1137100	EP		2001-09-26	SONY		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP84 NOV 05 2008 PATENT & TRADEMARK OFFICE

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6337677		2002-01-08	HIGASHI	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	62-262502	JP		1987-11-14	YUNIDEN KK		☒
	2	9102386	WO		1991-02-21	SIEMENS		☒
	3	5500889	JP		1993-02-18	N/A		☒

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835 11950835 - GAU: 2821
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	4	2001267841	JP		2001-09-28	SONY		☒
	5	02000811U	JP		2008-10-29	N/A		☐
	6	1223637	EP		2005-03-30	FRACTUS		☐
	7	1137100	EP		2001-09-26	SONY		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature	/Robert Karacsony/	Date Considered	12/17/2009

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /RK/

PTO/SB/82 (01-06)
Approved for use through 12/31/2008. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REVOCATION OF POWER OF ATTORNEY WITH NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS		
	Application Number	11/950,835-Conf. #7241
	Filing Date	December 5, 2007
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint the practitioners associated with the Customer Number: 61060

☒ Please change the correspondence address for the above-identified application to:

☒ The address associated with Customer Number: 61060

OR

☐ Firm or Individual Name	WINSTEAD PC Stanley R. Moore				
Address	P.O. Box 50784				
City	Dallas				
Country	US	State	TX	Zip	75201
Telephone	(214) 745-5400	Email			

I am the:

☐ Applicant/Inventor.

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature			
Name	Carles Puente Baliarda		
Date	December 21, 2009	Telephone	+34 93 544 26 90

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 1 forms are submitted.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 21, 2009 Electronic Signature for Brenda I. Brown: /Brenda I. Brown/

PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Fractus, S.A.

Application No./Patent No.: 11/950,835 Filed/Issue Date: December 5, 2007

Titled: COUPLED MULTIBAND ANTENNAS

Fractus, S.A. (Name of Assignee) , a Corporation (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [x] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] an assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made) the patent application/patent identified above by virtue of either:

A. [x] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 023628, Frame 0642, or for which a copy thereof is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[x] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature	December 21, 2009 Date
Carles Puente Baliarda Printed or Typed Name	C.T.O. Title

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: December 21, 2009 Electronic Signature for Brenda I. Brown: /Brenda I. Brown/

5459902v.1 47005/P015WUSC1

Electronic Acknowledgement Receipt

EFS ID:	6676123
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson/Brenda Brown
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	21-DEC-2009
Filing Date:	05-DEC-2007
Time Stamp:	10:40:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		REVPOAandSTATEMENT47005P015WUSC1.PDF	70053 6f49a0c80e91e611a2602f9857a33866e7b08a82	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	1	1
	Assignee showing of ownership per 37 CFR 3.73(b).	2	2
Warnings:			
Information:			
	Total Files Size (in bytes):	70053	

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
11/950,835		2821	

OC000000038097299

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 61060 on 10/01/2009

- **Correspondence Address**
- **Maintenance Fee Address**
- **Power of Attorney Address**

The address of record for Customer Number 61060 is:

61060
WINSTEAD PC
P.O. BOX 50784
DALLAS, TX 75201

PART 1 - ATTORNEY/APPLICANT COPY
page 1 of 1

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1	7241

23932 7590 07/17/2009
JENKENS & GILCHRIST, PC
1445 ROSS AVENUE
SUITE 3200
DALLAS, TX 75202

EXAMINER	
ART UNIT	PAPER NUMBER
2821	

MAIL DATE	DELIVERY MODE
07/17/2009	PAPER

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

DATE: 07/14/2009

JENKENS & GILCHRIST, PC
1445 ROSS AVENUE
SUITE 3200
DALLAS, TX 75202

To: Applicant of Serial Number 11950835
Filed on 05-DEC-2007
(Art Unit 2821)

It is estimated that this application will receive an Office action in approximately 10 months. This is an estimate that is based on the current inventory level of applications filed in this art area and the current staffing levels in this Art Unit. The USPTO is dedicated to minimizing first action and total pendency, and we are targeting resources to help address backlogs in art areas with high new application filings. Thank you for your inquiry.

Customer Service Office in Technology Center: 2800

Phone Number: 571-272-2800
Central Fax Number: 571-273-8300

Applicant/Attorney Contact Information:

Phone Number:
Fax Number:

OIPE
JUN 29 2009
PATENT & TRADEMARK OFFICE

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: June 24, 2009 Signature: Brenda I. Brown
(Brenda I. Brown)

IFW

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

STATUS INQUIRY

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

Dear Sir:

It is respectfully requested that the representative named below be advised of the status of the above-identified application. Please advise us of when we might expect to receive an Office Action from the Patent and Trademark Office.

Dated: June 24 2009

Respectfully submitted,

By _____
Shoaib A. Mitha
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

5387446v.1 47005/P015WUSC1

OIPE
NOV 05 2008
PATENT & TRADEMARK OFFICE

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: November 3, 2008 Signature: Brenda I. Brown
(Brenda I. Brown)

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits, as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information

as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: November 3, 2008

Respectfully submitted,

By_____
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: November 3, 2008 Signature: (Brenda I. Brown)

OIPE
NOV 05 2008
PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits, as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information

as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: November 3, 2008

Respectfully submitted,

By_____
Shoaib A. Mithani
Registration No.: 61,654
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

OIPE IAP84
NOV 05 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6337677		2002-01-08	HIGASHI	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	62-262502	JP		1987-11-14	YUNIDEN KK		☒
	2	9102386	WO		1991-02-21	SIEMENS		☒
	3	5500889	JP		1993-02-18	N/A		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	4	2001267841	JP		2001-09-28	SONY		☒
	5	02000811U	JP		2008-10-29	N/A		☐
	6	1223637	EP		2005-03-30	FRACTUS		☐
	7	1137100	EP		2001-09-26	SONY		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP84 NOV 05 2008 PATENT & TRADEMARK OFFICE

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6337677		2002-01-08	HIGASHI	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	62-262502	JP		1987-11-14	YUNIDEN KK		☒
	2	9102386	WO		1991-02-21	SIEMENS		☒
	3	5500889	JP		1993-02-18	N/A		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	4	2001267841	JP		2001-09-28	SONY		☒
	5	02000811U	JP		2008-10-29	N/A		☐
	6	1223637	EP		2005-03-30	FRACTUS		☐
	7	1137100	EP		2001-09-26	SONY		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

PATENT ABSTRACTS OF JAPAN

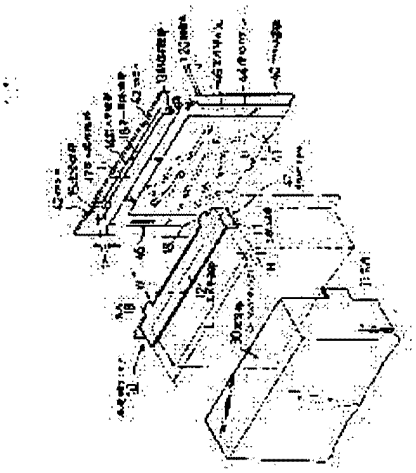
(11)Publication number : **62-262502**
(43)Date of publication of application : **14.11.1987**

(51)Int.Cl. H01Q 13/18
H01Q 9/40
H01Q 13/08

(21)Application number : **61-104837**
(22)Date of filing : **09.05.1986**

(71)Applicant : **YUNIDEN KK**
(72)Inventor : **HIKIMA HIDEO**

(54) ANTENNA FOR RADIO COMMUNICATION EQUIPMENT



(57)Abstract:
PURPOSE: To facilitate the adjustment of an antenna impedance by connecting a sub horizontal line part provided in parallel with a main horizontal face part mutually at a prescribed position and inserting a capacitor to a sub rising line part connected to one end of the sub horizontal line part.
CONSTITUTION: A ground pattern 44 is provided to one face of a printed circuit board 40 corresponding to a shield housing 30 and the both are fitted by using a projecting piece 31 and a projecting insertion hole 46. The shield housing 30 acts like a ground conductor to the main horizontal face part 12 of the antenna and the main rising face part 11 connected to one end of the main horizontal face part 12 and the main rising face part 11 connected to one end of the main horizontal face 12 is soldered to the shield housing 30. On the other hand, the sub horizontal line part 14 and the sub rising line part 13 connected thereto are formed on one side of the printed circuit board 40, the main horizontal face part 12 and the sub horizontal face part 14 are bonded by using a tongue 18 and a notch 42, and a capacitor 20 is inserted between the sub rising line part 13 and a feeding point. The impedance matching of the antenna is adjusted by the capacitor 20, a connecting point and the shape of antenna.

(19)日本国特許庁(JP)　(11)特許出願公開

(12)公開特許公報(A)　昭62-262502

(51)Int.Cl.⁴	識別記号	庁内整理番号	(43)公開　昭和62年(1987)11月14日
H 01 Q 13/18		7741-5J	
9/40		7105-5J	
13/08		7741-5J	審査請求　有　発明の数 1　(全12頁)

(54)発明の名称　無線通信機器用アンテナ

(21)特　願　昭61-104837

(22)出　願　昭61(1986)5月9日

(72)発明者　引馬　英雄　市川市行徳駅前1-21-5　第一さつき荘103号

(71)出願人　ユニデン株式会社　市川市鬼高4丁目7番4号

(74)代理人　弁理士　福田　信行　外2名

明　細　書

1.発明の名称

無線通信機器用アンテナ

2.特許請求の範囲

1)　一端が地導体(30)に接続し、他端に向かって高さHに亘り起立した第一の幅qの導電性主起立面部(11)と；

一端が上記主起立面部(11)の上記他端に接続し、該主起立面部(11)に対して直交しながら他端に向かって長さLに亘り水平に伸びた第二の幅Wの導電性主水平面部(12)と；

一端が給電点(20)を介して上記地導体(30)に臨み、他端に向かって上記主起立面部(11)と平行に伸びた線状の導電性副起立線部(13)と；

一端が上記副起立線部(13)の上記他端に接続し、上記主水平面部(12)に対して離間距離sを置きながら、他端に向かって該主水平面部(12)に平行に伸びた線状の導電性副水平線部(14)と；

上記副水平線部(14)の上記他端を上記主水平面部(12)の他端位置(Pe)または該他端位置(Pe)から所定の距離(p',p'',p''',....)だけ離れた部分に電気的に接続する連結部(15)と；

から成ることを特徴とする無線通信機器用アンテナ(10)。

2)　副水平線部(14)は、その長さの全部または一部に、インピーダンス調整用のキャパシタを構成する第一の幅t1の第一導体幅部(16)を有することを特徴とする特許請求の範囲1)に記載の無線通信機器用アンテナ(10)。

3)　副水平線部(14)は、その長さの一部に、中心周波数調整用のキャパシタを構成する第二の幅t2の第二導体幅部(17)を有することを特徴とする特許請求の範囲1)または2)に記載の無線通信機器用アンテナ(10)。

3.発明の詳細な説明

(産業上の利用分野)

本発明は無線通信機器用のアンテナに関し、特に移動無線機とか携帯無線機のアンテナとすると好適な小型板状アンテナの改良に関する。

（従来の技術）

車両搭載の無線機とかトランシーバ、さらには昨今汎用され始めているコードレス電話機等、移動無線機ないし携帯無線機用のアンテナとしては、もっとも普通にはホイップアンテナに代表されるように、古典的なλ／4モノポールアンテナの使用が考えられ、現にこれまでにはこれが多用されてきた。なおλは、使用周波数fの波長である。

しかし、大きく言って無線通信という観念では、アンテナを高くする程、地形、地物の影響を受け難く、到来波に対する受信感度は高くなるが、上記のようなモノポールアンテナでは、ここで問題にしているような移動無線機用ないし携帯無線機用として使用する限り、おのずからその高さには限度が生じ、余り高く張ることはできないため、必ずしも望ましい感度を得られるとは限らなかった。

かと言って十分低くできるということもなく、最低高にも上記λ／4に従う制限があり、昨今の

この種無線機におけるように、各種装置回路の採用等により回路部分は著しく小型化して行く傾向にあるにも拘らず、アンテナ部分の小型化は阻害されていたし、特にコードレス電話機のリモートユニットのように、通話者が室内を持ち歩くような携帯用無線機のアンテナとしては、全くにしてふさわしくなかった。

また、こうしたモノポールアンテナは、その動作原理上にも問題があり、電界感応型アンテナであることから、近くにいる人やその他の導体の影響を受け易く、実用状態ではアンテナの性能が低下していることもままあった。

さらに言えば、一般に移動無線通信では、基地局より垂直偏波で送信しても、伝搬路の地形、構築物等により反射、散乱されて偏波面が傾き、移動局への到来波は水平偏波の方が強くなることがある。こうした傾向は特にビル、鉄塔等が乱立する都市内で顕著である。

相対的には微弱な電波を使用する構内無線通信でも然りであり、据え付けられた機械、什器類、

天井、柱、壁等で反射、散乱され、送信波とは異なる偏波面で移動局に到来する方がむしろ普通である。

このため、モノポールアンテナを用いてなお、こうした伝搬電波の偏波に対処させようとするならば、例えば二つのモノポールアンテナを用いてこれらをそれぞれ垂直、水平の双方に指向させ、いわゆる偏波ダイバーシティ効果を期待しなければならないが、これはもとより、移動局用のアンテナシステムとしてはおおよそそぐわないものである。

このような事情により、従来からもこうしたモノポールアンテナに代え、小型化が図り易く、磁界感応型であって、本質的には偏波ダイバーシティ効果に類似の効果を有するアンテナとして、第6図に示されるような逆L型アンテナとか第7図に示されるような逆F型アンテナを採用しようとする試みがなされ始めてきた。

第6図(A)、第7図(A)は、それぞれこうした従来の逆L型、逆F型の各アンテナの基本構成を示し、また第6図(B)、第7図(B)は、当該各基本構成に即した実際の作成例を示している。

まず第6図（A）、(B)に示されている逆L型アンテナ60から説明すると、これは、それぞれ幅Wを有する起立面部61と、この起立面部61に一端において電気的に接続しながら直角に折れた水平面部62とから成り、水平面部62の長さLと起立面部61の高さ（ないし長さ）Hとの和が使用周波の波長λに対してλ／4となるように図られていて、給電点（起電点とも呼ばれる）20は起立面部61の下端と地導体ないし接地30との間に設けられている。

第6図(B)に示されているように、ここに例示した実際の作成例では、地導体30はプリント基板40に組上げられている回路部分（図示せず）をシールドするシールドハウジング30の上端面で構成されており、また逆L型アンテナ60自体も、このプリント基板40に物理的に支持されている。もちろん、起立面部61、水平面部62、シールドハウジング30は導電性材料、一般に錫メッキ鋼鋼板等

の適当な金属製で、これらを物理的に支持するプリント基板40は、ガラスエポキシ等の絶縁材料製である。

一方、第７図（A），(B) に示される逆Ｆ型アンテナ70は、上記の逆Ｌ型アンテナ60と同様、長さＬの導電性水平面部72と高さ（ないし長さ）Ｈの導電性起立面部71とが一端で互いに電気的に接続しながらほぼ直交する関係にあり、上記長さの和（Ｌ＋Ｈ）はλ／4となるよう図られているが、起立面部71の下端は直接にシールドハウジングとして構成されている地導体30に接続され、給電点20は第７図(A) に示されるように、起立面部71と水平面部71との接続点から距離Ｄだけ離れた部位から取り出されている。

この距離Ｄは、第７図(B) に示されるように、二次元的に見ると距離d1，d2に分解して考えることができる。また、図示の逆Ｆ型アンテナ70では、起立面部71はその幅qが水平面部のそれWよりも狭くなっているが、これは指向性を改善するためである。なお、逆Ｌ型アンテナ60においても逆Ｆ型アンテナ70においても、一般に起立面部61，71の高さＨはλ／10程度に選ばれるのが普通なようである。

（発明が解決しようとする問題点）

第６図及び第７図に示された逆Ｌ型ないし逆Ｆ型アンテナは、モノポールアンテナに比せば優れた諸点を有している。

まず第一に、三次元的な形態寸法がモノポールアンテナに比せば随分と小さくできることが挙げられる。そして第６図(B) 及び第７図(B) に示されるように、プリント基板上に搭載された回路部品と共存することができ、したがって無線機機器の筐体内に収め込むことができて、その小型化に対する大きな障害とならず、むしろ小型化に適合できる可能性がある。

第二に、こうした逆Ｌ型ないし逆Ｆ型アンテナ60，70は、本来的には垂直偏波用であるが、放射電力こそ20～30dB程度低下しているものの、水平偏波成分をも有しているので、単一のアンテナでも潜在的に偏波ダイバーシティ機能を有している

ことである。

しかし、こうした従来の言わば板状アンテナでは、給電線の特性インピーダンスとの整合が難しくなるという問題が生じ易い。

例えば先に述べたように、起立面部61，71の高さＨと水平面部62，72の長さＬとの和（Ｌ＋Ｈ）は、使用周波数ｆが定まれば必然的に定まってしまうが、一般には起立面部61，71の高さＨを小さくしたいことが多い。

こうした場合、高さＨの低減に伴い、一般に並列インダクタンスの増加によりアンテナインピーダンスは上昇しがちで、ために給電線とのインピーダンス不整合が生じ易いのである。

しかるに、こうした従来のアンテナ60，70において、高さＨを低減してなお、インピーダンス整合を図るには、まず一つに水平面部62，72の幅Ｗを調整する手法がある。

しかし、この幅Ｗは、狭くする分には良いが、広くしなければならない場合、無線機に要求される寸法上の制限から必要な幅に設定できないことがある。換言すればこの水平面部62，72の幅Ｗの調整によるインピーダンス調整自由度は、それ程大きく採れないのである。

してみるに、同じ従来例でも、第６図に示された逆Ｌ型アンテナ60と第７図に示された逆Ｆ型アンテナとを比べた場合、第７図示の逆Ｆ型アンテナ70の方が、ことインピーダンス調整に関しては若干は有利であると言える。

何故なら、第６図に示された逆Ｌ型アンテナ60では、先のように高さＨが限定された場合、インピーダンス調整は専ら水平面部62の幅Ｗの調整にのみ頼らねばならないのに対し、第７図に示された逆Ｆ型アンテナ70の場合には、高さＨや幅Ｗが、共に機器小型化という寸法的要因から限定されることがあったとしても、給電点20の引き出し位置、すなわち距離Ｄの変更、またはより実際的に第７図(B) 中の距離d1，d2の変更によるインピーダンスの調整という手段が残されているからである。

が、実際上は、こうした手段によるインピーダ

ンス調整範囲は十分とは言えなかった。そのため逆に、結局は機器寸法の方に制約を及ぼし、起立面部71の高さHは余り低くはできないことが多かった。

また上記のように、逆L型よりは多少優れていると思われる第7図示の逆F型アンテナ70の場合にも、給電点20に関する距離d1，d2の調整のいかんによっては、当該給電点20の取り出しが難しいという、機器製作上の新たな欠点が加わってしまっていた。

本発明はこうした従来の欠点にかんがみて成されたもので、例えアンテナの主要部分の幾何的な寸法や給電点の取り出し位置が限定されても、インピーダンス整合の取り易い、言い換えればアンテナインピーダンスの調整自由度が高く、小型化にさらに最適な新たなアンテナ構成を提供せんとするものである。

（問題点を解決するための手段）

本発明においては上記目的を達成するため、下記構成の無線通信機器用アンテナを提供する。

一端が地導体(30)に接続し、他端に向かって高さHに亘り起立した第一の幅qの導電性主起立面部(11)と；

一端が上記主起立面部(11)の上記他端に接続し、該主起立面部(11)に対して直交しながら他端に向かって長さLに亘り水平に伸びた第二の幅Wの導電性主水平面部(12)と；

一端が給電点(20)を介して上記地導体(30)に臨み、他端に向かって上記主起立面部(11)と平行に伸びた線状の導電性副起立線部(13)と；

一端が上記副起立線部(13)の上記他端に接続し、上記主水平面部(12)に対して離間距離sを置きながら、他端に向かって該主水平面部(12)に平行に伸びた線状の導電性副水平線部(14)と；

上記副水平線部(14)の上記他端を上記主水平面部(12)の他端位置(Po)または該他端位置(Po)から所定の距離(p',p'',p''',.....)だけ離れた部分に電気的に接続する連結部(15)と；

から成ることを特徴とする無線通信機器用アンテナ(10)。

（作用及び効果）

本発明の構成によれば、主起立面部(11)の高さ（ないし長さ）Hと主水平面部(12)の長さLとで所定の寸法（L＋H），一般に使用周波の波長λに対してλ／4に相当する長さを構成させるに際し、本アンテナ(10)の取付け対象となる無線通信機器小型化の要求等から、主起立面部(11)の高さHを必要に応じて低減させた結果、そしてまた同様の理由による制約から主水平面部(12)の幅Wを余り大きくできなかった結果、そのままでは給電線とのインピーダンス整合が難しくなるような場合にも、当該インピーダンス調整のための自由度が極めて高いので、十分なる整合を取ることができる。

まず第一に、主水平面部(12)に対する副水平線部(14)の離間距離sをしてインピーダンス調整が可能である。この離間距離sの調整は、本アンテナ(10)を大型化することが全くない。

第二に、副水平線部(14)が連結部(15)を介して主水平面部(12)に接続される点の位置を変えることによってもインピーダンス調整が図れる。この点の調整、変更も、本アンテナ(10)の全体としての主要寸法を大型化させることは全くない。

したがって例えば、給電点(20)の取出し位置が製作上の理由から固定されても、上記二者の手法により、大きな調整範囲でインピーダンスの整合を取ることができる。

さらに、本発明において設けられた副水平線部(14)には、特許請求範囲第二項に記載されているように、第一の幅t1の第一導体幅部(18)を取付けることができる。この第一導体幅部(18)は、等価回路的には並列キャパシタンスとして働くので、特にアンテナ高さHを低くした結果、並列インダクタンスが上昇しても、この第一導体幅部(18)があると、さらに並列にキャパシタンスが入ることになり、アンテナインピーダンスの上昇が抑えられるのである。もちろん、その並列キャパシタンスの装荷量は、当該第一導体幅部(18)の幅t1やその長さにより調整できる。

また、特許請求の範囲第三項に示されるよう

に、上記の第一導体幅部(16)の代わりに、またはそれに加えて、第二の幅t2の第二導体幅部(17)を副水平線部(14)に設ければ、その幅t2や長さ、ひいてはその面積寸法のいかんにより、微調整用キャパシタを構成させることができる。

特にこの第二導体幅部(17)を電圧値最大となる主水平面部(12)の他端の直下に設けると、アンテナ共振系における中心周波数foを調整することもできる。

また、この第二導体幅部(17)の形成位置を副水平線部(14)の長さに沿って変化させると、インピーダンス微調整機能も呈することになる。

こうしたことから明かなように、本発明のアンテナ(10)は、従来の逆L型ないし逆F型アンテナの長所はそのままに、インピーダンス整合上の問題を極めて合理的に解決したものである。

特に、本発明アンテナ(10)を無線機回路を構成するプリント基板(40)の上に一緒に組え付けるときには、一般に給電点(20)はプリント基板(40)の面に沿った位置に設けることが最も簡単で望ましいが、従来の逆F型アンテナにおいてこのようにすると、唯一、インピーダンス調整の手段として残されていたこの給電点位置の変更という自由度すら失われてしまうのに対し、本発明ではこの自由度は失われても、それに代わる少なくとも二つの自由度を有しているので、何等問題が生じないという利点がある。

こうしたことから結局、本発明のアンテナ(10)は、特に小型化の進んでいる移動無線機ないし携帯無線機の内蔵アンテナとして最も有効に作用することが分かる。ただしもちろん、これは限定的なことではなく、固定の基地局側に本発明アンテナを用いてもそれなりに有効に使うことができる。

なお、放射効率ないし受信感度に関しては、従来の逆L型ないし逆F型のそれに比し、優れこそすれ、決して遜色のないものが得られるし、主起立面部(11)の幅qを主水平面部(14)の幅Wとは異ならせて、より狭いものとすれば、無指向性化に寄与させることもできる。

〈実　施　例〉

第1図(A)～(D)には本発明に即して構成されたアンテナ10の各実施例の概略構成が示されており、第1図(E)及び(F)はそれら実施例の要部を横から見た場合の若干異なった各構成例を示している。

第1図(A)に示される実施例が本発明によって構成されるアンテナとしては最も基本的な構成のものであって、まず、一端が地導体30に接続し、他端に向かって高さ(ないし長さ)Hに立ち起立した主起立面部11と、一端がこの主起立面部11の上記他端に接続し、主起立面部11に対して直交しながら長さLに亘り水平に伸びた主水平面部12を有している。

もちろん、本書で言う直交とか平行とは、原理設計上の用語であって、実際に作成された場合に製作公差や製造機器の精度等の諸要因から、完全な直角ないし平行状態から外れた場合をも含む総括語である。

しかるに、第1図(A)では分からないが、第1図(E)または(F)に示されるように、上記の主起立面部11と主水平面部12は、それぞれ幅q，Wを有する板状ないし面状のものであり、図示の場合は共に同じ幅寸法(q＝W)となっているが、後述する理由により、主起立面部11の幅qが仮想線11'で切断線を示すように、q＝q'＜Wとなっていても良い。

これらの主起立面部11，主水平面部12は、後述の作成例にも見られるように、例えば銅メッキとかクロームメッキの薄鋼板等、適当な導電性材料板を一般に折り曲げ成形等して得ることができる。

本発明アンテナ10ではさらに、一端が給電点20を介して地導体30に臨み、上記の主起立面部11に対して平行に起ち上がった副起立線部13と、一端がこの副起立線部13の起ち上がり端に接続し、当該副起立線部13に対して直交し、かつ上記の主水平面部12に対しては距離sを置いて平行に伸びる副水平線部14も有している。

そしてこの第1図(A)に示される実施例では、

この副水平線部14の他端が連結部15にて主水平面部12の他端に電気的に接続されている。

これら副起立線部13、副水平線部14は、適当な導電性材料製の線状物であれば良く、特に後述の実際的な作成例に見られるように、対象となる無線機器に必要な回路部品を搭載し、かつまた主起立面部11、主水平面部12を物理的に支持するプリント基板40の上に形成された導電パターンとして簡単、合理的に構成することができる。

これに対し、連結部15は面状でも線状でも良いが、当然、導電性を有している必要はあり、後述の作成例に見られるように、プリント基板40の上にパターニングされた導電線路とすることがやはり便利である。

こうした第一の実施例によれば、主起立面部11の高さHと主水平面部12の長さLとで使用周波数fの波長λに対し、λ／4 に相当する長さを構成させるに際し、本アンテナ10の取付け対象となる無線通信機器小型化の要求等から、主起立面部11の高さHを必要に応じて定められた値まで低減させねばならず、そしてまた同様の理由による制約から、主水平面部12の幅Wも定められた幅に設定しなければならないときにも、アンテナインピーダンスと給電線のインピーダンスとの間の不整合を解消するため、主水平面部12に対する副水平線部14の離間距離sの調整をして当該インピーダンス調整をなすことができる。そしてこの離間距離sの調整は、本アンテナ10の最大寸法を大型化する方向には作用させないで済む。

こうした第1図(A)に示される基本的な実施例は、第1図(B)に示されるように展開することができる。

すなわち、先の基本的な実施例では、主水平面部12に対して副水平線部14の電気的な接続を取るための連結部15は、当該主水平面部12の端部位置Poに配されていたが、この接続部位は、当該端部位置Poから第1図(B)中において距離p'で示されるように、主水平面部12の長さの途中に変更することができる。

さらに、距離p'' ,p''',.....や仮想線の連結部15,...で示されるように、当該接続部位を変更、調整することにより、同様にアンテナインピーダンスの調整を図ることができる。

これはまた、アンテナインピーダンスの調整自由度の数を増したことになり、にも拘らず、こうした調整、変更も、アンテナ全体としての最大寸法を大型化させることが全くない。

したがって例えば、後述の作成例に見られるように、給電点20の取出し位置が機器製作上の理由から例えば主水平面部12の一辺の真下等に限定、固定されても、上記のように離間距離sと連結部15の接続部位までの距離p',p'',p''',.....の調整自由度が残されているので、所求のインピーダンス整合を取ることができる。

さらに、第1図(C)に示される実施例のように本発明において設けられた副水平線部14に、第一の幅t1の第一導体幅部16を取付けると、この第一導体幅部16は等価回路的には並列キャパシタンスとして働くので、特に主起立面部11の高さによって専ら支配されるアンテナ高さHを低くした結果、並列インダクタンスが上昇しても、この第一導体幅部16があると、さらに並列にキャパシタンスが入ることになり、アンテナインピーダンスの上昇を抑えることができる。

もちろん、その並列キャパシタンスの装荷量は、当該第一導体幅部16の幅t1やその長さにより調整可能である。

もっともこの第一導体幅部16は、その製作の実際においては、後述の作成例に見られるように、副水平線部14の高さ方向に亘る導体幅を調整することによって当該副水平線部14と実質的に一体の部材として構成することができる。

第1図(D)はさらに望ましい実施例を示しており、図示の場合、上記の第一導体幅部16の副起立線部13とは対向する端部側に、上記第一の幅t1よりも広い第二の幅t2の第二導体幅部17を副水平線部14に設けてある。

これは、当該幅t2や長さ、ひいてはその面積寸法のいかんにより、微調整用キャパシタを構成するもので、この実施例におけるように、特にこの

第二導体幅部17を分布電圧値最大となる主水平面部12の主起立面部11とは対向する側の端部直下に設けると、アンテナ共振系における中心周波数foを効果的に調整することができる。その結果例については第4図に即して後述する。

また、この第二導体幅部17の形成位置を副水平線部14の長さに沿って変化させると、先の第一導体幅部16と同様、インピーダンス微調整機能も呈することになる。したがってこれを換言すれば、この第二の導体幅部17は、必ずしも第一導体幅部16と共存させる必要はなく、これのみが副水平線部14に設けられるようになっていても良い。

ところで、第1図(E)や第1図(F)に示されるように、実際上、副水平線部14の設置位置は、原理上は主水平面部12の幅Wの方向に見てある程度は任意の位置とすることができる。そしてその位置のいかんによってもまた、アンテナインピーダンスは変更、調整することができる。

例えば第1図(E)の場合には、当該副水平線部14及びこの副水平線部14に上述の第一、第二導体幅部16，17等が取付けられているときにはそれらが、主水平面部12の一辺の真下に距離sを置いて位置しているし、第1図(F)の場合には、当該主水平面部12の一辺の真下よりも外側に離れる方向に斜めに距離sを置いて位置している。

その外、第1図(E)に示される位置よりもさらに内方にずれて設けられていても良いのであるが、実際上は第1図(E)に示されるように、主水平面部の一辺の真下程度の位置に設けるのが望ましい。

何とならば、この一辺に沿って以下の作成例ではプリント基板が備えられ、したがってこのプリント基板に副起立線部13、副水平線部14、さらには第一、第二導体幅部16，17、連結部15等をパターン配線することがもっとも簡単、かつ合理的な作成法だからである。

第2図、第3図は、第1図(D)に示される望ましい実施例を実際に作成した場合を示している。なお参考までに、適用対象とする無線機器はコードレス電話機を選んだ。

これらの図面中にはプリント基板40が示されている。これはガラスエポキシ等、公知既存の適当なる材料製のもので良く、この大域的面積部分には通常のパターニング技術により、適用対象となる無線機器の回路構成に必要な回路部品群を搭載する導体パターン41が形成されている。

図示の場合、このパターンは片面パターンとなっているが、実際には昨今の技術動向に即し、チップ部品等を多用する関係上、両面パターンとされることが多い。

この作成例においては、本発明のアンテナ10は当該プリント基板40の上縁の所定面積幅部分に沿って形成されるようにしている。

すなわち、本発明アンテナ10にまずもって必要な主起立面部11、主水平面部12は、錫メッキとかクロームメッキ等の適当な金属板を高さH、長さLに折り曲げ成形することにより得ているが、この主要部11，12をプリント基板40の対応部位に物理的に固定する都合上、主水平面部11の一辺には離間して二つの舌片18，18が設けられている。

もちろん、この舌片18，18は、上記折り曲げ成形に先立つプレス成形時に一緒に打ち抜かれて良いものであるが、特に図面上、後方に位置する一方の舌片18は、単に物理的な固定の用のみでなく、連結部15の一部として電気的な接続にも寄与するものである。

プリント基板40の方には、まずその上縁に舌片18，18を収める切欠き42，42が形成されている。そして図面上、手前に位置するその一方に関しては、本発明アンテナが設けられるのとは逆の面側に、当該切欠き42に沿って導電パターン43が設けられている。これは半田付けにより、切欠き42内に収めた舌片18を物理的に固定するもので、導電性とは言え、そうした意味からであって、特に回路的に関与するものではない。

一方、図面上、後方に位置する切欠き42に沿っては、第2図に特に良く示されているように、まず第1図各実施例に即して述べた連結部15に相当する導電パターン15が形成され、これと一連に、ただし直角方向にプリント基板上縁に沿って伸び

る副水平線部14の導電パターン16が形成されている。

導電パターン14の導体幅t1は、実質的に第1図(C)または(D)に示される実施例における第一導電幅部18を構成しているのと等価となっており、また連結部15の下に連続して形成されている導電パターン17は、第1図(D)に示される実施例中の第二導体幅t2の第二導体幅部17に相当する。

同様に第2図に特に良く示されているように、プリント基板40の上縁に沿って伸びた副水平線部14の対向端は、下側に向かって折れた導電パターン13を構成しており、この部分13がこれまで述べてきた副起立線部13に相当する。

したがってこの副起立線部13の下端と接地との間に給電点20が形成されるが、この作成例による実施例では、プリント基板の回路構成パターン面部分の周囲を接地パターン44が取囲んでいるので、それぞれアンテナ10に向いた面から裏面側にスルーホールとか適当な帯状導電部材を貫通させることにより、今度は第3図に特に良く示されてプリント基板40の裏面側にて第3図仮想線で示すように折り曲げられるとか、さらにはその上に半田付けされるとかするものである。

こうすれば、当該シールドハウジング30はプリント基板40の上にあって回路部分を覆いながら固定され、かつ接地パターン44または45に電気的にも導通が取られるため、その本来の目的であるシールド機能を営むことができる。

このようにしてプリント基板40上に配置された後、このハウジングを第2図中、仮想線の半田付部分47にて示すように、本発明アンテナ10の主起立面部11の下端に対し、電気的な導通を取れば、本発明アンテナ10に関する地導体30としての機能をも併せ有するようになる。

したがって、先に少し述べたように、本アンテナ10の主水平面部12に設けた舌片18，18を対応する切欠き42，42に収めた後、半田付け等により連結部15と固定用導電パターン部分43とに固定すれば、物理的固定と連結部15に対する電気的接続とが同時に図られ、もって本発明アンテナ10がプリントいるように、裏面接地パターン45に外側導電ハウジングが半田付けにより電気的、物理的に固定された適当なコネクタ22を設けて、これにて回路系との接続を取るようにしている。なお、こうしたコネクタ22は、この種のアンテナ接続技術において各種各様のものが公知となっており、特に詳細を示す必要はない。

主起立面部11の下端は、本発明の要旨構成に即し、地導体30に接続を取られる必要があるが、この作成例による実施例の場合、当該地導体30は、プリント基板40に設けられた回路構成部分をシールドするシールドハウジング30の上端面部分にて合理的に構成されるようにしている。

当該シールドハウジング30は、それをプリント基板40に物理的に固定するため、側縁部に突片31，31が複数個（図示の場合は二つ示されている）、形成されている。

これら突片31，31は、接地パターン44，45の所で貫通するようにプリント基板40に開けられている突片挿入孔46，46内に挿入された後、当該プリント基板40の上に組込まれた形で完成する。

もちろん、第2図，第3図は斜視図であるため、寸法関係や位置関係が詳細には分からないが、こうして完成された本発明アンテナ10の各部の配置関係は第1図(D)に示された実施例に相当するものとなる。

ただし、第1図(E)と(F)との関係に示されるように、副起立線部13，副水平線部14，連結部15等はプリント基板40の裏面側に形成されていても良いし、連結部15については、例えば主水平面部12の先端をさらに下側に折り返すようにして面状に形成し、その一側縁がプリント基板に形成された導電パターンに接触することにより、副水平線部14と接続されるようになっていても良い。

また、第1図(A)～(C)に示された実施例も、ほぼ同様の手順，手法で作成できることは明かである。特に第1図(A)，(B)に示される実施例のように、あえて第一導体幅部18や第二導体幅部17は不要にする場合には、第2，3図において副水平線部14の持つ導体幅が余り大きなキャパシタン

ス成分を持たないように、意図的に十分細くパターニングする等図れば良い。

いづれにしてもこのような作成例によれば、形態からだけ見ると、プリント基板40の上に形成された従来回路に必要な面積部分に加えて、単に逆L型の板部分11，12の面積部分が追加になっているだけでこの対象となる無線機器に必要なアンテナ10を組込み得るものとなり、無線機器の外面部分に露出させなくとも良いことにもなるため、当該無線機器の外形状をスマートにし、小型化を図るに最適なものとなる。

しかるに、主起立面部11の高さH、幅q，主水平面部の長さL，幅Wが無線機器小型化上の寸法設計的な要因により定められ、また給電点20の取出し位置も例えば第２，３図示のように固定されたにしても、連結部15の配設位置や、第一導体幅部16の幅t1のパターニング時の幅設計のいかん等により、大きな自由度でアンテナインピーダンスの調整が図れることは既述した通りであるが、第二導体幅部17を例えばその幅t2に関して可変にした場合、それはアンテナ共振系における中心周波数foの変化として認めることができる。

例えば第二導体幅部17の当該幅t2がある最適幅になっていた場合、第４図に実線で示される曲線Coのように中心周波数foに整合するカーブが得られていたとすると、導体幅t2をそれより小さくすると特性は破線のカーブCuで示されるように高域側にシフトする。導体幅t2を増した場合には逆に低域側にシフトすることは当然である。このシフト幅は結構大きくでき、したがってこのように第二導体幅部17を図水平線部14に対する本発明の望ましい実施例によれば、中心周波数foの調整自由度も高いものとすることができる。

以上のような作成例に従って作成された本発明アンテナにおいて、実際にコードレス電話機の携帯側（リモートユニット側）と基地局側（ベースユニット側）の双方に使用して得られた指向特性を第５図（A），(B) に示す。

同図(A) は携帯側に使用したもの、同図(B) は基地局側に使用したものであるが、まず同図(A) 中、実線のカーブCvで示されるように、携帯側に組込まれた本発明アンテナの垂直偏波指向性は、主起立面部11の影響で、これの設けられている方向である図示の場合の 270° 方向に感度の落ち込みがあるものの、ナル(null)点は認められず、実質上、理想に近い無指向性と考えることができる。

これに関してはまた、先に述べたように、当該主起立面部11の幅qを第１図(E) や第１図(F) に示されるq'のように狭めれば、より丸い無指向性とすることができる。第１図(E) と(F) とにおいて当該切残す幅部分q'が左右で異なっているのは、都合によりどちらを狭めても良いことを示している。

さらに第５図(A) 中において、仮想線のカーブChで示したように、本発明のアンテナ10は、垂直偏波成分よりはレベル的に10～20dB程度の低下はあるものの、水平偏波成分に関しても極端なナル点のない無指向性を示している。

したがって、この携帯側に用いた本発明アンテナは、いづれの方向からの到来波に対しても感度を示す偏波ダイバーシティ機能を持っていることが分かる。

また、第５図(B) に示される基地局側の本発明アンテナでは、アンテナ本体は携帯側と全く同一であるが、垂直、水平共に、より無指向性が高くなっていることが分かる。

これは、基地局側の機器においては、各種制御回路が携帯側より複雑化し、電話回線との接続回路部分等もあるため、シールドハウジング30がこれらを内包する関係上、携帯側より寸法的に大きくなった結果、アンテナから見た地導体30も面積的に大きくなったが故と考えられる。いづれにしてもこれらの特性は相当に望ましいものであること間違いない。

なお、上記作成例はあくまで一例であってこれに限定されるものではなく、第１各図に示される本発明アンテナを実際にどのようにして作成するのかは、本発明を使用しようとする当業者の選択に任される問題である。

4.図面の簡単な説明

第1図は本発明アンテナの各実施例の概略構成図、第2図及び第3図は第1図に即して構成される本発明アンテナの作成例の概略構成図、第4図は本発明アンテナの実施例における共振系の中心周波数調整に関する説明図、第5図は本発明アンテナの実際の作成例により得られた指向性に関する特性図、第6図は従来の逆L型アンテナの概略構成図、第7図は従来の逆F型アンテナの概略構成図、である。

図中、10は全体としての本発明アンテナ、11は主起立面部、12は主水平面部、13は副起立線部、14は副水平線部、15は連結部、16は第一導体幅部、17は第二導体幅部、20は給電点、30はアンテナに関する地導体の一例としてのシールドハウジング、40はプリント基板、である。

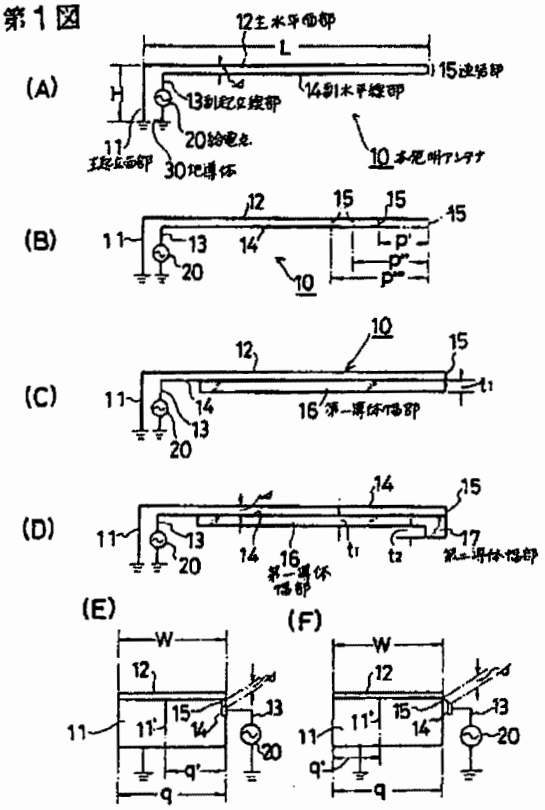
出願人　ユニデン株式会社

代理人　福田信行

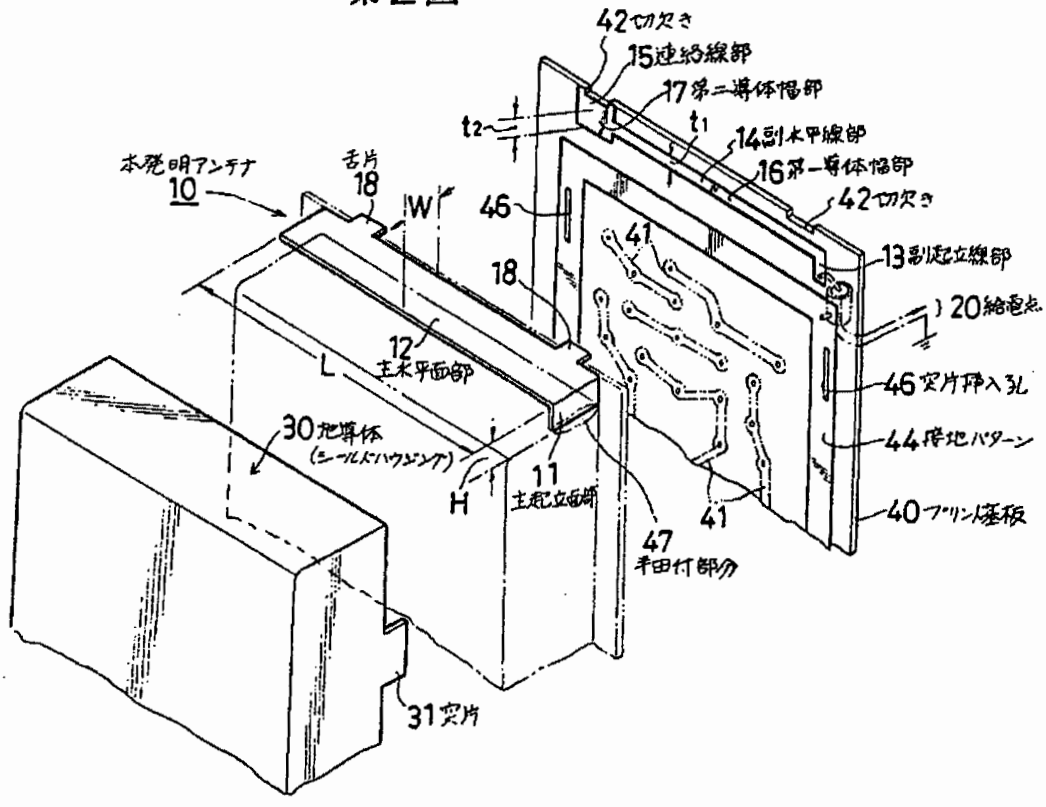
代理人　福田武通

代理人　福田賢三

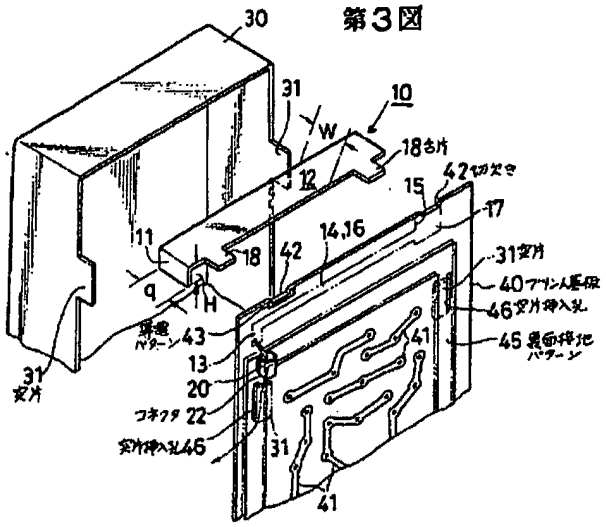
第1図



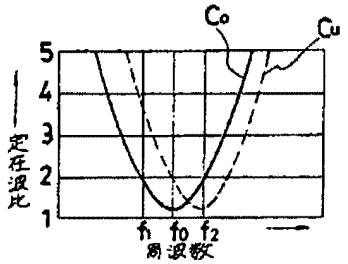
第2図



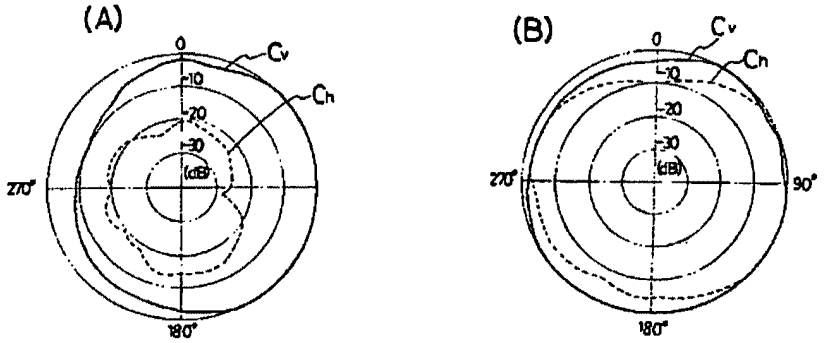
第3図


30
31
10
W
12
18
42
15
17
11
18
42
14,16
31
40
46
q
H
43
41
45
13
20
22
46
31
41

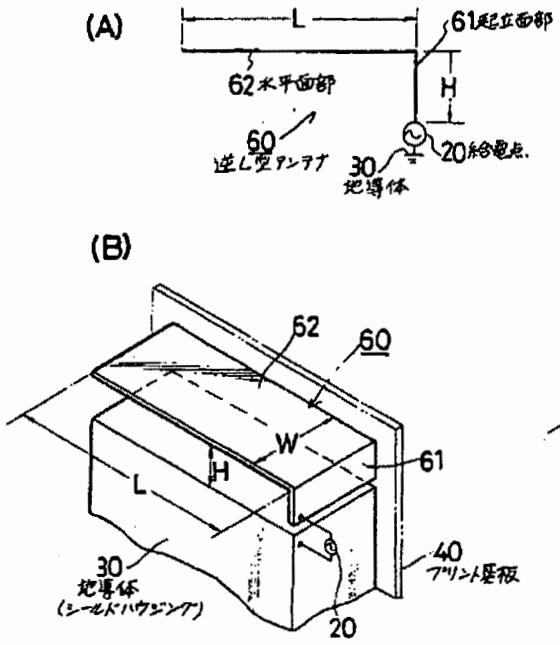
第4図


Co
Cu
5
4
3
2
1
f1
f0
f2
周波数

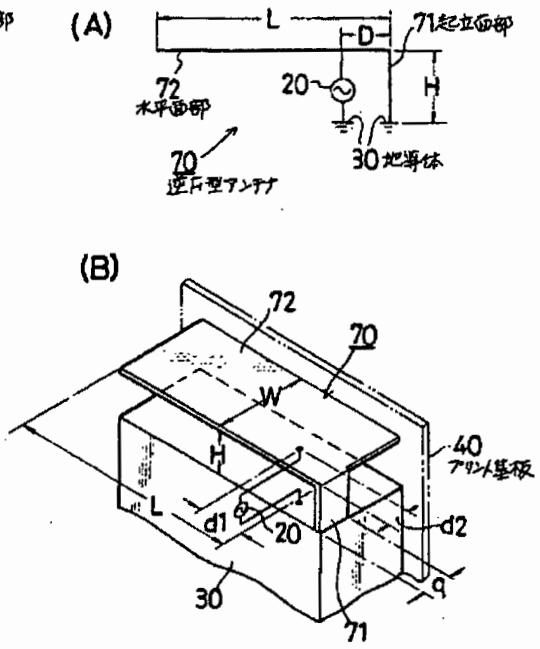
第5図


(A)
0
Cv
10
Ch
20
30
(dB)
270°
90°
180°
(B)
0
Cv
Ch
10
20
30
(dB)
270°
90°
180°

第6図


(A)
L
61起立面部
62水平面部
H
60
逆L型アンテナ
30
地導体
20給電点
(B)
62
60
W
H
L
61
30
地導体
(シールドハウジング)
40
プリント基板
20

第7図


(A)
L
D
71起立面部
72
水平面部
20
H
70
逆F型アンテナ
30地導体
(B)
72
70
W
H
40
プリント基板
L
d1
20
d2
30
71

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 246 026 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **02.03.94** (51) Int. Cl.5: **H01Q 1/24**

(21) Application number: **87304052.1**

(22) Date of filing: **06.05.87**

(54) Antenna for wireless communication equipment.

(30) Priority: **09.05.86 JP 104837/86**

(43) Date of publication of application:
19.11.87 Bulletin 87/47

(45) Publication of the grant of the patent:
02.03.94 Bulletin 94/09

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI NL SE

(56) References cited:
EP-A- 0 177 362
US-A- 3 736 591
US-A- 4 516 127

PATENT ABSTRACTS OF JAPAN volume 9, no. 118, 23th May 1985,pages E 316-1841;& JP-A-60007204 (TOUYOU TSUWSHINKI) 16-01-1985

PATENT ABSTRACTS OF JAPAN volume 9, no 178, page E330-1901;& JP-A -60047522 (NIPPON DENSHIN DENWAKOSHA) 14-03-1985

PATENT ABSTRACTS OF JAPAN volume 7, no. 208, 14th September 1983,page E198-1353;& JP-A-58104504(MATSUSHITA DENKI SANGYO) 22-06-1983

(73) Proprietor: **UNIDEN CORPORATION**
7-4 Onitaka 4-chome
Ichikawa-shi Chiba-ken(JP)

(72) Inventor: **Hikuma, Hideo**
Daiichi Satsukiso 103
1-21-5 Gyotoku Ekimae
Ichikawa-shi Chiba-ken(JP)

(74) Representative: **Smith, Norman Ian et al**
F.J. CLEVELAND & COMPANY
40-43 Chancery Lane
London WC2A 1JQ (GB)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

EP 0 246 026 B1

Description

The present invention relates to antennas for wireless communication equipment, and particularly to improvements in compact plate antennas which are suitable for use as antennas for mobile or portable communication equipment.

A typical configuration for antennas for communication equipment or transceivers mounted aboard vehicles, or for mobile or portable communication equipment such as cordless telephones, has been the classical λ/4 monopole antenna as typified by the whip antenna. This is the most widespread type and has been used in most cases up to date. Here, λ is the wavelength at the operating frequency f.

Generally speaking, when an antenna is raised to a higher elevation, it becomes proportionally less susceptible to the influences of the topography and surface objects and gains a higher sensitivity in the reception of incoming radio waves. However, as long as the aforesaid monopole antennas were used in mobile or portable communication equipment such as those dealt with here, there were restrictions on their height. Since they could not be raised up very high, it was not always possible to achieve a desirable sensitivity.

It is also undesirable to position an antenna too low, and there is the limitation that the aforesaid λ/4 must be followed at the minimum. Even though there has been a tendency in recent communication equipment to miniaturize the circuit parts remarkably by adopting various types of integrated circuits, no progress has been made in miniaturization of antenna parts, and miniaturization has proved to be entirely unsuitable for the antennas of portable communication equipment which are carried around indoors by a person while speaking, such as the remote units of cordless telephones.

Monopole antennas also have problems in their basic principles of operation. Since the antennas are of the type sensitive to electric fields, they are easily susceptible to the influences of persons or other dielectric substances in the vicinity, and the antenna performance has sometimes deteriorated under the conditions of actual use.

Concerning this point, generally in mobile wireless communications, even if the waves are transmitted from the base station as vertically polarized waves, their plane of polarization becomes inclined as the waves are reflected and scattered by the topography, structures, etc. located in the path of propagation, so that horizontal polarization is sometimes stronger than vertical polarization in the waves when they arrive at a mobile station. This tendency is especially pronounced in cities where there are many tall buildings, steel towers, and the like.

The same may be said about wireless local intercommunication systems. Here also, the waves are reflected and scattered by the equipment installed, and by machines, implements, ceilings, columns, beams and the like, so that very often the waves arriving at a mobile station have a different plane of polarization from the waves which were transmitted.

For this reason, when monopole antennas are used in an attempt to deal with this polarization of the propagated radio waves, one must rely on the so-called polarization diversity effect, for example by positioning two monopole antennas, one vertically and one horizontally. However, such a method is disadvantageous with respect to the space factor in antenna systems for mobile stations.

On account of these circumstances, attempts have begun to be made in the past to use inverted-L antennas such as that shown in Figure 1, or inverted-F antennas such as that shown in Figure 2, instead of these monopole antennas. These antennas are easy to miniaturize, are of the type sensitive to magnetic fields and have an effect essentially similar to the polarization diversity effect.

Figure 1(A) and Figure 2(A) show the basic configurations of these inverted-L and inverted-F antennas of the past, and Figure 1(B) and Figure 2-(B) show examples of actual antennas fabricated according to the basic configurations in each case.

Let us first explain the inverted-L antenna 10 shown in Figures 1(A) and (B). It consists of a vertical planar part 11 having a width W, and a horizontal planar part 12 which is bent at a right angle while being electrically connected at one end to this vertical planar part 11. The antenna is designed so that the sum of the length L of the horizontal planar part 12 and the height (or length) H of the vertical planar part 11 is equivalent to λ/4 with respect to the wavelength λ of the operating frequency.

The feeding point P is located between the bottom of the vertical planar part 11 and the ground or earth E.

In the actual example of an antenna shown in Figure 1(B), the ground E is configured on the upper surface of the shield housing (ground E) which shields the circuit parts (not shown in the drawing) which are assembled on a printed circuit board B. The inverted-L antenna 10 itself is also supported physically on this printed circuit board B. Of course, the vertical planar part 11, the horizontal planar part 12 and the shield housing E are made of conductive materials, generally suitable metals such as tinned steel sheets, and the printed circuit board B supporting them is made of an insulating materials such as glass epoxy.

The inverted-F antenna 20 shown in Figures 2-(A) and (B), like the aforesaid inverted-L antenna 10, has a conductive horizontal planar part 22 with a length L and a conductive vertical planar part 21 with a height (or length) H positioned more or less at right angles towards each other, while the two parts are electrically connected to each other on one end. This antenna is also designed so that the sum of the aforesaid lengths (L + H) is equivalent to λ/4. However, the bottom of the vertical planar part 21 is directly connected to the ground E, which comprises the shield housing, and the feeding point P is led out from a position separated by a distance D from the connecting point of the vertical planar part 21 and the horizontal planar part 22, as is shown in Figure 2(A).

As is shown in Figure 2(B), the distance D can be considered by separating it into two parts: distances d_1 and d_2. In the inverted-F antenna 20 shown in the drawing, the vertical planar part 21 has a width q less than the width W of the horizontal planar part. This is for the purpose of improving the directivity. EP-A-0177362 and JP-A-58-104504 describe an antenna of the inverted-F type. The usual practice is to design inverted-L antennas 10 or inverted-F antennas 20 so that the height H of the vertical planar parts 11, 21 is equal to about λ/10.

The inverted-L and inverted-F antennas shown in Figures 1 and 2 are superior in many respects to monopole antennas.

First of all, one may mention that their three-dimensional size can be made much smaller than that of monopole antennas. Moreover, they can coexist with the circuit parts mounted on a printed circuit board, as is shown in Figure 1(B) and Figure 2(B). Consequently, they can easily be housed inside the frames of communication equipment and can be miniaturized.

Second, although these inverted-L and inverted-F antennas 10, 20 are originally for use with vertically polarized waves, they also have horizontally polarized components, even though their radiation power has been reduced by about 20-30 dB. Therefore, even though they are single antennas, they have potentially a polarization diversity function.

However, a problem which tends to occur easily in the so-called plate antennas of this type of the past is the fact that it is difficult to match the impedance with the characteristic impedance of the feeder line.

For example, as mentioned above, the sum (L + H) of the height H of the vertical planar parts 11, 21 and the length L of the horizontal planar parts 12, 22 will necessarily be determined once the operating frequency f is determined. However, in most cases it is desirable to reduce the height H of the vertical planar parts 11, 21.

In these cases, the antenna impedance generally tends to rise as the height H is reduced because of the increase of the parallel inductance. For this reason, mismatching of the impedance with the feeder line tends to occur easily.

Nevertheless, there are still ways of matching the impedance in these conventional antennas 10, 20 even if the height H is reduced. First, there is the method of adjusting the width W of the horizontal planar parts 12, 22. However, although there is no problem when this width W must be reduced, when it must be increased it becomes impossible to set it at the necessary width on account of the restrictions on the dimensions required in communication equipment. That is, there is not a very large degree of freedom in adjusting the impedance by adjusting the width W of the horizontal planar parts 12, 22.

On account of this, even among the conventional examples, if we compare the inverted-L antenna 10 shown in Figure 1 with the inverted-F antenna shown in Figure 2, one may say that the inverted-F antenna 20 shown in Figure 2 is somewhat more advantageous with respect to adjustment of the impedance.

This is true for the following reason. In the inverted-L antenna 10 shown in Figure 1, when the height H is restricted, one must rely solely on adjustment of the width W of the horizontal planar part 12 for adjusting the impedance. On the other hand, in the inverted-F antenna 20 shown in Figure 2, even though both height H and width W may be restricted on account of dimensional requirements connected with miniaturization of the equipment, there still remains the means of adjusting the impedance by changing the lead-out position of the feeding point P, that is changing the distance D, or more realistically, by changing distances d_1 and d_2 in Figure 2(B).

However, in actual fact, the range within which the impedance could be adjusted by these means was by no means sufficient. For this reason, restrictions were imposed on the dimensions of the equipment, and in most cases it was not possible to reduce the height H of the vertical planar part 21 very much.

In the case of the inverted-F antenna 20 in Figure 2, which would seem to be somewhat superior to the inverted-L type, as mentioned above, there is an additional drawback in manufacturing of the equipment. That is, it becomes difficult to lead out the feeding point P when the distance d_1, d_2 concerning the feeding point P are adjusted in certain ways.

SUMMARY OF THE INVENTION

An object of this invention is to provide a highly suitable new antenna configuration which has a good efficiency, in which miniaturization is possible, and in which impedance matching can be done easily even if the dimensions of the main antenna parts and the lead-out position of the feeding point are restricted, that is, in which there is a high degree of freedom in adjusting the antenna impedance.

According to the present invention there is provided an antenna for wireless communication equipment comprising a conductive main generally vertical planar part having a first width and a first length which is connected at one end to the ground and a conductive main generally horizontal planar part having a second width and a second length and which extends at substantially right angles towards said main vertical planar part, and which is connected at its one end to the other end of the main vertical planar part the sum of the first length and the second length being equivalent to a quarter wave length at an operating frequency; characterised in that the antenna includes a conductive secondary generally vertical linear part which faces towards and extends in parallel to said main vertical planar part, and which is connected at its one end to the feeding point; and a conductive secondary generally horizontal linear part which extends in parallel to said main horizontal planar part, and spaced from said main horizontal planar part by a predetermined distance, and which is connected at its one end to the other end of said secondary vertical linear part, and which is connected at the other end thereof to the other end of said main horizontal planar part.

In configurations in accordance with this invention, when configuring the prescribed dimensions in terms of the height (or length) of the main vertical planar part and the length of the main horizontal planar part -- generally a length equivalent to $\lambda/4$ with respect to the wavelength λ of the operation frequency --, it is possible to attain sufficient matching of the impedance with the feeder line since there is an extremely high degree of freedom in adjusting the impedance. This is true even in cases where matching of the impedance with the feeder line would he difficult without modifications. This is possible, firstly, because the height of the main vertical planar part has been reduced as necessary on account of requirements such as miniaturization of the wireless communication equipment on which the antenna is to be mounted, and, secondly, because the width of the main horizontal planar part could not be increased very much on account of restrictions based on the same reason.

First, it is possible to adjust the impedance by adjusting the distance separating the secondary horizontal linear part from the main horizontal planar part. Adjustments of this distance will not result in any increases of the antenna sizes.

Second, the aforesaid secondary horizontal linear part and the aforesaid main horizontal planar part are connected through a coupling part while maintaining the prescribed interval between them. It is also possible to adjust the impedance by varying the position of the point where they are connected. Adjustments and changes of this point also will not result in any increases of the main dimensions of the antenna as a whole. Consequently, even if the lead-out position of the feeding point is fixed on account of reasons having to do with manufacturing, the impedance can be matched within a large range of adjustment by means of the two methods described above.

Furthermore, a first conductor width part having a first width can be mounted on the secondary horizontal linear part. This first conductor width part operates as a parallel capacitance in the manner of an equivalent circuit. Therefore, if this first conductor width part is present, capacitance will still be admitted in parallel even if the parallel inductance rises as a result of lowering the antenna height, and the rise of the antenna impedance can be suppressed. The amount of this parallel capacitance mounted can, of course, be adjusted by means of the width or length of the first conductor width part.

Moreover, if a second conductor width part having a second width is provided on the secondary horizontal linear part instead of or in addition to the aforesaid first conductor width part, it is possible to configure a capacitor for fine adjustment regardless of its width or length, that is, regardless of its area dimensions.

In particular, if this second conductor width part is located immediately under the other end of the main horizontal planar part, where the voltage has its largest value, it is also possible to adjust the central frequency in the antenna resonance system.

If the position where this second conductor width part is formed is moved along the length of the secondary horizontal linear part, it will be able to display the function of making fine adjustments of the impedance.

As is clear from these facts, the antennas of this invention have solved extremely rationally the problems in impedance matching, while retaining unchanged the advantages of the conventional inverted-L and inverted-F antennas.

In particular when the antennas of this invention are incorporated together with communication equipment circuits on printed circuit boards, it will

generally be easiest and most desirable to locate the feeding point on a position along the surface of the printed circuit board. However, if this had been done in the inverted-F antennas of the past, this would have meant the loss of a degree of freedom in varying the position of the feeding point, which was the only remaining means of adjusting the impedance. On the other hand, this invention has the advantage that, even if this freedom is lost, no problems arise since there still remain at least two alternative degrees of freedoms.

It is clear from this that the antennas of this invention operate most effectively as built-in antennas in mobile or portable communication equipment, in which particular progress has been made in miniaturization. However, this is naturally not intended to restrict their application, and the antennas of this invention can be used effectively in their own way in stationary base stations as well.

It is also possible to obtain antennas with better radiation efficiency and reception sensitivity than the conventional inverted-L and inverted-F antennas. If the main vertical planar part is given a width different from the width of the main horizontal planar part and is made narrower, this can also contribute to converting them to nondirectional antennas.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1(A) and (B) are schematic drawings of the configuration of a conventional inverted-L antenna.

Figures 2(A) and (B) are schematic drawings of the configuration of a conventional inverted-F antenna.

Figures 3(A) - (F) are schematic drawings of the configuration of various embodiments of antennas of this invention.

Figures 4 and 5 are schematic drawings of the configurations of examples of antennas of this invention configured in accordance with Figure 3.

Figure 6 is an explanatory diagram of adjustment of the central frequency of the resonance system in an embodiment of the antennas of this invention.

Figures 7(A) and (B) are characteristic drawings concerning the directivity obtained by actual examples of antennas of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figures 3(A) - (D) are schematic drawings of the configuration of various embodiments of the antennas 100 of this invention. Figures 3(E) and (F) show examples of somewhat different configurations in which the major parts of these embodiments are viewed from the side.

The embodiment shown in Figure 3(A) is the most basic configuration of an antenna made up in accordance with this invention. First of all, it has a main vertical planar part 101 and a main horizontal planar part 102. One end of the main vertical planar part is connected to the ground 110, and it stands erect for a height (or length) H up to its other end. The main horizontal planar part 102 extends horizontally along a length L at right angles to the main vertical planar part 101, and one end of it is connected to the other end of this main vertical planar part 101.

Naturally, the words such as "right angles" or "parallel" are used here for the sake of convenience in explanation, and they have a meaning which allows some divergences from perfect right angles or parallels on account of factors such as the manufacturing tolerances in fabricating the actual elements or the precision of the manufacturing equipment.

That is, as is shown in Figure 3(E) or (F), the aforesaid main vertical planar part 101 and main horizontal planar part 102 are plate-shaped or planar shaped and have widths of q and W, respectively. In the cases shown in the drawings, they both have the same width dimensions (q = W) . However, it does not matter if q' < W, as when the width q of the main vertical planar part 101 has a cutting line at the imaginary line 101' for the reasons described below.

The main vertical planar part 101 and the main horizontal planar part 102 can be made, generally speaking, by bending and forming sheets of suitable conductive materials such as tinned or chromium-plated steel plates, as is seen also in the examples of antennas described below.

In addition, the antennas 100 of this invention have a secondary vertical linear part 103 and a secondary horizontal linear part 104. The secondary vertical linear part 103 stands up in parallel to the aforesiad main vertical planar part 101, and one end of it passes through the feeding point P and abuts on the ground 110. The secondary horizontal linear part 104 is at right angles to the secondary vertical linear part 103, extends in parallel to the aforesaid main horizontal planar part 102, separated by a distance s, and one end of it connects with the ascending end of this secondary vertical linear part 103.

In this embodiment illustrated in Figure 3(A), the other end of this secondary horizontal linear part 104 is electrically connected by a coupling part 105 with the other end of the main horizontal planar part 102.

The secondary vertical linear part 103 and the secondary horizontal linear part 104 may be linear materials made of any suitable conductive material.

In particular, they can be configured simply and rationally as conductive patterns formed on the printed circuit board 120 on which are mounted the circuit parts necessary for the communication equipment in question and which supports physically the main vertical planar part 101 and the main horizontal planar part 102, as shown in the examples of actual antennas given below.

On the other hand, the coupling part 105 may be either planar or linear in shape, but it naturally must have electrical conductivity, and it is convenient for it to be made of conductive lines patterned on the printed circuit board 120, as is seen in the examples of antennas described below.

In this first embodiment, when configuring a length equivalent to $\lambda/4$ with respect to the wavelength λ of the operating frequency f with a total length (L + H) equal to the total of the height H of the main vertical planar part 101 and the length L of the main horizontal planar part, it will be necessary to reduce the height H of the main vertical planar part 101 to a determined value on account of requirements of miniaturization of the wireless communication equipment on which this antenna 100 is to be mounted. When it is necessary to set the width W of the main horizontal planar part 102 also at a determined value, on account of restrictions based on the same reason, it is possible to adjust the antenna impedance by adjusting the distance s between the secondary horizontal linear part 104 and the main horizontal planar part 102 in order to dissolve the mismatching between the antenna impedance and the impedance of the feeder line. By adjusting this distance s, it is possible to avoid increasing the maximum dimensions of the antenna 100.

The basic embodiment shown in Figure 3(A) can also be expanded in the manner shown in Figure 3(B).

That is, in the basic embodiment above, the coupling part 105 for making electrical connections between the secondary horizontal linear part 104 and the main horizontal planar part 102 was positioned in the end position Po of the main horizontal planar part 102, but this connection position can be changed along the length of the main horizontal planar part 102, as is shown by distance p' in Figure 3(B).

In addition, the antenna impedance can be adjusted similarly by changing and adjusting the connection position, as shown by distances p", p"', ... and by the coupling part 105 indicated by the imaginary lines.

This also means an increase in the number of degrees of freedom in adjusting the antenna impedance. In spite of this, these adjustments and changes do not result in any increases of the maximum dimensions of the antenna as a whole.

Therefore, even if the lead-out position of the feeding point P is limited and fixed, for example at a place immediately below one side of the main horizontal planar part 102 because of reasons having to do with manufacturing of the equipment, as is seen, for example, in the examples of antennas described below, it is still possible to perform the desired impedance matching because there still is a degree of freedom in adjusting the distance s and the distances p' , p", p"', ... to the connection position of the coupling part 105, as described above.

In addition, if the first conductor width part 106 having a first width t_1 is mounted on the secondary horizontal linear part 104 provided in this invention, as in the embodiment shown in Figure 3(C), this first conductor width part 106 operates as a parallel capacitance in the manner of an equivalent circuit. Therefore, even though the parallel inductance may rise as a result of lowering the antenna height H, which is governed exclusively by the height of the main vertical planar part 101, the capacitance will still enter in parallel if this first conductor width part 106 is present, and it will be possible to suppress the rise of the antenna impedance.

Naturally, the amount of parallel capacitance mounted can be adjusted in accordance with the width t_1 of the first conductor width part 106 or its length.

Of course, when it is actually being manufactured, this first conductor width part 106 can be configured as a structural member essentially integrated with the secondary horizontal linear part 104, as is seen in the examples of antennas described below. This can be done by adjusting the conductor width along the elevation direction of the secondary horizontal linear part 104.

Figure 3(D) shows another preferred embodiment. In the case shown, the second conductor width part 107 having a second width t_2 greater than the aforesaid first width t_1 is provided on the secondary horizontal linear part 104, on the end of the aforesaid first conductor width part 106 facing towards the secondary vertical linear part 103.

This means that a capacitor for fine adjustments is configured here, depending upon its width t_2 or length, or in the final analysis its area dimensions. If this second conductor width part 107 is located immediately under the end part of the main horizontal planar part 102 on the side facing towards the main vertical planar part 101, where the distributed voltage reaches its maximum value, as in this embodiment, it is possible to adjust effectively the center frequency fo in the antenna resonance system. An example of an actual antenna is shown in Figure 4.

If the position where this second conductor width part 107 is formed is varied along the length

of the secondary horizontal linear part 104, it will also be able to display the function of making fine adjustments of the impedance, just as in the case of the first conductor width part 106 mentioned above. That is, it is not always necessary for this second conductor width part 107 to coexist with the first conductor width part 106, and it alone may be located on the secondary horizontal linear part 104.

As is shown in Figure 3(E) or Figure 3(F), in actual fact, the position where the secondary horizontal linear part 104 is located can be, in principle, selected freely, to a certain degree, in the direction of the width W of the main horizontal planar part 102. The antenna impedance can also be varied and adjusted in accordance with its position.

For example, in the case shown in Figure 3(E), this secondary horizontal linear part 104, and also the aforesaid first and second conductor width parts 106, 107 (when they are mounted on this secondary horizontal linear part 104), are located immediately below one side of the main horizontal planar part 102, separated by a distance s. In the case shown in Figure 3(F), they are located at an oblique position outside from the point immediately below one end of the main horizontal planar part 102, separated by a distance s.

In addition, they may also be located at a position even further inward from the position shown in Figure 3(E). However, in actual fact, it is preferable to locate them in a position more or less directly below one end of the main horizontal planar part, as is shown in Figure 3(E). This is so because the printed circuit board is provided along this end in the examples of antennas described below, and consequently the simplest and most rational fabricating method is that of wiring the secondary vertical linear part 103, the secondary horizontal linear part 104, as well as the first and second conductor width parts 106, 107 and the coupling part 105 by patterning them on this printed circuit board.

Figures 4 and 5 illustrate an actual antenna fabricated on the basis of the preferred embodiment shown in Figure 3(D). For reference purposes, a cordless telephone was selected as the applicable communication equipment.

The printed circuit board 120 is shown in these drawings. It may be made of a suitable existing, publicly known material such as glass epoxy, and the conductor patterns 121 for mounting the group of circuit parts needed to configure the applicable communication equipment are formed by ordinary patterning techniques on the part of the board with the board area.

In the case illustrated in the drawings, these patterns are on one side of the board, but double-sided patterns are actually used most frequently, since chip parts are used in most cases.

In this example of an antenna, the antenna 100 of this invention is formed along the width part of a predetermined area on the upper edge of the printed circuit board 120.

That is, the main vertical planar part 101 and the main horizontal planar part 102 which are necessary to an antenna 100 of this invention are obtained by bending and forming suitable steel plates with tinning or chrome plating to height H and length L. Since these principal parts 101, 102 are physically fastened to the corresponding positions on the printed circuit board 120, two tongues 108, separated by an interval, are provided on one side of the main horizontal planar part 101.

Naturally, these tongues 108 may be formed by blanking at the same time as the press-forming prior to the aforesaid bending. However, the tongue 108 located towards the back in the drawing not only serves for physically fastening the parts, but also contributes to the electrical connections as a part of the coupling part 105.

Notches 122 into which to fit the tongues 108 are first formed on the upper edge of the printed circuit board 120. Along the notch 122 located towards the front in the drawing, a conductive pattern 123 is provided on the plane opposite to the plane where the antenna of this invention is located. It is for the purpose of fastening by soldering the tongue 108 when it is fitted inside the notch 122, and it does not play any particular role in the circuitry.

A conductive pattern 105 corresponding to the coupling part 105 mentioned in connection with the embodiments in Figure 3 is formed along the notch 122 located to the rear, as is shown in Figure 4. The conductive pattern 104 of the secondary horizontal linear part 104, which extends along the upper edge of the printed circuit board, is formed in connection with it, but extending in a rectangular direction.

The conductor width t_1 of the conductive pattern 104 is equivalent to that making up the first conductor width part 106 in the embodiments shown in Figure 3(C) or (D). Moreover, the conductive pattern 107 which is formed continuously below the coupling part 105 corresponds to the second conductor width part 107 having second conductor width t_2 in the embodiment shown in Figure 3(D).

Similarly, as is shown in Figure 4, the opposite end of the secondary horizontal linear part 104 extending along the upper edge of the printed circuit board 102 forms a conductive pattern 103 bending downwards, and this part 103 corresponds to the secondary vertical linear part 103 described thus far.

Consequently, the feeding point P is formed between the bottom of this secondary vertical linear part 103 and the ground. In this embodiment, the grounding pattern 124 surrounds the pattern planar parts making up the circuits of the printed circuit board. Therefore, through holes or suitable rod-shaped conductive components are made to penetrate through to the rear surface of the printed circuit board from the surface facing towards the antenna 100. In this way, suitable connectors 132 are provided, by which the conductive outer housing is connected and fastened by soldering to the grounding pattern 125 on the rear surface, and connections are made in this way with the circuit system, as is shown in Figure 5. These connectors 132 are not given in detail, since various types of them are well known in the art of connecting antennas of this type.

The lower ends of the main vertical planar part 101 must have connections with the ground 110. In this embodiment, the ground 110 is formed on the top surface part of the shield housing 110 which shields the parts making up the circuitry on the printed circuit board 120.

A number of projections 111 (two are shown in the example illustrated in the drawings) are formed on the side parts of the shield housing 110 in order to fasten it physically to the printed circuit board 120.

These projections 111 are first inserted inside the projection insertion holes 126 provided in the printed circuit board 120 so that they will penetrate through at the location of the grounding patterns 124, 125. Then they are bent on the rear side of the printed circuit board 120, as is shown by the imaginary lines in Figure 5, or they may also be soldered in place after having been bent. In this way, the shield housing 110 is located over the printed circuit board 120, is fastened in place while covering the circuit parts, and is also connected electrically with the grounding pattern 124 (or 125). This enables it to fulfill the shield function which is its purpose.

If this housing, after it has been placed on the printed circuit board 120 in this way, is electrically connected to the bottom of the main vertical planar part 101 of the antenna 100 of this invention, as in the soldered part 127 shown by the imaginary lines in Figure 4, it will also be able to function as the ground 110 with respect to the antenna 100 of this invention.

Therefore, after the tongues 108 provided on the main horizontal planar part 102 of the antenna 100 have been fitted into the corresponding notches 122, as mentioned above, they are fastened by soldering or the like to the coupling part 105 and to the conductive pattern 123 for use in fastening. Then they will be able to provide at the same time both physical fastening and electrical connections with the coupling part 105. With this, the antenna 100 is incorporated onto the printed circuit board 120 and completed.

Of course, since Figures 4 and 5 are oblique drawings, they do not show the relative dimensions and relative positions in detail. However, the relative placements of the various parts of the antenna 100 of this invention when completed in this manner will correspond to those in the embodiment shown in Figure 3(D).

However, as is shown in the relationship between Figures 3(E) and (F), the secondary vertical linear part 103, the secondary horizontal linear part 104, and the coupling part 105 may also be formed on the rear side of the printed circuit board 120. The coupling part 105 may be formed in a planar shape, with the tip of the main horizontal planar part 102 bent back downwards, and it may be connected to the secondary horizontal linear part 104 by bringing one end of it in contact with the conductive patterns formed on the printed circuit board.

It is obvious that the embodiments shown in Figures 3(A) - (C) can also be fabricated by approximately the same procedures and techniques. Especially in cases where the first conductor width part 106 and the second conductor width part 107 are made unnecessary, as in the embodiments shown in Figures 3(A) and (B), it will be sufficient to adopt a method in which the patterning in Figures 4 and 5 is intentionally made quite fine so that the conductor widths containing the secondary horizontal linear part 104 will not have capacitance components which are too large.

In any case, such embodiments are desirable even when considered from the viewpoint of the shape alone, since an antenna 100 necessary for the applicable communication equipment can be incorporated into it by merely adding the area of the inverted-L plate parts 101 and 102 to the area needed by the conventional circuits formed on the printed circuit board 120. The antenna does not need to be exposed on the outside of the communication equipment. This gives the communication equipment a smart shape and is most suitable in miniaturizing the equipment.

Furthermore, the height H and width q of the main vertical planar part 101 and the length L and width W of the main horizontal planar part are determined by factors of dimensional design in miniaturizing the communication equipment. Furthermore, even if the lead-out position of the feeding point P is fixed, as is shown in Figures 4 and 5, adjustment of the antenna impedance can still be adjusted with a large degree of freedom, by means of the placement position of the coupling part 105 and by the width design during patterning of the

width t_1 of the first conductor width part 106, as has already been described. If, for example, the width t_2 of the second conductor width part 107 is made variable, this can be regarded as a variation of the central frequency fo in the antenna resonance system.

In a case where, for example, the width t_2 of the second conductor width part 107 had a certain optimal width, let us suppose that a curve matching the central frequency fo had been obtained, as in curve Co shown by the solid line in Figure 6. In such a case, if the conductor width t_2 is made even smaller, the characteristics will shift towards the higher frequency side, as in curve Cu shown by the broken line. Naturally, the characteristics will shift in the opposite direction, towards the lower frequency side, if the conductor width t_2 is increased. The width of this shift can be quite large. Therefore, it is possible to attain a high degree of freedom in adjusting the central frequency fo by using a preferred embodiment of this invention in which the second conductor width part 107 is on the secondary horizontal linear part 104, as described here.

Figures 7(A) and (B) show the directivity characteristics obtained with antennas of this invention fabricated in accordance with the foregoing examples. The antennas were actually used in both the portable side (remote unit side) of a cordless telephone and in its base station side (base unit side).

Figure 7(A) shows the characteristics obtained when the antenna was used in the portable side, and Figure 7(B) shows those obtained when it was used in the base station side. Curve Cv, shown by the solid line in Figure 7(A) plots the vertical polarization directivity of the antenna incorporated in the portable side. There is no observable null point, even though there is a drop in sensitivity, on account of the influence of the main vertical planar part 101, in the 270° direction, which is the direction where it is installed in the case shown in the figure. The results may be considered to display a non-directivity virtually near the ideal.

In this connection, a rounder non-directivity can be achieved if the width q of the main vertical planar part 101 is made narrower, as shown by q' in Figures 3(E) and (F), as described above. The fact that the remaining width parts q' are different on the left and on the right in Figures 3(E) and (F) indicates that it does not matter on which side the width is made narrower.

Furthermore, the antenna 100 displays a non-directivity, with no extreme null points, for the horizontally polarized components as well, even though the level is about 10-20 dB lower than the vertically polarized components, as is shown by curve Ch indicated by the imaginary line in Figure 7(A).

Consequently, it is clear that the antenna of this invention used on the portable side has a polarization diversity function displaying a sensitivity to incoming waves from all directions.

In the antenna of this invention on the base station side, it is clear from Figure 7(B) that the non-directivity is higher both vertically and horizontally, even though the antenna proper is exactly the same as that used on the portable side.

It is believed that this is because the various control circuits in the equipment on the base station side are more complicated than those on the portable side, and there are also circuit parts for connections with the telephone lines. Therefore, since the shield housing 110 contains them, the dimensions are larger than those of the portable side. As a result, the ground 110 has a larger area from the antenna's viewpoint. In any case, it is certain that these characteristics are quite desirable.

The aforesaid antennas are merely examples, and this invention is not limited to them alone. How actually to fabricate the antennas of this invention shown in the drawings in Figure 3 is a question left to the selection of the person skilled in the art who employs this invention.

Claims

1. An antenna (100) for wireless communication equipment comprising a conductive main generally vertical planar part (101) having a first width (q,q') and a first length (H) which is connected at one end to the ground (100) and a conductive main generally horizontal planar part (102) having a second width (W) and a second length (L) and which extends at substantially right angles towards said main vertical planar part (101), and which is connected at its one end to the other end of the main vertical planar part (101) the sum of the first length (H) and the second length (L) being equivalent to a quarter wave length at the operating frequency (F); characterised in that the antenna includes a conductive secondary generally vertical linear part (103) which faces towards and extends in parallel to said main vertical planar part (101), and which is connected at its one end to the feeding point (P); and a conductive secondary generally horizontal linear part (104) which extends in parallel to said main horizontal planar part (102), and spaced from said main horizontal planar part (102) by a predetermined distance, and which is connected at its one end to the other end of said secondary vertical linear part (103), and which is connected at the other end thereof to the other end of said main horizontal planar

part (102).

2. An antenna (100) for wireless communication equipment according to claim 1 in which the other end of said secondary horizontal linear part (104) is connected electrically by a coupling part (105) to the other end position of said main horizontal planar part (102) or to a part which is separated by a predetermined distance from said other end position.

3. An antenna (100) for wireless communication equipment according to claim 1 or claim 2, in which the secondary horizontal linear part (104) has along all or part of its length a first conductor width part (106) having a first width (t_1) which makes up a capacitor for impedance adjustment.

4. An antenna (100) for wireless communication equipment according to claim 3, in which the secondary horizontal linear part (104) has along part of its length a second conductor width part (107) having a second width (t_2) which makes up a capacitor for adjusting the center frequency.

5. An antenna (100) for wireless communication according to any preceding claim in which the main vertical planar part (101) and the main horizontal planar part (102) are made up by forming steel sheets in an L-shape, and the secondary vertical linear part (103) and the secondary horizontal linear part (104) are formed by printing on a circuit board (120).

6. An antenna (100) for wireless communication equipment according to claim 5, in which the ground (110) is a shield housing which shields the circuitry.

Patentansprüche

1. Antenne (100) Für ein Gerät zur drahtlosen Nachrichtenübertragung, mit einem leitenden, im wesentlichen vertikalen, ebenen Hauptteil (101), das eine erste Breite (q, q') und eine erste Länge (H) besitzt und mit einem Ende an Erde (100) angeschlossen ist, und einem leitenden, im wesentlichen horizontalen, ebenen Hauptteil (102), das eine zweite Breite (w) und eine zweite Länge (L) besitzt, sich im wesentlichen rechtwinklig zu dem vertikalen, ebenen Hauptteil (101) hin erstreckt und mit seinem einen Ende an das andere Ende des vertikalen, ebenen Hauptteils (101) angeschlossen ist, wobei die Summe der ersten Länge (H) und der zweiten Länge (L) einem Viertel der Wellenlänge der Betriebsfrequenz (F) entspricht, dadurch gekennzeichnet, daß die Antenne ein leitendes, im wesentlichen senkrechtes, lineares Sekundärteil (103) beinhaltet, das zum vertikalen, ebenen Hauptteil (101) hin ausgerichtet ist, parallel zu diesem verläuft und mit seinem einen Ende an den Quellpunkt (P) angeschlossen ist, und ein leitendes, im wesentlichen horizontales, lineares Sekundärteil (104) aufweist, das parallel zum horizontalen, ebenen Hauptteil (102) verläuft, mit einem vorbestimmten Abstand zu dem horizontalen, ebenen Hauptteil (102) angeordnet ist, mit seinem einen Ende an das andere Ende des vertikalen, linearen Sekundärteils (103) angeschlossen ist und mit seinem anderen Ende an das andere Ende des horizontalen, ebenen Hauptteils (102) angeschlossen ist.

2. Antenne (100) für ein Gerät zur drahtlosen Nachrichtenübertragung nach Anspruch 1, bei der das andere Ende des horizontalen, linearen Sekundärteils (104) mittels einem Kopplungsteil (105) elektrisch an die andere Endposition des horizontalen, ebenen Hauptteils (102) oder an ein Teil angeschlossen ist, das mit einem vorbestimmten Abstand von der anderen Endposition angeordnet ist.

3. Antenne (100) für ein Gerät zur drahtlosen Nachrichtenübertragung nach Anspruch 1 oder 2, bei der das horizontale, lineare Sekundärteil (104) entlang seiner Gesamt- oder einer Teillänge davon ein erstes Leiterbreitteil (106) mit einer ersten Breite (t_1) aufweist, das einen Kondensator zur Impedanzjustierung bildet.

4. Antenne (100) für ein Gerät zur drahtlosen Nachrichtenübertragung nach Anspruch 3, bei der das horizontale, lineare Sekundärteil (104) entlang einem Teil seiner Länge ein zweites Leiterbreitteil (107) mit einer zweiten Breite (t_2) aufweist, das einen Kondensator zur Mittenfrequenzjustierung bildet.

5. Antenne (100) für ein Gerät zur drahtlosen Nachrichtenübertragung nach einem der vorangehenden Ansprüche, bei der das vertikale, ebene Hauptteil (101) und das horizontale, ebene Hauptteil (102) durch das Biegen eines Metallblechs in eine L-form hergestellt sind, und bei der das vertikale, lineare Sekundärteil (103) und das horizontale, lineare Sekundärteil (104) durch das Bedrucken einer Leiterplatte (120) hergestellt sind.

6. Antenne (100) für ein Gerät zur drahtlosen Nachrichtenübertragung nach Anspruch 5, bei

der die Erdung (110) ein Abschirmgehäuse ist, das die Schaltung abschirmt.

Revendications

1. Antenne (100) pour dispositif de communication sans fil comprenant une partie principale plane généralement verticale conductrice (101) ayant une première largeur (q, q') et une première longueur (H) qui est reliée à une extrémité à la terre (100) et une partie principale plane généralement horizontale conductrice (102) ayant un seconde largeur (W) et une seconde longueur (L) et qui s'étend sensiblement à angle droit vers ladite partie plane verticale principale (101), et qui est reliée à une extrémité à l'autre extrémité de la partie plane verticale principale (101) la somme de la première longueur (H) et de la seconde longueur (L) étant équivalente à un quart de longueur d'onde à la fréquence de fonctionnement (F); caractérisée en ce que l'antenne comporte une partie secondaire linéaire conductrice (103) généralement verticale (103) qui fait face à et s'étend parallèlement à ladite partie plane verticale principale (101), et qui est reliée à une extrémité au point d'alimentation (P); et une partie secondaire conductrice (104) linéaire généralement horizontale s'étendant parallèlement à ladite partie plane horizontale principale (102), et étant écartée de ladite partie plane horizontale principale (102) d'une distance prédéterminée et qui est reliée à une extrémité à l'autre extrémité de ladite partie linéaire verticale secondaire (103), et qui est reliée à son autre extrémité à l'autre extrémité de ladite partie plane horizontale principale (102).

2. Antenne (100) pour dispositif de communication sans fil conforme à la revendication 1 dans laquelle l'autre extrémité de ladite partie linéaire horizontale secondaire (104) est reliée électriquement par une partie de couplage (105) à l'autre position d'extrémité de ladite partie plane horizontale principale (102) ou à une partie qui est séparée par une distance prédéterminée de ladite autre position d'extrémité.

3. Antenne (100) pour dispositif de communication sans fil conforme à la revendication 1 ou à la revendication 2, dans laquelle la partie linéaire horizontale secondaire (104) comporte, le long de tout ou partie de sa longueur, une première partie de conducteur en largeur (106) ayant une première largeur (t_1) qui forme une capacité pour l'ajustement d'impédance.

4. Antenne (100) pour dispositif de communication sans fil conforme à la revendication 3, dans laquelle la partie linéaire horizontale secondaire (104) comporte le long d'une partie de sa longueur une seconde partie de conducteur en largeur (107) ayant une seconde largeur (t_2) qui forme une capacité pour ajuster la fréquence centrale.

5. Antenne (100) pour dispositif de communication sans fil conforme à l'une quelconque des revendications précédentes, dans laquelle la partie plane verticale principale (101) et la partie plane horizontale principale (102) sont constituées en formant des feuilles d'acier en forme de L, et la partie linéaire verticale secondaire (103) et la partie linéaire horizontale secondaire (104) sont formées par impression sur une plaque de circuit imprimé (120).

6. Antenne (100) pour dispositif de communication sans fil conforme à la revendication 5, dans laquelle la terre (110) est une enceinte de blindage qui protège les circuits.

FIG. 1 (A)

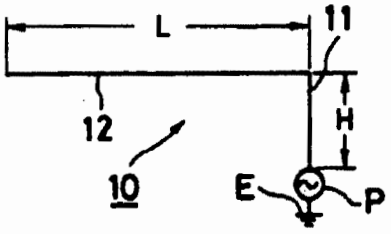


FIG. 1 (B)

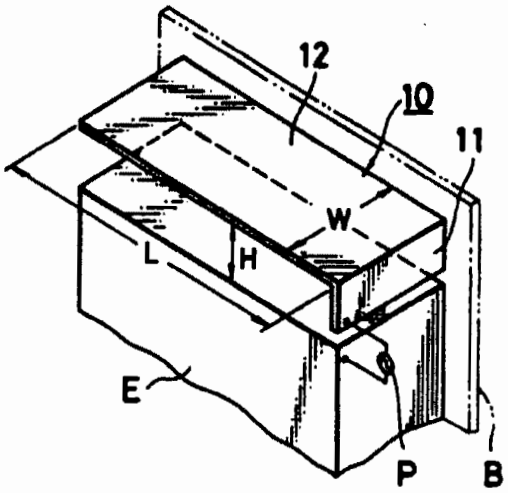


FIG. 2 (A)

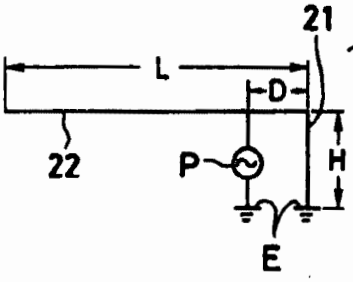


FIG. 2 (B)

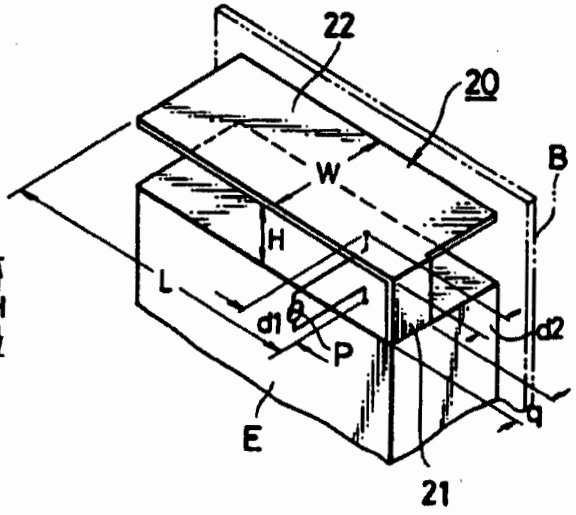


FIG.3(A)

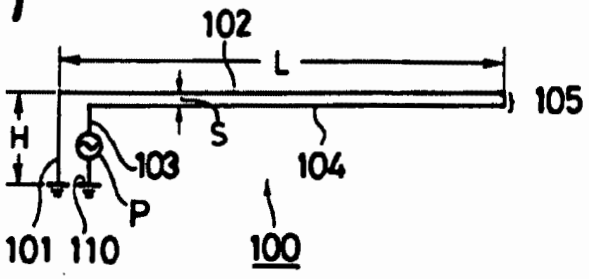


FIG.3(B)

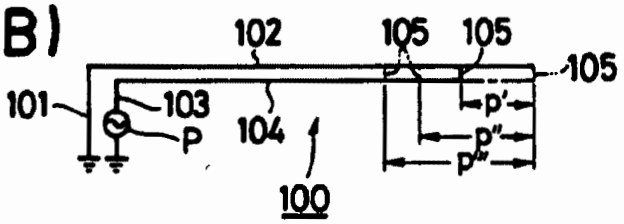


FIG.3(C)

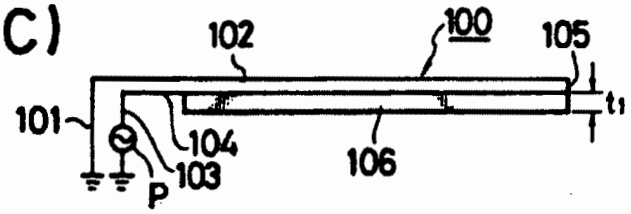


FIG.3(D)

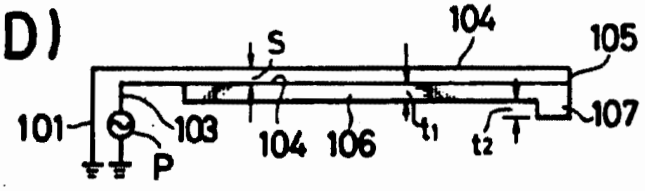


FIG.3(E)

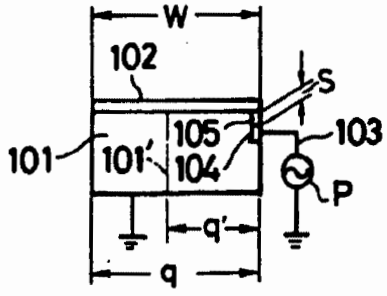


FIG.3(F)

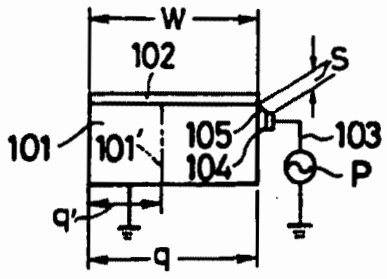


FIG. 4

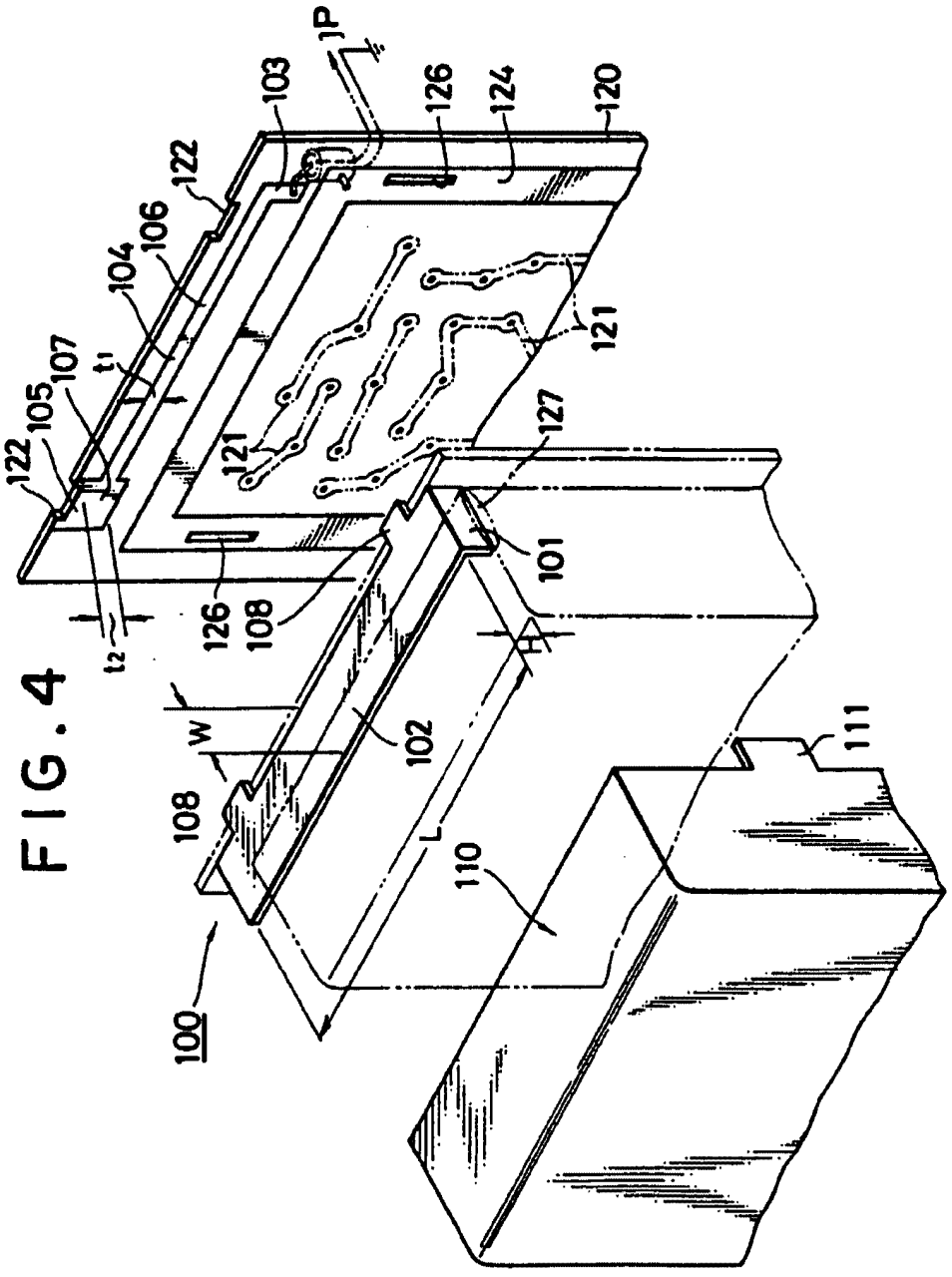

1P
103
126
124
120
122
106
104
107
105
122
t1
121
121
127
101
126
108
t2
102
W
108
L
110
111
100

FIG. 5

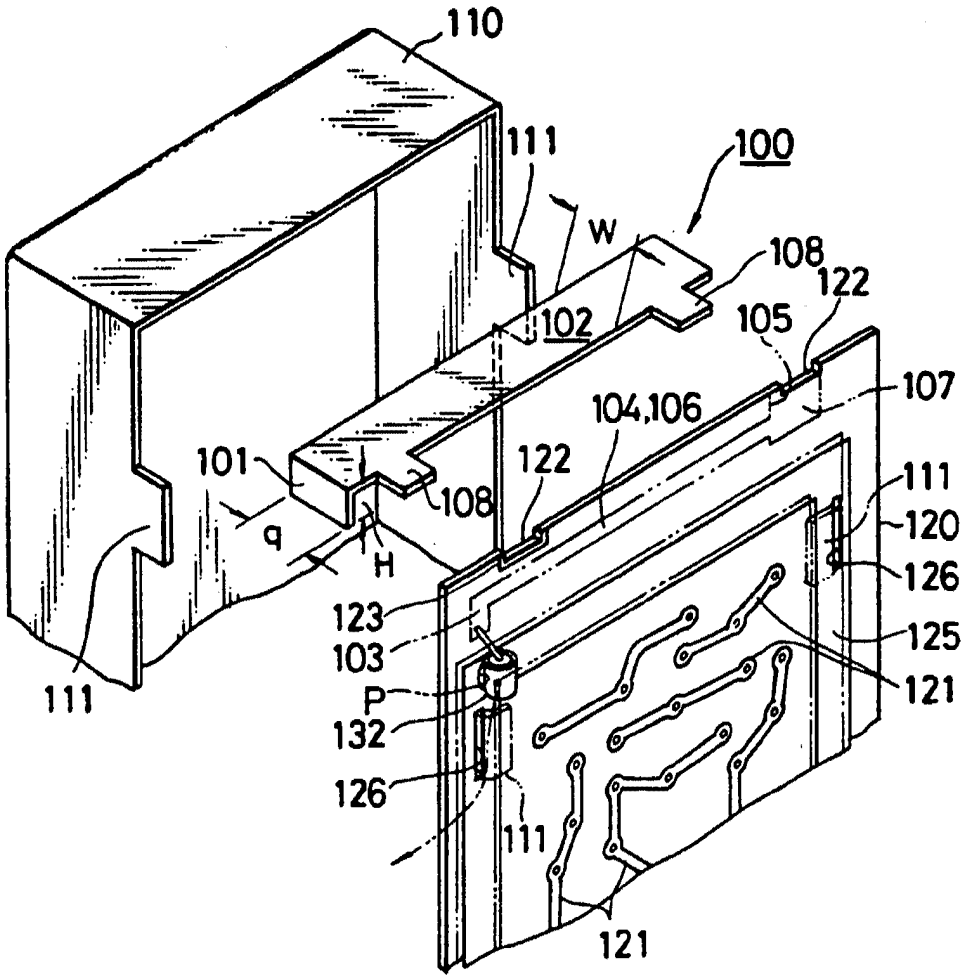

110
111
100
W
108
122
102
105
107
104,106
101
122
108
111
120
q
H
126
123
125
103
P
121
132
126
111
121

FIG. 6

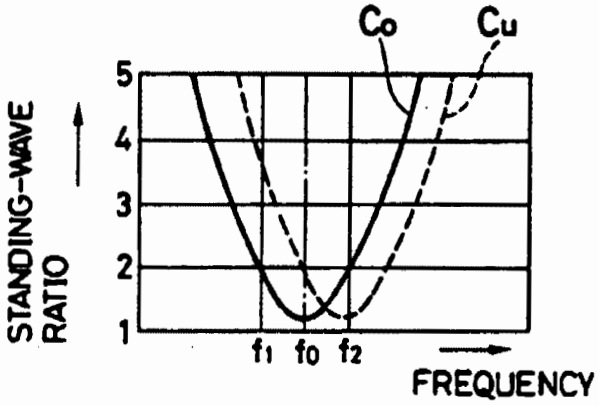


FIG. 7(A)

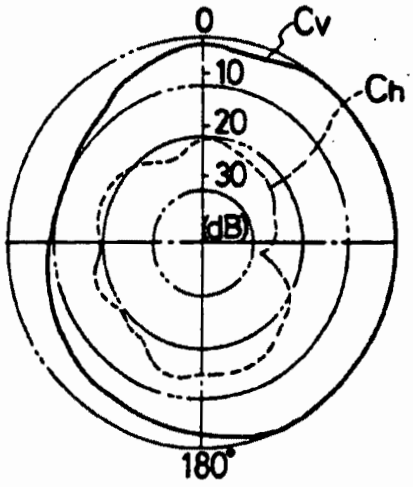
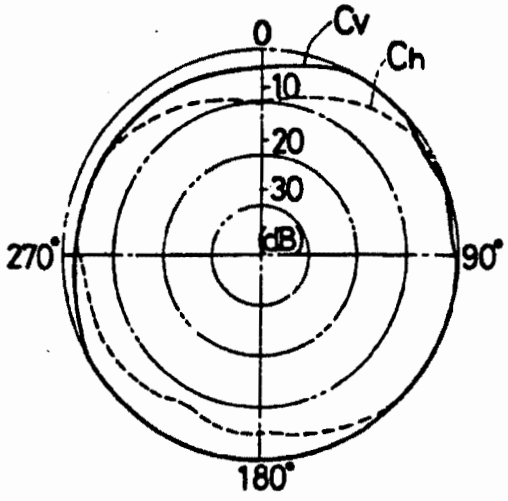


FIG. 7(B)



PCT WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales Büro
INTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)

(51) Internationale Patentklassifikation 5 : H01Q 1/24, 9/04

A1

(11) Internationale Veröffentlichungsnummer: WO 91/02386

(43) Internationales Veröffentlichungsdatum: 21. Februar 1991 (21.02.91)

(21) Internationales Aktenzeichen: PCT/EP90/01227

(22) Internationales Anmeldedatum: 26. Juli 1990 (26.07.90)

(30) Prioritätsdaten:
A 1815/89 27. Juli 1989 (27.07.89) AT

(71) Anmelder *(nur für AT)*: SIEMENS AKTIENGESELLSCHAFT ÖSTERREICH [AT/AT]; Siemensstr. 88-92, A-1210 Wien (AT).

(71) Anmelder *(für alle Bestimmungsstaaten ausser AT US)*: SIEMENS AKTIENGESELLSCHAFT [DE/DE]; Wittelbacherplatz 2, D-8000 München 2 (DE).

(72) Erfinder; und
(75) Erfinder/Anmelder *(nur für US)* : RASINGER, Josef [AT/AT]; Brühlerstr. 106/2, A-2340 Mödling (AT). SCHOLTZ, Arpad, Ludwig [AT/AT]; Amalienstraße 75/2/12/129, A-1130 Wien (AT). BONEK, Ernst [AT/AT]; Stinglgasse 18, A-1140 Wien (AT).

(74) Gemeinsamer Vertreter: SIEMENS AKTIENGESELLSCHAFT ÖSTERREICH; Postfach 22 16 34, D-8000 München 22 (DE).

(81) Bestimmungsstaaten: AT (europäisches Patent), BE (europäisches Patent), CH (europäisches Patent), DE (europäisches Patent)*, DK (europäisches Patent), ES (europäisches Patent), FR (europäisches Patent), GB (europäisches Patent), IT (europäisches Patent), JP, LU (europäisches Patent), NL (europäisches Patent), SE (europäisches Patent), US.

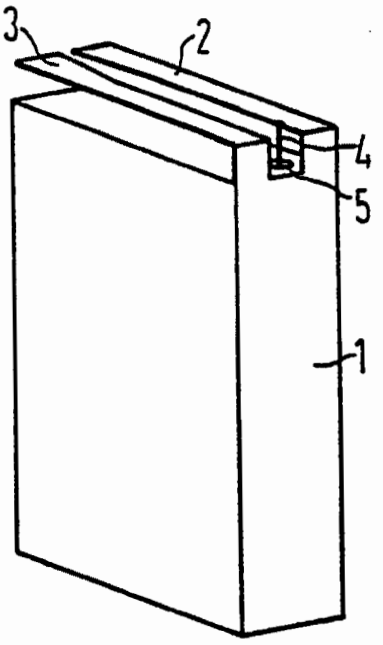
Veröffentlicht
Mit internationalem Recherchenbericht.
Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist. Veröffentlichung wird wiederholt falls Änderungen eintreffen.

(54) Title: TRANSMITTING AND RECEIVING ARRANGEMENT FOR PORTABLE APPLIANCES

(54) Bezeichnung: SENDE- UND/ODER EMPFANGSANORDNUNG FÜR TRAGBARE GERÄTE

(57) Abstract

An antenna for the transmitter and receiver of a portable radio appliance (cordless telephone, mobile telephone, pager, telepoint appliance, etc.) consists essentially of two sheet metal angles (2, 3) arranged side by side. One of the two elements is excited with high-frequency currents by means of a coaxial supply line (4). The second sheet metal angle (3) is excited through radiation coupling by the first sheet metal angle (2). The sheet metal angles (2, 3) are aligned in the same direction and the distance between them in the end region is considerably less than in the bent edge of the apex line. This results in high cross-currents and low impedance. The antenna can also be modified by supplying both sheet metal angles (2, 3), subdivision into two identical partial antennae or several sheet metal angles. The sheet metal angles can consist of metal foils placed on a plastic housing. An embodiment with wire angles is also possible.



(57) Zusammenfassung

Eine Antenne für Sender und Empfänger eines tragbaren Funkgerätes (Schnurlos-Telefon, Mobil-Telefon, Pager, Telepoint-Gerät etc.) besteht im wesentlichen aus zwei Blechwinkeln (2, 3), die nebeneinander angeordnet sind. Eines der beiden Elemente wird mittels einer koaxialen Speiseleitung (4) mit Hochfrequenzströmen erregt. Der zweite Blechwinkel (3) wird durch Strahlungskopplung vom ersten Blechwinkel (2) angeregt. Die Blechwinkel (2, 3) sind gleichorientiert und der Abstand zwischen ihnen ist im Endbereich erheblich kleiner als an der Knickkante der Scheittellinie. Dadurch entstehen hohe Querströme und eine kleine Impedanz. Die Antenne kann auch durch Speisung beider Blechwinkel (2, 3), Aufteilung auf zwei identische Teilantennen oder mehrere Blechwinkel modifiziert werden. Die Blechwinkel können aus Metallfolien bestehen, die auf ein Kunststoffgehäuse aufgebracht sind. Darüberhinaus ist auch eine Ausführung mit Drahtwinkeln möglich.

BENENNUNGEN VON "DE"

Bis auf weiteres hat jede Benennung von "DE" in einer internationalen Anmeldung, deren internationaler Anmeldetag vor dem 3. Oktober 1990 liegt, Wirkung im Gebiet der Bundesrepublik Deutschland mit Ausnahme des Gebietes der früheren DDR.

LEDIGLICH ZUR INFORMATION

Code, die zur Identifizierung von PCT-Vertragsstaaten auf den Kopfbögen der Schriften, die internationale Anmeldungen gemäss dem PCT veröffentlichen.

AT	Österreich	ES	Spanien	MG	Madagaskar
AU	Australien	FI	Finnland	ML	Mali
BB	Barbados	FR	Frankreich	MR	Mauritanien
BE	Belgien	GA	Gabon	MW	Malawi
BF	Burkina Fasso	GB	Vereinigtes Königreich	NL	Niederlande
BG	Bulgarien	GR	Griechenland	NO	Norwegen
BJ	Benin	HU	Ungarn	PL	Polen
BR	Brasilien	IT	Italien	RO	Rumänien
CA	Kanada	JP	Japan	SD	Sudan
CF	Zentrale Afrikanische Republik	KP	Demokratische Volksrepublik Korea	SE	Schweden
CG	Kongo	KR	Republik Korea	SN	Senegal
CH	Schweiz	LI	Liechtenstein	SU	Soviet Union
CM	Kamerun	LK	Sri Lanka	TD	Tschad
DE	Deutschland	LU	Luxemburg	TG	Togo
DK	Dänemark	MC	Monac	oUS	Vereinigte Staaten von Amerika

Sende- und/oder Empfangsanordnung für tragbare Geräte

Die Erfindung betrifft eine Sende- und/oder Empfangsanordnung für tragbare Geräte, bestehend aus einem Abschirmgehäuse und einer damit leitend verbundenen Antenne, die aus zwei oder mehreren im wesentlichen gleichorientierten abgewinkelten Antennenresonatoren besteht.

In der EP-A 177 362 ist eine Breitband-Antenne für tragbare Funkgeräte beschrieben. Sie besteht aus zwei abgewinkelten Resonatoren unterschiedlicher Resonanzfrequenz. Beide Resonatoren werden von einer gemeinsamen Leitung aus über eine Abzweigung in der Art einer "Inverted-F-Antenne" gespeist. Die Antennenresonatoren wirken unabhängig voneinander und bilden keine Einheit. Daher ist auch der Wirkungsgrad nicht besonders groß. Der Abstand zwischen den parallelen Schenkeln ist konstant.

In der US 4,584,585 ist eine Antenne mit Resonatoren aus Drahtwinkeln beschrieben. Ein Resonator wird am Ende angespeist und bildet eine "Inverted-L-Antenne". Der zweite Resonator ist strahlungsgekoppelt. Mit dieser Anordnung wird zwar ein guter Wirkungsgrad erreicht, die Antenne hat jedoch eine feste Impedanz und ist schlecht anpaßbar. Die Form des aktiven Antennenresonators ist verhältnismäßig schwierig zu biegen, und die Grundplatte weist darüberhinaus auch noch eine Stufe auf. Die Bandbreite ist verhältnismäßig gering.

"Inverted-F-Antennen" sind aus T. Taga und K. Tsunekawa, "Performance Analysis of a Built-In Planar Inverted F Antenna for 800 MHz Band Portable Radio Units," IEEE Trans., Selected Areas in Commun., vol. SAC-5, no.5, pp. 921-929, June (1987) bekannt. Eine Anpassung derartiger Antennen erfolgt durch Variation der Position des Speisepunktes.

Der Erfindung liegt die Aufgabe zugrunde, die Sende- bzw. Empfangsleistung der Antenne zu verbessern, wobei bei großer

Bandbreite eine einfache Herstellbarkeit und gute Anpaßbarkeit gewährleistet sein soll.

Dies wird gemäß Patentanspruch 1 durch eine Sende- und/oder Empfangsanordnung für tragbare Geräte erreicht, bestehend aus einem Abschirmgehäuse und einer damit leitend verbundenen Antenne, die über mindestens eine Speiseleitung mit einem Sendeausgang bzw. Empfängereingang verbunden ist, wobei das Abschirmgehäuse aus Metall und die Antenne aus zwei oder mehreren im wesentlichen gleichorientierten abgewinkelten Antennenresonatoren besteht, wobei nur ein Antennenresonator mit der Speiseleitung verbunden und der Speisepunkt zwischen der Knickkante des Scheitelbereiches und dem freien Resonatorende ist, wobei eine koaxiale Durchführung für die Speiseleitung vorhanden und die Speiseleitung über ein Duplexfilter mit Senderausgang und Empfängereingang verbunden ist und wobei zum Variieren der Eingangsimpedanz der Antenne der Abstand zwischen den Antennenresonatoren im Endbereich erheblich kleiner als an der Knickkante des Scheitelbereiches ist.

Die nichtgespeisten Resonatoren der Antenne werden strahlungsgekoppelt durch den gespeisten Resonator angeregt, wodurch die Bandbreite der Antenne vergrößert wird. Durch die abgewinkelte Form und die Verbreiterung der Enden fließen Ströme in allen drei Raumrichtungen. Es bilden sich hohe Querströme aus, die eine kleine Impedanz bedingen. Dadurch werden Lücken in der Richtcharakteristik der Antenne gefüllt. Durch den geringen Platzbedarf ist die Anordnung hervorragend für Mobilfunkanwendungen geeignet. Sie ist leicht herstellbar und die gesamte Hochfrequenz-, Niederfrequenz- und Digitalelektronik eines tragbaren Funkgerätes kann im Abschirmgehäuse untergebracht werden. Das Metallgehäuse dient gleichzeitig als Erdnachbildung für die Antenne. Durch Änderung des Befestigungspunktes der Speiseleitung am Antennenresonator und dadurch, daß zum Variieren der Eingangsimpezanz der Antenne die Resonatoren im Bereich ihrer Enden verbreitert sind, ist der Variationsbereich besonders

groß. Daher können in vielen Anwendungsfällen Anpassungsnetzwerke zwischen Antenne und Sendeendstufe bzw. Sendefilter, sowie zwischen Antenne und Empfängereingang bzw. Empfangsfilter eingespart werden. Die Anordnung der zueinander im wesentlichen parallelen Antennenresonatoren kann auch als Schlitzantenne beschrieben werden, wobei durch Breite und Form des Schlitzes zwischen den Resonatoren die Eingangsimpedanz in weiten Grenzen variabel ist.

Die Aufgabe kann nach Patentanspruch 2 auch dadurch gelöst werden, daß die Sende- und/oder Empfangsanordnung für tragbare Geräte aus einem Abschirmgehäuse und einer damit leitend verbundenen Antenne besteht, die über mindestens eine Speiseleitung mit einem Senderausgang bzw. Empfängereingang verbunden ist, wobei das Abschirmgehäuse aus Metall und die Antenne aus zwei oder mehreren im wesentlichen gleichorientierten abgewinkelten Antennenresonatoren besteht und mindestens zwei Antennenresonatoren mit einer Speiseleitung verbunden und die Speisepunkte zwischen der Knickkante der Scheitelbereiche und den freien Resonatorenenden sind, wobei eine koaxiale Durchführung für jede Speiseleitung vorhanden und die Speiseleitungen über je einen Sende- und Empfangsfilter mit dem Senderausgang und Empfängereingang verbunden sind und wobei zum Variieren der Eingangsimpedanz der Antenne der Abstand zwischen den Antennenresonatoren im Endbereich erheblich kleiner als an der Knickkante der Scheitelbereiche ist.

Zu den Vorteilen der Anordnung nach Anspruch 1 wird durch die Speisung zweier Antennenresonatoren und die Verbindung der Speiseleitungen mit Sende- und Empfangsfilter eine teilweise Entkoppelung von Senderausgang und Empfängereingang erreicht. Darüberhinaus ist eine getrennte Optimierung von Sender- und Empfängeranpassung möglich.

Die Antenne kann sich im Prinzip über jeder beliebigen Seitenfläche des Abschirmgehäuses befinden. In Versuchen hat es

sich jedoch als günstig erwiesen, daß die Antennenresonatoren an der Oberseite bzw. Deckfläche des Abschirmgehäuses angeordnet sind. Für einen Diversity-Betrieb besteht die Antenne aus mindestens zwei gespeisten, einander gegenüberliegenden Teilantennen. Beide Teilantennen können gleich lang sein, es entsteht Doppelresonanz. Die Antenne besteht aus Lambda/4-Resonatoren. Daher kann die Bandbreite noch weiter vergrößert werden, wenn die Länge der Antennenresonatoren ungleich ist.

Ein zuverlässiger mechanischer Aufbau wird dadurch erreicht, daß die abgewinkelten Antennenresonatoren aus Blechwinkeln gebildet sind. Zur Verbesserung der Abstrahlcharakteristik ist es vorteilhaft, daß drei Blechwinkeln vorhanden sind und der mittlere Blechwinkel mit der Speiseleitung verbunden ist. Zur Herstellung der Metallteile in einem einzigen Arbeitsgang ist es vorteilhaft, daß das Abschirmgehäuse und die Blechwinkel aus einem flachen Blech ausgestanzt und in die entsprechende Form gebogen sind. Es ist aber auch möglich, daß die Blechwinkeln auf das Abschirmgehäuse gelötet bzw. mit ihm leitend verbunden sind.

Die mechanische Belastbarkeit der Antenne wird dadurch erhöht, daß die Blechwinkel U-förmigen Längsschnitt aufweisen und der nicht gespeiste, bzw. nicht strahlungsgekoppelte Schenkel an einer aus dem Abschirmgehäuse herausragenden Platine leitend befestigt und über eine Massefläche mit dem Abschirmgehäuse verbunden ist. Eine besondere Steifigkeit wird dadurch erreicht, daß die Platine zwischen die freien Resonatorenden der Blechwinkel ragt und die Resonatorenenden mit der Platine verbunden sind. Durch diese Maßnahmen ist die Antenne auf der Platine integrierbar.

Eine besondere mechanische Widerstandsfähigkeit ist dadurch gegeben, daß das Abschirmgehäuse von einem Kunststoffgehäuse umgeben ist, auf das die Blechwinkel als Metallfolie außen oder

innen aufgebracht und über eine Massedurchführung mit dem Abschirmgehäuse verbunden sind.

Darüberhinaus ist es auch vorteilhaft, daß die abgewinkelten Antennenresonatoren aus Drahtwinkeln gebildet sind. Diese Drahtwinkeln laufen derart aufeinander zu, daß ihre freien Resonatorenden nur knapp voneinander entfernt sind. Auch hier fließen dann hohe Ströme und es ergibt sich eine kleine Impedanz. Der "Inverted-F-Aufbau" hat gegenüber dem "Inverted-L-Aufbau" den Vorteil einer höheren Güte der Anpassung an die Breitbandigkeit. Die Verbesserung beträgt etwa 50 - 100 %.

Die Erfindung wird anhand mehrerer Ausführungsbeispiele und von Zeichnungen näher erläutert. Es zeigen:
Fig. 1 ein Beispiel mit zwei Blechwinkeln,
Fig. 2 den Grundriß mit dem Antennenbereich,
Fig. 3 ein Beispiel mit zwei Speiseleitungen,
Fig. 4 ein Beispiel mit zwei Teilantennen,
Fig. 5 ein Beispiel mit drei Antennenresonatoren,
Fig. 6 ein Beispiel der Integration auf einer Platine,
Fig. 7 ein Beispiel mit Resonatoren aus Metallfolie und
Fig. 8 ein Beispiel mit Resonatoren aus Drahtwinkeln.

In den folgenden Ausführungsbeispielen werden Antennen mit zwei oder mehreren abgewinkelten Resonatoren beschrieben, die in tragbare Funkgeräte, wie Schnurlos-Telefone, Mobil-Telefone, Pager, "Telepoint-Geräte" etc. einbaubar ist. Als interne Antenne für ein digitales Schnurlos-Telefon ist sie auf das 1,7 GHz-Band eingestellt. Die gemeinsamen Funktionsmerkmale sind im Allgemeinen nur im ersten Ausführungsbeispiel angegeben.

Der Aufbau einer ersten Antenne ist in Fig. 1 dargestellt. Auf einem Abschirmgehäuse 1 sind an der Oberseite die beiden als Antenne wirkenden Blechwinkel 2,3 angebracht. Das Abschirmgehäuse 1 beinhaltet die gesamte Hochfrequenz-, Niederfrequenz- und Digitalelektronik des Mobilteiles eines Schnurlos-Telefons.

Außer der Schirmung erfüllt das Abschirmgehäuse 1 auch die Funktion einer Erdnachbildung für die Antenne und beeinflußt die Bandbreite. Je größer es ist, desto kleiner wird die Bandbreite. Die Oberseite des Abschirmgehäuses 1 hat sich als günstiger Platz für die Anbringung der Antenne herausgestellt.

Das Abschirmgehäuse 1 (bzw. Teile desselben) und die Blechwinkel 2,3 sind aus einem flachen Blech ausgestanzt und wie in der Fig. 1 dargestellt zurechtgebogen. Mit dem ersten Blechwinkel 2 ist eine Speiseleitung 4 verbunden, die über eine koaxiale Durchführung 5 aus dem Inneren des Abschirmgehäuses 1 herausführt. Der erste Blechwinkel 2 ist somit das gespeiste Element der Antenne, der zweite Blechwinkel 3 ist mit dem ersten Blechwinkel 2 strahlungsgekoppelt. Die Speiseleitung 4 ist im Inneren des Abschirmgehäuses 1 über einen Duplexfilter mit einem Empfängereingang bzw. Senderausgang verbunden.

Fig. 2 zeigt den Befestigungspunkt der Speiseleitung 4 am ersten Blechwinkel 2. Der Ort dieses Befestigungspunktes und die Formgebung der einander zugewandten Kanten der Blechwinkel 2,3 gestattet es, die Eingangsimpedanz der Antenne über einen großen Bereich zu variieren. Die Blechwinkel 2,3 sind zu den Enden hin verbreitert. Dadurch wird ein Anpassungsnetzwerk zwischen der Antenne und dem Senderausgang bzw. Empfängereingang eingespart. Die beiden Blechwinkel 2,3 weisen eine unterschiedliche Länge auf. Aufgrund der daraus folgenden unterschiedlichen Resonanzfrequenzen der Einzelstrahler ergibt sich eine erhebliche Steigerung der Bandbreite gegenüber einer vergleichbaren, nur aus einem einzigen Blechwinkel bestehenden Antenne.

Eine alternative Möglichkeit der Verbindung von Sender und Empfänger mit der erfindungsgemäßen Antenne ist in Fig. 3 dargestellt. Der erste Blechwinkel 2 ist mit der ersten Speiseleitung 4 verbunden, der zweite Blechwinkel 3 mit einer zweiten Speiseleitung 6. Die Speiseleitungen 4,6 sind über Durchführungen 5 herausgeführt. Der Senderausgang ist über ein Sendefilter

mit dem ersten Blechwinkel 2 verbunden. Entsprechend ist der Empfängereingang über ein Empfangsfilter mit dem zweiten Blechwinkel 3 verbunden. Durch diese Art der Ausführung wird ein Teil der erforderlichen Entkopplung von Senderausgang und Empfängereingang bewirkt. Die Variation der Eingangsimpedanz durch Formgebung der Blechwinkel 2,3 und Variation des Befestigungspunktes der Speiseleitungen 4,6 erfolgt wie beim ersten Ausführungsbeispiel.

Fig. 4 zeigt eine Antennenanordnung für Diversity-Betrieb. Dem Abschirmgehäuse 1 sind auf der Schmalseite zwei Teilantennen vorgelagert. Die erste Teilantenne besteht aus den ersten beiden Blechwinkeln 2,3. Die zweite Teilantenne ist identisch aufgebaut und besteht aus Blechwinkeln 7,8. Die Anspeisung für die erste Teilantenne erfolgt über die Speiseleitung 4 durch eine koaxiale Durchführung 5, für die zweite Teilantenne gilt entsprechendes. Die Länge der Resonatoren beträgt Lambda/4. Beide Teilantennen sind gleich lang und es kommt zu einer Doppelresonanz.

Bei der in Fig. 5 dargestellten Sende- und Empfangsanordnung ist zwischen den beiden Blechwinkeln 2,3 ein dritter Blechwinkel 9 vom Abschirmgehäuse 1 her angeordnet. Das freie Resonatorende des dritten Blechwinkels 9 ist symmetrisch gegen die ersten beiden Blechwinkel 2,3 hin verbreitert. Über die koaxiale Durchführung 5 ist die Speiseleitung 4 mit dem dritten Blechwinkel 9 verbunden. Die beiden ersten Blechwinkel 2,3 sind strahlungsgekoppelt.

Im Beispiel nach Fig. 6 besteht das Abschirmgehäuse 1 aus zwei Teilen und umschließt eine Platine 12, auf der die Bauelemente des Gerätes angeordnet sind. Die Platine 12 ragt auf der oberen Schmalseite zwischen den Teilen des Abschirmgehäuses 1 heraus und ist mit einer Massefläche 14 versehen. Die Antenne besteht aus Blechwinkeln 10,11, die einen U-förmigen Längsschnitt aufweisen. Sie sind durch eine Lötstelle 13 über die ganze Länge

des jeweils unteren Schenkels der Blechwinkel 10,11 mit der Massefläche 14 verbunden und an der Platine 12 befestigt. Die Speisung erfolgt über eine Leiterbahn durch die Durchführung 5 im Abschirmgehäuse 1 und eine Ausnehmung im unteren Schenkel des Blechwinkels 10 zum Speisepunkt 15. Auch hier ist der Blechwinkel 10 mit der Platine 12 verbunden. Falls erforderlich, kann auch das freie Resonatorende mit der Platine 12 verbunden werden. Es ist sowohl eine getrennte als auch eine gemeinsame Speisung der Blechwinkel 10,11 möglich.

Bei einem weiteren Beispiel nach Fig. 7 ist das Abschirmgehäuse 1 von einem Kunststoffgehäuse 16 umgeben. Die Blechwinkel 2,3 sind außen auf das Kunststoffgehäuse 16 aufgespritzt. Es wäre auch möglich, sie herauszuätzen. Von einem Speisepunkt 17 aus ist der Blechwinkel 2 mit dem Sender/Empfänger verbunden. Über eine Massedurchführung 18 wird der Kontakt der Blechwinkel 2,3 mit dem Abschirmgehäuse 1 hergestellt.

Die Antenne der Sende- und Empfangsanordnung nach Fig. 8 ist aus Drahtwinkeln 19,20 hergestellt. Sie laufen aufeinander zu und sind am freien Resonatorende nur mehr knapp voneinander entfernt. Die Drahtwinkel 19,20 sind an das Abschirmgehäuse 1 angelötet, und der zweite Drahtwinkel 20 ist über eine Speiseleitung 4 mit dem Sender/Empfänger verbunden. Dazu weist das Abschirmgehäuse 1 eine koaxiale Durchführung 5 auf. Diese Drahtwinkel 19,20 sind gestreckt ausgeführt und haben daher eine einfache Form. Das Abschirmgehäuse 1 weist keine Stufe auf.

Patentansprüche:

1. Sende- und/oder Empfangsanordnung für tragbare Geräte, bestehend aus einem Abschirmgehäuse (1) und einer damit leitend verbundenen Antenne, die über mindestens eine Speiseleitung (4) mit einem Senderausgang bzw. Empfängereingang verbunden ist, wobei das Abschirmgehäuse (1) aus Metall und die Antenne aus zwei oder mehreren im wesentlichen gleichorientierten abgewinkelten Antennenresonatoren besteht, wobei nur ein Antennenresonator mit der Speiseleitung (4) verbunden und der Speisepunkt zwischen der Knickkante des Scheitelbereiches und dem freien Resonatorende ist, wobei eine koaxiale Durchführung (5) für die Speiseleitung (4) vorhanden und die Speiseleitung (4) über ein Duplexfilter mit Senderausgang und Empfängereingang verbunden ist und wobei zum Variieren der Eingangsimpedanz der Antenne der Abstand zwischen den Antennenresonatoren im Endbereich erheblich kleiner als an der Knickkante des Scheitelbereiches ist.

2. Sende- und/oder Empfangsanordnung für tragbare Geräte, bestehend aus einem Abschirmgehäuse (1) und einer damit leitend verbundenen Antenne, die über mindestens eine Speiseleitung (4) mit einem Senderausgang bzw. Empfängereingang verbunden ist, wobei das Abschirmgehäuse (1) aus Metall und die Antenne aus zwei oder mehreren im wesentlichen gleichorientierten abgewinkelten Antennenresonatoren besteht und mindestens zwei Antennenresonatoren mit einer Speiseleitung (4,6) verbunden und die Speisepunkte zwischen der Knickkante der Scheitelbereiche und den freien Resonatorenden sind, wobei eine koaxiale Durchführung (5) für jede Speiseleitung (4,6) vorhanden und die Speiseleitungen (4,6) über je einen Sende- und Empfangsfilter mit dem Senderausgang und Empfängereingang verbunden sind und wobei zum Variieren der Eingangsimpedanz der Antenne der Abstand zwischen den Antennenresonatoren im Endbereich erheblich kleiner als an der Knickkante der Scheitelbereiche ist.

3. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Antennenresonatoren an der Oberseite bzw. Deckfläche des Abschirmgehäuses (1) angeordnet sind.

4. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Antenne aus mindestens zwei gespeisten, einander gegenüberliegenden Teilantennen besteht.

5. Anordnung nach einem der vorherigen Ansprüche, dadurch gekennzeichnet, daß die Länge der Antennenresonatoren ungleich ist.

6. Anordnung nach einem der vorherigen Ansprüche, dadurch gekennzeichnet, daß die abgewinkelten Antennenresonatoren aus Blechwinkeln (2,3; 7,8) gebildet sind.

7. Anordnung nach Anspruch 6, dadurch gekennzeichnet, daß drei Blechwinkel (2,3,9) vorhanden und der mittlere Blechwinkel (9) mit der Speiseleitung (4) verbunden ist.

8. Anordnung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß das Abschirmgehäuse (1) und die Blechwinkel (2,3; 7,8; 9) aus einem flachen Blech ausgestanzt und in die entsprechende Form gebogen sind.

9. Anordnung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß die Blechwinkel (2,3; 7,8; 9) auf das Abschirmgehäuse (1) gelötet bzw. mit ihm leitend verbunden sind.

10. Anordnung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß die Blechwinkel (10,11) U-förmigen Längsschnitt aufweisen und der nicht gespeiste, bzw. nicht strahlungsgekoppelte Schenkel an einer aus dem Abschirmgehäuse (1) herausragenden Platine (12) leitend befestigt und über eine Massefläche (14) mit dem Abschirmgehäuse (1) verbunden ist.

11. Anordnung nach Anspruch 10, dadurch gekennzeichnet, daß die Platine (12) zwischen die freien Resonatorenden der Blechwinkel (10,11) ragt und die Resonatorenden mit der Platine (12) verbunden sind.

12. Anordnung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß das Abschirmgehäuse (1) von einem Kunststoffgehäuse (16) umgeben ist, auf das die Blechwinkel (2,3) als Metallfolie außen oder innen aufgebracht und über eine Massedurchführung (18) mit dem Abschirmgehäuse (1) verbunden ist.

13. Anordnung nach einem der Ansprüche 1-5, dadurch gekennzeichnet, daß die abgewinkelten Antennenresonatoren aus Drahtwinkeln (19,20) gebildet sind.

FIG.1

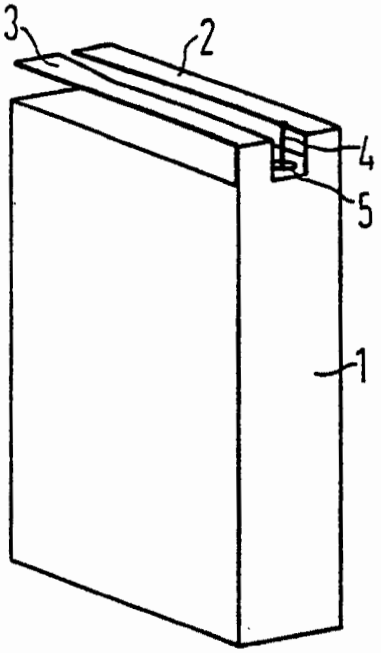


FIG.3

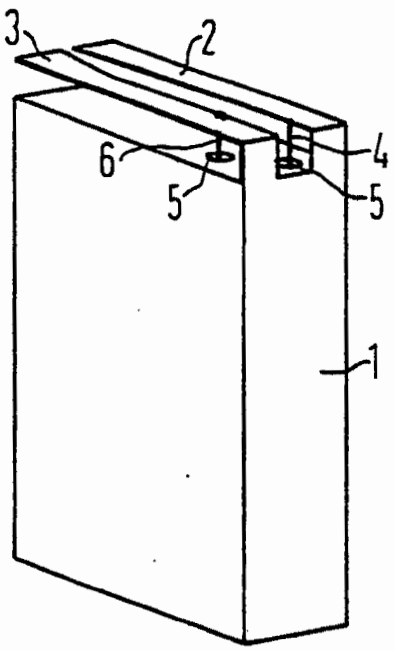


FIG.2

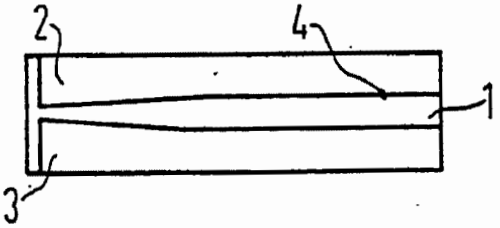


Fig.4

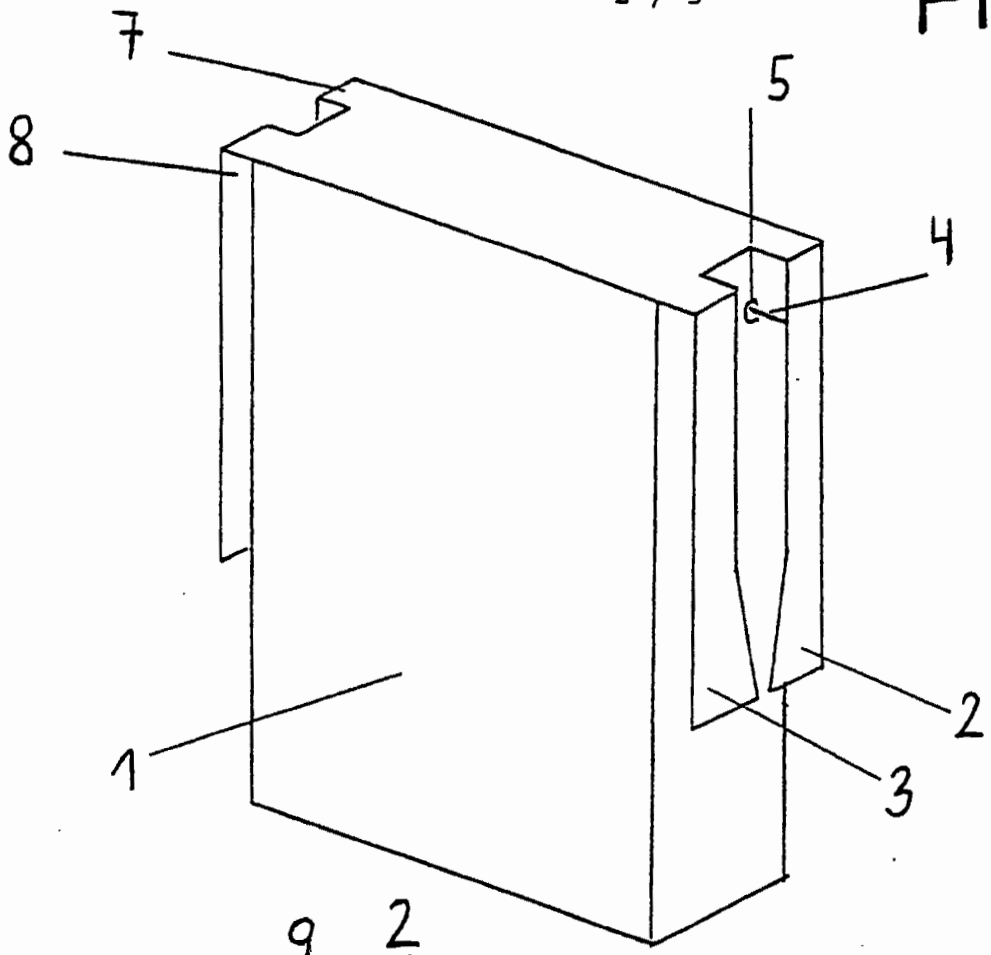
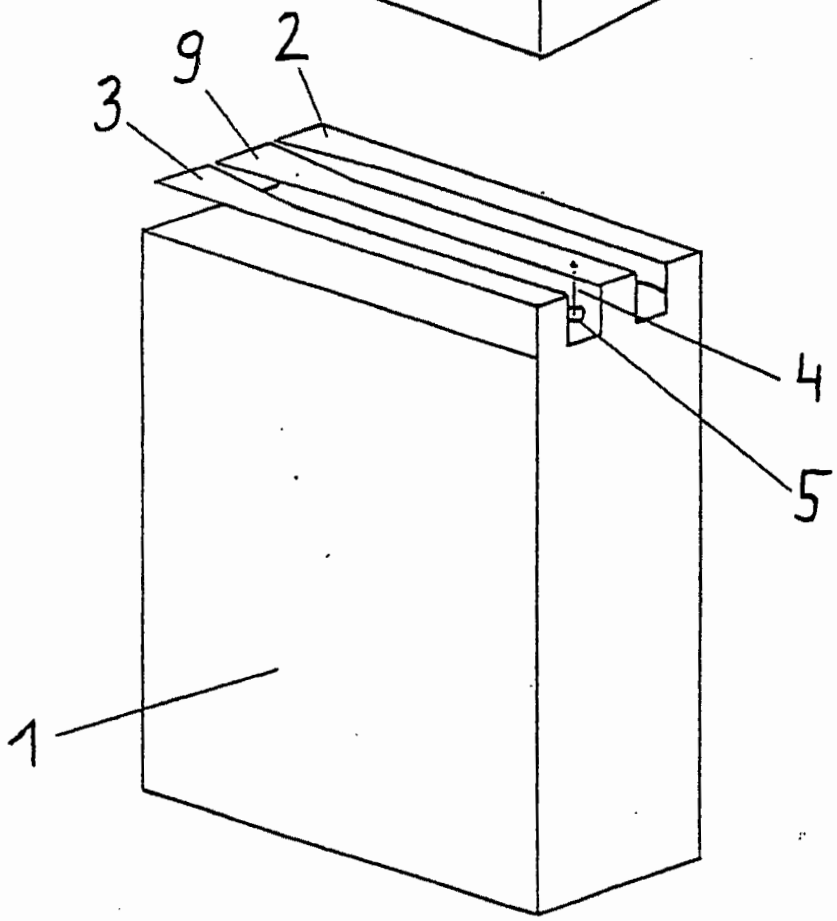


Fig.5



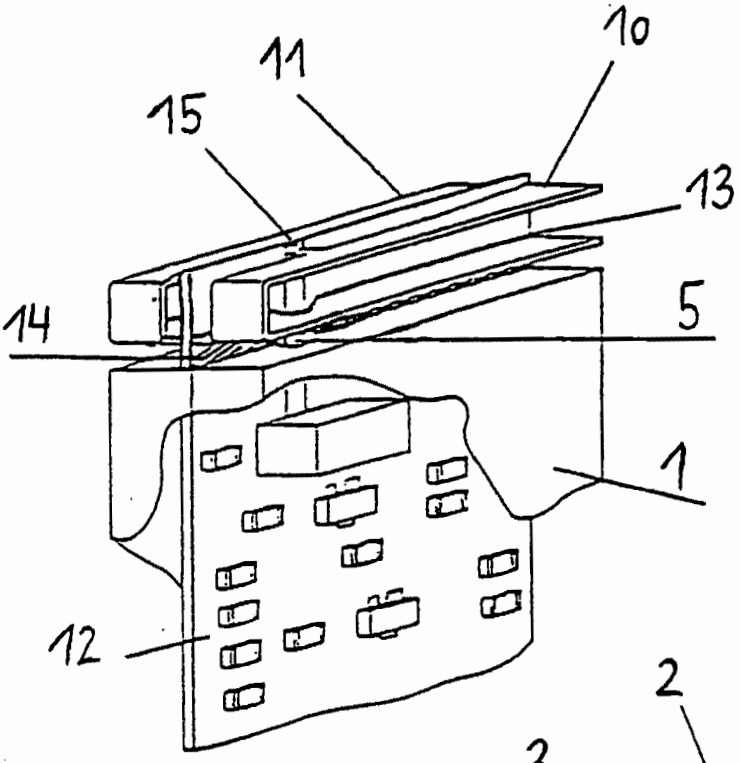


Fig. 6

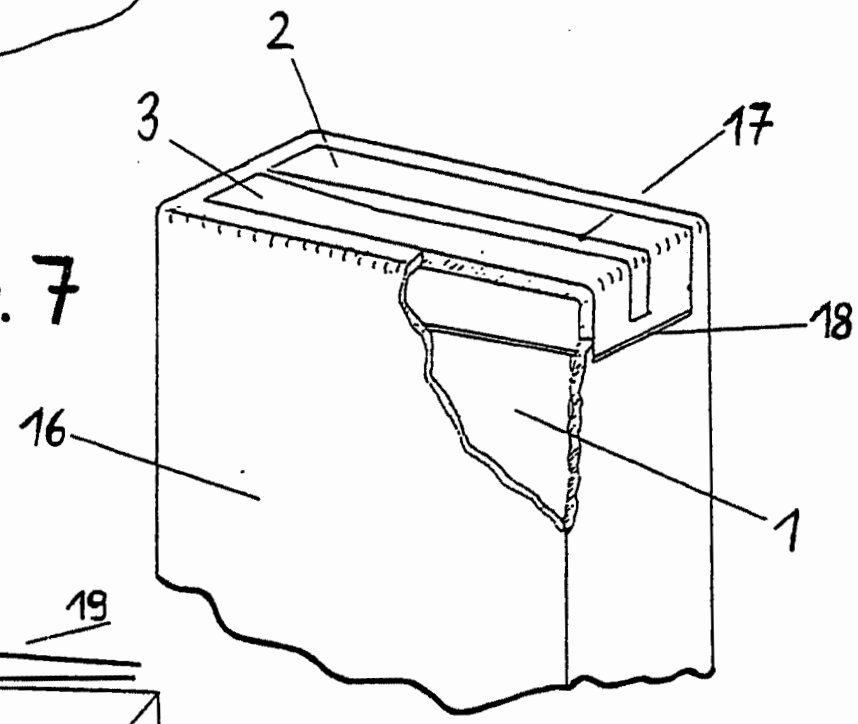


Fig. 7

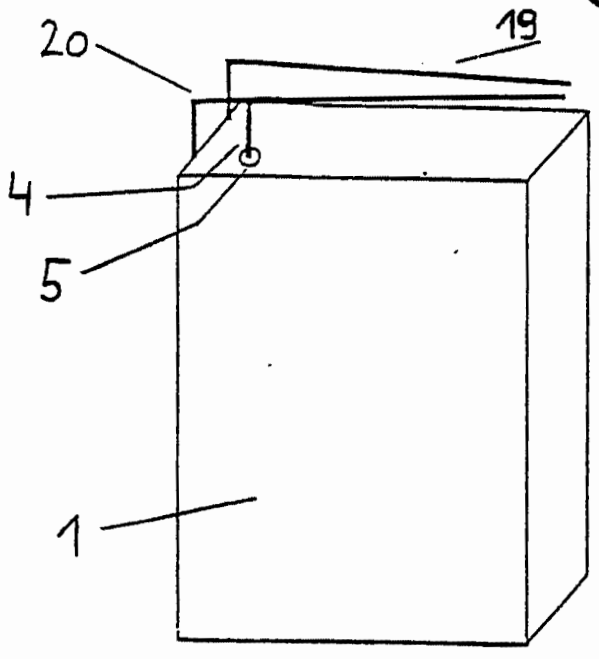


Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP90/01227

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[5]: H01Q 1/24; H01Q 9/04

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
Int.Cl[5]	H01Q; H04B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	GB, A, 2067842 (THE SECRETARY OF STATE FOR DEFENCE) 30 July 1981 see page 1, lines 12 - 67; Figures 1,5	1,2
A	WO, A, 8404427 (MOTOROLA) 8 November 1984 see abstract; figures 1,2	1,2,13
A	US, A, 4849765 (MARKO) 18 July 1989 see abstract; figures 1,2,3A,3B	1,2

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 November 1990 (30.11.90)	19 December 1990 (19.12.90)
International Searching Authority	**Signature of Authorized Officer**
European Patent Office	

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 9001227

SA 39549

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 30/11/90
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A-2067842	30-07-81	None		
WO-A-8404427	08-11-84	US-A-	4494120	15-01-85
		AU-A-	2866384	19-11-84
		CA-A-	1213668	04-11-86
		EP-A-	0140960	15-05-85
US-A-4849765	18-07-89	None		

EPO FORM P0479

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

I. KLASSIFIKATION DES ANMELDUNGSGEGENSTANDS (bei mehreren Klassifikationssymbolen sind alle anzugeben)[6]

Nach der Internationalen Patentklassifikation (IPC) oder nach der nationalen Klassifikation und der IPC

Int.Kl. 5 H01Q1/24 ; H01Q9/04

II. RECHERCHIERTE SACHGEBIETE

Recherchierter Mindestprüfstoff [7]

Klassifikationssystem	Klassifikationssymbole
Int.Kl. 5	H01Q ; H04B

Recherchierte nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Sachgebiete fallen [8]

III. EINSCHLAGIGE VEROFFENTLICHUNGEN [9]

Art.*	Kennzeichnung der Veröffentlichung [11], soweit erforderlich unter Angabe der maßgeblichen Teile [12]	Betr. Anspruch Nr.[13]
A	GB,A,2067842 (THE SECRETARY OF STATE FOR DEFENCE) 30 Juli 1981 siehe Seite 1, Zeilen 12 - 67; Figuren 1, 5	1, 2
A	WO,A,8404427 (MOTOROLA) 08 November 1984 siehe Zusammenfassung; Figuren 1, 2	1, 2, 13
A	US,A,4849765 (MARKO) 18 Juli 1989 siehe Zusammenfassung; Figuren 1, 2, 3A, 3B	1, 2

* Besondere Kategorien von angegebenen Veröffentlichungen [10] :

"A" Veröffentlichung, die den allgemeinen Stand der Technik definiert, aber nicht als besonders bedeutsam anzusehen ist

"E" älteres Dokument, das jedoch erst am oder nach dem internationalen Anmeldedatum veröffentlicht worden ist

"L" Veröffentlichung, die geeignet ist, einen Prioritätsanspruch zweifelhaft erscheinen zu lassen, oder durch die das Veröffentlichungsdatum einer anderen im Recherchenbericht genannten Veröffentlichung belegt werden soll oder die aus einem anderen besonderen Grund angegeben ist (wie ausgeführt)

"O" Veröffentlichung, die sich auf eine mündliche Offenbarung, eine Benutzung, eine Ausstellung oder andere Maßnahmen bezieht

"P" Veröffentlichung, die vor dem internationalen Anmeldedatum, aber nach dem beanspruchten Prioritätsdatum veröffentlicht worden ist

"T" Spätere Veröffentlichung, die nach dem internationalen Anmeldedatum oder dem Prioritätsdatum veröffentlicht worden ist und mit der Anmeldung nicht kollidiert, sondern nur zum Verständnis des der Erfindung zugrundeliegenden Prinzips oder der ihr zugrundeliegenden Theorie angegeben ist

"X" Veröffentlichung von besonderer Bedeutung; die beanspruchte Erfindung kann nicht als neu oder auf erfinderischer Tätigkeit beruhend betrachtet werden

"Y" Veröffentlichung von besonderer Bedeutung; die beanspruchte Erfindung kann nicht als auf erfinderischer Tätigkeit beruhend betrachtet werden, wenn die Veröffentlichung mit einer oder mehreren anderen Veröffentlichungen dieser Kategorie in Verbindung gebracht wird und diese Verbindung für einen Fachmann naheliegend ist

"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

IV. BESCHEINIGUNG

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
30. NOVEMBER 1990	19. 12. 90
Internationale Recherchenbehörde	**Unterschrift des bevollmächtigten Bediensteten**
EUROPAISCHES PATENTAMT	ANGRABEIT F.F.K.

Formblatt PCT/ISA/210 (Blatt 2) (Januar 1985)

ANHANG ZUM INTERNATIONALEN RECHERCHENBERICHT ÜBER DIE INTERNATIONALE PATENTANMELDUNG NR.

EP 9001227
SA 39549

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben.
Die Angaben über die Familienmitglieder entsprechen dem Stand der Datei des Europäischen Patentamts am 30/11/90
Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie		Datum der Veröffentlichung
GB-A-2067842	30-07-81	Keine		
WO-A-8404427	08-11-84	US-A-	4494120	15-01-85
		AU-A-	2866384	19-11-84
		CA-A-	1213668	04-11-86
		EP-A-	0140960	15-05-85
US-A-4849765	18-07-89	Keine		

EPO FORM P0473

Für nähere Einzelheiten zu diesem Anhang : siehe Amtsblatt des Europäischen Patentamts, Nr.12/82

Description of WO9102386

Sending and/or receipt arrangement for portable devices the invention relates to a sending and/or a receipt arrangement for portable devices, existing from a shielding case and a connected antenna conductive thereby which consist of two or several essentially same-oriented angled antenna resonators.

In the EP-A 177,362 a broadband antenna for portable radios is described. It consists different resonant frequency of two angled resonators. Both resonators become fed from a common line over a branch in the type of a "Inverted F antenna". The antenna resonators work independently and form no unit. Therefore also the efficiency is not particularly large. The distance between the parallel legs is constant in US 4.584.585 is an antenna with resonators from wire angles described. A resonator is angespeist at the end and forms a "Inverted L antenna". The second resonator is radiation-coupled. With this arrangement a good efficiency achieved becomes, the antenna has however a fixed impedance and is poor adaptable. The form of the active antenna resonator is to be bent relatively difficult, and points the base plate in addition also still another stage up. The bandwidth is relatively small.

"Inverted F antennas" are from T. Taga and K. Tsunekawa, "performance analysis OF A Built into planar Inverted F antenna for 800 MHZ band portable radio of unit," IEEE of Trans., Selected AREAs in Commun., volume. SAC-5, no.5, pp. 921-929, June (1987) known. A matching of such antennas made by variation of the position of the Speisepunktes.

Der Erfindung liegt die Aufgabe zugrunde, die Sende- bzw.

To improve reception power of the antenna, whereby with larger Bandwidth a simple fabrication and a good adaptability ensured to be is.

This becomes in accordance with claim 1 by a sending and/or a receipt arrangement for portable devices achieved, existing from a shielding case and a connected antenna conductive thereby, those over at least a supply line with a transmission exit and/or. Receiver entrance connected is, whereby the shielding case of metal and the antenna consist of two or several essentially same-oriented angled antenna resonators, whereby only one antenna resonator with the supply line is connected and the feed point between the break edge of the vertex range and the free resonator end, whereby a coaxial feedthrough for the supply line present and the supply line is over a duplex filter with transmitter exit and receiver entrance connected and whereby a significant small for varying the input impedance of the antenna the distance between the antenna resonators is in the end region as at the break edge of the vertex range.

The not-fed resonators of the antenna become radiation-coupled excited by the fed resonator, whereby the bandwidth of the antenna becomes enlarged. By the angled form and the widening of the ends currents flow in all three directions in space. High shunt currents are formed, a small impedance the involve. Thus gaps in the directional characteristic of the antenna become filled. Is by the small space requirement those > Arrangement excellent for applications of portable radios suitable. It is light producible and the entire high frequency, low frequency and digital electronics of a portable radio can in the shielding case accommodated become.

The metal housing serves simultaneous as earth reproduction for the antenna. By change of the fastening spot of the supply line at the antenna resonator and thus

that widened for varying the Eingangsimpezanz of the antenna the resonators are in the range of their ends, the variation range is particularly large. Therefore matching networks between antenna and transmission output stage can and/or in many applications. Transmission filter, as well as between antenna and receiver entrance and/or. Receipt filters saved become. The arrangement of to each other essentially parallel antenna resonators can become also as slot antenna described, whereby is within wide limits variable by width and form of the slot between the resonators the input impedance.

The object can also become after claim 2 thereby dissolved that the sending and/or receipt arrangement consist for portable devices of a shielding case and a connected antenna conductive thereby, those over at least a supply line with a transmitter exit and/or. Receiver entrance connected is, whereby consists the shielding case from metal and the antenna of two or several essentially same-oriented angled antenna resonators and at least two antenna resonators with a supply line connected and the feed points between the break edge of the vertex ranges and the free resonator ends are, whereby a coaxial feedthrough for each supply line present and the supply lines over one sending and receipt filter each with the transmitter exit and receiver entrance connected are and whereby a significant small for varying the input impedance of the antenna the distance between the antenna resonators is in the end region as at the break edge of the vertex ranges.

The advantages of the arrangement according to claim 1 sending and reception become filter a partial decoupling of transmitter exit and receiver entrance achieved by the supply of two antenna resonators and the connection of the supply lines with.

In addition a separate optimization of transmitter and receiver adjustment is possible.

The antenna can be in principle over any side surface of the shielding case. In experiments it proved itself however as favourable that the antenna resonators at the top and/or. Top surface of the shielding case disposed are. For a Diversity-Betrieb the antenna consists of at least two fed, each other opposite partial antennas. Both partial antennas can be same prolonged, it develop for double resonance. The antenna consists of Lambda/4-Resonatoren. Therefore the bandwidth can become still other enlarged, if the length of the antenna resonators is unequal.

A reliable mechanical structure becomes achieved by the fact that the angled antenna resonators from sheet metal angles are formed. To the improvement of the radiation characteristic it is favourable that three sheet metal angles present are and the middle sheet metal angle with the supply line is connected.

To the production of the metal parts in a single operation it is favourable that the shielding case and the sheet metal angles from a flat sheet punched and into the corresponding form are bent. In addition, it is possible that sheet metal angles on the shielding case the soldered and/or. with it conductive connected is.

The mechanical maximum stress of the antenna becomes increased by the fact that the sheet metal angles exhibit u-shaped longitudinal section and the not fed, and/or. not radiation-coupled legs at from the shielding case prominent a board conductive fixed and over a mass-flat with the shielding case connected is. A special rigidity becomes achieved by the fact that the board rises up between the free resonator ends of the sheet metal angles and the resonator ends with the board connected are. By these measures the antenna on the board is integrable.

A special mechanical resistance is connected inside applied on which the sheet metal angles as metal foil outer or thereby given that the shielding case is of a plastic housing surrounded, and over a mass execution with the shielding case is.

In addition it is also favourable that the angled antenna resonators from wire angles are formed. This wire angles it approach in such a manner one on the other that their free resonator ends are only scarcely from each other remote. Then high currents and it flow also here arise a small impedance. The "Inverted F structure" has the advantage of a higher quality of the matching in relation to the Inverted I structure" to the wide-bandness. The improvement amounts to about 50 - 100%.

The invention becomes on the basis several embodiments and more near explained of designs. Show: Fig. 1 an example with two sheet metal angles, Fig. 2 the plan view with the antenna range, Fig. 3 an example with two supply lines, Fig. 4 an example with two partial antennas, Fig. 5 an example with three antenna resonators, Fig. 6 an example of the integration on a board, Fig. 7 an example with resonators from metal foil and Fig. 8 an example with resonators from wire angles.

In the subsequent embodiments antennas with two or several angled resonators described, those into portable radios, become like schnurlos-telephones, mobile telephones, pager, "Telepoint apparatuses" etc. is applicable. As internal antenna for a digital schnurlos-telephone them are on 1.7 GHz band set. The common operation characteristics are generally only in the first embodiment indicated.

The structure of a first antenna is in Fig. 1 shown. On a shielding case 1 both the sheet metal angle acting as antenna is 2.3 mounted at the top. The shielding case 1 the included entire high frequency, Niederfrequenzund digital electronics of the mobile part of a schnurlos-telephone.

Except the shielding the satisfied shielding case 1 also the function of an earth reproduction for the antenna and affected bandwidth. Ever large it is, the smaller becomes the bandwidth. The top of the shielding case 1 turned out as favourable place for the mounting of the antenna.

The shielding case 1 (and/or. Parts of the same) and the sheet metal angles 2.3 are punched from a flat sheet and as in the Fig. 1 shown into shape-bent. With the first sheet metal angle 2 a supply line is 4 connected, which leads 5 out over a coaxial feedthrough from the interior of the shielding case 1. The first sheet metal angle 2 is thus the fed element of the antenna, the second sheet metal angle 3 is with the first sheet metal angle 2 radiation-coupled. The supply line 4 is inside the shielding case 1 over a duplex filter with a receiver entrance and/or. Transmitter exit connected.

Fig. 2 shows the fixing point of the supply line 4 at the first sheet metal angle 2. The location of this fastening spot and the moulding of each other directed edges of the sheet metal angles 2.3 allowed it to vary the input impedance of the antenna over a wide range. Die Blechwinkel 2,3 sind zu den Enden hin verbreitert. Thus a matching network between the antenna and the transmitter exit becomes and/or. Receiver entrance saved.

The two sheet metal angles 2.3 exhibit a different length. Due to the different resonant frequencies of the single emitters subsequent from it a significant increase of the bandwidth results opposite a comparable, only antenna existing from a single sheet metal angle.

An alternative possibility of the connection of transmitter and receiver with the antenna according to invention is in Fig. 3 shown. The first sheet metal angle 2 is 4 connected with the first supply line, the second sheet metal angle 3 with a second supply line 6. The supply lines 4.6 are led out over feedthroughs 5. The transmitter exit is over a transmission filter with the first sheet metal angle 2 connected. Corresponding one is the receiver entrance over a receipt filter with the second sheet metal angle 3 connected. By this type of the embodiment a part of the required decoupling of transmitter exit and receiver entrance becomes effected. The variation of the input impedance by moulding of the sheet metal angles 2.3 and variation of the fastening spot of the supply lines 4.6 made as with the first embodiment.

Fig. an antenna assembly for Diversity-Betrieb shows 4. Two partial antennas are pre-aged to the shielding case 1 on the narrow side. The first partial antenna consists of the first two sheet metal angles 2,3. The second partial antenna is identical constructed and consists of sheet metal angles 7,8. The Anspeisung for the first partial antenna made over the supply line 4 by a coaxial feedthrough 5, for the second partial antenna applies for corresponding. The length of the resonators amounts to Lambda/4.

Both partial antennas are same prolonged and it come to a double resonance.

With in Fig. 5 represented sending and receipt arrangement is between the two sheet metal angles 2.3 a third sheet metal angle 9 of the shielding case 1 ago disposed. The free resonator end of the third sheet metal angle 9 is symmetrical 2.3 widened against the first two sheet metal angles. Over the coaxial feedthrough 5 the supply line is 4 9 connected with the third sheet metal angle. The two first sheet metal angles 2.3 are radiation-coupled.

In the example after Fig. the shielding case 1 consists and encloses 6 of two parts a board 12, are disposed on which the devices of the apparatus. The board 12 stands out on the upper narrow side between the parts of the shielding case 1 and is provided with a M*scefläche 14. The antenna consists of sheet metal angles 10.11, which exhibit an u-shaped longitudinal section. They are 12 fixed by a solder joint 13 over the whole length of the lower in each case leg of the sheet metal angles 10.11 with the mass-flat 14 connected and at the board. The supply made over a conductive trace by the feedthrough 5 in the shielding case 1 and a recess in the lower leg of the sheet metal angle 10 to the feed point 15. The sheet metal angle is 10 12 connected also with the board here. If necessary, also the free resonator end with the board can become 12 connected. It is both a separate and a common supply of the sheet metal angles 10.11 possible.

With an other example after Fig. 7 is the shielding case 1 of a plastic housing 16 surrounded. The sheet metal angles 2.3 are sprayed on outer on the plastic housing 16. It would be also possible to out-corrode them. From a feed point 17 out is the sheet metal angle 2 with the transmitter/receiver connected. Over a mass execution 18 the contact of the sheet metal angles 2.3 with the shielding case becomes 1 manufactured.

The antenna of the sending and receipt arrangement after Fig. 8 is from wire angles 19.20 manufactured. They approach one on the other and are at the free resonator end only more scarcely from each other remote. The wire angles 19.20 are 1 soldered to the shielding case, and the second wire angle 20 is over a supply line 4 with the transmitter/receiver connected. In addition the shielding case 1 exhibits a coaxial feedthrough 5. These wire angles 19.20 are stretched performed and have therefore a simple form. The shielding case 1 does not exhibit stage.

Patentansprüche:

1. Sending and/or receipt arrangement for portable devices, existing from a shielding case (1) and a connected antenna conductive thereby, those over at least a supply line (4) with a transmitter exit and/or. Receiver entrance connected is, whereby the shielding case (1) consists the antenna of metal and of two or several essentially same-oriented angled antenna resonators, whereby only one antenna resonator with the supply line (4) is connected and the feed point between the break edge of the vertex range and the free resonator end, whereby a coaxial feedthrough (5) for the supply line (4) is present and the supply line (4) over a duplex filter with transmitter exit and receiver entrance connected and whereby a significant small for varying the input impedance of the antenna the distance between the antenna resonators is in the end region as at the break edge of the vertex range.

2. Sending and/or receipt arrangement for portable devices, existing from a shielding case (1) and a connected antenna conductive thereby, those over at least a supply line (4) with a transmitter exit and/or. Receiver entrance connected is, whereby the shielding case (1) from metal consists and the antenna of two or several essentially same-oriented angled antenna resonators and at least two antenna resonators with a supply line (4,6) are connected and the feed points between the break edge of the vertex ranges and the free resonator ends, whereby a coaxial feedthrough (5) for each supply line (4,6) present and the supply lines (4,6) over one sending and receipt filter each with the transmitter exit and receiver entrance connected are and whereby a significant small for varying the input impedance of the antenna the distance between that antenna resonators is in the end region as at the break edge of the vertex ranges.

3. Arrangement according to claim 1 or 2, D A D u r C h g e k e n n z e i C h n e t that the antenna resonators at the top and/or. Top surface of the shielding case (1) disposed are.

4. Arrangement according to claim 1 or 2, D A D u r C h g e k e n n z e i C h n e t that the antenna consists of at least two fed, each other opposite partial antennas.

5. Arrangement after one of the previous claims, D A D u r C h g e k e n n z e i C h n e t that the length of the antenna resonators is unequal.

6. Arrangement after one of the previous claims, D A D u r C h g e k e n n z e i C h n e t that the angled antenna resonators from sheet metal angles (2,3; 7,8) formed is.

7. Arrangement according to claim 6, D A D u r C h g e k e n n z e i C h n e t that three sheet metal angles (2,3,9) present and the middle sheet metal angle (9) with the supply line (4) is connected.

8. Arrangement according to claim 6 or 7, D A D u r C h g e k e n n z e i C h n e t that the shielding case (1) and the sheet metal angles (2,3; 7,8; 9) from a flat sheet punched and into the corresponding form bent is.

9. Arrangement according to claim 6 or 7, D A D u r C h g e k e n n z e i C h n e t that the sheet metal angles (2,3; 7,8; 9) on the shielding case (1) soldered and/or. with it conductive connected is.

10. Arrangement according to claim 6 or 7, D A D u r C h g e k e n n z egg i C h ne t that the sheet metal angles (10,11) exhibit UFO RMI towards longitudinal section and the not fed, and/or. not radiation-coupled legs at one from the shielding case (1) prominent board (12) conductive fixed and over a mass-flat (14) with the shielding case (1) connected is.

11. Arrangement according to claim 10, D A D u r C h g e k e.n n z e i C h n e t that the board (12) rises up between the free resonator ends of the sheet metal angles (10,11) and the resonator ends with the board (12) connected is.

12. Arrangement according to claim 6 or 7, D A D u r C h g e k e n n z e i C h n e t that the shielding case (1) of a plastic housing (16) is surrounded, on which the sheet metal angles (2,3) as metal foil outer or inside applied and over a mass execution (18) with the shielding case (1) connected is.

13. Arrangement after one of the claims 1-5, D A D u r C h g e k e n n z e i C h n e t that the angled antenna resonators from wire angles (19,20) are formed.

TRANSMITTING AND RECEIVING ARRANGEMENT FOR PORTABLE APPLIANCES

Publication number: JP5500889T

Publication date: 1993-02-18

Inventor:

Applicant:

Classification:

- international: ***H01Q1/24; H01Q9/04; H01Q19/00;*** **H01Q1/24; H01Q9/04; H01Q19/00;** (IPC1-7): H01Q1/24

- European: H01Q1/24A1A; H01Q9/04B2; H01Q19/00B

Application number: JP19900512360 19900726

Priority number(s): AT19890001815 19890727

Also published as:

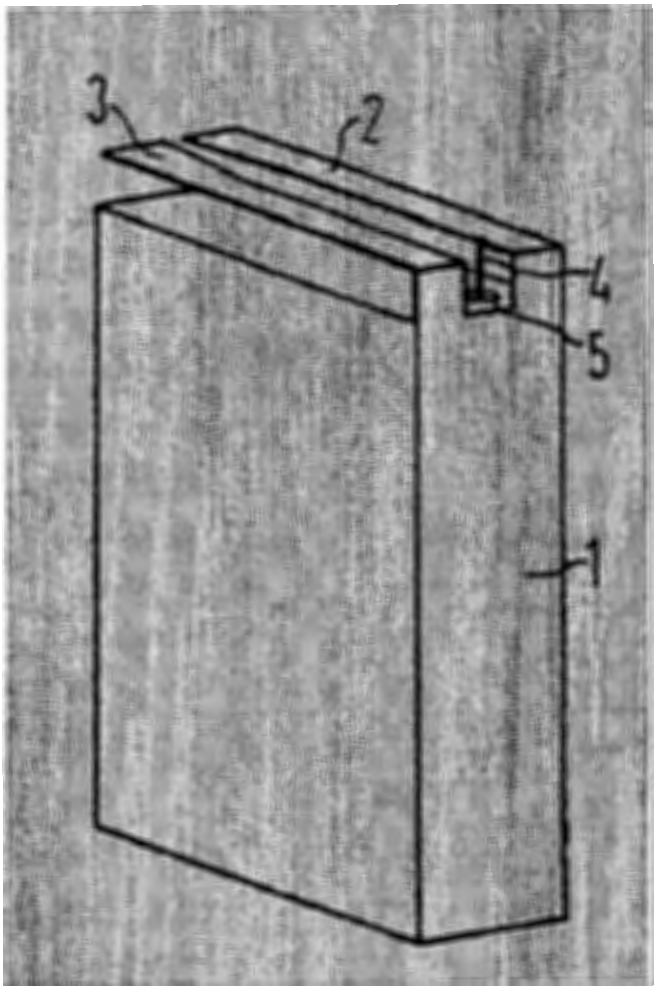
- WO9102386 (A1)
- EP0484454 (A1)
- US5365246 (A1)
- EP0484454 (A0)
- EP0484454 (B1)

Report a data error here

Abstract not available for JP5500889T

Abstract of corresponding document: **WO9102386**

An antenna for the transmitter and receiver of a portable radio appliance (cordless telephone, mobile telephone, pager, telepoint appliance, etc.) consists essentially of two sheet metal angles (2, 3) arranged side by side. One of the two elements is excited with high-frequency currents by means of a coaxial supply line (4). The second sheet metal angle (3) is excited through radiation coupling by the first sheet metal angle (2). The sheet metal angles (2, 3) are aligned in the same direction and the distance between them in the end region is considerably less than in the bent edge of the apex line. This results in high cross-currents and low impedance. The antenna can also be modified by supplying both sheet metal angles (2, 3), subdivision into two identical partial antennae or several sheet metal angles. The sheet metal angles can consist of metal foils placed on a plastic housing. An embodiment with wire angles is also possible.



Data supplied from the ***esp@cenet*** database - Worldwide

⑲日本国特許庁(JP)　　⑪特許出願公表

⑫公表特許公報(A)　　平5−500889

⑬公表　平成5年(1993)2月18日

⑤Int. Cl.⁵	識別記号	庁内整理番号	審査請求 未請求
H 01 Q 1/24	Z	7046−5J	予備審査請求 有　部門(区分) 7(3)

(全 5 頁)

⑭発明の名称　携帯用機器のための送信及び／又は受信装置

⑳特　願　平2−512360
⑧⑫出　願　平2(1990)7月26日
⑧⑤翻訳文提出日　平4(1992)1月24日
⑧⑥国際出願　PCT/EP90/01227
⑧⑦国際公開番号　WO91/02386
⑧⑦国際公開日　平3(1991)2月21日
優先権主張　㉜1989年7月27日㉝オーストリア(AT)㉛A1815/89

⑦②発明者　ラジンガー、ヨーゼフ　オーストリア国　A−2340　メトリング　プリューラーシュトラーセ　106／2
⑦①出願人　シーメンス　アクチエンゲゼルシャフト　ドイツ連邦共和国　D−8000　ミュンヘン　2　ウイッテルスバッヒアープラッツ　2
⑦④代理人　弁理士　富村　潔

⑧①指定国　AT(広域特許),BE(広域特許),CH(広域特許),DE(広域特許),DK(広域特許),ES(広域特許),FR(広域特許),GB(広域特許),IT(広域特許),JP,LU(広域特許),NL(広域特許),SE(広域特許),US

最終頁に続く

請求の範囲

1．　遮蔽ケース（1）並びにこのケースに導電接続され少なくとも一つの給電線（4）を介して送信機出力端又は受信機入力端に接続されたアンテナから成り、遮蔽ケース（1）が金属から成り、アンテナがほぼ同じ方向に折り曲げられた二つ以上のアンテナ共振器から成り、一つのアンテナ共振器だけが給電線（4）に接続され、給電点が頂部領域の折り曲げ線と共振器自由端部との間にあり、給電線（4）のための同軸貫通部（5）が設けられ、給電線（4）が二重フィルタを介して送信機出力端及び受信機入力端に接続され、アンテナの入力インピーダンスの変更のために端部領域のアンテナ共振器間の間隔が頂部領域の折り曲げ線におけるより著しく小さいことを特徴とする携帯用機器のための送信及び／又は受信装置。

2．　遮蔽ケース（1）並びにこのケースに導電接続され少なくとも一つの給電線（4）を介して送信機出力端又は受信機入力端に接続されたアンテナから成り、遮蔽ケース（1）が金属から成り、アンテナがほぼ同じ方向に折り曲げられた二つ以上のアンテナ共振器から成り、少なくとも二つのアンテナ共振器が給電線（4、6）に接続され、給電点が頂部領域の折り曲げ線と共振器自由端部との間にあり、各給電線（4、6）のための同軸貫通部（5）が設けられ、給電線（4、6）が各一つの送信フィルタ及び受信フィルタを介して送信機出力端及び受信機入力端に接続され、アンテナの入力インピーダンスの変更のために端部領域のアンテナ共振器間の間隔が頂部領域の折り曲げ線におけるより著しく小さいことを特徴とする携帯用機器のための送信及び／又は受信装置。

3．　アンテナ共振器が遮蔽ケース（1）の上面又は頂部面に配置されていることを特徴とする請求の範囲1又は2記載の装置。

4．　アンテナが、給電され相互に向かい合う少なくとも二つの部分アンテナから成ることを特徴とする請求の範囲1又は2記載の装置。

5．　アンテナ共振器の長さが等しくないことを特徴とする請求の範囲1ないし4の一つに記載の装置。

6．　折り曲げられたアンテナ共振器がアングル板（2、3；7、8）から形成されていることを特徴とする請求の範囲1ないし5の一つに記載の装置。

7．　三つのアングル板（2、3、9）が設けられ、中央のアングル板（9）が給電線（4）に接続されていることを特徴とする請求の範囲6記載の装置。

8．　遮蔽ケース（1）及びアングル板（2、3；7、8；9）が1枚の平らな板から打ち抜かれ相応の形に曲げられることを特徴とする請求の範囲6又は7記載の装置。

9．　アングル板（2、3；7、8；9）が遮蔽ケース（1）上にろう付けされるか、又は遮蔽ケースに導電接続されることを特徴とする請求の範囲6又は7記載の装置。

10．　アングル板（10、11）がU字形の長手方向断面を有し、給電されない又は寄生的に結合されない脚が遮蔽ケース（1）から突出するプリント配線板（12）に導電固定され、接地面（14）を介して遮蔽ケース（1）に接続されていることを特徴とする請求の範囲6又は7記載の装置。

11．　プリント配線板（12）がアングル板（10、11）の共振器自由端部間に突出し、共振器端部がプリント配線板（12）に接続されていることを特徴とする請求の範囲10記載の装置。

12．　遮蔽ケース（1）がプラスチックケース（16）により囲まれ、プラスチックケース上にアングル板（2、3）が金属箔として外又は内側に取り付けられ、接地貫通部（18）を介して遮蔽ケース（1）に接続されていることを特徴とする請求の範囲6又は7記載の装置。

13．　折り曲げられたアンテナ共振器がアングル線材（19、23）から構成されていることを特徴とする請求の範囲1ないし5の一つに記載の装置。

明　細　書

携帯用機器のための送信及び／又は受信装置

この発明は、遮蔽ケース並びにほぼ同方向に向けて折り曲げられた二つ以上のアンテナ共振器を有し遮蔽ケースに導電接続されたアンテナから成る、携帯用機器のための送信及び／又は受信装置に関する。

欧州特許出願公開第177362号公報には携帯用無線機のための広帯域アンテナが記載されている。このアンテナは異なる共振周波数の折り曲げられた二つの共振器から成る。両共振器は共通の導線から分岐を介して「逆Ｆ形アンテナ」の方式で給電される。アンテナ共振器は相互に無関係に働きユニットを形成しない。従って効率は特に大きくはない。平行な脚の間の間隔は一定である。

アメリカ合衆国特許第4584585号明細書にはアングル線材から成る共振器を備えるアンテナが記載されている。第１の共振器は端部で給電され「逆し形アンテナ」を形成する。第２の共振器は容量的に結合されている。この装置により良好な効率が達成されるが、しかしアンテナは一定のインピーダンスを有し整合性が悪い。能動性アンテナ共振器の形状は比較的曲げにくく、更に台板は段部さえも有する。帯域幅は比較的狭い。

「逆Ｆ形アンテナ」は多賀及び恒川の論文「８００ＭＨｚ帯域ポータブルラジオユニットのための組込み式平面逆Ｆ形アンテナの性能解析」アイトリプルイー　トランザクションズ、セレクテッド　エリアズ　イン　コミュニケーション、第ＳＡＣ－５巻、第５号、第９１２～９２９ページ、６月（１９８７年）から知られている。この種のアンテナの整合は給電点の位置の変更により行われる。

この発明の課題は、アンテナの送信能力又は受信能力を改善し、その際広い帯域幅であって簡単な製造可能性及び良好な整合性を保証することにある。

この課題は請求の範囲１に基づき、遮蔽ケース及びこのケースに導電接続されたアンテナから成り、アンテナが少なくとも一つの給電線を介して送信機出力端又は受信機入力端と接続され、その際遮蔽ケースが金属から成り、アンテナがほぼ同方向に折り曲げられた二つ以上のアンテナ共振器から成り、一つのアンテナ共振器だけが給電線に接続され、給電点が頂部領域の折り曲げ線と自由な共振器端部との間にあり、給電線のための同軸貫通部が設けられ、給電線が二重フィルタを介して送信機出力端及び受信機入力端と結合され、アンテナの入力インピーダンスの変更のためにアンテナ共振器間の間隔が端部領域では頂部領域の折り曲げ線におけるよりも小さいような、携帯用機器のための送信及び／又は受信装置により解決される。

アンテナの非給電共振器は容量的に結合されて給電共振器により励振され、その結果アンテナの帯域幅が拡大される。折り曲げられた形状及び端部の拡幅により電流がすべての三つの空間方向へ流れる。その際小さいインピーダンスを引き起こす大きい横流が生じる。それによりアンテナの方向特性の開際が得たされる。小さい所要空間により装置は移動形無線機用途のために著しく適している。この装置は容易に製造可能であり、携帯用無線機のすべての高周波、低周波及びディジタル電子回路を遮蔽ケース中に収容することができる。金属ケースは同時にアンテナのための等価大地として働く。給電線のアンテナ共振器への取り付け点の変更により、及びアンテナの入力インピーダンスの変更のために共振器がその端部領域で拡幅されることにより、変更範囲が特に大きくなる。従って多くの用途においてアンテナと送信出力回路又は送信フィルタとの間並びにアンテナと受信機入力端又は受信フィルタとの間の整合回路を省略することができる。相互にほぼ平行なアンテナ共振器の配置はスロットアンテナと呼ぶこともでき、その際共振器間のスロットの幅及び形状により入力インピーダンスを広い限界内で変更できる。

この発明の課題はまた請求の範囲２に基づき、携帯用機器のための送信及び／又は受信装置が遮蔽ケース及びこのケースに導電接続されたアンテナから成り、アンテナが少なくとも一つの給電線を介して送信機出力端又は受信機入力端と接続され、遮蔽ケースが金属から成り、アンテナがほぼ同方向に折り曲げられた二つ以上のアンテナ共振器から成り、少なくとも二つのアンテナ共振器が給電線と接続され、給電点が頂部領域の折り曲げ線と自由な共振器端部との間にあり、各給電線のための同軸貫通部が設けられ、給電線が各一つの送信フィルタ及び受信フィルタを介して送信機出力端及び受信機入力端と接続され、アンテナの入力インピーダンスの変更のためにアンテナ共振器間の間隔を端部領域では頂部領域の折り曲げ線におけるより著しく小さくすることにより解決される。

請求の範囲１に記載の装置の長所に加えて、二つのアンテナ共振器の給電並びに給電線と送信フィルタ及び受信フィルタとの接続により、送信機出力端と受信機入力端との部分的な結合が達成される。更に送信機整合と受信機整合との分離された最適化が可能である。

アンテナは原理的には遮蔽ケースのそれぞれ任意の側面上に設けることもできる。しかしながら実験ではアンテナ共振器が遮蔽ケースの上面又は頂部面に配置されるのが有利であることが判明している。ダイバーシチ運転のためにはアンテナは、給電され相互に向かい合う少なくとも二つの部分アンテナから成る。両部分アンテナを同じ長さとすれば二重共振が生じる。アンテナは１／４共振器から成る。従ってアンテナ共振器の長さを異ならせれば、帯域幅を一層拡大することができる。

信頼性のある機械的構造は、折り曲げられたアンテナ共振器がアングル板から形成されることにより達成される。放射特性の改善のために、三つのアングル板が設けられ、中央のアングル板が給電線と接続されるのが有利である。唯一の工程で金属部品を製造するためには、遮蔽ケース及びアングル板が１枚の平板から打ち抜かれ相応の金型の中で曲げられるのが有利である。しかしアングル板を遮蔽ケース上にろう付けするか、遮蔽ケースと導電接続することも可能である。

アンテナの機械的負荷能力は、アングル板がＵ字形の長手方向断面を有し、給電されない又は容量的に結合されない脚が遮蔽ケースから突出するプリント配線板に導電固定され、接地面を介して遮蔽ケースと接続されることにより高められる。特別な剛性は、プリント配線板がアングル板の共振器自由端部の間に突出し、共振器端部がプリント配線板と接続されることにより達成される。この処置によりアンテナをプリント配線板上に組み込むことができる。

特別の機械的抵抗力は、遮蔽ケースがプラスチックケースにより囲まれ、このプラスチックケース上にアングル板が金属箔として外又は内側に取り付けられ、接地貫通部を介して遮蔽ケースと接続されることにより与えられる。

更に折り曲げられたアンテナ共振器がアングル線材から形成されるのも有利である。これらのアングル線材は、共振器の自由端部が相互に僅かしか離れないように相互に接近しながら延びている。そしてここでも大きい電流が流れ小さいインピーダンスが生じる。「逆Ｆ形構造」は「逆し形構造」に比べて広帯域性への適合のＱが一層高いという長所を有する。改善は約５０～１００％である。

この発明を複数の実施例及び図面により詳細に説明する。

第１図は二つのアングル板を備える実施例を、

第２図はアンテナ領域の平面図を、

第３図は二つの給電線を備える実施例を、

第４図は二つの部分アンテナを備える実施例を、

第５図は三つのアンテナ共振器を備える実施例を、

第６図はプリント配線板上に組み込まれた実施例を、

第７図は金属箔から成る共振器を備えた実施例を、

第８図はアングル線材から成る共振器を備えた実施例を示す。

以下の実施例では折り曲げられた二つ以上の共振器を備えるアンテナを説明するが、これらのアンテナはコードレス電話機、移動形電話機、ポケットベル、テレポイント機器などのような携帯用無線機に組み込み可能である。ディジタル形コードレス電話機のための内部アンテナとしてはアンテナは１．７ＧＨｚ帯域に調整されている。共通な機能的特徴は一般論として第１の実施例だけにおいて述べる。

第１のアンテナの構造が第１図に示されている。遮蔽ケース１の上面にアンテナとして働く二つのアングル板２、３が取り付けられている。遮蔽ケース１はコードレス電話機の移動部分のすべての高周波、低周波及びディジタル電子回路を収容する。遮蔽ケース１は遮蔽のほかにアンテナのための等価大地の機能をも満たしまた帯域幅に影響を与える。ケースが大きいほど帯域幅は一層小さくなる。遮蔽ケース１の上面はアンテナの取り付けのための有利な場所であることが判明している。

遮蔽ケース１（又はその部品）及びアングル板２、３は１枚の平らな板から打ち抜かれ、第１図に示すように折り曲げられている。第１のアングル板２には給

電線４が接続されており、この給電線は同軸貫通部５を介して遮蔽ケース１の内部から導出されている。従って第１のアングル板２はアンテナの給電要素であり、第２のアングル板３は第１のアングル板２と容量的に結合されている。給電線４は遮蔽ケース１の内部で二重フィルタを介して受信機入力端又は送信機出力端に接続されている。

第２図は第１のアングル板２への給電線４の取り付け点を示す。この取り付け点の位置及びアングル板２、３の相互に向かい合う縁の形状付与により、アンテナの入力インピーダンスを広い範囲にわたり変更することが可能になる。アングル板２、３は端部へ向かって拡幅されている。それによりアンテナと送信機出力端又は受信機入力端との間の整合回路が省略される。両アングル板２、３は異なる長さを有する。個々の放射体のそれにより生じる異なる共振周波数に基づき、単一のアングル板だけから成るアンテナに比べて帯域幅の著しい増大が生じる。

送信機及び受信機のこの発明に基づくアンテナとの結合の別の可能性が第３図に示されている。第１のアングル板２は第１の給電線４と接続され、第２のアングル板３は第２の給電線６と接続されている。給電線４、６は貫通部５を介して導出されている。送信機出力端は送信フィルタを介して第１のアングル板２と結合されている。同様に受信機入力端は受信フィルタを介して第２のアングル板３と結合されている。この種の構成により送信機出力端と受信機入力端との必要な減結合の一部がもたらされる。アングル板２、３の形状付与による入力インピーダンスの変更及び給電線４、６の取り付け点の変更は、第１の実施例の場合と同様に行われる。

第４図はダイバーシチ運転のためのアンテナ装置を示す。遮蔽ケース１には狭幅側面上に二つの部分アンテナが取り付けられている。第１の部分アンテナは第１の両アングル板２、３から成る。第２の部分アンテナは同様に構成されアングル板７、８から成る。第１の部分アンテナのための給電は同軸貫通部５を貫く給電線４を介して行われ、第２の部分アンテナに対しても同様である。共振器の長さは$\lambda/4$である。両部分アンテナは同じ長さであり二重共振をもたらす。

第５図に示された送信装置及び受信装置の場合には、両アングル板２、３の間に第３のアングル板９が遮蔽ケース１から配置されている。第３のアングル板９の共振器自由端部は対称に第１の両アングル板２、３へ向かって拡幅されている。同軸の貫通部５を介して給電線４が第３のアングル板９に接続されている。第１の両アングル板２、３は容量的に結合されている。

第６図に示す実施例では遮蔽ケース１が二つの部分から成りプリント配線板１２を囲み、このプリント配線板上には装置の構成部品が配置されている。プリント配線板１２は遮蔽ケース１の両部分の間から上側短側面上に突出し接地面１４を備える。アンテナはU字形長手方向断面を有するアングル板１０、１１から成る。アンテナはろう付け個所１３によりアングル板１０、１１のそれぞれ下側の脚の全長にわたり接地面１４と結合され、プリント配線板１２に取り付けられている。給電は導体路により遮蔽ケース１の貫通部５及びアングル板１０の下側脚の空所を通って給電点１５で行われる。ここでもアングル板１０はプリント配線板１２と結合されている。必要な場合には共振器の自由端部をプリント配線板１２と結合することもできる。アングル板１０、１１の分離された給電ばかりでなく共通な給電も可能である。

第７図に示す別の実施例の場合には、遮蔽ケース１がプラスチックケース１６により囲まれている。アングル板２、３はプラスチックケース１６の外面上に埋込まれている。アングル板をエッチングにより作り出すことも可能である。給電点１７によりアングル板２は送信機／受信機と結合されている。接地貫通部１８を介してアングル板２、３の遮蔽ケース１との接触が形成される。

第８図に示す送信装置及び受信装置のアンテナはアングル線材１９、２０から作られている。アンテナは相互に接近しながら延び、共振器の自由端部では相互に僅かに離れているにすぎない。アングル線材１９、２０は遮蔽ケース１にろう付けされ、第２のアングル線材２０は給電線４を介して送信機／受信機と結合されている。このために遮蔽ケース１は同軸貫通部５を有する。これらのアングル線材１９、２０は延ばして構成され、従って簡単な形状を有する。遮蔽ケース１は段部を有しない。

FIG.1

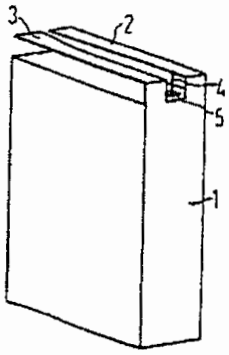


FIG.3

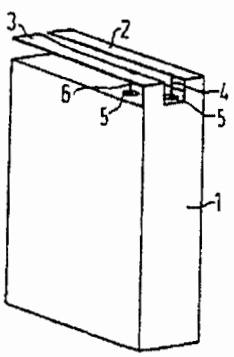


FIG.2

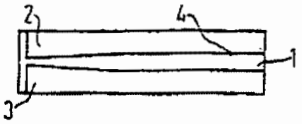


Fig.4

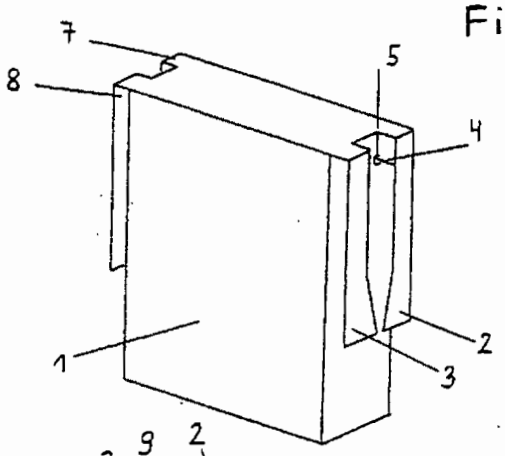
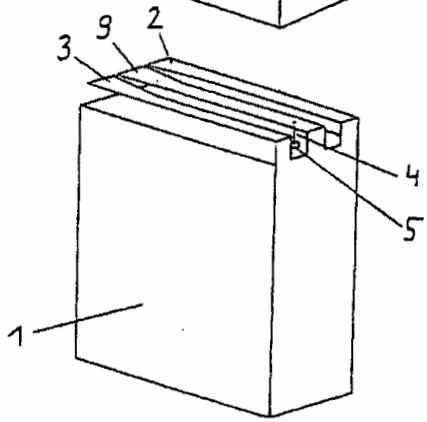


Fig.5



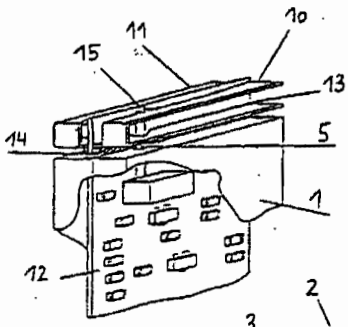


Fig. 6

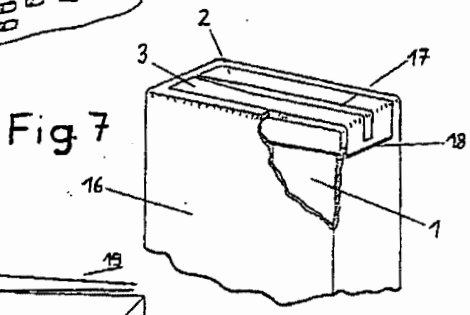


Fig. 7

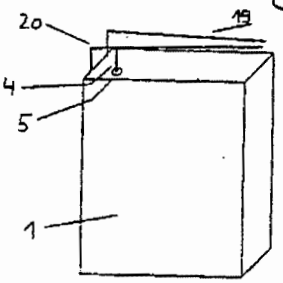


Fig. 8

国際調査報告

International Application No PCT/EP90/01227

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.[5]: H01Q 1/24; H01Q 9/04

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System: Classification Symbols

Int.Cl.[5] H01Q; B04B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB, A, 2067842 (THE SECRETARY OF STATE FOR DEFENCE) 30 July 1981 see page 1, lines 12 - 67; figures 1,5	1,2
A	WO, A, 8404427 (MOTOROLA) 8 November 1984 see abstract; figures 1,2	1,2,13
A	US, A, 4849765 (HARRO) 18 July 1989 see abstract; figures 1,2,3A,3B	1,2

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 November 1990 (30.11.90)	19 December 1990 (19.12.90)
International Searching Authority: European Patent Office	Signature of Authorized Officer

Form PCT/ISA/210 (second sheet) January 1985

国際調査報告

EP 9001227
SA 39549

30/11/90

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-2067842	30-07-81	None	
WO-A-8404427	08-11-84	US-A- 4494120 AU-A- 2866384 CA-A- 1213668 EP-A- 0140960	15-01-85 19-11-84 04-11-86 15-05-85
US-A-4849765	18-07-89	None	

第1頁の続き

⑦発 明 者　ショルツ、アルバート　ルート　オーストリア国　A−1130　ウイーン　アマリエンシュトラーセ
ヴィッヒ　75／2／12／129

⑦発 明 者　ボネーク、エルンスト　オーストリア国　A−1140　ウイーン　シュテイングルガッセ　18

ANTENNA SYSTEM AND PORTABLE RADIO EQUIPMENT

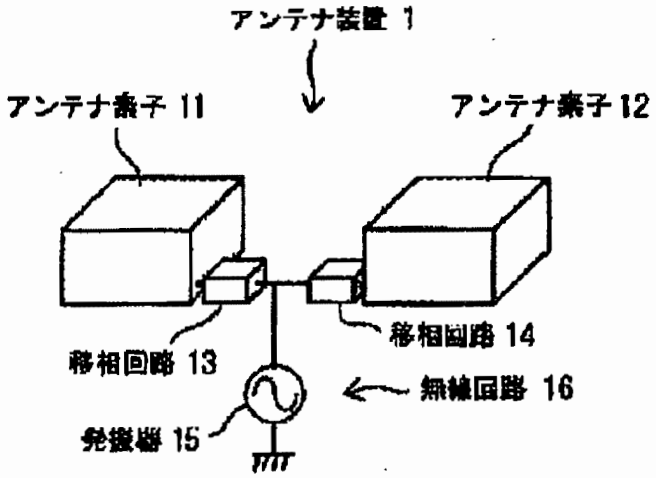
Publication number: JP2001267841
Publication date: 2001-09-28
Inventor: KOSAKAI OSAMU
Applicant: SONY CORP
Classification:
- International: ***H01Q1/24; H01Q3/34; H01Q5/00; H01Q21/30; H04B1/40;*** **H01Q1/24; H01Q3/30; H01Q5/00; H01Q21/30; H04B1/40;** (IPC1-7): H01Q21/30; H04B1/40
- European: H01Q1/24A1A; H01Q3/34; H01Q5/00C; H01Q21/30
Application number: JP20000081124 20000323
Priority number(s): JP20000081124 20000323

Also published as:
EP1137100 (A2)
US6894648 (B2)
US2002000937 (A1)
EP1137100 (A3)
CN1167299C (C)

Report a data error here

Abstract of **JP2001267841**

PROBLEM TO BE SOLVED: To provide an antenna system which has simple device structure and can be used at a plurality of comparatively close frequency bands. SOLUTION: Phase shifting circuits 13, 14 for changing the phase of a radio wave so as to obtain high impedance when one antenna element is used at the resonance frequency of the other antenna element are respectively connected between the feeding points of the two antenna elements 11, 12 having respectively different resonance frequency bands and a radio circuit 16.



Data supplied from the ***esp@cenet*** database - Worldwide

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号
特開2001－267841
(P2001－267841A)
(43)公開日　平成13年９月28日(2001.9.28)

(51)Int.Cl.⁷	識別記号	Ｆ Ｉ	テーマコード(参考)
Ｈ０１Ｑ　21/30		Ｈ０１Ｑ　21/30	５Ｊ０２１
Ｈ０４Ｂ　1/40		Ｈ０４Ｂ　1/40	５Ｋ０１１

審査請求　未請求　請求項の数12　ＯＬ　（全 8 頁）

(21)出願番号　特願2000－81124(P2000－81124)

(22)出願日　平成12年３月23日(2000.3.23)

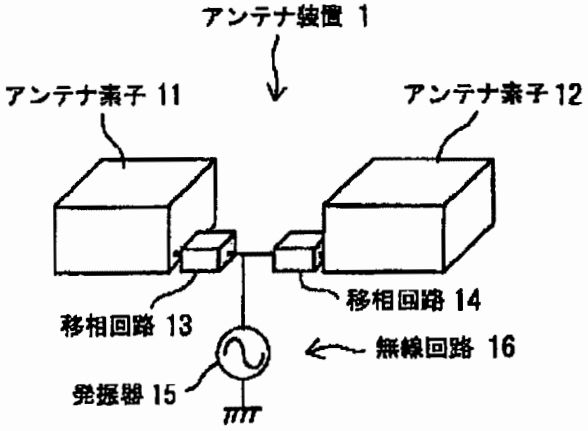
(71)出願人　000002185
ソニー株式会社
東京都品川区北品川６丁目７番35号

(72)発明者　小堺　修
東京都品川区北品川６丁目７番35号　ソニー株式会社内

Ｆターム(参考)　5J021 AA02 AA05 CA05 FA05 FA32 HA05 JA03
5K011 DA02 GA05 GA06 JA01 KA13

(54)【発明の名称】　アンテナ装置および携帯無線機

(57)【要約】
【課題】　単純な装置構成で比較的近接した複数の周波数で使用可能なアンテナ装置を提供する。
【解決手段】　異なる共振周波数を有する２つのアンテナ素子１１および１２の給電点と無線回路１６との間に、一方のアンテナ素子において他方のアンテナ素子の共振周波数で使用されたときに高インピーダンスとなるようにこの電波の位相を変化させる移相回路１３および１４をそれぞれ接続する。



1

【特許請求の範囲】

【請求項１】　２つの周波数の電波を送信あるいは受信するアンテナ装置において、
異なる共振周波数を有する２つのアンテナ素子の給電点がそれぞれ、位相を変化させる２つの移相回路を介して無線回路と接続されることを特徴とするアンテナ装置。

【請求項２】　前記移相回路は、接続されたそれぞれの前記アンテナ素子において、他方の前記アンテナ素子の前記共振周波数で使用されたときに高インピーダンスとなるように、この電波の位相を変化させることを特徴とする請求項１記載のアンテナ装置。

【請求項３】　前記移相回路は集中定数回路で構成されることを特徴とする請求項１記載のアンテナ装置。

【請求項４】　前記移相回路は分布定数回路で構成されることを特徴とする請求項１記載のアンテナ装置。

【請求項５】　複数の周波数の電波を送信あるいは受信するアンテナ装置において、
異なる共振周波数を有する複数のアンテナ素子の給電点がそれぞれ、位相を変化させる複数の移相回路を介して無線回路と接続されることを特徴とするアンテナ装置。

【請求項６】　前記移相回路は、接続されたそれぞれの前記アンテナ素子において、他の前記アンテナ素子の前記共振周波数で使用されたときに高インピーダンスとなるように、この電波の位相を変化させることを特徴とする請求項５記載のアンテナ装置。

【請求項７】　前記移相回路は集中定数回路で構成されることを特徴とする請求項５記載のアンテナ装置。

【請求項８】　前記移相回路は分布定数回路で構成されることを特徴とする請求項５記載のアンテナ装置。

【請求項９】　複数の周波数の電波を送信あるいは受信する携帯無線機において、
異なる共振周波数を有する２つのアンテナ素子の給電点がそれぞれ、位相を変化させる２つの移相回路を介して無線回路と接続されることを特徴とするアンテナ装置を搭載する携帯無線機。

【請求項１０】　前記携帯型無線機は携帯型電話機であることを特徴とする請求項９記載の携帯無線機。

【請求項１１】　複数の周波数の電波を送信あるいは受信する携帯無線機において、
異なる共振周波数を有する複数のアンテナ素子の給電点がそれぞれ、位相を変化させる複数の移相回路を介して無線回路と接続されることを特徴とするアンテナ装置を搭載する携帯無線機。

【請求項１２】　前記携帯型無線機は携帯型電話機であることを特徴とする請求項１１記載の携帯無線機。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、２つあるいはそれ以上の周波数の電波を送信あるいは受信するアンテナ装置に関し、特に、携帯電話機をはじめとする携帯無線機

2

に搭載することが可能なアンテナ装置およびこの携帯無線機に関する。

【０００２】

【従来の技術】近年、携帯電話機が急速に普及しているが、携帯電話機では伝送効率を高め雑音や干渉を防ぐために、使用する周波数の広帯域化の要求が高まっている。しかし、従来の携帯電話機のアンテナ構造では広い周波数帯域をカバーできないことから、複数の周波数で使用可能なアンテナを搭載してより広帯域での送受信を実現させる方法等の開発が進められている。

【０００３】図１８および図１９に複数の周波数帯で使用可能な従来のアンテナの例を示す。図１８は無給電素子を使用する場合、図１９は複数の放射導体を使用する場合の例である。

【０００４】図１８に示すアンテナ１８０では、伝送線である同軸ケーブル１８１に誘電体基板１８２が接続され、この誘電体基板１８２に放射導体１８３と無給電素子１８４が近接して配置されており、複共振特性を得る方法として多く用いられている。また、図１９に示すアンテナ１９０では無給電素子１８４を用いずに、基板１９１上に異なる共振周波数を有する複数の放射導体１９２および１９３を並べて１つの給電点１９４から給電することで複共振特性を得ている。なお、アンテナ１９０は接地点１９５で接地されている。

【０００５】

【発明が解決しようとする課題】図１８に示した無給電素子を配置するアンテナ１８０では、無給電素子１９４と放射素子１９３との位置関係がアンテナのインピーダンス特性に大きな影響を与えるため、任意のアンテナ配置ができないことが問題となっている。

【０００６】また、図１９に示した無給電素子を配置しないアンテナ１９０でも、複数の周波数帯で共振する放射導体１９２および１９３を並べることから、大きな収容スペースが必要であった。さらにこのタイプのアンテナでは、一般に互いの動作周波数が１０％程度の範囲で接近していると動作しにくいという問題点もあった。これは、アンテナ１９０のような構成では、アンテナの放射導体１９２および１９３をスリットで分離し、それぞれの共振周波数で動作させて複共振を実現しているが、それぞれの放射導体１９２および１９３はある程度の広帯域性を有しており、周波数が近接している場合はアンテナとしてスリットで分離した状態にならず、複共振を得ることができないためである。しかし、上述したような携帯電話機では近接した周波数で使用できる必要がある。

【０００７】本発明は以上のような課題に鑑みてなされたものであり、単純な構成で比較的近接した複数の周波数で使用可能なアンテナ装置を提供することを目的とする。また、本発明の他の目的は、単純な構成で比較的近接した複数の周波数で使用可能な携帯無線機を提供する

ことである。

【０００８】

【課題を解決するための手段】本発明では上記課題を解決するために、２つの周波数の電波を送信あるいは受信するアンテナ装置において、異なる共振周波数を有する２つのアンテナ素子の給電点がそれぞれ、位相を変化させる２つの移相回路を介して無線回路と接続されることを特徴とするアンテナ装置が提供される。

【０００９】このようなアンテナ装置では、アンテナ素子を移相回路を介して給電点に接続することにより、隣接する他のアンテナ素子の共振周波数でのインピーダンス特性が調整されてアンテナ間の影響が取り除かれ、単純な構成で比較的近接した異なる周波数での使用が可能になる。

【００１０】また、本発明では、複数の周波数の電波を送信あるいは受信する携帯無線機において、異なる共振周波数を有する２つのアンテナ素子の給電点がそれぞれ、位相を変化させる２つの移相回路を介して無線回路と接続されることを特徴とするアンテナ装置を搭載する携帯無線機が提供される。

【００１１】このような携帯無線機では、搭載されたアンテナ装置において、アンテナ素子が移相回路を介して給電点に接続されることにより、隣接する他のアンテナ素子の共振周波数でのインピーダンス特性が調整されてアンテナ間の影響が取り除かれ、単純な装置構成で比較的近接した異なる周波数の電波の送信あるいは受信が可能となる。

【００１２】

【発明の実施の形態】以下、本発明の実施の形態を図面を参照して説明する。なお、以下の記述では特別に記述しない限り電波の送信時に関して説明を行うものとするが、アンテナ装置において送信と受信の動作は可逆な関係にあり、受信時に関しても同様の性質を有することは明らかである。

【００１３】図１に本発明のアンテナ装置の主な構成を示す。アンテナ装置１は、異なる共振周波数をもつ２つのアンテナ素子によって２波長の電波を送信し、主に携帯電話等の携帯型無線機に搭載されて使用されるが、これに限らず一般の無線装置に適用可能である。

【００１４】アンテナ装置１では、異なる周波数を共振周波数にもつ２つのアンテナ素子１１および１２が、それぞれの給電点において移相回路１３および１４に接続され、所定の２波長の電波を発生する発振器１５を含む無線回路と、この移相回路１３および１４が接続される。発振器１５によって発生された電力は単純に分岐、分配されて、それぞれ移相回路１３および１４を介してアンテナ素子１１および１２に供給される。移相回路１３及び１４は、集中定数回路あるいは分布定数回路で構成される。

【００１５】ここで、アンテナ素子１１の共振周波数をｆ１、アンテナ素子１２の共振周波数をｆ２とすると、移相回路１３は共振周波数ｆ２の電波に対して、また移相回路１４は共振周波数ｆ１の電波に対して、それぞれ所定量分だけ位相を変化させる。すなわち、アンテナ素子１１および１２についてはそれぞれのもつ共振周波数ｆ１およびｆ２で整合がとれており、それぞれの移相回路１３および１４は、他方の共振周波数ｆ２およびｆ１の電波が供給されたときに動作しないように実験的に求められた所定の量だけ位相を変化させる。

【００１６】この位相変化量の設定についてスミスチャートを用いて説明する。図２はアンテナ素子１１の入力インピーダンス特性例を示すスミスチャートであり、（ａ）は移相回路１３が接続されない場合、（ｂ）は移相回路１３が接続された場合を示す。また、図３はアンテナ素子１２の入力インピーダンス特性例を示すスミスチャートであり、（ａ）は移相回路１４が接続されない場合、（ｂ）は移相回路１４が接続された場合を示す。

【００１７】これらのスミスチャートは、入力インピーダンスを回路の特性インピーダンス５０Ωによって正規化した正規化インピーダンスについて、実数部を例えば図２（ａ）のレジスタンス線２１で、虚数部がリアクタンス線２２でそれぞれ表している。またこれらのスミスチャートでは、入力波の周波数を変化させたときの入力インピーダンス特性が図中に示された円状の軌跡で表されており、時計回りに周波数を上昇させたときの記録が示されている。

【００１８】アンテナ素子１１単体での入力インピーダンス特性は、図２（ａ）で矢印によって示された共振周波数ｆ１のときにチャートのほぼ中央部となり、整合がとれている。このアンテナ素子１１から移相回路１３によって位相変化量ｄφ１だけ変化した状態が図２（ｂ）であり、チャート上ではｆ１の位置を変えずにｆ２の位置が位相変化量ｄφ１分だけ回転されて表されている。すなわち図２（ｂ）では、移相回路１３によって、入射波の周波数がｆ１のときの整合が保たれたまま、ｆ１のときと比較してｆ２のときの入力インピーダンスが十分高くなっており、ｆ２のときにアンテナ素子１１が動作しないように位相変化量ｄφ１が設定されていることがわかる。

【００１９】また同様に、図３（ａ）ではアンテナ１２の共振周波数ｆ２のときに整合がとれているが、図３（ｂ）ではチャート上でのｆ２の位置を変えずにｆ１の位置が位相変化量ｄφ２分だけ回転されて表され、移相回路１４によって、入射波の周波数がｆ２のときの整合が保たれたまま、ｆ１での入力インピーダンスが十分高くなるように位相変化量ｄφ２が設定されていることがわかる。

【００２０】このように、移相回路による位相変化によって、近接する他方のアンテナ素子の共振周波数での入力インピーダンスが十分大きくなるので、アンテナ素子

の動作周波数による互いの影響を非常に小さくすることができ、両アンテナ素子を並列接続させるという単純な構造で、２つの周波数で動作が可能なアンテナ装置を実現することができる。

【００２１】次に、上記のアンテナ装置１で使用される移相回路の例を示す。図４および図５に集中定数回路によって構成される移相回路の例を示す。図４は＋（正）の位相変化量を実現する移相回路であり、図５は－（負）の位相変化量を実現する移相回路である。また、図６、図７および図８に分布定数回路によって構成される移相回路の例を示す。図６は同軸線路、図７は平行２線路、図８はマイクロストリップ線路である。

【００２２】集中定数回路による移相回路の例として、図４では、直列にインダクタ４１が接続され、並列にコンデンサ４２および４３が接続されている。ここで、図２（ａ）のスミスチャートにおいて移相の変化を考えてみると、直列にインダクタ４１が挿入されると、インピーダンス特性の軌跡はレジスタンス線２１に沿って時計回りに移動する。また、チャート上にレジスタンス線２１と左右対称に描かれる図示しないコンダクタンス線を考えると（イミタンスチャート）、コンデンサ４２および４３が並列に挿入されると、軌跡はコンダクタンス線に沿って時計回りに移動する。つまり、この移相回路によって入射波の位相が正方向に移動していることがわかる。

【００２３】また、図５では、直列にコンデンサ５１が接続され、並列にインダクタ５２および５３が接続されている。同様にスミスチャートで考えてみると、直列にコンデンサ５１が挿入されると、軌跡はレジスタンス線２１に沿って反時計回りに移動する。また、並列にインダクタ５２および５３が挿入されると、軌跡はコンダクタンス線に沿って反時計回りに移動する。つまり、この移相回路によって入射波の位相が負方向に移動していることがわかる。

【００２４】一方、移相回路として用いる分布定数回路として、図６の同軸線路、図７の平行２線路、図８のマイクロストリップ線路等が適用可能である。図６の同軸線路は、内部導体６１と図示しない外部導体と、これを支持する誘電体６２で構成される。一般に外部導体は編み組み線で、内部導体６１は単線またはより線であり、誘電体６２としてはポリエチレン等が充填される。また、図７の平行２線路は、短波帯の送受信用やテレビの給電線として一般に用いられているもので、構造が簡単でコストが安いが、線路間の電波の放射がみられ、同軸線路と比較して誘導妨害や放射損がきわめて大きい。また、図８のマイクロストリップ線路は、平板上の導体８１上に誘電体８２と導体８３が構成されている。

【００２５】図６、図７および図８中にはそれぞれの回路の通過後の位相変化量ｄφを求める式を示したが、これらの式のように分布定数回路では、信号が通過する伝送線路の物理的な長さしを変えることによって通過後の信号の位相を変えている。それぞれの伝送線路では導体の太さ、厚さや誘電体の比誘電率εｒ等によって回路の物理的長さと回路内での電気的長さの関係が異なるが、位相変化の効果としてはどの回路を用いても得ることができる。しかし、基板上に実装できるという構造上の利点や、製造コストの低さから、携帯型無線機に用いる場合の移相回路としてはマイクロストリップ線路が最も適すると考えられる。

【００２６】次に、図９および図１０に、アンテナ素子１１および１２を合わせた総合のインピーダンス特性について、また図１１および図１２にリターンロス特性について、それぞれ回路シミュレーションによって求めた計算値例を示す。図９は移相回路１３および１４が接続された場合、図１０は移相回路１３および１４が接続されない場合の入力インピーダンス特性であり、また、図１１は移相回路１３および１４が接続された場合、図１２は移相回路１３および１４が接続されない場合のリターンロス特性である。

【００２７】なお、図９、図１０、図１１および図１２の値を求めたシミュレーションでは移相回路として分布定数回路を用いており、周波数を１ＧＨｚから３ＧＨｚまで変化させたときの特性を記録している。アンテナ素子１１および１２の共振周波数ｆ１、ｆ２をそれぞれ１．９５ＧＨｚ、２．１４ＧＨｚとし、図中でこれらの周波数のときの計測点をそれぞれＭ１、Ｍ２で示しており、計測点Ｍ１、Ｍ２の入力インピーダンスの計測値をＺ１、Ｚ２で、リターンロスの計測値をＲＬ１、ＲＬ２でそれぞれ示している。

【００２８】図９では、周波数がｆ１、ｆ２のときにほぼチャートの中心にあって、この周波数のときほぼ整合がとれており、また、図１１ではｆ１、ｆ２以外の部分で損失が明らかに高くなっている。しかし、図１０では動作周波数での整合がとれていない状態であり、図１２では動作周波数での損失が大きい。したがって、移相回路１３および１４の接続によってアンテナ素子間の影響が抑制され、良好な２周波動作特性が得られている。このようにアンテナ装置１は、単純な装置構成でありながらも、近接した２つの周波数での使用に対して良好な動作特性を有する。また、同様の装置構成により離れた２つの周波数を選んで動作させることも当然可能である。

【００２９】なお、上記のアンテナ装置１において、移相回路で変化させる位相変化量を上記で設定された位相変化量にｎλ／２（λは隣接するアンテナ素子の使用波の波長、ｎは整数）を加えた場合でも、アンテナの性質から理論的には明らかに上記と同様の動作が可能である。このことは例えば、図２（ｂ）および図３（ｂ）で、スミスチャートの外周円の目盛りは１周で波数０．５であり、図の測定線を１回転しても元の図での位置と同じになることからも明らかである。しかし実際の回路

では、｜ｎ｜が増加するにつれて損失が増加し、これにともなって使用可能な周波数帯域が減少する等の問題が生じるため、ｎを極力小さくすることが望ましい。

【００３０】また、上記ではアンテナ素子を２つ用いたアンテナ装置について説明したが、２つ以上の複数のアンテナ素子を用いて同様に、移相回路が接続されたアンテナ素子を並列に無線回路に接続することによって、複数の周波数での動作が可能なアンテナ装置を実現することができる。このようなアンテナ装置１で動作可能な周波数の数は、アンテナ素子の周波数特性および移相回路の周波数特性によって決定され、本質的に動作周波数の数に制限はない。しかし、実際には４周波数程度での動作が上限ということができ、例えばこのようなアンテナ装置の場合、あるアンテナ素子において、これに接続する移相回路の対象の周波数は、他のアンテナ素子の動作周波数の中から１つが選ばれることになり、これ以外のアンテナ素子の動作周波数においては必ずしも良好なインピーダンス特性を得られるとは限らず、動作可能な周波数自体が限定されることも考えられる。

【００３１】次に、図１３、図１４、図１５、図１６および図１７に、本発明のアンテナ装置に適用可能なアンテナ素子の例を示す。図１３はダイポールアンテナ、図１４はループアンテナ、図１５は板状逆Ｆアンテナ、図１６は逆Ｌアンテナ、図１７はヘリカルアンテナである。

【００３２】図１３のダイポールアンテナを用いた例では、共振波の波長をλとすると、ダイポールアンテナ１３１および１３２の長さは通常λ／２に選ばれるが、アンテナ長をこれより短くするときは整合がとれない場合があるため、その際は移相回路１３および１４との間に整合回路１７および１８が接続される。また、無線回路１６は通常、回路の一端が接地された不平衡回路であり、ダイポールアンテナは平衡型アンテナであるので、これらを直接接続すると不平衡電流が流れて電力の損失が生じるため、平衡不平衡変換回路（Balun：a balance to unbalance transformer）１９の接続が必要である。このダイポールアンテナの一種で、先端給電型であるホイップアンテナは、車載用や携帯無線機に一般的に使用されており、本発明のアンテナ装置をこれらの機器に搭載する際のアンテナ素子として好適である。

【００３３】また、図１４のループアンテナ１４１および１４２では、通常直径が１波長以下に選ばれ、これ以下の場合には各アンテナ素子と移相回路１３および１４の間に整合回路１７および１８が接続される。またループアンテナは平衡型アンテナであるので、無線回路１６との間に平衡不平衡変換回路１９の接続が必要である。

【００３４】また、図１５の板状逆Ｆアンテナ１５１および１５２は、不平衡アンテナであるので平衡不平衡変換回路は不要で、無線回路１６と移相回路１３および１４を直接接続することができ、アンテナ自体で整合が可能であるので、整合回路を接続する必要もない。この板状逆Ｆアンテナやこれを応用したアンテナ素子は、携帯電話機用の内蔵アンテナ等に使用されており、本発明のアンテナ装置を携帯電話機に搭載する際のアンテナ素子として好適である。

【００３５】また、図１６の逆Ｌアンテナ１６１および１６２は不平衡型のアンテナ素子で、モノポールアンテナを低姿勢化するために折り曲げた構造をしており、通常は別途整合回路１７および１８の接続を必要とする。

【００３６】また、図１７のヘリカルアンテナ１７１および１７２は、不平衡型のらせん状のアンテナ素子で、らせんの直径や長さによって指向性アンテナや水平方向無指向性アンテナとして用いられることがある。通常は移相回路１３および１４との間に整合回路１７および１８が接続される。

【００３７】

【発明の効果】以上説明したように、本発明のアンテナ装置では、アンテナ素子を移相回路を介して給電点に接続することにより、隣接する他のアンテナ素子の共振周波数でのインピーダンス特性が調整されてアンテナ間の影響が取り除かれ、単純な構成で比較的近接した異なる周波数での使用が可能になる。

【００３８】また、本発明の携帯無線機では、搭載されたアンテナ装置において、アンテナ素子が移相回路を介して給電点に接続されることにより、隣接する他のアンテナ素子の共振周波数でのインピーダンス特性が調整されてアンテナ間の影響が取り除かれ、単純な装置構成で比較的近接した異なる周波数の電波の送信あるいは受信が可能となる。

【図面の簡単な説明】

【図１】本発明のアンテナ装置の主な構成を示す図である。

【図２】共振周波数がｆ１のアンテナ素子の入力インピーダンス特性例を示すスミスチャートであり、（ａ）は移相回路が接続されない場合、（ｂ）は移相回路が接続された場合を示す。

【図３】共振周波数がｆ２のアンテナ素子の入力インピーダンス特性例を示すスミスチャートであり、（ａ）は移相回路が接続されない場合、（ｂ）は移相回路が接続された場合を示す。

【図４】集中定数回路によって構成される移相回路の例であり、正の位相変化量を実現する移相回路を示す図である。

【図５】集中定数回路によって構成される移相回路の例であり、負の位相変化量を実現する移相回路を示す図である。

【図６】分布定数回路によって構成される移相回路の例であり、同軸線路を示す図である。

【図７】分布定数回路によって構成される移相回路の例であり、平行２線路を示す図である。

9

【図８】分布定数回路によって構成される移相回路の例であり、マイクロストリップ線路を示す図である。

【図９】移相回路が接続された場合の入力インピーダンス特性を示すスミスチャートである。

【図１０】移相回路が接続されない場合の入力インピーダンス特性を示すスミスチャートである。

【図１１】移相回路が接続された場合のリターンロス特性を示す図である。

【図１２】移相回路が接続されない場合のリターンロス特性を示す図である。

【図１３】本発明のアンテナ装置に適用可能なアンテナ素子の例であるダイポールアンテナを示す図である。

【図１４】本発明のアンテナ装置に適用可能なアンテナ素子の例であるループアンテナを示す図である。

10

＊【図１５】本発明のアンテナ装置に適用可能なアンテナ素子の例である板状逆Ｆアンテナを示す図である。

【図１６】本発明のアンテナ装置に適用可能なアンテナ素子の例である逆Ｌアンテナを示す図である。

【図１７】本発明のアンテナ装置に適用可能なアンテナ素子の例であるヘリカルアンテナを示す図である。

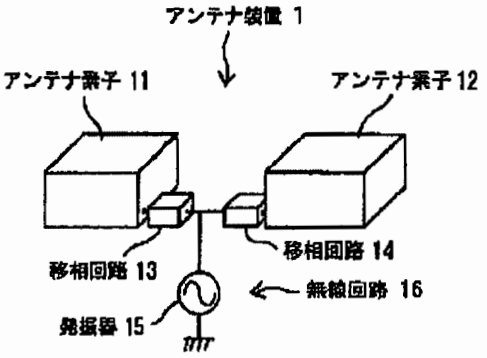
【図１８】複数の周波数で使用可能な無給電素子を使用したアンテナの例を示す図である。

【図１９】複数の周波数で使用可能な複数の放射導体を使用したアンテナの例を示す図である。

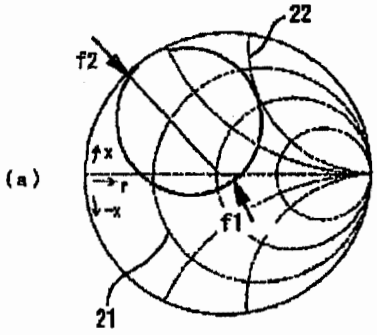
【符号の説明】

１……アンテナ装置、１１、１２……アンテナ素子、１３、１４……移相回路、１５……発振器、１６……無線回路

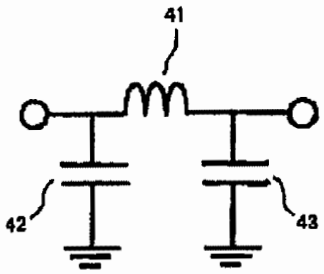
【図１】



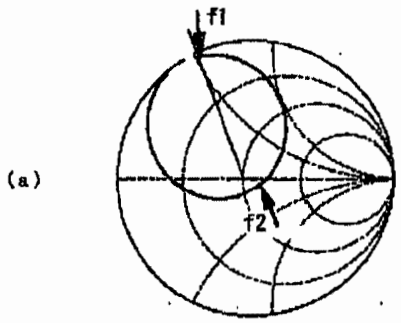
【図２】

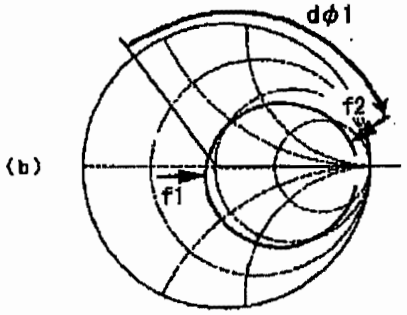


【図４】

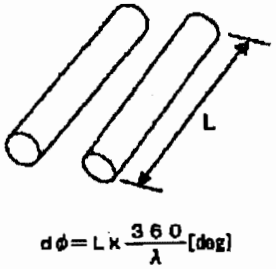


【図３】

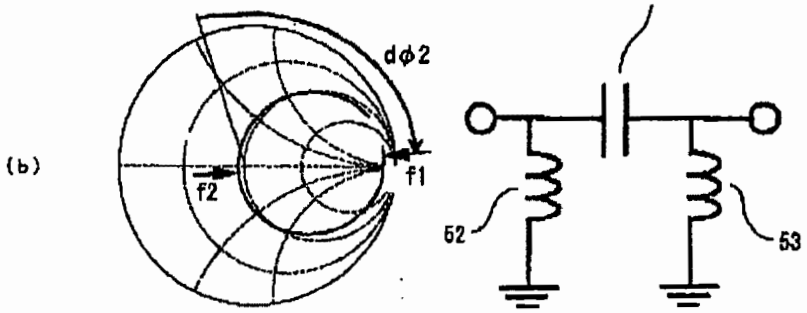




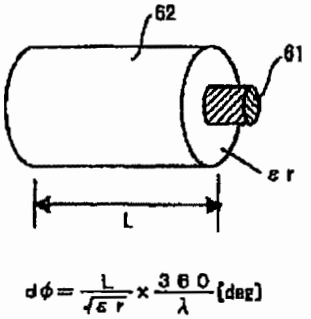
【図７】



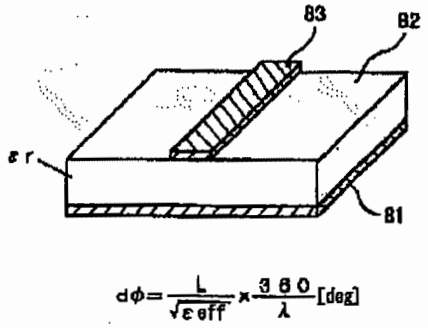
【図５】



【図６】

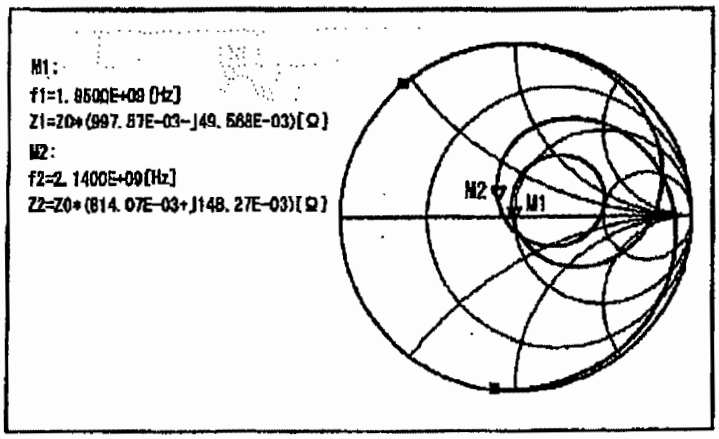


【図８】



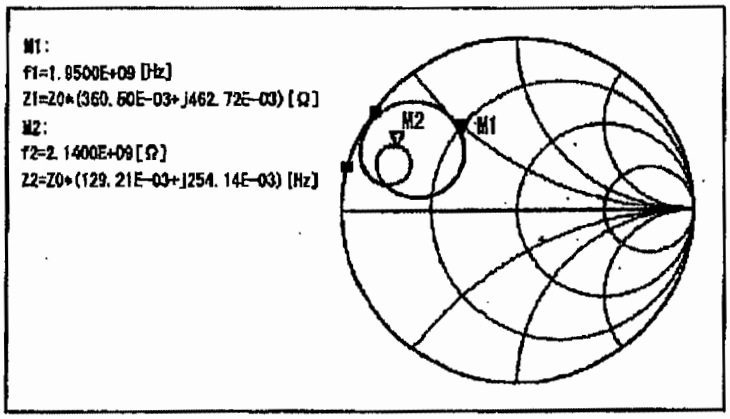
$$d\phi = \frac{L}{\sqrt{\varepsilon eff}} \times \frac{360}{\lambda} [deg]$$

【図９】



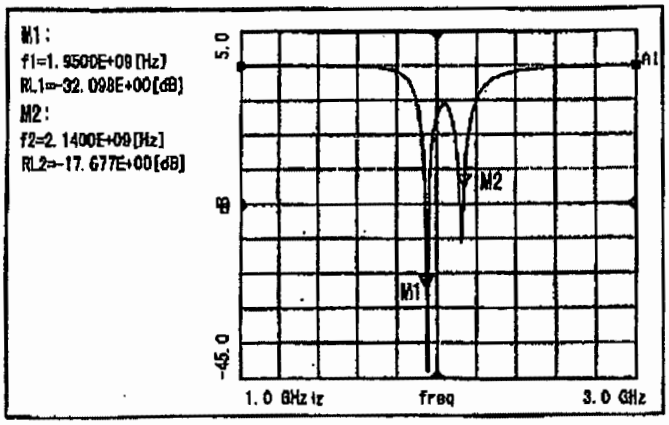
移相回路が接続された場合の入力インピーダンス特性

【図１０】



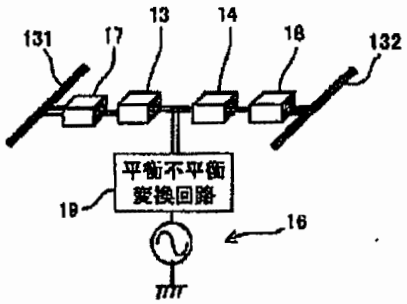
移相回路が接続されない場合の入力インピーダンス特性

【図１１】

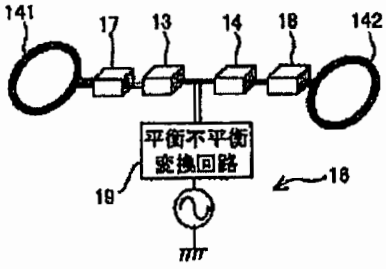


移相回路が接続された場合のリターンロス特性

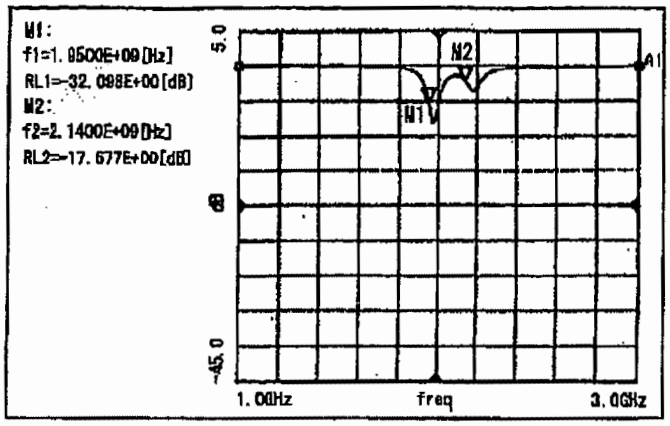
【図１３】



【図１４】

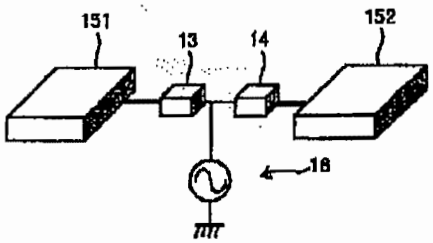


【図１２】

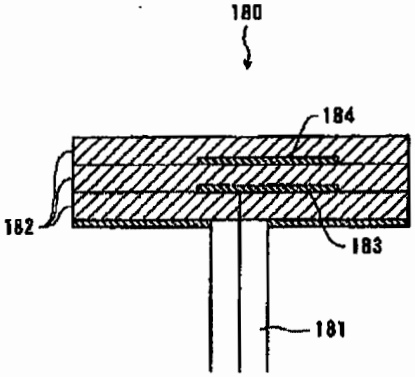


移相回路が損失されない場合のリターンロス特性

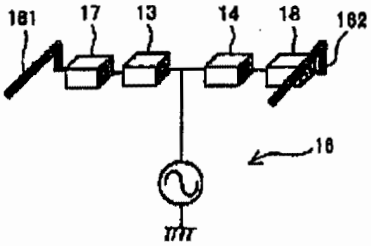
【図１５】



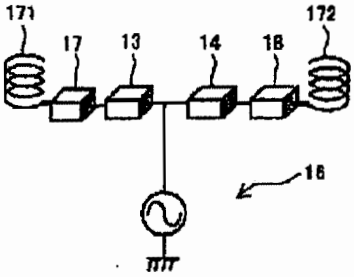
【図１８】



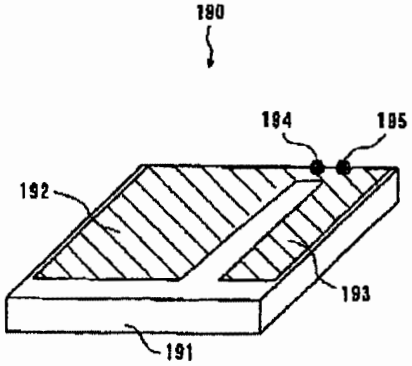
【図１６】



【図１７】



【図１９】



⑲日本国特許庁(JP)　⑪実用新案出願公開

⑫公開実用新案公報(U)　平2-811

⑤Int.Cl.'	識別記号	庁内整理番号	⑬公開　平成2年(1990)1月5日
H 01 Q 1/32	A	6751-5J	
1/50		6751-5J	
5/01		7210-5J	

審査請求　未請求　請求項の数 1　(全3頁)

⑭考案の名称　無給電素子付自動車用ガラスアンテナ

⑳実　願　昭63-78379
㉒出　願　昭63(1988)6月13日

㉑考案者　大江　幸三　愛知県豊田市トヨタ町1番地　トヨタ自動車株式会社内
㉑考案者　西岸田　道彦　愛知県豊田市トヨタ町1番地　トヨタ自動車株式会社内
㉑考案者　鈴木　正浩　愛知県豊田市トヨタ町1番地　トヨタ自動車株式会社内
㉑出願人　トヨタ自動車株式会社　愛知県豊田市トヨタ町1番地
㉔代理人　弁理士　吉田　研二

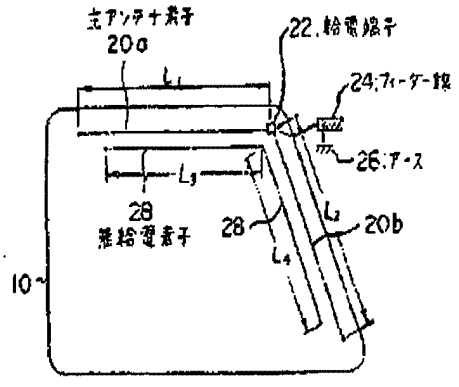
㉑実用新案登録請求の範囲

アンテナフィーダ給接続用の給電端子を有し所定帯域の受信を行う主アンテナ素子と、この主アンテナ素子と電磁結合するように主アンテナ素子に沿って近接配置され広帯域の受信を行うために主アンテナ素子の受信帯域からシフトした帯域の受信を行う無給電素子と、から構成された無給電素子付自動車用ガラスアンテナ。

図面の簡単な説明

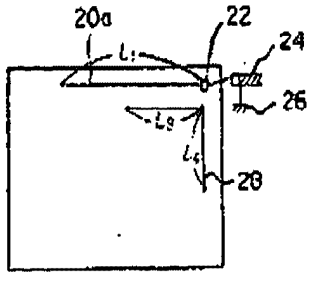
第1図は本考案に係る無給電素子付自動車用ガラスアンテナの好適な第1実施例を示す構成図、第2図～第4図は本考案のアンテナで得られる電流分布を示す説明図、第5図は同一受信帯域で広帯域化を図る場合のアンテナ感度特性を示すグラフ図、第6図及び第7図は異なる受信帯域に亘って広帯域化を図る場合のアンテナ感度特性を示すグラフ図、第8図は本考案の第2実施例を示す構成図、第9図は本考案の第3実施例を示す構成図、第10図は本考案の第4実施例を示す構成図、第11図は本考案の第5実施例を示す構成図、第12図は従来のアンテナの設置位置及びその構成を示す図、第13図は従来のアンテナにおいて分離アンテナを設けた場合の構成を示す図である。

10…サイドウインドガラス、12…アンテナ素子、14，22…給電端子、16…分離アンテナ、20…主アンテナ素子、24…同軸ケーブル、28…無給電素子。

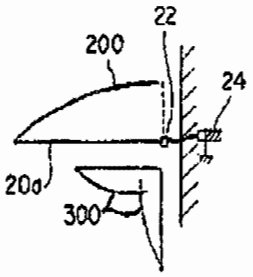


第1実施例の構成図

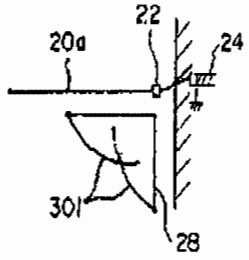
第 1 図



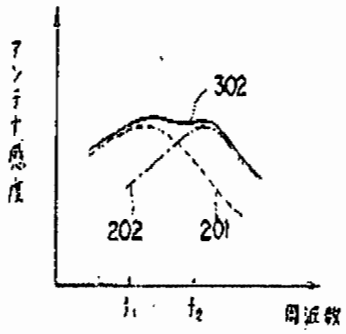
第 2 図



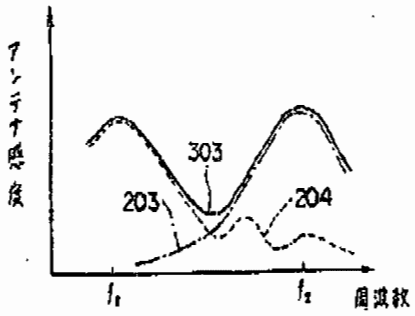
第 3 図



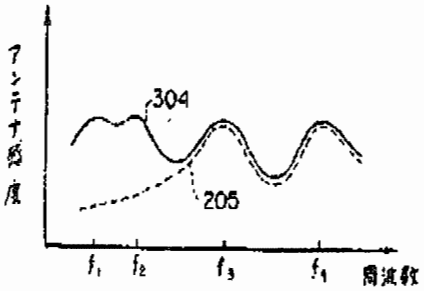
第 4 図



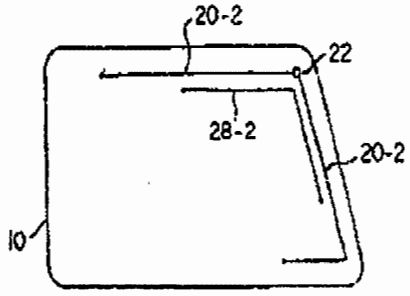
第 5 図



第 6 図

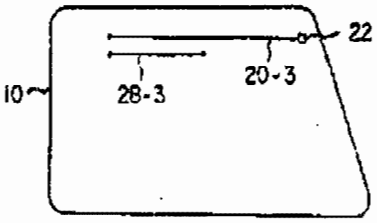


第 7 図



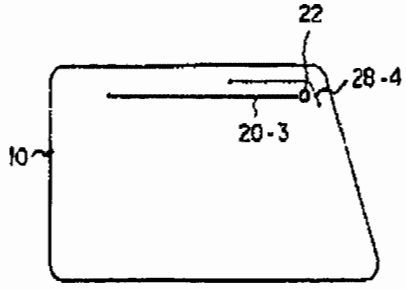
第2実施例の構成図

第 8 図



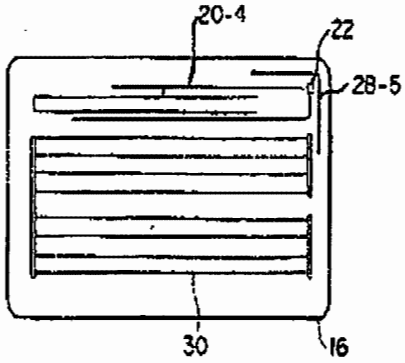
第3実施例の構成図

第 9 図



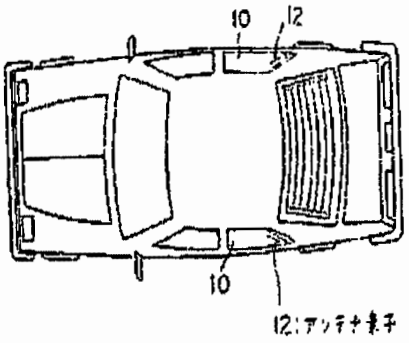
第4実施例の構成図

第 10 図

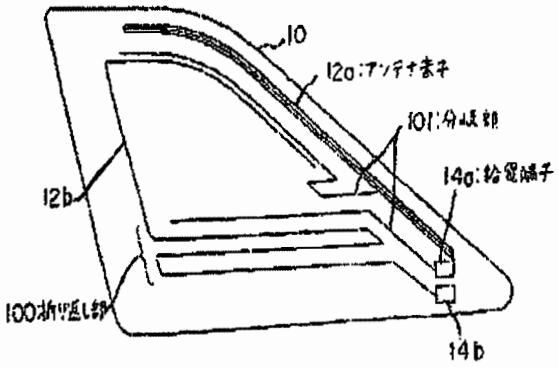


第5実施例の構成図

第 11 図



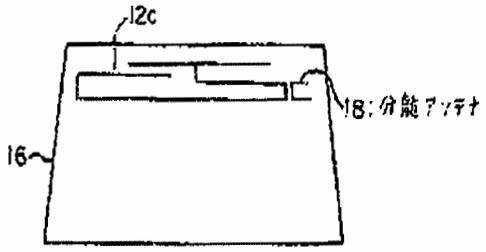
(a)



(b)

従来のアンテナの構成図

第 12 図



分離アンテナを設けた従来アンテナの図

第 13 図

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 223 637 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
30.03.2005 Bulletin 2005/13

(21) Application number: **99974041.8**

(22) Date of filing: **20.09.1999**

(51) Int Cl.[7]: **H01Q 1/36**, H01Q 5/00

(86) International application number:
PCT/ES1999/000296

(87) International publication number:
WO 2001/022528 (29.03.2001 Gazette 2001/13)

(54) MULTILEVEL ANTENNAE

MEHREBENENANTENNE

ANTENNES MULTINIVEAU

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(43) Date of publication of application:
17.07.2002 Bulletin 2002/29

(60) Divisional application:
05000379.7

(73) Proprietor: **Fractus, S.A.**
08190 Sant Cugat del Valles (Barcelona) (ES)

(72) Inventors:
- **PUENTE BALIARDA, Carles,**
  Avda Alcalde Barnils64-68
  E-08190 St Cugat Del Valles (BARCELONA) (ES)
- **BORJA BORAU, Carmen,**
  Avda Alcalde Barnils 64-68
  E-08190 St Cugat Del Valles (BARCELONA) (ES)
- **ANGUERA PROS, Jaume,**
  Avda Alcalde Barnils 64-68
  E-08190 St Cugat Del Valles (BARCELONA) (ES)
- **SOLER CASTANY, Jordi,**
  Avda Alcalde Barnils 64-68
  E-08190 St Cugat Del Valles (BARCELONA) (ES)

(74) Representative: **Carpintero Lopez, Francisco**
Herrero & Asociados, S.L.,
Alcalá, 35
28014 Madrid (ES)

(56) References cited:
WO-A-97/06578 **ES-A- 2 112 163**
US-A- 4 907 011

- **HOHFELD R.G. AND COHEN N.: 'Self-similarity and the geometric requirements for frequency independence in antennae' WORD SCIENTIFIC, FRACTALS vol. 7, no. 1, March 1999, pages 79 - 84**
- **JAGGARD D.L.: 'Fractal electrodynamics and modeling. Directions in electromagnetic wave modeling' PROCEEDINGS OF THE INTERNATIONAL CONFERENCE. BERTONI & FELSEN 1991, NEW YORK, USA, pages 435 - 446**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 223 637 B1

Description

OBJECT OF THE INVENTION

[0001] The present invention relates to antennae formed by sets of similar geometrical elements (polygons, polyhedrons electro magnetically coupled and grouped such that in the antenna structure may be distinguished each of the basic elements which form it.

[0002] More specifically, it relates to a specific geometrical design of said antennae by which two main advantages are provided: the antenna may operate simultaneously in several frequencies and/or its size can be substantially reduced.

[0003] The scope of application of the present invention is mainly within the field of telecommunications, and more specifically in the field of radio-communication.

BACKGROUND AND SUMMARY OF THE INVENTION

[0004] Antennae were first developed towards the end of the past century, when James C. Maxwell in 1864 postulated the fundamental laws of electromagnetism. Heinrich Hertz may be attributed in 1886 with the invention of the first antenna by which transmission in air of electromagnetic waves was demonstrated. In the mid forties were shown the fundamental restrictions of antennae as regards the reduction of their size relative to wavelength, and at the start of the sixties the first frequency-independent antennae appeared. At that time helixes, spirals, logoperiodic groupings, cones and structures defined solely by angles were proposed for construction of wide band antennae.

[0005] In 1995 the Spanish Patent nº 9501019 (publication number nº 2.112.163) introduced the fractal or multifractal type antennae), which due to their geometry presented a multifrequency behavior and in certain cases a small size. In this patent the antenna is designed according to the principles of fractal geometry, in which the antenna has a self-similar structure resulting from the repetition of a geometrical motif or generator.

[0006] Later were introduced multitriangular antennae (Patent nº 9800954) which operated simultaneously in bands GSM 900 and GSM 1800.

[0007] The antennae described in the present patent starting from fractal and multitriangular type antennae, depart from those geometries to solve several problems of a practical nature which limit the behavior of said antennae and reduce their applicability in real environments.

[0008] From a scientific standpoint strictly fractal antennae are impossible, as fractal objects are a mathematical abstraction which include an infinite number of elements. It is possible to generate antennae with a form based on said fractal objects, incorporating a finite number of iterations. The performance of such antennae is limited to the specific geometry of each one. For example, the position of the bands and their relative spacing is related to fractal geometry and it is not always possible, viable or economic to design the antennae maintaining its fractal appearance and at the same time placing the bands at the correct area of the radioelectric spectrum. To begin, truncation implies a clear example of the limitations brought about by using a real fractal type antenna which attempts to approximate the theoretical behavior of an ideal fractal antenna. Said effect breaks the behavior of the ideal fractal structure in the lower band, displacing it from its theoretical position relative to the other bands and in short requiring a too large size for the antenna which hinders practical applications.

[0009] In addition to such practical problems, it is not always possible to alter the fractal structure to present the level of impedance of radiation diagram which is suited to the requirements of each application. Due to these reasons, it is often necessary to leave the fractal geometry and resort to other types of geometries which offer a greater flexibility as regards the position of frequency bands of the antennae, adaptation levels and impedances, polarization and radiation diagrams.

[0010] Multitriangular structures (Patent nº 9800954) were an example of non-fractal structures with a geometry designed such that the antennae could be used in base stations of GSM and DCS cellular telephony. Antennae described in said patent consisted of three triangles joined only at their vertices, of a size adequate for use in bands 890 MHz - 960 MHz and 1710 MHz - 1880 MHz. This was a specific solution for a specific environment which did not provide the flexibility and versatility required to deal with other antennae designs for other environments.

[0011] These problems are solved by an antenna according to claim 1. Their geometry is much more flexible, rich and varied, allowing operation of the antenna from two to many more bands, as well as providing a greater versatility as regards diagrams, band positions and impedance levels, to name a few examples. Although they are not fractal, multilevel antennae are characterised in that they comprise a number of elements which may be distinguished in the overall structure. Precisely because they clearly show several levels of detail (that of the overall structure and that of the individual elements which make it up), antennae provide a multiband behavior and/or a small size. The origin of their name also lies in said property.

[0012] The present invention consists of an antenna whose radiating element is characterised by its geometrical shape, which basically comprises several polygons or polyhedrons of the same type. That is, it comprises for example triangles, squares, pentagons, hexagons or even circles and ellipses as a limiting case of a polygon with a large number of sides, as well as tetrahedra, hexahedra, prisms, dodecahedra, etc. coupled to each other electrically (either through at least one point of contact o through a small separation providing a capacitive coupling) and grouped in structures of a higher level such

that in the body of the antenna can be identified the polygonal or polyhedral elements which it comprises. In turn, structures generated in this manner can be grouped in higher order structures in a manner similar to the basic elements, and so on until reaching as many levels as the antenna designer desires.

[0013] Its designation as multilevel antenna is precisely due to the fact that in the body of the antenna can be identified at least two levels of detail: that of the overall structure and that of the majority of the elements (polygons or polyhedrons) which make it up. This is achieved by ensuring that the area of contact or intersection (if it exists) between the majority of the elements forming the antenna is only a fraction of the perimeter or surrounding area of said polygons or polyhedrons.

[0014] A particular property of multilevel antennae is that their radioelectric behavior can be similar in several frequency bands. Antenna input parameters (impedance and radiation diagram) remain similar for several frequency bands (that is, the antenna has the same level of adaptation or standing wave relationship in each different band), and often the antenna presents almost identical radiation diagrams at different frequencies. This is due precisely to the multilevel structure of the antenna, that is, to the fact that it remains possible to identify in the antenna the majority of basic elements (same type polygons or polyhedrons) which make it up. The number of frequency bands is proportional to the number of scales or sizes of the polygonal elements or similar sets in which they are grouped contained in the geometry of the main radiating element.

[0015] In addition to their multiband behavior, multilevel structure antennae usually have a smaller than usual size as compared to other antennae of a simpler structure. (Such as those consisting of a single polygon or polyhedron). This is because the path followed by the electric current on the multilevel structure is longer and more winding than in a simple geometry, due to the empty spaces between the various polygon or polyhedron elements. Said empty spaces force a given path for the current (which must circumvent said spaces) which travels a greater distance and therefore resonates at a lower frequency. Additionally, its edge-rich and discontinuity-rich structure simplifies the radiation process, relatively increasing the radiation resistance of the antenna and reducing the quality factor Q, i.e. increasing its bandwidth.

[0016] Therefore, a multilevel antenna has a small size compared to circular, square or triangular antenna whose perimeter can be circumscribed in the multilevel structure and which operates in the same frequency of resonance.

[0017] Thus, the main characteristic of multilevel antennae are the following:

- A multilevel geometry comprising polygon or polyhedron of the same class, electromagnetically coupled and grouped to form a larger structure. In multilevel geometry most of these elements are clearly visible as their area of contact, intersection or interconnection (if these exist) with other elements is always less than 50% of their perimeter.

- The radioelectric behavior resulting from the geometry: multilevel antennae can present a multiband behavior (identical or similar for several frequency bands) and/or operate at a reduced frequency, which allows to reduce their size.

[0018] In specialized literature it is already possible to find descriptions of certain antennae designs which allow to cover a few bands. However, in these designs the multiband behavior is achieved by grouping several single band antennae or by incorporating reactive elements in the antennae (concentrated elements as inductors or capacitors or their integrated versions such as posts or notches) which force the apparition of new resonance frequencies. Multilevel antennae on the contrary base their behavior on their particular geometry, offering a greater flexibility to the antenna designer as to the number of bands (proportional to the number of levels of detail), position, relative spacing and width, and thereby offer better and more varied characteristics for the final product.

[0019] A multilevel structure can be used in any known antenna configuration. As a nonlimiting example can be cited: dipoles, monopoles, patch or microstrip antennae, coplanar antennae, reflector antennae, wound antennae or even antenna arrays. Manufacturing techniques are also not characteristic of multilevel antennae as the best suited technique may be used for each structure or application. For example: printing on dielectric substrate by photolithography (printed circuit technique); dieing on metal plate, repulsion on dielectric, etc.

[0020] Publication WO 97/06578 discloses a fractal antenna for a cellular telephone.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Further characteristics and advantages of the invention will become apparent in view of the detailed description which follows of a preferred embodiment of the invention given for purposes of illustration only and in no way meant as a definition of the limits of the invention, made with reference to the accompanying drawings, in which:

Figure 1 shows a specific example of a multilevel element comprising only triangular polygons.

Figure 2 shows examples of assemblies of multilevel antennae in several configurations: monopole (2.1), dipole (2.2), patch (2.3), coplanar antennae (2.4), horn (2.5-2.6) and array (2.7).

Figure 3 shows examples of multilevel structures based on triangles.

Figure 4 shows examples of multilevel structures based on parallelepipeds.

Figure 5 examples of multilevel structures based on pentagons.

Figure 6 shows of multilevel structures based on hexagons.

Figure 7 shows of multilevel structures based on polyhedrons.

Figure 8 shows an example of a specific operational mode for a multilevel antenna in a patch configuration for base stations of GSM (900 MHz) and DCS (1800 MHz)cellular telephony.

Figure 9 shows input parameters (return loss on 50 ohms) for the multilevel antenna described in the previous figure.

Figure 10 shows radiation diagrams for the multilevel antenna of figure 8: horizontal and vertical planes.

Figure 11 shows an example of a specific operation mode for a multilevel antenna in a monopole construction for indoors wireless communication systems or in radio-accessed local network environments.

Figure 12 shows input parameters (return loss on 50 ohms) for the multilevel antenna of the previous figure.

Figure 13 shows radiation diagrams for the multilevel antenna of figure 11.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

[0022] In the detailed description which follows f a preferred embodiment of the present invention permanent reference is made to the figures of the drawings, where the same numerals refer to the identical or similar parts.

[0023] The present invention relates to an antenna which includes at least one construction element in a multilevel structure form. A multilevel structure is characterized in that it is formed by gathering several polygon or polyhedron of the same type (for example triangles, parallelepipeds, pentagons, hexagons, etc., even circles or ellipses as special limiting cases of a polygon with a large number of sides, as well as tetrahedra, hexahedra, prisms, dodecahedra, etc. coupled to each other electromagnetically, whether by proximity or by direct contact between elements. A multilevel structure or figure is distinguished from another conventional figure precisely by the interconnection (if it exists) between its component elements (the polygon or polyhedron). In a multilevel structure at least 75% of its component elements have more than 50% of their perimeter (for polygons) not in contact with any of the other elements of the structure. Thus, in a multilevel structure it is easy to identify geometrically and individually distinguish most of its basic component elements, presenting at least two levels of detail: that of the overall structure and that of the polygon or polyhedron elements which form it. Its name is precisely due to this characteristic and from the fact that the polygon or polyhedron can be included in a great variety of sizes. Additionally, several multilevel structures may be grouped and coupled electromagnetically to each other to form higher level structures. In a multilevel structure all the component elements are polygons with the same number of sides or polyhedron with the same number of faces. Naturally, this property is broken when several multilevel structures of different natures are grouped and electromagnetically coupled to form meta-structures of a higher level.

[0024] In this manner, in figures 1 to 7 are shown a few specific examples of multilevel structures.

Figure 1 shows a multilevel element exclusively consisting of triangles of various sizes and shapes. Note that in this particular case each and every one of the elements (triangles, in black) can be distinguished, as the triangles only overlap in a small area of their perimeter, in this case at their vertices.

Figure 2 shows examples of assemblies of multilevel antennae in various configurations: monopole (21), dipole (22), patch (23), coplanar antennae (24), coil in a side view (25) and front view (26) and array (27). With this it should be remarked that regardless of its configuration the multilevel antenna is different from other antennae in the geometry of its characteristic radiant element.

Figure 3 shows further examples of multilevel structures (3.3-3.15) with a triangular origin, all comprised of triangles. Note that case (3.14) is an evolution of case (3.13); despite the contact between the 4 triangles, 75% of the elements (three triangles, except the central one) have more than 50% of the perimeter free.

Figure 4 describes multilevel structures (4.4-4.14) formed by parallelepipeds (squares, rectangles, rhombi...). Note that the component elements are always individually identifiable (at least most of them are).

Figures 5, 6 and 7 show non limiting examples of other multilevel structures based on pentagons,

hexagons and polyhedron respectively.

[0025] It should be remarked that the difference between multilevel antennae and other existing antennae lies in the particular geometry, not in their configuration as an antenna or in the materials used for construction. Thus, the multilevel structure may be used with any known antenna configuration, such as for example and in a non limiting manner: dipoles, monopoles, patch or microstrip antennae, coplanar antennae, reflector antennae, wound antennae or even in arrays. In general, the multilevel structure forms part of the radiative element characteristic of said configurations, such as the arm, the mass plane or both in a monopole, an arm or both in a dipole, the patch or printed element in a microstrip, patch or coplanar antenna; the reflector for an reflector antenna, or the conical section or even antenna walls in a horn type antenna. It is even possible to use a spiral type antenna configuration in which the geometry of the loop or loops is the outer perimeter of a multilevel structure. In all, the difference between a multilevel antenna and a conventional one lies in the geometry of the radiative element or one of its components, and not in its specific configuration.

[0026] As regards construction materials and technology, the implementation of multilevel antennae is not limited to any of these in particular and any of the existing or future techniques may be employed as considered best suited for each application, as the essence of the invention is found in the geometry used in the multilevel structure and not in the specific configuration. Thus, the multilevel structure may for example be formed by sheets, parts of conducting or superconducting material, by printing in dielectric substrates (rigid or flexible) with a metallic coating as with printed circuits, by imbrications of several dielectric materials which form the multilevel structure, etc. always depending on the specific requirements of each case and application. Once the multilevel structure is formed the implementation of the antenna depends on the chosen configuration (monopole, dipole, patch, horn, reflector...). For monopole, spiral, dipole and patch antennae the multisimilar structure is implemented on a metal support (a simple procedure involves applying a photolithography process to a virgin printed circuit dielectric plate) and the structure is mounted on a standard microwave connector, which for the monopole or patch cases is in turn connected to a mass plane (typically a metal plate or case) as for any conventional antenna. For the dipole case two identical multilevel structures form the two arms of the antenna; in an opening antenna the multilevel geometry may be part of the metal wall of a horn or its cross section, and finally for a reflector the multisimilar element or a set of these may form or cover the reflector.

[0027] The most relevant properties of the multilevel antennae are mainly due to their geometry and are as follows: the possibility of simultaneous operation in several frequency bands in a similar manner (similar impedance and radiation diagrams) and the possibility of reducing their size compared to other conventional antennae based exclusively on a single polygon or polyhedron. Such properties are particularly relevant in the field of communication systems. Simultaneous operation in several freq bands allows a single multilevel antenna to integrate several communication systems, instead of assigning an antenna for each system or service as is conventional. Size reduction is particularly useful when the antenna must be concealed due to its visual impact in the urban or rural landscape, or to its unaesthetic or unaerodynamic effect when incorporated on a vehicle or a portable telecommunication device.

[0028] An example of the advantages obtained from the use of a multiband antenna in a real environment is the multilevel antenna AM1, described further below, used for GSM and DCS environments. These antennae are designed to meet radioelectric specifications in both cell phone systems. Using a single GSM and DCS multilevel antenna for both bands (900 MHz and 1800 MHz) cell telephony operators can reduce costs and environmental impact of their station networks while increasing the number of users (customers) supported by the network.

[0029] It becomes particularly relevant to differentiate multilevel antennae from fractal antennae. The latter are based on fractal geometry, which is based on abstract mathematical concepts which are difficult to implement in practice. Specialized scientific literature usually defines as fractal those geometrical objects with a non-integral Haussdorf dimension. This means that fractal objects exist only as an abstraction or a concept, but that said geometries are unthinkable (in a strict sense) for a tangible object or drawing, although it is true that antennae based on this geometry have been developed and widely described in the scientific literature, despite their geometry not being strictly fractal in scientific terms. Nevertheless some of these antennae provide a multiband behaviour (their impedance and radiation diagram remains practically constant for several freq bands), they do not on their own offer all of the behaviour required of an antenna for applicability in a practical environment. Thus, Sierpinski's antenna for example has a multiband behaviour with N bands spaced by a factor of 2, and although with this spacing one could conceive its use for communications networks GSM 900 MHz and GSM 1800 MHz (or DCS), its unsuitable radiation diagram and size for these frequencies prevent a practical use in a real environment. In short, to obtain an antenna which in addition to providing a multiband behaviour meets all of the specifications demanded for each specific application it is almost always necessary to abandon the fractal geometry and resort for example to multilevel geometry antennae. As an example, none of the structures described in figures 1, 3, 4, 5 and 6 are fractal. Their Hausdorff dimension is equal to 2 for all, which is the same as their topological dimension. Similarly, none of the multilevel structures of Figure 7 are fractal, with

their Hausdorff dimension equal to 3, as their topological dimension.

[0030] In any case multilevel structures should not be confused with arrays of antennae. Although it is true that an array is formed by sets of identical antennae, in these the elements are electromagnetically decoupled, exactly the opposite of what is intended in multilevel antennae. In an array each element is powered independently whether by specific signal transmitters or receivers for each element, or by a signal distribution network, while in a multilevel antenna the structure is excited in a few of its elements and the remaining ones are coupled electromagnetically or by direct contact (in a region which does not exceed 50% of the perimeter or surface of adjacent elements). In an array is sought an increase in the directivity of an individual antenna o forming a diagram for a specific application; in a multilevel antenna the object is to obtain a multiband behaviour or a reduced size of the antenna, which implies a completely different application from arrays.

[0031] Below are described, for purposes of illustration only, two non-limiting examples of operational modes for Multilevel Antennae (AM1 and AM2) for specific environments and applications.

MODE AM1

[0032] This model consists of a multilevel patch type antenna, shown in figure 8, which operates simultaneously in bands GSM 900 (890 MHz - 960 MHz) and GSM 1800 (1710 MHz - 1880 MHz) and provides a sector radiation diagram in a horizontal plane. The antenna is conceived mainly (although not limited to) for use in base stations of GSM 900 and 1800 mobile telephony.

[0033] The multilevel structure (8.10), or antenna patch, consists of a printed copper sheet on a standard fiberglass printed circuit board. The multilevel geometry consists of 5 triangles (8.1-8.5) joined at their vertices, as shown in figure 8, with an external perimeter shaped as an equilateral triangle of height 13.9 cm (8.6). The bottom triangle has a height (8.7) of 8.2 cm and together with the two adjacent triangles form a structure with a triangular perimeter of height 10.7 cm (8.8).

[0034] The multilevel patch (8.10) is mounted parallel to an earth plane (8.9) of rectangular aluminum of 22 x 18.5 cm. The separation between the patch and the earth plane is 3.3 cm, which is maintained by a pair of dielectric spacers which act as support (8.12).

[0035] Connection to the antenna is at two points of the multilevel structure, one for each operational band (GSM 900 and GSM 1800). Excitation is achieved by a vertical metal post perpendicular to the mass plane and to the multilevel structure, capacitively finished by a metal sheet which is electrically coupled by proximity (capacitive effect) to the patch. This is a standard system in patch configuration antennae, by which the object is to compensate the inductive effect of the post with the capacitive effect of its finish.

[0036] At the base of the excitation post is connected the circuit which interconnects the elements and the port of access to the antenna or connector (8.13). Said interconnexion circuit may be formed with microstrip, coaxial or strip-line technology to name a few examples, and incorporates conventional adaptation networks which transform the impedance measured at the base of the post to 50 ohms (with a typical tolerance in the standing wave relation (SWR) usual for these application under 1.5) required at the input/output antenna connector. Said connector is generally of the type N or SMA for micro-cell base station applications.

[0037] In addition to adapting the impedance and providing an interconnection with the radiating element the interconnection network (8.11) may include a diplexor allowing the antenna to be presented in a two connector configuration (one for each band) or in a single connector for both bands.

[0038] For a double connector configuration in order to increase the insulation between the GSM 900 and GSM 1800 (DCS) terminals, the base of the DCS band excitation post may be connected to a parallel stub of electrical length equal to half a wavelength, in the central DCS wavelength, and finishing in an open circuit. Similarly, at the base of the GSM 900 lead can be connected a parallel stub ending in an open circuit of electrical length slightly greater than one quarter of the wavelength at the central wavelength of the GSM band. Said stub introduces a capacitance in the base of the connection which may be regulated to compensate the residual inductive effect of the post. Furthermore, said stub presents a very low impedance in the DCS band which aids in the insulation between connectors in said band.

[0039] In figures 9 and 10 are shown the typical radioelectric behavior for this specific embodiment of a dual multilevel antenna.

[0040] Figure 9 shows return losses (L_r) in GSM (9.1) and DCS (9.2), typically under -14 dB (which is equivalent to SWR <1.5), so that the antenna is well adapted in both operation bands (890 MHz-960 MHz and 1710 MHz-1880 MHz).

[0041] Radiation diagrams in the vertical (10.1 and 10.3) and the horizontal plane (10.2 and 10.4) for both bands are shown in figure 10. It can be seen clearly that both antennae radiate using a main lobe in the direction perpendicular to the antenna (10.1 and 10.3), and that in the horizontal plane (10.2 and 10.4) both diagrams are sectorial with a typical beam width at 3 dB of 65°. Typical directivity (d) in both bands is d>7 Db.

Mode AM2

[0042] This model consists of a multilevel antenna in a monopole configuration, shown in figure 11, for wireless communications systems for indoors or in local access environments using radio.

[0043] The antenna operates in a similar manner si-

multaneously for the bands 1880 MHz-1930 MHz and 3400 MHz-3600 MHz, such as in installations with the system DECT. The multilevel structure is formed by three or five triangles (see figures 11 and 3.6) to which may be added an inductive loop (11.1). The antenna presents an omnidirectional radiation diagram in the horizontal plane and is conceived mainly for (but not limited to) mounting on roof or floor.

[0044] The multilevel structure is printed on a Rogers RO4003 dielectric substrate (11.2) of 5.5 cm width, 4.9 cm height and 0.8 mm thickness, and with a dielectric permittivity equal to 3.38. the multilevel element consists of three triangles (11.3-11.5) joined at the vertex; the bottom triangle (11.3) has a height of 1.82 cm, while the multilevel structure has a total height of 2.72 cm. In order to reduce the total size f the antenna the multilevel element is added an inductive loop (11.1) at its top with a trapezoidal shape in this specific application, so that the total size of the radiating element is 4.5 cm.

[0045] The multilevel structure is mounted perpendicularly on a metallic (such as aluminum) earth plane (11.6) with a square or circular shape about 18 cm in length or diameter. The bottom vertex of the element is placed on the center of the mass plane and forms the excitation point for the antenna. At this point is connected the interconnection network which links the radiating element to the input/output connector. Said interconnection network may be implemented as a microstrip, stripline or coaxial technology to name a few examples. In this specific example the microstrip configuration was used. In addition to the interconnection between radiating element and connector, the network can be used as an impedance transformer, adapting the impedance at the vertex of the multilevel element to the 50 Ohms (L_r<-14 dB, SWR <1.5) required at the input/output connector.

[0046] Figures 12 and 13 summarize the radioelectric behavior of antennae in the lower (1900) and higher bands (3500).

[0047] Figure 12 shows the standing wave ratio (SWR) for both bands: Figure 12.1 for the band between 1880 and 1930 MHz, and Figure 12.2 for the band between 3400 and 3600 MHz. These show that the antenna is well adapted as return losses are under 14 dB, that is, SWR <1.5 for the entire band of interest.

[0048] Figure 13 shows typical radiation diagrams. Diagrams (13.1), (13.2) and (13.3) at 1905 MHz measured in the vertical plane, horizontal plane and antenna plane, respectively, and diagrams (13.4), (13.5) and (13.6) at 3500 MHz measured in the vertical plane, horizontal plane and antenna plane, respectively.

[0049] One can observe an omnidirectional behaviour in the horizontal plane and a typical bilobular diagram in the vertical plane with the typical antenna directivity above 4 dBi in the 1900 band and 6 dBi in the 3500 band.

[0050] In the antenna behavior it should be remarked that the behavior is quite similar for both bands (both SWR and in the diagram) which makes it a multiband antenna.

[0051] Both the AM1 and AM2 antennae will typically be coated in a dielectric radome which is practically transparent to electromagnetic radiation, meant to protect the radiating element and the connection network from external aggression as well as to provide a pleasing external appearance.

[0052] A multilevel antenna, can be used as a multiband or miniature resonator when it radiates inefficiently.

[0053] Multilevel antennas, can incorporate an interconnection circuit which links the structure to an input/output connector and which is used to incorporate adaptation networks for impedances, filters or diplexers.

[0054] Further aspects of the present invention are described in the dependent claims.

[0055] It is not considered necessary to extend this description in the understanding that an expert in the field would be capable of understanding its scope and advantages resulting thereof, as well as to reproduce it.

Claims

1. An antenna including at least one multilevel structure wherein the multilevel structure comprises a set of polygonal or polyhedral elements having the same number of sides or faces, **characterised in that** not all the polygonal or polyhedral elements have the same size, each of said elements being electromagnetically coupled to at least one other of said elements either directly through at least one point of contact or through a small separation providing coupling, wherein for at least 75% of said polygonal or polyhedral elements, the region or area of contact between said polygonal or polyhedral elements is less than 50% of the perimeter or area of said elements, thereby allowing to geometrically distinguish in the multilevel structure the majority of the polygonal or polyhedral elements which form it.

2. An antenna including at least one multilevel structure according to claim 1, **characterized in that** the antenna is a multiband antenna.

3. An antenna including at least one multilevel structure according to claim 1 or 2, **characterized in that** the multilevel structure comprises polygonal or polyhedral elements of at least two different types of shapes.

4. An antenna including at least one multilevel structure according to the any of the preceding claims, **characterized in that** not all the regions or areas of contact between polygonal or polyhedral elements have the same size.

5. An antenna including at least one multilevel struc-

ture according to any of the preceding claims, **characterized in that** the multilevel structure comprises at least four polygonal or polyhedral elements.

6. An antenna including at least one multilevel structure, according to any of the preceding claims, **characterized in that** at least one multilevel structure is formed exclusively by triangles.

7. An antenna including at least one multilevel structure, according to any of the claims 1 to 5, **characterized in that** the multilevel structure is formed exclusively by polygons of a single type, selected from the group consisting of: four sided polygons, pentagons, hexagons, heptagons, octagons, decagons, dodecagons,

8. An antenna including at least one multilevel structure, according to any of the claims 1 to 5, **characterized in that** the multilevel structure is formed exclusively by circles or ellipses.

9. An antenna including at least one multilevel structure, according to any of the claims 1 to 5, **characterized in that** at least one multilevel structure is formed exclusively by polyhedrons.

10. An antenna including at least one multilevel structure, according to any of the claims 1 to 5, **characterized in that** at least one multilevel structure is formed exclusively by cylinders or cones.

11. An antenna including at least one multilevel structure, according to any of the preceding claims, **characterized in that** the multilevel structure is mounted in a monopole configuration.

12. An antenna including at least one multilevel structure, according to claim 11, **characterized in that** said monopole is mounted substantially perpendicular to a groundplane.

13. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** the multilevel structure is mounted substantially parallel to the earth plane in a patch antenna configuration.

14. An antenna including at least one multilevel structure, according to claims 9 and 10, **characterized in that** the multilevel structure is included in one of the radiating elements of a planar microstrip or patch structure with at least one parasitic element.

15. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** the multilevel structure is included in at least one arm of a dipole configuration antenna.

16. An antenna including at least one multilevel structure, according toany of the claims 1 to 7, **characterized in that** the multilevel structure forms part of the antenna in a substantially coplanar configuration with a groundplane.

17. An antenna including at least one multilevel structure, according to claims 1 to 7, **characterized in that** the multilevel structure forms at least one of the faces in a pyramidal horn.

18. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** the multilevel structure or its perimeter form the cross section of a conical or pyramidal horn type antenna.

19. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** the perimeter of the multilevel structure determines the shape of at least one loop in a spiral antenna.

20. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** it is part of an array of antennas.

21. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** the multilevel structure is constructed from a conducting, superconducting or dielectric material, or a combination thereof.

22. An antenna including at least one multilevel structure, according to claims 1 to 8, **characterized in that** the antenna has a smaller size compared to a circular, square or triangular antenna whose perimeter can be circumscribed in the multilevel structure and which operates in the same frequency of resonance.

23. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** the multiband behavior allows it to operate simultaneously in several frequencies and thereby to be shared by several communication services or systems.

24. ain antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** it is used in base stations of mobile telephony, in communications terminals such as transmitters or receivers, in vehicles, communications satellites or in radar systems.

25. An antenna including at least one multilevel struc-

ture, according to any of the claims 1 to 8, **characterized in that** is used as a multiband or miniature resonator when it radiates inefficiently.

26. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** incorporates an interconnection circuit which links the structure to the input/output connector and which is used to incorporate adaptation networks for impedances, filters or diplexers.

27. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** the multilevel structure is loaded with capacitive or inductive elements to change at least one among the following features: size, resonance frequency, radiation patterns or impedance.

28. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** comprises several multilevel structures of the same type, that is with the same characteristic polygon or polyhedron, same number, arrangement and coupling between elements, referred to as first level structures, are grouped in higher order structures in a manner similar to that of the polygonal or polyhedral elements which form the first level multilevel structure.

29. An antenna including at least one multilevel structure, according to any of the claims 1 to 6, **characterized in that** the multilevel structure comprises five triangles joined at their vertices, and forms an external perimeter shaped as a triangle.

30. An antenna including at least one multilevel structure, according to any of the claims 1 to 6, **characterized in that** the multilevel structure comprises five triangles joined at their vertices, and a trapezoidal-shaped inductive loop joined at its top.

31. An antenna including at least one multilevel structure, according to any of the claims 1 to 8, **characterized in that** the multilevel structure consist of a printed copper sheet on a fiberglass printed circuit board.

32. An antenna including at least one multilevel structure according to any preceding claims **characterized in that** said antenna operates at least at both GSM and DCS bands.

33. An antenna including art least one multilevel structure according to any preceding claims **characterized in that** said antenna operates at multiple frequency bands, and wherein at least one of said frequency bands is operating within the 890-960 MHz - 1710-1880 MHz frequency range.

34. An antenna including at least one multilevel structure according to any preceding claims **characterized in that** said antenna operates at multiple frequency bands, and wherein at least one of said frequency bands is operating within the 1880-1930 MHz - 3400-3600 MHz frequency range.

35. An antenna including at least one multilevel structure according to any preceding claims **characterized in that** the number of operating bands is proportional to the number of levels of the multilevel structure.

36. Portable communications device incorporating and antenna according to any of the preceding claims.

Patentansprüche

1. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, wobei die Struktur mit mehreren Ebenen eine Gruppe vieleckiger oder vielflächiger Elemente mit der gleichen Anzahl von Seiten bzw. Flächen umfasst, **dadurch gekennzeichnet, dass** nicht alle der vieleckigen oder vielflächigen Elementen die gleiche Größe haben, wobei jedes der Elemente entweder direkt über wenigstens einen Kontaktpunkt oder über einen kleinen Abstand, der Kopplung bewirkt, elektromagnetisch mit wenigstens einem anderen der Elemente gekoppelt ist und für wenigstens 75% der vieleckigen oder vielflächigen Elemente der Bereich bzw. die Fläche des Kontaktes zwischen den vieleckigen oder vielflächigen Elementen weniger als 50% des Umfangs bzw. der Fläche der Elemente beträgt, so dass in der Struktur mit mehreren Ebenen die Mehrzahl der vieleckigen bzw. vielflächigen Elementen, die sie bilden, geometrisch unterschieden werden kann.

2. Antenne, die wenigstens eine Struktur mit mehreren Ebenen nach Anspruch 1 enthält, **dadurch gekennzeichnet, dass** die Antenne eine Mehrbandantenne ist.

3. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen vieleckige oder vielflächige Elemente wenigstens zweier verschiedener Typen von Formen umfasst.

4. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** nicht alle Bereiche oder Flächen von Kontakt zwischen vieleckigen bzw. vielflächigen Elementen die gleiche Größe haben.

5. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen wenigstens vier vieleckige oder vielflächige Elemente umfasst.

6. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** wenigstens eine Struktur mit mehreren Ebenen ausschließlich durch Dreiecke gebildet wird.

7. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen ausschließlich durch Vielekke eines einzelnen Typs gebildet wird, die aus der Gruppe ausgewählt werden, die besteht aus:

   vierseitigen Vielecken, Fünfecken, Sechsekken, Siebenecken, Achtecken, Zehnecken, Zwölfecken.

8. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen ausschließlich durch Kreise oder Ellipsen gebildet wird.

9. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** wenigstens eine Struktur mit mehreren Ebenen ausschließlich durch Vielflächner gebildet wird.

10. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** wenigstens eine Struktur mit mehreren Ebenen ausschließlich durch Zylinder oder Kegel gebildet wird.

11. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen in einer Monopol-Konfiguration angebracht ist.

12. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach Anspruch 11, **dadurch gekennzeichnet, dass** der Monopol im Wesentlichen senkrecht zu einer Massefläche angebracht ist.

13. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen im Wesentlichen parallel zu der Erdfläche in einer Patch-Antennenkonfiguration angebracht ist.

14. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 9 und 10, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen in einem der Strahlungselemente einer planaren Mikrostreifen- oder Patch-Struktur mit wenigstens einem parasitären Element enthalten ist.

15. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen in wenigstens einem Arm einer Dipolkonfigurations-Antenne enthalten ist.

16. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen einen Teil der Antenne in einer im Wesentlichen koplanaren Konfiguration mit einer Massefläche bildet.

17. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 7, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen wenigstens eine der Flächen in einem Pyramidenhorn bildet.

18. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen oder ihr Umfang den Querschnitt einer Trichter- oder Pyramidenhorn-Antenne bildet.

19. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** der Umfang der Struktur mit mehreren Ebenen die Form wenigstens einer Schleife in einer Spiralantenne hat.

20. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** sie Teil einer Gruppe von Antennen ist.

21. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen aus einem leitenden, supraleitenden oder dielektrischen Material oder einer Kombination daraus aufgebaut ist.

22. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach den Ansprüchen 1 bis 8, **dadurch gekennzeichnet, dass** die Antenne eine geringere Größe hat als eine kreisförmige, viereckige oder dreieckige Antenne, deren Umfang in die

Struktur mit mehreren Ebenen eingeschrieben werden kann und die bei der gleichen Resonanzfrequenz arbeitet.

23. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** es ihr das Mehrbandverhalten erlaubt, gleichzeitig bei mehreren Frequenzen zu arbeiten, und so von mehreren Kommunikationsdiensten oder -systemen gemeinsam genutzt zu werden.

24. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** sie in Mobilfunk-Basisstationen, in Kommunikations-Endgeräten, wie beispielsweise Sendern oder Empfängern, in Fahrzeugen, Kommunikationssatelliten oder in Radarsystemen eingesetzt wird.

25. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** sie als ein Mehrbandoder Miniatur-Resonator verwendet wird, wenn sie unwirksam strahlt.

26. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** sie eine Verbindungsschaltung enthält, die die Struktur mit dem Eingangs-/Ausgangs-Verbinder verbindet, und die dazu dient, Anpassungsnetze für Impedanzen, Filter oder Diplexer zu integrieren.

27. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen mit kapazitiven oder induktiven Elementen bestückt ist, um wenigstens eines der folgenden Merkmale zu ändern: Größe, Resonanzfrequenz, Strahlungscharakteristik oder Impedanz.

28. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** sie mehrere Strukturen mit mehreren Ebenen des gleichen Typs umfasst, d.h. mit dem gleichen charakteristischen Vieleck oder Vielflächner, der gleichen Anzahl, Anordnung und Verbindung zwischen Elementen, die als Strukturen der ersten Ebene bezeichnet werden und in Strukturen höherer Ordnung auf ähnliche Weise wie die vieleckigen oder vielflächigen Elemente gruppiert sind, die die Struktur mit mehreren Ebenen der ersten Ebene bilden.

29. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen fünf Dreiecke umfasst, die an ihren Scheitelpunkten verbunden sind, und einen Außenumfang bildet, der wie ein Dreieck geformt ist.

30. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen fünf Dreiecke, die an ihren Scheitelpunkten verbunden sind, sowie eine trapezförmige induktive Schleife umfasst, die an ihrem oberen Ende verbunden ist.

31. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die Struktur mit mehreren Ebenen aus einer bedruckten Kupferfolie auf einer Glasfaser-Leiterplatte besteht.

32. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Antenne wenigstens sowohl im GSM- als auch im DCS-Band arbeitet.

33. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Antenne in mehreren Frequenzbändern arbeitet, wobei wenigstens eines der Frequenzbänder in dem Frequenzbereich 890-960MHz - 1710-1880 MHz arbeitet.

34. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Antenne in mehreren Frequenzbändern arbeitet, wobei wenigstens eines der Frequenzbänder in dem Frequenzbereich 1880-1930 MHz - 3400-3600 MHz arbeitet.

35. Antenne, die wenigstens eine Struktur mit mehreren Ebenen enthält, nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Anzahl von Arbeitsbändern proportional zur Anzahl von Ebenen der Struktur mit mehreren Ebenen ist.

36. Tragbare Kommunikationsvorrichtung, in die eine Antenne nach einem der vorangehenden Ansprüche integriert ist.

Revendications

1. Antenne comprenant au moins une structure multiniveau dans laquelle la structure multiniveau com-

prend une série d'éléments polygonaux ou polyédriques ayant le même nombre de côtés ou de faces, **caractérisée en ce que** les éléments polygonaux ou polyédriques n'ont pas tous la même taille, chacun des éléments étant couplé de manière électromagnétique à au moins un autre des éléments soit directement par au moins un point de contact soit par une petite séparation assurant le couplage, dans laquelle pour au moins 75% des éléments polygonaux ou polyédriques, la région ou la zone de contact entre les éléments polygonaux ou polyédriques est inférieure à 50% du périmètre ou surface des éléments, ce qui permet de distinguer géométriquement dans la structure multiniveau la majorité des éléments polygonaux ou polyédriques qui la forment.

2. Antenne comprenant au moins une structure multiniveau selon la revendication 1, **caractérisée en ce que** l'antenne est une antenne multibande.

3. Antenne comprenant au moins une structure multiniveau selon la revendication 1 ou 2, **caractérisée en ce que** la structure multiniveau comprend des éléments polygonaux ou polyédriques d'au moins deux types de formes différents.

4. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** toutes les régions ou zones de contact entre les éléments polygonaux ou polyédriques n'ont pas la même taille.

5. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la structure multiniveau comprend au moins quatre éléments polygonaux ou polyédriques.

6. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** au moins une structure multiniveau est formée exclusivement par des triangles.

7. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 5, **caractérisée en ce que** la structure multiniveau est formée exclusivement par des polygones d'un seul type, sélectionnés dans un groupe composé de : polygones à quatre côtés, pentagones, hexagones, heptagones, octogones, décagones, dodécagones.

8. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 5, **caractérisée en ce que** la structure multiniveau est formée exclusivement par des cercles ou des ellipses.

9. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 5, **caractérisée en ce que** au moins une structure multiniveau est formée exclusivement par des polyèdres.

10. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 5, **caractérisée en ce que** au moins une structure multiniveau est formée exclusivement par des cylindres ou des cônes.

11. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la structure multiniveau est montée dans une configuration monopolaire.

12. Antenne comprenant au moins une structure multiniveau selon la revendication 11, **caractérisée en ce que** le monopole est monté de manière sensiblement perpendiculaire à un plan de sol.

13. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** la structure multiniveau est montée de manière sensiblement parallèle au plan de masse dans une configuration d'antenne à plaque.

14. Antenne comprenant au moins une structure multiniveau selon les revendications 9 et 10, **caractérisée en ce que** la structure multiniveau est comprise dans l'un des éléments rayonnants d'un microruban planaire ou structure à plaque avec au moins un élément passif.

15. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 8, **caractérisée en ce que** la structure multiniveau est comprise dans au moins un bras d'une antenne à configuration bipolaire.

16. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications 1 à 7, **caractérisée en ce que** la structure multiniveau fait partie de l'antenne dans une configuration sensiblement dans le même plan que le plan de sol.

17. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 7, **caractérisée en ce que** la structure multiniveau forme au moins l'une des faces dans un cornet pyramidal.

18. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée**

en ce que la structure multiniveau ou son périmètre forment la coupe d'une antenne de type cornet conique ou pyramidal.

19. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** le périmètre de la structure multiniveau détermine la forme d'au moins une boucle dans une antenne à spirale.

20. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce qu'**elle fait partie d'une matrice d'antennes.

21. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** la structure multiniveau est construite à partir d'un matériau conducteur, super-conducteur ou diélectrique ou d'une combinaison de ces derniers.

22. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** l'antenne a une forme plus petite comparée à une antenne circulaire, carrée ou triangulaire dont le périmètre peut être circonscrit dans la structure multiniveau et qui fonctionne dans la même fréquence de résonance.

23. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** le comportement multibande lui permet de fonctionner simultanément dans plusieurs fréquences et par conséquent d'être partagée par plusieurs services ou systèmes de communication.

24. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce qu'** elle est utilisée dans des stations de base de téléphonie mobile, dans des terminaux de communication tels que des émetteurs ou récepteurs, dans des véhicules, des satellites de communication ou des systèmes radar.

25. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce qu'** elle est utilisée comme résonateur multibande ou miniature lorsque ses radiations sont inefficaces.

26. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce qu'** elle intègre un circuit d'interconnexion qui relie la structure au connecteur d'entrée/sortie et qui est utilisé pour incorporer des réseaux d'adaptation pour les impédances, les filtres ou les diplexeurs.

27. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** la structure multiniveau est chargée avec des éléments capacitifs ou inductifs pour changer au moins l'une des caractéristiques suivantes : taille, fréquence de résonance, motifs de radiation ou impédance.

28. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce qu'** elle comprend plusieurs structures multiniveau du même type, c'est à dire avec le même polygone ou polyèdre caractéristique, le même nombre, le même agencement et le même couplage entre les éléments, appelées structures de premier niveau qui sont groupées en structures d'ordre supérieur d'une manière similaire à celle des éléments polygonaux ou polyédriques qui forment la structure multiniveau de premier niveau.

29. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 6, **caractérisée en ce que** la structure multiniveau comprend cinq triangles joints à leurs sommets et forme un périmètre extérieur ayant la forme d'un triangle.

30. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 6, **caractérisée en ce que** la structure multiniveau comprend cinq triangles joints à leurs sommets et une boucle inductive de forme trapézoïdale jointe à son sommet.

31. Antenne comprenant au moins une structure multiniveau selon les revendications 1 à 8, **caractérisée en ce que** la structure multiniveau consiste en une feuille de cuivre imprimé sur une carte de circuit imprimé en fibre de verre.

32. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'antenne fonctionne au moins à la fois sur les bandes GSM et DCS.

33. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'antenne fonctionne sur des bandes de fréquence multiples et dans laquelle au moins l'une des bandes de fréquence fonction dans la gamme de fréquence comprise entre 890-960 Mhz et 1710-1880 Mhz.

34. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'antenne fonctionne sur des bandes de fréquence multiples et dans laquelle au moins l'une des ban-

des de fréquence fonctionne dans la gamme de fréquence comprise entre 1880-1930 Mhz et 3400-3600 Mhz.

35. Antenne comprenant au moins une structure multiniveau selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le nombre de bandes sur lesquelles elle peut fonctionner est proportionnel au nombre de niveaux de la structure multiniveau.

36. Système de communication portable incorporant une antenne selon l'une quelconque des revendications précédentes.

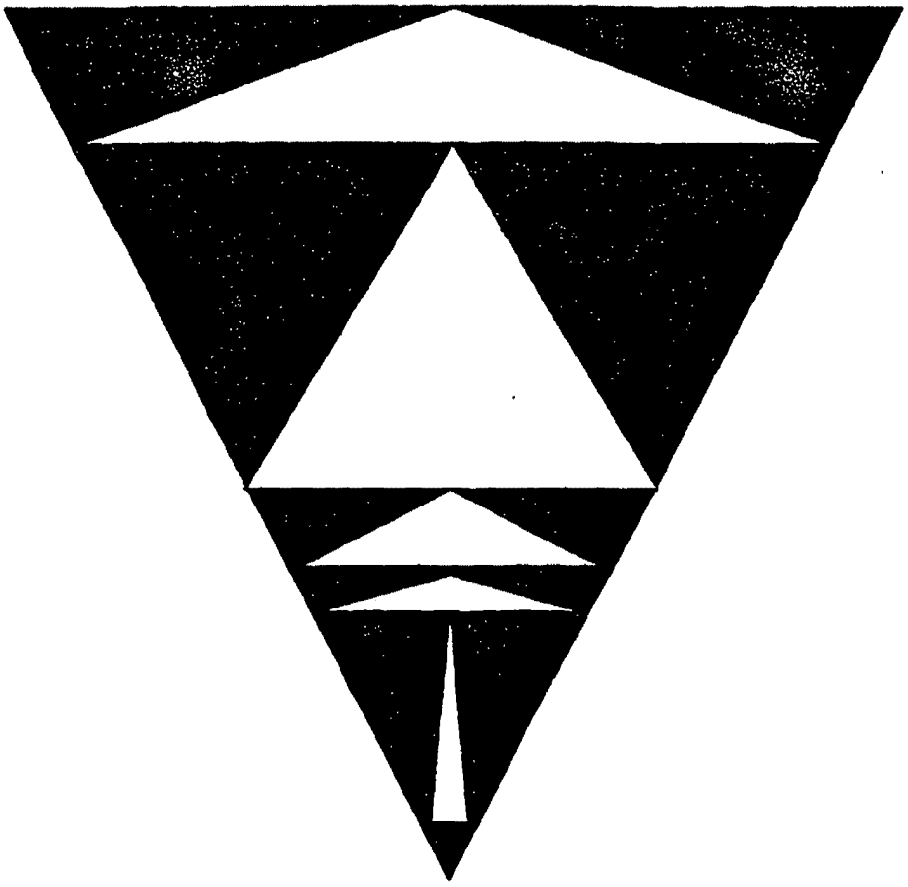


FIG. 1

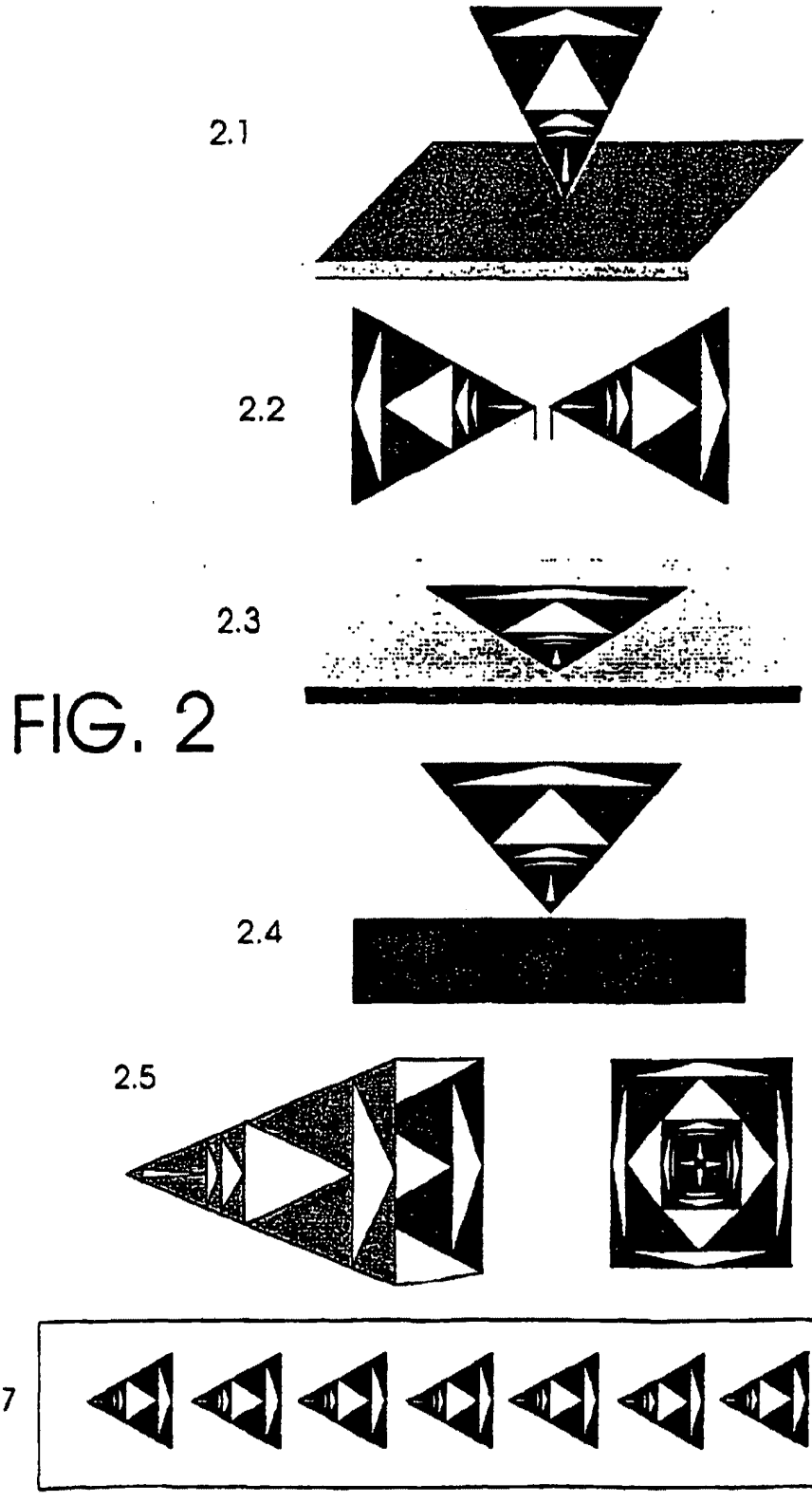


FIG. 2

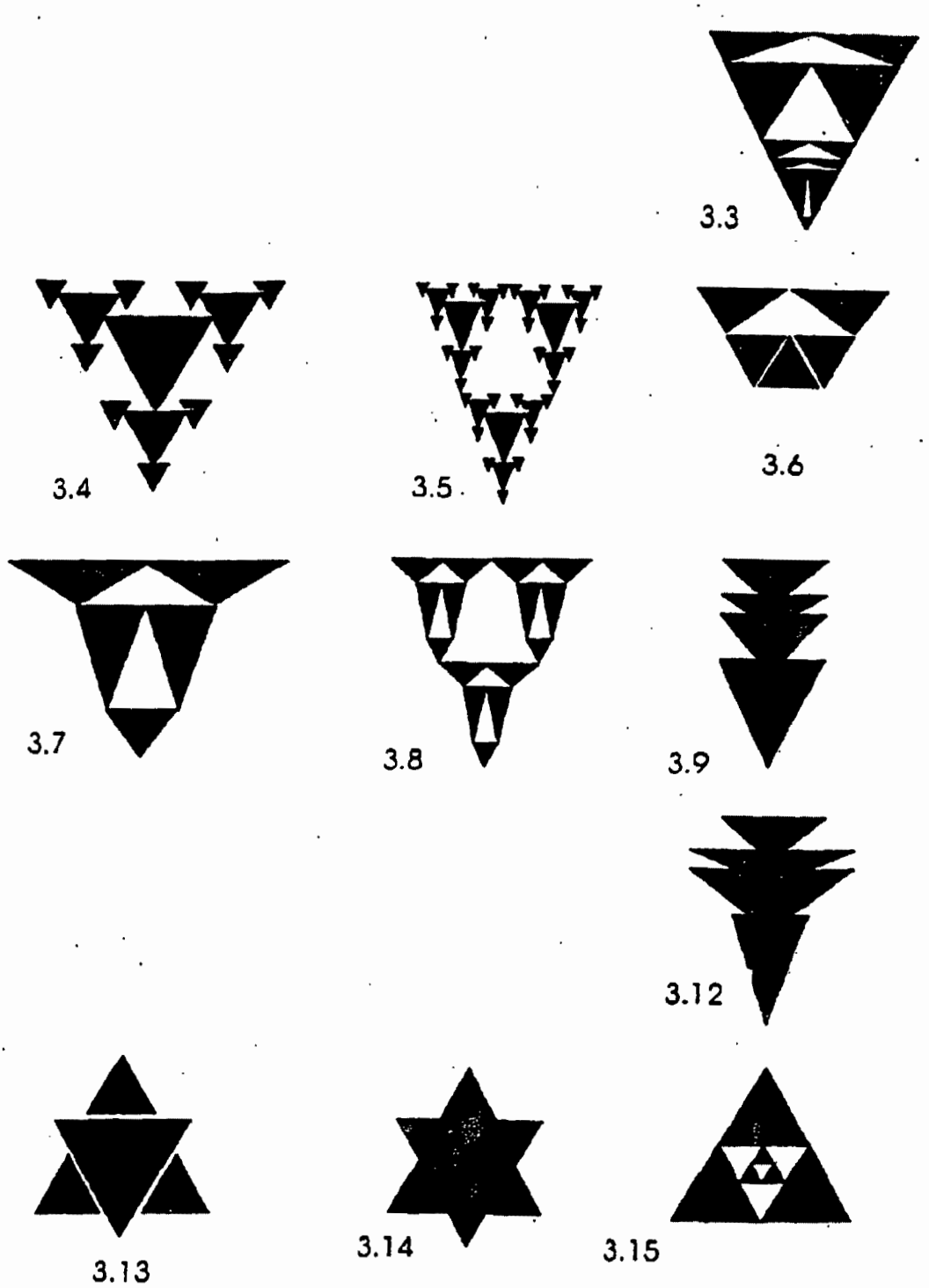


FIG. 3

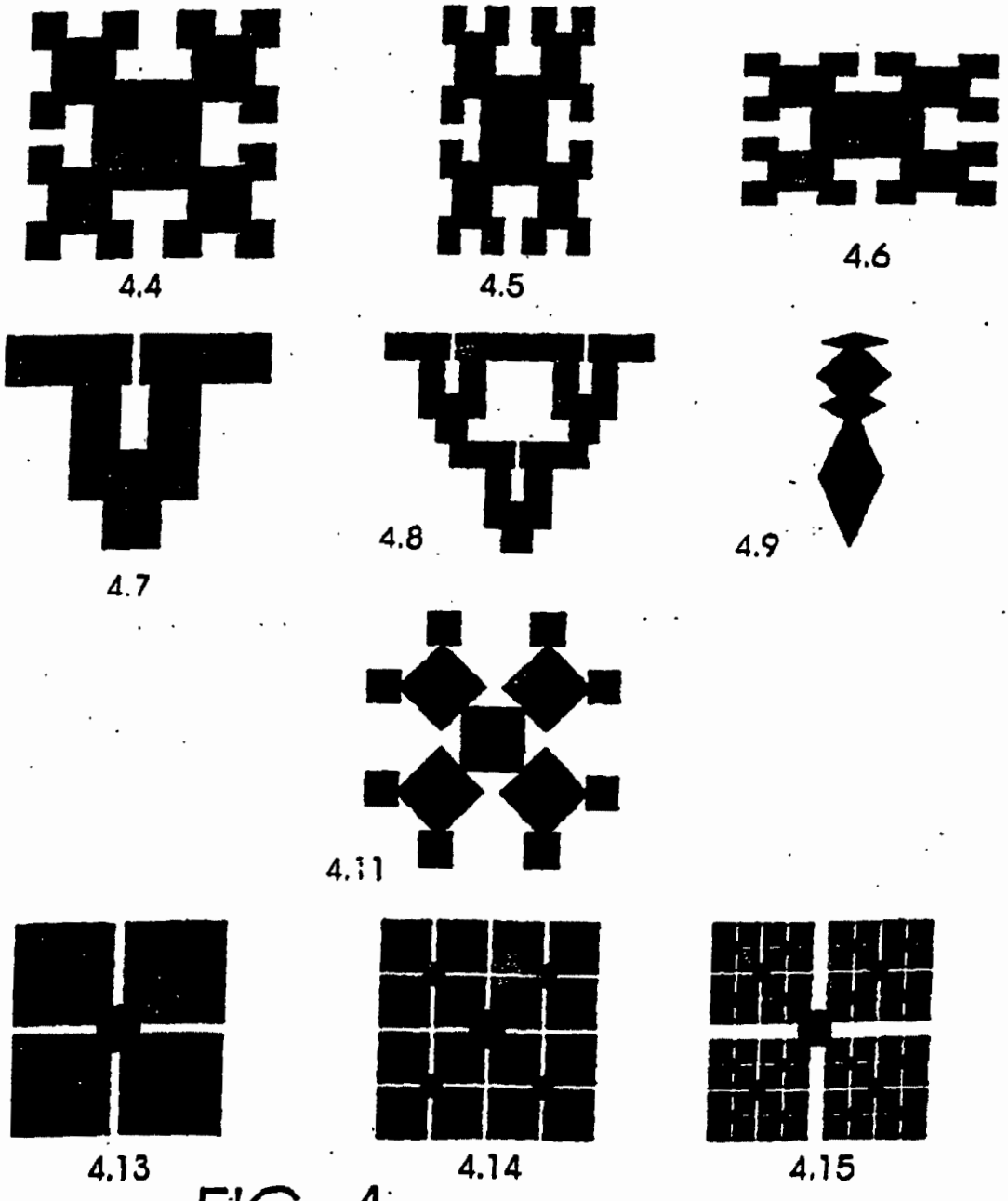
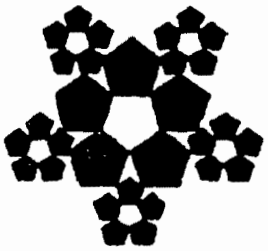


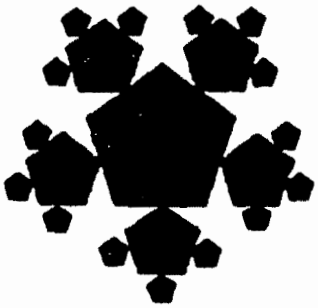
FIG. 4



5.3



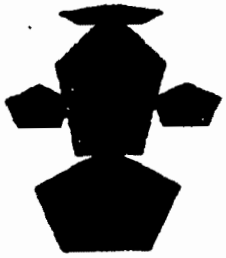
5.4



5.5



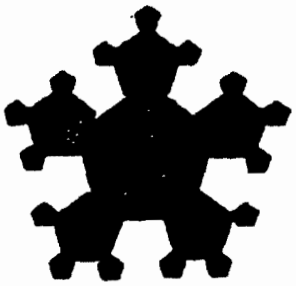
5.6



5.7

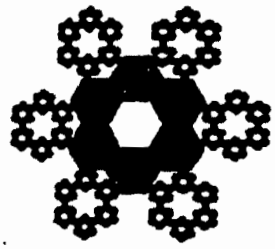


5.8



5.9

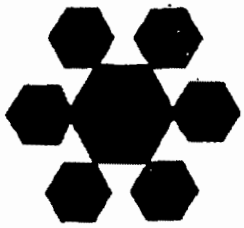
FIG. 5



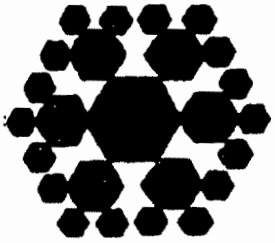
6.3



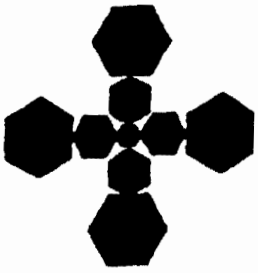
6.4



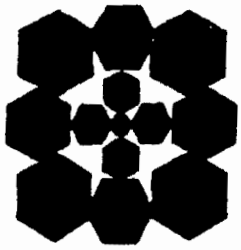
6.5



6.6



6.7

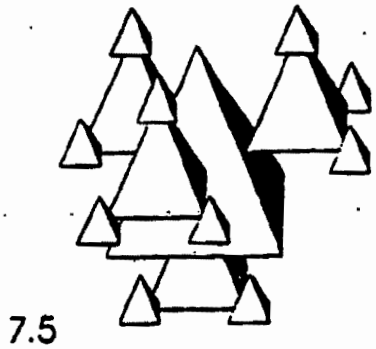


6.8

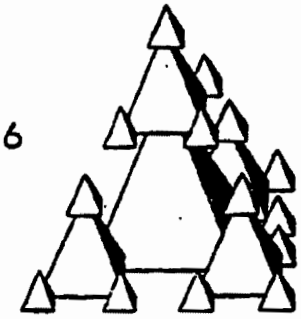


6.9

FIG. 6



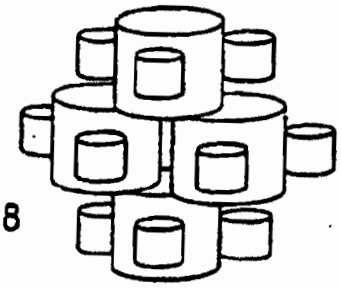
7.5



7.6



7.7



7.8

FIG. 7

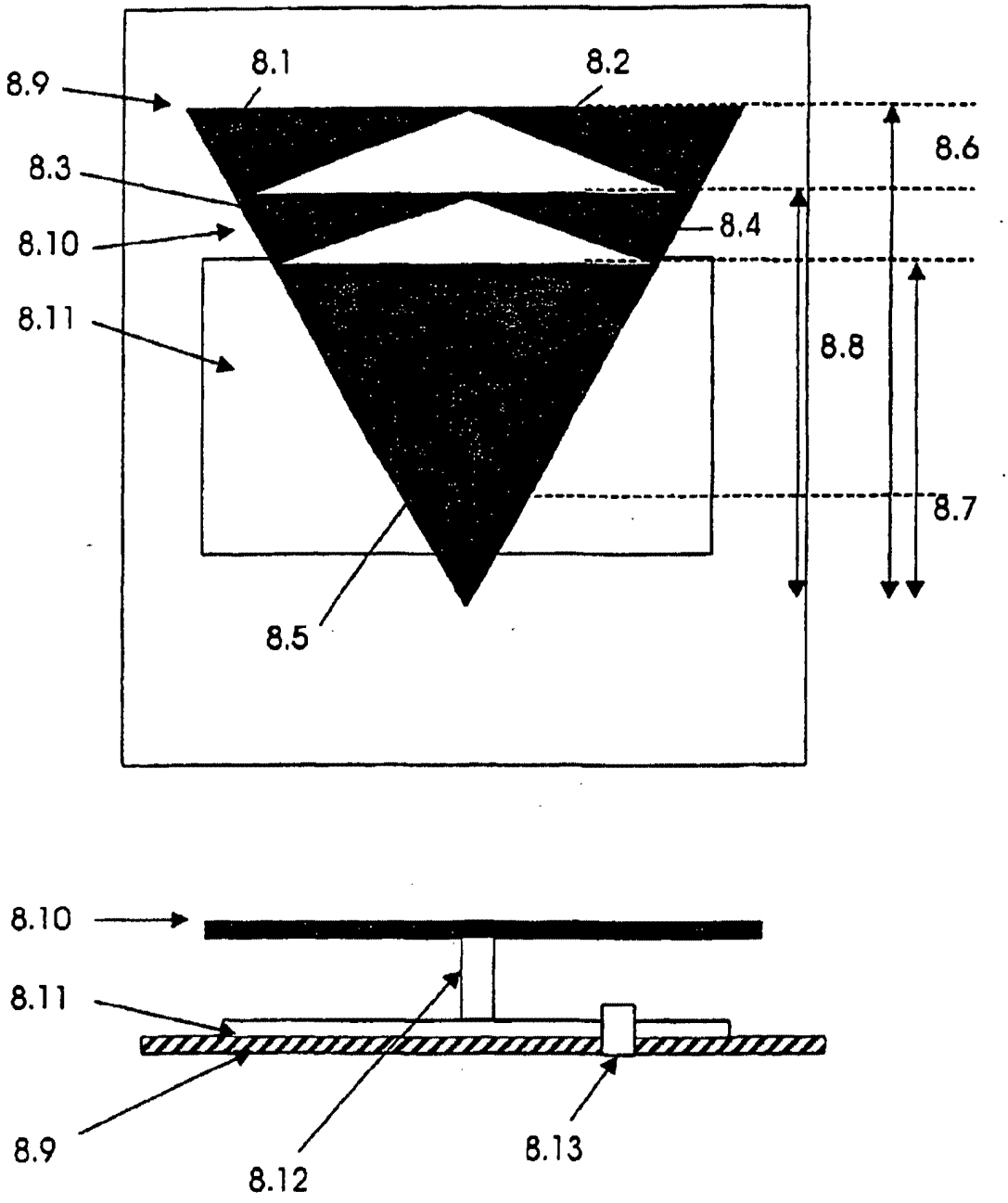


FIG. 8

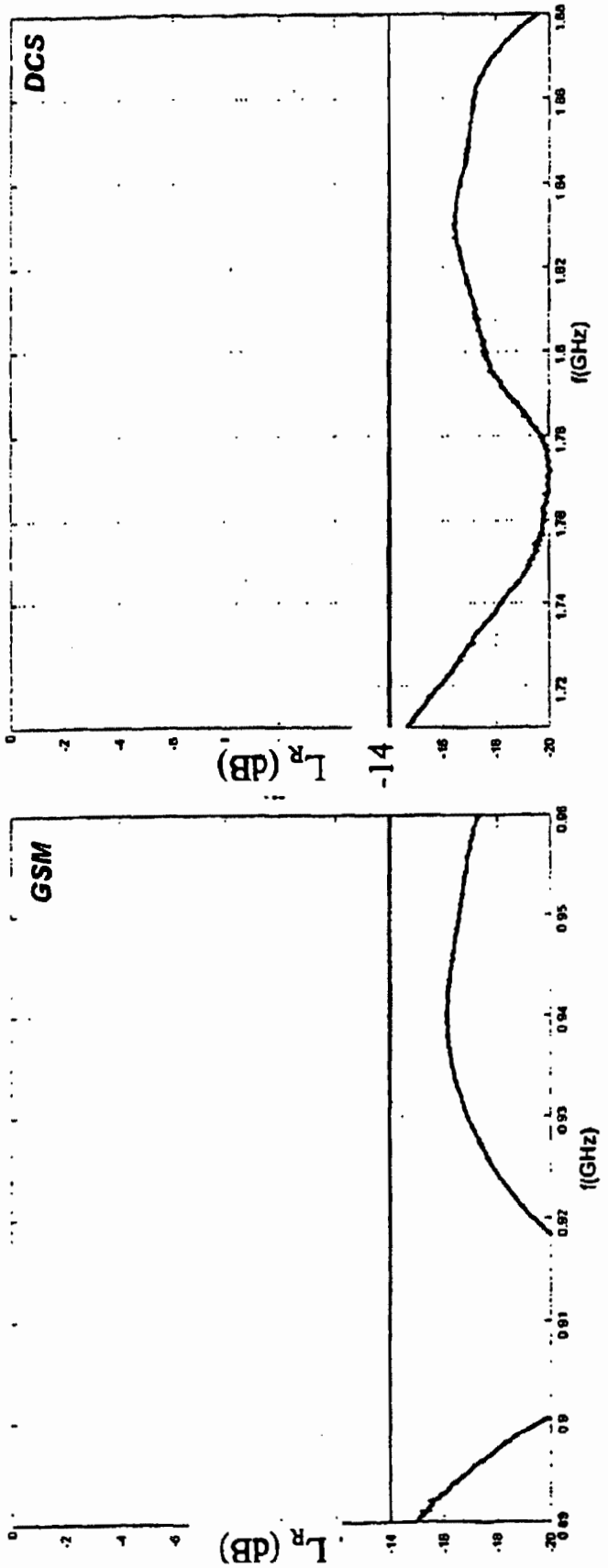
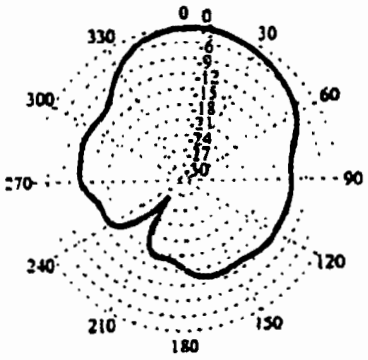
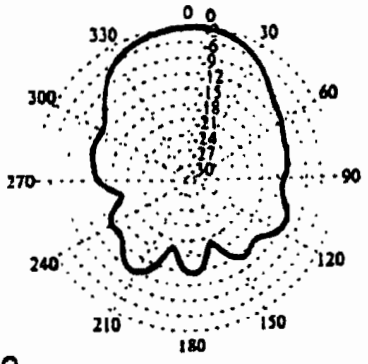


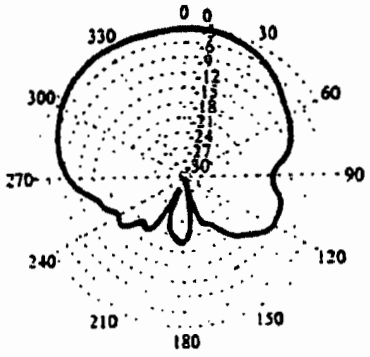
FIG. 9



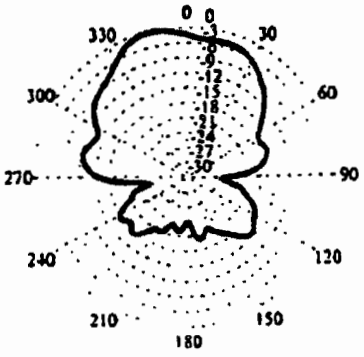
10.1



10.2



10.3



10.4

FIG. 10

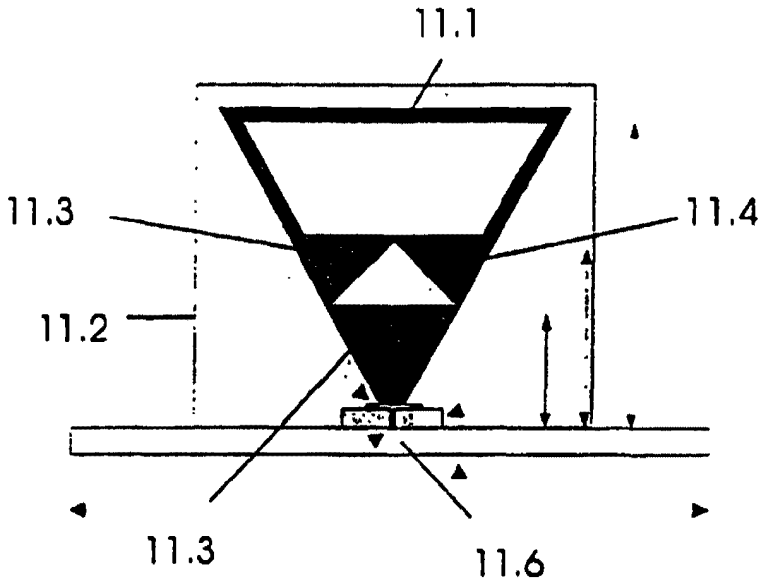
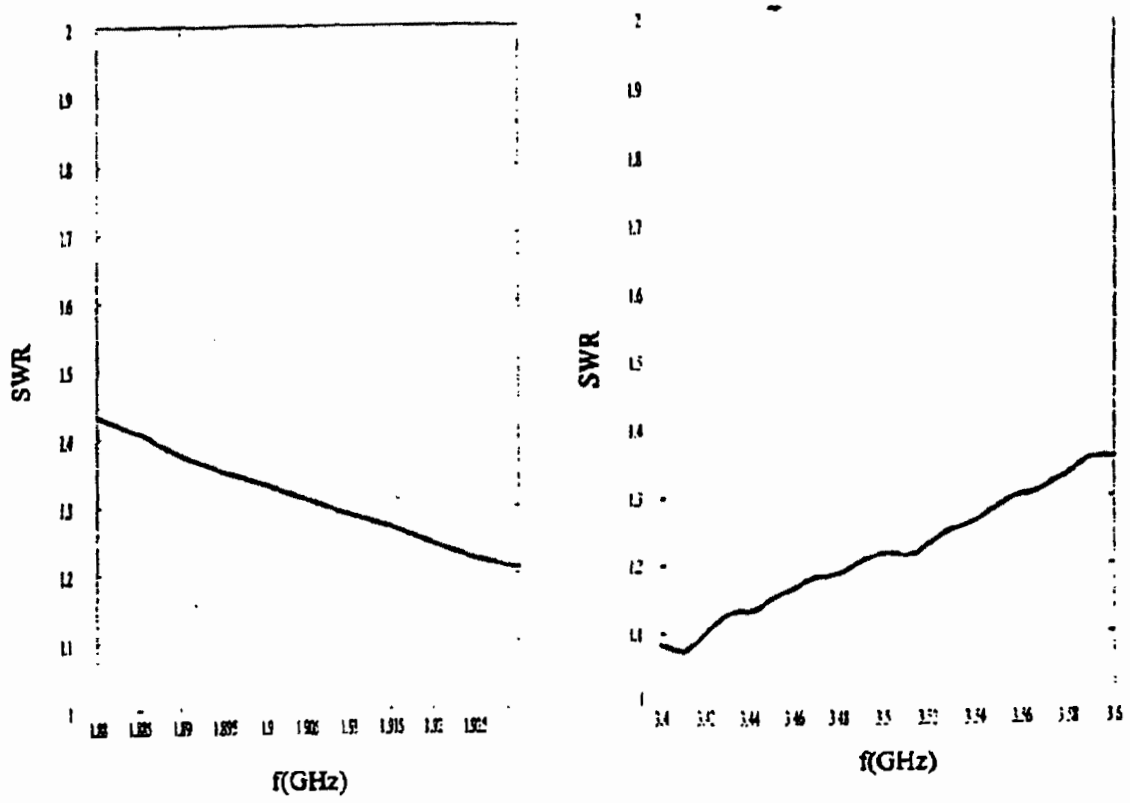


FIG. 11

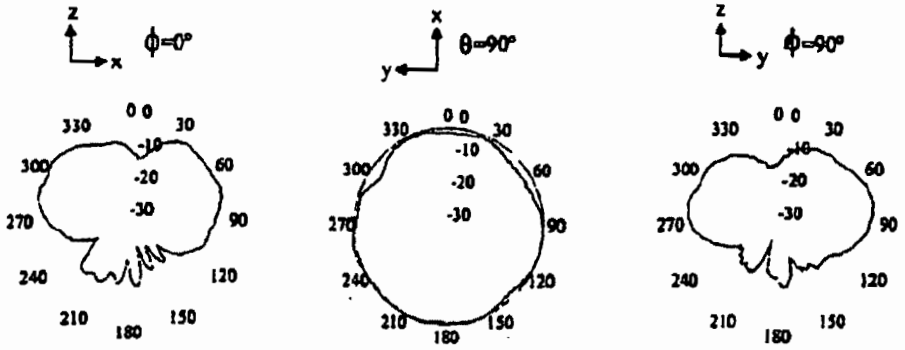


12.1

12.2

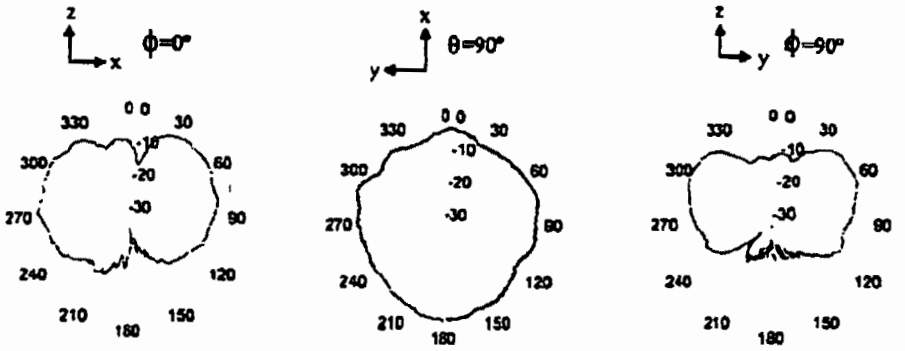
FIG. 12

f=1905 MHz



13.1 13.2 13.3

f=3500 MHz



13.4 13.5 13.6

FIG. 13

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 137 100 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.09.2001 Bulletin 2001/39

(51) Int Cl.[7]: **H01Q 1/24**, H01Q 3/34, H01Q 5/00, H01Q 21/30

(21) Application number: **01302451.8**

(22) Date of filing: **16.03.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **23.03.2000 JP 2000081124**

(71) Applicant: **SONY CORPORATION**
Tokyo 141 (JP)

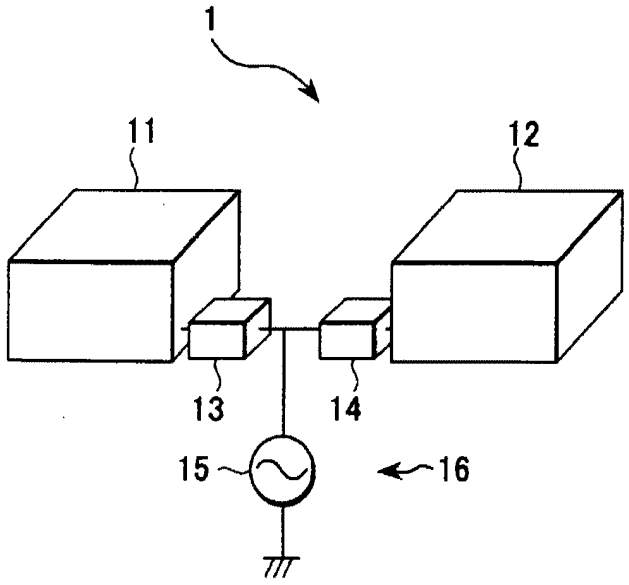
(72) Inventor: **Kozakai, Osamu**
Shinagawa-ku, Tokyo (JP)

(74) Representative:
Robinson, Nigel Alexander Julian et al
D. Young & Co.,
21 New Fetter Lane
London EC4A 1DA (GB)

(54) Antenna apparatus and a portable wireless communication apparatus using the same

(57) An antenna apparatus featuring a simple configuration and operability at a plurality of frequencies which are relatively proximate is provided. Phase shift circuits are connected respectively between feed points of a pair of antenna elements having different resonant frequencies and a radio circuit so as to shift phase of the radio waves and to increase an impedance of one of the antenna elements when the one of the antenna elements is used at the resonant frequency of the other one of the antenna elements.

FIG.5



EP 1 137 100 A2

Description

[0001] The present invention relates to an antenna apparatus for transmitting or receiving radio waves in two or more frequency bands, and in particular, to an antenna apparatus capable of being installed in a portable wireless communication apparatus such as a portable telephone.

[0002] Recently, portable telephones are rapidly proliferating, and a demand for use with a broader frequency band is increasing so as to improve transmission efficiency and prevent a noise as well as interference in the portable telephone. Because an antenna construction of a conventional portable telephone does not allow to be used with a wide frequency band, developments of new antenna apparatus and methods, which are operable at a plurality of frequencies, and able to realize a broader band wireless transmission and reception, are in progress.

[0003] FIGs. 1 and 2 show examples of antennae which are operable in a plurality of frequency bands. FIG. 1 shows such an example using a parasitic antenna element, and FIG. 2 shows such an example using a plurality of radiating conductors.

[0004] In an antenna 180 shown in FIG. 1, a coaxial line 181 is connected to a dielectric substrate 182. In this dielectric substrate 182, a radiating conductor element 183 and a parasitic element 184 are disposed in proximity. This arrangement is widely used for obtaining a multiple resonant characteristic. Further, in an antenna 190 shown in FIG. 2, where no parasitic antenna element 184 is used, a plurality of radiating conductor elements 192 and 193 each having a different resonance frequency is arrayed on a substrate 191, and they are supplied with power from single feed point 194 to obtain a multiple resonant characteristic. By way of example, the antenna 190 is grounded at a ground point 195.

[0005] The antenna 180 having the parasitic antenna element disposed therein as shown in FIG. 1 involves such a problem that a discretionary arrangement of antenna elements is impossible because that a relationship in positions between the parasitic antenna element 194 and the radiating element 193 has a significant influence on a characteristic impedance of its antenna apparatus.

[0006] Also, in the antenna 190 shown in FIG. 2, in which no parasitic antenna element is disposed, there is required a large space for accommodating the radiating elements 192 and 193 arrayed therein which resonate in a plurality of frequency bands. In addition, this type of antenna has such a problem that the antenna may not be operable if these frequency bands are in proximity and overlap by approximately 10%. This is because that in such an arrangement as of the antenna 190, a multiple resonant of respective radiating conductors 192 and 193 is realized by spacing apart therebetween by means of a slit and operating them at respective resonant frequencies. However, because of a certain degree of broad band characteristic owned by respective radiating conductors 192 and 193, if their frequency bands are in close proximity, the effect by the slit to space apart therebetween and the multiple resonant are not attained. Despite of the above, it is required to be operable at frequencies which are in proximity for use in the aforementioned portable telephone.

[0007] The present invention has been contemplated to address the aforementioned problems associated with the related art. An object of at least preferred embodiments of the invention is to provide an antenna apparatus which has a simple configuration and is operable at a plurality of proximate frequencies.

[0008] Another object of at least preferred embodiments of the invention is to provide a portable wireless telephone which has simple configuration and is operable at a plurality of frequencies which are relatively proximate.

[0009] In order to accomplish the aforementioned objects of the invention, an antenna apparatus capable of transmitting and/or receiving radio waves at two frequencies is provided, in which feed points of two antenna elements having different resonant frequencies are connected to a radio circuit via two phase shift circuits which shift phases of radio waves.

[0010] In this antenna apparatus according to the present invention, because the antenna elements are connected to the feed point via respective phase shift circuits, an impedance characteristic of one antenna element at the resonance frequency of the other antenna element is adjusted so as to eliminate adverse influences between these antenna elements, thereby enabling operation at two frequencies which are relatively in close proximity, by use of the antenna apparatus which is realized in a simple configuration.

[0011] Further, according to the present invention, a portable communication apparatus is provided for receiving and/or transmitting radio waves at a plurality of frequencies, which portable communication apparatus is comprised of two antenna elements each having a different resonance frequency, and two phase shift circuits for changing phases of radio waves, wherein the feed points of the two antenna elements are connected to a radio circuit via the phase shift circuits respectively.

[0012] In such a portable wireless communication apparatus, because the antenna elements are connected to the feed point via respective phase shift circuits, an impedance characteristic of one antenna element at a resonance frequency of the other antenna element is adjusted to eliminate adverse influences between these antenna elements, thereby enabling reception and/or transmission of radio waves at different frequencies which are relatively in close proximity, by use of the antenna apparatus realized in a simple configuration.

[0013] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is a diagram showing an example of antenna using a parasitic antenna element, which is operable at a plurality of frequencies;

FIG. 2 is a diagram showing an example of antennae using a plurality of radiating conductors, which is operable at a plurality of frequencies;

FIG. 3 is a diagram showing an appearance of an example of portable telephones to which an antenna apparatus of the present invention is applicable;

FIG. 4 is a schematic block diagram showing an internal arrangement of the portable telephone of FIG. 3;

FIG. 5 is a schematic block diagram indicating main portions of an antenna apparatus of one example of the present invention;

FIGs. 6A and 6B are Smith charts indicating examples of input impedance characteristics of an antenna element having a resonance frequency of f1, wherein FIG. 6A indicates an instance without connecting a phase shift circuit while FIG. 6B indicates an instance with a phase shift circuit connected;

FIGs. 7A and 7B are Smith charts indicating examples of input impedance characteristics of another antenna element having a resonance frequency of f2, wherein FIG. 7A indicates an instance without connecting a phase shift circuit while FIG. 7B indicates an instance with a phase shift circuit connected;

FIG. 8 shows an example of the phase shift circuit comprising a lumped circuit, and which indicates a phase shift circuit for realizing a positive quantity of phase shift;

FIG. 9 shows an example of the phase shift circuit comprising a lumped circuit, and which indicates a phase shift circuit for realizing a negative quantity of phase shift;

FIG. 10 is an example of the phase shift circuit comprising a distributed constant circuit, and which indicates a coaxial line;

FIG. 11 is an example of the phase shift circuit comprising a distributed constant circuit, and which indicates a parallel twin line;

FIG. 12 is an example of the phase shift circuit comprising a distributed constant circuit, and which indicates a micro-strip line;

FIG. 13 is a Smith chart depicting an input impedance characteristic when a phase shift circuit is connected;

FIG. 14 is a Smith chart depicting an input impedance characteristic when a phase shift circuit is not connected;

FIG. 15 is a diagram depicting a return-loss characteristic when a phase shift circuit is connected;

FIG. 16 is a diagram depicting a return-loss characteristic when a phase shift circuit is not connected;

FIG. 17 is a diagram showing a dipole antenna as an example applicable to the antenna apparatus of the present invention;

FIG. 18 is a diagram showing a loop antenna as an example applicable to the antenna apparatus of the present invention;

FIG. 19 is a diagram showing a plane inverted F pattern antenna as an example applicable to the antenna apparatus of the present invention;

FIG. 20 is a diagram showing an inverted L pattern antenna as an example applicable to the antenna apparatus of the present invention; and

FIG. 21 is a diagram showing a helical antenna as an example applicable to the antenna apparatus of the present invention.

[0014] Preferred embodiments of the present invention will now be described with reference to accompanying drawings. In the following description, features of the present invention will be described, unless otherwise described, by way of example of those obtained in wireless transmission. However, it is not limited thereto, and the same features should be construed to be obtained in wireless reception because of a reversible relationship between reception and transmission of radio waves.

[0015] FIG. 3 is a diagram showing an overview of an example of a portable telephone to which an antenna apparatus of the present invention may be applicable. The portable telephone 100 of the present example comprises an folding body 210 including a first housing 221, a second housing 231 and a hinge 211. In the first housing 221, an antenna 1, a speaker 223, an external LCD 232, a jog dial 226 and an internal LCD 222 are mounted. In the second housing, an operation key unit 233 and microphone 234 are mounted. Further, the portable telephone 100 comprises an open/close-state sensing switch 251 and a protrusion part 252 for detecting an open/close state of the folding body 210, and a closed state sensing switch 253 and a magnet part 254 for detecting a closed state of the holding body 210.

[0016] FIG. 4 is a schematic block diagram showing an example of an internal arrangement of the portable telephone of FIG. 3. The same notations are used in FIG. 4 as that of FIG. 3 for parts performing same functions. In addition to the above-mentioned parts, the portable telephone 100 of the present example further comprises a duplex unit 260, a receiving unit 261, a transmitting unit 262, a digital signal processing unit (DSP) 263, a control unit 264, RAM 265 and ROM 266.

[0017] FIG. 5 schematically shows principle portions of an antenna apparatus in accordance with an embodiment of the present invention. An antenna apparatus 1 of the present embodiment, which transmits radio waves of two different wavelengths using two antenna elements having different resonance frequencies, may be used for a portable wireless communication apparatus such as a portable wireless telephone. However, the present invention is not limited to the present embodiment, and may be applicable to any other types of wireless apparatus using radio waves to transmit and/or re-

ceive signal as well.

[0018] In the antenna apparatus 1, two antenna elements 11 and 12 having resonance frequencies different from each other are coupled to phase shift circuits 13 and 14 respectively at respective feed points, and to a radio circuit including an oscillator 15 for generating radio waves of two predetermined wavelengths. A power generated by oscillator 15 is simply branched and distributed to antenna elements 11 and 12 via phase shift circuits 13 and 14 respectively. The phase shift circuits 13 and 14 are comprised of a lumped circuit or a distributed constant circuit.

[0019] Assuming that a resonance frequency of the antenna element 11 is f1 and a resonance frequency of the antenna element 12 is f2, the phase shift circuit 13 coupled to the antenna element 11 shifts phase of radio waves of the resonance frequency f2 by a prescribed quantity, and also the phase shift circuit 14 coupled to the antenna element 12 shifts phase of radio waves of the resonance frequency f1 by a prescribed quantity. Namely, respective antenna elements 11 and 12 are designed to have impedance matching at their own resonance frequencies f1 and f2, by arranging such that respective phase shift circuits 13 and 14 shift phases of radio waves by prescribed quantities which are experimentally determined so as to ensure not to be operable even when radio waves of the other resonance frequencies f2 or f1 different from its own resonance frequency is supplied.

[0020] Set-up of the prescribed phase shift quantity will be described using a Smith chart. FIGs. 6A and 6B show Smith charts depicting input impedance characteristics of antenna element 11, where FIG. 6A depicts an instance without connecting the phase shift circuit 13, and FIG. 6B an instance with the phase shift circuit 13 connected. Further, FIGs 7A and 7B show Smith charts depicting input impedance characteristics of the antenna element 12, where FIG. 7A depicts an instance without connecting the phase shift circuit 14, and FIG. 7B an instance with the phase shift circuit 14 connected.

[0021] In these Smith charts, where a circuit characteristic impedance of 50 ohms normalizes its input impedance, a real part of the normalized impedance is indicated, for example, in FIG. 6A by a resistance line 21, and an imaginary part thereof by a reactance line 22 respectively. Further, in these Smith charts, input impedance characteristics are shown as recorded by a circular locus when the frequency of input radio waves is shifted, i.e., when the frequency is increased clockwise.

[0022] An input impedance characteristic for the antenna element 11 alone is denoted by resonance frequency f1 indicated by an arrow in FIG. 6A which is approximately in the center portion on the chart, thereby indicating to be in a matched impedance state at fl. A state shifted by a phase shift quantity $d\phi 1$ from the above state by means of the phase shift circuit 13 is depicted in FIG. 6B, where the position of f2 is shown as rotated by the phase shift quantity $d\phi 1$ on the chart while the position of f1 unchanged. Namely, from FIG. 6B, it is known that by means of the phase shift circuit 13, while maintaining the matching state at frequency f1 for the input wave, an input impedance at f2 is increased sufficiently compared with that at f1, and its phase shift quantity $d\phi 1$ is set appropriately so that antenna element 11 will not operate at f2.

[0023] Likewise in FIG. 7A, a matching state is obtained at resonance frequency f2 for the antenna element 12. However, in FIG. 7B, where the position of f1 is indicated as rotated by a phase shift quantity $d\phi 2$ without changing the position of f2 on the chart, it is known that by means of the phase shift circuit 14, its phase shift quantity $d\phi 2$ is set appropriately so that an input impedance at f1 becomes sufficiently high while maintaining the matching state at frequency f2 for the input wave.

[0024] As described above, by phase shifting with the phase shift circuit, the input impedance of the antenna element at the resonance frequency of the other antenna element in proximity is increased substantially, thereby minimizing mutual RF interference at respective operating frequencies of the proximate antenna elements, and thereby enabling to provide the antenna apparatus of the present invention which is operable at two different frequencies, and which may be implemented in a simple construction to array plural antennae in parallel connection.

[0025] Now, examples of the phase shift circuits for use in the aforementioned antenna apparatus 1 will be described in the following. FIGs. 8 and 9 show examples of the phase shift circuits comprising a lumped circuit. FIG. 8 is a phase shift circuit which realizes a positive (+) phase shift quantity. FIG. 9 is a phase shift circuit which realizes a negative (-) phase shift quantity. Further, FIGs. 10, 11 and 12 show examples of phase shift circuits comprising a distributed constant circuit. FIG. 10 is a coaxial line, FIG. 11 is a parallel twin line, and FIG. 12 is a micro-strip line.

[0026] An example of the phase shift circuits comprising a lumped circuit is shown in FIG. 8, where an inductance 41 is connected in series, and capacitors 42 and 43 are 'connected in parallel. Here, when we consider a change of phase shift on the Smith chart of FIG. 6A for an instance where inductance 41 inserted in series, a locus of impedance characteristics thereon is moved clockwise along the resistance line 21. Further, when we assume a conductance line (not shown) which is drawn symmetrically relative to the resistance line 21 on the chart (immittance chart), and when the capacitors 42 and 43 are inserted in parallel, a locus thereof is moved clockwise along the conductance line. Accordingly, by use of this phase shift circuit, the phase of input waves is shifted to a positive direction.

[0027] Further, in FIG. 9, a capacitor 51 is connected in series, and inductors 52 and 53 are connected in parallel. Referring to the Smith chart, if the capacitor 51 is inserted in series, the locus thereof is moved counterclockwise along the resistance line 21. Still further, if the

inductors 52 and 53 are inserted in parallel, the locus thereof is moved counter-clockwise along the conductance line. Accordingly, by means of this phase shift circuit, the phase of input waves is moved to a negative direction.

[0028] On the other hand, the distributed constant circuit implemented as the phase shift circuit may include the coaxial line of FIG. 10, the parallel twin line of FIG. 11, the micro-strip line of FIG. 12 and the like. The coaxial line of FIG. 10 comprises an internal conductor 61, an external conductor which is not shown, and a dielectric member 62 for supporting the external conductor. Generally, a braided wire is used as the external conductor, a single or stranded wire is used as the internal conductor 61, and polyethylene or the like is used as the dielectric member 62. The parallel twin line shown in FIG. 11 which is used widely as a feeder line for transmission and reception of a short wave band and for television waves, has a simple structure and a low cost to manufacture. However, because of an internal radiation between its parallel twin lines, there occur a very large inductive interference and radiation loss in comparison with those of the coaxial line. The micro-strip line of FIG. 12 comprises a plane conductor 81, a dielectric member 82 mounted thereon and a conductor 83.

[0029] In FIGs. 10, 11 and 12, equations for obtaining a phase shift quantity $d\phi$ resulted by transmitting through respective phase shift circuits are given. As depicted in these equations, the phase of signal after it is transmitted through these distributed constant circuits is shifted by a change in a physical length L of their lines. A relationship between a physical length of its circuit and an electrical length within its circuit changes depending on a diameter, a thickness, and a specific dielectric constant εr of its line. However, as for the effect for shifting the phase, any of these circuits can be used for this purpose. Further, in consideration of advantages in terms of ease of mounting on a substrate as well as of a low cost in manufacture, the micro-strip line is considered most preferable as a phase shift circuit for use in the portable communication apparatus.

[0030] In the next, examples of calculations of a total impedance characteristic of the antenna elements 11 and 12 combined together as well as of return-loss characteristics which were obtained by circuit simulation respectively will be described with reference to FIGs. 13 and 14, as well as with reference to FIGs. 15 and 16, respectively. FIG. 13 shows an input impedance characteristic where the phase shift circuits 13 and 14 are connected whereas FIG. 14 shows an input impedance characteristic where the phase shift circuits 13 and 14 are not connected. Further, FIG. 15 shows a return-loss characteristic where the phase shift circuits 13 and 14 are connected whereas FIG. 16 shows a return-loss characteristic where the phase shift circuits 13 and 14 are not connected.

[0031] By way of example, in respective circuit simulations of FIGs. 13, 14, 15 and 16, the distributed constant circuit was used as the phase shift circuit, and respective impedance characteristics were recorded while the frequency was changed from 1GHz to 3GHz. Resonance frequencies f1 and f2 of the antenna elements 11 and 12 are set at 1.95GHz and 2.14GHz, respectively. Respective points of measurement at these frequencies are depicted as M1 and M2 respectively on the charts, and values of input impedance measured at M1 and M2 are denoted by Z1 and Z2, and also values of return-losses measured are denoted by RL1 and RL2 respectively.

[0032] With reference to FIG. 13, with respect to frequency f1 or f2, M1 or M2 is approximately in the center portion on the chart thereby indicating an impedance matching at this frequency. Further, with reference to FIG. 15, it is clearly shown that in portions other than at f1 or f2, a loss increases substantially. In FIG. 14, however, a mismatching at each operational frequency is shown. In FIG. 16, a large loss at each operational frequency is shown. Thereby, it is known that by provision of the phase shift circuits 13 and 14, adverse interference between antenna elements is suppressed, and an excellent two-frequency operation characteristic is obtained. As described above, the antenna apparatus 1 in accordance with the present embodiment of the present invention has an excellent operational characteristic even when two proximate frequencies are in use despite its simple construction. Further, it should be noted that it is also possible to make two remote frequencies which are discretionary selected to be operable in the same antenna arrangement described above.

[0033] Furthermore, in the antenna apparatus 1 described above, the same operation as described above may be obtained in view of the theoretical principle of the antenna even when a phase shift quantity of $n\ \lambda/2$ (where λ is a wavelength of an operational frequency of a proximate antenna element, and n is an integer) is added to the phase shift quantity determined above by means of the phase shift circuit. This is also clear from the fact that in FIGs. 6B and 7B, where one turn of scales around the outer circumference of its Smith charts corresponds to 1/2 of its wavelength, one rotation around the measurement line on the chart returns to its original position on the chart. In an actual circuit, however, available frequency bands may be more limited as a value of |n| increases because of shortcomings such as increasing loss with higher |n| value. Accordingly, it is preferable to minimize the value of n.

[0034] In the foregoing description of the present invention, the antenna apparatus having two antenna elements have been explained, however, it is not limited thereto, and it is also possible to realize an antenna apparatus which is operable at a plurality of frequencies by using more than two antenna elements, and connecting in parallel such antenna elements via respective phase shift circuits to its radio circuit. Frequency characteristics of these antenna elements and those of the phase shift circuits determine the number of frequencies

operable in this antenna apparatus 1, and there is basically no limitation in the number of operable frequencies. In practice, however, the number of operable frequencies may be limited up to approximately four. For example, in such antenna equipment, a frequency of interest to be handled by the phase shift circuit connected to a given antenna element will have to be selected from operational frequencies belonging to the other antenna elements. Accordingly, good impedance characteristic is not always ensured to be obtained at any operational frequencies other than the one corresponding to the respective phase shift circuit, and it may be considered that the operable frequency itself is limited.

[0035] Further, with reference to FIGs. 17, 18, 19, 20 and 21, some examples of the antenna elements applicable to the antenna equipment in accordance with the embodiment of the present invention are shown. FIG. 17 shows a dipole antenna, FIG. 18 a loop antenna, FIG. 19 a plane inverted F pattern antenna, FIG. 20 an inverted L pattern antenna, and FIG. 21 a helical antenna, respectively.

[0036] In the case of FIG. 17 using the dipole antenna, assuming a wavelength of its resonance frequency to be λ, lengths of dipole antennae 131 and 132 are normally selected to be λ /2. When their antenna lengths are desired to be shortened, a matching circuit 17 and 18 are connected between each antenna element and its phase shift circuits 13 and 14 respectively in order to avoid a probable mismatching due to shortened length of the dipole antenna. Further, because that the radio circuit 16 is normally an unbalanced circuit with one end of the circuit grounded whereas the dipole antenna is a balanced antenna, if they are coupled directly, an unbalanced current will flow therebetween thereby causing a power loss. Therefore, a balanced-to-unbalanced transformer (Balun) 19 is required to be connected therebetween. A whip antenna of a front end feed type which is one of the aforementioned dipole antennas is widely used for vehicle communication and portable communication apparatus. The antenna apparatus of the present invention is, therefore, desirable as antenna elements to be mounted in these wireless communication apparatus.

[0037] As for loop antennae 141 and 142 shown in FIG. 18, its loop diameter is normally selected to be less than one wavelength of the frequency of radio waves, and if a large impedance mismatching exists, the matching circuits 17 or 18 is connected between each antenna element and its phase shift circuits 13 or 14, respectively. Further, because that the loop antenna is a balanced antenna, a Balun circuit 19 needs to be connected between the antennae and the radio circuit 16.

[0038] Plane inverted F pattern antennae 151 and 152 shown in FIG. 19 are unbalanced antennae, therefore, the connection of the Balun circuit is not necessary, thereby allowing a direct coupling of the radio circuit 16 and the phase shift circuits 13 and 14. There is no need of connection of a matching circuit because of a capability of self-matching by the antennae themselves. This type of plane inverted F pattern antennae or its modified antenna elements are used as a built-in antenna for a portable telephone, therefore, the antenna apparatus of the present invention is preferable for use as antenna elements to be installed in the portable telephone.

[0039] Further, inverted L pattern antennae 161 and 162 shown in FIG. 20 are unbalanced antenna elements, and have a folded monopole antenna structure in order to realize a lower attitude. Normally, there are required additional connection of the matching circuits 17 and 18.

[0040] Still further, helical antennae 171 and 172 shown in FIG. 21 are unbalanced helical type antenna elements. They may be used as directional antennae or horizontal non-directional antennae depending on its helical diameter and length. Normally, they are used with the matching circuits 17 and 18 connected between each antenna element and its phase shift circuits 13 and 14.

[0041] As described heretofore, according to the antenna apparatus of the invention, because that the antenna elements are connected to the feed point via respective phase shift circuits so as to enable adjustment of the characteristic impedance of a given antenna element at the different resonance frequency of the other proximate antenna element and to eliminate the adverse effect between these antennae, operability of this antenna apparatus at different frequencies which are relatively proximate is enabled by provision of the antenna apparatus of at least preferred embodiments of the present invention which is realized in a simple configuration.

[0042] Further, according to the portable wireless communication apparatus provided with the antenna apparatus of at least preferred embodiments of the present invention, because that the antenna elements are connected to the feed point via respective phase shift circuits so as to enable adjustment of the characteristic impedance of a given antenna element at the resonance frequency of the other proximate antenna element and to eliminate adverse effects between these antennae, reception and transmission of radio waves with different frequencies, which are relatively proximate, are enabled by provision the antenna apparatus of at least preferred embodiments of the present invention realized in a simple configuration.

Claims

1. An antenna apparatus for receiving or transmitting radio waves at two different frequencies, comprising:

   a pair of antenna elements having different resonant frequencies, and
   a pair of phase shift circuits for shifting phase

of said radio waves, wherein
feed points of said pair of antenna elements are connected to a radio circuit via said pair of phase shift circuits, respectively.

2. An antenna apparatus according to claim 1, wherein:
one of said phase shift circuits which are coupled to said one of said antenna elements shifts phase of said radio waves so as to increase an impedance of said one of said antenna elements at the resonance frequency of the other one of said antenna elements.

3. An antenna apparatus according to claim 1, wherein:
said phase shift circuit comprises a lumped circuit.

4. An antenna apparatus according to claim 1, wherein:
said phase shift circuit comprises a distributed constant circuit.

5. An antenna apparatus for receiving or transmitting radio waves at a plurality of frequencies, comprising:

a plurality of antenna elements having different resonant frequencies; and
a plurality of phase shift circuits for shifting phase of said radio waves, wherein
feed points of said plurality of antenna elements are connected to a radio circuit via said plurality of phase shift circuits, respectively.

6. The antenna apparatus according to claim 5, wherein:
one of said phase shift circuits which is coupled to said one of said antenna elements shifts phase of said radio waves so as to increase an impedance of said one of said antenna elements at the resonance frequency of another one of said antenna elements.

7. The antenna apparatus according to claim 5, wherein:
each of said plurality of phase shift circuits comprises a lumped circuit.

8. The antenna apparatus according to claim 5, wherein:
each of said plurality of phase shift circuits comprises a distributed constant circuit.

9. A portable wireless communication apparatus having an antenna apparatus for receiving or transmitting radio waves at a plurality of frequencies, said antenna apparatus comprising:

a plurality of antenna elements having different resonant frequencies; and
a plurality of phase shift circuits for shifting phase of said radio waves, wherein
feed points of said plurality of antenna elements are connected to a radio circuit via said plurality of phase shift circuits, respectively.

10. The portable wireless communication apparatus according to claim 9, wherein:
said portable wireless communication apparatus is a portable telephone.

FIG.1

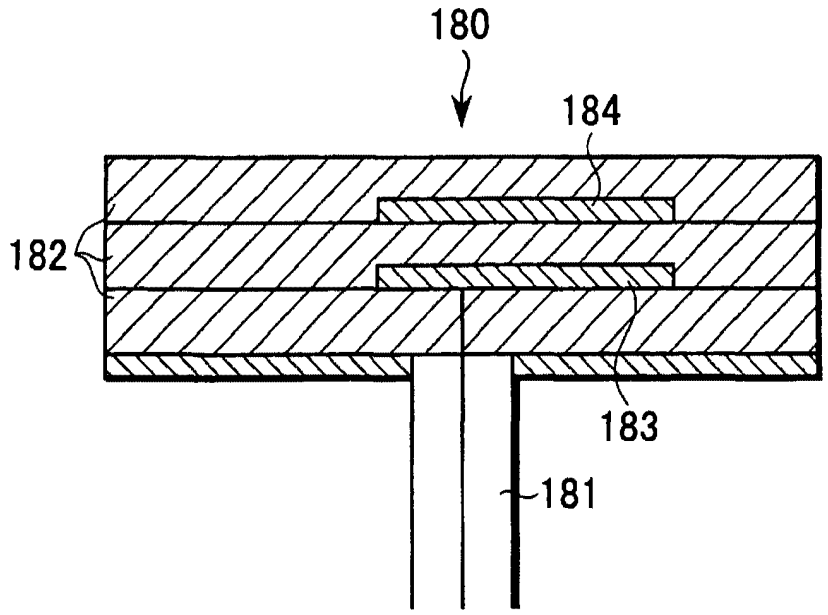


FIG.2

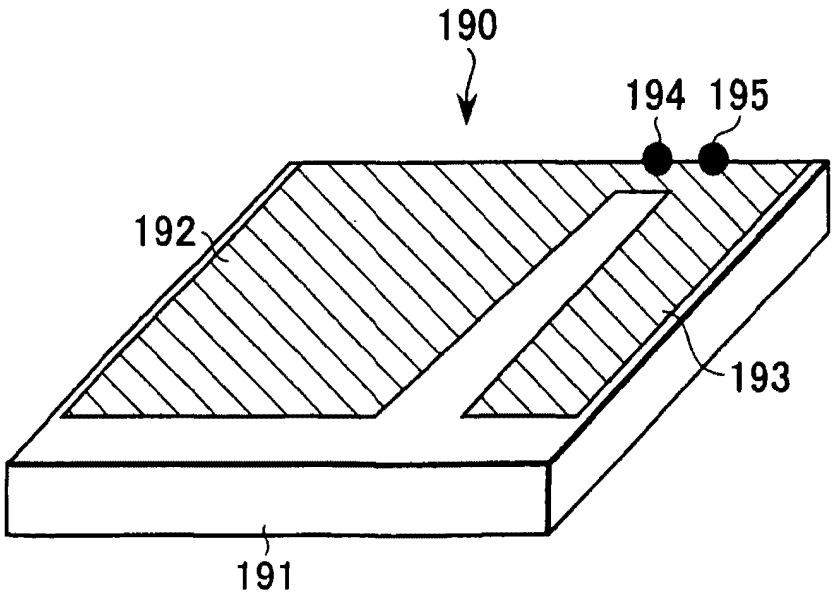


FIG.3

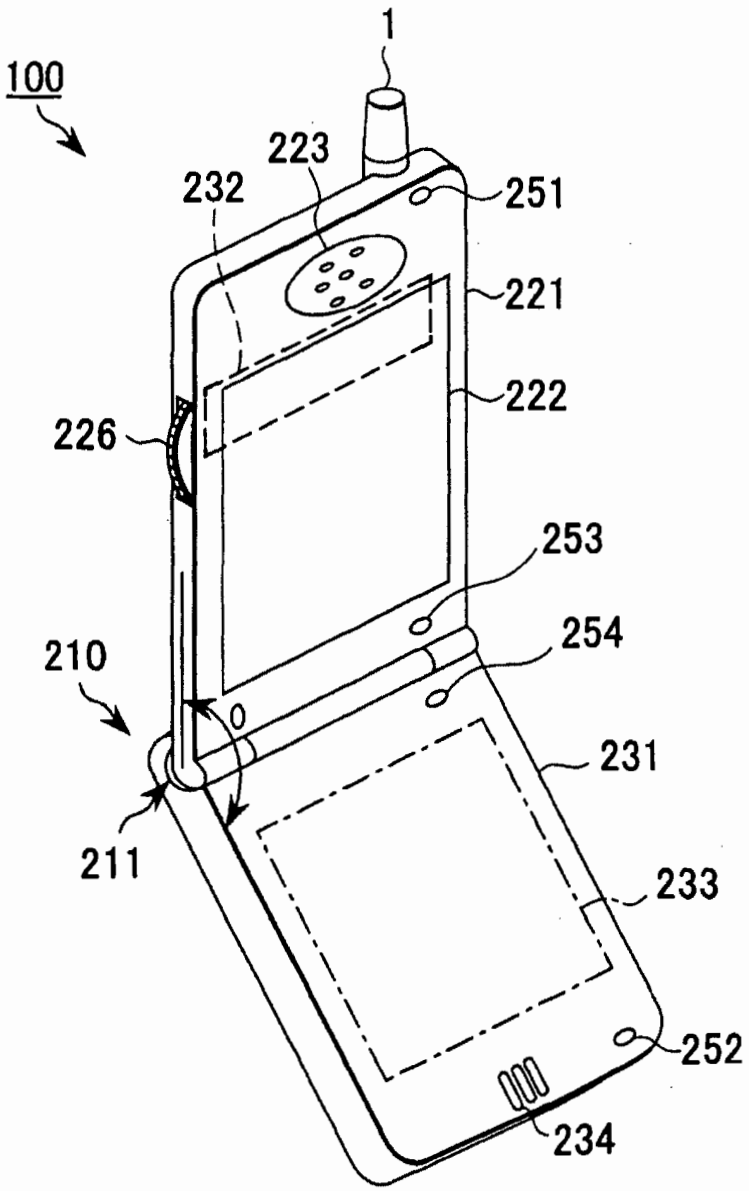
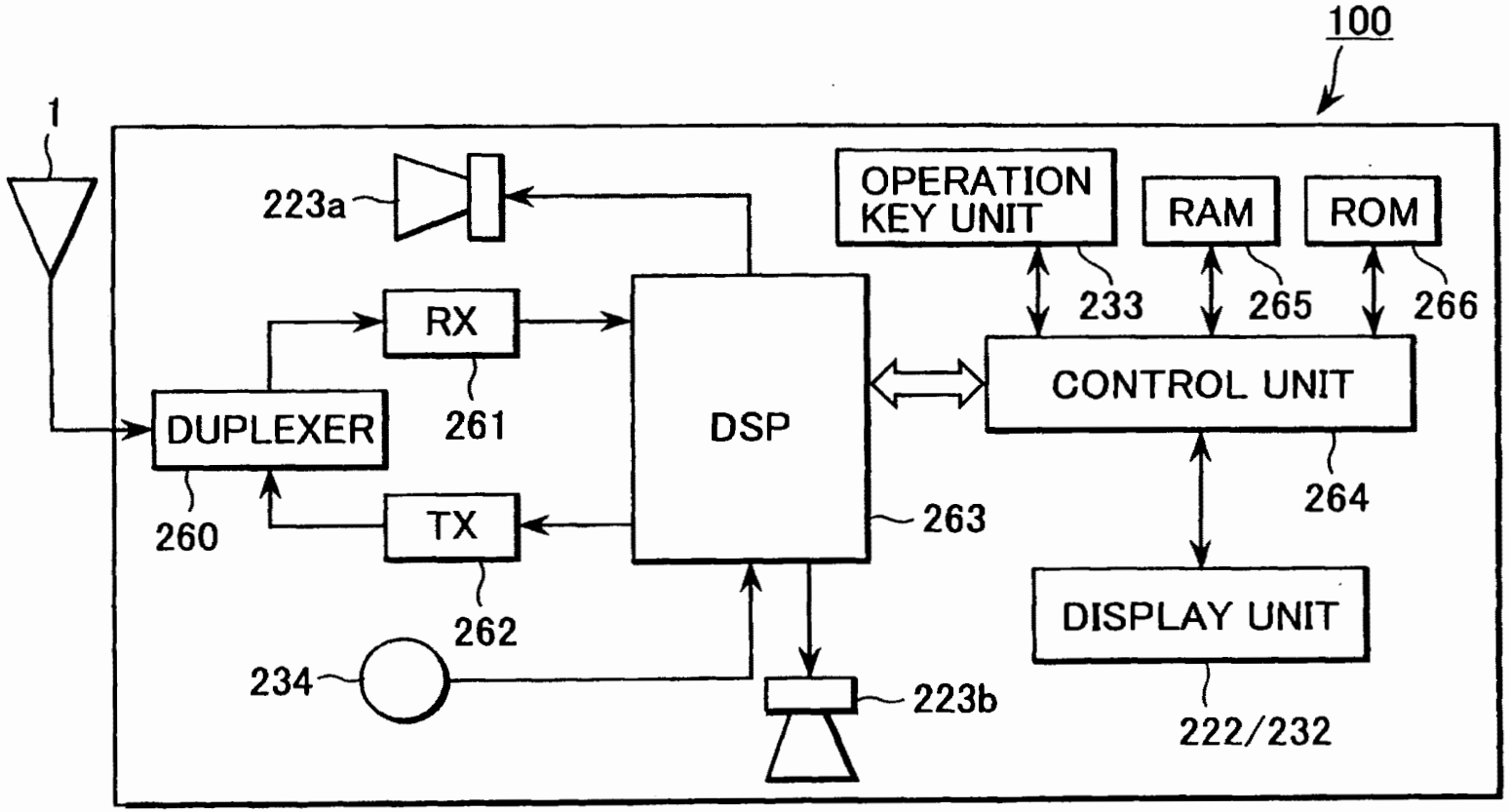


FIG.4



EP 1 137 100 A2

FIG.5

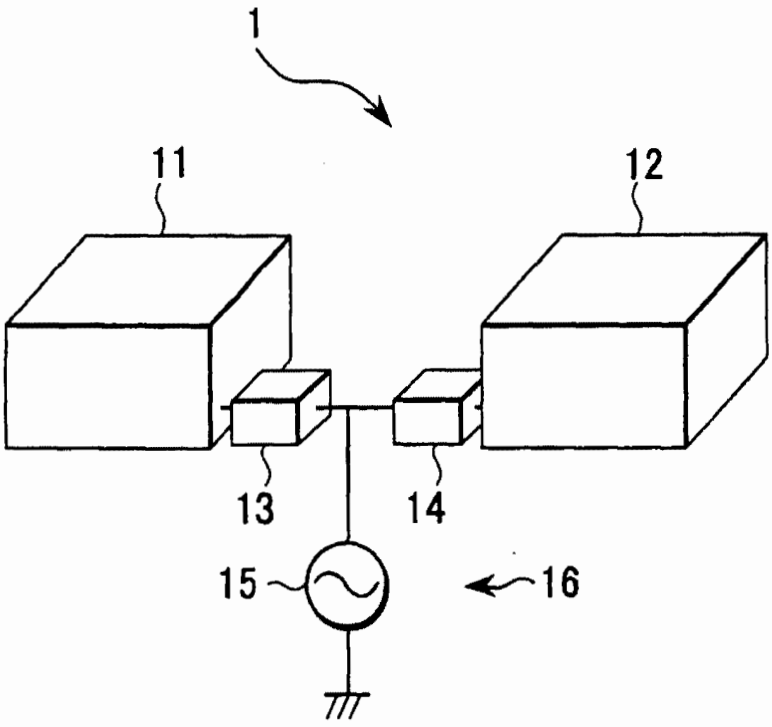


FIG.6A

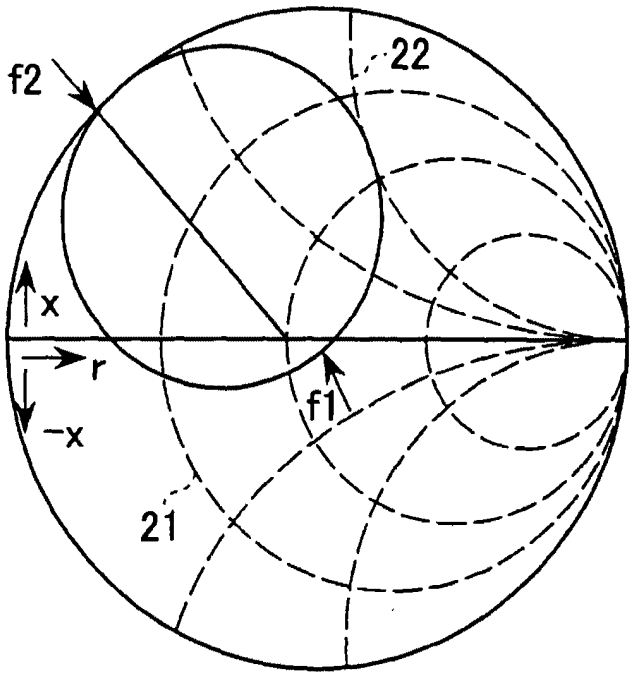


FIG.6B

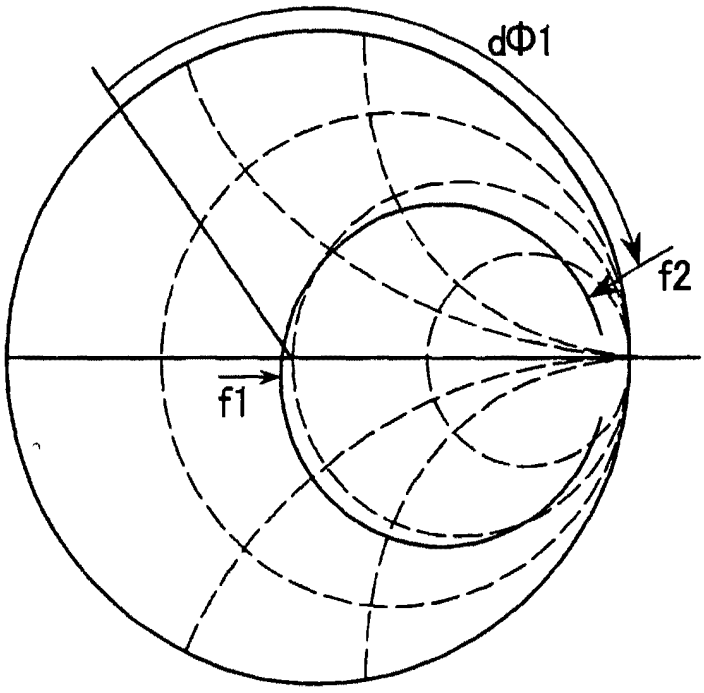


FIG.7A

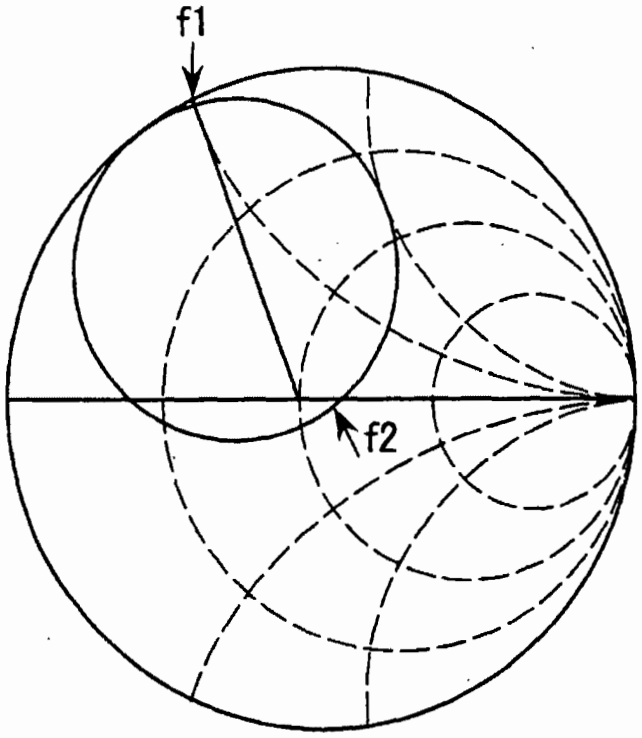


FIG.7B

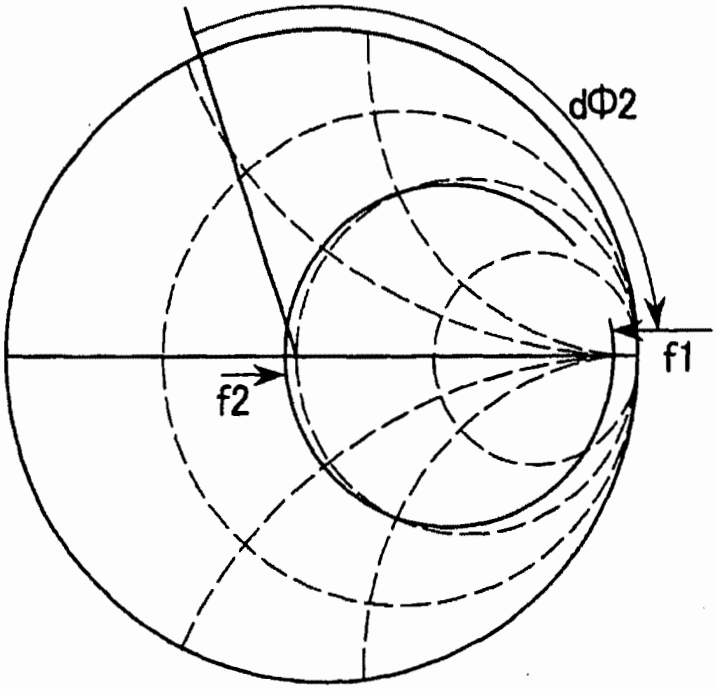


FIG.8

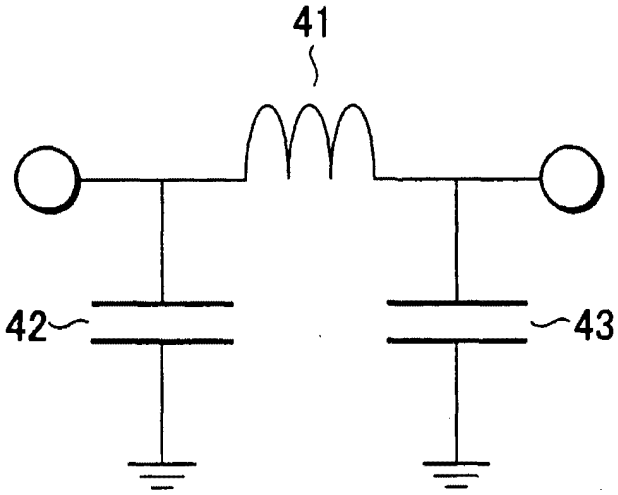


FIG.9

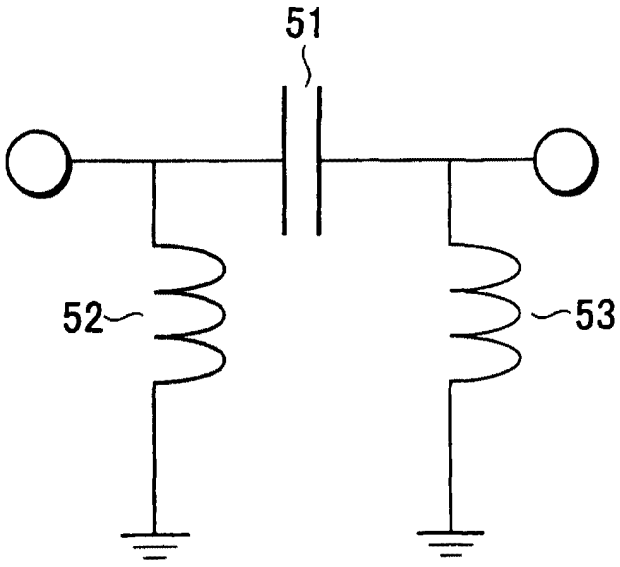
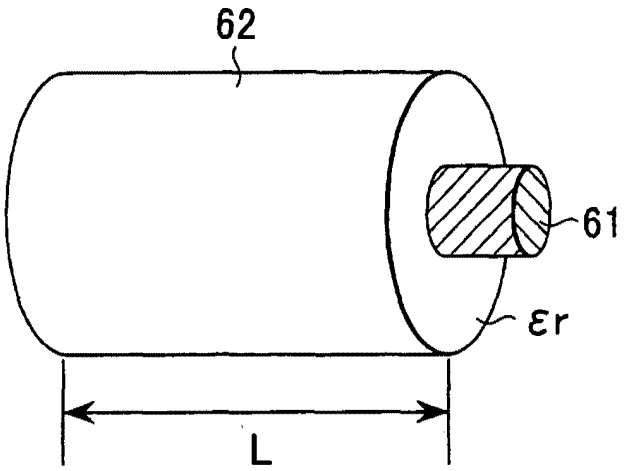
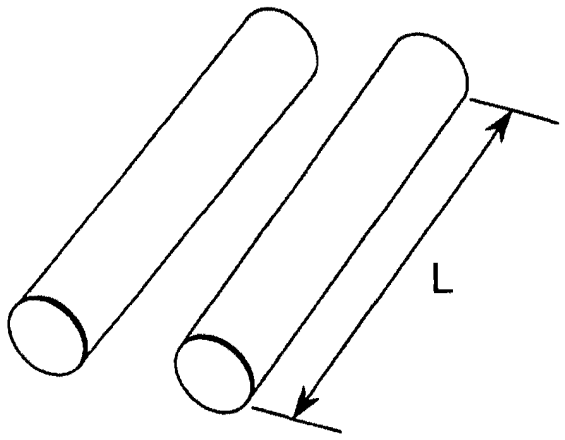


FIG.10



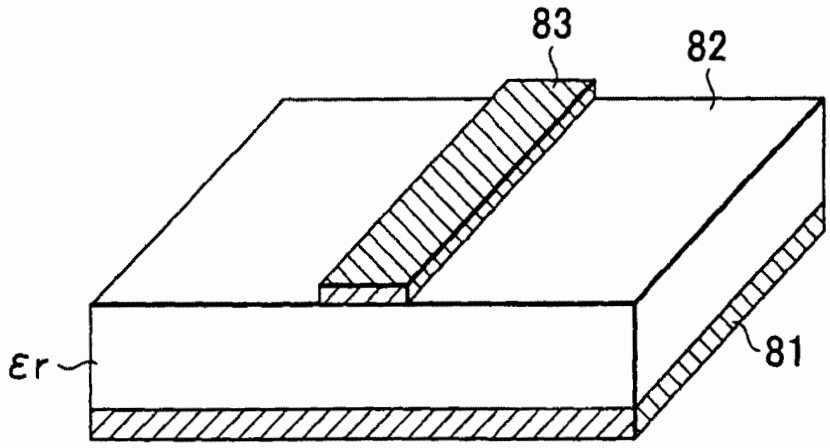
$$d\Phi = \frac{L}{\sqrt{\varepsilon r}} \times \frac{360}{\lambda} [\text{deg}]$$

FIG.11



$$d\Phi = L \times \frac{360}{\lambda} [\text{deg}]$$

FIG.12



$$d\Phi = \frac{L}{\sqrt{\varepsilon eff}} \times \frac{360}{\lambda} [deg]$$

FIG.13

M1:
f1=1.9500E+09[Hz]
Z1=Z0*(997.57E-03-j49.568E-03)[Ω]

M2:
f2=2.1400E+09[Hz]
Z2=Z0*(814.07E-03+j148.27E-03)[Ω]

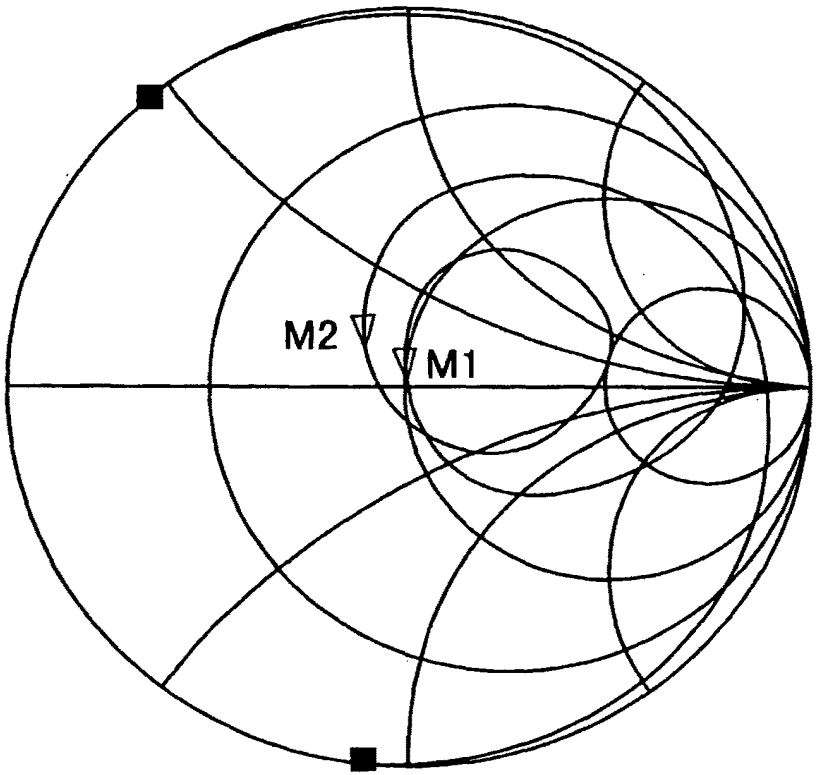


FIG.14

M1:
f1=1.9500E+09[Hz]
Z1=Z0*(360.50E-03+j462.72E-03)[Ω]

M2:
f2=2.1400E+09[Ω]
Z2=Z0*(129.21E-03+j254.14E-03)[Hz]

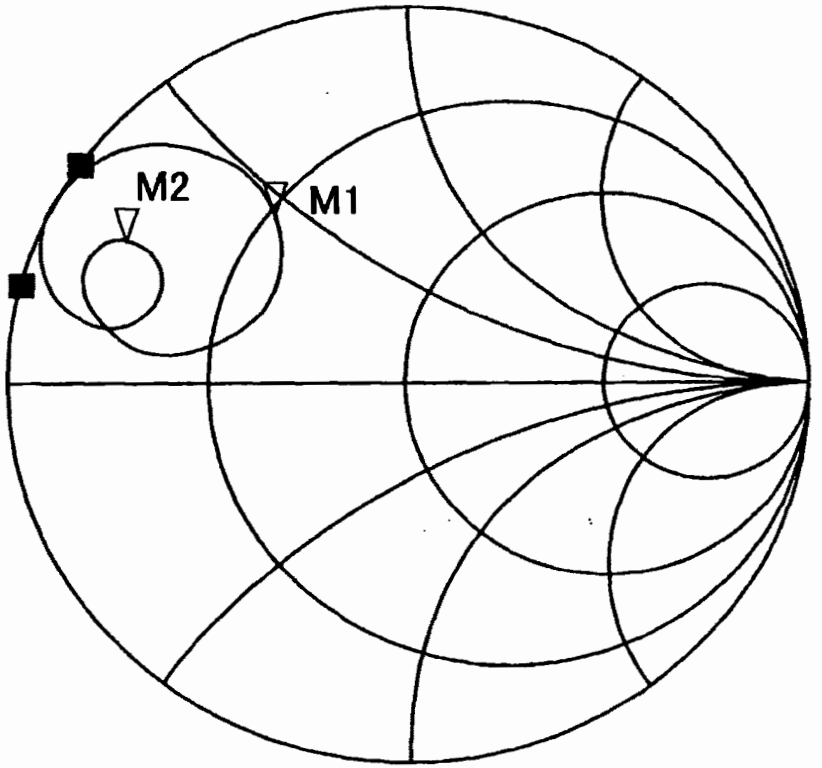


FIG.15

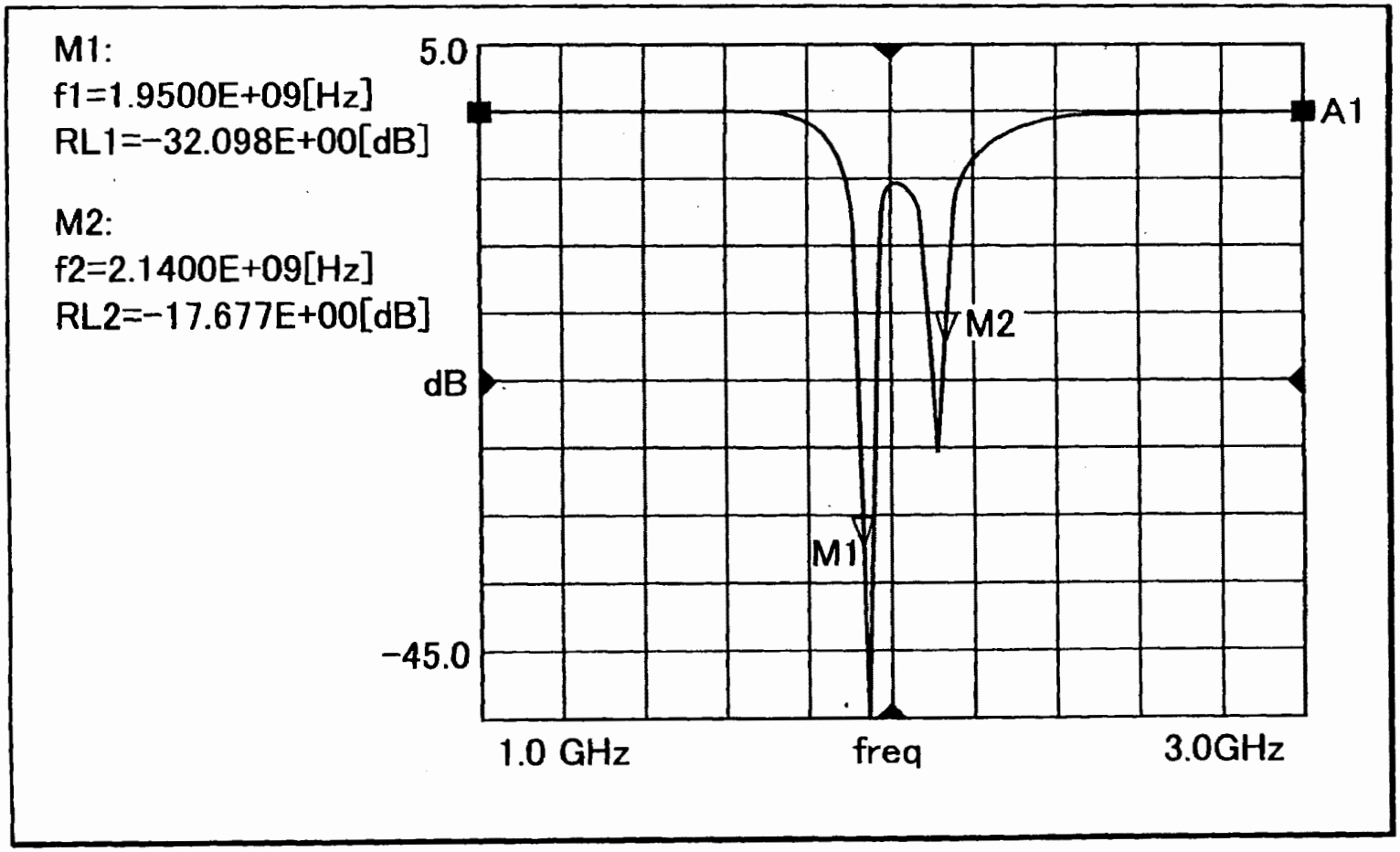

M1:
f1=1.9500E+09[Hz]
RL1=−32.098E+00[dB]
M2:
f2=2.1400E+09[Hz]
RL2=−17.677E+00[dB]
5.0
dB
−45.0
A1
M2
M1
1.0 GHz
freq
3.0GHz

FIG.16

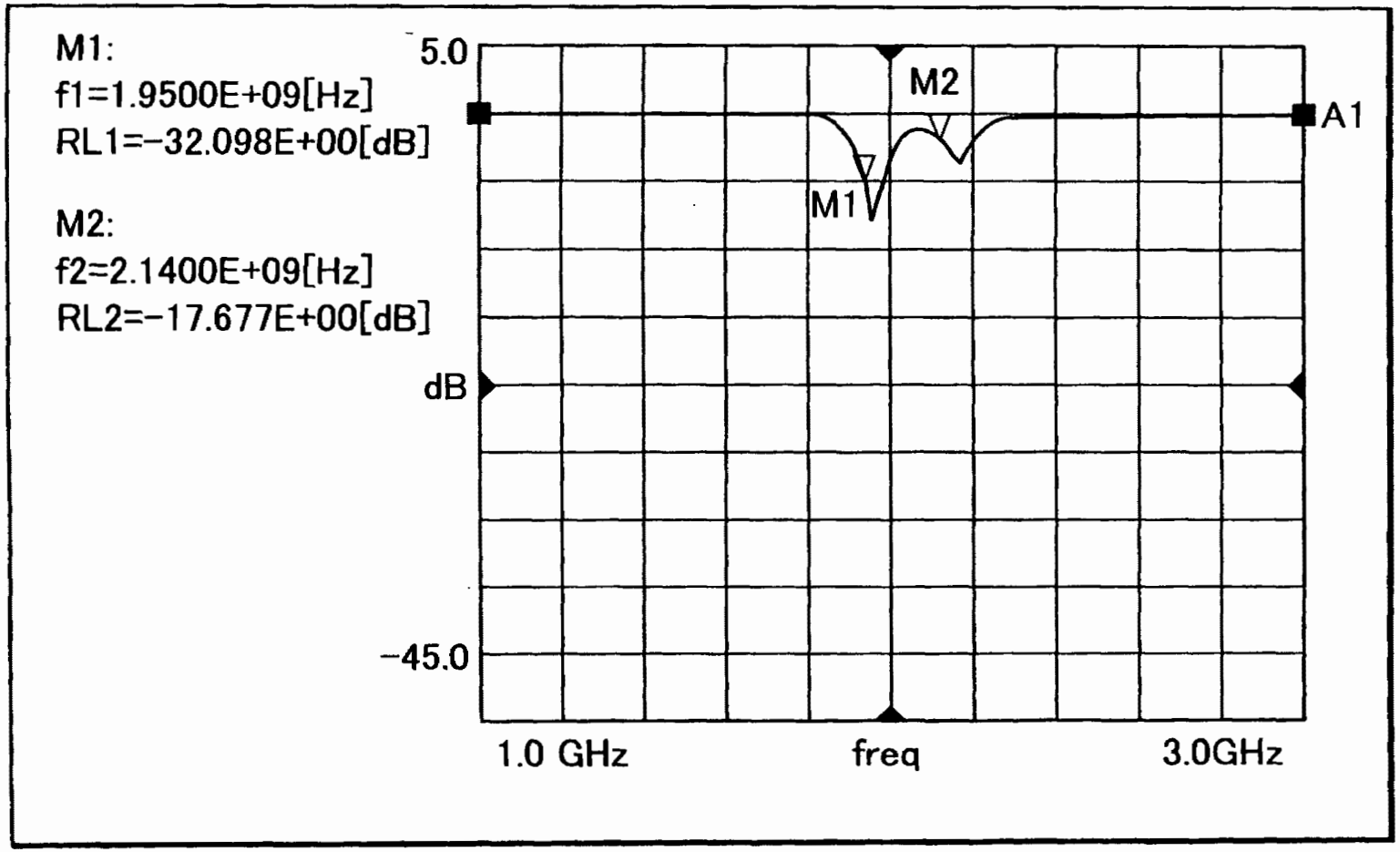

M1:
f1=1.9500E+09[Hz]
RL1=−32.098E+00[dB]
M2:
f2=2.1400E+09[Hz]
RL2=−17.677E+00[dB]
5.0
dB
−45.0
M1
M2
A1
1.0 GHz
freq
3.0GHz

FIG.17

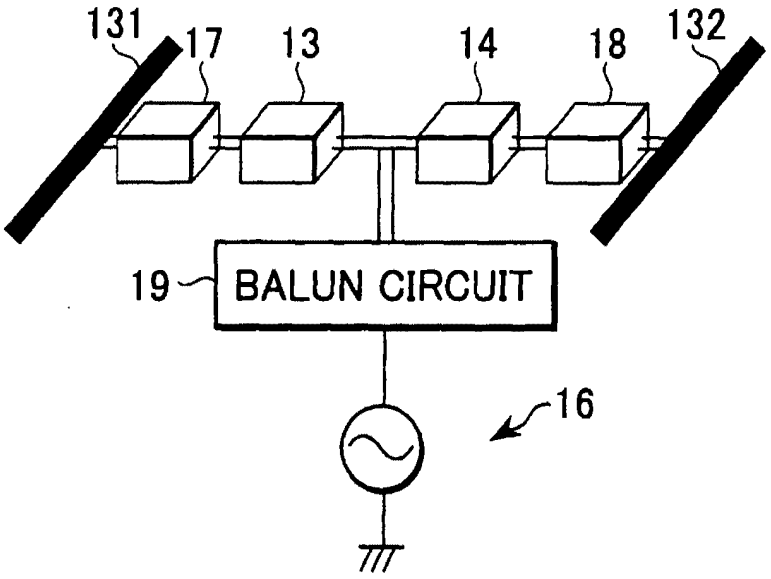

131
17
13
14
18
132
19
BALUN CIRCUIT
16

FIG.18

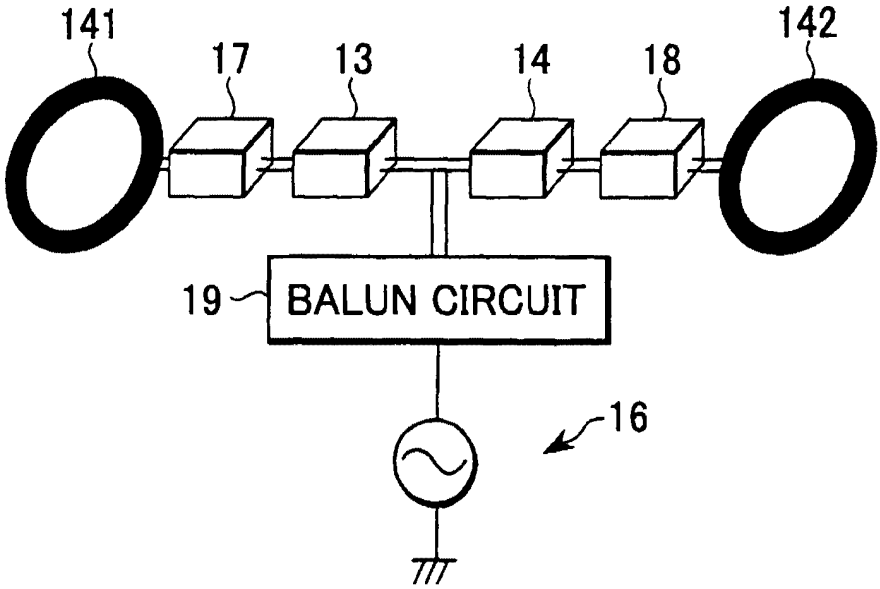

141
17
13
14
18
142
19
BALUN CIRCUIT
16

FIG.19

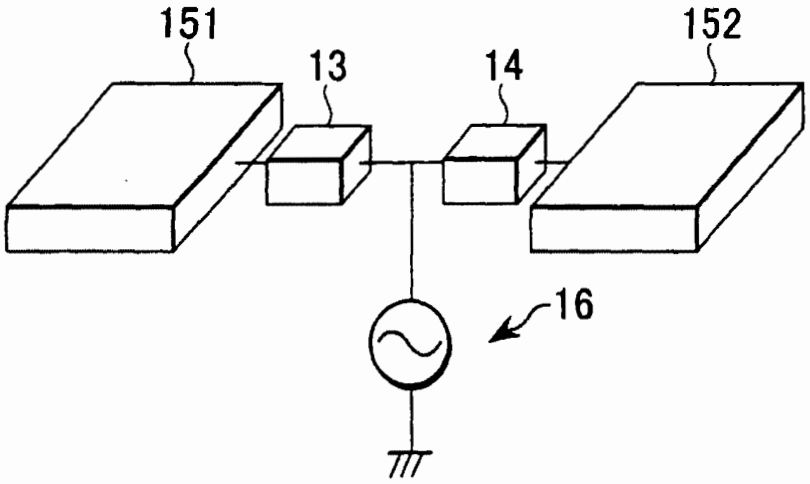


FIG.20

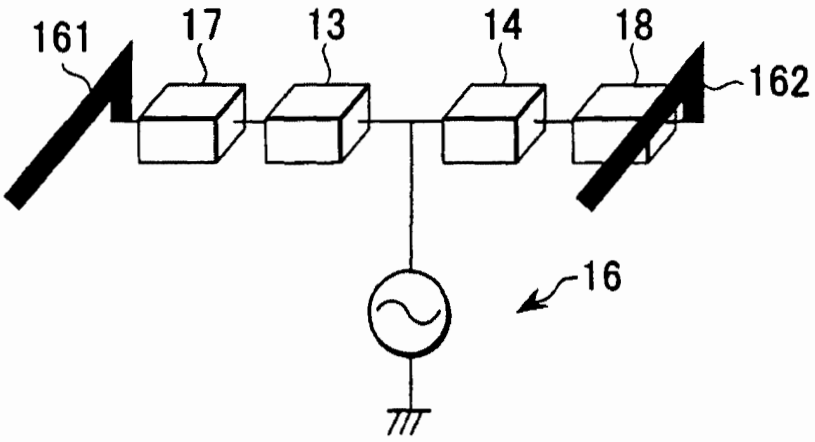
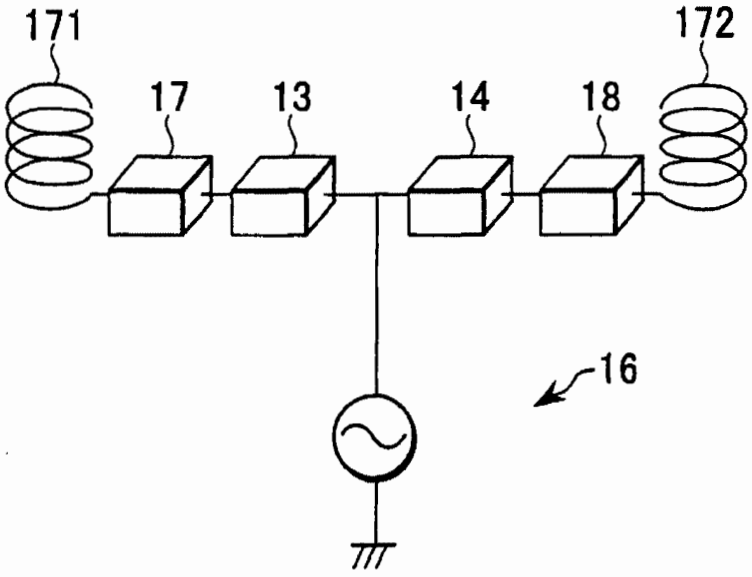


FIG.21



IF2

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: August 26, 2008 Signature: Tracie London
(Tracie London)

OIPE IAP29 SEP 02 2008 PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information

as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: August 25, 2008

Respectfully submitted,

By _____
Stanley R. Moore
Registration No.: 26,958
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: August 26, 2008 Signature: Tracie London
(Tracie London)

USPTO IAP20 SEP 02 2008 PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information

as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: August 25, 2008

Respectfully submitted,

By _____

Stanley R. Moore
Registration No.: 26,958
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP79 SEP 02 2008 PATENT & TRADEMARK OFFICE

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1445821	EP	A1	2004-08-11	MATSUSHITA ELECTRIC INDUSTRIAL		☐
	2	1538694	EP	A1	2005-06-08	MATSUSHITA ELECTRIC INDUSTRIAL		☐

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ANGUERA, J.; RISCO, S., Coupled monopoles on a handset / wireless PCB, Fractus, January 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

OIPE IAP79
SEP 02 2008
PATENT & TRADEMARK OFFICE

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1445821	EP	A1	2004-08-11	MATSUSHITA ELECTRIC INDUSTRIAL		☐
	2	1538694	EP	A1	2005-06-08	MATSUSHITA ELECTRIC INDUSTRIAL		☐

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ANGUERA, J.; RISCO, S., Coupled monopoles on a handset / wireless PCB, Fractus, January 2008	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 538 694 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
08.06.2005 Bulletin 2005/23

(21) Application number: **03741127.9**

(22) Date of filing: **26.06.2003**

(51) Int Cl.[7]: **H01Q 1/24**

(86) International application number:
PCT/JP2003/008149

(87) International publication number:
WO 2004/010530 (29.01.2004 Gazette 2004/05)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR

(30) Priority: **19.07.2002 JP 2002210612**
24.01.2003 JP 2003015675
12.06.2003 JP 2003167962

(71) Applicant: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
Kadoma-shi, Osaka 571-8501 (JP)

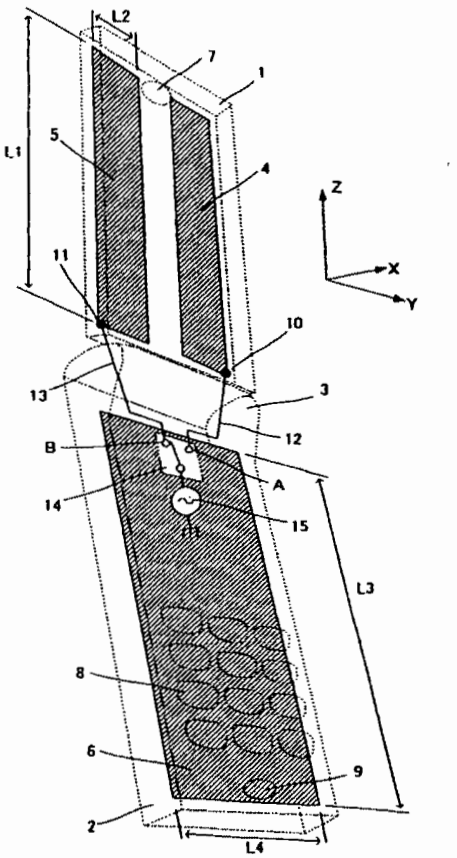
(72) Inventors:
- **SAITO, Yutaka**
  Nomi-gun, Ishikawa 923-1224 (JP)
- **KOYANAGI, Yoshio**
  Ebina-shi, Kanagawa 243-0405 (JP)
- **YAMADA, Kenichi**
  Yokohama-shi, Kanagawa 240-0022 (JP)
- **KOSHI, Masashi**
  Kanazawa-shi, Ishikawa 920-0348 (JP)
- **YAMAZAKI, Yukari**
  Kanazawa-shi, Ishikawa 920-0022 (JP)

(74) Representative: **Schuster, Thomas, Dipl.-Phys.**
Grünecker, Kinkeldey, Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) PORTABLE WIRELESS MACHINE

(57) An upper case (1) is connected to a lower case (2) in a hinge portion (3) so as to freely rotate. A plate shaped conductor (4) and a plate shaped conductor (5) are disposed along the surface of the case in the upper case (1). A ground plate (6) is formed in a ground pattern of a circuit board disposed in the lower case (2). The plate shaped conductor (4) and the plate shaped conductor (5) are selected by a high frequency switch (14) and connected to one end of a feeding portion (15). The other end of the feeding portion (15) is connected to the ground plate (6) to form a dipole antenna.

FIG. 1



EP 1 538 694 A1

Description

<Technical Field>

[0001] The present invention relates to a portable radio device such as a portable telephone, and more particularly to a portable radio device having a collapsible casing.

<Background Art>

[0002] A portable radio device with a collapsible structure ordinarily has a mechanism including an upper casing and a lower casing connected by a hinge so as to be freely open and close. Thus, the portable radio device can take an opening state and a closing state. The portable radio device has two advantages of a high visibility and an easy portability that a viewable display screen can be enlarged under a state that the device is opened and used (namely, an opening state) and the device can be made compact under a state that the device is closed and used (a closing state) from the viewpoint of such structural characteristics.

[0003] As an antenna of a foldable portable telephone, a protrusion type antenna disposed in a casing is disclosed in JP-A-2001-45123.

[0004] For such a protrusion type antenna, a helical antenna or an extensible mono-pole antenna is ordinarily employed. Since the antenna portion protrudes from the casing, an antenna gain can be raised while a hand holds the portable telephone.

[0005] However, since the antenna portion is protruded, when the portable telephone is taken out from a pocket or the like, the antenna may be sometimes caught by a part of the pocket so that the portable telephone is hardly taken out.

[0006] As compared therewith, as an antenna contained in the casing of the foldable portable telephone, a strip line antenna is disclosed in JP-A-10-308618. Further, in JP-A-2001-284934, a hinge portion contained antenna is disclosed. Further, in JP-A-2001-156898, an antenna contained in an upper casing is disclosed.

[0007] Still further, as a flip type antenna contained in the casing of the portable telephone, a coil type antenna is described in JP-A-9-64778 and a micro-strip line antenna is described in JP-A-10-190330.

[0008] Further, JP-A-10-84406 discloses a plurality of element contained antenna in which a dipole antenna as a radiation element contained in an upper casing is combined with a non-feeding element contained in a lower casing.

[0009] Since the above-described antenna contained in the casing has no part protruding from the casing, the antenna is not caught by a part of the pocket or the like. However, since the direction of a main polarized wave emitted from the antenna is limited to a specific direction, a difference is undesirably generated in the antenna gain between a case that the portable telephone is held by a left hand during speaking (a left hand speaking state) and a case that the portable telephone is held by a right hand (a right hand speaking state).

[0010] Further, in the hinge portion contained antenna, under a state in which the portable telephone is allowed to come near to the ear and the mouth to speak (refer this state as to a speaking state, hereinafter), when the hinge portion is held by a hand, the antenna gain may be sometimes undesirably deteriorated, because the antenna portion is covered with the hand.

[0011] Further, in the flip part contained antenna, while the flip part is closed, a portable telephone main body is allowed to come near to the antenna portion so that the antenna gain may be possibly deteriorated.

[0012] Still further, in the plurality of element contained antenna, while the upper and lower casings are opened to speak, when a part near the radiation element is covered with a hand, the antenna gain may be undesirably deteriorated.

[0013] It is an object of the present invention to provide a portable radio device having an antenna with a high performance under various using states.

<Disclosure of the Invention>

[0014] A portable radio device according to the present invention comprises: a first casing; a second casing; a connection portion connecting the first casing to the second casing so as to freely rotate; a first antenna element provided in the first casing; a conductor element provided in the second casing to form a dipole antenna together with the first antenna element; and a feeding portion having one end electrically connected to the first antenna element and the other end electrically connected to the conductor element.

[0015] According to this structure, the antenna elements respectively accommodated in the first and second casings integrally operate as the dipole antenna. Thus, under a using state in which the portable radio device is held by a hand, a high antenna gain can be operationally obtained.

[0016] Further, in the portable radio device according to the present invention, a plurality of first antenna elements are provided in the first casing and a switching portion is further provided for switching the plurality of first antenna elements to connect them to the feeding portion.

[0017] According to this structure, a directional diversity effect can be obtained. Under a speaking state, even when the portable radio device is held by either of a left hand and a right hand, a high antenna gain can be obtained.

[0018] Further, in the portable radio device according to the present invention, the switching portion switches whether the plurality of the first antenna elements are electrically connected to the feeding portion or electrically connected to the conductor element, respectively.

[0019] According to this structure, a diversity effect having a higher directivity is operationally obtained.

[0020] Further, in the portable radio device according to the present invention, a half-wavelength element electrically connected between at least one of the plurality of the first antenna elements and the switching portion is further provided.

[0021] According to this structure, even when the portable radio device is closed, a high antenna performance is obtained.

[0022] Further, in the portable radio device according to the present invention, a plurality of half-wavelength elements respectively electrically connected to the plurality of the first antenna elements are further provided and the switching portion selectively switches the plurality of the first antenna elements and the plurality of the half-wavelength elements to connect them to the feeding portion.

[0023] According to this structure, even when the portable radio device is closed, a high antenna performance can be obtained and a directional diversity effect can be also obtained.

[0024] Further, in the portable radio device according to the present invention, impedance matching portions respectively individually corresponding to the plurality of the first antenna elements are further provided.

[0025] According to this structure, even when the portable radio device is closed, the high antenna performance can be obtained.

[0026] Further, the portable radio device according to the present invention further comprises: a casing opening and closing state detecting portion for detecting whether or not the first casing and the second casing are mutually opened; and a control portion for controlling the switching portion in accordance with the detected result of the casing opening and closing state detecting portion.

[0027] According to this structure, a high antenna performance corresponding to the opening or the closing state of the portable radio device can be obtained.

[0028] Further, in the portable radio device according to the present invention, a control portion is further provided for deciding the receiving level of a radio circuit portion to control the switching portion to raise the receiving level.

[0029] According to this structure, a high antenna performance can be always ensured under various using states of the portable radio device.

[0030] Further, in the portable radio device according to the present invention, the antenna element and the conductor element are respectively formed in plate shapes along the surfaces of the first casing and the second casing.

[0031] According to this structure, the first antenna element and the conductor element are respectively incorporated in the first casing and the second casing. However, the first casing and the second casing can be respectively formed with small thickness, so that they can sufficiently operationally meet a light and thin portable radio device.

[0032] Further, in the portable radio device according to the present invention, a circuit board formed in the second casing and having a radio circuit is further provided. The conductor element is formed in a ground pattern formed on the circuit board disposed in the second casing. A ground of the radio circuit portion is electrically connected to the ground pattern and the feeding portion is provided in the radio circuit portion.

[0033] According to this structure, a high antenna performance can be ensured and a thin portable radio device can be easily formed.

[0034] Further, the portable radio device according to the present invention further comprises: a second antenna element provided in the second casing near the connection portion; an opening and closing state detecting portion for detecting the opening and closing states of the first casing and the second casing; and a switching portion for selecting and switching any one of the first antenna element and the second antenna element to a connection to a signal processing portion for performing a signal process. When the first casing and the second casing are opened, the first antenna element and the conductor element form the dipole antenna, and when the first casing and the second casing are closed, the second antenna element and the conductor element form a mono-pole antenna.

[0035] According to this structure, even when the upper casing and the lower casing are opened or closed, the high antenna performance can be assured.

[0036] Further, in the portable radio device according to the present invention, when the first casing and the second casing are opened, the switching portion selects the first antenna element, and when the upper casing and the lower casing are closed, the switching portion selects the second antenna element.

[0037] According to this structure, even when the upper casing and the lower casing are opened or closed, the high antenna performance can be assured.

[0038] Further, the portable radio device according to the present invention further comprises: a second antenna element provided in the second casing near the connection portion; a receiving field intensity measuring portion for measuring the receiving field intensity of a signal received by the first antenna element or the second antenna element;

and a switching portion for selecting and switching the antenna element having a higher receiving field intensity to a connection to a signal processing portion for performing a signal process in accordance with the measured result of the receiving field intensity measuring portion. The first antenna element has a first feeding point to be electrically connected to the conductor element. The second antenna element has a second feeding point to be electrically connected to the conductor element. The first feeding point and the second feeding point are provided at the diagonal positions of opposed sides when the first casing and the second casing are opened.

[0039] According to this structure, a high antenna gain can be obtained either in a speaking sate by using a left hand or in a speaking state by using a right hand.

[0040] Further, the portable radio device according to the present invention further comprises: a first matching portion for matching the impedance of the first antenna element to a prescribed value; and a second matching portion for matching the impedance of the second antenna element to a prescribed value.

[0041] According to this structure, a high antenna performance can be ensured.

[0042] Further, the portable radio device according to the present invention further comprises: a circuit board provided in the second casing; a plurality of feeding portions mutually separated from others for feeding electric current to the antenna element; a radio circuit disposed in the circuit board; and a switching portion provided between the plurality of feeding portions and the radio circuit to select and connect any one of the plurality of the feeding portions to the radio circuit.

[0043] According to this structure, a feeding position to the first antenna element can be changed. Accordingly, since directivity can be changed, a directional diversity effect can be obtained and a high antenna performance can be obtained in a speaking state.

[0044] The portable radio device according to the present invention further comprises: a circuit board provided in the second casing; a radio circuit disposed in the circuit board and electrically connected to the feeding portion; a ground portion spaced from the feeding portion to connect the antenna element to the circuit board; and a switching portion for switching whether the ground portion is connected to the circuit board or the circuit board and the ground portion are opened.

[0045] According to this structure, whether or not a part of the first antenna element separated from the feeding portion is grounded in the circuit board can be switched. Accordingly, since directivity can be changed, a directional diversity effect can be obtained and a high antenna performance can be obtained in a speaking state.

[0046] Further, in the portable radio device according to the present invention, a plurality of ground portions are provided and the ground portions are disposed to be spaced apart in the end part of the antenna element connected to the second casing.

[0047] According to this structure, since the directivity can be changed, the directional diversity effect can be obtained and the high antenna performance can be obtained in a speaking state.

[0048] Further, in the portable radio device according to the present invention, the switching portion switches the ground portions respectively.

[0049] According to this structure, whether or not each part of the first antenna element separated from the feeding portion is grounded in the circuit board can be switched. Accordingly, since the directivity can be changed, the directional diversity effect can be obtained and the high antenna performance can be obtained in a speaking state.

[0050] Further, in the portable radio device according to the present invention, the connection portion has an electric conductivity and the ground portion is electrically connected to the antenna element through the connection portion.

[0051] According to this structure, the connection portion itself can serve as a feeder. Accordingly, a step for providing the feeder is not required, so that the number of assembling steps can be reduced and a cost can be decreased.

[0052] Further, in the portable radio device according to the present invention, the connection portion has an electric conductivity and the feeding portion is electrically connected to the antenna element through the connection portion.

[0053] Accordingly to this structure, the connection portion itself can serve as a feeder. Accordingly, a step for providing the feeder is not required, so that the number of assembling steps can be reduced and a cost can be decreased.

[0054] Further, the portable radio device according to the present invention further comprises: a control circuit for controlling the switching portion in accordance with the level of a receiving signal received by the radio circuit.

[0055] According to this structure, the feeding portion or the ground portion is switched in accordance with the level of the receiving signal. Accordingly, even when the portable radio device is held by either a left hand or a right hand in a speaking state, a high antenna performance can be obtained.

[0056] Further, in the portable radio device according to the present invention, the first antenna element is an electric conductive frame forming a part of the first casing.

[0057] According to this structure, since the electric conductive frame forming a part of the upper casing is used as the antenna element, the thickness of the portable radio device can be decreased.

<Brief Description of the Drawings>

[0058]

Fig. 1 is a schematic structural diagram of a portable radio device in a first embodiment of the present invention;
Figs. 2A and 2B are diagrams showing the directivity of an antenna of the portable radio device according to the first embodiment;
Figs. 3A and 3B are explanatory views for explaining using states of the portable radio device according to the first embodiment;
Figs. 4A and 4B are diagrams showing the directivity of the antenna under a state in which the portable radio device according to the first embodiment is inclined by 60 degrees;
Fig. 5 is a schematic structural diagram of a portable radio device in a second embodiment of the present invention;
Figs. 6A and 6B are diagrams showing the directivity of an antenna of the portable radio device according to the second embodiment;
Fig. 7 is a schematic structural diagram of a portable radio device in a third embodiment of the present invention;
Fig. 8 is an explanatory view showing the operation of a closing state (first) of the portable radio device according to the third embodiment;
Fig. 9 is an explanatory view showing the operation of a closing state (second) of the portable radio device according to the third embodiment;
Figs. 10A and 10B are diagrams showing the directivity of an antenna of the portable radio device according to the third embodiment;
Fig. 11 is a schematic structural diagram of a portable radio device in a fourth embodiment of the present invention;
Fig. 12 is a schematic structural diagram of a portable radio device in a fifth embodiment of the present invention;
Fig. 13 is a schematic structural diagram of a portable radio device in a sixth embodiment of the present invention;
Fig. 14 is a front view showing a portable radio device in a seventh embodiment;
Fig. 15 is a side view showing the portable radio device of the seventh embodiment;
Fig. 16 is an explanatory view showing a state that the portable radio device of the seventh embodiment is held by a left hand at an inclination angle of 60 degrees;
Fig. 17 is an explanatory view showing the operation of an antenna when a first antenna element is selected while the portable radio device of the seventh embodiment is in a left hand speaking state;
Fig. 18 is an explanatory view showing directivity when the first antenna element is selected while the portable radio device of the seventh embodiment is in a left hand speaking state;
Fig. 19 is an explanatory view showing the operation of an antenna when a second antenna element is selected while the portable radio device of the seventh embodiment is in a left hand speaking state;
Fig. 20 is an explanatory view showing directivity when the second antenna element is selected while the portable radio device of the seventh embodiment is in a left hand speaking state;
Fig. 21 is an explanatory view showing a state that the portable radio device of the seventh embodiment is held by a right hand at an inclination angle of 60 degrees;
Fig. 22 is an explanatory view showing the operation of an antenna when a first antenna element is selected while the portable radio device of the seventh embodiment is in a right hand speaking state;
Fig. 23 is an explanatory view showing directivity when the first antenna element is selected while the portable radio device of the seventh embodiment is in a right hand speaking state;
Fig. 24 is an explanatory view showing the operation of an antenna when a second antenna element is selected while the portable radio device of the seventh embodiment is in a right hand speaking state;
Fig. 25 is an explanatory view showing directivity when the second antenna element is selected while the portable radio device of the seventh embodiment is in a right hand speaking state;
Fig. 26 is a front view showing a portable radio device for explaining an eighth embodiment;
Fig. 27 is a diagram for explaining the operation of an antenna of the portable radio device according to the eighth embodiment;
Fig. 28 is a diagram showing the directivity of the antenna of the portable radio device according to the eighth embodiment;
Fig. 29 is a diagram showing a speaking state that a user holds the portable radio device according to the eighth embodiment by a left hand;
Fig. 30 is a diagram for explaining the operation of the antenna of the portable radio device according to the eighth embodiment;
Fig. 31 is a diagram showing the directivity of the antenna of the portable radio device according to the eighth embodiment;
Fig. 32 is a diagram showing a speaking state that a user holds the portable radio device according to the eighth

embodiment by a right hand;
Fig. 33 is a front view showing a portable radio device for explaining a ninth embodiment;
Fig. 34 is a side view showing the portable radio device for explaining the ninth embodiment of the present invention;
Fig. 35 is a front view showing a portable radio device for explaining a tenth embodiment of the present invention;
Fig. 36 is a diagram showing the directivity of an antenna of the portable radio device according to the tenth embodiment of the present invention; and
Fig. 37 is a diagram showing the directivity of the antenna of the portable radio device according to the tenth embodiment of the present invention.

[0059] In the drawings, reference numerals 1, 104 and 210 designate upper cases, 2,105 and 211 designate lower cases, 3, 106, 212a, 212b and 212c designate hinge portions, 4 designates a plate shaped conductor, 5 designates a plate shaped conductor, 6 designates a ground plate, 7 designates a speaker, 8 designates an operating key, 9 designates a microphone, 10,11,34, 35, 108 and 113 designate feeding points, 12 and 13 designate feeders, 14, 24, 25, 31, 33 and 36 designate high frequency switches, 15 designates a feeding portion, 30 and 32 designate helical elements, 37, 38, 110 and 114 designate matching circuits, 39 designates a control portion, 40 designates a magnet switch, 41 designates a permanent magnet, 42 designates a printed circuit board, 43 designates a ground pattern, 44, 112 and 224 designate radio circuit portions, 45 designates a level deciding portion, 101 and 102 designate antenna elements, 103 and 221 designate circuit boards, 111 designates a high frequency switch, 127 designates a switch control portion, 128 designates an opening and closing detecting portion, 203 and 204 designate feeding portions, 205, 206, 222a, 222b and 228 designate matching circuits, 213 designates a sound port, 214 designates a metal frame, 215a, 15b, 15c, 19a, 19b and 19c designate hinge fittings, 216 and 229 designate attaching screws, 217 and 226 designate tapped hole parts, 218a, 218b and 218c designate rotating shafts, 220a, 220b and 220c designate feeding terminals, 223, 227a and 227b designate switches and 225 designates a control circuit portion.

<Best Mode for Carrying Out the Invention>

(First Embodiment)

[0060] Fig. 1 is a schematic structural diagram of a portable radio device in a first embodiment of the present invention. The portable radio device in this embodiment is a portable radio device having a foldable structure and is shown in an opened state (refer this state as to an opening state, hereinafter) in Fig. 1. The portable radio device includes an upper case 1, a lower case 2, a hinge portion 3, a plate shaped conductor 4, a plate shaped conductor 5, a ground plate 6, a speaker 7, an operating key 8 and a microphone 9.

[0061] The upper case 1 and the lower case 2 as one example of a first casing and a second casing are formed with a resin as an insulator and ordinarily set to the length of about 10 mm and the width of about 50 mm. The upper case 1 and the lower case 2 are respectively connected in the hinge portion 3 so as to freely rotate. Thus, a foldable or a collapsible structure is formed.

[0062] In the upper end part of the upper case 1, the speaker 7 is disposed. In the lower end part of the lower case 2, the microphone 9 is disposed respectively. In a speaking state that a user holds the portable radio device by a hand to speak, the user can use the portable radio device by allowing the speaker 7 to come near to the ear and the microphone 9 to come near to the mouth respectively.

[0063] The plate shaped conductors 4 and 5 as one example of a first antenna element are made of a copper plate having, for instance, the length L1 of about 90 mm and the width L2 of about 15 mm. The plate shaped conductors 4 and 5 are disposed along the surface of the upper case 1 in the inner part of the upper case 1. Further, the thickness of the plate shaped conductors 4 and 5 is set to, for instance, about 0.1 mm. The plate shaped conductors 4 and 5 are disposed so as not to structurally interfere with other components such as the speaker 7 or a display element in the inner part of the upper case 1 having the thickness as thin as, for instance, about 6 mm.

[0064] The ground plate 6 as one example of a conductor element is made of, for instance, a conductor plate having the length L3 of about 90 mm and the width L4 of about 45 mm. The ground plate may use a ground pattern of a circuit board disposed in the lower case 2. The ground plate 6 whose thickness is set to 1 mm or smaller is disposed so as not to structurally interfere with other components such as the operating key 8 or the microphone 9 in the lower case 2.

[0065] A feeding point 10 and a feeding point 11 provided in the lower parts of the plate shaped conductor 4 and the plate shaped conductor 5 are electrically connected to a high frequency switch 14 by a feeder 12 and a feeder 13. As the feeder 12 and the feeder 13, a flexible wire rod that can be freely bent is used. Thus, the upper case 1 can rotate in the hinge portion 3.

[0066] The high frequency switch 14 is formed by, for instance, an FET or a PIN diode to suitably select the high frequency signals of the feeder 12 and the feeder 13(suitably select a larger one of the high frequency signals on the basis of, for instance, the directions of the cases 1 and 2 or the magnitude of the high frequency signals of the feeders

12 and 13) to transmit the high frequency signal to one end of a feeding portion 15. The feeding portion 15 is an antenna feeding portion of a transmitting and receiving circuit disposed in the lower case 2. The other end of the feeding portion 15 is grounded in the ground plate 6.

[0067] In the portable radio device constructed as described above, an operation of an antenna when radio frequency is set to, for instance, 900 MHz (wavelength is about 333 mm) is described below as an example.

[0068] In the high frequency switch 14, when an A side terminal is selected, the plate shaped conductor 4 is selected. In this case, the plate shaped conductor 4 and the ground plate 6 operate as, for instance, a dipole antenna of half-wavelength. Further, when the high frequency switch 14 selects a B side terminal, the plate shaped conductor 5 and the ground plate 6 likewise operate as, for instance, a dipole antenna of, about half-wavelength. Accordingly, the plate shaped conductors 4 and 5 and the ground plate 6 operate as the dipole antenna provided in the upper case 1 and the lower case 2 of the portable radio device.

[0069] The antenna current of the dipole antenna constructed as described above is distributed over a wide range from the upper ends of the plate shaped conductors 4 and 5 and the lower end of the ground plate 6. Accordingly, for instance, when the user holds only the lower case 2 by the hand, or when the user holds only the hinge portion 3 by the hand, the deterioration of an antenna gain is suppressed to a minimum. This arises because of a reason why the antenna current is distributed throughout a wide range from the upper end of the upper case 1 to the lower end of the lower case 2. Thus, even when the antenna current of a specific part is influenced by the hand, the influence given to the operation of all the antenna is low.

[0070] Figs. 2A and 2B are diagrams showing the directivity of the dipole antenna shown in Fig. 1. In Fig. 2A, the directivity 16 and the directivity 17 respectively show the directivities of Eθ(vertically polarized wave) components on an XY plane. Further, in Fig. 2B, the directivity 18 and the directivity 19 respectively show the directivities of Eθ components on a YZ plane.

[0071] Further, the directivity 16 and the directivity 18 show the directivities of a state that the A side of the high frequency switch 14 in Fig. 1 is selected, that is, the plate shaped conductor 4 is selected. Further, the directivity 17 and the directivity 19 show the directivities of a state that the B side of the high frequency switch 14 is selected, that is, the plate shaped conductor 5 is selected.

[0072] As apparent from Figs. 2A and 2, when the plate shaped conductor 4 is selected, a gain in the direction of Y is high. When the plate shaped conductor 5 is selected, the gain in the direction of -Y is high. As described above, when the plate shaped conductor 4 or the plate shaped conductor 5 having a higher gain is automatically selected by the high frequency switch 14, a directional diversity effect can be obtained.

[0073] Now, the antenna gain under a state that the portable radio device in a speaking state will be described below. Figs. 3A and 3B are diagrams showing speaking states that the user holds the portable radio device by a left hand or a right hand to allow the device to come near to the ear or the mouth for speaking. As shown in Figs. 3A and 3B, under the speaking state, the portably radio device is frequently inclined by about 60 degrees from a direction of Z. Further, the hand by which the user holds the portable radio device cannot be frequently limited to the left hand or the right hand. Accordingly, under both the states shown in Figs. 3A and 3B, the high antenna gain is required for the portable radio device.

[0074] In a land mobile telecommunication system like a portable telephone system, it has been know that a radio wave coming to the portable radio device from a radio base station has an elevation angle θ of 90 degrees in coordinate systems shown in Figs. 3A and 3B, that is, the radio wave is concentrated in the direction of a horizontal plane (XY plane). Accordingly, the high antenna gain in the direction of the horizontal plane is required for the antenna for the portable radio device under both the states shown in Figs. 3A and 3B.

[0075] Figs. 4A and 4B respectively show directivities on an XZ plane under a state that the portable radio device shown in Fig. 1 is disposed to be inclined by 60 degrees, that is, when the portable radio device is located in the speaking states shown in Figs.3A and 3B. Coordinate systems shown in Figs. 4A and 4B respectively correspond to the coordinate systems shown in Figs. 3a and 3B.

[0076] In Fig. 4A, the directivity 20 and the directivity 21 respectively show the directivities of Eθ(vertically polarized wave) components on the XZ plane when the portable radio device is held by the left hand. Further, in Fig. 4B, the directivity 22 and the directivity 23 respectively show the directivities of Eθ (vertically polarized wave) components on the XZ plane when the portable radio device is held by the right hand.

[0077] Further, the directivity 20 and the directivity 22 show the directivities of a state that the A side of the high frequency switch 14 in Fig. 1 is selected, that is, the plate shaped conductor 4 is selected. Further, the directivity 21 and the directivity 23 show the directivities of a state that the B side of the high frequency switch 14 is selected, that is, the plate shaped conductor 5 is selected.

[0078] As apparent from Figs. 4A and 4B, when the portable radio device is held by the left hand, the directivity 21 of the state that the plate shaped conductor 5 is selected has a higher gain on the XY plane. Further, when the portable radio device is held by the right hand, the directivity 22 of the state that the plate shaped conductor 4 is selected has a higher gain on the XY plane.

[0079] As described above, when the right hand and the left hand respectively hold the portable radio device, the different plate shaped conductors 4 and 5 respectively have higher gains. In this embodiment, this phenomenon is employed to provide, for instance, a detecting unit, which is not shown in the drawings, for automatically detecting the directions of the cases 1 and 2, that is, whether the portable radio device is held by the right hand or the left hand. A switching unit is provided for automatically switching the high frequency switch 14 shown in Fig. 1 to the higher gain in accordance with the directions of the cases 1 and 2 detected by the detecting unit. Thus, the high antenna gain can be obtained in any of the speaking states that the portable radio device is held by the left hand or the right hand. Further, a measuring unit for measuring the respective gains of the plate shaped conductors 4 and 5 and a switching unit for automatically switching the switch to the higher gain on the basis of the gains measured by the measuring unit may be provided, so that the high antenna gain can be obtained in any of the speaking states that the portable radio device is held by the left hand or the right hand.

[0080] In this embodiment, the two plate shaped conductors are incorporated in the upper case 1 to switch them. However, a single plate shaped conductor may be provided in the upper case. Also in this case, the antenna gain in a speaking state can be improved.

[0081] The form of the plate shaped conductor contained in the upper case 1 is not limited to the form shown in this embodiment. A structure operating together with the ground plate contained in the lower case 2 as a dipole antenna of, for instance, about half-wavelength may obtain the same effects.

[0082] The plate shaped conductors contained in the upper case 1 may be respectively formed with a conductor for supporting, for instance, a liquid crystal display in view of a mechanism, or the plate shaped conductor may be respectively formed with a conductor thin film stuck to the surface of a resin of the upper case 1 or a conductor thin film embedded in the resin.

[0083] Further, in order to reduce an influence that the portable radio device is allowed to come near to the head part of a user, particularly to the ear under a speaking state, the plate shaped conductors incorporated in the upper case 1 are desirably arranged at positions separate from the surface of the upper case on which the speaker 7 is disposed, that is, at positions near a surface opposed to the surface on which the speaker 7 is disposed as much as possible.

(Second Embodiment)

[0084] Fig. 5 is a schematic structural diagram of a portable radio device in a second embodiment of the present invention. The portable radio device in this embodiment is also a portable radio device having a foldable or collapsible structure. In Fig. 5, an opened state (refer this state to as an opening state, hereinafter) is shown. In Fig. 5, duplicated portions of Fig. 1 are designated by the same reference numerals.

[0085] In the portable radio device shown in Fig. 5, the plate shaped conductor 4 or the plate shaped conductor 5 that is not selected is grounded in a ground plate 6.

[0086] In Fig. 5, feeders 12 and 13 are respectively connected to high frequency switches 24 and 25. The high frequency switch 24 performs an operation for switching whether an electric signal of the feeder 12 is transmitted to a feeding portion 15 or grounded to the ground plate 6. Further, the high frequency switch 25 performs an operation for switching whether an electric signal of the feeder 13 is transmitted to the feeding portion 15 or grounded in the ground plate 6.

[0087] Here, for instance, when a terminal B1 side of the high frequency switch 25 is selected and the plate shaped conductor 5 is connected to the feeding portion 15, a terminal A2 side of the high frequency switch 24 is selected and the plate shaped conductor 4 is grounded in the ground plate 6. On the contrary, when a terminal A1 side of the high frequency switch 24 is selected and the plate shaped conductor 4 is connected to the feeding portion 15, a terminal B2 side of the high frequency switch 25 is selected and the plate shaped conductor 5 is grounded in the ground plate 6.

[0088] Figs. 6A and 6B show directivities when the high frequency switches are operated as described above. In Fig. 6A, the directivity 26 and the directivity 27 respectively show the directivities of Eθ(vertically polarized wave) components on an XY plane. In Fig. 6B, the directivity 28 and the directivity 29 respectively show the directivities of Eθ components on a YZ plane.

[0089] Further, the directivity 26 and the directivity 28 show the directivities of a state that the terminal A1 side of the high frequency switch 24 and the terminal B2 side of the high frequency switch 25 in Fig. 5 are selected, that is, the directivities of a state that an electric current is supplied to the plate shaped conductor 4 and the plate shaped conductor 5 is grounded in the ground plate 6. Further, the directivity 27 and the directivity 29 show the directivities of a state that an electric current is supplied to the plate shaped conductor 5 and the plate shaped conductor 4 is grounded in the ground plate 6.

[0090] As apparent from Figs. 6A and 6B, when the plate shaped conductor 4 is turned on, a gain in the direction of Y is high. When the plate shaped conductor 5 is turned on, the gain in the direction of -Y is high. This tendency is the same as the tendency shown in Fig. 2. However, an amount of variation of a maximum gain in Fig. 6 is apparently

higher than that of Fig. 2. This arises because of a reason why the plate shaped conductor that is not turned on is grounded in the ground plate 6 so that these members operate as a rejecting element. As described above, a directional diversity effect obtained by the structure shown in Fig. 5 is higher than that obtained by the structure shown in Fig. 1.

[0091] The structures of the high frequency switch 24 and the high frequency switch 25 are not limited to the structure shown in this embodiment. Any of structures that can switch whether the plate shaped conductor is turned on or grounded in the ground plate may obtain the same effects.

(Third Embodiment)

[0092] Fig. 7 is a schematic structural diagram of a portable radio device according to a third embodiment of the present invention. The portable radio device in this embodiment is also a portable radio device having a foldable or collapsible structure. In Fig. 7, an opened state (refer this state to as an opening state, hereinafter) is shown. In Fig. 7, the duplicated portions of Fig. 1 are designated by the same reference numerals.

[0093] In Fig. 7, a helical element 30 is inserted between a plate shaped conductor 5 and a high frequency switch 31.

[0094] In Fig. 7, the helical element 30 is formed by winding a conductor in a coil shape. The electric length thereof is preferably set to substantially half-wavelength in an operating frequency (for instance, 900 MHz). In this case, the helical element 30 is inserted between the plate shaped conductor 5 and the high frequency switch 31, so that a phase for exciting the plate shaped conductor 5 is inverted.

[0095] Figs. 8 and 9 are side views of the portable radio device shown in Fig. 7 and show states that an upper case 1 and a lower case 2 are closed (refer this state to as a closing state, hereinafter). Fig. 8 shows a state that a terminal A1 side of the high frequency switch 31 shown in Fig. 7 is selected, that is, a plate shaped conductor 4 is selected. Fig. 9 shows a state that a terminal A2 side of the high frequency switch 31 shown in Fig. 7 is selected, that is, the plate shaped conductor 5 is selected.

[0096] In the state shown in Fig. 8, the phases of antenna currents distributed in the plate shaped conductor 4 and a ground plate 6 are shown by arrow marks. Accordingly, the antenna currents on the plate shaped conductor 4 and the ground plate 6 are respectively cancelled to each other so that a radiation resistance is extremely lowered. Thus, the radiation efficiency of an antenna is lowered to increase a loss in non-matching of impedance. As a result, an antenna gain of this state is decreased to reduce a bandwidth.

[0097] As compared therewith, in the state that the terminal A2 side of the high frequency switch 31 as shown in Fig. 9 is selected, that is, in the state that the helical element 30 and the plate shaped conductor 5 are selected, the phases of antenna currents distributed on the plate shaped conductor 5 and the ground plate 6 correspond to each other.

[0098] Figs. 10A and 10B show the directivities of Eθ components of the state shown in Fig. 9 on an XY plane and an XZ plane. As apparent from Fig.10A and Fig. 10B, the Eθ components substantially have no directivities on a horizontal plane (XY plane) and have 8-shaped directivities on the XZ plane. Under this state, a high antenna gain and a wide bandwidth can be assured.

[0099] In such a way, when the portable radio device is in the opening state, the high frequency switch 31 is switched to the terminal A1 side. When the portable radio device is in the closing state, the high frequency switch 31 is switched to the terminal A2 side. Thus, an antenna performance can be obtained in both the states.

[0100] Any of the helical elements 30 whose electric length has substantially half-wavelength may have the same effects. For instance, a meander pattern printed on a printed circuit board or an insulator may be employed. Further, the helical element 30 may be formed with a meander conductor as a part of the plate shaped conductor 5.

(Fourth Embodiment)

[0101] Fig. 11 is a schematic structural diagram of a portable radio device in a fourth embodiment of the present invention. The portable radio device of this embodiment is also a portable radio device having a foldable or collapsible structure. Fig. 11 shows an opened state (refer this state to as an opening state, hereinafter). In Fig. 11, duplicated portions to those of Fig. 7 are designated by the same reference numerals.

[0102] In the portable radio device shown in Fig. 11, a helical element 32 is inserted between a feeding point 34 of a plate shaped conductor 4 and a high frequency switch 33 and a feeding point 11 of a plate shaped conductor 5 is connected to the high frequency switch 33.

[0103] In Fig. 11, the helical element 32 has the same electric characteristics as those of a helical element 30. A high frequency switch 31 and the high frequency switch 33 are selected by a high frequency switch 36 to supply electric current to a feeding portion 15.

[0104] In the above-described structure, under a state that a terminal A1 side of the high frequency switch 31 and a terminal B1 side of the high frequency switch 33 are selected, the plate shaped conductor 4 or the plate shaped conductor 5 and a ground plate 6 operate as a dipole antenna having the same structure shown in Fig. 1 which is formed by the plate shaped conductor 4 or the plate shaped conductor 5-and the ground plate 6. In the opening state,

this state is desirably selected. In that case, a high antenna gain can be obtained. Then, at this time, the plate shaped conductor 4 or the plate shaped conductor 5 is selected by the high frequency switch 36 so that a directional diversity effect is obtained.

[0105] Then, under a closing state, a terminal A2 side of the high frequency switch 31 and a B2 side of the high frequency switch 33 are desirably selected. In this state, an antenna operation similar to that of the structure shown in Fig. 9 is achieved so that the high antenna gain can be obtained under the closing state. At this time, the plate shaped conductor 4 or the plate shaped conductor 5 is selected by the high frequency switch 36 so that a directional diversity effect under the closing state can be obtained.

(Fifth Embodiment)

[0106] Fig. 12 is a schematic structural diagram of a portable radio device in a fourth embodiment of the present invention. The portable radio device of this embodiment is also a portable radio device having a foldable or collapsible structure. Fig. 12 shows an opened state (refer this state to as an opening state, hereinafter). In Fig. 12, duplicated portions to those of Fig. 7 are designated by the same reference numerals.

[0107] In the portable radio device shown in Fig. 12, a matching circuit 37 and a matching circuit 38 are provided. When a plate shaped conductor 4 is selected in the opening state, or when a plate shaped conductor 5 is selected in a closing state, a suitable impedance matching is performed for both the cases.

[0108] Further, in the portable radio device shown in Fig. 12, a control portion 39, a magnet switch 40 and a permanent magnet 41 are added to detect the opening state or the closing state of the portable radio device and switch a high frequency switch 31 in accordance therewith.

[0109] In Fig. 12, the matching circuit 37 and the matching circuit 38 are formed with, for instance, concentrated constant elements such as inductance and condensers. The matching circuit 37 operates so that the impedance of a dipole antenna formed by the plate shaped conductor 4 in the opening state and a ground plate 6 is matched with the impedance (ordinarily, 50 Ω) of a feeding portion 15. Further, the matching circuit 38 operates so that the impedance of an antenna formed by the plate shaped conductor 5 in the closing state, a helical element 30 and the ground plate 6 is matched with the impedance of the feeding portion 15.

[0110] As described above, the suitable matching circuits are provided respectively for the plate shaped conductors or the opening and closing states. Thus, an antenna performance for each of the states is more improved.

[0111] Then, for instance, in the closing state, since the magnet switch 40 comes near to the permanent magnet 41, the magnet switch 40 is turned ON. The control portion 39 detects this state and operates to switch the high frequency switch 31 to a terminal B side. On the other hand, in the opening state, the magnet switch 40 is turned OFF to switch the high frequency switch 31 to a terminal A side.

[0112] In such a way, suitable antenna states are selected in accordance with the detected results of the opening and closing states, so that a high antenna gain can be obtained for both the states.

[0113] The matching circuit is not limited to a circuit composed of the concentrated constant elements and may be formed by, for instance, a plane circuit disposed on a printed circuit board. Further, means for detecting the opening and closing states is not limited to the magnet switch and the permanent magnet. For instance, means for detecting an operation of a mechanism of a hinge portion may be employed, or means interlocking with an operating state such as a speaking mode or a waiting mode of the portable radio device may be employed.

(Sixth Embodiment)

[0114] Fig. 13 is a schematic structural diagram of a portable radio device in a sixth embodiment of the present invention. The portable radio device of this embodiment is also a portable radio device having a foldable or collapsible structure. Fig. 13 shows an opened state (refer this state to as an opening state, hereinafter). In Fig. 13, duplicated portions to those of Fig. 7 or Fig. 12 are designated by the same reference numerals.

[0115] In the portable radio device shown in Fig. 13, the ground plate 6 in the portable radio device shown in Fig. 7 is formed with a ground pattern 43 on a printed circuit board 42. A radio circuit portion 44 and a level deciding portion 45 mounted on the printed circuit board 42 are added.

[0116] In Fig. 13, as the printed circuit board 42, for instance, a glass epoxy base having the thickness of about 1 mm is used. The ground pattern 43 is formed with a silver foil pattern printed on the surface or the inner layer of the printed circuit board 42. The ground pattern 43 functions as an antenna in the same manner as that of the ground plate 6 in Fig. 7. Such a structure is provided so that the ground plate operating as the antenna does not need to be overlaid on the printed circuit board 42 as an originally necessary component. Thus, the decrease of thickness of a lower case 2 of the portable radio device can be realized.

[0117] The radio circuit portion 44 is composed of a transmitting circuit and a receiving circuit and covered with electromagnetic shielding means such as a shield case. A signal selected by a high frequency switch 31 is transmitted

to the radio circuit portion 44 and the ground of the radio circuit portion 44 is grounded in the ground pattern 43. In accordance with such a structure, to an antenna formed by plate shaped conductors 4 and 5 and the ground pattern 43, electric current is fed by the radio circuit portion 44.

[0118] The level deciding portion 45 includes a function for deciding whether a receiving level obtained in the receiving circuit that forms the radio circuit portion 44 is high or low and a function for switching the high frequency switch 31 in accordance therewith. Specifically, the level determining portion 45 determines the receiving levels respectively obtained when the high frequency switch 31 is switched to a terminal A side or a terminal B side and operates to select the terminal side of a higher receiving level. For instance, when the portable radio device of this embodiment is applied to a time division multiplex connection (TDMA) system, a series of operations as described above are continuously carried out at a suitable timing. Accordingly, a high antenna gain can be always ensured.

(Seventh Embodiment)

[0119] Fig. 14 is a front view showing a portable radio device for explaining a seventh embodiment of the present invention. Fig. 15 is a side view showing the portable radio device for explaining the seventh embodiment of the present invention. As shown in these figures, the portable radio device of this embodiment is a foldable or collapsible radio device in which an upper case 104 and a lower case 105 are connected together by a hinge portion 106. The upper case and the lower case are rotated on the hinge portion 106 so that two states including an opening state and a closing state may be obtained. The upper case 104 and the lower case 105 are made of molded products of a resin as an insulator.

[0120] In the upper case 104, an antenna element 101 and a speaker 107 having a sound generating element are provided. The antenna element 101 is formed with a plate shaped conductor base. However, the antenna element 101 is not limited to the plate shaped conductor base. For instance, a ground pattern of a circuit board provided in the upper case 104 or a metallic frame for mechanically supporting the speaker 107 may be employed, or a metallic plate forming the upper case 104 itself may be employed. Further, the speaker 107 is used when a user listens to a sound upon speaking. A sound hole surface for emitting sound is directed to the direction of X in a coordinate system shown in Fig. 14. The user allows his ear to come into contact with a part near the speaker 107 on an X side surface outside the upper case 104 to speak.

[0121] Further, in the lower case 105, an antenna element 102 as an example of a second antenna element and a circuit board 103 as an example of a conductor element are provided. The antenna element 102 is an L-shaped conductor plate and a long side part thereof is arranged along a Y-axis direction in the vicinity of the hinge portion 106 in the lower case 105. The long side of the antenna element 102 has a length of about 1/4 to 1/2 wavelength relative to a radio signal.

[0122] The circuit board 103 is a printed circuit board on which circuits for realizing a radio communication function or various kinds of other functions are mounted. A ground pattern serving as an earth potential of the circuits is formed on a substantially entire surface thereof. Further, the circuit board 103 includes a matching circuit 110 as one example of a first matching portion, a matching circuit 114 as one example of a second matching portion, a high frequency switch 111 and a switch control portion 127 as one example of a switching portion, a radio circuit portion 112 as one example of a receiving field intensity measuring portion and a signal processing portion, and an opening and closing detecting portion 128 as one example of an opening and closing detecting portion.

[0123] The matching circuit 110 serves to match the impedance of the antenna element 1 with, for instance, 50 Ω and is connected to the antenna element 101 at a feeding point 108 through a feeder 109. The matching circuit 110 is arranged at a position near the right side (Y) of the circuit board 103. The feeding point 108 is arranged at a position near the right side (Y) by viewing the portable radio device from a front surface (X) side on the antenna element 101.

[0124] Further, the matching circuit 114 serves to match the impedance of the antenna element 102 with, for instance, 50 Ω and is connected to the antenna element 102 at a feeding point 113 through a feeder. The matching circuit 114 is arranged at a position near the left side (-Y) on the circuit board 103, that is, a side opposed the matching circuit 110. The feeding point 113 is arranged at a position near the left side (-Y) by viewing the portable radio device from a front surface (X) side on the antenna element 102, that is. A side opposed to the feeding point 108.

[0125] The high frequency switch 111 is composed of an FET or a PIN diode or the like to select either the matching circuit 110 or the matching circuit 114 and transmit a signal received by the antenna element 101 or the antenna element 102 to the radio circuit portion 112. The radio circuit portion 112 performs a signal process to a transmitted signal or a received signal, and especially measures the receiving field intensity of the signal received by the antenna element 101 or the antenna element 102. Further, the opening and closing detecting portion 128 serves to detect the opening and closing states of the upper case 104 and the lower case 105 and is realized by for instance, a permanent magnet, a Hall element and a mechanical switch or the like.

[0126] The switch control portion 127 serves to control the high frequency switch 111 to select the antenna element having a higher receiving intensity in accordance with the detected result of the opening and closing detecting portion

128 or the receiving field intensity of each of the antenna elements 101 and 102 measured by the radio circuit portion 112. Owing to a below-described reason, the switch control portion 127 selects the antenna element 101 side under the opening state and selects the antenna element 102 side under the closing state.

[0127] An antenna operation in the portable radio device of the seventh embodiment having the above-described components will be described below. In the following description, it is assumed that radio frequency is 1.5 GHz (wavelength of 200 mm) is used.

[0128] Initially, the antenna operation under a state in which the upper case 104 and the lower case105 are opened as shown in Fig. 14 will be described. Under this state, when the matching circuit 110 side, that is, the antenna element 101 side is selected by the high frequency switch 111, the antenna element 101 and the circuit board 103 are arranged in a straight line. Thus, these members serve as a dipole antenna of one wavelength. On the other hand, when the matching circuit 113 side, that is, the antenna element 102 side is selected, the antenna element 102 feeds unbalanced electric current to the circuit board 103 through the feeding point 113 and further operates while the antenna element 102 is electro-magnetically connected to the antenna element 101. In such a way, under the opening state, even when either of the antenna elements is selected, a high antenna performance is obtained.

[0129] Then, the antenna operation when the upper case 104 and the lower case 105 are closed is described below. Under this state, when the antenna element 101 side is selected by the high frequency switch 111, the antenna element 101 comes near to the circuit board 103. Thus, antenna currents have opposite phases to be cancelled to each other, so that an antenna performance is deteriorated. On the other hand, when the antenna element 102 side is selected by the high frequency switch 111, the antenna element 102 operates as a mono-pole antenna of 1/4 wavelength for feeding unbalanced electric current to the circuit board 103 through the feeding point 113. Accordingly, the antenna performance higher than that when the antenna element 101 is selected is obtained. In such a way, under the closing state, when the antenna element 102 side is selected, a higher antenna performance can be obtained.

[0130] Now, an antenna operation under a state that the user holds the portable radio device of this embodiment by a left hand to speak will be described below. Fig. 16 to Fig. 20 are explanatory views showing antenna operations and directivities when the portable radio device of this embodiment is held by a left hand (a left hand speaking state). An average inclination angle α at which the user holds the portable radio device under the speaking state is ordinarily 60 degrees. Fig. 16 is an explanatory view showing a state that the portable radio device of this embodiment is held by the left hand at the inclination angle of 60 degrees.

[0131] As shown in Fig. 17, when the antenna element 101 side is selected by the high frequency switch 111, since the lower case 105 is held by the hand, the radiation of radio wave from the circuit board 103 provided in the lower case 105 is decreased and the radiation from electric current 115 on the antenna element 101 has a control. As a result, a main polarized wave component on a horizontal plane (XY plane) becomes a horizontal ($E\varphi$) component. Accordingly, as shown in Fig. 18, in the directivity on the horizontal plane (XY plane), the directivity 120 of a horizontally polarized wave ($E\varphi$) component is higher in the direction of a Y side (left hand side) than the directivity 119 of a vertically polarized wave ($E\theta$).

[0132] On the other hand, as shown in Fig. 19, when the antenna element 102 side is selected by the high frequency switch 111, the radiation from an electric current 118 due to a vector synthesis of an electric current 116 on the antenna element 102 and an electric current 117 on the antenna element 101 electro-magnetically connected to the electric current 116 has a control. As a result, the vertically polarized wave ($E\theta$) component on the horizontal (XY) plane is higher than that when the antenna element 101 is selected. Accordingly, as shown in Fig. 20, in the directivity on the horizontal (XY) plane, the directivity 121 of the vertically polarized wave ($E\theta$)is higher in the direction of the Y side (left hand side) than the directivity 122 of the horizontally polarized wave ($E\varphi$) component.

[0133] Generally, as an index showing the effective antenna performance of the portable radio device under a speaking state, a pattern average gain (PAG) expressed by a below-described formula (1) is employed. In the formula (1), $G_\theta(\varphi)$ and $G_\varphi(\varphi)$ respectively indicate power directivities on the horizontal plane (XY plane) of the vertically polarized wave component and the horizontally polarized wave. Further, C_{VH} indicates a correction factor related to the cross polarization power ratio (a power ratio of the vertically polarized wave component to the horizontally polarized wave component) of an arriving wave inputted to an antenna.

$$PAG = \frac{1}{2\pi}\int_0^{2\pi}\left[G_\theta\left(\frac{\pi}{2},\phi\right)+\frac{1}{C_{VH}}G_\phi\left(\frac{\pi}{2},\phi\right)\right]d\phi \quad \cdots\cdots\cdots(1)$$

[0134] It is known that the ordinary cross polarization power ratio in the multi-wave environment of a land mobile telecommunication is 4 to 9dB. This indicates that the electric power of the vertically polarized wave of the arriving wave is higher by 4 to 9 dB than the electric power of the horizontally polarized wave. Accordingly, the formula (1)

means that the vertically polarized wave is weighted and the power directivities on the horizontal plane are averaged. C_{VH} is explained as 9dB, hereinafter. Therefore, in the antenna for the portable radio device, the vertically polarized wave component is increased in a using state to obtain the high pattern average gain (PAG).

[0135] The PAG is used to show radiation characteristics in Fig. 18 and Fig. 20. The PAG obtained when the antenna element 101 is selected is - 15dBd (dipole ratio gain). On the other hand, the PAG obtained when the antenna element 102 is selected is - 11.5dBd, which is higher by 3.5dB than the former. Accordingly, in the left hand speaking state, when the antenna element 102 is selected, the PAG becomes higher.

[0136] Now, an antenna operation under a state that the user holds the portable radio device of this embodiment by a right hand to speak will be described below. Fig. 21 to Fig. 25 are explanatory views showing antenna characteristics and directivities when the portable radio device of this embodiment is held by a right hand (a right hand speaking state). Fig. 21 is an explanatory view showing a state that the portable radio device of this embodiment is held by the right hand at an inclination angle of 60 degrees.

[0137] As shown in Fig. 22, when the antenna element 101 side is selected by the high frequency switch 111, since the lower case 105 is held by the hand similarly to the case of the left hand, the radiation of radio wave from the circuit board 3 provided in the lower case 105 is decreased and the radiation from electric current 115 on the antenna element 101 has a control. As a result, the vertically polarized wave ($E\theta$) component on the horizontal (XY) plane is higher than that when the antenna element 102 is selected. Accordingly, as shown in Fig. 23, in the directivity on the horizontal plane (XY plane), the directivity 123 of the vertically polarized wave ($E\theta$) component is higher in the direction of a -Y side (right hand side) than the directivity 124 of the horizontally polarized wave ($E\varphi$) component.

[0138] On the other hand, as shown in Fig. 24, when the antenna element 102 side is selected by the high frequency switch 111, the radiation from an electric current 118 due to a vector synthesis of an electric current 116 on the antenna element 102 and an electric current 117 on the antenna element 101 electro-magnetically connected to the electric current 116 has a control. As a result, the vertically polarized wave ($E\theta$) component on the horizontal (XY) plane is higher than that when the antenna element 101 is selected. As a result, the horizontally polarized wave ($E\varphi$) component on the horizontal (XY) plane is increased. Accordingly, as shown in Fig. 25, in the directivity on the horizontal (XY) plane, the directivity 126 of the horizontally polarized wave ($E\varphi$) component is higher in the direction of the -Y side (right hand side) than the directivity 125 of the vertically polarized wave ($E\theta$) component.

[0139] As shown in Fig. 25, the PAG obtained when the antenna element 1 is selected is - 11dBd (dipole ratio gain). On the other hand, the PAG obtained when the antenna element 102 is selected is - 14dBd, which is lower by 3dB than the former. Accordingly, in the right hand speaking state, when the antenna element 101 is selected, the PAG becomes higher.

[0140] As described above, in the portable radio device of this embodiment, when the upper case 104 and the lower case 105 are opened, either the antenna element 101 or the antenna element 102 having a higher antenna performance is selected. When the upper case and the lower case are closed, the antenna element 2 side is forcedly selected. Thus, the high antenna performance can be ensured in any of the opening and closing states. Further, when in the right hand speaking state, the antenna element 1 is selected, and, in the left hand speaking state, the antenna element 102 is selected, the high antenna gain as large as -11.5dBd can be obtained in any state of the left hand speaking and the right hand speaking.

[0141] In this embodiment, as shown in Fig. 14, the feeding point 108 of the antenna element 101 is arranged at the right (Y) side and the feeding point 113 of the antenna element 102 is arranged at the left (-Y) side. When the arrangement of these feeding points is reversed, the tendency of the PAG in the left hand speaking state and the right hand speaking state is reversed. Even in this case, effects by the above-described diversity operation can be likewise obtained. Further, as an antenna element opposed to the antenna element 101 and the antenna element 102, the circuit board 103 provided in the lower case 105 is used. However, this antenna element may be, for instance, a metallic plate for shielding the circuit or a conductor plate provided exclusively for the antenna element.

(Eighth Embodiment)

[0142] Fig. 26 is a front view showing a portable radio device for explaining an eighth embodiment of the present invention. As shown in Fig. 26, the portable radio device of the eighth embodiment includes an upper case 210 as one example of a first casing and a lower case 211 as one example of a second casing connected to the upper case 210 by a hinge portion 212a as one example of a connection portion so as to freely rotate. The upper case 210 and the lower case 211 are made of molded products of a resin as an insulator.

[0143] In the front surface (the direction of an X side) of the upper case 210, a sound port 213 for guiding sound generated in a sound generating element such as a speaker provided in the upper case 210 to an external part is provided. The sound port 213 is provided so as to be located near the ear of a user when the user holds a foldable or collapsible portable telephone device 201 by a hand to speak.

[0144] In the upper case 210, a plate shaped conductor 202 is arranged as one example of a first antenna element.

In the dimensions of the plate shaped conductor 202, for instance, a long side L21 has 90 mm and a short side L23 has about 45mm. In the lower end (- Z side) of the plate shaped conductor 202, a feeding point 203 is provided in a left end (-Y side) and a feeding point 204 is provided in a right end (Y side). To the feeding point 203 and the feeding point 204, a matching circuit 205 and a matching circuit 206 are respectively connected through feeders (an illustration is omitted) or the like.

[0145] In the lower case 211, a circuit board 221 is provided. On the circuit board 221, circuit elements for realizing the functions of the portable radio device are mounted and the matching circuits 205 and 206, a switch 223, a radio circuit 224 and a control circuit 225 are disposed. In the dimensions of the circuit board 221, for instance, a long side L22 has 90 mm and a short side L23 has about 45 mm. On the circuit board 221, a ground pattern (an illustration is omitted) as the earth potential of the circuit is formed in a substantially entire surface.

[0146] In the matching circuit 205 and the matching circuit 206, the ground ends of the matching circuit 205 and the matching circuit 206 are respectively grounded in the ground pattern on the circuit board 221. The switch 223 is switched to select either the matching circuit 205 or the matching circuit 206. The selected matching circuit is connected to the radio circuit 224. Here, the switch 223 shows one example of a switching portion and is a high frequency switch composed of, for instance, an FET or a PIN diode. The radio circuit 224 includes a receiving circuit and a transmitting circuit. Further, the control circuit 225 detects a receiving signal level in the radio circuit 224 and controls the switch 223 to switch so as to select the matching circuit 205 or the matching circuit 206 in which the receiving signal level is constantly high.

[0147] In the above-described structure, the plate shaped conductor 202 and the ground pattern formed on the circuit board 221 operate as a dipole antenna. The matching circuit 205 and the matching circuit 206 match the impedance of the plate shaped conductor 202 with the circuit impedance (ordinarily, 50 Ω)of the radio circuit 224.

[0148] Now, an antenna operation of the portable radio device according to the eighth embodiment will be described by way of an example in which operating frequency is set to 1.5 GHz.

[0149] Fig. 27 is a diagram showing the antenna operation when the switch 223 is switched to select the matching circuit 205, that is, the feeding point 203. In Fig. 27, parts designated by the same reference numerals as those of Fig. 26 show the same components.

[0150] As shown in Fig. 27, when the feeding point 203 side is selected, a feeding source 230 is connected to the feeding point 203 in the left end (-Y side) of the plate shaped conductor 202 and a feeding point 231 in the left end (-Y side) of the circuit board 221.

[0151] Fig. 28 shows a directivity of a dipole antenna on a YZ plane when the switch 223 is switched to select the matching circuit 205. As shown by the directivity 240a in Fig. 28, an antenna gain in the direction of Y is higher by about 5dB than a gain in the direction of -Y.

[0152] Fig. 29 shows a state that the user holds the portable radio device by a left hand to speak. Under this state, the portable radio device is held so that the sound port 213 (see Fig. 26) directed to the front surface, that is, to the direction of X is located near the left ear of the user. At this time, as shown in Fig. 29, the direction of Y in a coordinate system in Fig. 26 is directed to a direction inclined slightly forward viewed from the direction of a vertex by the user. As shown in Fig. 28, when the switch 223 is switched to select the feeding point 203, the antenna gain in the direction of Y is higher than that in the direction of -Y. Thus, in Fig. 29, the antenna gain is high in the direction of the vertex and low in the direction of the shoulder of the user. Accordingly, an influence of the shoulder of the user is reduced and an antenna performance in a speaking state when the user holds the portable radio device by the left hand is increased.

[0153] Fig. 30 is a diagram showing an antenna operation when the switch 223 is switched to select the matching circuit 206, that is, the feeding point 204. In Fig. 30, parts designated by the same reference numerals as those of Fig. 26 show the same components.

[0154] As shown in Fig. 30, when the feeding point 204 side is selected, a feeding source 232 is connected to the feeding point 204 at the right end (Y side) of the plate shaped conductor 202 and a feeding point 233 at the right end (Y side) of the circuit board 221.

[0155] Fig. 31 shows a directivity of a dipole antenna on the YZ plane when the switch 223 is switched to select the matching circuit 205. As shown by the directivity 240b in Fig. 31, an antenna gain in the direction of -Y is higher by about 5dB than an antenna gain in the direction of Y. That is, the directivity 240b shows opposite characteristics to those of the directivity shown 240a in Fig. 31.

[0156] Fig. 32 shows a state that the user holds the portable radio device by a right hand to speak. As described above, when the switch 223 is switched to select the feeding point 204, since the antenna gain in the direction of -Y is higher than that in the direction of Y, the antenna gain is high in the direction of the vertex and low in the direction of the shoulder of the user. Accordingly, an influence of the shoulder of the user is reduced to improve an antenna performance under a speaking state in which the user holds the portable radio device by the right hand.

[0157] In this embodiment, the two feeding points are arranged at the left end and the right end of the plate shaped conductor 202. However, for instance, three or more feeding points may be disposed at different positions and they may be switched. In this case, tree or more of different directivities can be obtained.

[0158] Further, the dimensions of the plate shaped conductor 202 and the circuit board 221 are not limited to those shown in the eighth embodiment. When the ratio of the length of the short side to the length of long side is about 1/5 or higher, an effect of switching the directivity may be obtained.

[0159] Further, the control circuit 225 detects the direction of the portable radio device, that is, by which of the hands the user holds the portable radio device. The switch 223 may be switched in accordance with the detected results. In that case, the control circuit 225 is not necessarily connected to the radio circuit 224.

[0160] In the portable radio device according to the eighth embodiment of the present invention, a plurality of feeding portions are provided in the plate shaped conductor and these feeding portions are switched by the switch 223, so that the directivity of an antenna can be changed. Further, a directional diversity effect can be obtained without adding antenna elements for diversity. Further, even when the portable radio device is held either the left hand or the right hand under the speaking state, a high antenna performance can be obtained.

(Ninth Embodiment)

[0161] Fig. 33 is a front view showing a portable radio device for explaining a ninth embodiment of the present invention. Fig. 34 is a side view showing the portable radio device for explaining the ninth embodiment of the present invention. In Figs. 33 and 34, duplicated portions to those of Fig. 26 are designated by the same reference numerals and the explanation thereof is omitted.

[0162] As shown in Figs. 33 and 34, the portable radio device of the ninth embodiment employs a structure that an upper case 210 is connected to a lower case 211 by a hinge portion 212b and may have two states including an opening state and a closing state by rotating the cases on the hinge portion 212b.

[0163] In the front surface side (a side in the direction of X) of the upper case 210 in the drawing, that is, on a surface having a sound port 213 arranged, a metallic frame 214 is mounted. For the metallic frame 214, light metal having high electric conductivity and high strength, for instance, magnesium alloy is used. Such kind of metal is used so that the strength of the thin upper case 210 can be ensured and the metallic frame 214 can function as an antenna element. The length L21 of the long side of the metallic frame 214 has, for instance, about 90 mm. The outer package surface of the metallic frame 214 is ordinarily painted for dressing. Here, an explanation thereof is omitted.

[0164] In the lower case 211, a circuit board 221 is provided. In the circuit board 221, matching circuits 222a and 222b, a switch 223, a radio circuit 224 and a control circuit 225 are arranged.

[0165] The hinge portion 212b includes hinge fittings 215a and 215b for connecting the upper case 210 to the lower case 211, hinge fittings 219a and 219b provided in the lower case 211, and rotating shafts 218a and 218b for connecting the hinge fittings 215a and 215b to the hinge fittings 219a and 219b so as to respectively freely rotate.

[0166] In both the right and left side parts (directions of $\pm$Y) of the lower end (-Z side) of the metallic frame 214, tapped holes for attaching the metallic frame 214 to the upper case 210 are opened. On the hinge fittings 215a and 215b formed in L shapes, tapped holes for attaching them to the upper case 210 are opened. Attaching screws 216 are attached to tapped hole parts 217 of the upper case 210 respectively through the tapped holes of the metallic frame 214 and the hinge fittings 215a and 215b. According to this structure, the metallic frame 214 is electrically connected to the hinge fittings 215a and 215b, and the upper case 210 and the metallic frame 214 are mechanically fixed to the hinge fittings 215a and 215b.

[0167] The hinge fitting 215a is connected to the hinge fitting 219a provided in the left side (-Y side) of the upper end (Z side) of the lower case 211 through the rotating shaft 218a so as to freely rotate. The hinge fitting 215b is connected to the hinge fitting 219b provided in the right side (Y side) of the upper end (Z side) of the lower case 211 through the rotating shaft 218b so as to freely rotate.

[0168] In the hinge fittings 219a and 219b, tapped holes for attaching them to the lower case 211 are opened. Further, in feeding terminals 220a and 220b, tapped holes are also opened. Attaching screws 229 are attached to tapped hole parts 226 (Fig. 27) of the lower case 211 through the tapped holes of the feeding terminals 220a and 220b and the hinge fittings 219a and 219b. According to this structure, the hinge fittings 219a and 219b are respectively electrically connected to the feeding terminals 220a and 220b, and the lower case 211, the hinge fittings 219a and 219b and the feeding terminals 220a and 220b are respectively mechanically fixed.

[0169] The hinge fittings 215a and 215b, the rotating shafts 218a and 218b and the hinge fittings 219a and 219b are respectively made of electrically conductive metal and are electrically conducted at contact points between them. Accordingly, the metallic frame 214 is electrically connected to the feeding terminals 220a and 220b through the attaching screws 216, the hinge fittings 215a and 215b, the rotating shafts 218a and 218b, the hinge fittings 219a and 219b and the attaching screws 229 and mechanically fixed.

[0170] In the lower case 211, the matching circuit 222a is arranged in the left end (a side in the direction of -Y) part of the upper end (the side of the direction of Z). The matching circuit 222a is connected to the feeding terminal 220a. Further, the matching circuit 222b is arranged in the right end (a side in the direction of Y) part of the upper end (the side in the direction of Z) of the lower case 211. The matching circuit 222b is connected to the feeding terminal 220b.

The feeding terminal 220a is connected to the matching circuit 222a by, for instance, a spring contact or solder. Similarly, the feeding terminal 220b is connected to the matching circuit 222b on the circuit board 221 provided in the lower case 211, by for instance, a spring contact or solder. The long side L24 of the circuit board 21 has, for instance, about 90 mm.

[0171] The matching circuit 222a is connected to a terminal a of the switch 223 on the circuit board 221. The matching circuit 222b is connected to a terminal b of the switch 223. The ground ends (an illustration is omitted) of the matching circuits 222a and 222b are grounded in a ground pattern on the circuit board 221. The switch 223 is switched to select either the matching circuit 222a or 222b and the selected matching circuit is connected to the radio circuit 224. Here, the switch 223 is a high frequency switch formed with, for instance, an FET or a PIN diode. The radio circuit 224 includes a receiving circuit and a transmitting circuit or the like. The control circuit 225 detects a receiving signal level in the radio circuit 224 and controls the switch 223 to switch so as to select the matching circuit 222a or the matching circuit 222b in which the receiving signal level is constantly high.

[0172] According to the above-described structure, the metallic frame 142 and the hinge portion 212b and the ground pattern on the circuit board 221 operate as a dipole antenna. At this time, the metallic frame 214 and the hinge portion 212b operate as a first antenna element having the length of L25 (for instance, 110 mm). The matching circuits 222a and 222b match the impedance of the first antenna element with the input impedance (ordinarily, 50 Ω) of the radio circuit 224. Further, the ground pattern on the circuit board 221 having the length of L24 operates as a second antenna element. Here, a gap G between the hinge fittings 219a and 219b and the ground pattern on the circuit board 21 is desirably wide as much as possible (for instance, 2 mm or more; or when the portable radio device is used with 800 MHz, λ/20 or more) from the viewpoint of an antenna performance.

[0173] Now, an antenna operation of the portable radio device having the above-described structure will be described below.

[0174] When the switch 223 is switched to select the matching circuit 222a side, that is, the feeding terminal 220a side, characteristics near the directivity 240a shown in Fig. 28 are obtained. When the switch 223 is switched to select the matching circuit 222b side, that is, the feeding terminal 220b side, characteristics near the directivity 240b shown in Fig. 31 are obtained. Accordingly, a directional diversity effect can be obtained for arriving radio waves inputted to the portable radio device from various directions.

[0175] Further, as shown in Fig. 29, in the speaking state in which the portable radio device is held by the left hand, the matching circuit 222a is selected to obtain a high antenna performance. On the contrary, as shown in Fig. 32, in the speaking state in which the portable radio device is held by the right hand, the matching circuit 222b is selected. Under this state, the high antenna performance can be likewise obtained. Accordingly, the switch 223 is switched to select either of the matching circuit 222a and the matching circuit 222b so that a state can be selected in which the antenna performance is increased correspondingly to both the states that the portable radio device is held by the left hand or the right hand under the speaking state.

[0176] In the ninth embodiment, the two feeding portions are arranged at the left end and the right end of the plate shaped metallic frame 214. However, for instance, three or more feeding portions may be disposed at different positions and they may be switched. In this case, tree or more of different directivities can be obtained.

[0177] Further, the dimensions of the metallic frame 214 and the circuit board 221 are not limited to those shown in the ninth embodiment. When the ratio of the short side to the long side is about 1/5 or higher, an effect of switching the directivity may be obtained.

[0178] Further, in the ninth embodiment, the two hinge fittings are spaced apart right and left and attached to the right and left sides. However, even when the hinge fitting 219a is formed integrally with the hinge fitting 219b, if a plurality of feeding portions is provided at prescribed intervals, the same effects can be obtained.

[0179] Further, the control circuit 225 detects the direction of the portable radio device, that is, by which of the hands the user holds the portable radio device. The switch 223 may be switched in accordance with the detected results. In that case, the control circuit 225is not necessarily connected to the radio circuit 224.

[0180] In the ninth embodiment, the hinge fittings 215a and 215b, the rotating shafts 218a and 218b and the hinge fittings 219a and 219b are respectively electrically conducted together. However, they may be electro-magnetically connected together by a capacitive reactance.

[0181] In the portable radio device according to the ninth embodiment of the present invention, a plurality of feeding portions are connected to the hinge portions connected to the metallic frame and these feeding portions are switched by the switch, so that the directivity of an antenna can be changed. Further, a directional diversity effect can be obtained without adding antenna elements for diversity. Further, even when the portable radio device is held either the left hand or the right hand under the speaking state, a high antenna performance can be obtained. Further, the metallic frame forming a part of the upper case has a function of the antenna element. Thus, the decrease of thickness of the portable radio device can be realized.

(Tenth Embodiment)

[0182] Fig. 35 is a front view showing a portable radio device for explaining a tenth embodiment of the present invention. In Fig. 35, duplicated portions to those of Fig. 26 are designated by the same reference numerals and the explanation thereof is omitted.

[0183] As shown in Fig. 35, in the portable radio device according to the tenth embodiment, a hinge portion 212c that includes a hinge fitting 215c provided between hinge fittings 215a and 215b, a rotating shaft 218c attached to the hinge fitting 215c so as to freely rotate and a hinge fitting 219c attached to the rotating shaft 218c so as to freely rotate is attached to an upper case 210. To the hinge portion 212c, a feeding terminal 220c attached to the hinge fitting 219c is connected. The feeding terminal 220c is connected to a matching circuit 228 disposed on a circuit board 221 by a spring contact or solder or the like. The matching circuit 228 is connected to a radio circuit 224. Further, the ground end (an illustration is omitted) of the matching circuit 228 is grounded in a ground pattern (an illustration is omitted) of the circuit board. In the tenth embodiment, the feeding terminal 220c and the matching circuit 223 show one examples of a feeding portion.

[0184] A switch 227a is connected between a feeding terminal 220a and the ground pattern (the illustration is omitted) of the circuit board 221. A switch 227b is connected between a feeding terminal 220b and the ground pattern (the illustration is omitted) of the circuit board 221. In the tenth embodiment, the feeding terminals 220a and 220b show one examples of a ground portion.

[0185] The switches 227a and 227b are high frequency switches formed by, for instance, an FET or a PIN diode like the switch 223 shown in Fig. 33. A control circuit 225 detects a receiving signal level in the radio circuit 224 and controls the switch (switches 227a and 227b) in which the receiving signal level is always high to be selected.

[0186] An antenna operation of the portable radio device constructed as described above will be described below.

[0187] In Fig. 35, when the switch 227a is turned ON and the switch 227b is turned OFF, the directivity of an antenna is high in a gain in the direction of Y like the directivity 250a shown in Fig. 36. On the contrary, when the switch 227a is turned OFF and the switch 227b is turned ON, the directivity of an antenna is high in a gain in the direction of -Y like the directivity 250b shown in Fig. 37. Further, when both the switch 227a and the switch 227b are turned OFF, an intermediate directivity of the directivity 250a and the directivity 250b is obtained. When both the switch 227a and the switch 227b are turned ON, antenna characteristics are deteriorated. Therefore, the control operation of the control circuit 225 is desirably set not to select this state.

[0188] Accordingly, a directional diversity effect that can control three kinds of directivities for arriving radio waves inputted to the portable radio device from various directions can be obtained.

[0189] Further, in the speaking state shown in Fig. 29 obtained when the portable radio device is held by the left hand, the switch 227a is turned ON and the switch 227b is set to OFF. Thus, a high antenna performance is obtained. On the contrary, in the speaking state as shown in Fig. 32 obtained when the portable radio device is held by the right hand, the switch 227a is turned OFF and the switch 227b is set to ON. Under this state, the high antenna performance is also obtained.

[0190] In the tenth embodiment, the feeding portion is disposed at a central portion and the two ground portions for switching a ground are disposed at both ends. However, even when the feeding portion is disposed at one end and the ground portion is disposed at one end opposed thereto, a directional diversity effect can be obtained.

[0191] Further, the control circuit 225 detects the direction of the portable radio device, that is, by which of the hands the user holds the portable radio device. The switch 223 may be switched in accordance with the detected results. In that case, the control circuit 225 is not necessarily connected to the radio circuit 224.

[0192] In the tenth embodiment, the hinge fittings 215a, 215b and 215c, the rotating shafts 218a, 218b and 218c and the hinge fittings 219a, 219b and 219c are respectively electrically conducted together. However, they may be electro-magnetically connected together by a capacitive reactance.

[0193] In the portable radio device according to the tenth embodiment of the present invention, the feeding portion and a plurality of ground portions are connected to the hinge portions connected to a metallic frame and the ground portions are switched by the switch, so that the directivity of an antenna can be changed. Further, a directional diversity effect can be obtained without adding antenna elements for diversity. Further, even when the portable radio device is held either the left hand or the right hand under the speaking state, a high antenna performance can be obtained. Further, the metallic frame forming a part of the upper case has a function of the antenna element. Thus, the decrease of thickness of the portable radio device can be realized.

[0194] The present invention is described in detail by referring to the specific embodiments, however, it is to be understood to a person with ordinary skill in the art that various changes or modifications may be made without departing the spirit and the scope of the present invention.

[0195] This application is based on Japanese Patent Application (No. 2002-210612) filed in July 19, 2002, Japanese Patent Application (No. 2003-015675) filed in January 24, 2003, and Japanese Patent Application (No. 2003-167962) filed in June 12, 2003 and the contents thereof are taken in as references.

<Industrial Applicability>

[0196] As described above, the portable radio device according to the present invention can obtain a high performance in various using states.

Claims

1. A portable radio device comprising:

   a first casing;
   a second casing;
   a connection portion, connecting the first casing to the second casing so as to freely rotate;
   a first antenna element, provided in the first casing;
   a conductor element, provided in the second casing to form a dipole antenna together with the first antenna element; and
   a feeding portion, having one end electrically connected to the first antenna element and the other end electrically connected to the conductor element.

2. The portable radio device as set forth in claim 1, wherein a plurality of first antenna elements are provided in the first casing; and the portable radio device further comprising a switching portion which switches the plurality of first antenna elements so as to connect to the feeding portion.

3. The portable radio device as set forth in claim 2, wherein the switching portion switches whether the plurality of the first antenna elements are electrically connected to the feeding portion or the plurality of the first antenna elements are electrically connected to the conductor element, respectively.

4. The portable radio device as set forth in claim 2, further comprising a half-wavelength element being electrically connected between at least one of the plurality of the first antenna elements and the switching portion.

5. The portable radio device as set forth in claim 2, further comprising a plurality of half-wavelength elements being respectively electrically connected to the plurality of the first antenna elements,
   wherein the switching portion selectively switches the plurality of the first antenna elements and the plurality of the half-wavelength elements so as to connect to the feeding portion.

6. The portable radio device as set forth in claim 1, further comprising a plurality of impedance matching portions respectively corresponding to the plurality of the first antenna elements.

7. The portable radio device as set forth in claim 2, further comprising:

   a casing opening and closing state detecting portion, detecting whether or not the first casing and the second casing are opened to each other; and
   a control portion, controlling the switching portion in accordance with the detected result of the casing opening and closing state detecting portion.

8. The portable radio device as set forth in claim 2, further comprising a control portion, determining a receiving level of a radio circuit portion to control the switching portion so as to raise the receiving level.

9. The portable radio device as set forth in claim 1, wherein the antenna element and the conductor element are respectively formed in plate shapes along the surfaces of the first casing and the second casing.

10. The portable radio device as set forth in claim 9, further comprising:

    a circuit board, provided in the second casing and having a radio circuit,

    wherein the conductor element is formed in a ground pattern which is formed on the circuit board provided in the second casing;
    wherein a ground of the radio circuit portion is electrically connected to the ground pattern; and

wherein the feeding portion is provided in the radio circuit portion.

11. A portable radio device as set forth in claim 1, further comprising:

a second antenna element, provided in the second casing near the connection portion;
an opening and closing state detecting portion, detecting the opening and closing states of the first casing and the second casing; and
a switching portion, selecting and switching any one of the first antenna element and the second antenna element to a connection to a signal processing portion for performing a signal process in accordance with the detected result of the casing opening and closing state detecting portion,

wherein when the first casing and the second casing are opened, the first antenna element and the conductor element form the dipole antenna; and
wherein when the first casing and the second casing are closed, the second antenna element and the conductor element form a mono-pole antenna.

12. The portable radio device as set forth in claim 11, wherein when the first casing and the second casing are opened, the switching portion selects the first antenna element; and
wherein when the upper casing and the lower casing are closed, the switching portion selects the second antenna element.

13. The portable radio device as set forth in claim 1, further comprising:

a second antenna element provided in the second casing near the connection portion;
a receiving field intensity measuring portion, measuring the receiving field intensity of a signal received by the first antenna element or the second antenna element; and
a switching portion, selecting and switching the antenna element having a higher receiving field intensity to a connection to a signal processing portion for performing a signal process in accordance with the measured result of the receiving field intensity measuring portion,

wherein the first antenna element has a first feeding point for electrically connecting to the conductor element;
wherein the second antenna element has a second feeding point for electrically connecting to the conductor element; and
wherein the first feeding point and the second feeding point are provided at the diagonal positions of opposed sides when the first casing and the second casing are opened.

14. The portable radio device as set forth in claim 11, further comprising:

a first matching portion, matching the impedance of the first antenna element to a prescribed value; and
a second matching portion, matching the impedance of the second antenna element to a prescribed value.

15. The portable radio device as set forth in claim 1, further comprising:

a circuit board, provided in the second casing;
a plurality of feeding portions, feeding electric current to the antenna element and being separated to each other;
a radio circuit, disposed in the circuit board; and
a switching portion, provided between the plurality of feeding portions and the radio circuit and selecting any one of the plurality of the feeding portions to connect the radio circuit.

16. The portable radio device as set forth in claim 1, further comprising:

a circuit board, provided in the second casing;
a radio circuit, disposed in the circuit board and electrically connected to the feeding portion;
a ground portion, spaced from the feeding portion and connecting the antenna element to the circuit board; and
a switching portion, switching whether the ground portion is connected to the circuit board or the ground portion and the circuit board are opened.

17. The portable radio device as set forth in claim 16, wherein a plurality of ground portions are provided; and
wherein the ground portions are disposed so as to be spaced apart in the end part of the antenna element connected to the second casing.

18. The portable radio device as set forth in claim 17, wherein the switching portion switches the ground portions respectively.

19. The portable radio device as set forth in claim 16, wherein the connection portion has an electric conductivity; and
wherein the ground portion is electrically connected to the antenna element through the connection portion.

20. The portable radio device as set forth in claim 1, wherein the connection portion has an electric conductivity; and
wherein the feeding portion is electrically connected to the antenna element through the connection portion.

21. The portable radio device as set forth in claim 15, further comprising:

a control circuit, controlling the switching portion in accordance with the level of a receiving signal received by the radio circuit.

22. The portable radio device as set forth in claim 1, wherein the first antenna element is an electric conductive frame forming a part of the first casing.

FIG. 1

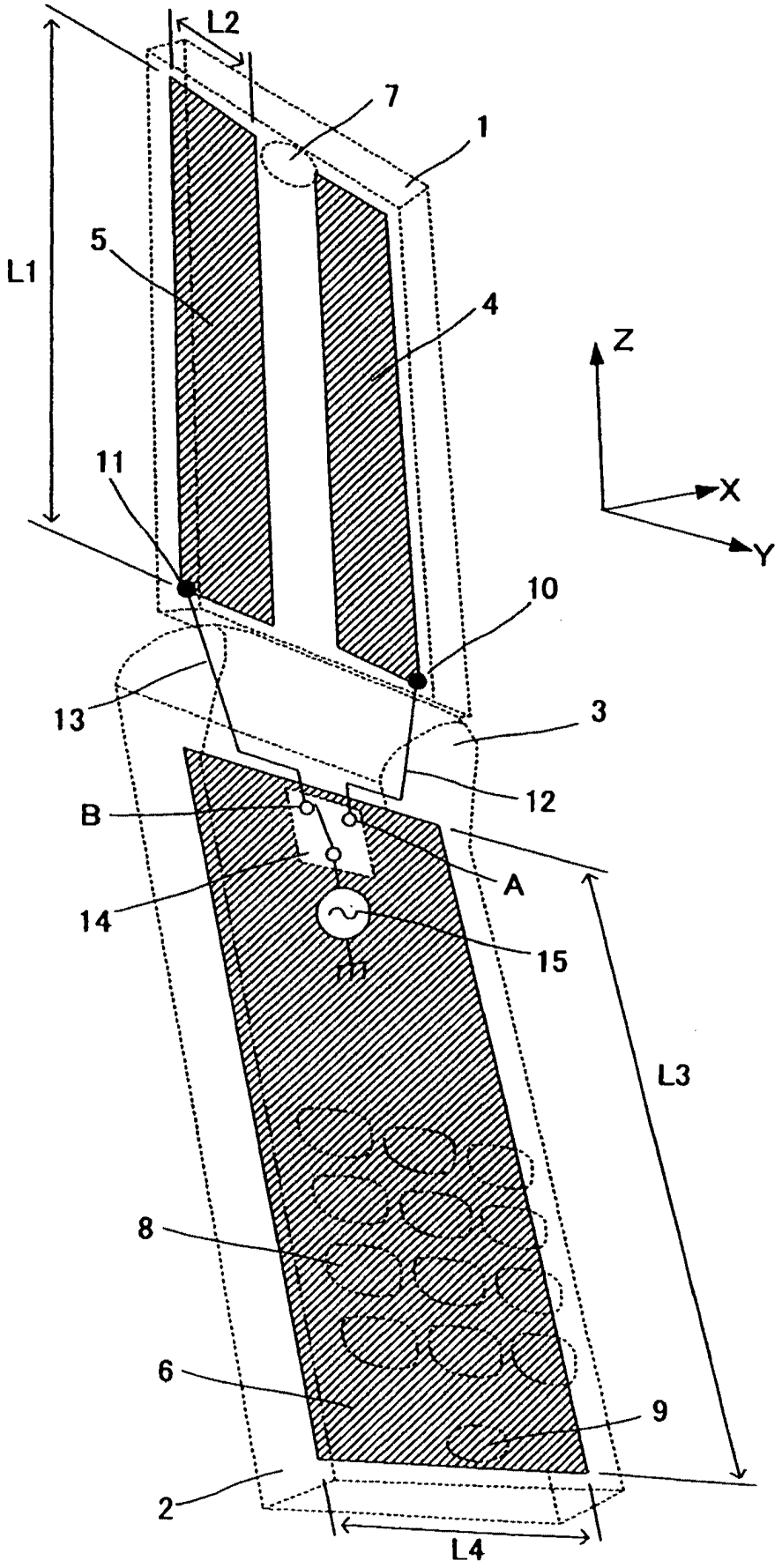


FIG. 2A

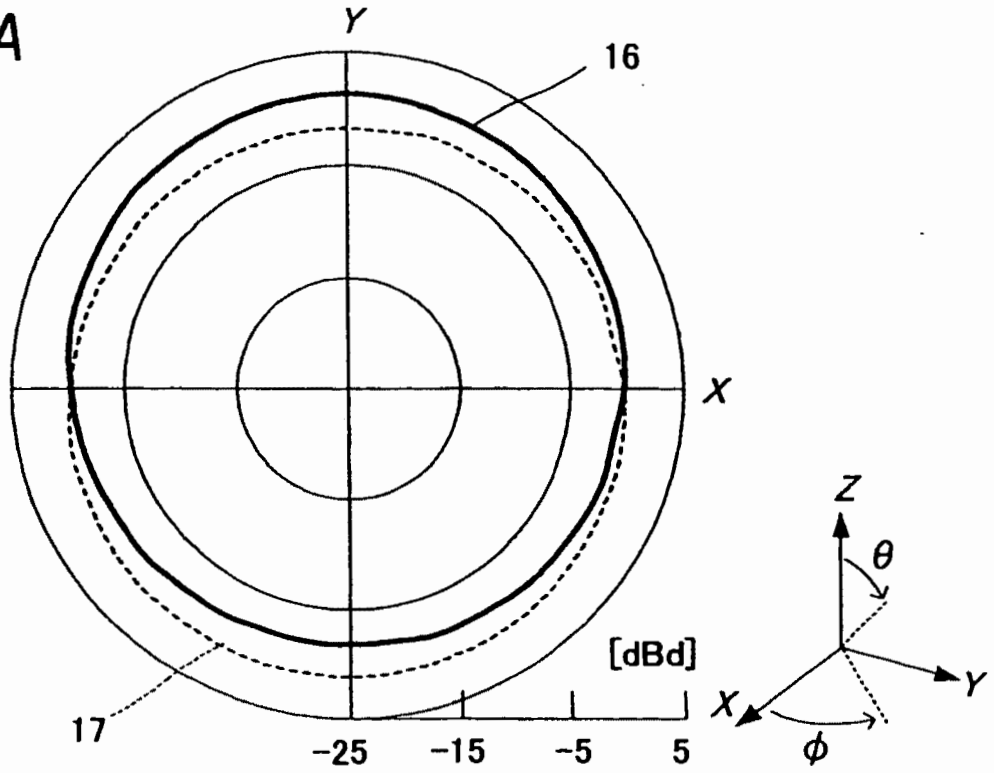


FIG. 2B

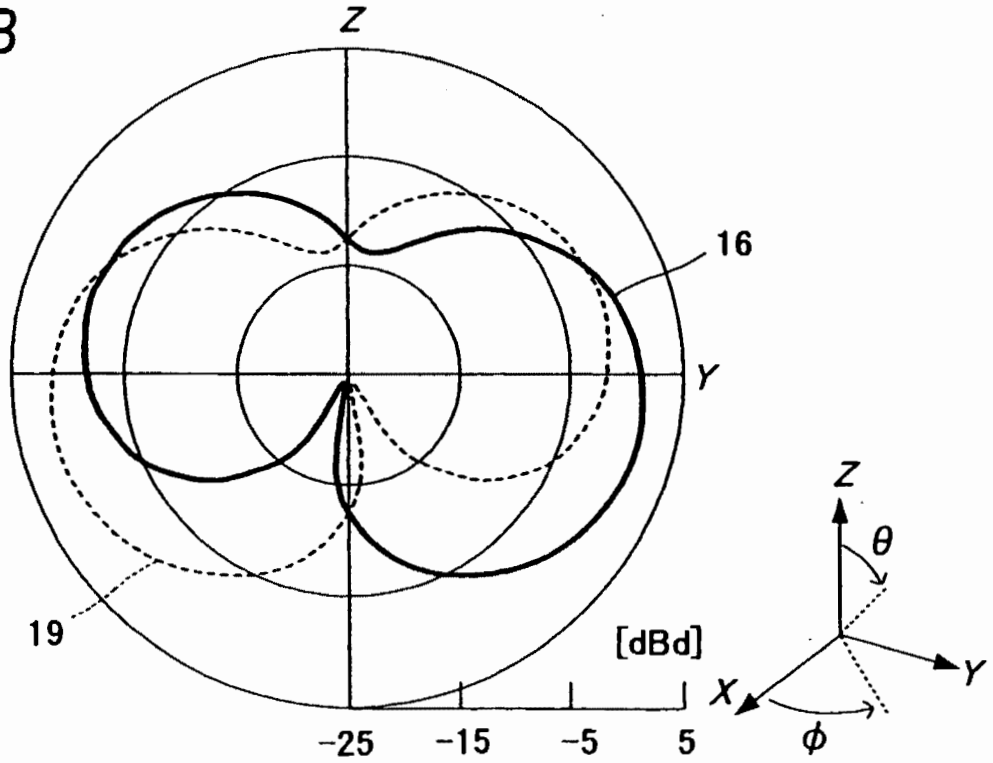


FIG. 3A

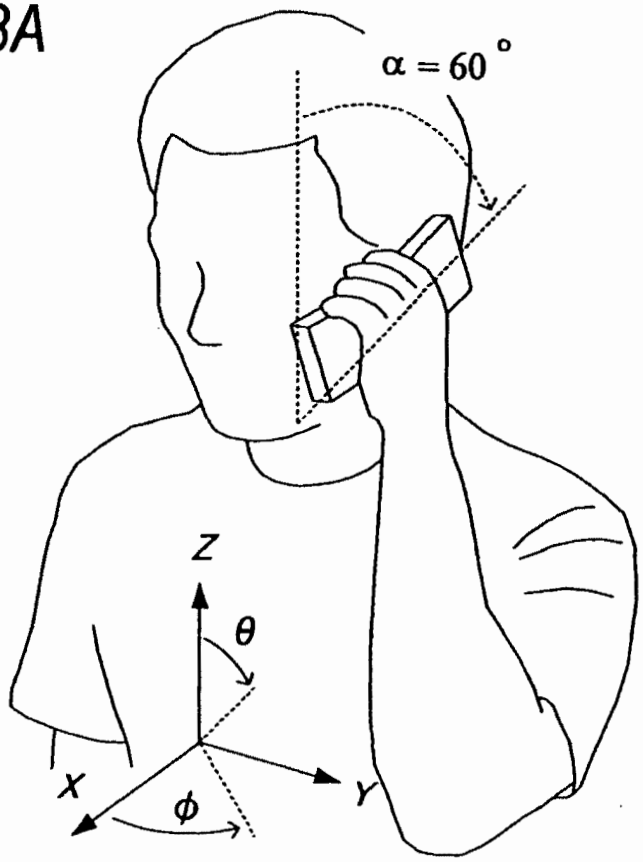


FIG. 3B

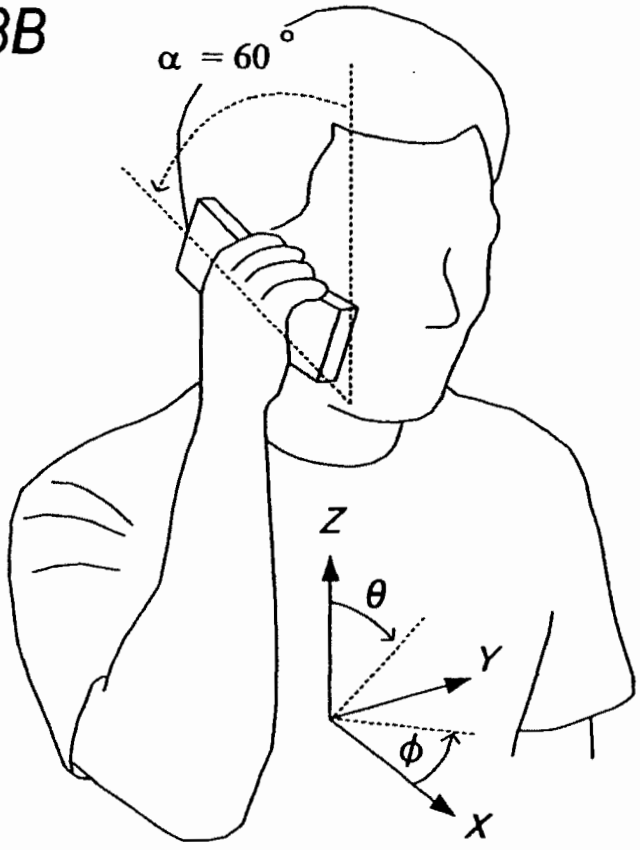


FIG. 4A

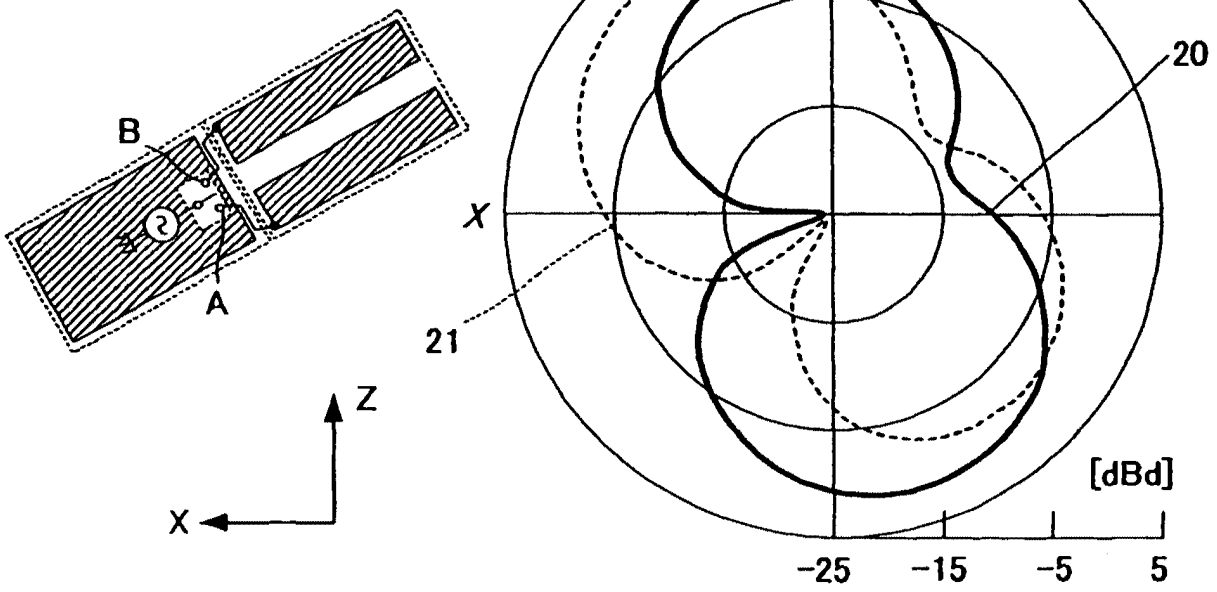


FIG. 4B

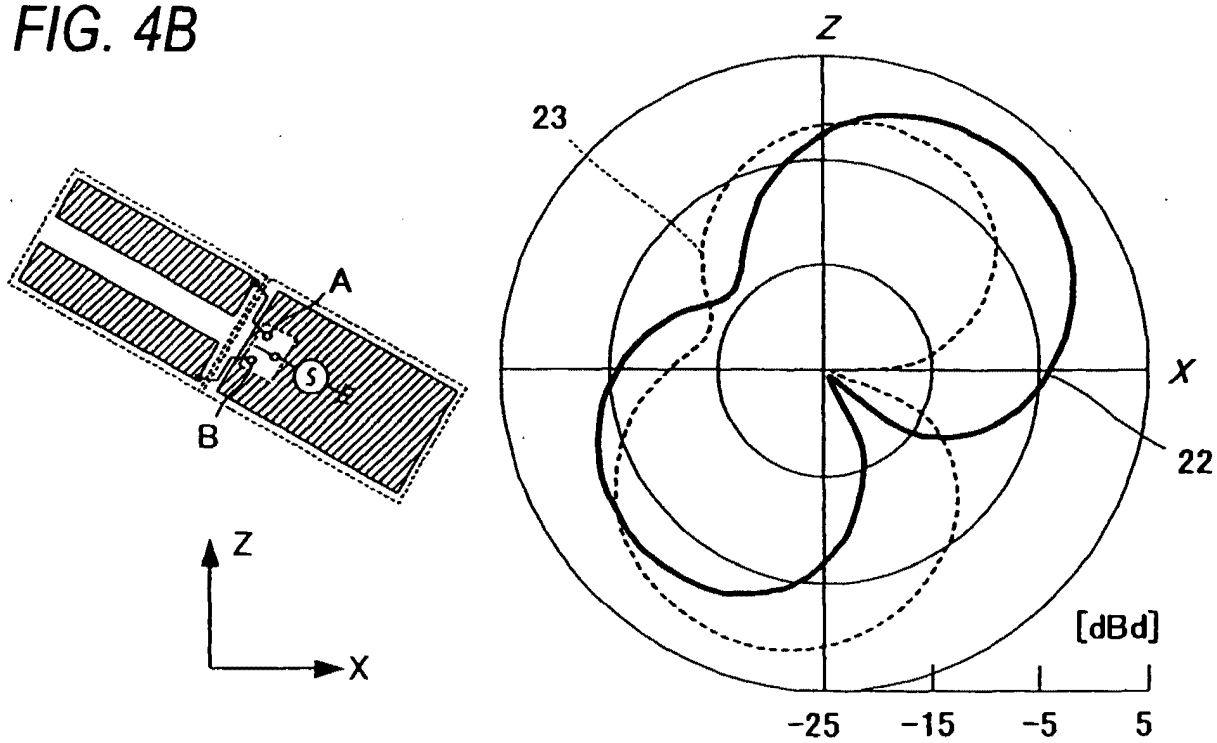


FIG. 5

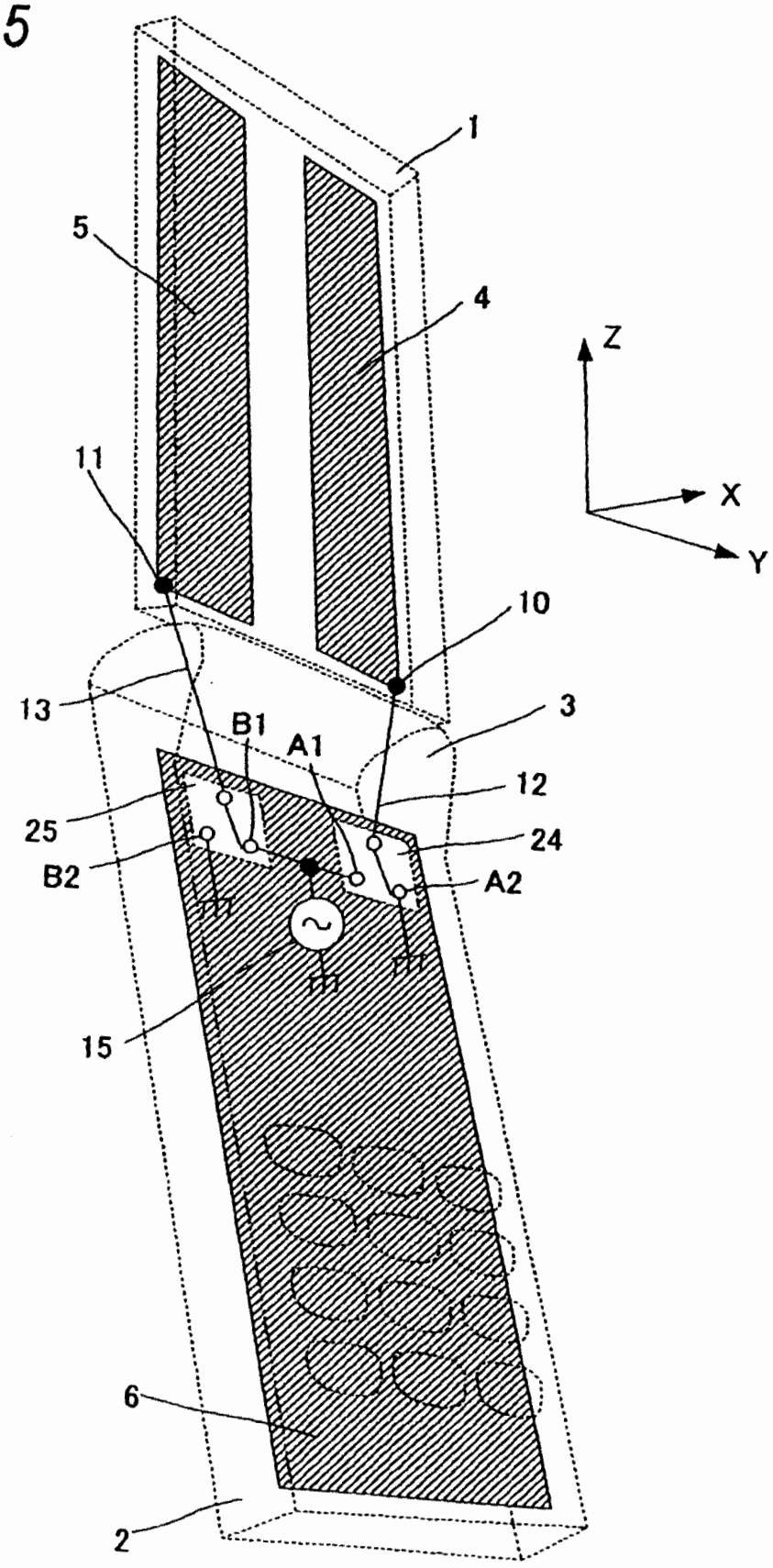


FIG. 6A

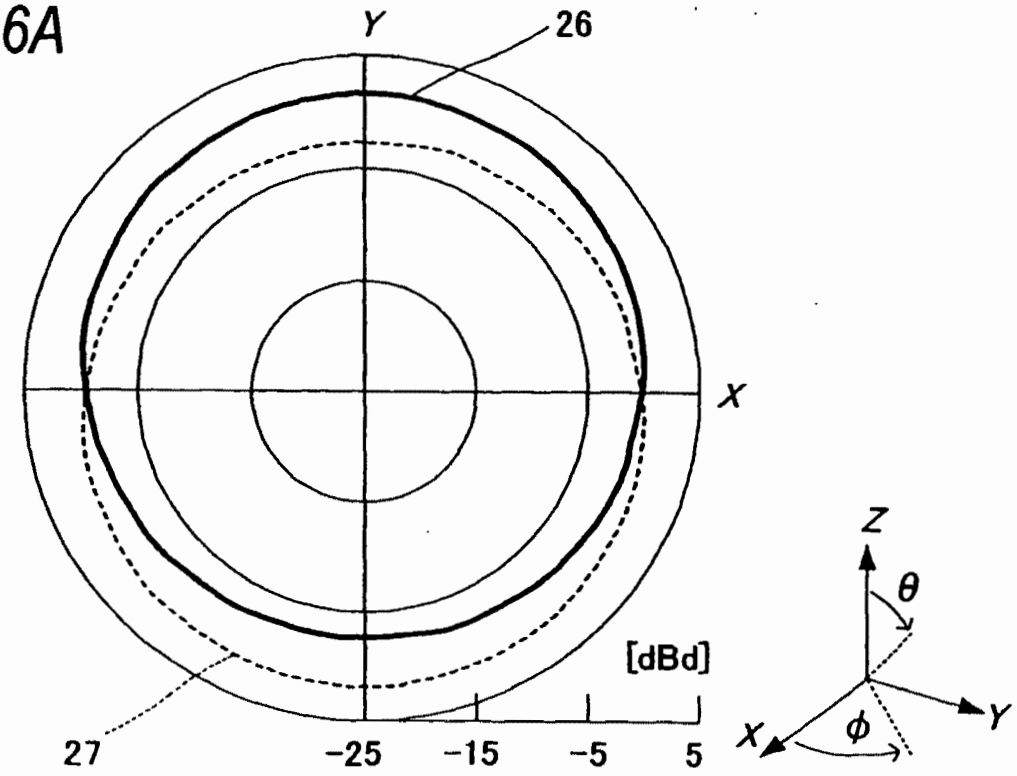


FIG. 6B

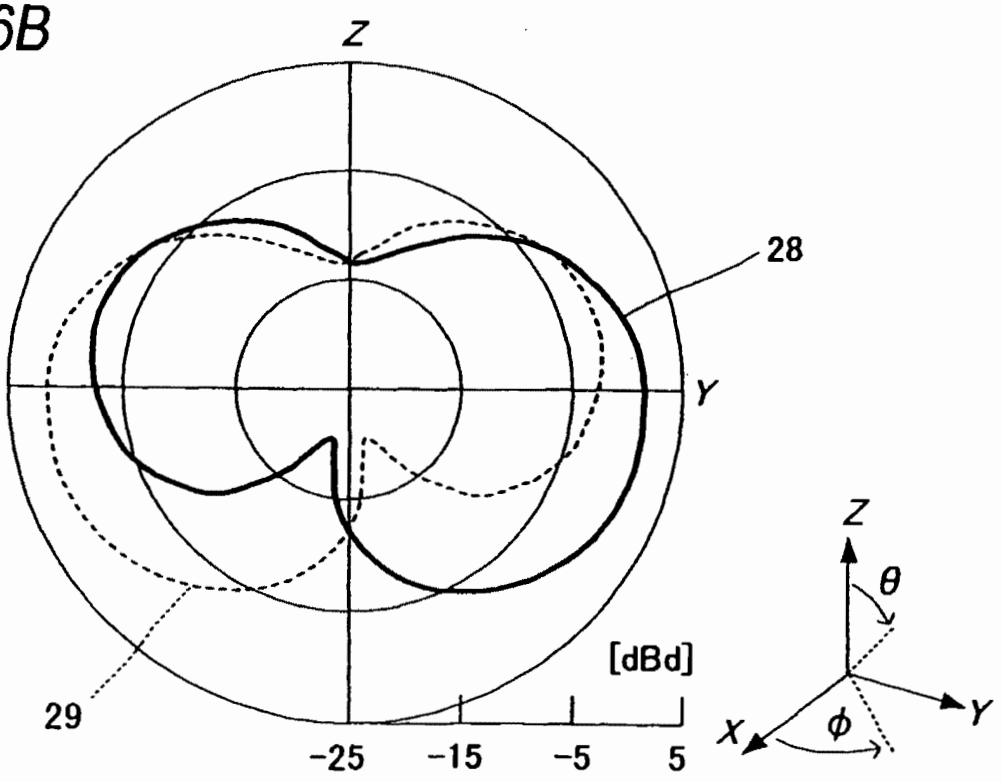


FIG. 7

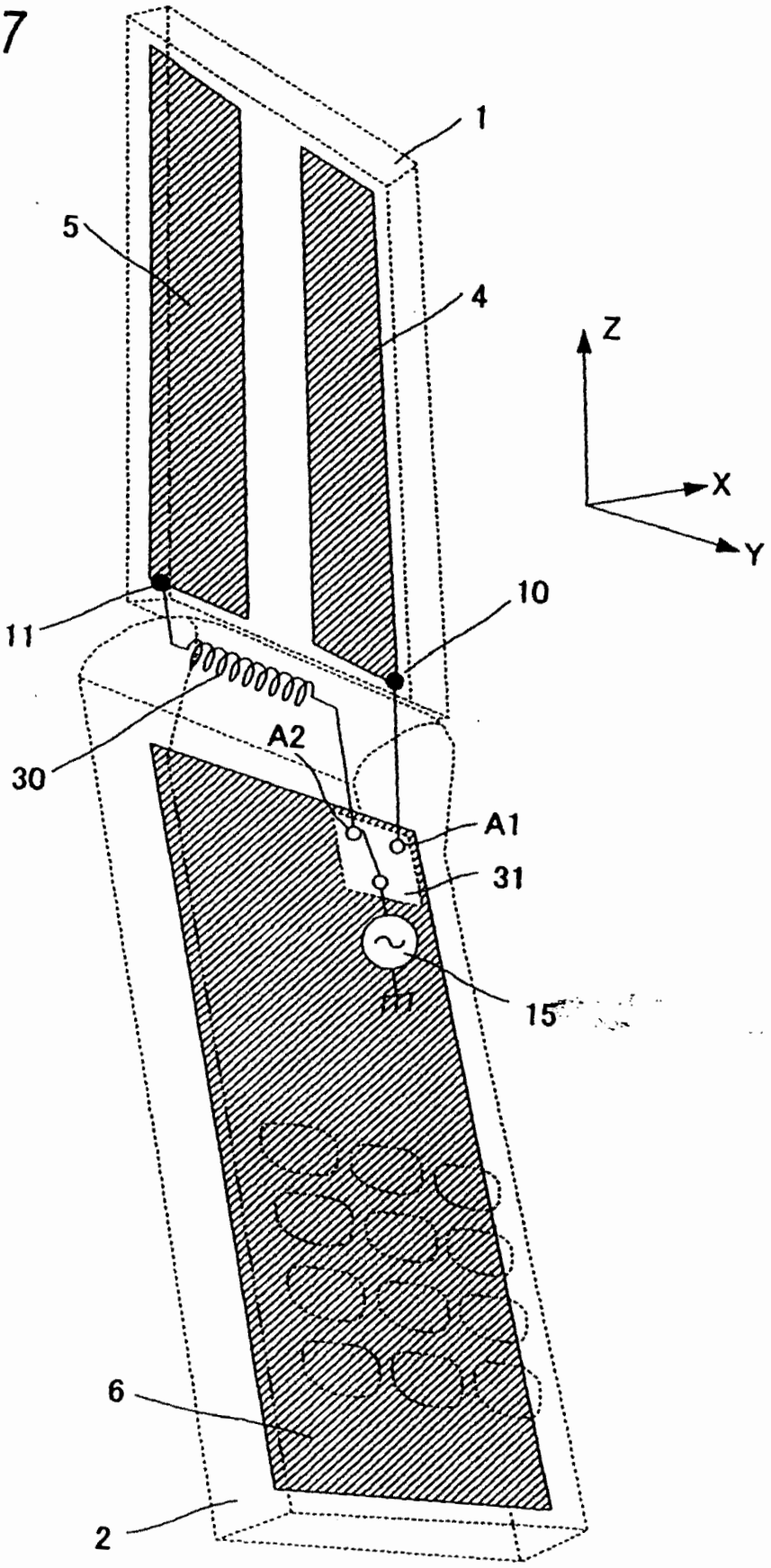


FIG. 8

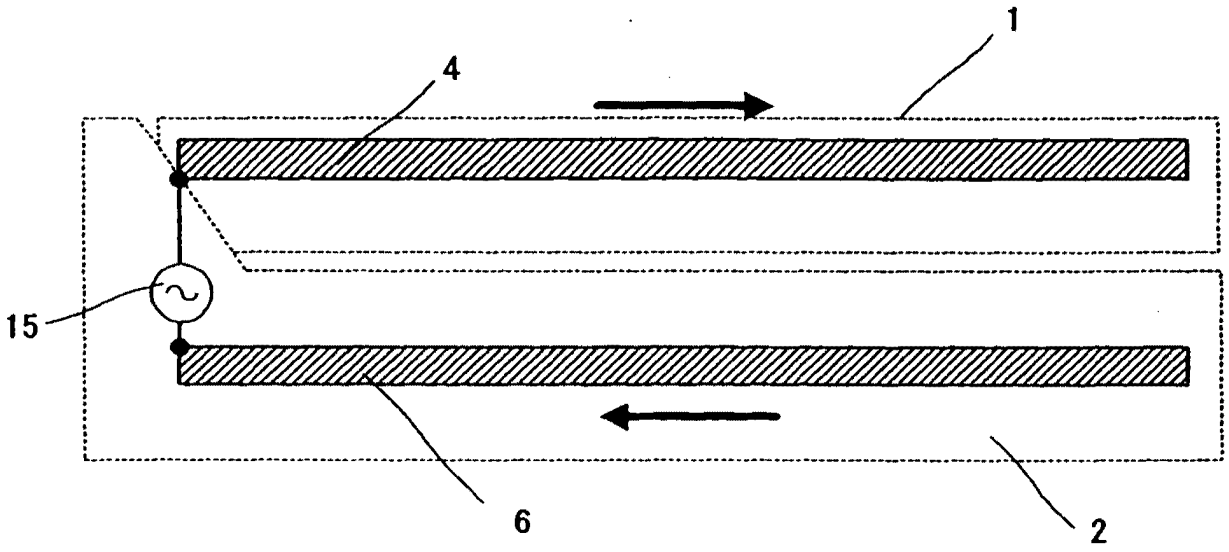


FIG. 9

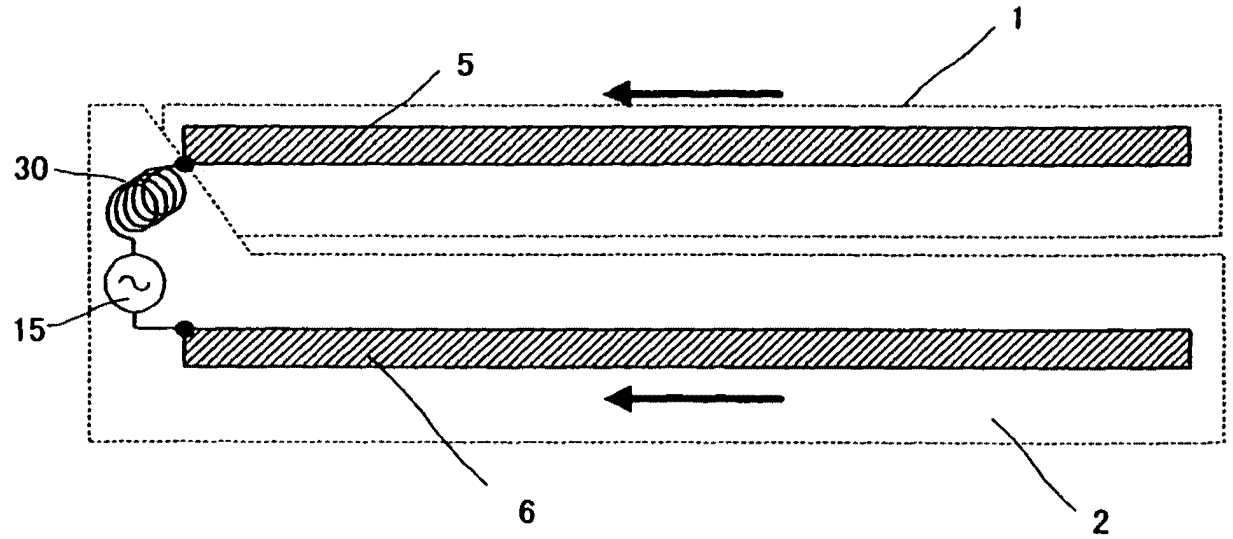


FIG. 10A

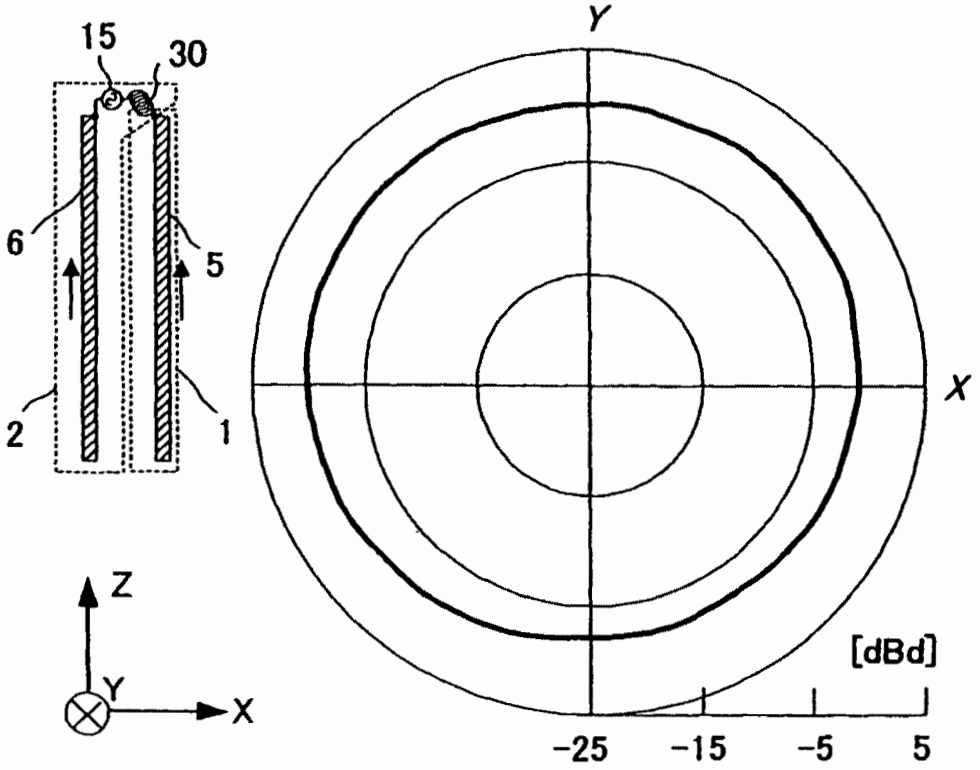


FIG. 10B

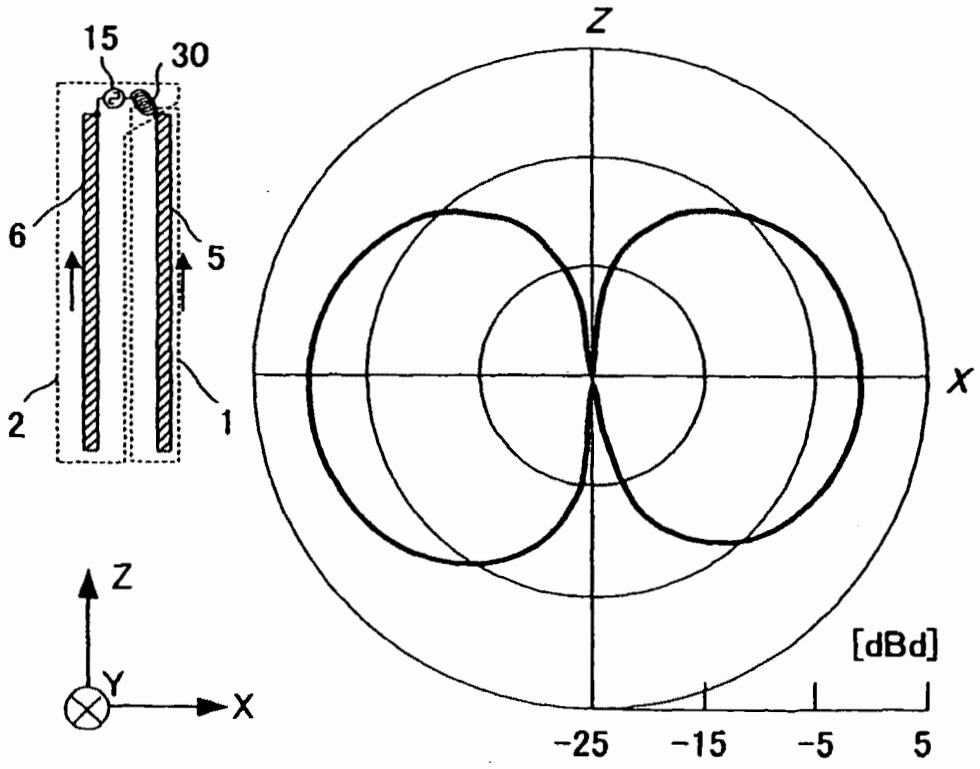


FIG. 11

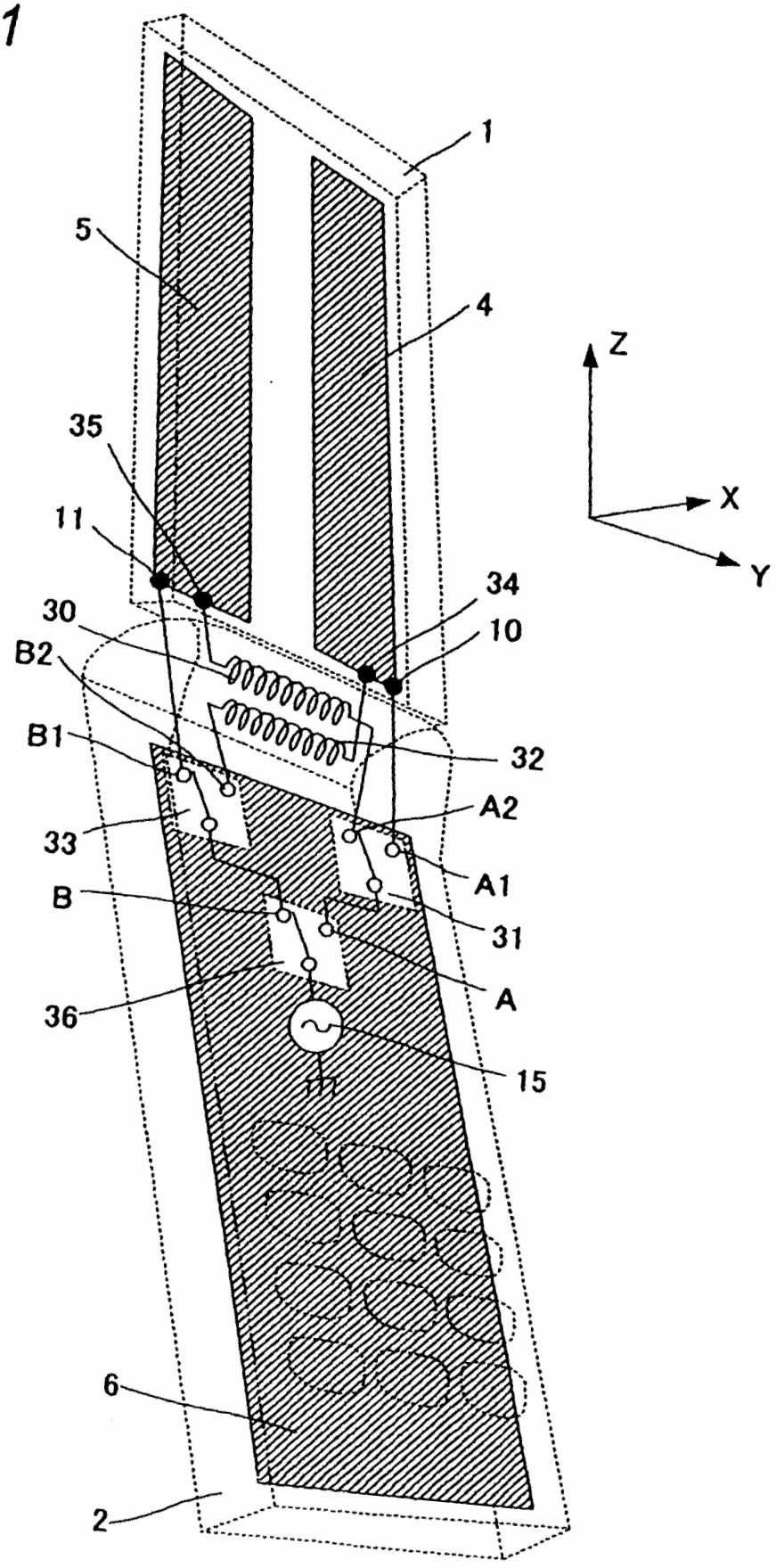


FIG. 12

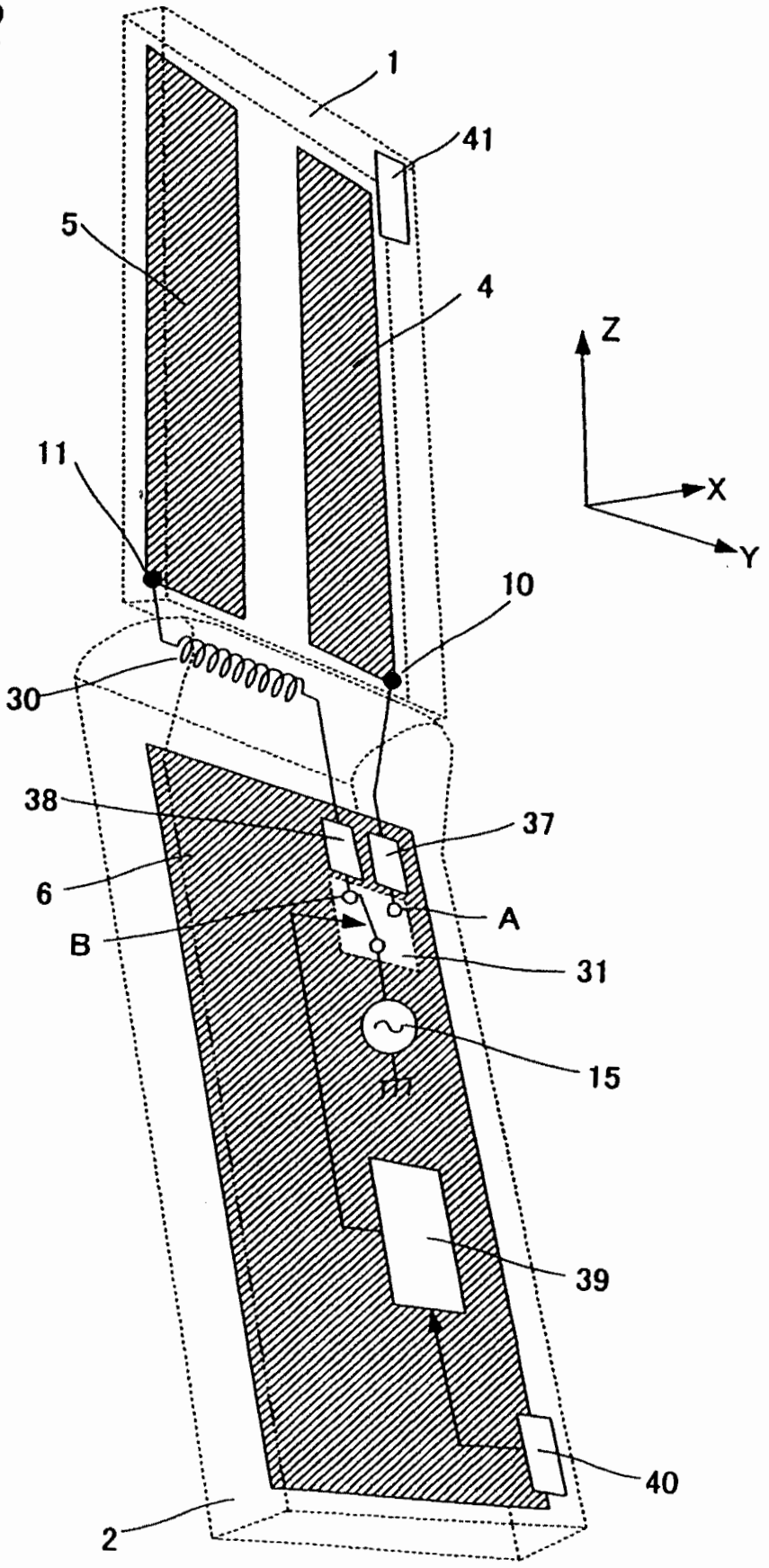


FIG. 13

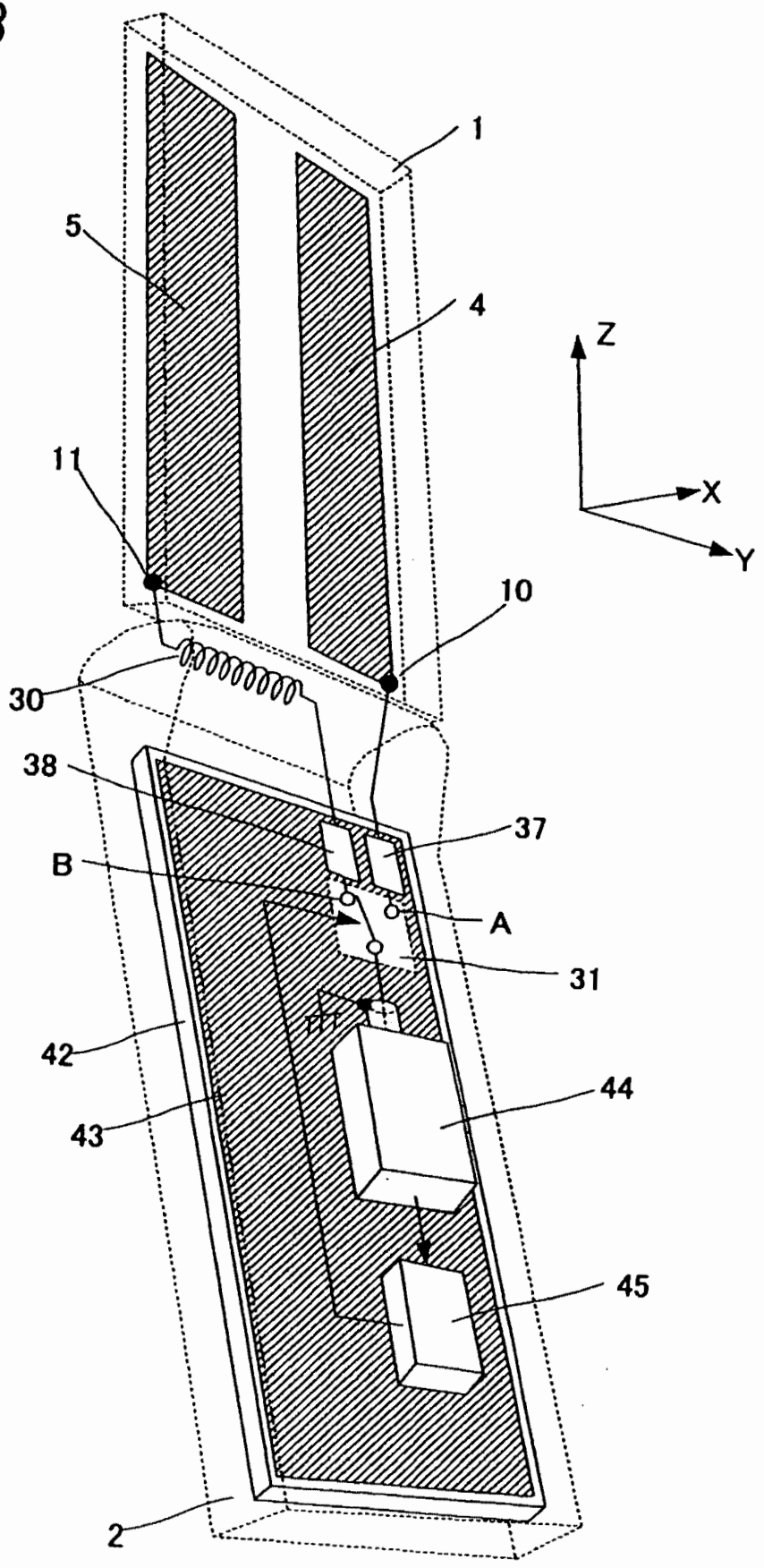


FIG. 14

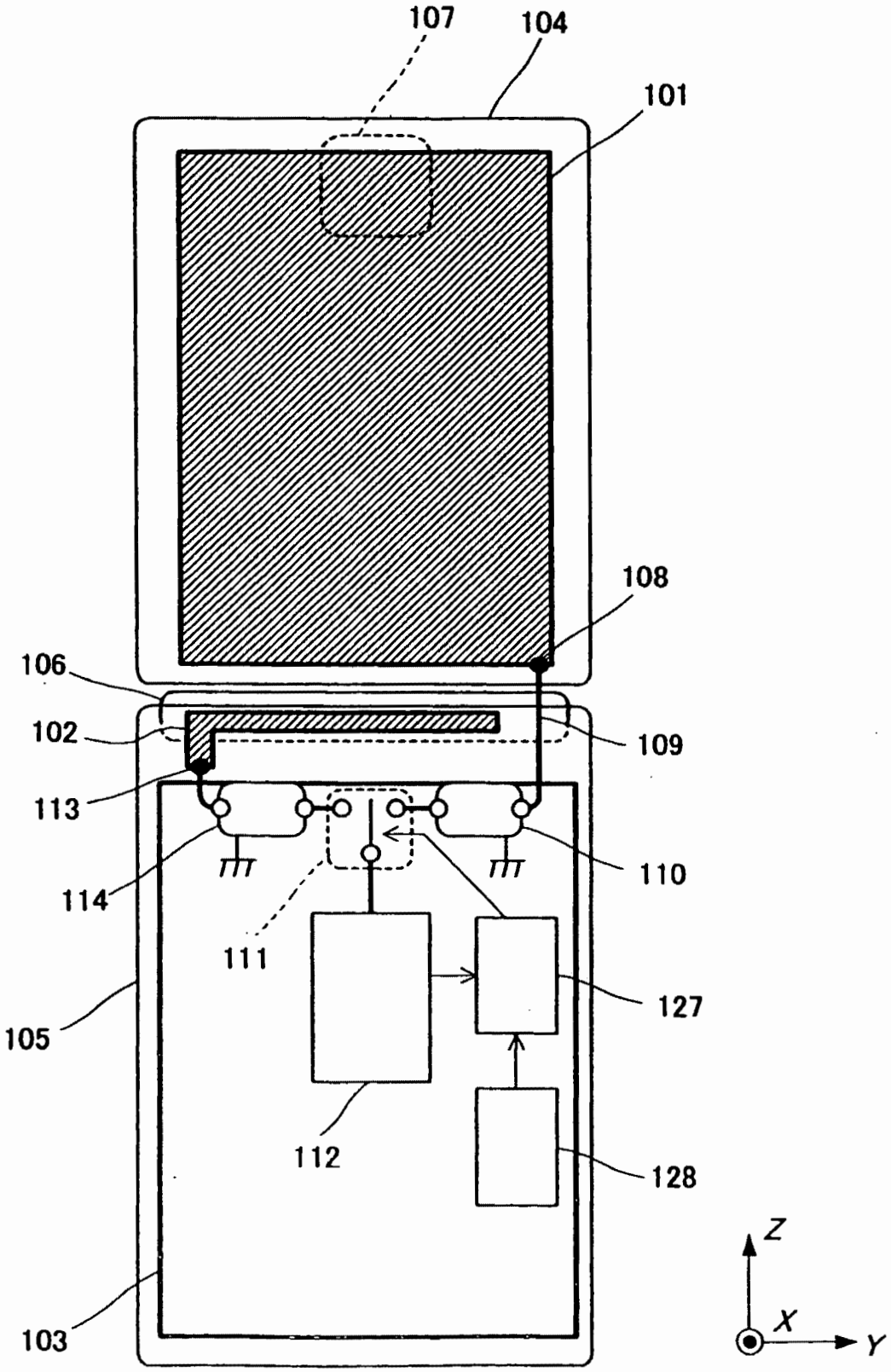

107
104
101
108
106
102
109
113
110
114
111
127
105
112
128
103
Z
X
Y

FIG. 15

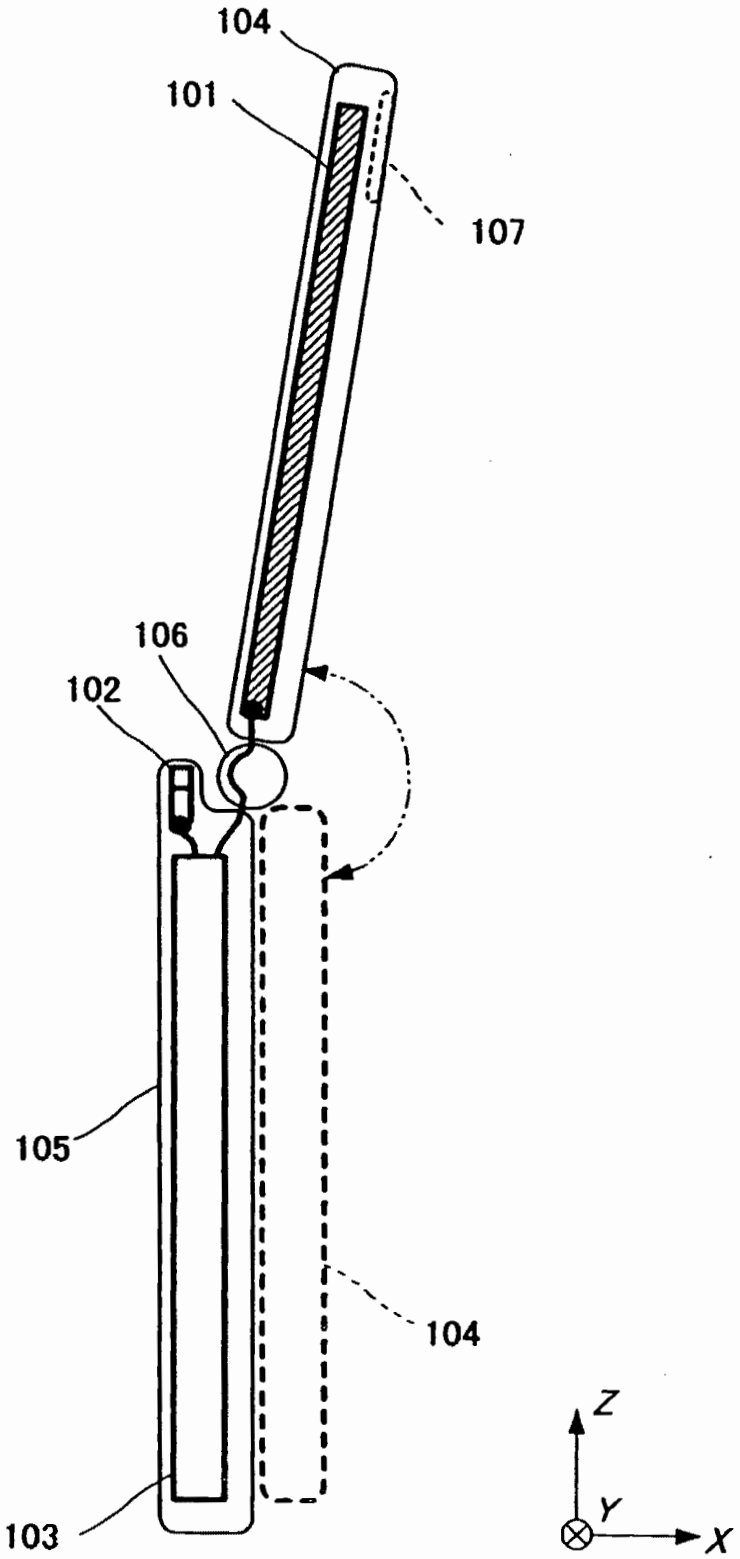


FIG. 16

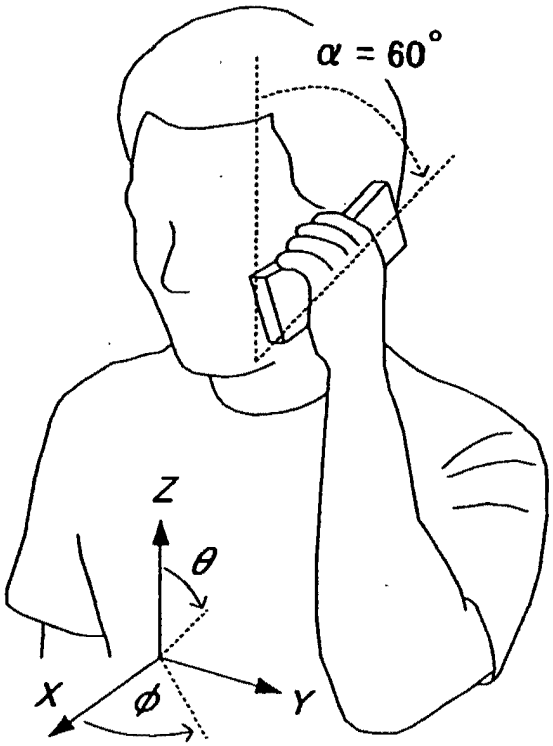


FIG. 17

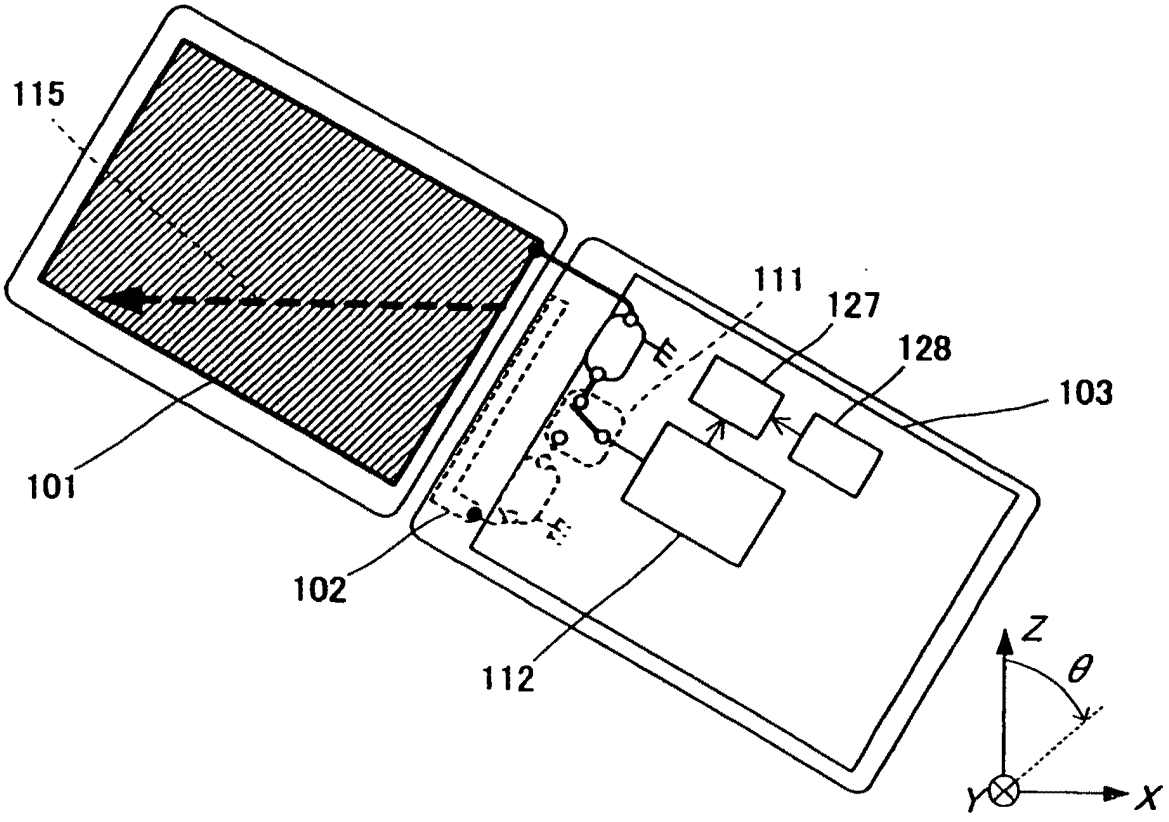


FIG. 18

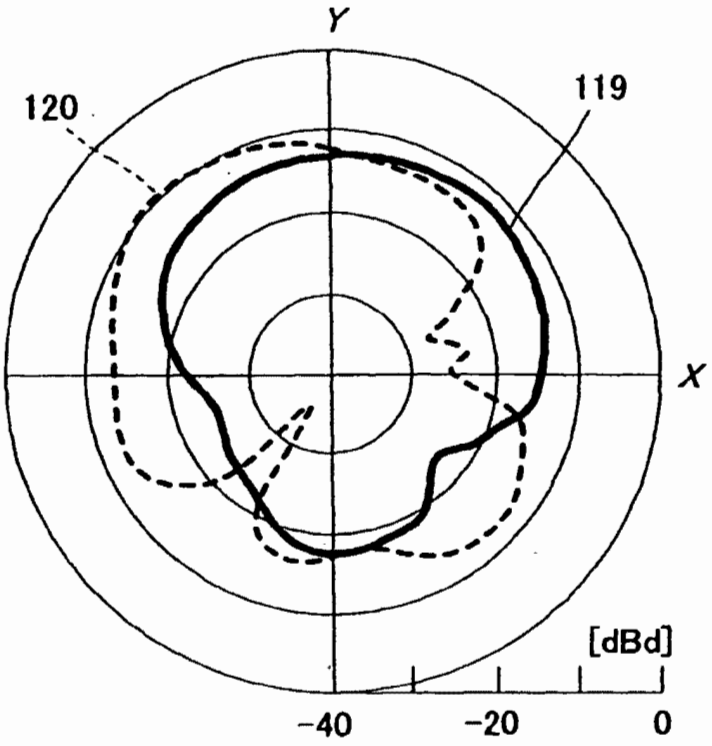

Y
120
119
X
[dBd]
-40
-20
0

FIG. 19

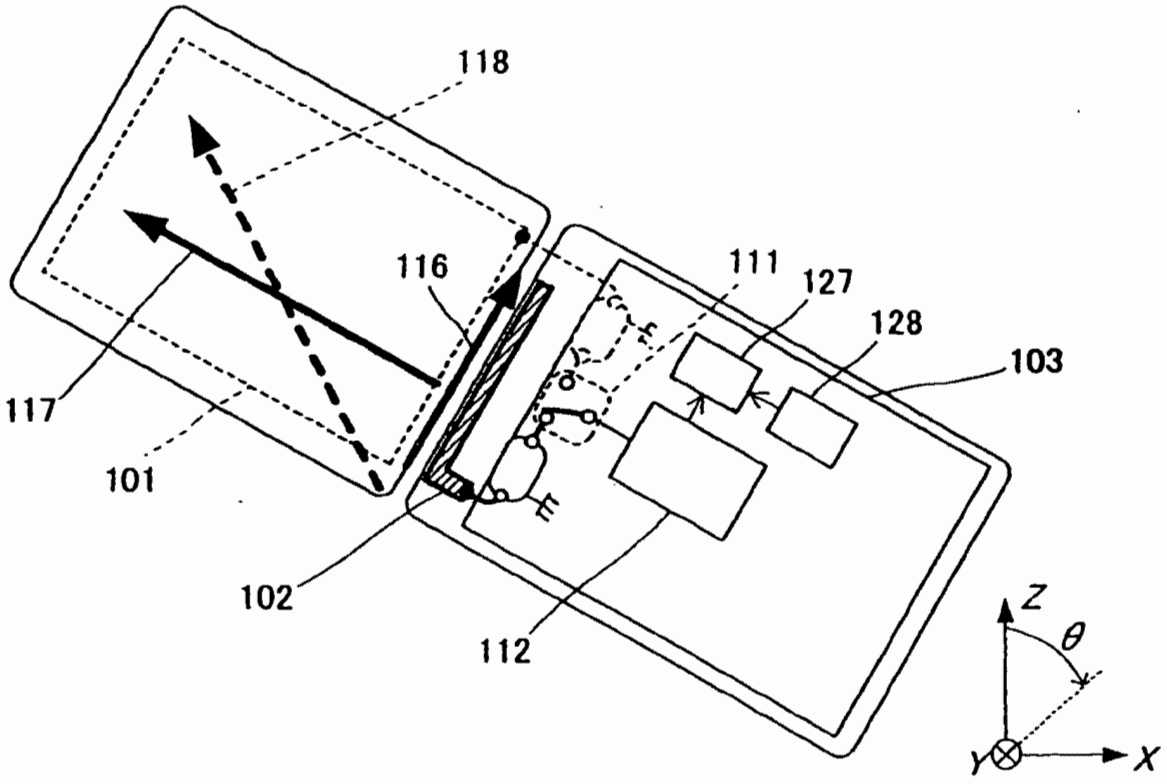

118
116
111
127
128
103
117
101
102
112
Z
θ
Y
X

FIG. 20

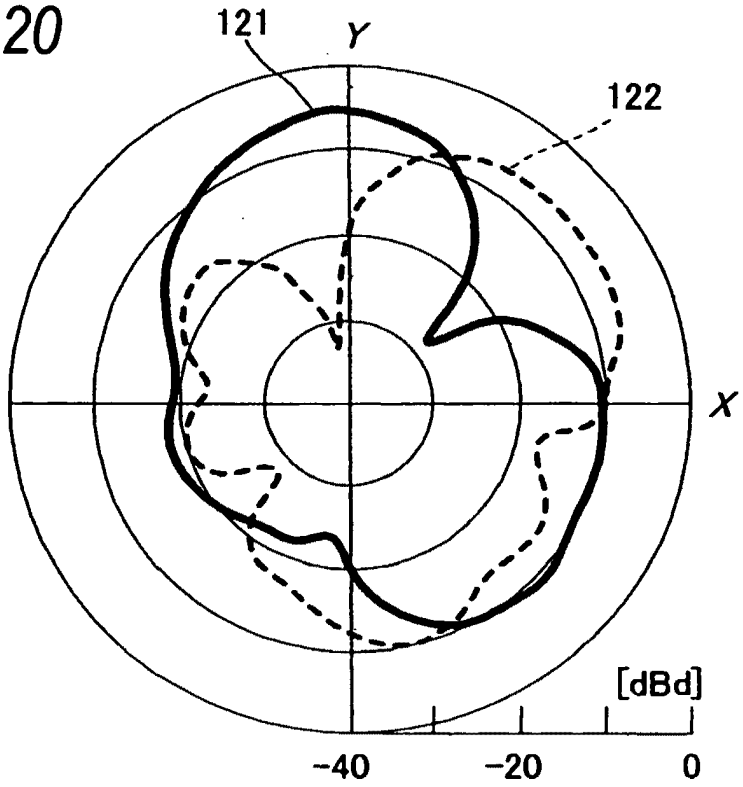


FIG. 21

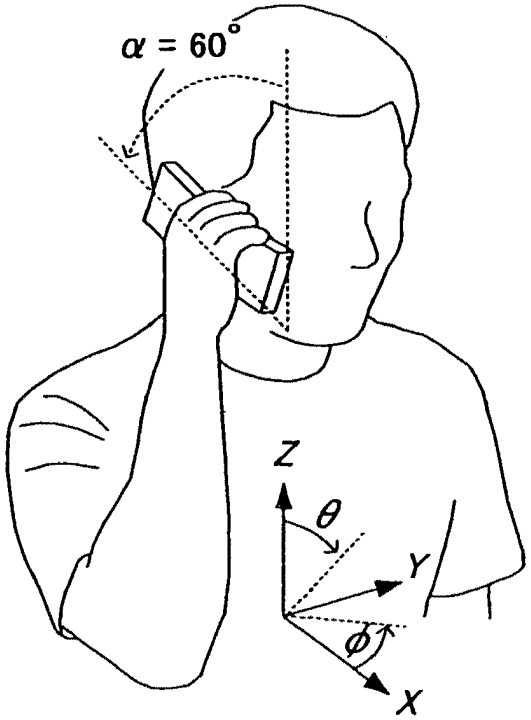


FIG. 22

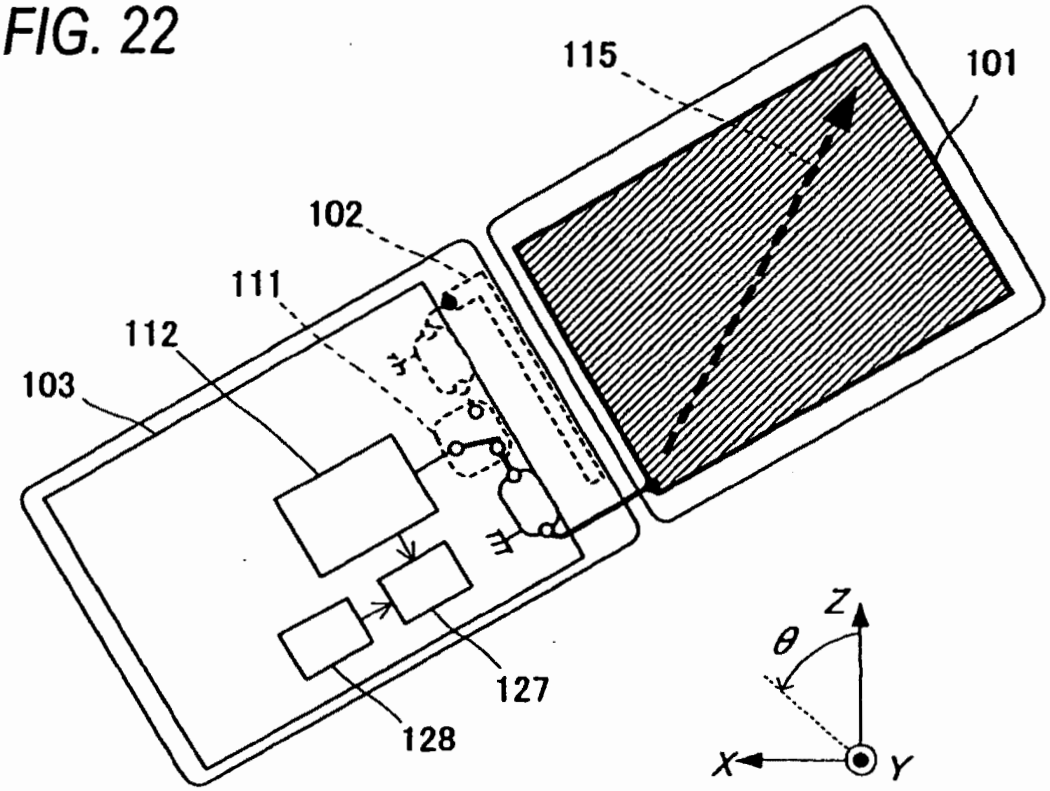


FIG. 23

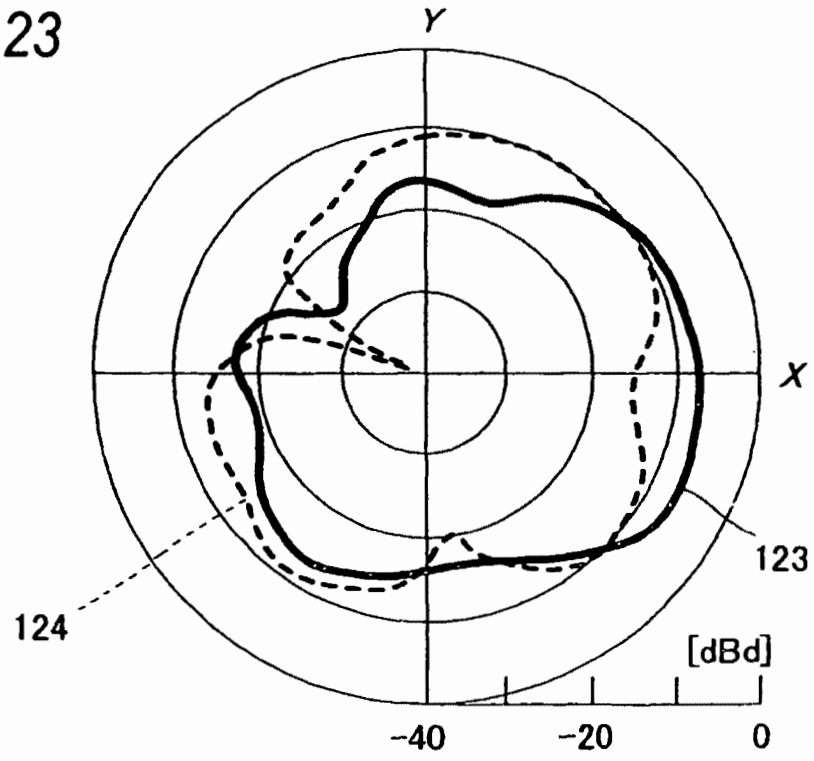


FIG. 24

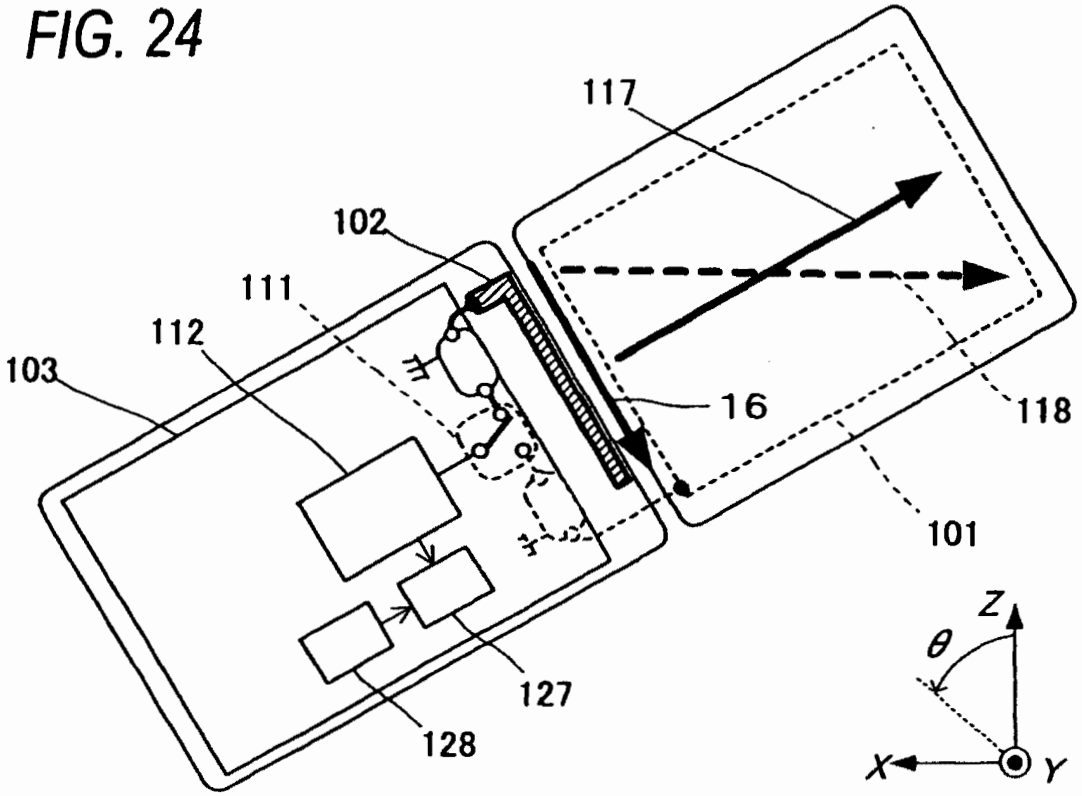


FIG. 25

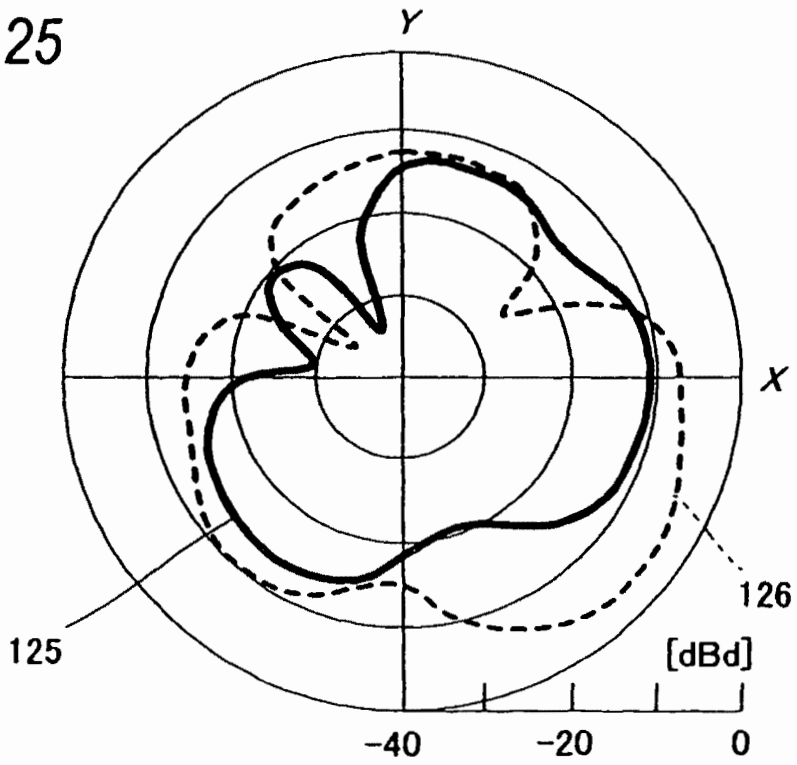


FIG. 26

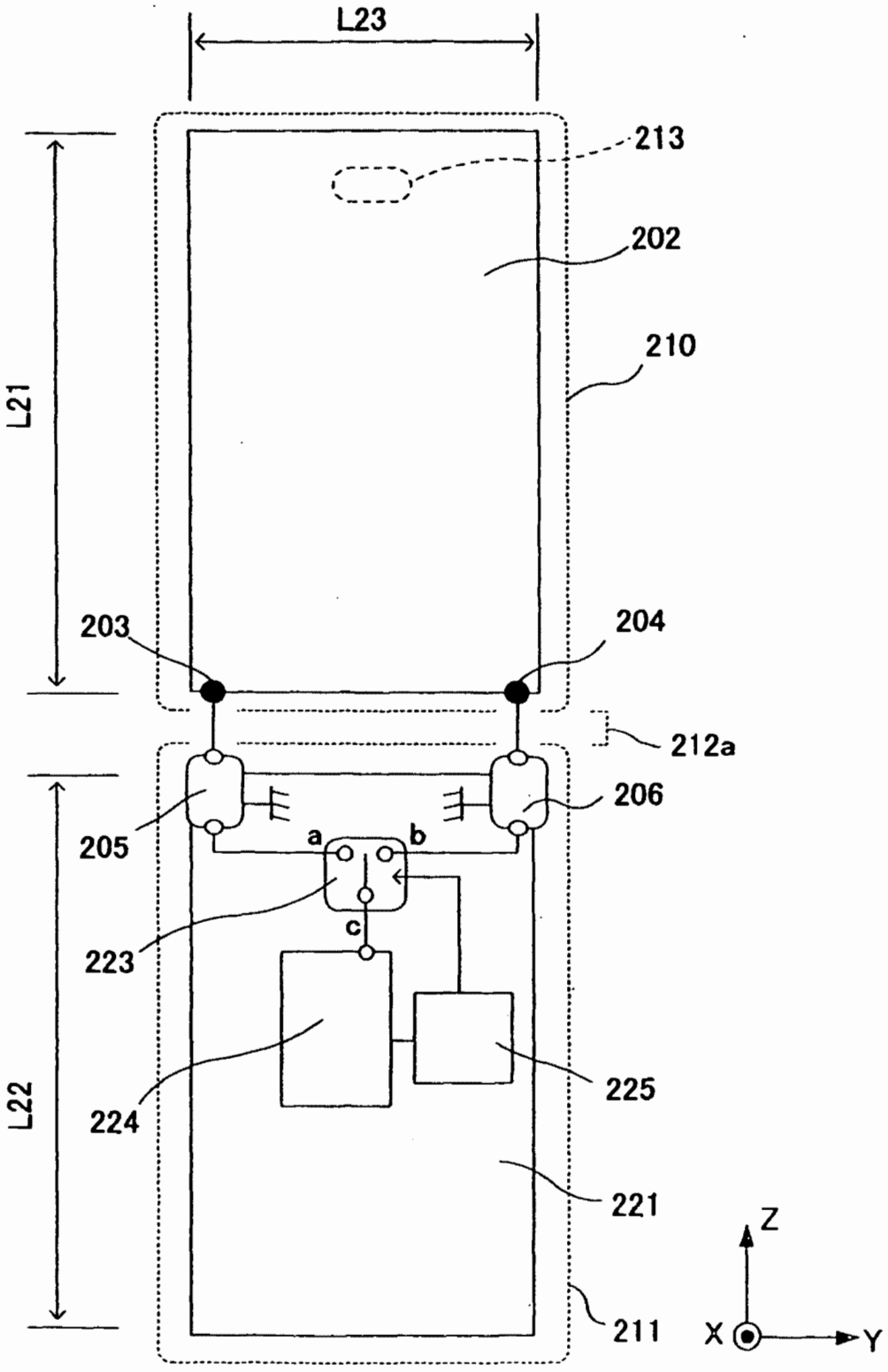

L23
213
202
210
L21
203
204
212a
206
205
a
b
c
223
224
225
L22
221
211
Z
X
Y

FIG. 27

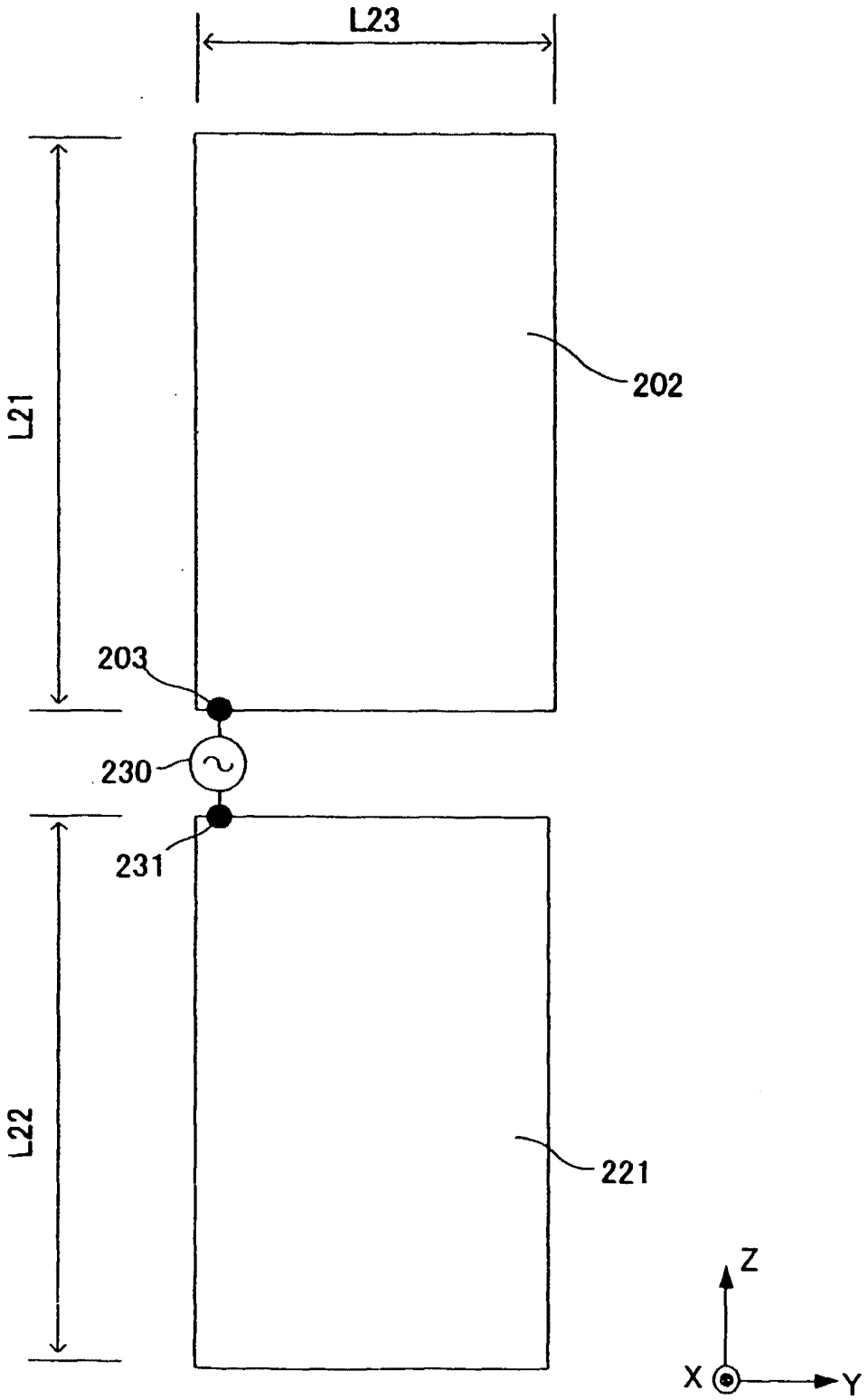


FIG. 28

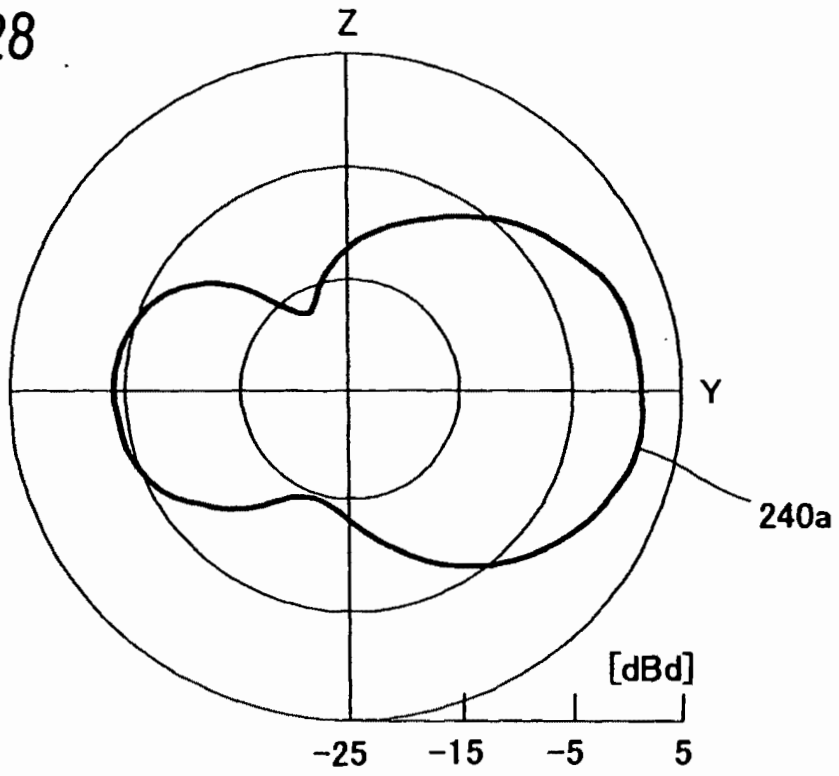


FIG. 29



FIG. 30

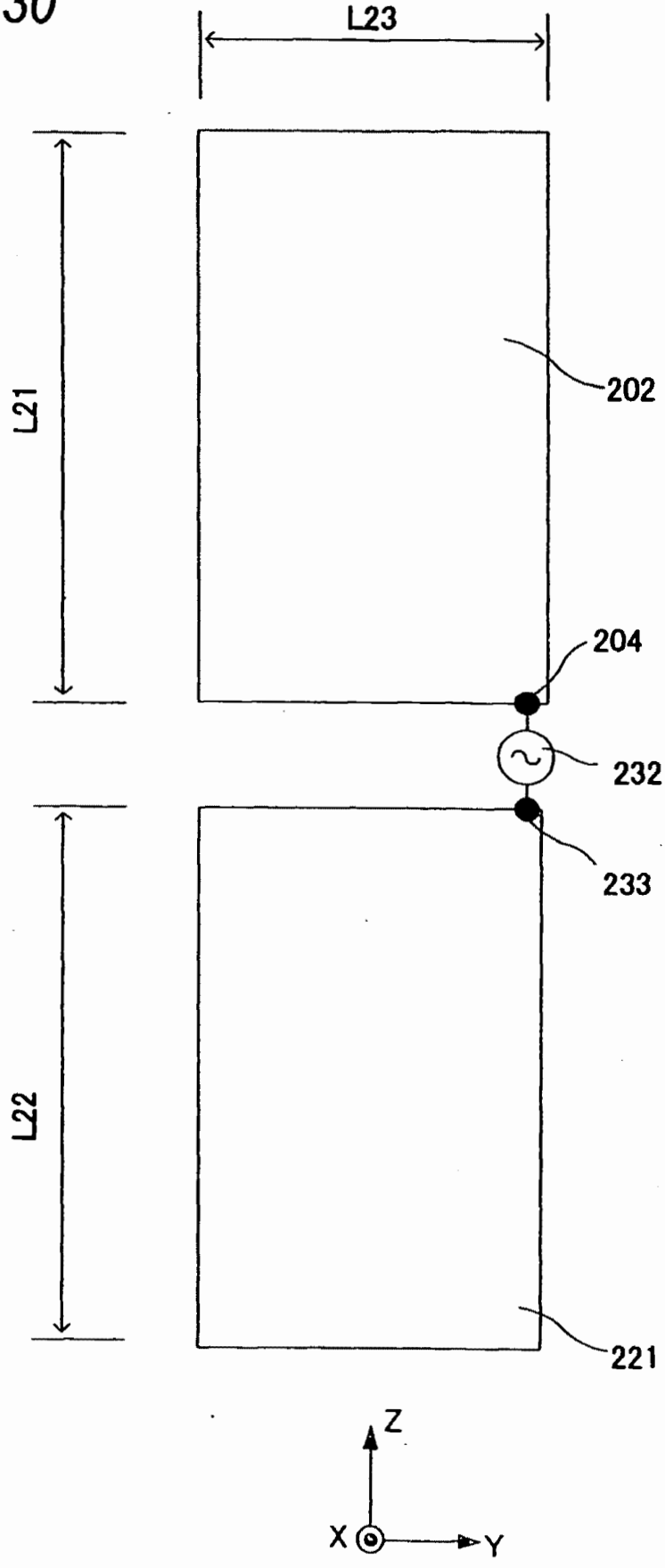


FIG. 31

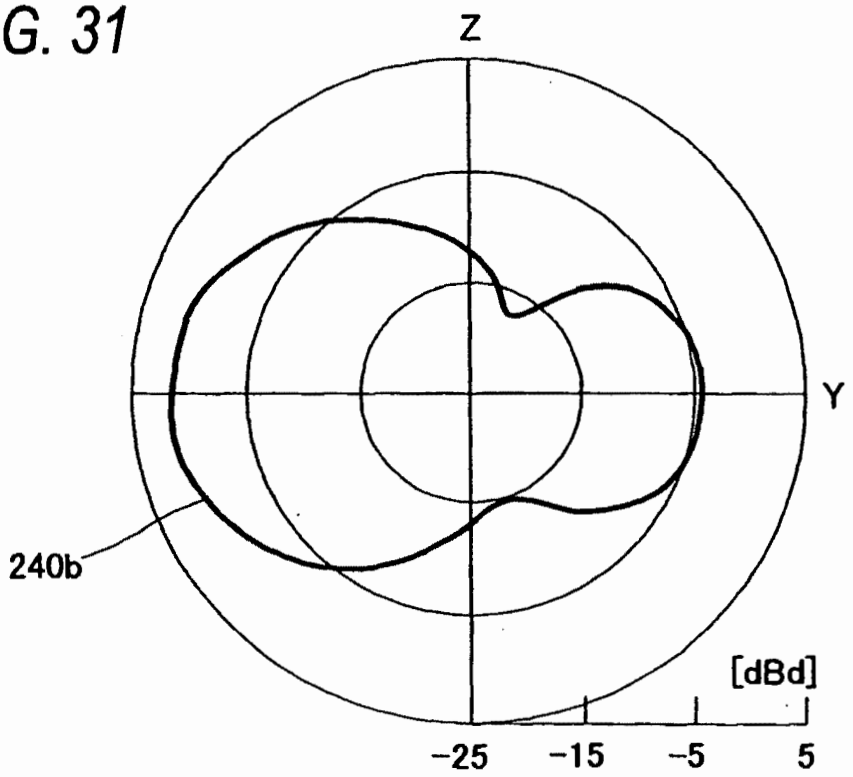


FIG. 32



FIG. 33

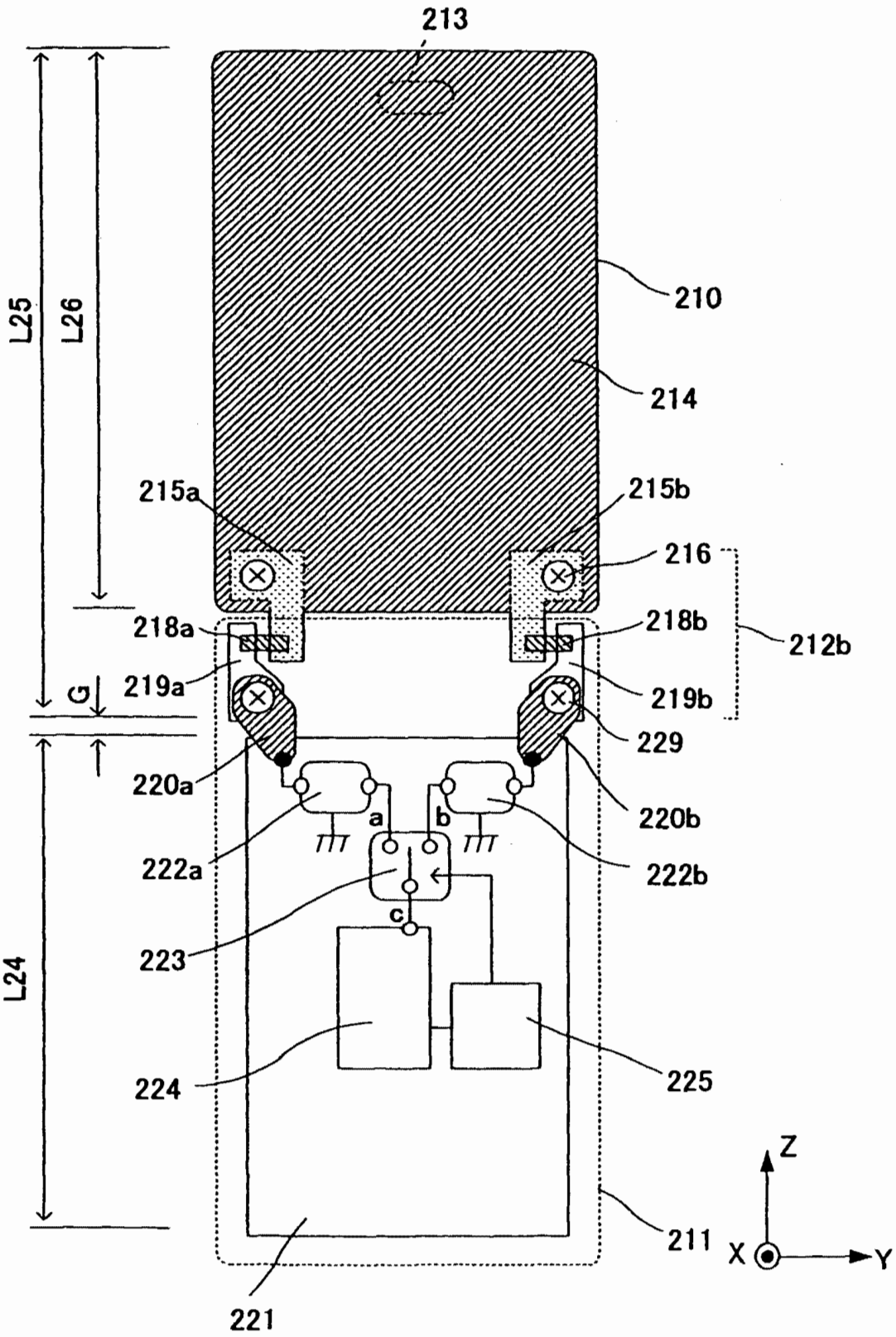

213
L25
L26
210
214
215a
215b
216
218a
218b
212b
219a
G
219b
229
220a
220b
a
b
222a
222b
c
223
L24
224
225
211
Z
X
Y
221

FIG. 34

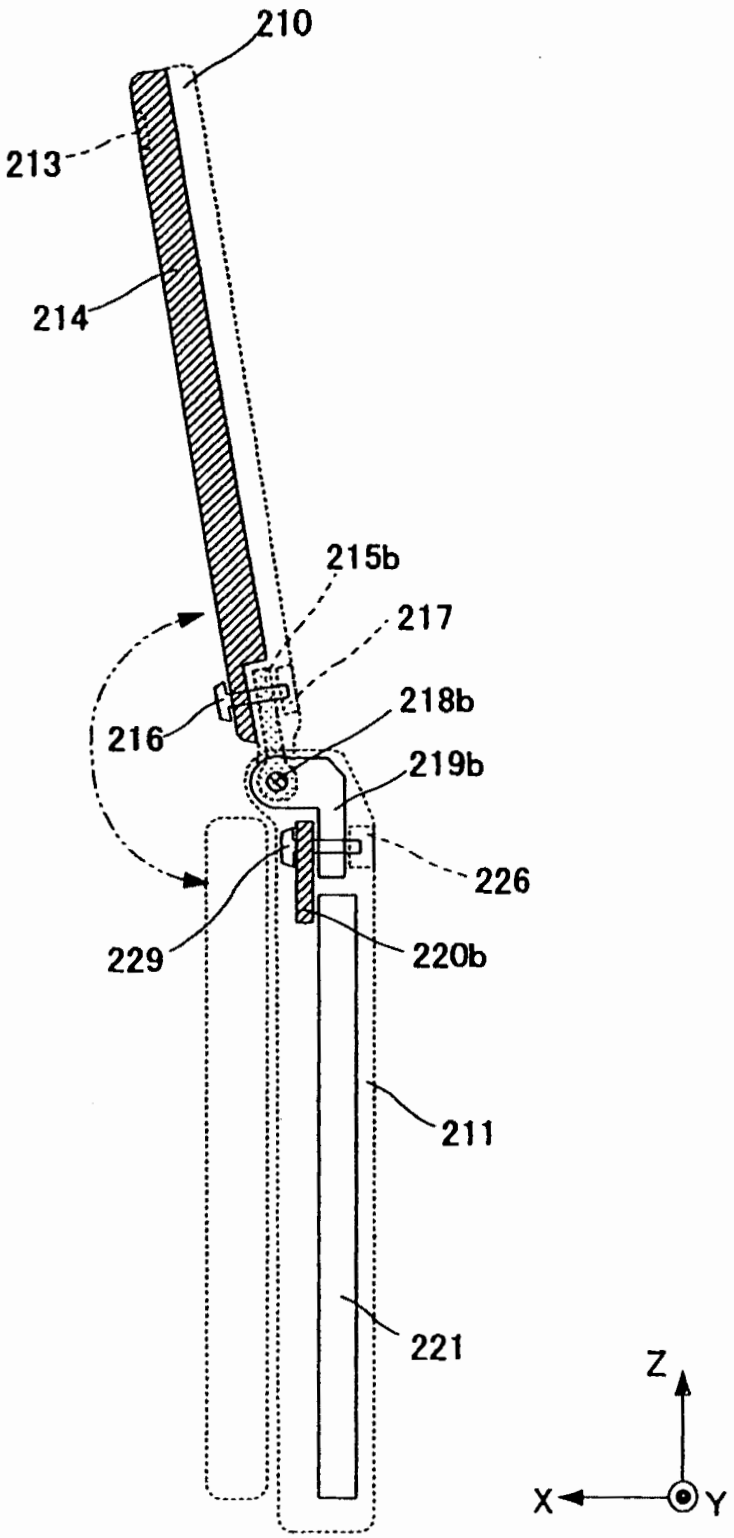


FIG. 35

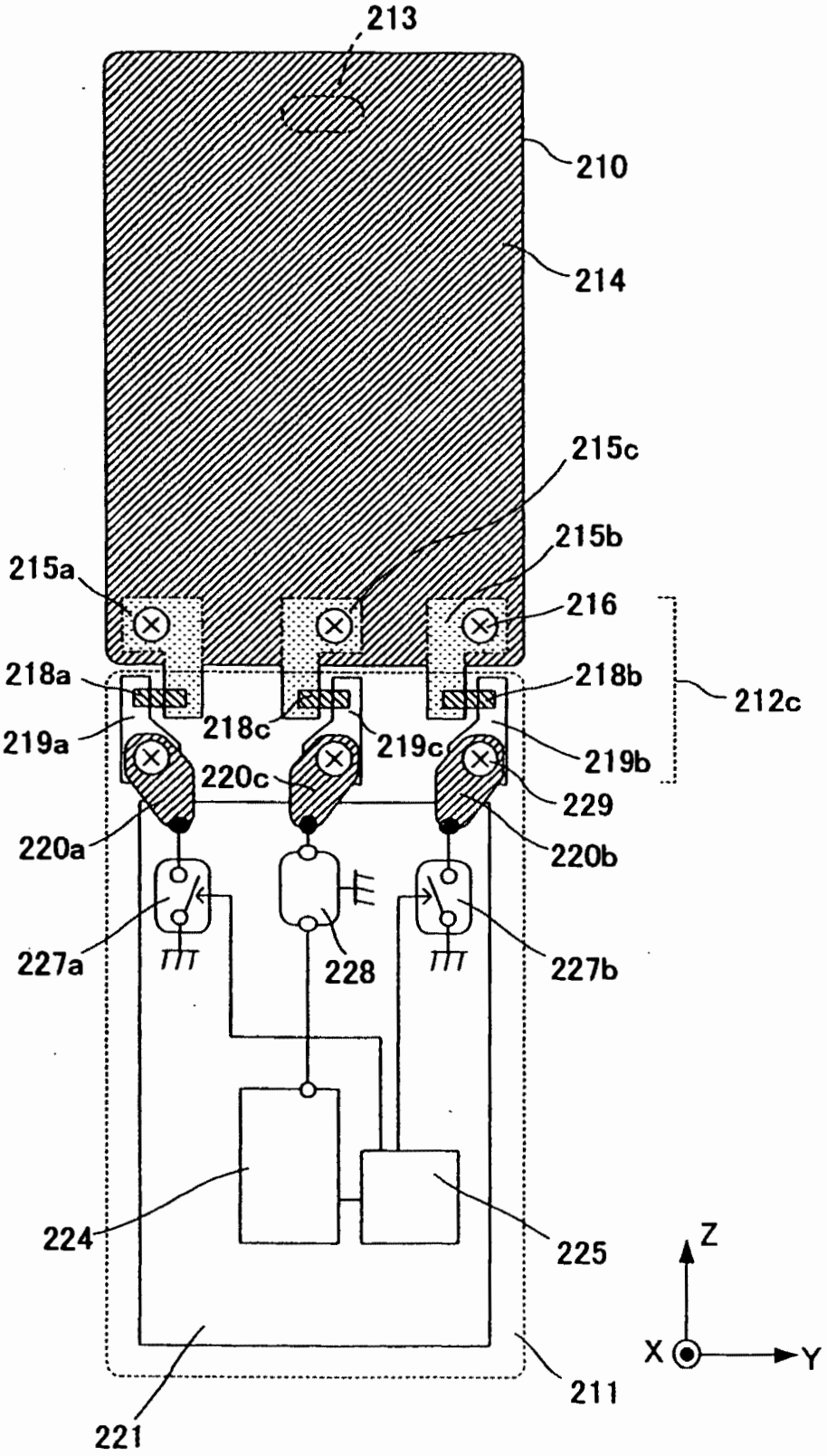

213
210
214
215c
215b
215a
216
218a
218b
212c
218c
219a
219c
219b
220c
229
220a
220b
227a
228
227b
224
225
Z
X
Y
211
221

FIG. 36

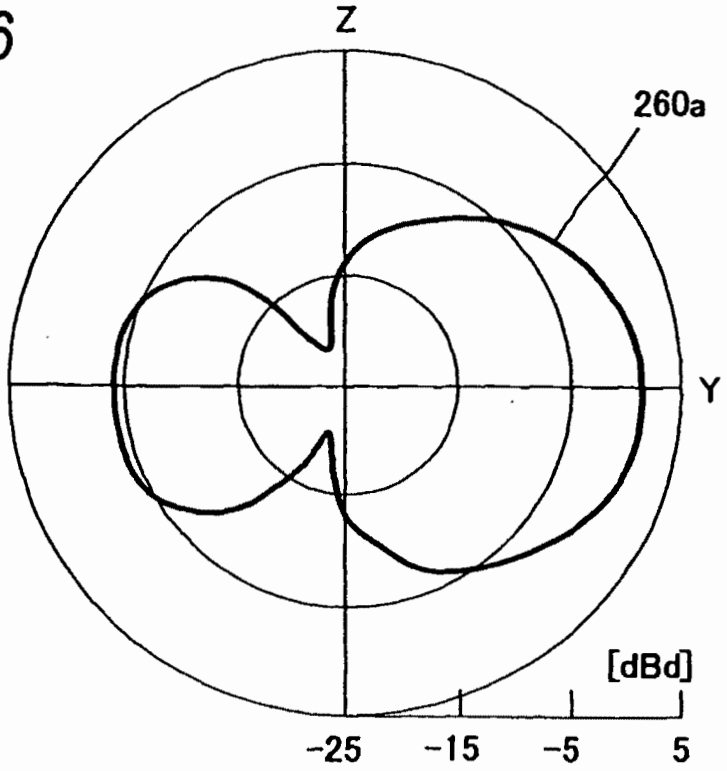
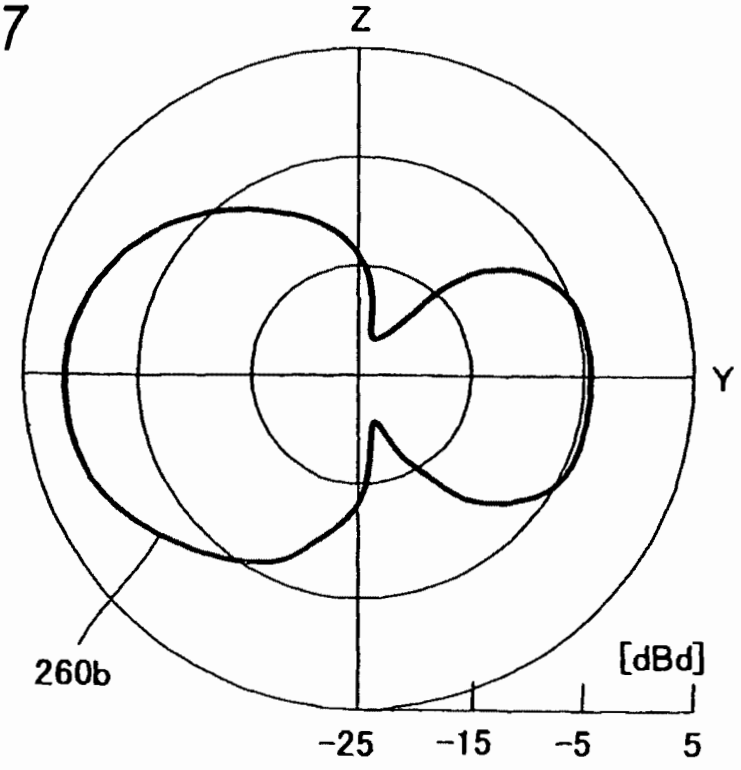


FIG. 37



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/08149

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01Q1/24

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] H01Q1/08, H01Q1/24, H01Q1/38, H01Q1/50, H01Q9/00, H01Q13/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Jitsuyo Shinan Toroku Koho	1996-2003

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 6-216621 A (Fujitsu Ltd.), 05 August, 1994 (05.08.94), Full text; Fig. 5 (Family: none)	1,9,20,22 2,6-8,10, 15-19,21
Y	JP 8-078949 A (Nippon Telegraph And Telephone Corp.), 22 March, 1996 (22.03.96), Page 3, Par. Nos. [0012] to [0015]; Fig. 1 (Family: none)	2,6-8
Y A	JP 2002-064314 A (Sony Corp.), 28 February, 2002 (28.02.02), Page 3, Par. Nos. [0016] to [0017]; Fig. 1 (Family: none)	7 11,12

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September, 2003 (25.09.03)	07 October, 2003 (07.10.03)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/08149

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-077611 A (TDK Corp.), 23 March, 2001 (23.03.01), Full text; all drawings (Family: none)	10
Y A	JP 2000-261532 A (Matsushita Electric Industrial Co., Ltd.), 22 September, 2000 (22.09.00), Page 2, Par. Nos. [0002] to [0003]; Fig. 10 (Family: none)	8 13
Y	JP 10-190345 A (Sharp Corp.), 21 July, 1998 (21.07.98), Full text; all drawings (Family: none)	15,21
Y	JP 2000-278024 A (Denso Corp.), 06 October, 2000 (06.10.00), Full text; all drawings (Family: none)	16-19,21
A	JP 10-065440 A (Murata Mfg. Co., Ltd.), 06 March, 1998 (06.03.98), Full text; all drawings (Family: none)	2-14
A	EP 0643436 A1 (MOTOROLA, INC.), 15 March, 1995 (15.03.95), Full text; all drawings & JP 1-198121 A Full text; all drawings & US 5014346 A	2-14
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 170422/1988 (Laid-open No. 090511/1990) (Kokusai Electric Co., Ltd.), 18 July, 1990 (18.07.90), Full text; all drawings (Family: none)	2-14
A	US 5561437 A (Motorola, Inc.), 01 October, 1996 (01.10.96), Full text; all drawings & JP 8-097622 A Full text; all drawings	2-14
A	JP 11-136025 A (Murata Mfg. Co., Ltd.), 21 May, 1999 (21.05.99), Full text; all drawings (Family: none)	16-19,21

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/08149

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The international search has revealed that the technical feature common to claims 1-22 is not novel since it is disclosed in document JP 6-216621 A (Fujitsu Ltd.), 5 August, 1994 (05.08.94), the full text, and Fig. 7. Consequently the common technical feature is not a special technical feature within the meaning of PCT Rule 13.2, second sentence, since the portable wireless machine makes no contribution over the prior art. Claims 2-14 involve a technical feature that one of first antenna elements is selected and connected to a feeding portion. Claims 15-19, 21 involve a technical feature that a single first antenna element has feeding portions, and one
(Continued to extra sheet.)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/08149

Continuation of Box No. II of continuation of first sheet (1)

of the feeding portions is selected and connected to a wireless circuit.

Therefore, claims 2-14, 15-19, 21 do not involve any common technical feature and lack the unity of invention.

Form PCT/ISA/210 (extra sheet) (July 1998)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 445 821 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.08.2004 Bulletin 2004/33

(21) Application number: **04002024.0**

(22) Date of filing: **30.01.2004**

(51) Int Cl.[7]: **H01Q 1/22**, H01Q 1/24, H01Q 1/27, H01Q 1/38, H01Q 5/00

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **06.02.2003 JP 2003029217**
20.02.2003 JP 2003042822

(71) Applicant: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
Kadoma-shi, Osaka 571-8501 (JP)

(72) Inventors:
- **Iwai, Hiroshi**
  Katano-shi Osaka 576-0021 (JP)
- **Yamamoto, Atsushi**
  Osaka-shi Osaka 538-0037 (JP)
- **Yamada, Kenichi**
  Yokohama-shi Kanagawa 240-0022 (JP)

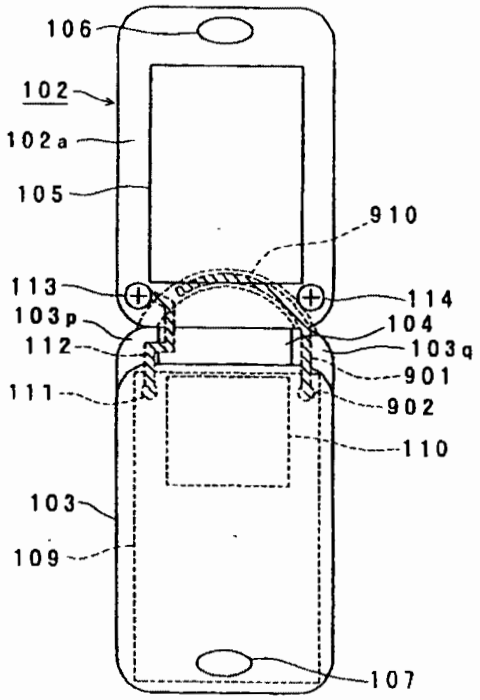
(74) Representative: **Eisenführ, Speiser & Partner**
Patentanwälte Rechtsanwälte
Postfach 10 60 78
28060 Bremen (DE)

(54) Portable radio communication apparatus provided with a boom portion

(57) In a portable radio communication apparatus including a housing, at least one part of at least one of the housing is formed as a housing electrical conductor portion by an electrically conductive material. The housing electrical conductor portion is connected with a radio communication circuit of the portable radio communication apparatus so as to operate as at least one part of an unbalanced type antenna of the radio communication circuit. Further, the portable radio communication apparatus further includes a boom portion coupled with the housing at least at two positions so as to provide at least one penetrating hole between the housing and the boom portion.

Fig. 1A

FIRST PREFERRED EMBODIMENT



EP 1 445 821 A1

Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to a portable radio communication apparatus including a housing, and in particular, relates to a potable radio communication apparatus provided with a boom portion and a part of housing operating as an antenna.

2. DESCRIPTION OF THE RELATED ART

[0002] Recently, portable radio communication apparatuses such as cellular phones have been increasingly made smaller in size and thinner. In addition, the portable radio communication apparatuses have been not only used as conventional cellular phones but also transformed to data terminal apparatuses for transmitting and receiving E-mails and for viewing web pages through WWW (World Wide Web). Due to this, liquid crystal displays have been made larger in size. In these circumstances, folding cellular phone terminals, which are considered to be suited to make the portable radio communication apparatuses smaller in size and make the liquid crystal displays larger in size, have been spread as disclosed in the following publications:

(a) Japanese Patent Laid-open Publication No. 2001-156898;
(b) Japanese Patent Laid-open Publication No. 2002-084355;
(c) Japanese Patent Laid-open Publication No. 2002-335180;
(d) Japanese Patent Laid-open Publication No. 2002-299931; and
(e) Japanese Patent Laid-open Publication No. 2002-516503.

[0003] However, since an external antenna protrudes from the upper housing, a user often feels uncomfortable as follows. When the user takes out the portable radio communication apparatus from his pocket, the external antenna is disadvantageously got stuck in his pocket. When the user sits on the chair with the communication apparatus put in his trouser pocket, the external antenna is uncomfortably and strongly pressed onto the user. On the other hand, when the communication apparatus is suspended from the user's neck without being put into his pocket, the center of gravity of the external antenna disadvantageously deviates from the center of the communication apparatus, and the external antenna disadvantageously becomes unbalanced because of its asymmetric structure in which the external antenna is located on either the right or left end portion of the portable radio communication apparatus.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a portable radio communication apparatus, which can solve the above-mentioned disadvantages, and which can be constituted so that even if the portable radio communication apparatus is put into his pocket of a user, the user does not feel uncomfortable.

[0005] It is another object of the present invention to provide a portable radio communication apparatus, which can solve the above-mentioned disadvantages, and which can be constituted so that if the same apparatus is suspended from the user's neck, the same apparatus can be suspended in a well-balanced manner while maintaining good antenna characteristics.

[0006] According to the aspect of the present invention, there is provided a portable radio communication apparatus including a housing. The portable radio communication apparatus includes at least one part of the housing, which is formed as a housing electrical conductor portion by an electrically conductive material. The housing electrical conductor portion is connected with a radio communication circuit of the portable radio communication apparatus so as to operate as at least one part of an antenna of the radio communication circuit. A boom portion is further provided to be coupled with the housing at least at two positions so as to provide at least one penetrating hole between the housing and the boom portion.

[0007] In the above-mentioned portable radio communication apparatus, the antenna is preferably an unbalanced type antenna.

[0008] In the above-mentioned portable radio communication apparatus, the portable radio communication apparatus is preferably a straight type portable radio communication apparatus. Otherwise, the portable radio communication apparatus is preferably a slide type portable radio communication apparatus in which an upper housing and a lower housing are slidable through a sliding mechanism, and at least one part of at least one of the upper housing and the lower housing is formed as a housing electrical conductor portion by an electrically conductive material. Alternatively, the portable radio communication apparatus is preferably a folding portable radio communication apparatus in which an upper housing and a lower housing are foldable through a hinge portion, and at least one part of at least one of the upper housing and the lower housing is formed as a housing electrical conductor portion by an electrically conductive material.

[0009] In the above-mentioned portable radio communication apparatus, the housing electrical conductor portion is preferably made by forming an electrical conductor layer on a dielectric housing which is at least one part of the housing. Further, the electrical conductor layer is preferably made by forming an electrical conductor pattern on the dielectric housing.

[0010] In the above-mentioned portable radio com-

munication apparatus, the electrical conductor layer preferably includes electrical conductor patterns different from each other on both surfaces of the dielectric housing, respectively, so that the antenna operates in a plurality of frequency bands.

[0011] In the above-mentioned portable radio communication apparatus, the electrical conductor layer preferably includes a plurality of electrical conductor portions having electric lengths different from each other, respectively, so that the antenna operates in a plurality of frequency bands.

[0012] The above-mentioned portable radio communication apparatus preferably further includes one of a slot and a slit which are formed in the electrical conductor layer.

[0013] In the above-mentioned portable radio communication apparatus, the upper housing preferably includes an upper first housing portion and an upper second housing portion, and at least one of the upper first housing portion and the upper second housing portion is formed as a housing electrical conductor portion by an electrically conductive material so that the housing electrical conductor portion operates as at least one part of the antenna of the portable radio communication apparatus.

[0014] In the above-mentioned portable radio communication apparatus, the lower housing preferably includes a lower first housing portion and a lower second housing portion, and at least one of the lower first housing portion and the lower second housing portion is formed as a housing electrical conductor portion by an electrically conductive material so that the housing electrical conductor portion operates as at least one part of the antenna of the portable radio communication apparatus.

[0015] In the above-mentioned portable radio communication apparatus, at least one part of the hinge portion preferably is formed as a hinge electrical conductor portion by an electrically conductive material, and the hinge electrical conductor portion is connected with the radio communication circuit of the portable radio communication apparatus so as to operate as at least one part of the antenna of the radio communication circuit.

[0016] In the above-mentioned portable radio communication apparatus, at least one part of the hinge portion is preferably formed as a hinge electrical conductor portion by an electrically conductive material so that the hinge electrical conductor portion operates as a parasitic element of the antenna of the radio communication circuit.

[0017] In the above-mentioned portable radio communication apparatus, the hinge portion is preferably made to be rotatable in at least biaxial directions.

[0018] The above-mentioned portable radio communication apparatus preferably further includes an electrically insulating layer formed on the hinge portion.

[0019] The above-mentioned portable radio communication apparatus preferably further includes a plurality of reactance elements having a plurality of reactance values different from each other, respectively, and a switching device for selectively switching over the plurality of reactance elements so as to connect selected one of the reactance elements with the housing electrical conductor portion.

[0020] The above-mentioned portable radio communication apparatus preferably includes a plurality of reactance elements having a plurality of reactance values different from each other, respectively, and a switching device for selectively switching over the plurality of reactance elements so as to connect selected one of the reactance elements with the housing electrical conductor portion through the hinge electrical conductor portion.

[0021] In the above-mentioned portable radio communication apparatus, the switching device preferably selectively switches over the plurality of reactance elements in accordance with whether the portable radio communication apparatus is in either one of an open state and a closed state thereof.

[0022] In the above-mentioned portable radio communication apparatus, the switching device preferably selectively switches over the plurality of reactance elements in accordance with a plurality of operating frequency bands of the portable radio communication apparatus.

[0023] In the above-mentioned portable radio communication apparatus, the switching device preferably selectively switches over the plurality of reactance elements in accordance with either one of transmission and receiving of the portable radio communication apparatus.

[0024] In the above-mentioned portable radio communication apparatus, the housing electrical conductor portion is preferably made of one of a dielectric material and a magnetic material, and the housing electrical conductor portion is connected with the radio communication circuit through an electrical insulator having a predetermined capacitance so that a radio signal from the radio communication circuit is fed through the capacitance of the electrical insulator to the housing electrical conductor portion.

[0025] The above-mentioned portable radio communication apparatus preferably further includes a thin-film-shaped electrically insulating sheet formed on the upper housing having the housing electrical conductor portion, and the thin-film-shaped electrically insulating sheet is made of one of a dielectric material and a magnetic material.

[0026] In the above-mentioned portable radio communication apparatus, the boom portion is preferably coupled with the housing so as to be laterally symmetric relative to a width direction of the portable radio communication apparatus.

[0027] In the above-mentioned portable radio communication apparatus, at least one part of the boom portion is preferably made of an electrically conductive ma-

terial. Alternatively, at least one part of the boom portion is preferably made of a flexible dielectric material.

[0028] The above-mentioned portable radio communication apparatus preferably further includes at least one antenna element provided in the boom portion and connected with the radio communication circuit. In this case, a further switching device is further provided which selectively switches over between at least one antenna element connected with the radio communication circuit and the antenna including the housing conductor portion.

[0029] The above-mentioned portable radio communication apparatus preferably further includes a plurality of antenna elements provided in the boom portion. The plurality of antenna elements is connected with the radio communication circuit, and has electric lengths different from each other, respectively.

[0030] The above-mentioned portable radio communication apparatus preferably further includes an external antenna provided in the housing. In this case, a still further switching device is further provided which selectively switches over between the external antenna and the antenna including the housing conductor portion.

[0031] The above-mentioned portable radio communication apparatus preferably further includes a built-in antenna provided in the housing. In this case, a still further switching device is further provided which selectively switches over between the built-in antenna and the antenna including the housing conductor portion.

[0032] According to the portable radio communication apparatus of the present invention, the boom portion connected with the housing at a position where the boom portion is substantially, laterally symmetric relative to the width direction of the portable radio communication apparatus. Further, there is further provided a combination of the first antenna element provided in the boom portion, and the second antenna which includes, as the constituent element, the housing whose one part is made of an electrically conductive material. It is thereby possible to transmit and receive radio waves without using any conventional external antenna. Therefore, it is possible to solve such a conventional disadvantage that the external antenna is sometimes got stuck in his pocket when the portable radio communication apparatus is taken out from his pocket. In addition, since the penetrating hole is formed in the space surrounded by the boom portion and the housing, it is possible to suspend the portable radio communication apparatus from the neck of the user with the strap attached to the boom portion. In this case, since it is unnecessary to use any conventional external antenna, the portable radio communication apparatus can be designed to be laterally symmetric, and the portable radio communication apparatus can be easily well balanced laterally when the apparatus is suspended from his neck.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] These and other objects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings throughout which like parts are designated by like reference numerals, and in which:

Fig. 1A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a first preferred embodiment of the present invention;

Fig. 1B is a side view of the portable radio communication apparatus shown in Fig. 1A;

Fig. 1C is a plan view of an antenna element 112 employed in the portable radio communication apparatus shown in Figs. 1A and 1B;

Fig. 2 is a circuit diagram of antenna elements 102A and 901 and a radio communication circuit 110 connected with antenna elements 102A and 901 of the portable radio communication apparatus shown in Fig. 1A;

Fig. 3A is a plan view of an electrically insulating ring 201 employed in a folding portable radio communication apparatus according to a first modified preferred embodiment of the first preferred embodiment of the present invention;

Fig. 3B is a side view of the portable radio communication apparatus that includes the insulating ring 201 shown in Fig. 3A;

Fig. 4 is a circuit diagram showing an equivalent circuit of an antenna apparatus of the folding portable radio communication apparatus shown in Figs. 3A and 3B;

Fig. 5A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a second modified preferred embodiment of the first embodiment of the present invention;

Fig. 5B is a side view of the portable radio communication apparatus shown in Fig. 5A;

Fig. 6A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a third modified preferred embodiment of the first preferred embodiment of the present invention;

Fig. 6B is a side view of the portable radio communication apparatus shown in Fig. 6A;

Fig. 7A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a second preferred embodiment of the present invention;

Fig. 7B is a side view of the portable radio communication apparatus shown in Fig. 7A;

Fig. 8A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of

the second preferred embodiment of the present invention;

Fig. 8B is a side view of the portable radio communication apparatus shown in Fig. 8A;

Fig. 9A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a third preferred embodiment of the present invention;

Fig. 9B is a side view of the portable radio communication apparatus shown in Fig. 9A;

Fig. 10A is a perspective view showing a hinge portion 503 for use in the portable radio communication apparatus shown in Figs. 9A and 9B;

Fig. 10B is a perspective view showing a fitting intrusive circular cylindrical member 505 connected with the hinge portion 503 shown in Fig. 10A and an antenna element 504 connected with the member 505;

Fig. 11A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a fourth preferred embodiment of the present invention;

Fig. 11B is a side view of the portable radio communication apparatus shown in Fig. 11A;

Fig. 12A is a perspective view showing a pair of hinge portions 603 and 604 employed in the portable radio communication apparatus shown in Figs. 11A and 11B;

Fig. 12B is a perspective view showing (a) a fitting intrusive circular cylindrical member 606 connected with the hinge portion 603 shown in Fig. 12A, (b) an antenna element 605 connected with the fitting intrusive circular cylindrical member 606, (c) a fitting intrusive circular cylindrical member 608 connected with the hinge portion 604 shown in Fig. 12A, and (d) an antenna element 607 connected with the fitting intrusive circular cylindrical member 608;

Fig. 13 is a circuit diagram showing a configuration of the radio communication circuit 110 connected with a hinge portion 604 of the portable radio communication apparatus shown in Figs. 11A and 11B;

Fig. 14A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the fourth preferred embodiment of the present invention;

Fig. 14B is a side view of the portable radio communication apparatus shown in Fig. 14A;

Fig. 15A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a fifth preferred embodiment of the present invention;

Fig. 15B is a side view of the portable radio communication apparatus shown in Fig. 15B;

Fig. 16 is a plan view of the portable radio communication apparatus when an upper housing 702 of the portable radio communication apparatus shown in Figs. 15A and 15B is rotated counterclockwise by about 45 degrees;

Fig. 17A is a plan view of the portable radio communication apparatus shown in Figs. 15A and 15B in an open state thereof;

Fig. 17B is a side view of the portable radio communication apparatus shown in Fig. 17A;

Fig. 18 is a circuit diagram showing a configuration of the antenna elements 702A and 901 and the radio communication circuit 110 connected with the antenna elements 702A and 901 in the portable radio communication apparatus shown in Fig. 17A;

Fig. 19A is a plan view of a portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the fifth preferred embodiment of the present invention;

Fig. 19B is a side view of the portable radio communication apparatus shown in Fig. 19A;

Fig. 20 is a longitudinal sectional view showing a detailed configuration in the vicinity of a flat electrical insulator 922 shown in Fig. 19B;

Fig. 21 is a longitudinal sectional view showing a detailed configuration in the vicinity of the antenna element 921 in a further modified preferred embodiment of the portable radio communication apparatus shown in Fig. 19A;

Fig. 22A shows a first implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from an inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 22B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 22A;

Fig. 22C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 22A;

Fig. 23A shows a second implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper first housing portion 102a of the portable ratio communication apparatus;

Fig. 23B is a plan view showing the inner side surface of the upper first housing portion 102a shown in Fig. 23A;

Fig. 23C is a plan view showing an outer side surface of the upper first housing portion 102a shown in Fig. 23A;

Fig. 24A shows a third implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable ratio communication apparatus;

Fig. 24B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 24A;

Fig. 24C is a plan view showing the outer side surface of the upper second housing portion 102b shown in Fig. 24A;

Fig. 25A shows a fourth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 25B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 25A;

Fig. 25C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 25A;

Fig. 26A shows a fifth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 26B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 26A;

Fig. 26C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 26A;

Fig. 27A shows a sixth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 27B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 27A;

Fig. 27C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 27A;

Fig. 28A shows a seventh implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 28B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 28A;

Fig. 28C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 28A;

Fig. 29A shows an eighth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 29B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 29A;

Fig. 29C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 29A

Fig. 30A shows a ninth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus;

Fig. 30B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 30A;

Fig. 30C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 30A;

Fig. 31A shows a tenth implemental example applied to the fifth preferred embodiment of the present invention, and is a plan view showing that the upper housing 702 of the portable radio communication apparatus is detached;

Fig. 31B is a side view of the portable radio communication apparatus shown in Fig. 31A;

Fig. 32A is a plan view of the folding portable radio communication apparatus in a closed state thereof according to a sixth preferred embodiment of the present invention;

Fig. 32B is a side view of the portable radio communication apparatus shown in Fig. 32A;

Fig. 33A a plan view of the portable radio communication apparatus shown in Figs. 32A and 32B in an open state thereof;

Fig. 33B is a side view of the portable radio communication apparatus shown in Fig. 33A;

Fig. 34 is a front view which illustrate one example in which the portable radio communication apparatus shown in Fig. 32A is used while being suspended from a neck of a user;

Fig. 35A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a modified preferred embodiment of the sixth preferred embodiment of the present invention;

Fig. 35B is a side view of the portable radio communication apparatus shown in Fig. 35A;

Fig. 36A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a seventh preferred embodiment of the present invention;

Fig. 36B is a side view of the portable radio communication apparatus shown in Fig. 36A;

Fig. 37A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to an eighth preferred embodiment of the present invention;

Fig. 37B is a side view of the portable radio communication apparatus shown in Fig. 37A;

Fig. 38A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the eighth preferred embodiment of the present invention;

Fig. 38B is a side view of the portable radio communication apparatus shown in Fig. 39A;

Fig. 39A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a ninth preferred embodiment of the present invention;

Fig. 39B is a side view of the portable radio communication apparatus shown in Fig. 39A;

Fig. 40A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a tenth preferred embodiment of the present invention;

Fig. 40B is a side view of the portable radio communication apparatus shown in Fig. 40A;

Fig. 41A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a modified preferred embodiment of the tenth preferred embodiment of the present invention;

Fig. 41B is a side view of the portable radio communication apparatus shown in Fig. 41A;

Fig. 42A is a plan view of a folding portable radio communication apparatus according to an eleventh preferred embodiment of the present invention;

Fig. 42B is a side view of the portable radio communication apparatus shown in Fig. 42A;

Fig. 43 is a longitudinal sectional view showing a detailed configuration of a boom portion 910 of a portable radio communication apparatus according to a further modified preferred embodiment of the preferred embodiments of the present invention;

Fig. 44A is a plan view of a slide type portable radio communication apparatus according to a twelfth preferred embodiment of the present invention;

Fig. 44B is a side view of the portable radio communication apparatus shown in Fig. 44A;

Fig. 45A is a plan view of a slide type portable radio communication apparatus according to a modified preferred embodiment of the twelfth preferred embodiment of the present invention;

Fig. 45B is a side view of the portable radio communication apparatus shown in Fig. 45A;

Fig. 46A is a plan view of a straight type portable radio communication apparatus according to a thirteenth preferred embodiment of the present invention;

Fig. 46B is a rear view of the portable radio communication apparatus shown in Fig. 46A;

Fig. 46C is a side view of the portable radio communication apparatus shown in Fig. 46A;

Fig. 47A is a plan view of a straight type portable radio communication apparatus according to a modified preferred embodiment of the thirteenth preferred embodiment of the present invention;

Fig. 47B is a rear view of the portable radio communication apparatus shown in Fig. 47A; and

Fig. 47C is a side view of the portable radio communication apparatus shown in Fig. 47A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] The preferred embodiments of the present invention will be described hereinafter with reference to the drawings. In the drawings, similar components are denoted by the same reference symbols, respectively.

FIRST PREFERRED EMBODIMENT

[0035] Fig. 1A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a first preferred embodiment of the present invention. Fig. 1B is a side view of the portable radio communication apparatus shown in Fig. 1A. Fig. 1C is a plan view of an antenna element 112 for use in the portable radio communication apparatus shown in Figs. 1A and 1B.

[0036] Referring to Figs. 1A and 1B, the portable radio communication apparatus according to the first preferred embodiment includes an upper housing 102 and a lower housing 103, where the housings 102 and 103 are connected with each other through a circular cylindrical uniaxial hinge portion 104, so as to be foldable through the circular cylindrical uniaxial hinge portion 104. The upper housing 102 includes an upper first housing portion 102a arranged on the inside thereof, and an upper second housing portion 102b arranged on the outside thereof. These upper first and second housing portions 102a and 102b are bonded and coupled together. A surface of the upper first housing portion 102a that opposes to the inside of the same apparatus will be referred to as an inner side surface, and a surface of the upper second housing portion 102b that opposes to the outside of the same apparatus will be referred to as an outer side surface, hereinafter. Further, the hinge portion 104 is formed integrally, for example, with the upper first housing portion 102a, is fitted into the central portion of an upper end (located between an upper left end 103p and an upper right end 103q) of the lower housing 103, and is penetrated through a circular cylindrical hollow of the circular cylindrical hinge portion 104. This leads to that the upper housing 102 and the lower housing 103 are rotatable and foldable about the hinge portion 104 by a circular cylindrical shaft (not shown) extending into the upper left end 103p and the upper right end 103q of the lower housing 103. The two housing portions 102a and 102b are penetrated into the upper first housing portion 102a from the inner side surface to the outer side surface and screwed by respective screws 113 and 114 on the left and right corner portions of the lower ends to a screw reception portion 115 of the

upper second housing portion 102b.

[0037] At least one part of the upper first housing portion 102a is made of an electrically conductive material such as magnesium or zinc, whereas the upper second housing portion 102b is made of an electrically insulating material such as a resin material. As will be described later in detail, all of the upper first housing portion 102b may be made of an electrically conductive material. Alternatively, the upper first housing portion 102b may be made of an electrically insulating material such as a resin material with an electrical conductor layer made of an electrically conductive material formed on its surface. The portion of the upper first housing portion 102a that is formed by at least the electrically conductive material will be referred to as a conductor portion hereinafter.

[0038] Further, a liquid crystal display 105 is located substantially in the central portion of the inner side surface of the upper first housing portion 102a and a sound hole portion 106 is arranged above the liquid crystal display 105 at an upper end portion of the inner side surface of the upper first housing portion 102a. A loudspeaker 154 of Fig. 2, that generates a voice of a party on the other end of the communication line during a telephone conversation, is arranged immediately under the sound hole portion 106 so that a user of the portable radio communication apparatus can listen to the voice generated by the loudspeaker 154 through the sound hole portion 106. Further, a microphone 107 is arranged on a surface of the lower housing 103 that opposes to the inside (whose surface will be referred to as an inner side surface hereinafter) in the vicinity of a lower end on an opposite side to the hinge portion 104, and a chargeable battery 108 is arranged on a surface of the opposite side to the microphone 107 on the lower housing 103 (whose surface will be referred to as an outer side surface hereinafter). A printed wiring board 109 is arranged on the inside of the lower housing 103 and substantially in the central portion of the lower housing 103 in the thickness direction thereof. As shown in Fig. 2, a radio communication circuit 110 that includes a radio receiver 152 and a radio transmitter 153 is formed on the printed wiring board 109.

[0039] A connection point 111 that serves as a feeding point of the radio communication circuit 110 is connected with a screw 113 of the upper housing 102 through an antenna element 122, and the screw 113 is electrically connected with the conductor portion of the upper first housing portion 102a. The antenna element 122 is provided so as to extend from the radio communication circuit 110 of the lower housing 103 to the screw 113 through an inside of an upper right end of the lower housing 103, an inside of the hinge portion 104, and an inside of the upper second housing portion 102b.

[0040] As shown in Fig. 1C, an electrical conductor ring 112a having a circular hole 112h is provided on one end of the antenna element 122. The screw 113 is penetrated through the circular hole 112h, and contacted and electrically connected with the conductor ring 112a. Therefore, the connection point 111 of the radio communication circuit 110 is electrically connected with the conductor portion of the upper first housing portion 102a through the antenna element 112 and the screw 113, and then, the antenna element 112 and the conductor portion of the upper first housing portion 102a operate as a first antenna element 102A of Fig. 2 of the portable radio communication apparatus.

[0041] A boom portion 910, which is made of a resin material (preferably a flexible resin material) which is curved and generally circular cylindrical, is provided so as to be connected with left and right ends on an upper end surface of the lower housing 103. Namely, both ends of the boom portion 910 are connected with the left and right ends of the upper end surface of the lower housing 103, respectively, so as to be substantially bilaterally symmetric in the width direction or the horizontal direction of the portable radio communication apparatus. In this case, in a space surrounded by the boom portion 910 and the lower housing 103, a penetrating hole (or an air space or gap) 910h is formed. In addition, an antenna element 901 that operates as a second antenna element of the portable radio communication apparatus and that has a length such as a quarter of wavelength or the like is included in the boom portion 910. Further, the antenna element 901 is electrically connected with a connection point 902 that serves as a feeding point of the radio communication circuit 110 from an inside of the boom portion 910 through an inside of the lower housing 103.

[0042] Fig. 2 is a circuit diagram of the antenna elements 102A and 901 and the radio communication circuit 110 connected with the antenna elements 102A and 901 of the portable radio communication apparatus shown in Fig. 1A.

[0043] Referring to Fig. 2, the antenna element 102A is connected with a first terminal of a circulator 151 through the connection point 111 and a contact "a" of a switch SW1, and further, the antenna element 901 is connected thereto through the connection point 902 and a contact "b" of the switch SW1. A second terminal of the circulator 151 is connected with the radio receiver 152 that includes the loudspeaker 154 and a third terminal thereof is connected with the radio transmitter 153 that includes the microphone 107. The operations of the radio receiver 152, the radio transmitter 153, and the switch SW1 are controlled by a controller 150.

[0044] A radio signal received by the antenna element 102A or 901 is inputted to the radio receiver 152 through the switch SW1 and the circulator 151. The radio receiver 152 subjects the inputted radio signal to low noise amplification, frequency transform, a demodulation processing, thereby extracting a voice and character data and image data contained in the radio signal from the radio signal, and outputting the extracted data to the loudspeaker 154 and also to the liquid crystal display 105 to display the extracted data on the display 105. On

the other hand, voice and character data and image data to be transmitted are inputted to the radio transmitter 153 from the microphone 107 or the controller 150. The radio transmitter 153 subjects a carrier signal to modulation, frequency transform, power amplification, and the like according to the inputted voice and character data and image data to thereby generate a radio signal, and outputs the radio signal to the antenna element 102A or 901 through the circulator 151 and the switch SW1 to project the radio signal.

[0045] The controller 150 compares, for example, a signal level of the radio signal received at the antenna element 102A with that of the radio signal received at the antenna element 901 and selectively switches over to the antenna element that receives the radio signal at the higher signal level using the switch SW1, thereby executing a reception diversity processing. Further, the controller selects one of the antenna elements based on results of the reception diversity processing to transmit the radio signal from the selected antenna element. Alternatively, by transmitting the radio signal using the both antenna elements 102A and 901 simultaneously and controlling the amplitude and the phase of the radio signal fed to the two antenna elements 102A and 901, the controller 150 may execute a transmission diversity processing.

[0046] As mentioned above, according to the first preferred embodiment, the conductor portion of the upper first housing portion 102a that is a part of the upper housing 102 is allowed to operate as a part of the antenna element 102A. Then, this leads to that the number of parts can be decreased while maintaining good antenna characteristics, and the manufacturing cost can be reduced. In addition, by forming the conductor portion of the upper first housing portion 102a using the electrically conductive material having an excellent mechanical strength such as magnesium or the like, it is possible to increase the strength of the portable radio communication apparatus against the impact such as that upon the user's dropping the same apparatus. Further, since no space occupied by an antenna apparatus is required, the portable radio communication apparatus can be made thinner and lighter in weight than the conventional apparatus. Besides, since an area of the antenna elements can be made larger than a conventional external antenna such as a helical antenna, the maximum value of a current density can be reduced and an SAR (Specific Absorption Rate) can be suppressed to be lower.

[0047] The SAR is a power absorbed by an organic structure having a unit mass when an organism such as a human is put in an electromagnetic field. The SAR is classified to a whole-body average SAR and a local SAR. The radiofrequency safety guideline specifies, for an ordinary environment (for ordinary people), that an arbitrary six-minute average of the whole-body average SAR is 0.08 W/kg or lower and the local SAR (six-minute average) for an arbitrary structure of 10 g is 2 W/kg or lower (3 W/kg for the limbs).

[0048] In the present preferred embodiment, the conductor portion of the upper first housing portion 102a is electrically connected with the antenna element 112 by the screw 113. However, the present invention is not limited to this, and they may be electrically connected with each other using the other method such as a soldering method, a crimping terminal connection method or a mechanical forced contact method without using the screw 113.

[0049] In the present preferred embodiment, the antenna element 102A is constituted by using the conductor portion of the upper first housing portion 102a and the antenna element 112. However, the present invention is not limited to this, and the antenna element 102A may be made of a feeding line such as a coaxial cable so as to feed the radio signal to the antenna element 102A through the feeding line.

[0050] In the present preferred embodiment, the portable radio communication apparatus includes the two antenna elements 102A and 901. However, the present invention is not limited to this; and the portable radio communication apparatus may not include the boom portion 910 and the antenna element 901.

[0051] In the present preferred embodiment, the circular cylindrical hinge portion 104 is employed. However, the present invention is not limited to this, and a biaxial hinge portion 704 of Fig. 15A may be employed.

[0052] In the present preferred embodiment, the boom portion 910 is connected with the lower housing 103. However, the present invention is not limited to this, and the boom portion 910 may be connected with the upper housing 102.

[0053] Fig. 3A is a plan view of an electrically insulating ring 201 employed in a folding portable radio communication apparatus according to a first modified preferred embodiment of the first preferred embodiment according to the present invention. Fig. 3B is a side view of the portable radio communication apparatus that includes the insulating ring 201 shown in Fig. 3A. Fig. 4 is a circuit diagram showing an equivalent circuit of the antenna apparatus of the folding portable radio communication apparatus shown in Figs. 3A and 3B.

[0054] In the portable radio communication apparatus shown in Figs. 1A and 1B, the antenna element 112 is screwed with the upper first housing portion 102a through the screw 113. However, the present invention is not limited to this. For example, the electrically insulating ring 201 made of a dielectric material and having a circular hole 201h shown in Fig. 3A may be inserted between the upper first housing portion 102a and an electrical conductor ring 112b (having a larger circular hole than the conductor ring 112a) of the antenna element 112 as shown in Fig. 3B, and this leads to that not only the screwing effect but also a capacitive feeding effect can be attained. As shown in Fig. 3B, the screw 113 is not mechanically contacted with the conductor ring 112b of the antenna element 112, and a capacitance

of the insulating ring 201 is formed between the screw 113 and the antenna element 112.

[0055] Therefore, as shown in the equivalent circuit of Fig. 4, the antenna element 102A is constituted, for example, so that a plurality of inductances L1, L2, ..., and LN is connected with each other by a connection point 102Ac on one end of each inductance. The connection point 102Ac is connected with the radio transmitter 153 through an inductance LM of the screw 113, the capacitance C0 of the insulating ring 201, and an inductance L0 of the antenna element 112. Since the antenna element 102A is constituted so that the plural inductances L1, L2, ..., and LN are connected with each other at the connection point 102Ac on one end of each inductance, the portable radio communication apparatus can provide wide band characteristics. In addition, there can be obtained the following two resonance frequencies: (a) a first resonance frequency obtained when the capacitance C0 of the insulating ring 201 is inserted; and (b) a second resonance frequency, which is higher than the first resonance frequency, and which is obtained when the capacitance C0 of the insulating ring 201 is not inserted. Then, this leads to that the portable radio communication apparatus can provide wide band characteristics and operate in the two bands.

[0056] Fig. 5A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a second modified preferred embodiment of the first preferred embodiment of the present invention. Fig. 5B is a side view of the portable radio communication apparatus shown in Fig. 5A.

[0057] In the portable radio communication apparatus according to the first preferred embodiment, a thin-film-shaped electrically insulating seal 301 made of a dielectric material or a magnetic material such as acryl and having a thickness such as about 0.2 to 0.3 mm may be formed on an entire surface or a part of the inside of the upper first housing portion 102a, for example, by adhesion, as shown in Figs. 5A and 5B. This can prevent a part of a human body from directly contacting with the inner side surface of the upper first housing portion 102a that operates as the antenna element 102A, and can lower the decrease in the antenna gain caused by the human body during a telephone conversation. In addition, the distance between the antenna element 102A and the human body can be set larger, and the SAR can be kept lower. Alternatively, a transparent panel or a coating member made of a dielectric material such as a resin material may be employed instead of the insulating seal 301.

[0058] Fig. 6A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a third modified preferred embodiment of the first preferred embodiment of the present invention. Fig. 6B is a side view of the portable radio communication apparatus shown in Fig. 6A.

[0059] The portable radio communication apparatus according to the third modified preferred embodiment of the first preferred embodiment is different from that according to the first preferred embodiment shown in Figs. 1A and 1B, in that the upper first housing portion 102a is divided to a first part 102a-1 and a second part 102a-2. In this case, the first and second parts 102a-1 and 102a-2 have half the thickness of the upper first housing portion 102a, respectively, and are fitted and bonded together in the vicinity of the lower end of the upper first housing portion 102a at a position where the screw 113 is arranged. The screw 113 is screwed with the screw reception portion 115 from the inner side surface of the upper housing 102 through the second part 102a-2 and the first part 102a-1 of the upper first housing portion 102a and the upper second housing portion 102b.

SECOND PREFERRED EMBODIMENT

[0060] Fig. 7A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a second preferred embodiment of the present invention. Fig. 7B is a side view of the portable radio communication apparatus shown in Fig. 7A. The portable radio communication apparatus according to the second preferred embodiment is different from that according to the first preferred embodiment in the following points.

(a) At least one part of the upper second housing portion 102b is made of an electrically conductive material such as magnesium or zinc, and the upper first housing portion 102a is made of an electrically insulating material such as a resin material or the like. All of the upper second housing portion 102b may be made of an electrically conductive material. Alternatively, the upper second housing portion 102b may be made of an electrically insulating material such as a resin material with an electrical conductor layer made of an electrically conductive material formed on its surface. The portion of the upper second housing portion 102b that is formed by at least the electrically conductive material will be referred to as a conductor portion hereinafter.

(b) The connection point 111 that serves as a feeding point of the radio communication circuit 110 is connected with the screw 113 of the upper housing 102 through the antenna element 122, and further, the screw 113 is electrically connected with the upper second housing portion 102b of the housing 102. Therefore, the connection point 111 of the radio communication circuit 110 is electrically connected with the conductor portion of the upper second housing portion 102b through the antenna element 112 and the screw 113, and then, the antenna element 112 and the conductor portion of the upper second housing portion 102b operate as the first antenna element 102A of the portable radio communication apparatus.

[0061] The portable radio communication apparatus constituted as mentioned above has the same functions and advantageous effects as those of the portable radio communication apparatus according to the first preferred embodiment. In addition, since the distance between the antenna element 102A and the human body can be set larger during a telephone conversation, the portable radio communication apparatus can advantageously suppress the decrease of the antenna gain caused by the electromagnetic influence of the human body. In addition, since the upper first housing portion 102a includes the liquid crystal display 105, it is necessary to secure a high strength of the upper first housing portion 102a against an impact upon the user's dropping the same apparatus. However, it is unnecessary to secure a high strength of the upper second housing portion 102b, thereby increasing the degree of freedom for designing the same apparatus.

[0062] In the present preferred embodiment, by inserting the insulating ring 201 shown in Fig. 3A between the antenna element 112 and the upper second housing portion 102b, the capacitive feeding to the antenna element 102A may be performed.

[0063] In the present preferred embodiment, the conductor portion of the upper second housing portion 102b is electrically connected with the antenna element 112 by the screw 113. However, the present invention is not limited to this, and they may be electrically connected with each other using the other method such as the soldering method, the crimping terminal connection method or the mechanical forced contact method without using the screw 113.

[0064] Fig. 8A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the second preferred embodiment of the present invention. Fig. 8B is a side view of the portable radio communication apparatus shown in Fig. 8A.

[0065] The portable radio communication apparatus according to the modified preferred embodiment of the second preferred embodiment is different from that according to the second preferred embodiment shown in Figs. 7A and 7B, in that the upper second housing portion 102b is divided to a first part 102b-1 and a second part 102b-2. In this case, the first and second parts 102b-1 and 102b-2 have half the thickness of the upper second housing portion 102b, respectively, and are fitted and bonded together in the vicinity of the lower end of the upper second housing portion 102b at a position at which the screw 113 is arranged. The screw 113 is screwed with the screw reception portion 115 from the inner side surface of the upper housing 102 through the upper first housing portion 102a, the first part 102b-1 and the second part 102b-2 of the upper second housing portion 102b.

THIRD PREFERRED EMBODIMENT

[0066] Fig. 9A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a third preferred embodiment of the present invention. Fig. 9B is a side view of the portable radio communication apparatus shown in Fig. 9A. Fig. 10A is a perspective view showing a hinge portion 503 for use in the portable radio communication apparatus shown in Figs. 9A and 9B. Fig. 10B is a perspective view showing a fitting intrusive circular cylindrical member 505 connected with the hinge portion 503 shown in Fig. 10A and an antenna element 504 connected with the member 505.

[0067] The portable radio communication apparatus according to the third preferred embodiment is different from that according to the first preferred embodiment shown in Figs. 1A and 1B in the following points.

(a) The portable radio communication apparatus includes the hinge portion 503 of Fig. 10A made of an electrically conductive material such as aluminum or zinc, instead of the hinge portion 104.

(b) The portable radio communication apparatus includes the antenna element 504, and the fitting intrusive circular cylindrical member 505 which is made of an electrically conductive material such as aluminum or zinc and fitted into the hinge portion 503, instead of the antenna element 112, as shown in Figs. 9A and 10B.

[0068] Referring to Fig. 10A, the hinge portion 503 is constituted by a circular cylindrical portion 503a and two leg portions 503b and 503c extending from left and right ends of the circular cylindrical portion 503a as being inclined from an upward direction, respectively. The leg portions 503b and 503c include circular holes 503bh and 503ch, respectively, so as to penetrate them in the thickness direction thereof in the vicinity of the ends thereof. The leg portions 503b and 503c are fitted into the upper second housing portion 102b, and screws 113 and 114 are inserted into the circular holes 503bh and 503ch, respectively. Then, the leg portions 503b and 503c are screwed with the upper second housing portion 102b by the screws 113 and 114.

[0069] Referring to Fig. 10B, one end of the antenna element 504 is connected with a part of a circular cylindrical end surface of the fitting intrusive circular cylindrical member 505. The fitting intrusive circular cylindrical member 505 is formed so that an outside diameter of the member 505 is substantially equal to an inside diameter of the circular cylindrical portion 503a of the hinge portion 503, and the fitting intrusive circular cylindrical member 505 is inserted into the circular cylindrical on the inside of the circular cylindrical portion 503a, and is fitted thereinto.

[0070] In the portable radio communication apparatus constituted as mentioned above, the connection point

111 that serves as the feeding point of the radio communication circuit 110 is electrically connected with the first upper housing portion 102a through the antenna element 504, the fitting intrusive circular cylindrical member 505, and the hinge portion 503. Therefore, the antenna element 504, the fitting intrusive circular cylindrical member 505, the hinge portion 503, and the upper first housing portion 102a can operate as the first antenna element 102A. In this case, at the connection point between the hinge portion 503 and the fitting intrusive circular cylindrical member 505 or at the connection point 111, an input impedance for the antenna is preferably low sufficiently to a predetermined impedance such as 50 Ω or the like in a predetermined frequency band such as 900 MHz or the like.

[0071] In the portable radio communication apparatus constituted as mentioned above, the antenna element 504, the hinge portion 503 and the upper first housing portion 102a operate as the first antenna element 102A. Therefore, as compared with the portable radio communication apparatus in which only the upper first housing portion 102a operates as the antenna element, the antenna apparatus can be made larger in size and the antenna gain can be thereby remarkably improved. Further, it is unnecessary to extend the antenna element 112 toward the upper housing 102 through the inside of the hinge portion 104 as shown in Fig. 1A. Therefore, a diameter of the hinge portion 104 can be made small, and the portable radio communication apparatus can be made thinner. Besides, it is possible to reduce the load on the antenna element 112 when the portable radio communication apparatus is opened or closed, and this leads to improvement of the durability of the portable radio communication apparatus.

[0072] In the present preferred embodiment, the portable radio communication apparatus may be constituted, so that, for example, the insulating ring 201 of Fig. 3A is inserted between the hinge portion 503 and the fitting intrusive circular cylindrical member 505 and then a radio signal is fed to the antenna element 102A through a capacitance.

[0073] In the present preferred embodiment, the fitting intrusive circular cylindrical member 503 is arranged in the circular cylindrical inside of the hinge portion 503. However, the present invention is not limited to this, and the antenna element 504 may be formed to extend toward the upper housing 102 as shown in Fig. 1A.

[0074] In the present preferred embodiment, the upper first housing portion 102a is employed as a part of the antenna element 102A. However, the present invention is not limited to this, and the hinge portion 503 may be electrically connected with the upper second housing portion 102b, and the upper second housing portion 102b may be employed as a component of the antenna elements 102A as shown in Fig. 7A. In this case, it is possible to set the distance between the human body and the antenna element 102A larger, and to suppress the decrease of the antenna gain caused by the electromagnetic influence of the human body during a telephone conversation.

FOURTH PREFERRED EMBODIMENT

[0075] Fig. 11A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a fourth preferred embodiment of the present invention. Fig. 11B is a side view of the portable radio communication apparatus shown in Fig. 11A. Fig. 12A is a perspective view showing a pair of hinge portions 603 and 604 employed in the portable radio communication apparatus shown in Figs. 11A and 11B. Fig. 12B is a perspective view showing (a) a fitting intrusive circular cylindrical member 606 connected with the hinge portion 603 shown in Fig. 12A, (b) an antenna element 605 connected with the fitting intrusive circular cylindrical member 606, (c) a fitting intrusive circular cylindrical member 608 connected with the hinge portion 604 shown in Fig. 12A, and (d) an antenna element 607 connected with the fitting intrusive circular cylindrical member 608. Fig. 13 is a circuit diagram showing a configuration of the radio communication circuit 110 connected with a hinge portion 604 of the portable radio communication apparatus shown in Figs. 11A and 11B.

[0076] The portable radio communication apparatus according to the fourth preferred embodiment is different from that according to the third preferred embodiment in the following points:

(a) The portable radio communication apparatus includes the hinge portions 603 and 604 made of an electrically conductive material such as magnesium or zinc, instead of the hinge portion 104.
(b) The fitting intrusive circular cylindrical member 606 which the antenna element 605 is connected with is fitted into the hinge portion 603.
(c) The fitting intrusive circular cylindrical member 608 which the antenna element 607 is connected with is fitted into the hinge portion 603.
(d) The antenna element 607 is connected with a reactance element 610 or 611 through a connection point 609 of the radio communication circuit 110. The reactance elements 610 and 611 may be variable reactance elements such as varactor diodes or the like.

[0077] Referring to Fig. 12A, the hinge portion 603 is constituted by a circular cylindrical portion 603a and a leg portion 603b, which extends from a circular cylindrical outer peripheral surface of the circular cylindrical portion 603a and has a circular hole 603h. The hinge portion 604 is constituted by a circular cylindrical portion 604a and a leg portion 604b, which extends from a circular cylindrical outer peripheral surface of the circular cylindrical portion 604a and has a circular hole 604h.

[0078] Referring to Fig. 12B, the circular cylindrical fit-

ting intrusive member 606, which the antenna element 605 is connected with, is inserted and fitted into a circular cylindrical inside of the circular cylindrical portion 603a of the hinge portion 603, and further, the circular cylindrical fitting intrusive member 608, which the antenna element 607 is connected with, is inserted and fitted into a circular cylindrical inside of the circular cylindrical portion 604a of the hinge portion 604.

[0079] Referring to Fig. 11A, the circular cylindrical portion 603a of the hinge portion 603 is inserted and fitted between an upper left end 103p of the lower housing 103 and a protruding circular cylindrical portion 103r, and the leg portion 603b of the hinge portion 603 is inserted and fitted to the upper second housing portion 102b. Then, the screw 113 is inserted into the circular hole 603h, and this leads to that the hinge portion 603 is screwed with the upper housing 102 by the screw 113. In addition, the circular cylindrical portion 604a of the hinge portion 604 is inserted and fitted between an upper left end 103q of the lower housing 103 and the protruding circular cylindrical portion 103r, and the leg portion 604b of the hinge portion 604 is inserted and fitted to the upper second housing portion 102b. Then, the screw 114 is inserted into the circular hole 604h, and this leads to that the hinge portion 604 is screwed with the upper housing 102 by the screw 114. The connection point 111 of the radio communication circuit 110 is connected with the fitting intrusive circular cylindrical member 606 through the antenna element 605 that is provided so as to extend into the lower housing 103. The connection point 609 of the radio communication circuit 110 is connected with the fitting intrusive circular cylindrical member 608 through the antenna element 607 that is provided so as to extend into the lower housing 103.

[0080] In the portable radio communication apparatus constituted as mentioned above, the connection point 111 of the radio communication circuit 110 is electrically connected with the upper first housing 102a through the antenna element 605, the fitting intrusive circular cylindrical member 606, the hinge portion 603, and the screw 113. In addition, the connection point 609 of the radio communication circuit 110 is electrically connected with the upper first housing 102a through the antenna element 607, the fitting intrusive circular cylindrical member 608, the hinge portion 604, and the screw 114. A circuit ranging from the antenna element 605 to the upper first housing portion 102a and a circuit ranging from the antenna element 607 to the upper first housing portion 102a constitute the first antenna element 102A. In the present preferred embodiment, as shown in Fig. 13, the antenna element 102A is connected with one of reactance elements 610 and 611 respectively having reactance values Xa and Xb different from each other, through the connection point 609 and a switch SW2 controlled by a controller 150.

[0081] In addition, the fitting intrusive circular cylindrical member 606 is connected with the connection point 111 through the antenna element 605, and the fitting intrusive circular cylindrical member 608 is connected with a terminal 609a of the connection point 609 arranged on the antenna element 607. Further, a terminal 609b of the connection point 609 is connected with the first reactance element 610, and a terminal 609c thereof is connected with the second reactance element 611.

[0082] For example, when the switch SW1 of Fig. 2 is switched over to the contact "a" or the contact "b" thereof to use only the antenna element 102A as the antenna apparatus and the switch SW2 of Fig. 13 is switched over to the contact "a" or the contact "b" thereof, the reactance value of the reactance element connected with the antenna element 102A changes, and then, the resonance frequency of the antenna element 120A changes. Therefore, an operating frequency can be switched over, for example, by time division of transmission and reception. Alternatively, by switching over the switch SW2 to the contact "a" or the contact "b", for example, in accordance with the open or closed state of the portable radio communication apparatus, the reactance elements 610 and 611 may be selectively switched over. As a result, a condition of an object located in the vicinity of the antenna element 102A changes depending on whether the portable radio communication apparatus is in an open state or a closed state thereof, and then, the reactance elements 610 and 611 are selectively switched over according to the condition so as to be able to obtain a higher antenna gain.

[0083] Furthermore, when the switch SW1 of Fig. 2, for example, is switched over to the contact "b" to use only the antenna element 102A as the antenna apparatus, the antenna element 102A can operate as a parasitic element. When the switch SW2 of Fig. 13 is switched over to the contact "a" or the contact "b", the reactance value of the reactance element connected with the antenna element 102A changes. Namely, it is possible to change the electric length of the antenna element 102A that operates as a parasitic element for the antenna element 901. Therefore, it is possible to change directivity characteristics of the entire antenna apparatus.

[0084] In the present preferred embodiment shown in Fig. 13, the two reactance elements 610 and 611 are selectively switched over. However, the present invention is not limited to this, and three or more reactance elements may be selectively switched over.

[0085] In the present preferred embodiment, the first antenna element 102A is constituted by using the upper first housing portion 102a. However, the present invention is not limited to this, and the first antenna element 102A may be constituted by using the upper second housing portion 102b.

[0086] In the present preferred embodiment, the hinge portions 603 and 604 made of the electrically conductive material are employed. However, the present invention is not limited to this, and the hinge portions 603 and 604 made of a dielectric material such as a resin material or the like may be employed, and the antenna

elements 605 and 607 may be directly and electrically connected with the upper first housing portion 102a.

[0087] Fig. 14A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the fourth preferred embodiment according to the present invention. Fig. 14B is a side view of the portable radio communication apparatus shown in Fig. 14A. The portable radio communication apparatus according to the first modified preferred embodiment of the fourth preferred embodiment is different from that according to the fourth preferred embodiment by including an antenna element 612, instead of the antenna element 607 and the fitting intrusive circular cylindrical member 608.

[0088] Referring to Fig. 14A, the antenna element 612 is formed to extend into the lower housing 103, the hinge portion 603, and the upper second housing portion 102b so as to be connected with the screw 114. Therefore, the connection point 609 of the radio communication circuit 110 is electrically connected with the upper first housing portion 102a through the antenna element 612 and the screw 114. The portable radio communication apparatus according to the modified preferred embodiment of the fourth preferred embodiment constituted as mentioned above has the same functions and advantageous effects as those of the portable radio communication apparatus according to the fourth preferred embodiment.

FIFTH PREFERRED EMBODIMENT

[0089] Fig. 15A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a fifth preferred embodiment of the present invention. Fig. 15B is a side view of the portable radio communication apparatus shown in Fig. 15A. Fig. 16 is a plan view of the portable radio communication apparatus when an upper housing 702 of the portable radio communication apparatus shown in Figs. 15A and 15B is rotated counterclockwise by about 45 degrees. Fig. 17A is a plan view of the portable radio communication apparatus shown in Figs. 15A and 15B in an open state thereof, and Fig. 17B is a side view of the portable radio communication apparatus shown in Fig. 17A.

[0090] The portable radio communication apparatus according to the fifth preferred embodiment is different from that according to the first preferred embodiment in the following points.

(a) The portable radio communication apparatus includes the biaxial hinge portion 704 having a CCD camera 706 arranged in central portion thereof, instead of the uniaxial hinge portion 104. It is noted that at least one part of the biaxial hinge portion 704 is made of an electrically conductive material, and the biaxial hinge portion 704 is provided in an upper central portion of a lower housing 703.

(b) The portable radio communication apparatus includes an antenna element 802, instead of the antenna element 112.

(c) The portable radio communication apparatus includes an upper housing 702 that includes an upper first housing portion 702a and an upper second housing portion 702b, instead of the upper housing 102. The upper housing 702 includes the same components as those of the upper housing 102. In addition, in a manner similar to that of the upper first housing portion 102a, at least one part of the upper first housing portion 702a is made of an electrically conductive material, and the upper first housing portion 702a includes a conductor portion.

(d) The portable radio communication apparatus includes the lower housing 703, instead of the lower housing 103. The lower housing 703 includes the same components as those of the lower housing 702.

[0091] Referring to Figs. 15A, 15B and 16, the upper housing 702 and the lower housing 703 are connected with each other, so that they are foldable through the biaxial hinge portion 704 and the upper housing 702 is rotatable about the biaxial hinge portion 704. Referring to Fig. 16, a key pad 705 is provided almost in the central portion of an inner side surface of the lower housing 703. Referring to Figs. 17A and 17B, the antenna element 802 is provided so as to extend from the inside of the lower housing 703 toward the upper housing 702 through the inside of the biaxial hinge portion 704. A connection point 801 (corresponding to the connection point 110 shown in Figs. 1 (a) and 1(b)) that serves as a feeding point of the radio communication circuit 110 is electrically connected with an electrical conductor portion of the upper first housing portion 702a through the antenna element 802. The antenna element 802 and the upper first housing portion 702a constitute the first antenna element 702A in a manner similar to the antenna element 102A of the first preferred embodiment.

[0092] Fig. 18 is a circuit diagram showing a configuration of the antenna elements 702A and 901 and the radio communication circuit 110 connected with the antenna elements 702A and 901 of the portable radio communication apparatus shown in Fig. 17A. Referring to Fig. 18, the antenna element 702A is electrically connected with the contact "a" of the switch SW1 through the connection point 801. The other circuits are constituted in a manner similar to that of Fig. 2. Accordingly, in the present preferred embodiment, the antenna elements 702A and 901 can be selectively switched over, and the portable radio communication apparatus according to the fifth preferred embodiment has the same functions and advantageous effects as those of the portable radio communication apparatus according to the first preferred embodiment.

[0093] In the present preferred embodiment, the antenna element 802 is connected with the conductor portion of the upper first housing portion 702a. However,

the present invention is not limited to this. At least one part of the upper second housing portion 702b may be made of an electrically conductive material and the antenna element 802 may be connected with the conductor portion of the upper second housing portion 702b. In this case, it is possible to make the distance between the human body and the antenna element 702A larger, and to suppress the decrease of the antenna gain caused by the electromagnetic influence of the human body during a telephone conversation.

[0094] Fig. 19A is a plan view of a portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the fifth preferred embodiment according to the present invention. Fig. 19B is a side view of the portable radio communication apparatus shown in Fig. 19A. Fig. 20 is a longitudinal sectional view showing a detailed configuration in the vicinity of a flat electrical insulator 922 shown in Fig. 19B.

[0095] The portable radio communication apparatus according to the modified preferred embodiment of the fifth preferred embodiment is different from that according to the fifth preferred embodiment as follows. A flat antenna element 921 is connected with a tip end of the antenna element 802, electrically connected with the conductor portion of the biaxial hinge portion 704 through the flat electrical insulator 922, and connected with the upper first housing portion 702a through the biaxial hinge portion 704. As shown in Fig. 20, the flat electrical insulator 922 is inserted between the flat antenna element 921 and the biaxial hinge portion 704 in the inside of the lower housing 703. In the portable radio communication apparatus constituted as mentioned above, a radio signal can be fed to the antenna apparatus through the capacitance in a manner similar to that of the portable radio communication apparatus shown in Fig. 3B.

[0096] Fig. 21 is a longitudinal sectional view showing a detailed configuration in the vicinity of the antenna element 921 of a further modified preferred embodiment of the portable radio communication apparatus shown in Fig. 19A. Referring to Fig. 21, the flat electrical insulator 922 shown in Fig. 20 is not employed, and the biaxial hinge portion 704 is constituted by forming an electrical conductor layer 704B on the resin housing portion 704A. In addition, the conductor layer 704B is electrically connected with the upper first housing portion 702a. By thus constituting the same apparatus, the flat antenna element 921 is electrically connected with the conductor layer 704B through the resin housing portion 704A. Therefore, in a manner similar to that of Fig. 20, in the portable radio communication apparatus, a radio signal can be fed to the antenna apparatus through the capacitance.

[0097] The various kinds of implemental examples applied to the preferred embodiments mentioned above will be next described.

[0098] Fig. 22A shows a first implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 22B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 22A. Fig. 22C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 22A.

[0099] Referring to Figs. 22A, 22B and 22C, an electrical conductor layer 102bm made of an electrically conductive material such as magnesium or zinc is formed on the inner side surface of a resin housing portion 102bp (including the screw reception portions 115), thereby constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the first implemental example constituted as mentioned above, by forming the conductor layer 102bm, the mechanical strength of the upper second housing portion 102b can be increased. In addition, since the upper housing 102 can be made of a resin material, the manufacturing cost can be reduced. Further, since a pattern of the conductor layer 102bm can be easily formed, it is possible to increase the degree of freedom for designing the antenna apparatus. Besides, since the upper second housing portion 102b is located on the opposite side of the head of an operator relative to the upper first housing portion 102a, it is possible to make the distance between the human body and the antenna element 112 larger, and to improve the antenna gain and the SAR during a telephone conversation.

[0100] Fig. 23A shows a second implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper first housing portion 102a of the portable ratio communication apparatus. Fig. 23B is a plan view showing the inner side surface of the upper first housing portion 102a shown in Fig. 23A. Fig. 23C is a plan view showing the outer side surface of the upper first housing portion 102a shown in Fig. 23A.

[0101] Referring to Figs. 23A, 23B and 23C, an electrical conductor layer 103bm made of a magnetic material such as magnesium or zinc is formed on an inner side surface of a resin housing portion 103bp (including inner peripheral surfaces of circular holes 115h on the respective screw reception portions 115 but not including the liquid crystal display 105), thereby constituting the upper first housing portion 102a, and then, for example, electrically connecting the antenna element 112 with the conductor layer 103bm. In the second implemental example constituted as mentioned above, by forming the conductor layer 103bm, the mechanical strength of the upper first housing portion 102a can be increased. In addition, since the upper housing 102 can be made of a resin material, the manufacturing cost can be reduced. Further, since a forming pattern of the conductor layer 103bm can be easily formed, it is possible to increase the degree of freedom for designing the an-

tenna apparatus.

[0102] Fig. 24A shows a third implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable ratio communication apparatus. Fig. 24B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 24A. Fig. 24C is a plan view showing the outer side surface of the upper second housing portion 102b shown in Fig. 24A.

[0103] Referring to Figs. 24A, 24B and 24C, the conductor layer 102bm made of a magnetic material such as magnesium or zinc is formed on the inner side surface of the resin housing portion 102bp (including one of the screw reception portions 115 but not including lower end portions in the vicinity of the screw reception portions 115), thereby constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the third implemental example constituted as mentioned above, the upper housing 102 can be electrically connected with the lower housing 103.

[0104] Fig. 25A shows a fourth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 25B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 25A. Fig. 25C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 25A.

[0105] Referring to Figs. 25A, 25B and 25C, the conductor layer 102bm is made of an electrically conductive material such as magnesium or zinc, and includes a rectangular slot 931, for example, along an end portion on the left side of the inner side surface in parallel to a vertical direction of the same apparatus. The conductor layer 102bm is formed on the inner side surface of a resin housing portion 102bp (including the screw reception portions 115). This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the fourth implemental example constituted as mentioned above, since the slot 931 is formed on the inner side surface of the upper second housing portion 102b, an electrical conductor having a plurality of electric lengths can be formed on the conductor layer 102bm, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands. Alternatively, a slit having an open end may be formed in place of the slot 931 of Figs. 25A and 25B.

[0106] Fig. 26A shows a fifth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 26B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 26A. Fig. 26C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 26A.

[0107] Referring to Figs. 26A, 26B and 26C, the conductor layer 102bm is made of an electrically conductive material such as magnesium or zinc, and includes a rectangular slit 932, for example, along the end portion on the left side of the inner side surface in parallel to the vertical direction of the same apparatus and extending toward an upper end portion thereof. The conductor layer 102bm is formed on the inner side surface of a resin housing portion 102bp (including the screw reception portions 115). This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the fifth implemental example constituted as mentioned above, since the slit 932 is formed on the inner side surface of the upper second housing portion 102b, an electrical conductor having a plurality of electric lengths can be formed on the conductor layer 102bm, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands. The slit 932 is formed to have a longitudinal length of a quarter of wavelength, and operates as a quarter-wave resonance element. Therefore, the slit 932 can be realized with half the length of the slot 931.

[0108] Fig. 27A shows a sixth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 27B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 27A. Fig. 27C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 27A.

[0109] Referring to Figs. 27A, 27B and 27C, the conductor layer 102bm made of an electrically conductive material such as magnesium or zinc and including a rectangular slot 933 extending, for example, along a lower end portion of the inner side surface in parallel to a lateral or horizontal direction of the same apparatus is formed on the inner side surface of the resin housing portion 102bp (including the screw reception portions 115). This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the sixth implemental example constituted as mentioned above, since the slot 933 is formed on the inner side surface of the upper second housing portion 102b, an electrical conductor having a plurality of electric lengths can be formed on the conductor layer 102bm, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands. Further, since the horizontal slot 933 is formed, a horizontally polarized radio wave can be projected from the

antenna element 102A. On the other hand, since a vertically polarized radio wave is projected from the antenna element 901, polarization diversity can be constituted by using these two antenna elements.

[0110] Fig. 28A shows a seventh implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 28B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 28A. Fig. 28C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 28A.

[0111] Referring to Figs. 28A, 28B and 28C, the conductor layer 102bm made of an electrically conductive material such as magnesium or zinc and including an inverted-U-shaped rectangular slot 934, which is formed to extend, for example, along the lower end portion of the inner side surface in parallel to the lateral or horizontal direction of the same apparatus, and which has end portions extending downward is formed on the inner side surface of the resin housing portion 102bp (including the screw reception portions 115). This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In the seventh implemental example constituted as mentioned above, since the slot 934 is formed on the inner side surface of the upper second housing portion 102b, an electrical conductor having a plurality of electric lengths can be formed on the conductor layer 102bm, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands. Further, by changing a formation pattern of the conductor layer 102bm, the length of the slot 934 can be adjusted so as to adjust the respective resonance frequencies.

[0112] Fig. 29A shows an eighth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 29B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 29A. Fig. 29C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 29A.

[0113] Referring to Figs. 29A, 29B and 29C, the conductor layer 102bm made of an electrically conductive material such as magnesium or zinc and including a rectangular slot 935 extending, for example, along the end portion on the left side of the inner side surface in parallel to the vertical direction of the same apparatus is formed on the inner side surface of the resin housing portion 102bp (including the screw reception portions 115). This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layer 102bm. In addition, an electrical conductor layer 102bma extending along the end portion on the left side of the outer side surface in parallel to the vertical direction is formed on the outer side surface of the upper second housing portion 102b, and this leads to formation of a parasitic element. In the eighth implemental example constituted as mentioned above, the antenna apparatus can project a radio wave through the slot 935, and further, the directivity characteristics of the antenna apparatus can be controlled using the conductor layer 102bma that serves as a parasitic element. Therefore, it is possible to project the radio wave so that the main beam thereof is directed, for example, in an opposite direction to a direction of the operator's body. Further, since the slot 935 is formed on the inner side surface of the upper second housing portion 102b, an electrical conductor having a plurality of electric lengths can be formed on the conductor layer 102bm, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands.

[0114] Fig. 30A shows a ninth implemental example applied to the preferred embodiments of the present invention, and is a perspective view seen from the inner side surface of the upper second housing portion 102b of the portable radio communication apparatus. Fig. 30B is a plan view showing the inner side surface of the upper second housing portion 102b shown in Fig. 30A. Fig. 30C is a plan view showing an outer side surface of the upper second housing portion 102b shown in Fig. 30A.

[0115] Referring to Figs. 30A, 30B and 30C, rectangular electrical conductor layers 102bm 1 and 120bm2 are formed on the inner side surface of the resin housing portion 102bp (including the screw reception portions 115). The rectangular electrical conductor layer 102bm1 made of an electrically conductive material such as magnesium or zinc is formed to extend, for example, along the end portion on the left side of the inner side surface in parallel to the vertical direction of the same apparatus. Further, the rectangular electrical conductor layer 102bm2 (which is different in the longitudinal length from the rectangular electrical conductor layer 102bm1) made of an electrically conductive material such as magnesium or zinc is formed to extend, for example, along the end portion on the right side of the inner side surface in parallel to the vertical direction of the same apparatus. This leads to constituting the upper second housing portion 102b, and then, for example, electrically connecting the antenna element 112 with the conductor layers 102bm1 and 102bm2. In the ninth implemental example constituted as mentioned above, since the two conductor layers 102bm1 and 102bm2 are formed on the inner side surface of the upper second housing 102b to serve a part of the antenna element 102A, an electrical conductor having a plurality of electric lengths can be formed on the antenna element 102A, and further, there can be realized the antenna element 102A that has a plurality of resonance frequencies and that can cover a plurality of frequency bands.

Further, by changing forming patterns of the respective conductor layers 102bm1 and 102bm2, the electric length of the antenna element 102A can be adjusted so as to adjust the respective resonance frequencies.

[0116] In the ninth implemental example, the portable radio communication apparatus may be constituted to selectively switch over the antenna element of the conductor layer 102bm1 and that of the conductor layer 102bm2. For example, the portable radio communication apparatus can be constituted to selectively switch over the two antenna elements so as to be able to attain a higher antenna gain depending on whether the portable radio communication apparatus is held in the operator's right hand or left hand.

[0117] Fig. 31A shows a tenth implemental example applied to the fifth preferred embodiment of the present invention, and is a plan view showing that the upper housing 702 of the portable radio communication apparatus is detached. Fig. 31B is a side view of the portable radio communication apparatus shown in Fig. 31A.

[0118] Referring to Figs. 31A and 31B, a resin layer 704p is formed on a front surface of the biaxial hinge portion 704 made of an electrically conductive material. Namely, by forming the resin layer 704p on the portion with which the operator's head contacts during a telephone conversation, the SAR can be reduced. The resin layer 704p may be formed by using a magnetic material.

SIXTH PREFERRED EMBODIMENT

[0119] Fig. 32A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a sixth preferred embodiment of the present invention. Fig. 32B is a side view of the portable radio communication apparatus shown in Fig. 32A. Fig. 33A a plan view of the portable radio communication apparatus shown in Figs. 32A and 32B in an open state. Fig. 33B is a side view of the portable radio communication apparatus shown in Fig. 33A.

[0120] The portable radio communication apparatus according to the sixth preferred embodiment is different from that according to the first preferred embodiment by including an antenna element 211, instead of the antenna element 112. The antenna element 211 is formed to extend from the connection point 111 of the radio communication circuit 110 toward a connection point 212 on the conductor portion of the upper first housing portion 102a through the inside of the lower housing 103, the inside of the hinge portion 104, and the inside of the upper first housing portion 102a. Therefore, the connection point 111 of the radio communication circuit 110 is electrically connected with the conductor portion of the upper first housing portion 120a through the antenna element 211.

[0121] The portable radio communication apparatus according to the sixth preferred embodiment constituted as mentioned above has the same functions and advantageous effects as those of the portable radio communication apparatus according to the first preferred embodiment. In addition, since the antenna element 901 is formed on the inside of the boom portion 910 and the conductor portion of the upper first housing portion 120a operates as the antenna element 102A, the portable radio communication apparatus can transmit and receive radio waves without employing the external antenna as required in the conventional portable radio communication apparatus. Therefore, it is possible to prevent the external antenna from being got stuck with an operator's pocket when taking out the same apparatus from his pocket. Further, since the penetrating hole 910h is formed in the space surrounded by the boom portion 910 and the lower housing 103, the portable radio communication apparatus can be suspended from a neck of a user with a strap 910s attached to the boom portion 910 as shown in Fig. 34. In this case, since it is unnecessary to use the external antenna as used in the conventional portable radio communication apparatus, the portable radio communication apparatus can be designed to be laterally symmetric, and further, the portable radio communication apparatus can be easily well balanced laterally or horizontally when the same apparatus is suspended from the neck of the user.

[0122] Fig. 35A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a modified preferred embodiment of the sixth preferred embodiment of the present invention. Fig. 35B is a side view of the portable radio communication apparatus shown in Fig. 35A. The portable radio communication apparatus according to the modified preferred embodiment of the sixth preferred embodiment is different from that according to the sixth preferred embodiment, in that at least one part of the upper second housing portion 102b is made of an electrically conductive material, and in that the antenna element 211 is electrically connected with the conductor portion of the upper second housing portion 102b at the connection point 212. Namely, the antenna element 102A is constituted by using the antenna element 211 and the conductor portion of the upper second housing portion 102b. In this case, the upper first housing portion 102a may be made of either a resin material or an electrical conductive material. By thus constituting the portable radio communication apparatus, it is possible to set the distance between the antenna element 102A and the human head larger, and to suppress the decrease of the antenna gain during a telephone conversation.

[0123] In the present preferred embodiment, the antenna element 211 may be constituted by using a feeding line such as a coaxial cable.

SEVENTH PREFERRED EMBODIMENT

[0124] Fig. 36A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a seventh preferred embodiment of the present invention. Fig. 36B is a side view of the portable

radio communication apparatus shown in Fig. 36A.

[0125] The portable radio communication apparatus according to the seventh preferred embodiment is different from that according to the third preferred embodiment, in that the fitting intrusive circular cylindrical member 505 connected with the antenna element 504 is inserted and fitted into the circular cylindrical portion of the hinge portion 104 made of an electrically conductive material which is coupled with the upper first housing portion 102a. By thus constituting the portable radio communication apparatus, the connection point 111 of the radio communication circuit 110 is electrically connected with the conductor portion of the upper first housing portion 102a through the antenna element 504, the fitting intrusive circular cylindrical member 505, and the hinge portion 104. Accordingly, the portable radio communication apparatus according to the seventh preferred embodiment has the same functions and advantageous effects as those of the portable radio communication apparatus according to the third preferred embodiment. In addition, in a manner different from that of the first preferred embodiment, it is unnecessary to extend the antenna element 504 toward the upper housing 102 through the inside of the hinge portion 104. Due to this, the thickness of the upper housing 102 can be made smaller and the diameter of the hinge portion 104 can be made smaller. Besides, the durability of the hinge portion 104 when the portable radio communication apparatus is opened or closed through the hinge portion 104 can be further improved.

[0126] In the present preferred embodiment, at least one part of the upper first housing portion 102a is made of an electrically conductive material. However, the present invention is not limited to this, and at least one part of the upper second housing portion 102b may be made of an electrically conductive material and the hinge portion 104 may be electrically connected with the upper second housing portion 102b. In this case, the antenna element 120A is constituted by using the antenna element 504, the fitting intrusive circular cylindrical member 505, the hinge portion 104, and the conductor portion of the upper second housing portion 102b. It is thereby possible to set the distance between the antenna element 102A and the human head larger during a telephone conversation, and to suppress the decrease of the antenna gain.

[0127] In the present preferred embodiment, the antenna element 504 may be constituted by using a feeding line such as a coaxial cable.

EIGHTH PREFERRED EMBODIMENT

[0128] Fig. 37A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to an eighth preferred embodiment of the present invention. Fig. 37B is a side view of the portable radio communication apparatus shown in Fig. 37A.

[0129] The portable radio communication apparatus according to the eighth preferred embodiment is different from that according to the fifth preferred embodiment shown in Fig. 17A, in that an antenna element 811 is formed to extend toward the conductor portion of the upper first housing portion 702a through the inside of the biaxial hinge portion 704, the inside of the upper second housing portion 702b, and the inside of the upper first housing portion 702a. Therefore, the connection point 801 of the radio communication circuit 110 is electrically connected with the upper first housing portion 702a at a connection point 812 through the antenna element 811. The portable radio communication apparatus according to the eighth preferred embodiment constituted as mentioned above has the same functions and advantageous effects as those of the portable radio communication apparatus according to the fifth preferred embodiment. By arranging the boom portion 910 of substantially laterally symmetric structure to be substantially laterally symmetric relative to the width direction or the horizontal direction of the portable radio communication apparatus, the design quality of the portable radio communication apparatus can be further improved. Even if the structure of the biaxial hinge portion 704 is larger, the design quality of the portable radio communication apparatus can be further improved.

[0130] The antenna element 811 can extend to be electrically insulated from the biaxial hinge portion 704, and the biaxial hinge portion 704 can operate as a parasitic element of the antenna element 102A or 901.

[0131] In the present preferred embodiment, the antenna element 811 is formed to extend into the upper first housing portion 702a and to be electrically connected with the conductor portion of the upper first housing portion 702a. However, the present invention is not limited to this, and the antenna element 811 may be connected with an electrical conductor portion of the biaxial hinge portion 704 connected with the conductor portion of the upper first housing portion 702a.

[0132] In the present preferred embodiment, the portable radio communication apparatus includes the antenna element 811. However, the present invention is not limited to this, and the portable radio communication apparatus may include the feeding line such as the coaxial cable, instead of the antenna element 811.

[0133] Fig. 38A is a plan view of a folding portable radio communication apparatus in an open state thereof according to a modified preferred embodiment of the eighth preferred embodiment of the present invention. Fig. 38B is a side view of the portable radio communication apparatus shown in Fig. 39A. The portable radio communication apparatus according to the modified preferred embodiment of the eighth preferred embodiment is different from that according to the eighth preferred embodiment, in that at least one part of the upper second housing portion 102b is made of an electrically conductive material, and in that the antenna element 811 is electrically connected with the upper second housing portion 102b. In this case, the antenna element

102A is constituted by using the antenna element 811 and the conductor portion of the upper second housing portion 702b. It is thereby possible to set the distance between the antenna element 102A and the human head larger during a telephone conversation, and to suppress the decrease of the antenna gain.

NINTH PREFERRED EMBODIMENT

[0134] Fig. 39A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a ninth preferred embodiment of the present invention. Fig. 39B is a side view of the portable radio communication apparatus shown in Fig. 39A.

[0135] The portable radio communication apparatus according to the ninth preferred embodiment is different from the portable radio communication apparatus according to the first preferred embodiment, in that an external antenna 951 such as a quarter-wave whip antenna is provided in the vicinity of the end portion of the upper second housing portion 102b on the opposite side of the hinge portion 104 in a portable radio communication apparatus 1001, instead of the first antenna element 102A that includes the antenna element 112 and the upper first housing portion 102a. According to the portable radio communication apparatus constituted as mentioned above, by combining the external antenna 951 that has conventionally function as a main antenna in both closed and open states thereof, with the antenna element 901 (not shown in Figs. 39A and 39B) provided in the boom portion 910, then a reception diversity processing can be executed which is improved as compared with the conventional portable radio communication apparatus. In addition, the degree of freedom for designing the same apparatus to satisfy required antenna characteristics can be further improved, the external antenna 951 smaller in size than that of the conventional portable radio communication apparatus can be employed, and the design quality can be further improved.

[0136] It is noted that the installment position of the external antenna element 951 described in the present preferred embodiment is just one example, and the installment position of the external antenna element 951 is not limited to this. For example, the external antenna 951 may be arranged in the lower housing 103. In this case, the boom portion 910 may be arranged in the upper housing 102.

[0137] In the above-mentioned embodiments described, the folding portable radio communication apparatus has been described. However, the present invention is not limited to this, and a straight portable radio communication apparatus may be provided in which the external antenna 851 and the antenna element 901 of the boom portion 910 may be combined.

TENTH PREFERRED EMBODIMENT

[0138] Fig. 40A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a tenth preferred embodiment of the present invention. Fig. 40B is a side view of the portable radio communication apparatus shown in Fig. 40A.

[0139] The portable radio communication apparatus according to the tenth preferred embodiment is different from the portable radio communication apparatus according to the ninth preferred embodiment, in that a built-in antenna element 952 such as a ceramic chip antenna or the like is provided on the inside of the upper second housing portion 102b in the vicinity of the end portion of the upper second housing portion 102b on the opposite side of the hinge portion 104 of the portable radio communication apparatus, instead of the external antenna 951. In the present preferred embodiment, the built-in antenna element 952 and the antenna element 901 of the boom portion 910 (not shown in Figs. 40A and 40B) constitute the antenna apparatus. By thus constituting the portable radio communication apparatus, it is possible to improve the design quality, and to improve the degree of freedom for designing the same apparatus.

[0140] Fig. 41A is a plan view of a folding portable radio communication apparatus in a closed state thereof according to a modified preferred embodiment of the tenth preferred embodiment of the present invention. Fig. 41 B is a side view of the portable radio communication apparatus shown in Fig. 41A.

[0141] The portable radio communication apparatus according to the modified preferred embodiment of the tenth preferred embodiment is different from the portable radio communication apparatus according to the tenth preferred embodiment, in that the built-in antenna element 952 is arranged on the inside of the lower housing 103 in the vicinity of the end portion of the lower housing 103 on the opposite side of the hinge portion 104. The portable radio communication apparatus according to the modified preferred embodiment of the tenth preferred embodiment has the same functions and advantageous effects as those of the portable radio communication apparatus according to the tenth preferred embodiment. As the distance between the antenna element 901 of the boom portion 910 and the built-in antenna element 952 becomes smaller, the correlation coefficient between the antenna elements 901 and 952 becomes higher by coupling between the antenna elements 901 and 952. As a result, the advantageous effects such as the diversity reception may possibly be lowered. Therefore, it is preferable that the antenna elements 901 and 952 are away from each other by at least a quarter of wavelength.

[0142] In the present preferred embodiment and the modified preferred embodiment of the tenth preferred embodiment, an instance in which the portable radio communication apparatus includes one built-in antenna element 952 has been described. However, the present invention is not limited to this, and the portable radio communication apparatus may include a plurality of

built-in antennas. In this case, it is possible to cover a plurality of frequency bands.

ELEVENTH PREFERRED EMBODIMENT

[0143] Fig. 42A is a plan view of a folding portable radio communication apparatus according to an eleventh preferred embodiment of the present invention. Fig. 42B is a side view of the portable radio communication apparatus shown in Fig. 42A.

[0144] The portable radio communication apparatus according to the eleventh preferred embodiment is different from that according to the first preferred embodiment in the following points.

(a) The lower housing 103 is constituted so that the lower first housing portion 103a located on the inside thereof and the lower second housing portion 103b located on the outside thereof are bonded together while opposing to each other. At least one part of the lower second housing portion 103b is made of the same electrically conductive material as that of the upper first housing portion 102a of the first preferred embodiment (this portion made of an electrically conductive material will be referred to as a conductor portion hereinafter). The portable radio communication apparatus includes a key pad 116 in the central portion of the inner side surface of the lower first housing portion 103a.

(b) The portable radio communication apparatus includes the radio communication circuit 110 of the upper second housing portion 102b.

(c) The portable radio communication apparatus includes an antenna element 962 extending from the upper second housing portion 102b toward the lower second housing portion 103b through the hinge portion 104.

[0145] Referring to Figs. 42A and 42B, the antenna element 962 is provided so as to extend from a connection point 961 (corresponding to the connection point 111 shown in Fig. 1A) that serves as a feeding point of the radio communication circuit 110 into the lower first housing portion 103a through the inside of the hinge portion 104, and one end of the antenna element 962 located on the inside of the lower first housing portion 103a is connected with a screw 963.

[0146] The screw 963 penetrates the lower housing 103 from the outer side surface of the lower second housing portion 103b toward a screw reception portion 964 of the lower first housing portion 103b, and this leads to that the lower housing 103 is screwed with the screw 963 and the screw 963 is electrically connected with the conductor portion of the lower second housing portion 103b. Accordingly, the connection point 961 of the radio communication circuit 110 is electrically connected with the conductor portion of the lower second housing portion 103b through the antenna element 962 and the screw 963. As a result, the antenna apparatus is constituted by using the antenna element 962 and the conductor portion of the lower second housing portion 103b. The portable radio communication apparatus constituted as mentioned above has the same functions and advantageous effects as those of the portable radio communication apparatus according to the first preferred embodiment.

[0147] In the present preferred embodiment, the antenna element 962 is connected with the conductor portion of the lower second housing portion 103b. However, the present invention is not limited to this, and at least one part of the lower first housing portion 103a may be made of an electrically conductive material, and the antenna element 962 may be connected with the conductor portion of the lower first housing portion 103a. Alternatively, the conductor portion may be formed on each of the lower first housing portion 103a and the lower second housing portion 103b.

TWELFTH PREFERRED EMBODIMENT

[0148] Fig. 44A is a plan view of a slide type portable radio communication apparatus according to a twelfth preferred embodiment of the present invention. Fig. 44B is a side view of the portable radio communication apparatus shown in Fig. 44A.

[0149] Referring to Figs. 44A and 44B, the portable radio communication apparatus according to the present preferred embodiment includes an upper housing 102c, a lower housing 103c, and a sliding mechanism. The sliding mechanism is constituted so that two sliding protrusions 182 formed on a rear surface of the upper housing 102c are fitted into slide grooves 181 formed on both side surfaces of the lower housing 130c in a longitudinal direction thereof, respectively, and so that the upper housing 102c is slidable along the longitudinal direction thereof in a direction indicated by an arrow 183. As shown in Fig. 44A and 44B, when the upper housing 102c is located on the upper side of the sliding mechanism, a keypad 116 of the lower housing 103c appears and is made operable by the user. On the other hand, when the upper housing 102c is located on the lower side of the sliding mechanism, the keypad 116 of the lower housing 103c is covered with the upper housing 102c and is made inoperable by the user. At that time, the upper housing 102c and the lower housing 103c are integrated with each other at a minimum occupied area, and the integrated housings become similar in a form to a straight type portable radio communication apparatus which will be described later. Further, a conductor layer 103cc made of an electrically conductive material is formed on a top portion of a rear surface of the lower housing 103c, and used as an antenna element 103A. In addition, built-in antenna elements 191 and 192 each constructed by, for example, a chip antenna are included internally in left and right end portions of a lower portion of the lower housing 103c, respective-

ly. Preferably, at least two of the three antenna elements 103A, 191, and 192 are formed, and transmission diversity and reception diversity are performed using the at least two antenna elements.

[0150] Fig. 45A is a plan view of a slide type portable radio communication apparatus according to a modified preferred embodiment of the twelfth preferred embodiment of the present invention. Fig. 45B is a side view of the portable radio communication apparatus shown in Fig. 45A.

[0151] Referring to Figs. 45A and 45B, the portable radio communication apparatus according to the present modified preferred embodiment is characterized, as compared with that of the twelfth preferred embodiment, in that the boom portion 910 including therein the antenna element 901 connected with the connection point 902 is coupled with both edges of the upper end surface of the lower housing 103c.

[0152] The characteristic constitutions of the portable radio communication apparatuses according to the first to eleventh preferred embodiments and their modified preferred embodiments may be applied to the slide type portable radio communication apparatuses according to the twelfth preferred embodiment and the modified preferred embodiment of the twelfth preferred embodiment.

THIRTEENTH PREFERRED EMBODIMENT

[0153] Fig. 46A is a plan view of a straight type portable radio communication apparatus according to the thirteenth preferred embodiment of the present invention. Fig. 46B is a rear view of the portable radio communication apparatus shown in Fig. 46A. Fig. 46C is a side view of the portable radio communication apparatus shown in Fig. 46A.

[0154] Referring to Figs. 46A, 46B, and 46C, the portable radio communication apparatus according to the present preferred embodiment is a straight type portable radio communication apparatus which includes an upper housing 102d and a lower housing 103d that are bonded to each other. For example, a conductor layer 103dc made of an electrically conductive material is formed on an upper portion of a rear surface of the lower housing 103d, and is used as the antenna element 103A. In addition, the built-in antenna elements 191 and 192 each constructed by, for example, a chip antenna are included in left and right end portions of a lower portion of the lower housing 103d, respectively. Preferably, at least two of the three antenna elements 103A, 191, and 192 are formed, and transmission diversity and reception diversity are performed using the at least two antenna elements.

[0155] Fig. 47A is a plan view of a straight type portable radio communication apparatus according to a modified preferred embodiment of the thirteenth preferred embodiment of the present invention. Fig. 47B is a rear view of the portable radio communication apparatus shown in Fig. 47A. Fig. 47C is a side view of the portable radio communication apparatus shown in Fig. 47A.

[0156] Referring to Figs. 47A, 47B and 47C, the portable radio communication apparatus according to the present modified preferred embodiment is characterized, as compared with that of the thirteenth preferred embodiment, in that the boom portion 910 including therein the antenna element 901 connected with the connection point 902 is coupled with both edges of an upper end surface of the lower housing 103d.

[0157] The characteristic constitutions of the portable radio communication apparatuses according to the first to eleventh preferred embodiments and their modified preferred embodiments may be applied to the straight type portable radio communication apparatuses according to the thirteenth preferred embodiment and the modified preferred embodiment of the thirteenth preferred embodiment.

[0158] In the above-mentioned preferred embodiments, the antenna or antenna element is preferably an unbalanced type antenna or antenna element.

MODIFIED PREFERRED EMBODIMENTS

[0159] Fig. 43 is a longitudinal sectional view showing a detailed configuration of a boom portion 910 of a portable radio communication apparatus according to a further modified preferred embodiment of the preferred embodiments of the present invention.

[0160] Referring to Fig. 43, a first electrical conductor antenna element layer 911 is formed on an upper surface of the boom portion 901, and a second electrical conductor antenna element layer 912 is formed on the lower surface of the boom portion 901 to be away from the first electrical conductor antenna element layer 911. Then, the two conductor antenna element layers 911 and 912 are electrically connected with each other at a connection point 913 in the lower housing 103, and the two conductor antenna element layers 911 and 912 are also connected with the connection point 902.

[0161] In the portable radio communication apparatus constituted as mentioned above, when the first conductor antenna element layer 911 is formed to have an electric length at which the layer 911 resonates in a lower frequency band such as 800 MHz band or the like. Further, the second conductor antenna element layer 912 is formed to have an electric length at which the layer 912 resonates in a higher frequency band such as 1.5 GHz band or the like. Then, the electric distance between the two layers 911 and 912 is smaller as the frequency becomes lower. Generally speaking, when the distance between a grounding conductor of the printed wiring board 106 in the lower housing 103, and the conductor antenna element 911 is equal to the distance between the grounding conductor thereof and the conductor antenna element 912, the antenna gain of the conductor antenna element layer in the lower frequency band is lowered. However, as shown in Fig. 43, by ar-

ranging the conductor antenna element in the lower frequency band on the outer side (upper side) away from the grounding conductor, it is possible to set the distance of the present conductor antenna element layer to the grounding conductor of the lower housing 103 larger. The capacitive coupling between the conductor antenna element layer 911 and the grounding conductor can be remarkably reduced. Therefore, the input impedance when the antenna apparatus is viewed from the feeding point can be further lowered. It is possible to easily attain impedance matching at a predetermined characteristic impedance such as 50 Ω or the like, and it is possible to realize high antenna gain characteristics in wide bands using the two conductor antenna element layers 911 and 912.

[0162] In the preferred embodiments mentioned above, the conductor portion that operates as the antenna element 102A is formed on one of the upper first housing portion 102a and the upper second housing portion 102b. However, the present invention is not limited to this, and the conductor portion that operates as the antenna element 102A may be formed on each of the upper first housing portion 102a and the upper second housing portion 102b.

[0163] In the preferred embodiments mentioned above, the conductor portion formed on one of the upper housing 102 and the lower housing 103. However, the present invention is not limited to this, and the conductor portion may be formed on each of the upper housing 102 and the lower housing 103.

[0164] In the preferred embodiments mentioned above, the whip antenna is employed as the external antenna. However, the present invention is not limited to this, and a fixed helical antenna may be employed. Further, an inverted-F antenna may be employed as the built-in antenna. Besides, a plurality of antenna apparatuses may be provided in the upper housing 102.

[0165] In the preferred embodiments mentioned above, the upper housing 102 is connected with the lower housing 103, for example, by the antenna element 112. However, the present invention is not limited to this, and the upper housing 102 may be connected with the lower housing 103 by an electrical conductor pattern on a flexible printed wiring board.

[0166] In the preferred embodiments mentioned above, the boom portion 910 is made of an electrically conductive material such as magnesium or zinc, and this leads to that the mechanical strength of the boom portion 910 can be increased. Accordingly, even if the portable radio communication apparatus falls down to the ground, it is possible to prevent the same apparatus from being damaged. In addition, since at least one part of the boom portion 910 is formed to be filled with a dielectric material such as a resin material, it is advantageously possible to lower the resonance frequency of the antenna element 901 of the boom portion 910, and the portable radio communication apparatus can be made smaller in size as compared with the same apparatus in which the boom portion 910 is not filled with the dielectric material. Further, by fixing the surroundings of the antenna element 901 by a dielectric material such as a resin material, it is possible to increase the mechanical strengths of the boom portion 910 and the antenna element 901, and to improve the mass-producibility of the same apparatus.

[0167] In the above-mentioned preferred embodiments, at least one part of the boom portion 910 may be made of an elastic or flexible resin material such as elastomer. In this case, when the portable radio communication apparatus is put on the ground and the user pressurizes the same apparatus from above such as inadvertently stamping down the same apparatus or inadvertently dropping the same apparatus from a holding state, the impact can be absorbed and the damage of the boom portion 910 can be prevented.

[0168] In the above-mentioned preferred embodiments, the shape of the boom portion 910 is not limited to that shown in the drawings. For example, the boom portion 910 may be formed to be trapezoidal or tapered. In addition, at least one part of the boom portion 910 may be made of a transparent or semitransparent resin material. In this case, the design quality can be further improved. Further, a light emission diode that projects light during transmission of the radio wave may be arranged in the boom portion 910.

[0169] As mentioned above, according to the folding portable radio communication apparatus according to the preferred embodiments, at least one part of the upper housing or lower housing is constituted to serve as the antenna element. Therefore, it is advantageously possible to increase the strength of the same apparatus against the impact such as that upon the user's dropping the same apparatus. In addition, since it is unnecessary to secure the space occupied by the antenna element, the number of parts can be decreased, and the portable radio communication apparatus can be made thinner and lighter in weight as compared with the conventional portable radio communication apparatus. Further, by allowing the hinge portion made of the electrically conductive material to function as a part of the antenna apparatus, the antenna apparatus can be made larger in size, and the antenna gain thereof can be further improved. Additionally, by bonding the thin-film-shaped electrically insulating sheet 301 made of the dielectric material or the magnetic material onto the surface of the upper first housing portion 102a, the distance between the human body and the antenna apparatus can be set larger, and then, the decrease of the antenna gain caused by the electromagnetic influence of the human body can be suppressed during a telephone conversation.

[0170] According to the portable radio communication apparatus of the preferred embodiments mentioned above, a combination of (a) a first antenna and (b) a second antenna is provided in the vicinity of the hinge portion of the lower housing of the folding portable radio communication apparatus, where (a) the first antenna

is the antenna element 901 of the boom portion 910 connected at a position at which the antenna element 901 is substantially laterally symmetric relative to the width direction or the horizontal direction of the same apparatus, and (b) the second antenna includes, as the component, the upper housing or lower housing at least one part of which is made of the electrically conductive material. It is thereby possible to transmit and receive radio waves without using the conventional external antenna. Therefore, it is possible to solve such a conventional disadvantages that the external antenna is sometimes got stuck with his pocket when the portable radio communication apparatus is taken out from his pocket. In addition, since the penetrating hole 910h is formed in the space surrounded by the boom portion 910 and the lower housing 103, it is possible to suspend the portable radio communication apparatus from the neck of the user with the strap 910s attached to the boom portion 910. In this case, since it is unnecessary to use any conventional external antenna, the portable radio communication apparatus can be designed to be laterally symmetric, and the portable radio communication apparatus can be easily well balanced laterally or horizontally when the same apparatus is suspended from the neck of the user.

[0171] Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

Claims

1. A portable radio communication apparatus comprising a housing,

   wherein at least one part of at least one of said housing is formed as a housing electrical conductor portion by an electrically conductive material,

   wherein said housing electrical conductor portion is connected with a radio communication circuit of said portable radio communication apparatus so as to operate as at least one part of an antenna of said radio communication circuit, and

   wherein said portable radio communication apparatus further comprises a boom portion coupled with said housing at least at two positions so as to provide at least one penetrating hole between said housing and said boom portion.

2. The apparatus as claimed in claim 1,

   wherein said antenna is an unbalanced type antenna.

3. The apparatus as claimed in claim 1 or 2,

   wherein said portable radio communication apparatus is a straight type portable radio communication apparatus.

4. The apparatus as claimed in claim 1 or 2,

   wherein said portable radio communication apparatus is a slide type portable radio communication apparatus in which an upper housing and a lower housing are slidable through a sliding mechanism, and

   wherein at least one part of at least one of said upper housing and said lower housing is formed as a housing electrical conductor portion by an electrically conductive material.

5. The apparatus as claimed in claim 1 or 2,

   wherein said portable radio communication apparatus is a folding portable radio communication apparatus in which an upper housing and a lower housing are foldable through a hinge portion, and

   wherein at least one part of at least one of said upper housing and said lower housing is formed as a housing electrical conductor portion by an electrically conductive material.

6. The apparatus as claimed in any one of claims 1 to 5,

   wherein said housing electrical conductor portion is made by forming an electrical conductor layer on a dielectric housing which is at least one part of said housing.

7. The apparatus as claimed in claim 6,

   wherein said electrical conductor layer is made by forming an electrical conductor pattern on said dielectric housing.

8. The apparatus as claimed in claim 6,

   wherein said electrical conductor layer includes electrical conductor patterns different from each other on both surfaces of said dielectric housing, respectively, so that said antenna operates in a plurality of frequency bands.

9. The apparatus as claimed in any one of claims 6 to 8,

   wherein said electrical conductor layer includes a plurality of electrical conductor portions having electric lengths different from each other, respectively, so that said antenna operates in a plurality of frequency bands.

10. The apparatus as claimed in any one of claims 6 to 8, further comprising one of a slot and a slit which are formed in said electrical conductor layer.

11. The apparatus as claimed in any one of claims 4 to

10,

wherein said upper housing includes an upper first housing portion and an upper second housing portion, and

wherein at least one of said upper first housing portion and said upper second housing portion is formed as a housing electrical conductor portion by an electrically conductive material so that said housing electrical conductor portion operates as at least one part of the antenna of the portable radio communication apparatus.

12. The apparatus as claimed in any one of claims 4 to 10,

wherein said lower housing includes a lower first housing portion and a lower second housing portion, and

wherein at least one of said lower first housing portion and said lower second housing portion is formed as a housing electrical conductor portion by an electrically conductive material so that said housing electrical conductor portion operates as at least one part of the antenna of the portable radio communication apparatus.

13. The apparatus as claimed in any one of claims 5 to 12,

wherein at least one part of said hinge portion is formed as a hinge electrical conductor portion by an electrically conductive material, and

wherein said hinge electrical conductor portion is connected with the radio communication circuit of said portable radio communication apparatus so as to operate as at least one part of the antenna of said radio communication circuit.

14. The apparatus as claimed in any one of claims 5 to 12,

wherein at least one part of said hinge portion is formed as a hinge electrical conductor portion by an electrically conductive material so that said hinge electrical conductor portion operates as a parasitic element of the antenna of said radio communication circuit.

15. The apparatus as claimed in claim 13 or 14,

wherein said hinge portion is made to be rotatable in at least biaxial directions.

16. The apparatus as claimed in any one of claims 13 to 15, further comprising an electrically insulating layer formed on said hinge portion.

17. The apparatus as claimed in any one of claims 1 to 16, further comprising:

a plurality of reactance elements having a plurality of reactance values different from each other, respectively; and

a switching device for selectively switching over said plurality of reactance elements so as to connect selected one of said reactance elements with said housing electrical conductor portion.

18. The apparatus as claimed in any one of claims 13 to 16, further comprising:

a plurality of reactance elements having a plurality of reactance values different from each other, respectively; and

a switching device for selectively switching over said plurality of reactance elements so as to connect selected one of said reactance elements with said housing electrical conductor portion through said hinge electrical conductor portion.

19. The apparatus as claimed in claim 17 or 18,

wherein said switching device selectively switches over said plurality of reactance elements in accordance with whether said portable radio communication apparatus is in either one of an open state and a closed state thereof.

20. The apparatus as claimed in claim 17 or 18,

wherein said switching device selectively switches over said plurality of reactance elements in accordance with a plurality of operating frequency bands of said portable radio communication apparatus.

21. The apparatus as claimed in claim 17 or 18,

wherein said switching device selectively switches over said plurality of reactance elements in accordance with either one of transmission and receiving of said portable radio communication apparatus.

22. The apparatus as claimed in any one of claims 1 to 21,

wherein said housing electrical conductor portion is made of one of a dielectric material and a magnetic material, and

wherein said housing electrical conductor portion is connected with said radio communication circuit through an electrical insulator having a predetermined capacitance so that a radio signal from said radio communication circuit is fed through the capacitance of the electrical insulator to said housing electrical conductor portion.

23. The apparatus as claimed in any one of claims 1 to 22, further comprising a thin-film-shaped electrically insulating sheet formed on the upper housing having said housing electrical conductor portion,

said thin-film-shaped electrically insulating sheet being made of one of a dielectric material and a magnetic material.

24. The apparatus as claimed in any one of claims 1 to 23,

wherein said boom portion is coupled with said housing so as to be laterally symmetric relative to a width direction of said portable radio communication apparatus.

25. The apparatus as claimed in any one of claims 1 to 24,

wherein at least one part of said boom portion is made of an electrically conductive material.

26. The apparatus as claimed in any one of claims 1 to 24,

wherein at least one part of said boom portion is made of a flexible dielectric material.

27. The apparatus as claimed in any one of claims 1 to 26, further comprising at least one antenna element provided in said boom portion and connected with said radio communication circuit.

28. The apparatus as claimed in claim 27, further comprising a further switching device for selectively switching over between at least one antenna element connected with said radio communication circuit and said antenna including said housing conductor portion.

29. The apparatus as claimed in any one of claims 1 to 26, further comprising a plurality of antenna elements provided in said boom portion, said plurality of antenna elements being connected with said radio communication circuit, and having electric lengths different from each other, respectively.

30. The apparatus as claimed in any one of claims 1 to 28, further comprising an external antenna provided in said housing.

31. The apparatus as claimed in claim 30, further comprising a still further switching device for selectively switching over between said external antenna and the antenna including said housing conductor portion.

32. The apparatus as claimed in any one of claims 1 to 28, further comprising a built-in antenna provided in said housing.

33. The apparatus as claimed in claim 32, further comprising a still further switching device for selectively switching over between said built-in antenna and the antenna including said housing conductor portion.

Fig. 1A

FIRST PREFERRED EMBODIMENT

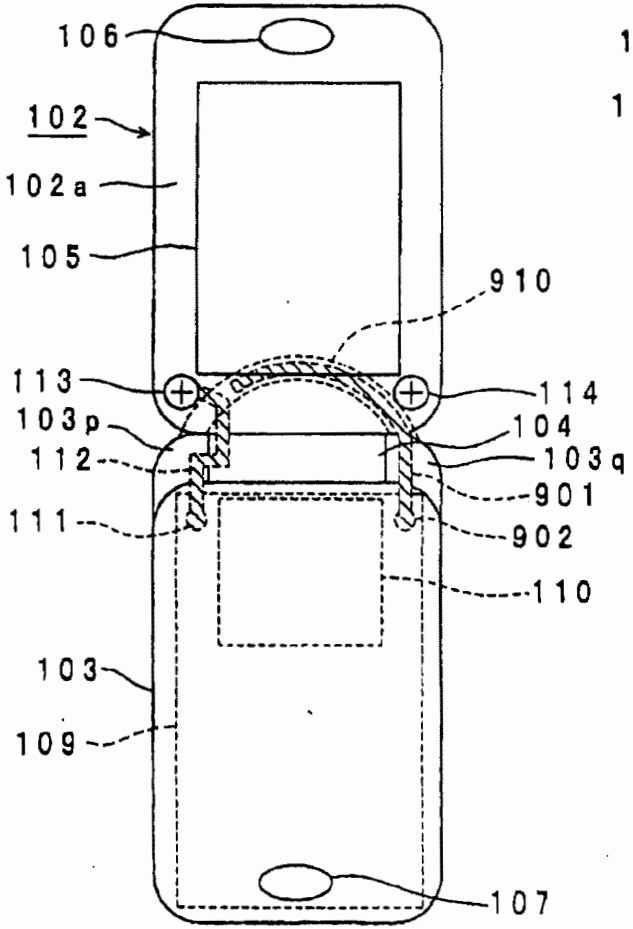


Fig. 1B

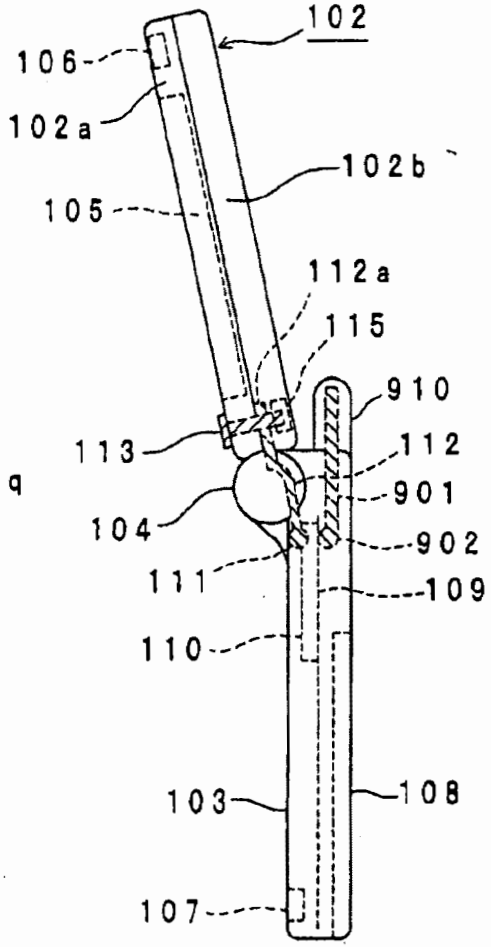


Fig. 1C

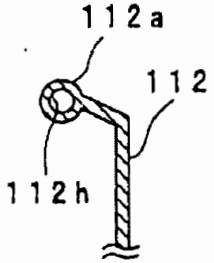


Fig. 2

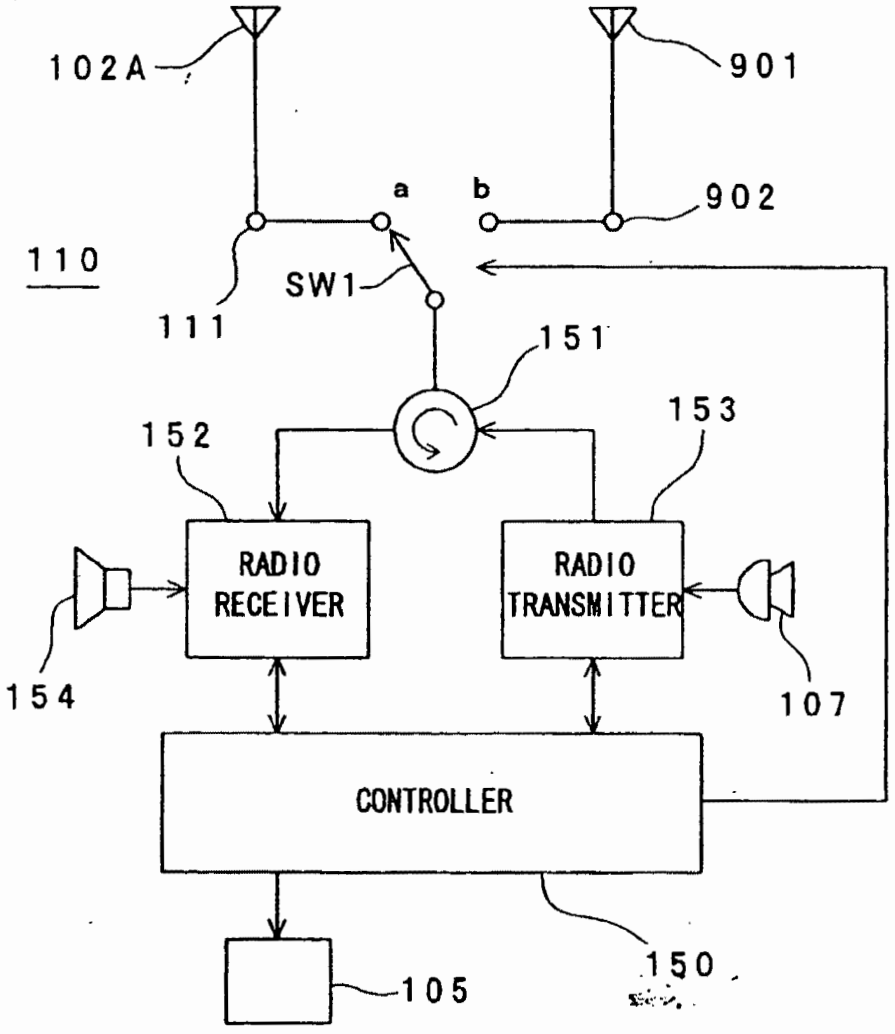

102A
901
a
b
902
110
SW1
111
151
153
152
RADIO RECEIVER
RADIO TRANSMITTER
154
107
CONTROLLER
105
150

Fig. 3A

FIRST MODIFIED PREFERRED EMBODIMENT
OF FIRST PREFERRED EMBODIMENT

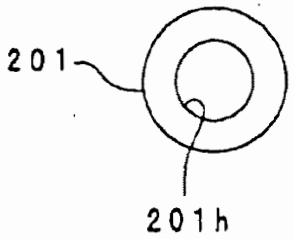


Fig. 3B

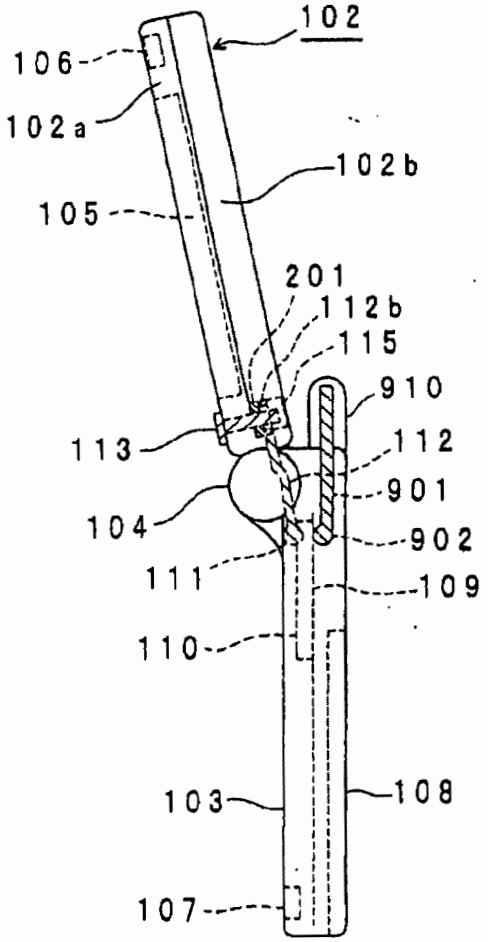


Fig. 4

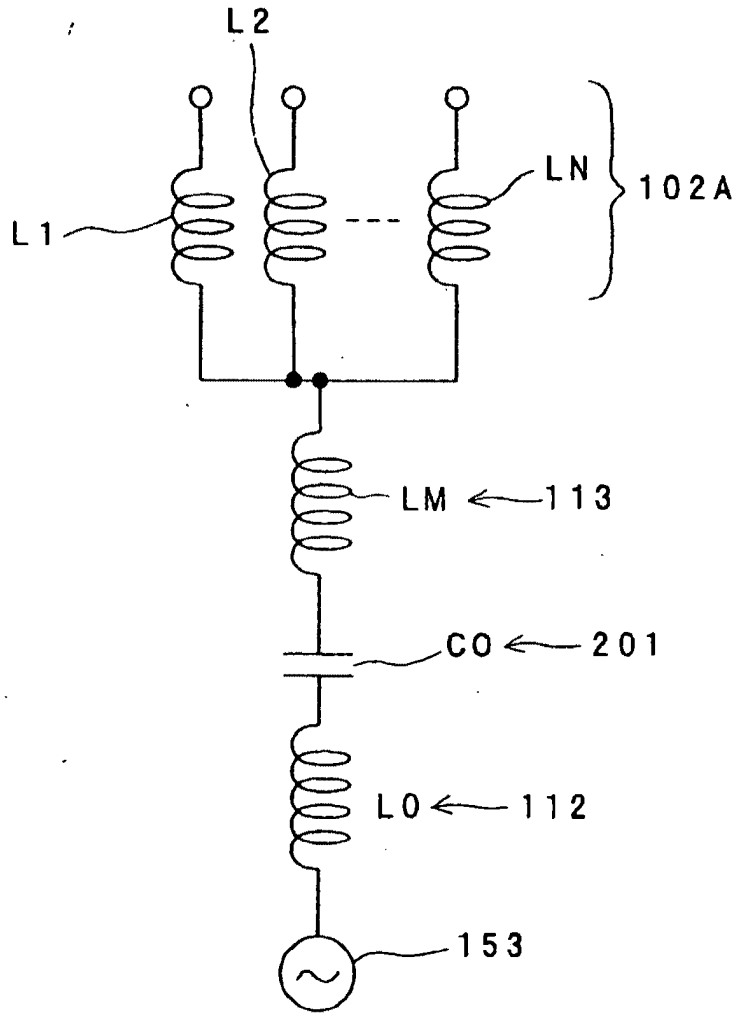


Fig. 5A

SECOND MODIFIED PREFERRED EMBODIMENT
OF FIRST PREFERRED EMBODIMENT

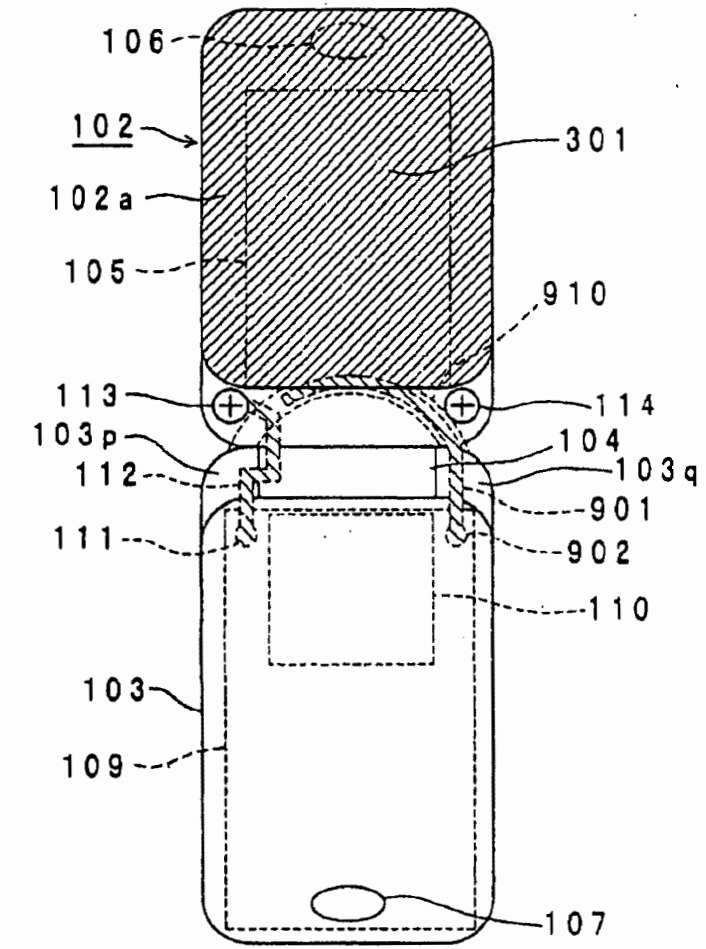


Fig. 5B

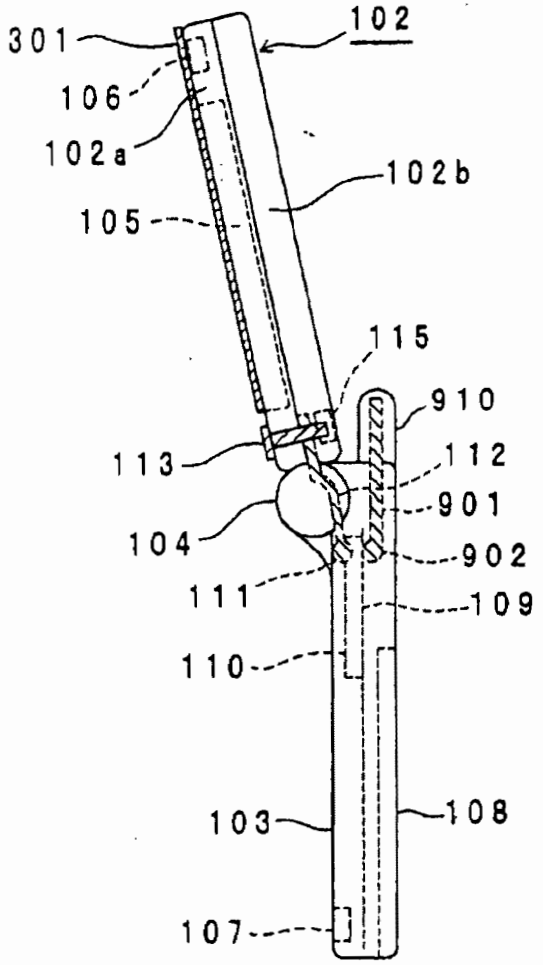


Fig. 6A

THIRD MODIFIED PREFERRED EMBODIMENT
OF FIRST PREFERRED EMBODIMENT

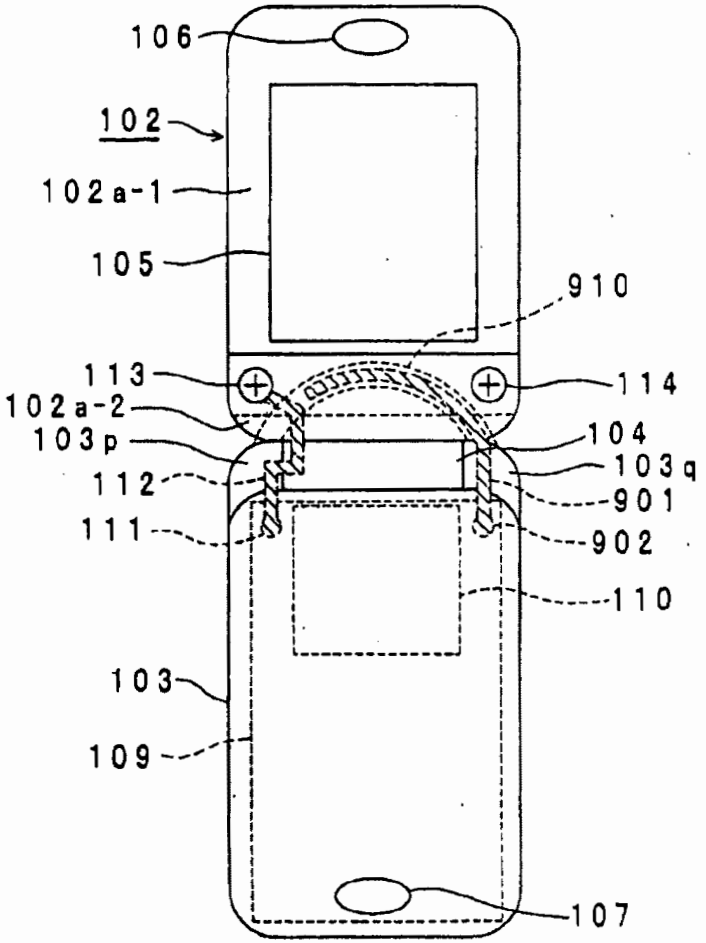


Fig. 6B

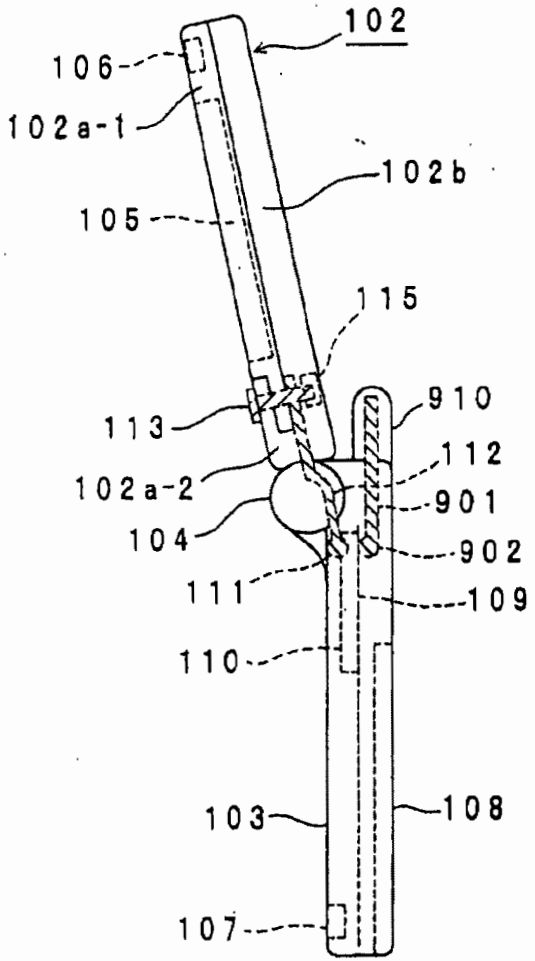


Fig. 7A

SECOND PREFERRED EMBODIMENT

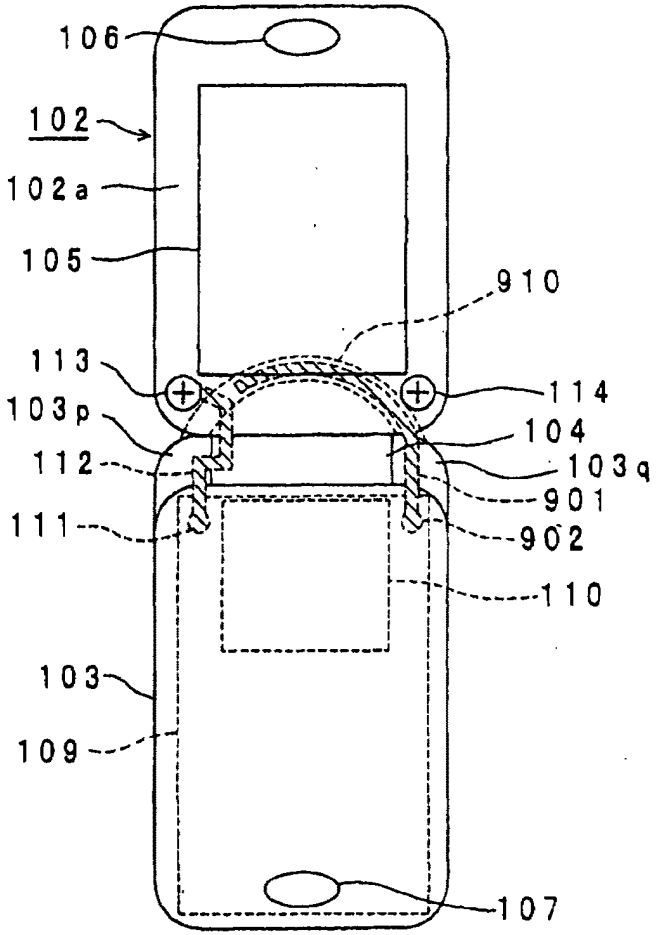


Fig. 7B

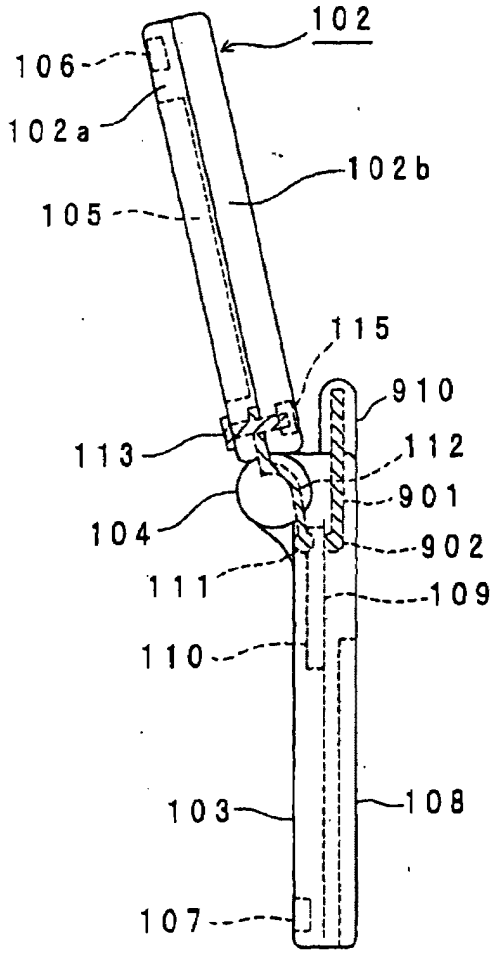


Fig. 8A

MODIFIED PREFERRED EMBODIMENT OF SECOND PREFERRED EMBODIMENT

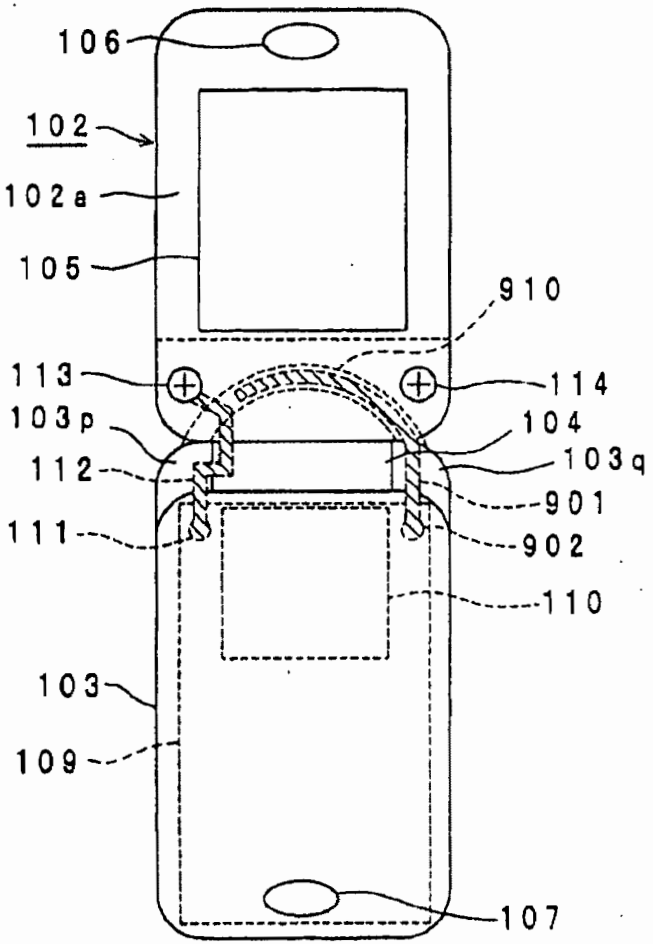


Fig. 8B

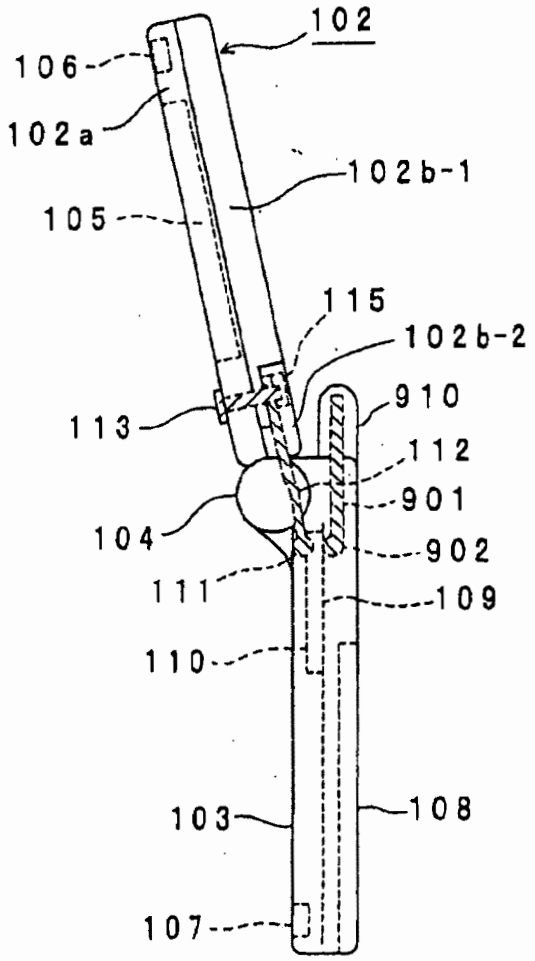


Fig. 9A

THIRD PREFERRED EMBODIMENT

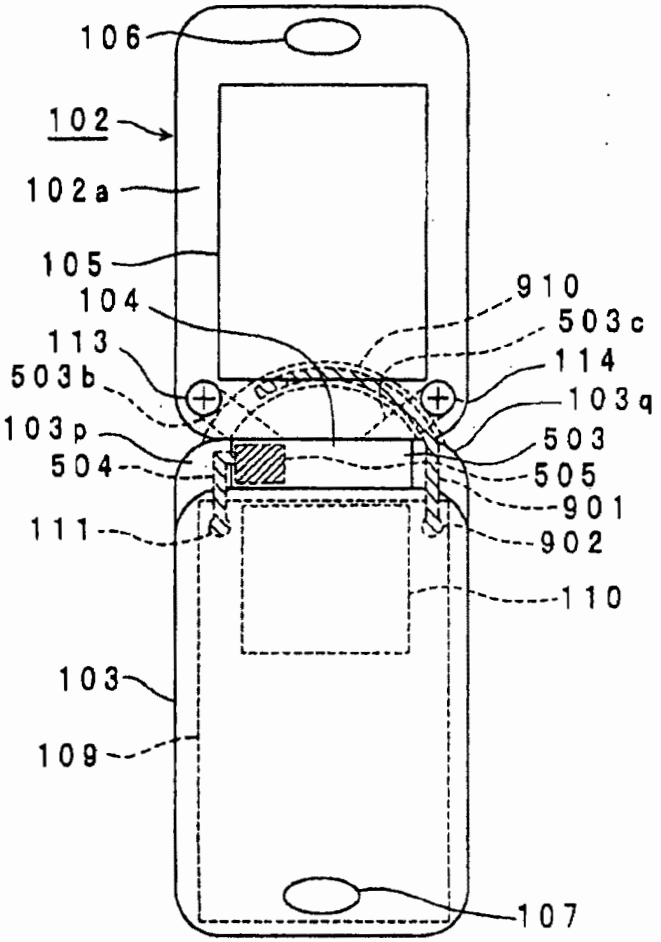


Fig. 9B

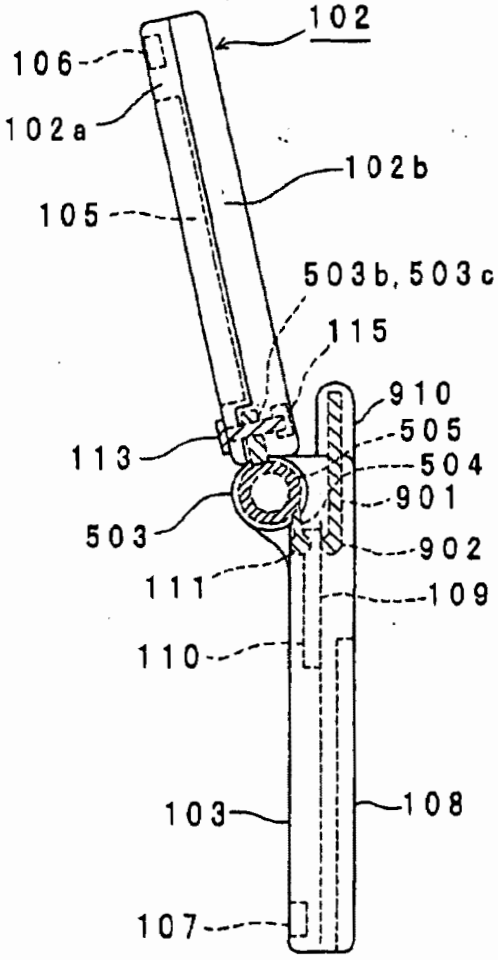


Fig. 10A

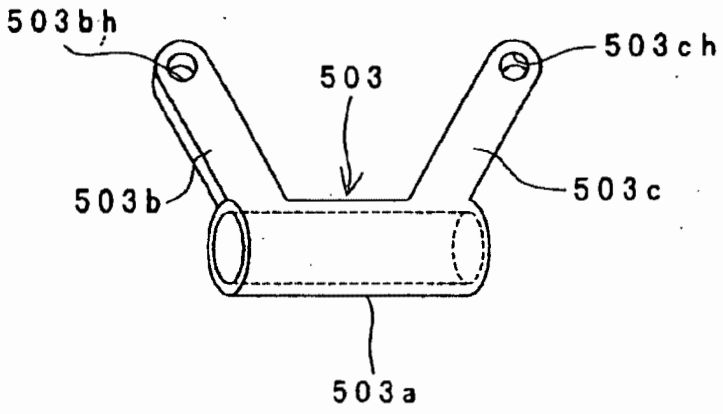


Fig. 10B

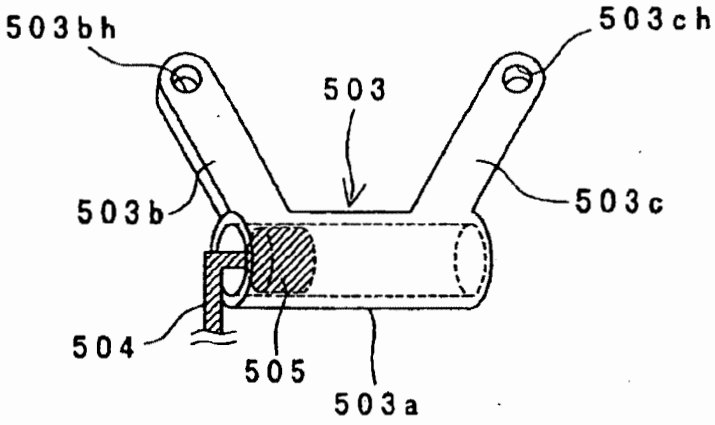


Fig. 11A

FOURTH PREFERRED EMBODIMENT

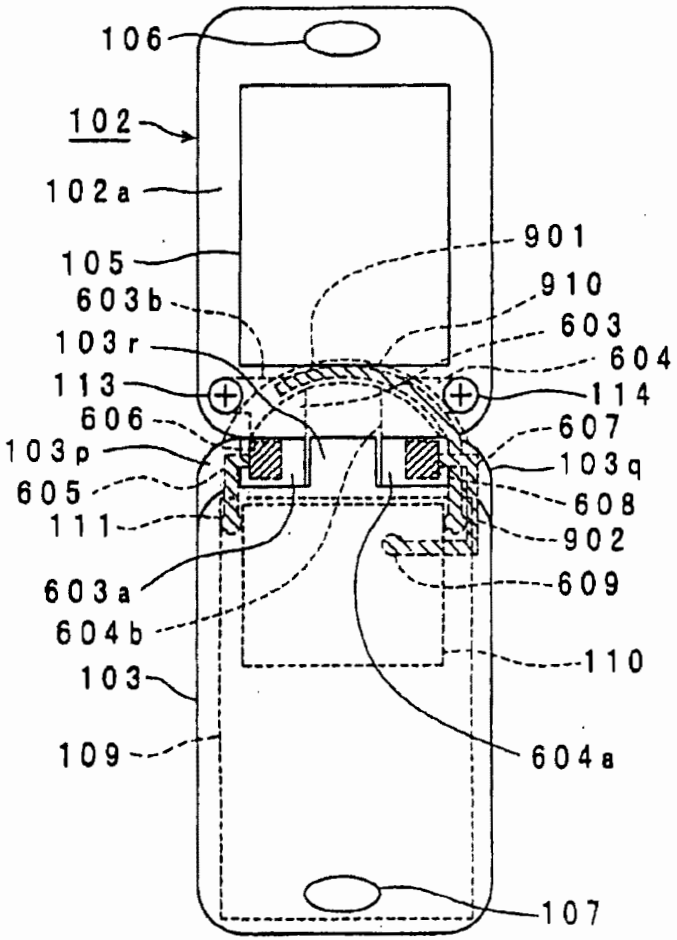


Fig. 11B

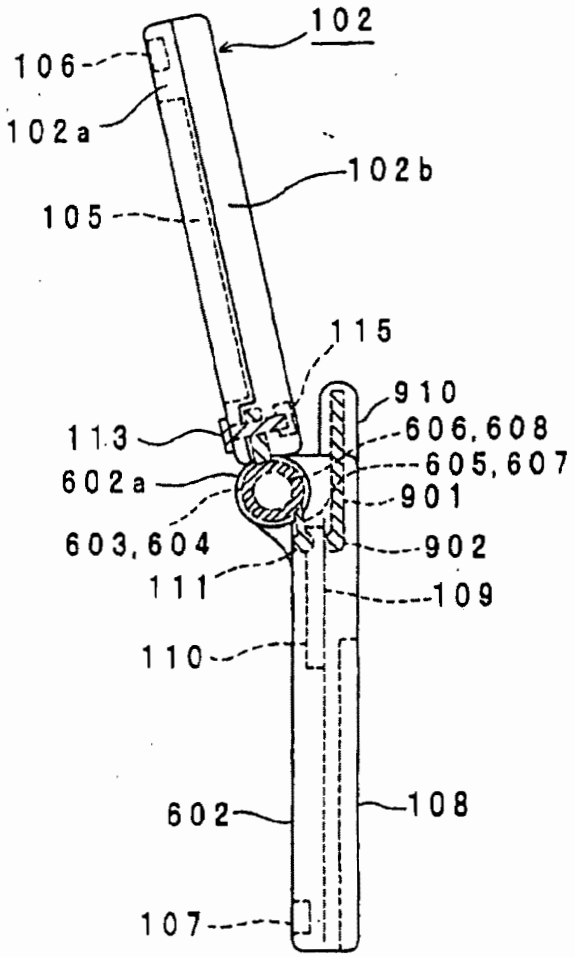


Fig. 12A

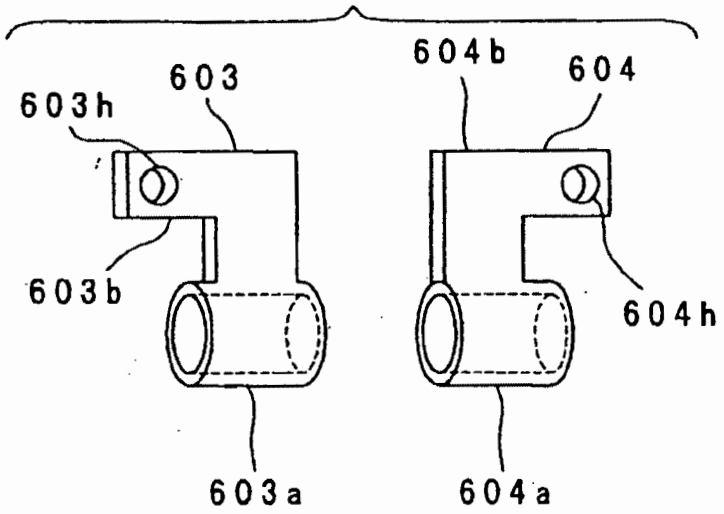


Fig. 12B

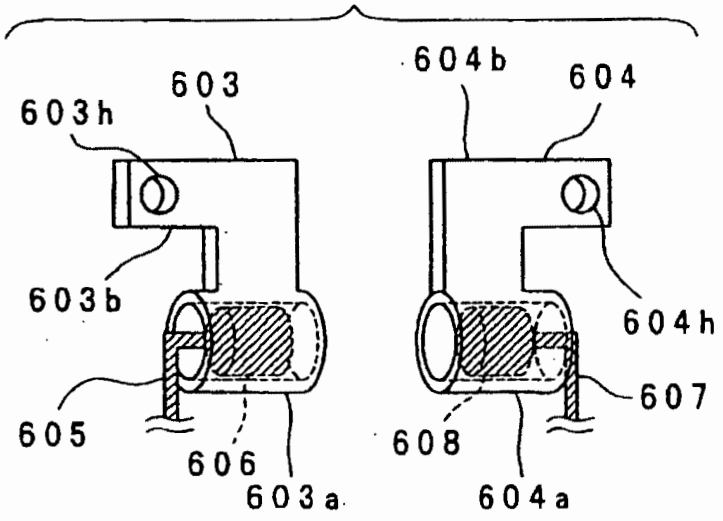


Fig. 13

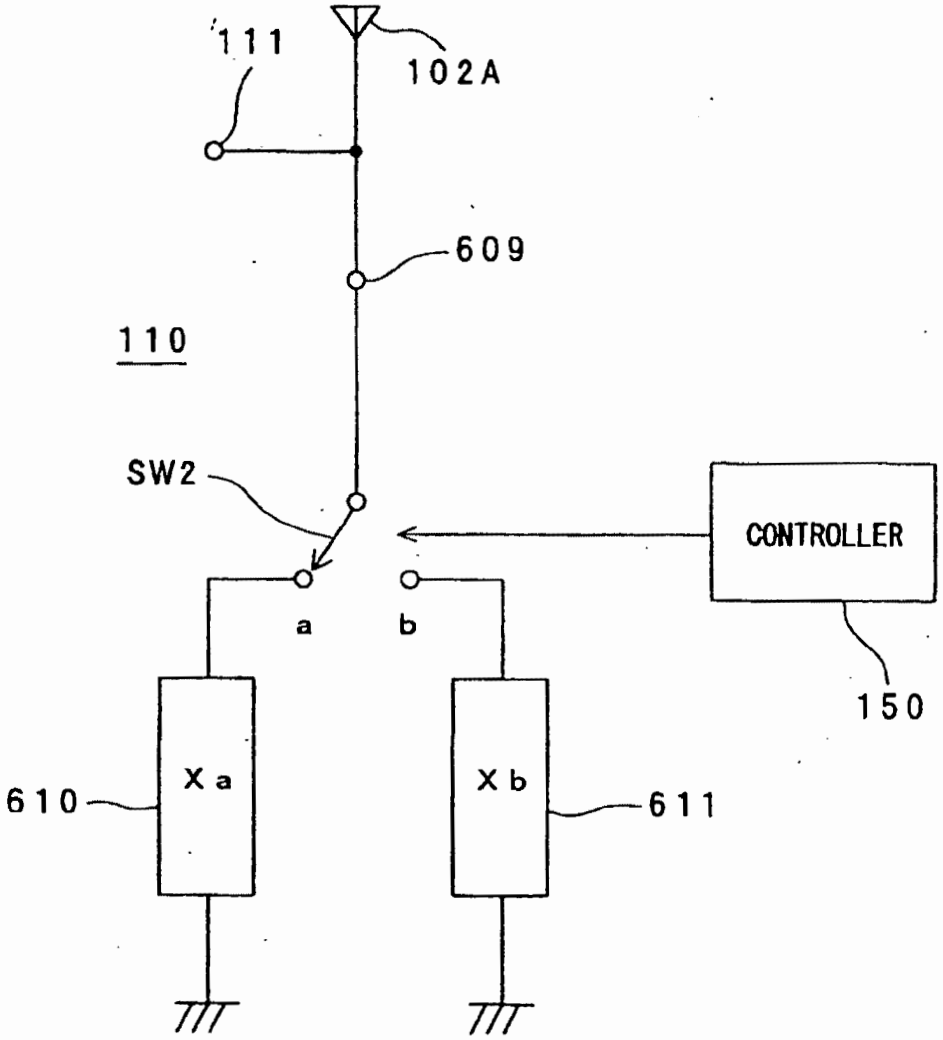


Fig. 14A

MODIFIED PREFERRED EMBODIMENT
OF FOURTH PREFERRED EMBODIMENT

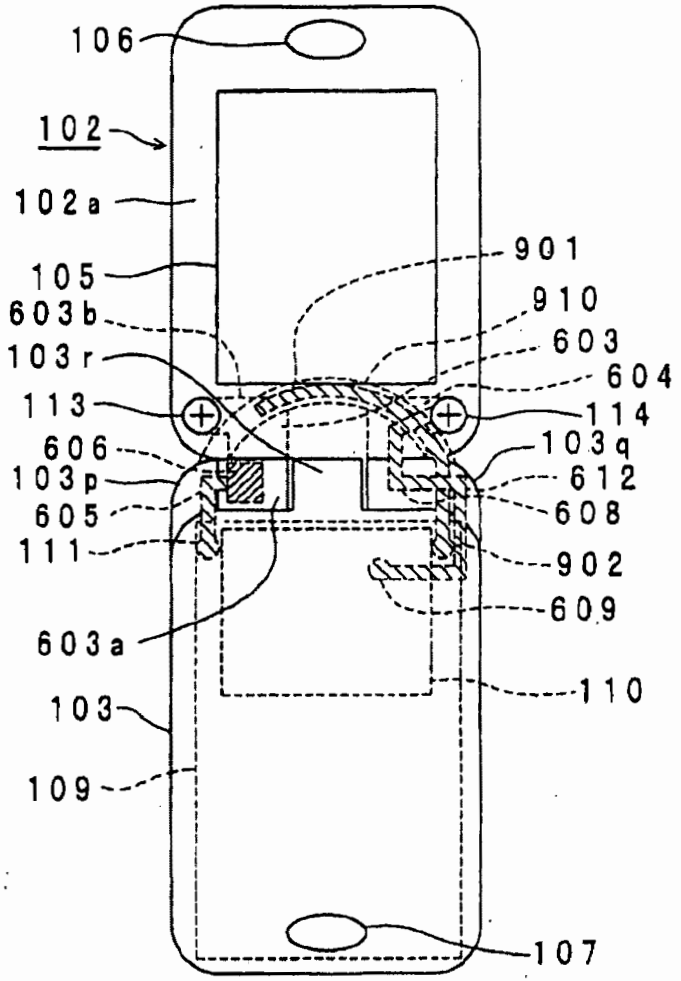


Fig. 14B

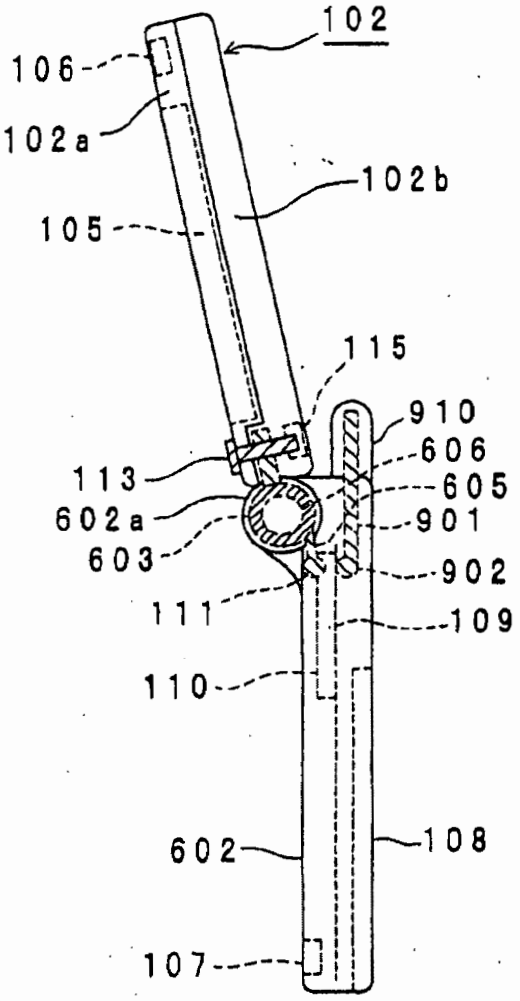


Fig. 15B

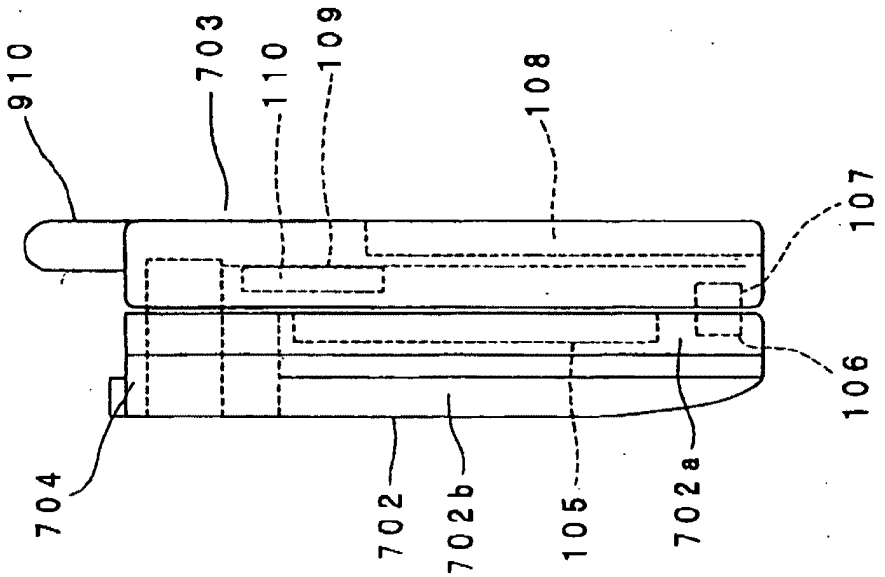


Fig. 15A

FIFTH PREFERRED EMBODIMENT

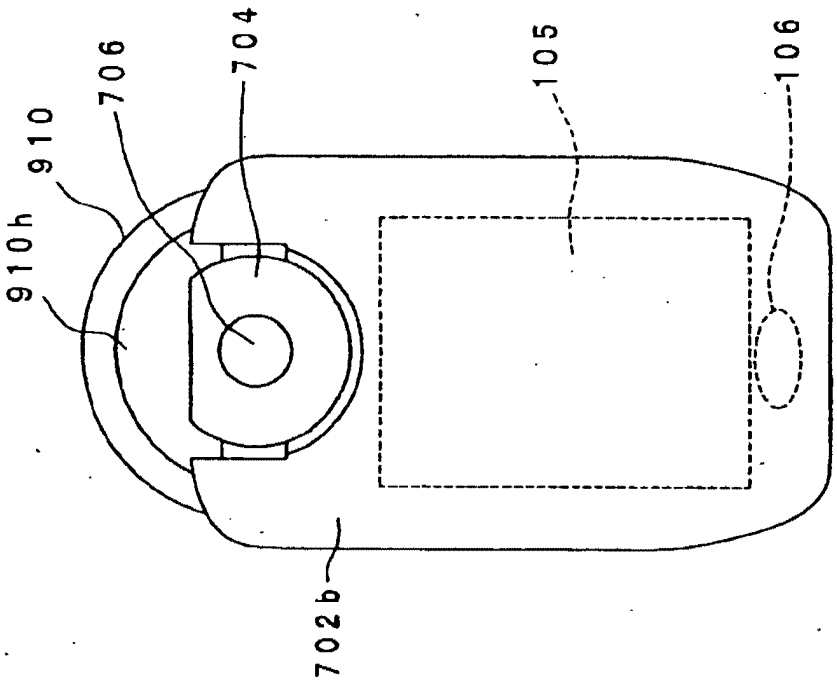


Fig. 16

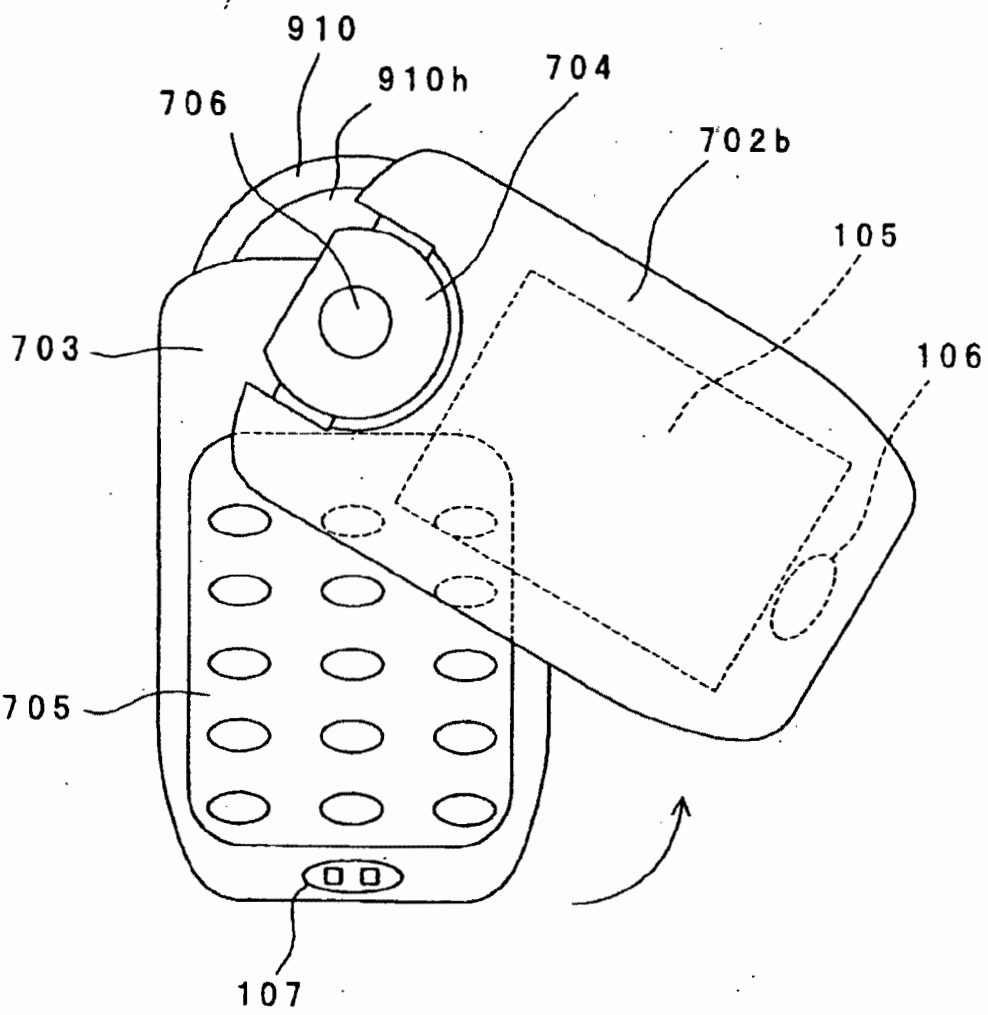


Fig. 17A

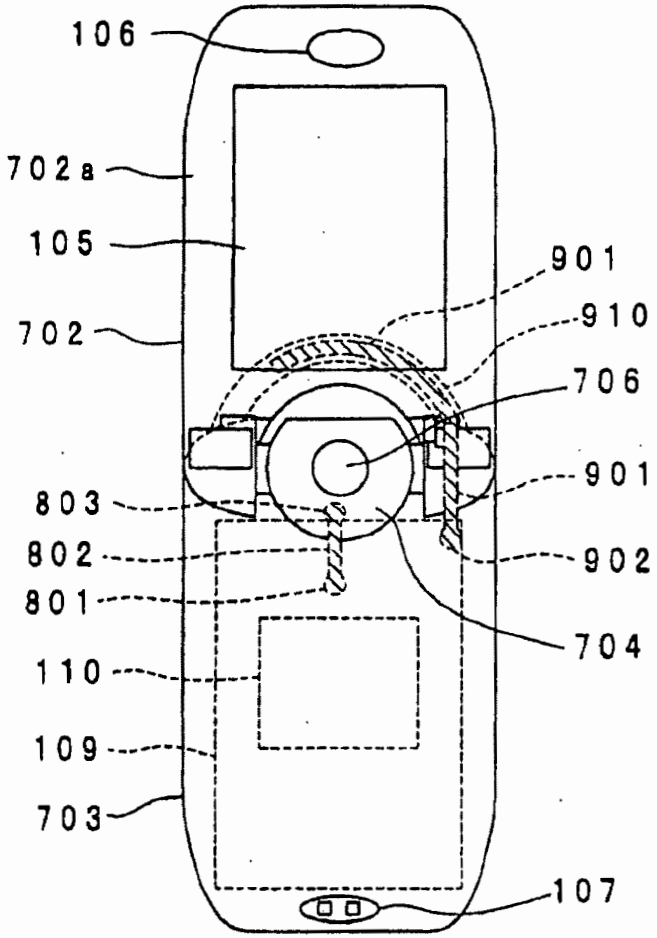


Fig. 17B

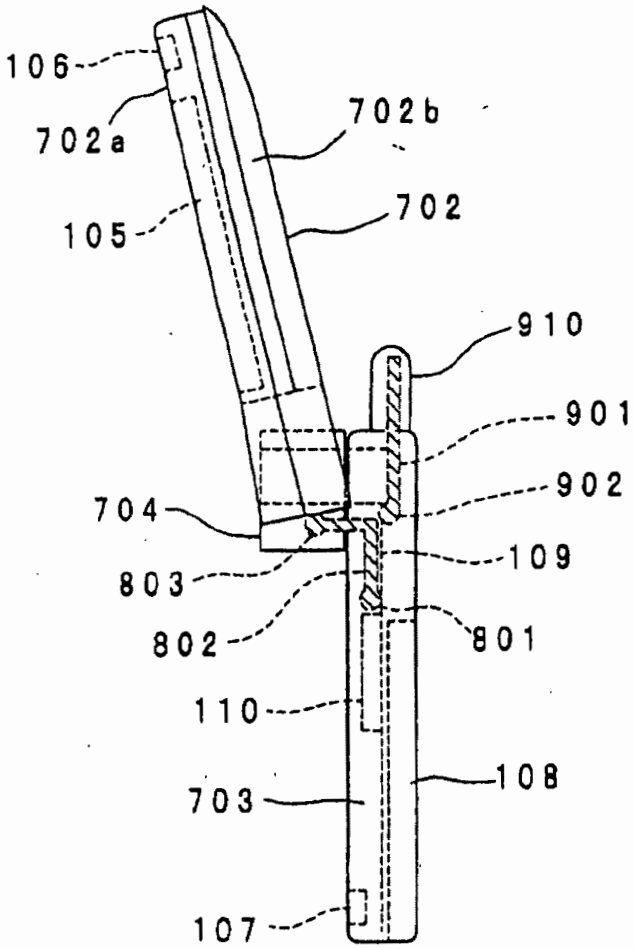


Fig. 18

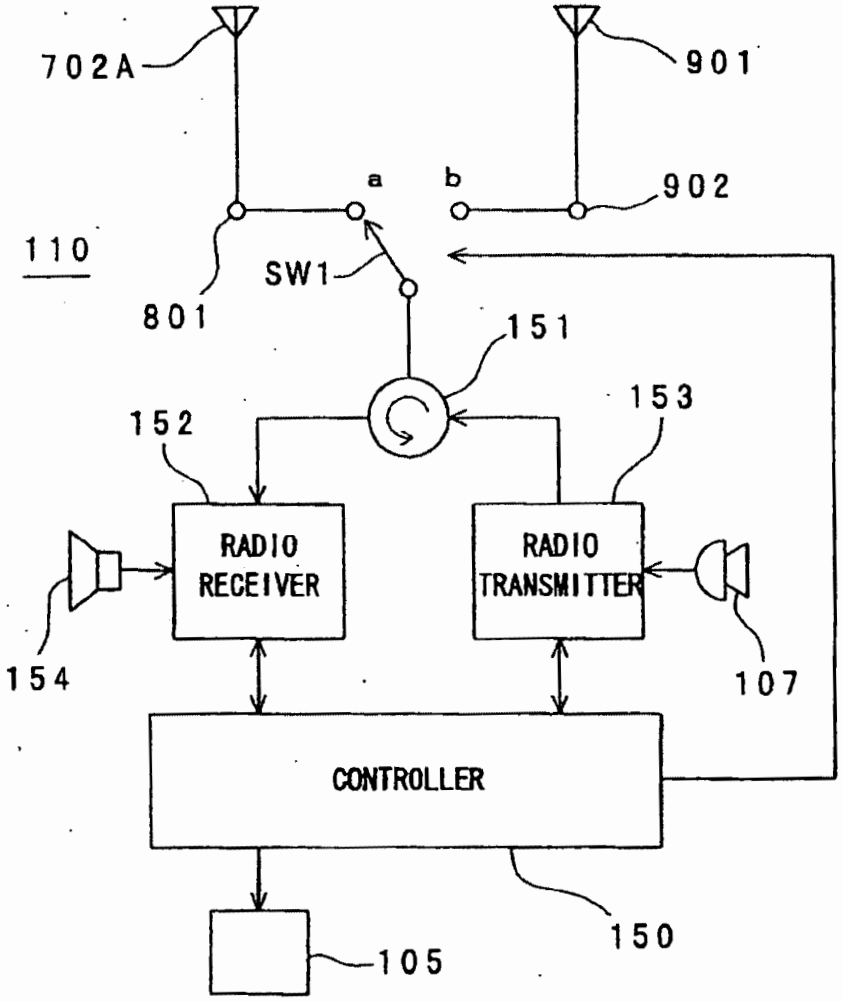

702A
901
a
b
902
110
SW1
801
151
153
152
RADIO RECEIVER
RADIO TRANSMITTER
154
107
CONTROLLER
150
105

Fig. 19A

MODIFIED PREFERRED EMBODIMENT OF
FIFTH PREFERRED EMBODIMENT

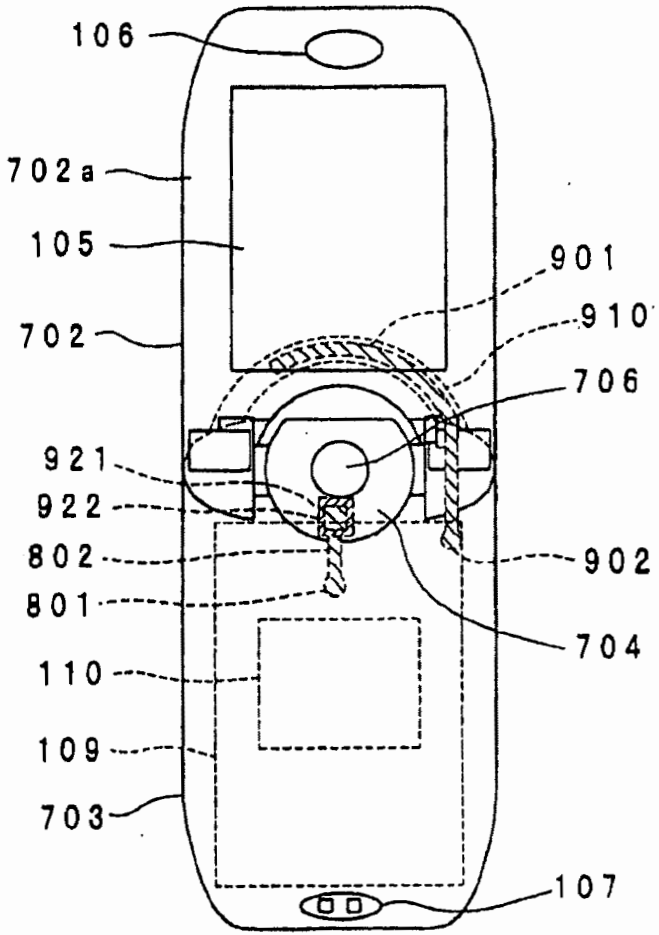


Fig. 19B

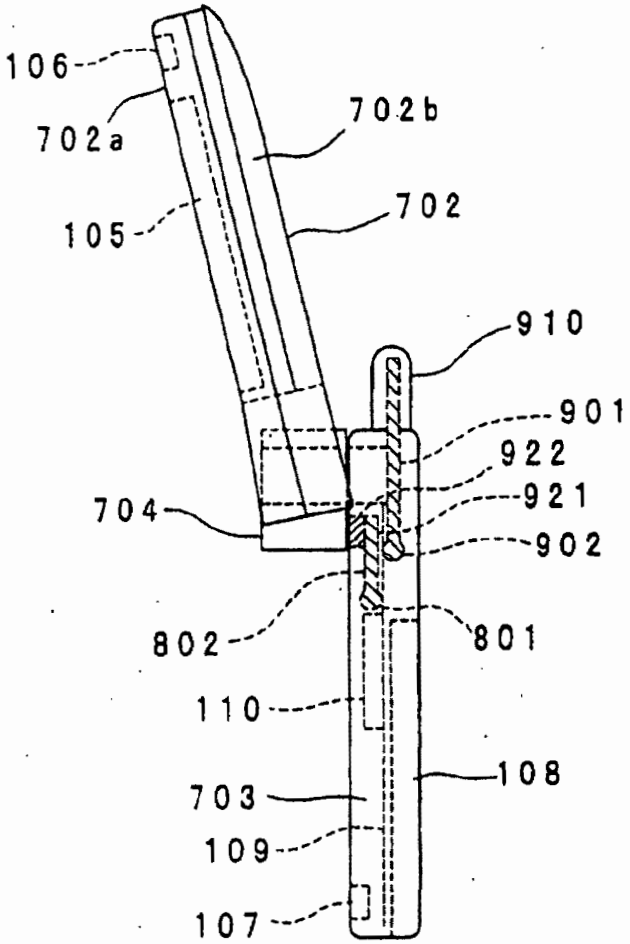


Fig. 20

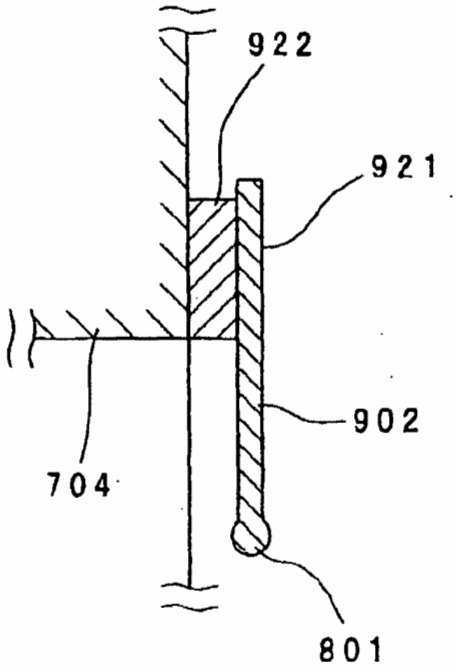


Fig. 21

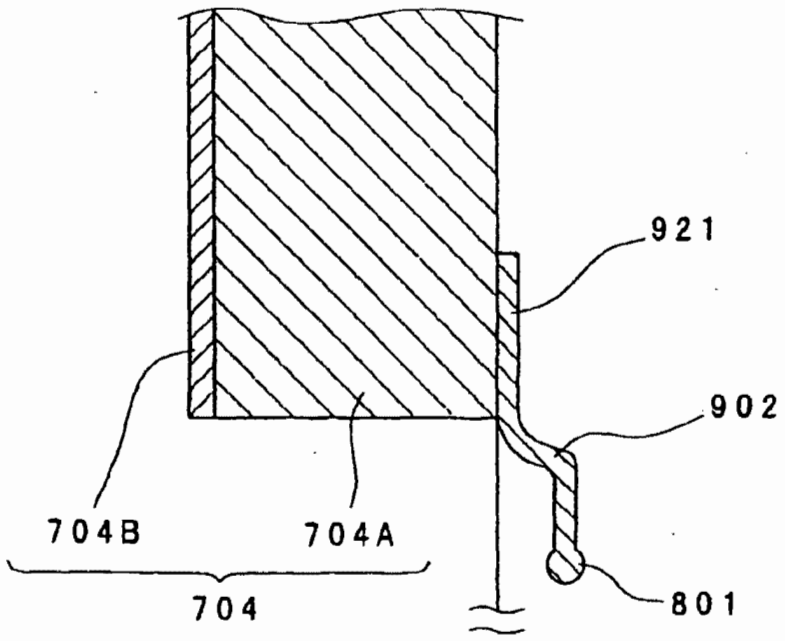


Fig. 22A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF FIRST IMPLEMENTAL EXAMPLE

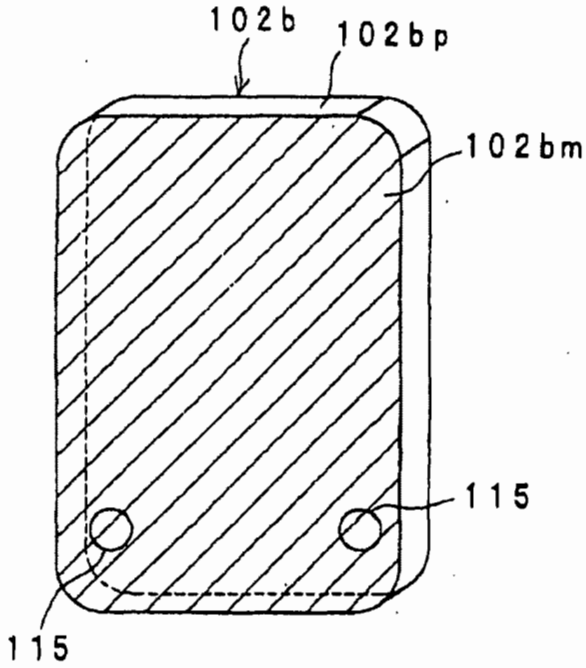


Fig. 22B

INNER SIDE SURFACE

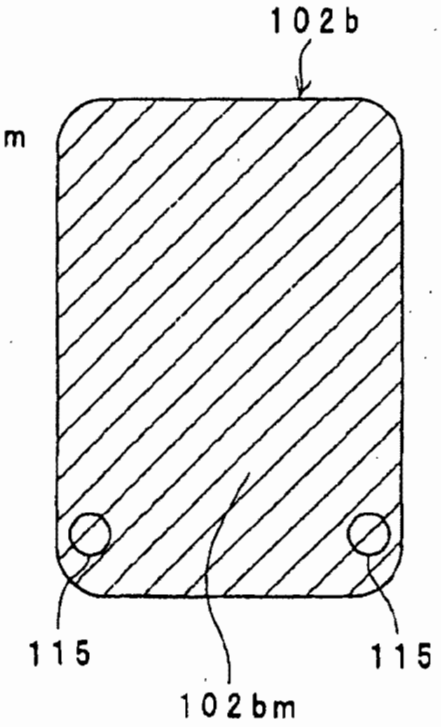


Fig. 22C

OUTER SIDE SURFACE

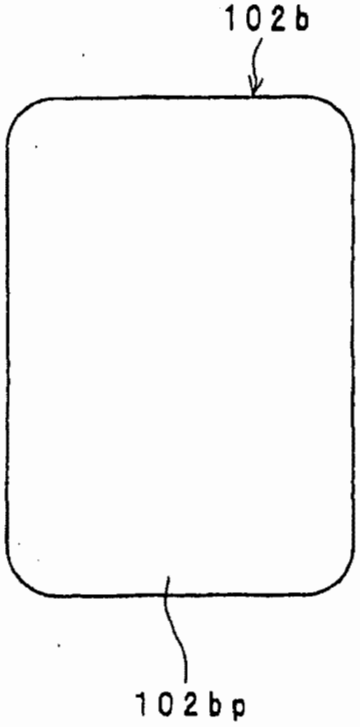


Fig. 23A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF SECOND IMPLEMENTAL EXAMPLE

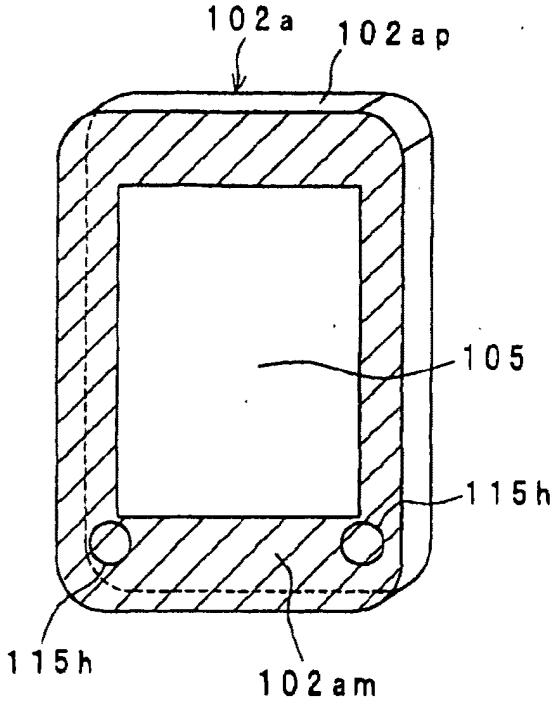


Fig. 23B

INNER SIDE SURFACE

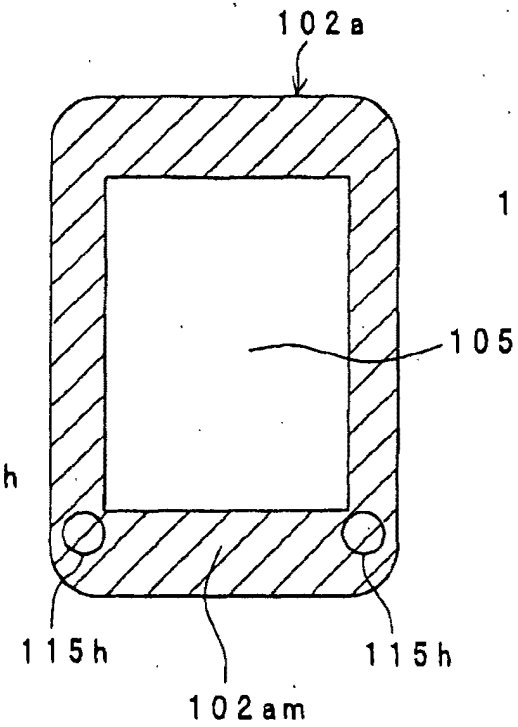


Fig. 23C

OUTER SIDE SURFACE

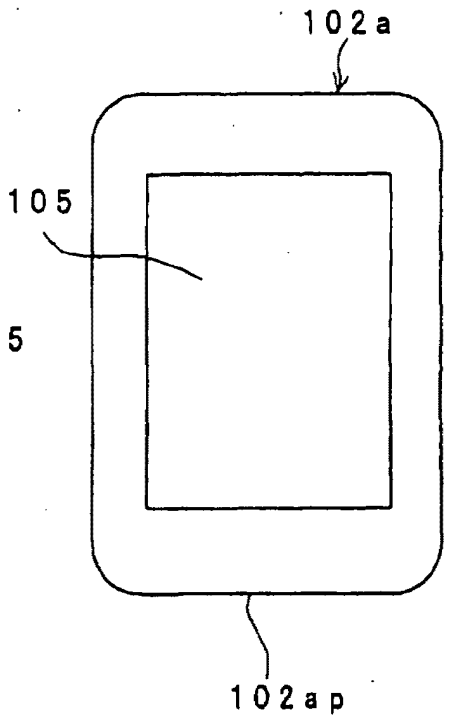


Fig. 24A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF THIRD IMPLEMENTAL EXAMPLE

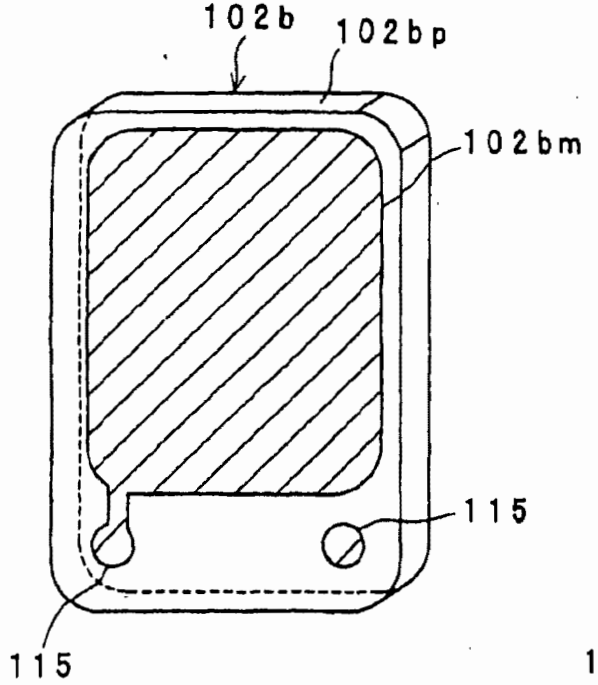


Fig. 24B

INNER SIDE SURFACE

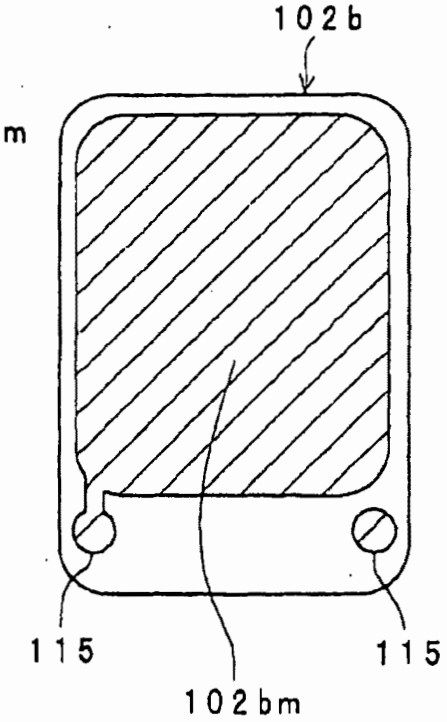


Fig. 24C

OUTER SIDE SURFACE

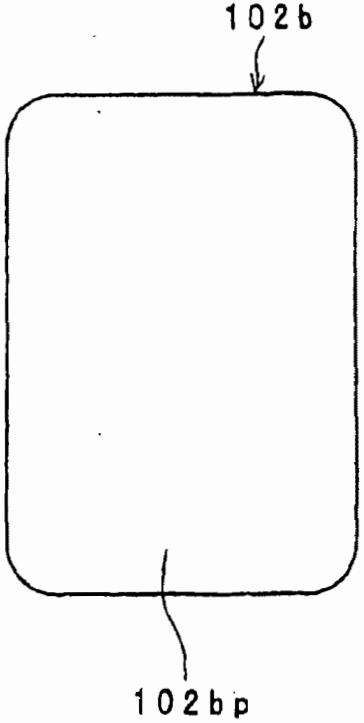


Fig. 25A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF FOURTH IMPLEMENTAL EXAMPLE

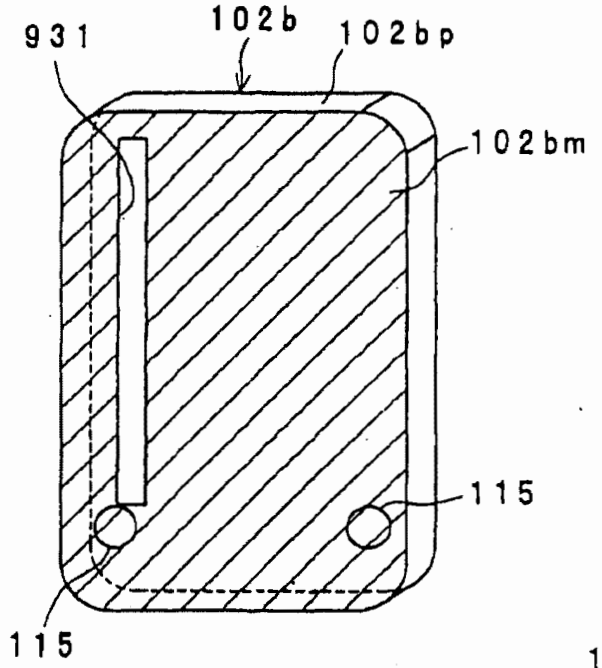


Fig. 25B

INNER SIDE SURFACE

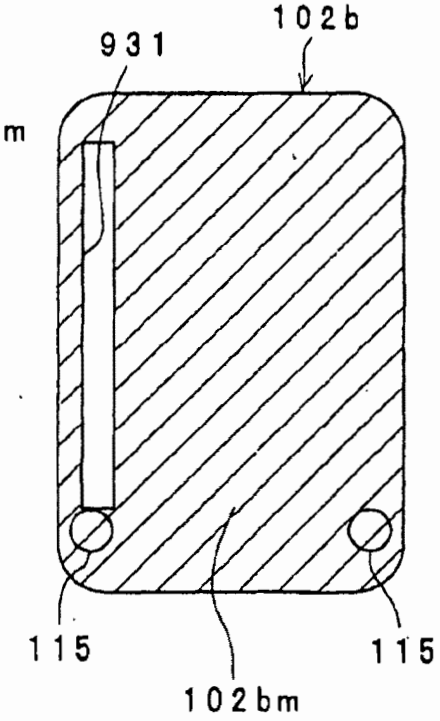


Fig. 25C

OUTER SIDE SURFACE

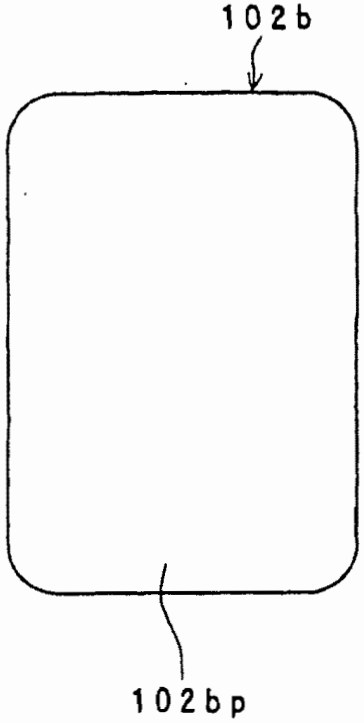


Fig. 26A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF FIFTH IMPLEMENTAL EXAMPLE

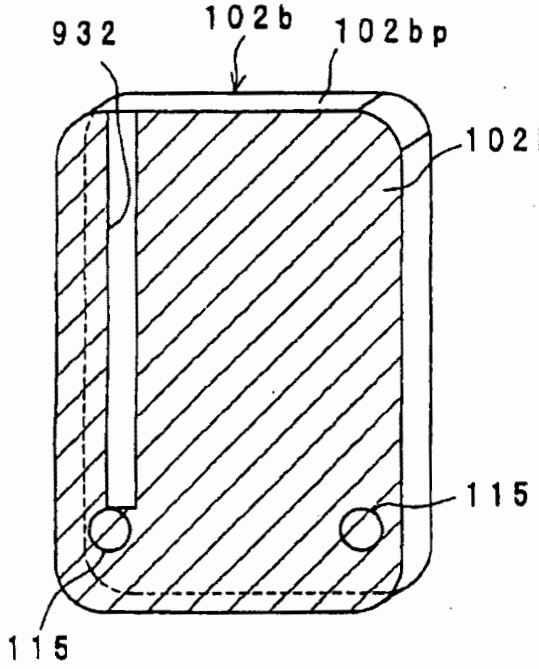


Fig. 26B

INNER SIDE SURFACE

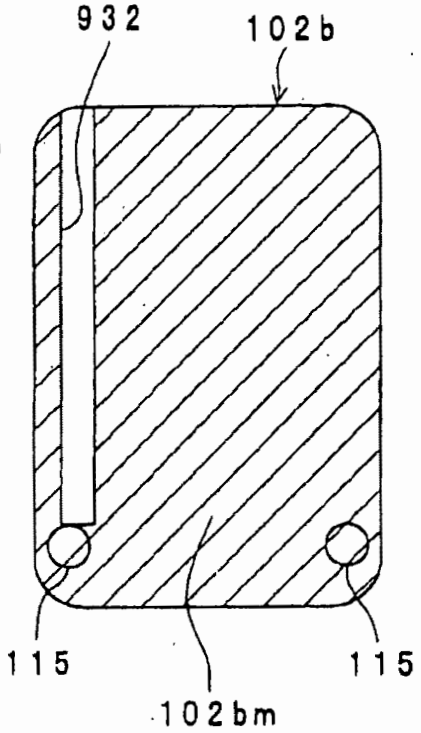


Fig. 26C

OUTER SIDE SURFACE

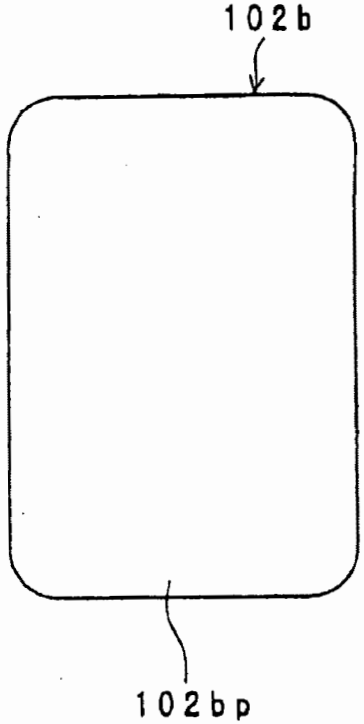


Fig. 27A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF SIXTH IMPLEMENTAL EXAMPLE

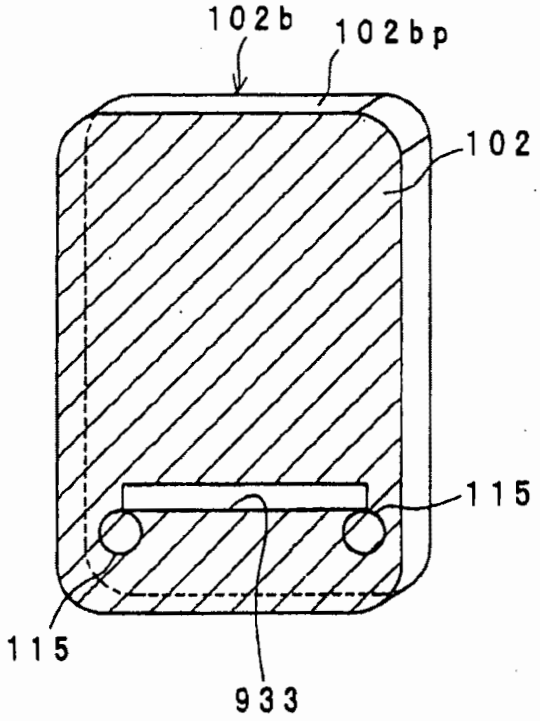


Fig. 27B

INNER SIDE SURFACE

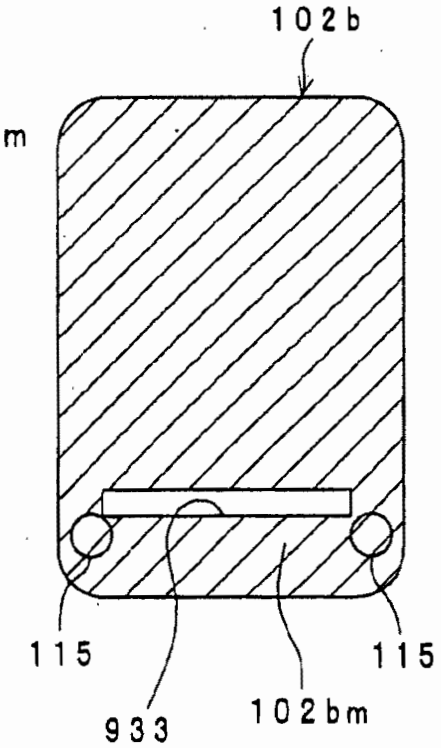


Fig. 27C

OUTER SIDE SURFACE

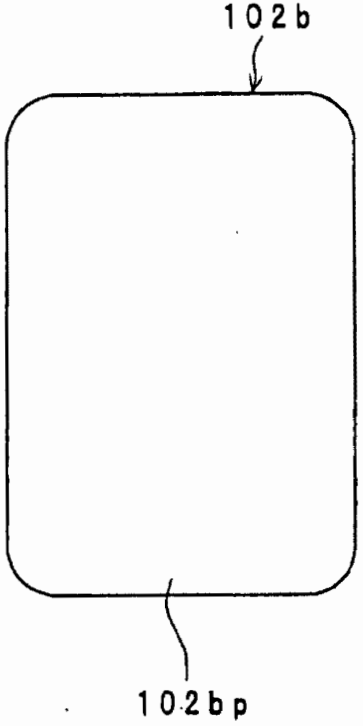


Fig. 28A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF SEVENTH IMPLEMENTAL EXAMPLE

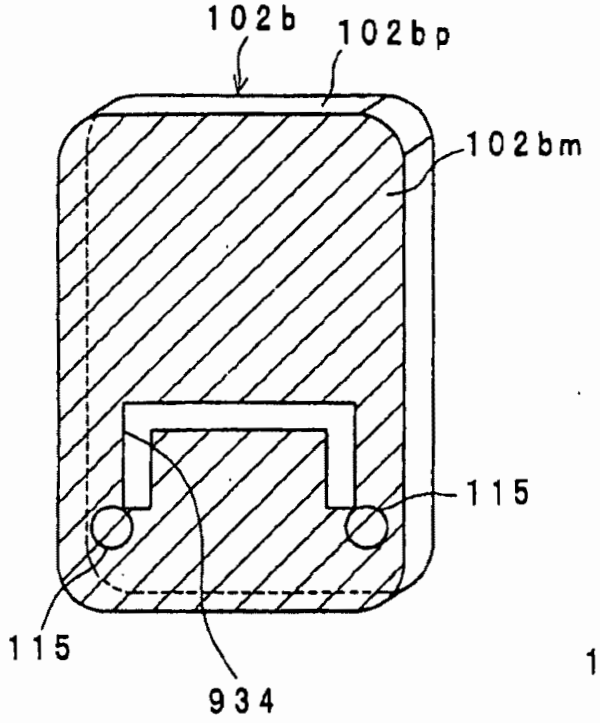


Fig. 28B

INNER SIDE SURFACE

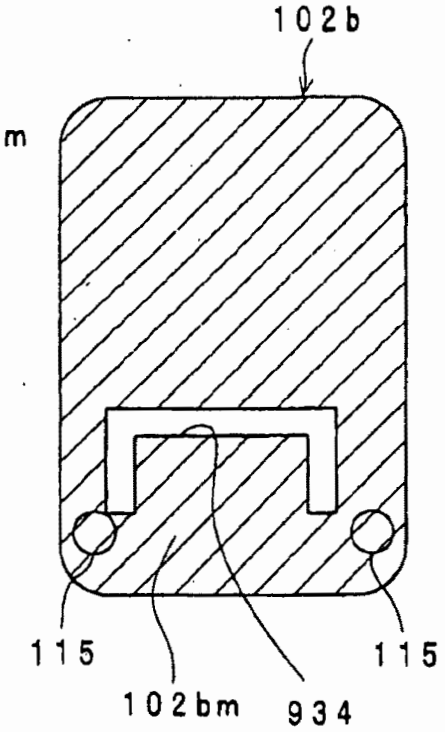


Fig. 28C

OUTER SIDE SURFACE

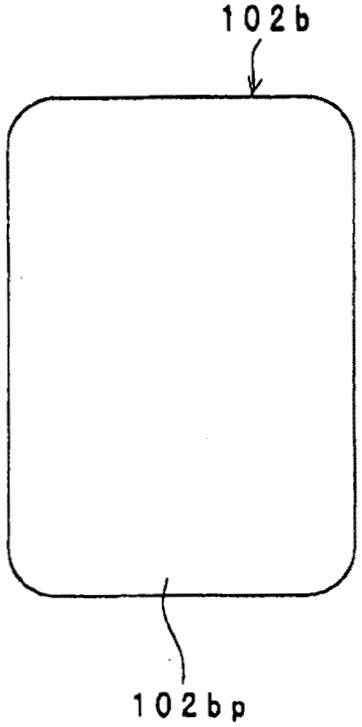


Fig. 29A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF EIGHTH IMPLEMENTAL EXAMPLE

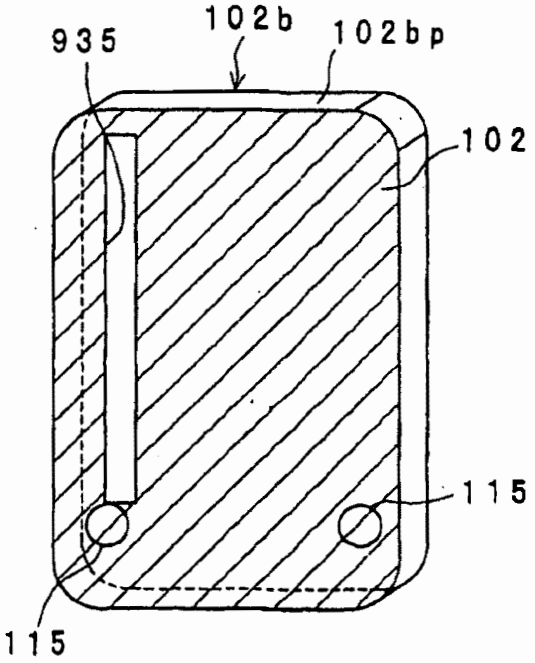


Fig. 29B

INNER SIDE SURFACE

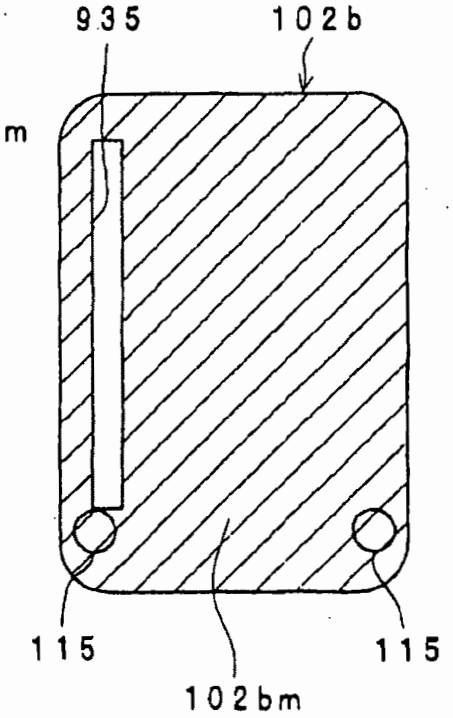


Fig. 29C

OUTER SIDE SURFACE

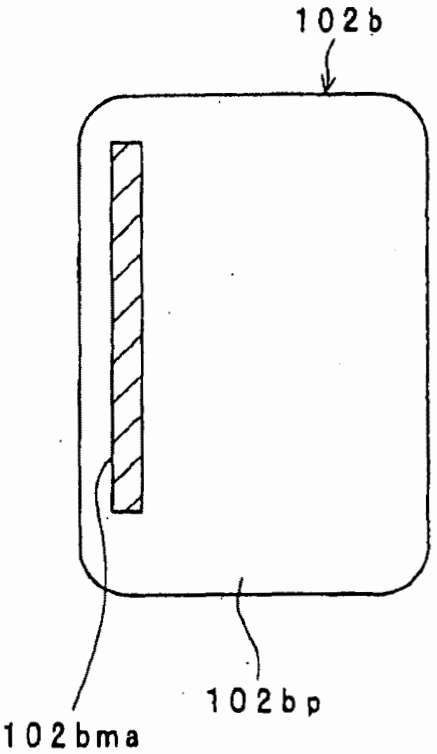


Fig. 30A

PERSPECTIVE VIEW SEEN FROM INNER SIDE SURFACE OF NINTH IMPLEMENTAL EXAMPLE

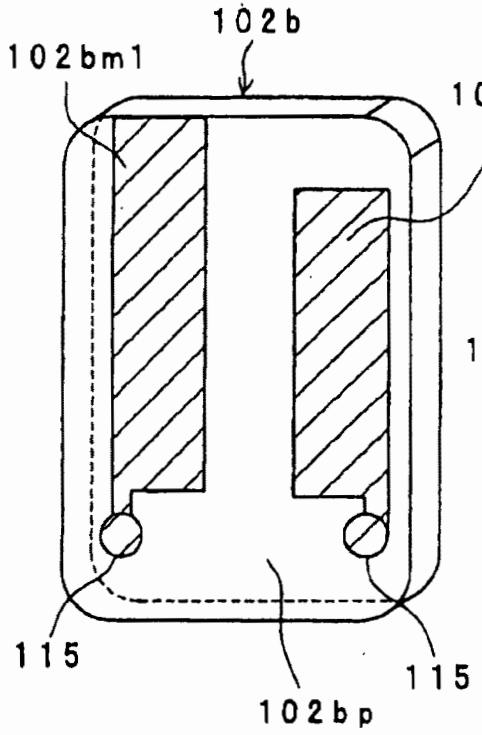


Fig. 30B

INNER SIDE SURFACE

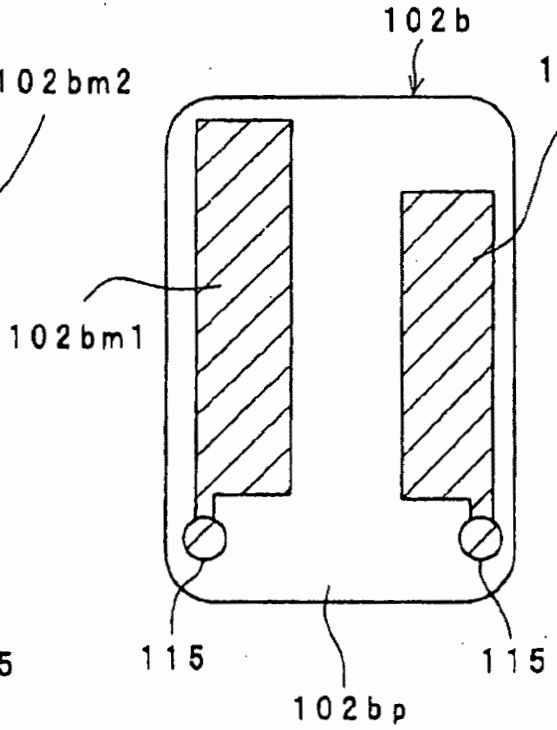


Fig. 30C

OUTER SIDE SURFACE

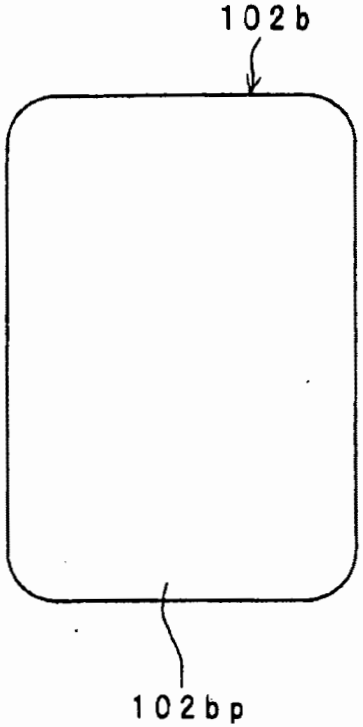


Fig. 31B

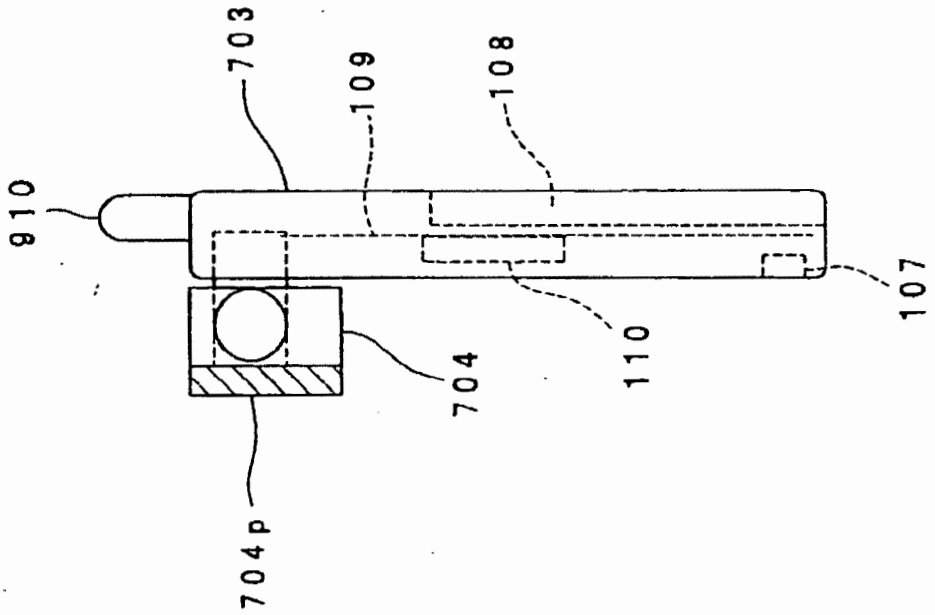


Fig. 31A

TENTH IMPLEMENTAL EXAMPLE

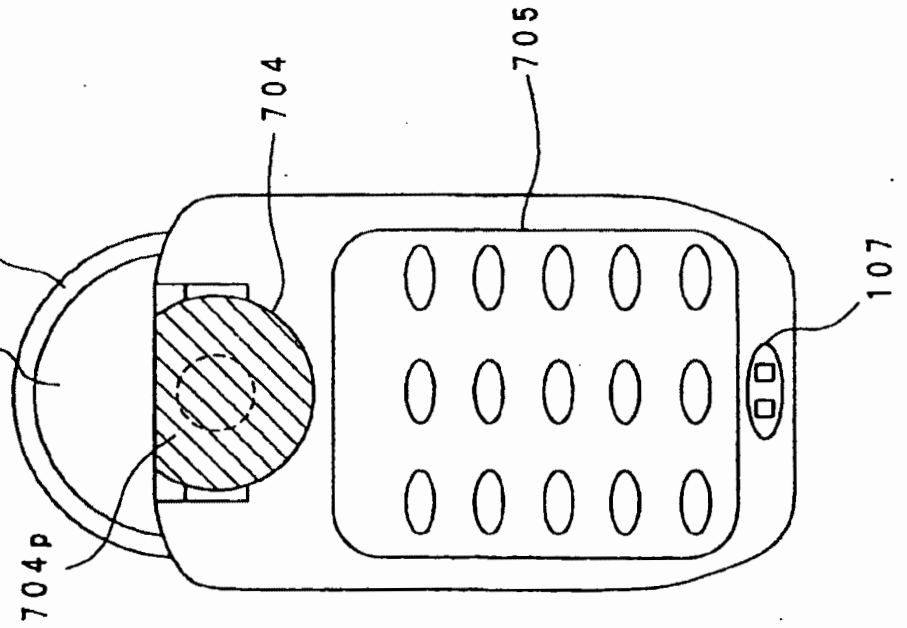


Fig. 32B

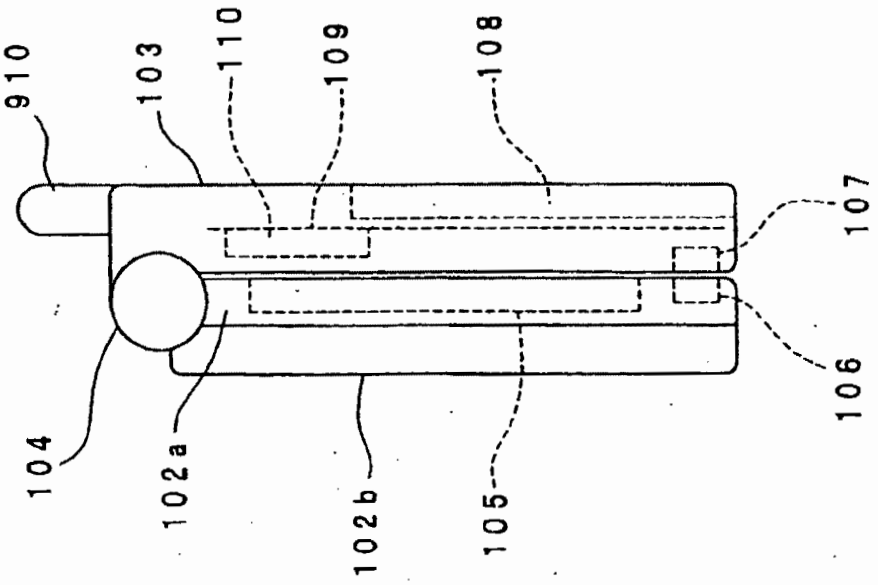


Fig. 32A

SIXTH PREFERRED EMBODIMENT

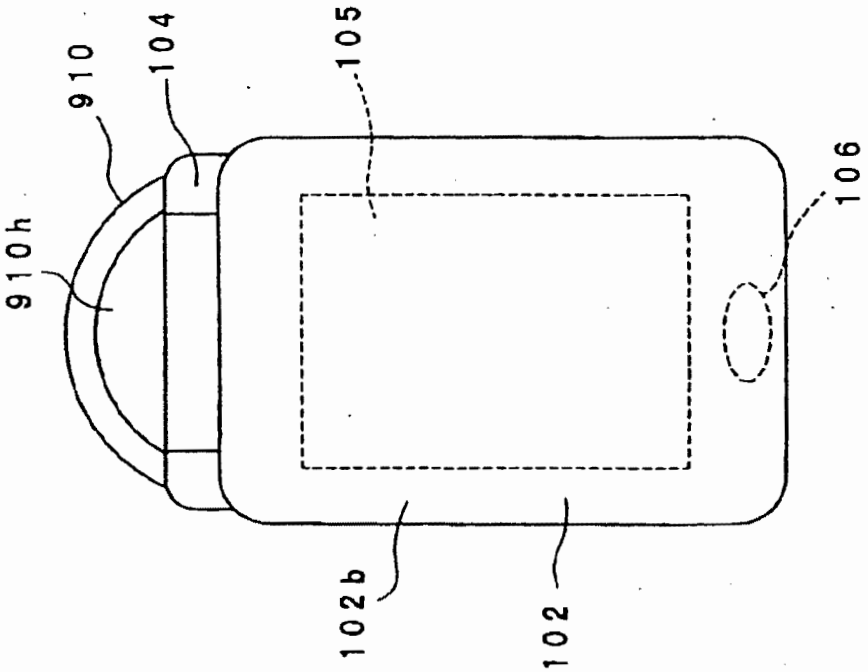


Fig. 33A

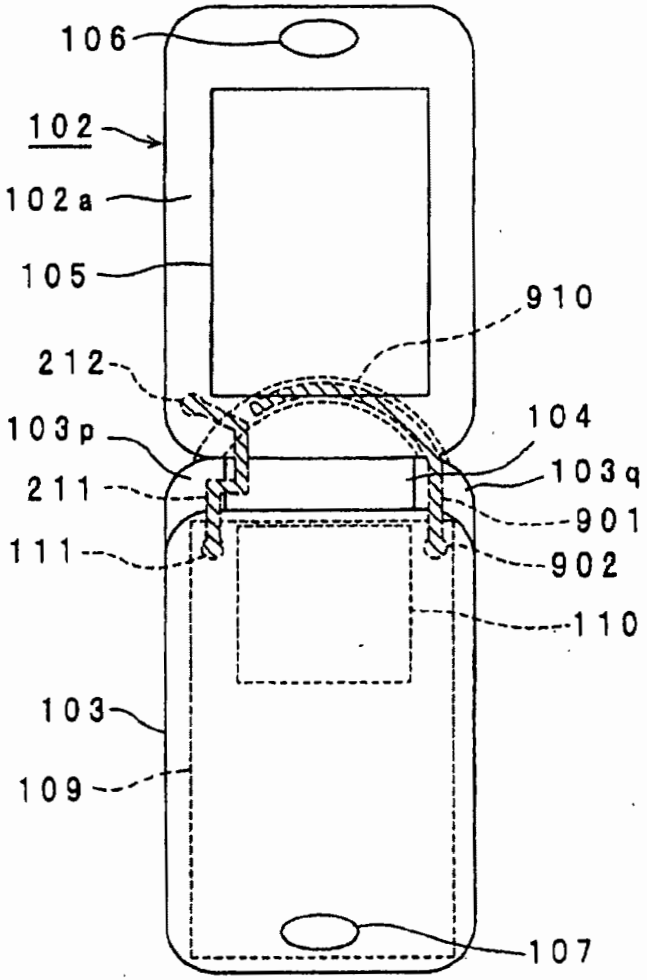


Fig. 33B

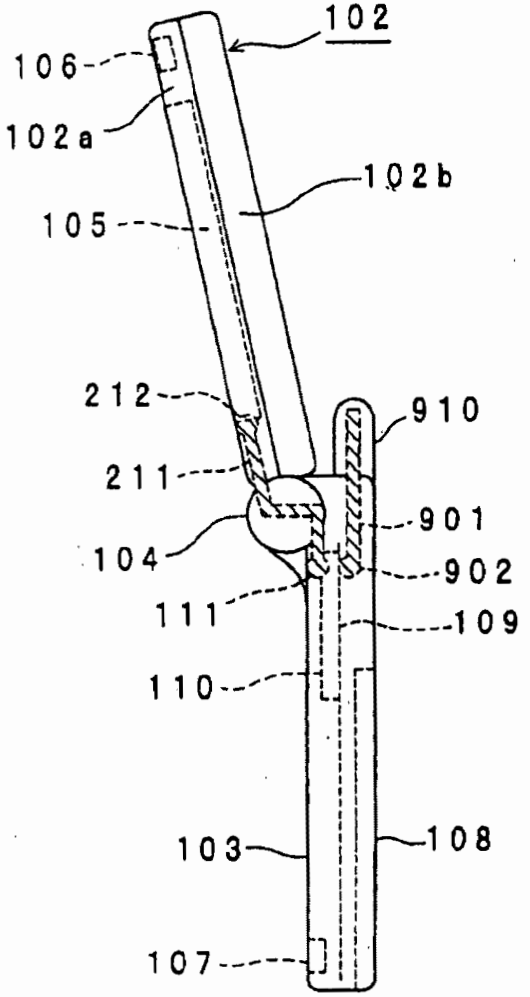


Fig. 34

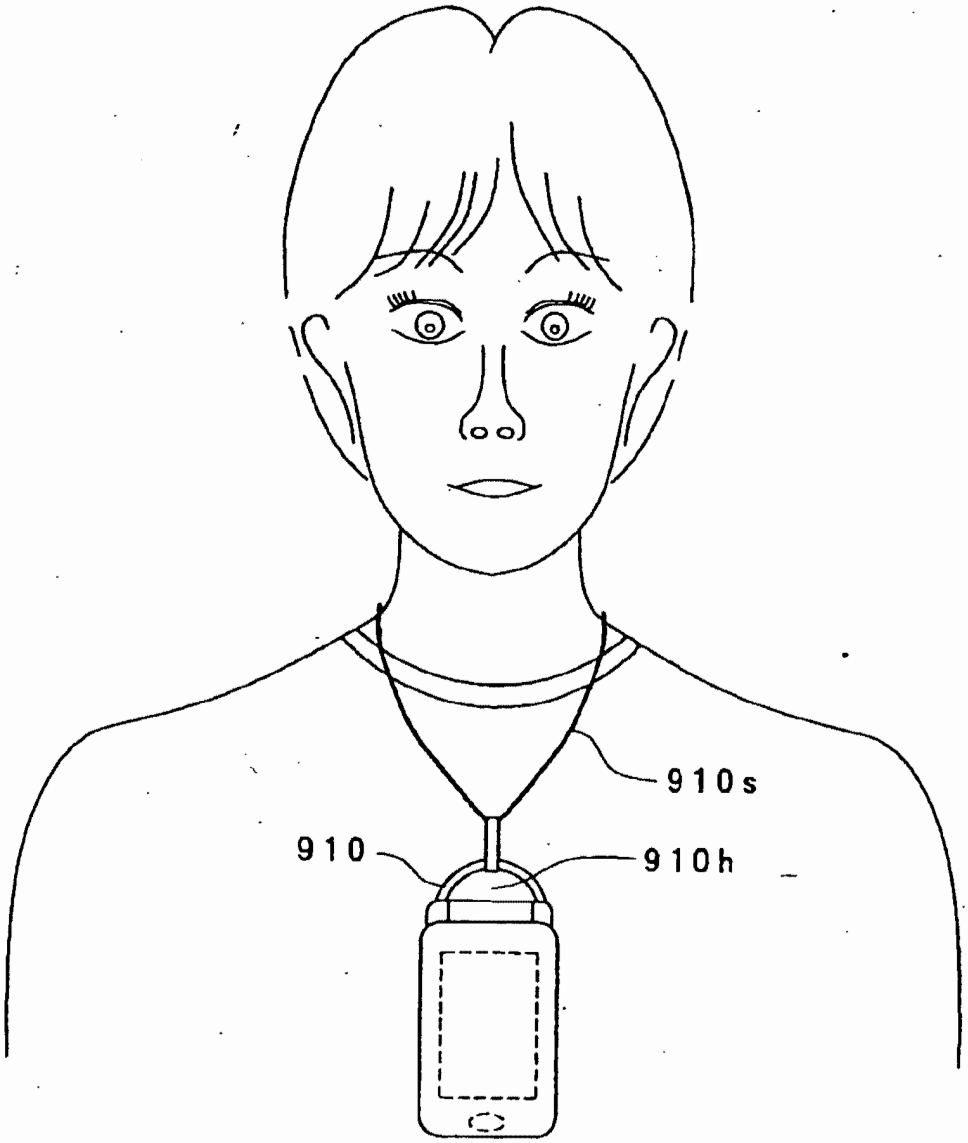


Fig. 35A

MODIFIED PREFERRED EMBODIMENT
OF SIXTH PREFERRED EMBODIMENT

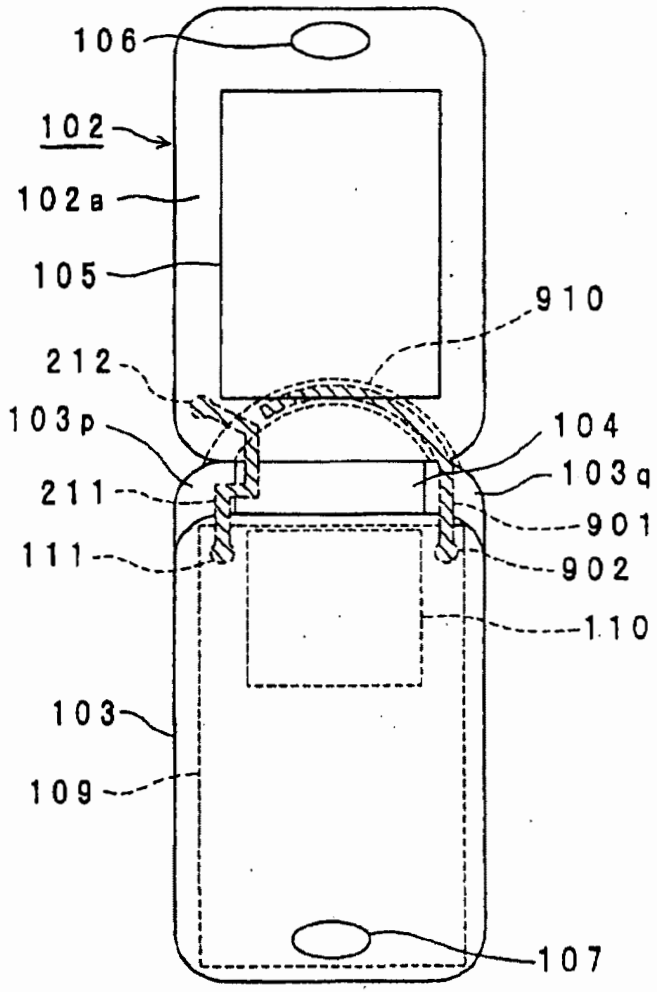


Fig. 35B

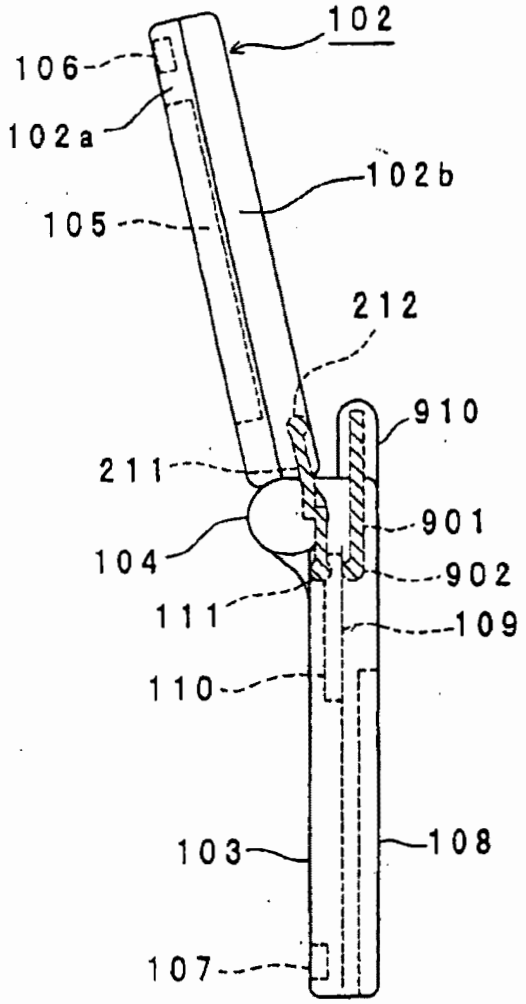


Fig. 36A

SEVENTH PREFERRED EMBODIMENT

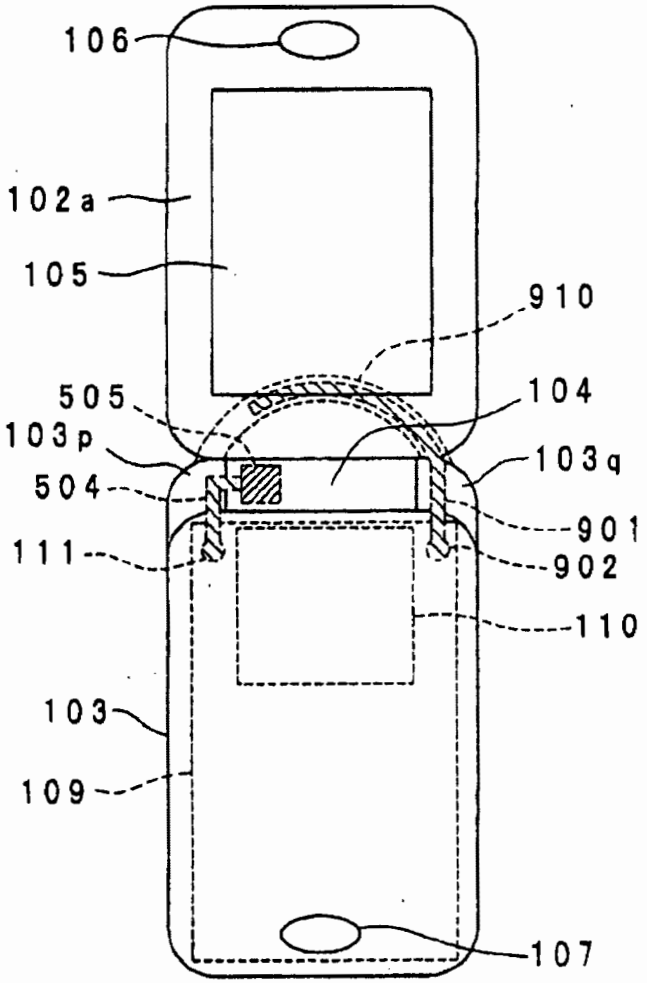


Fig. 36B

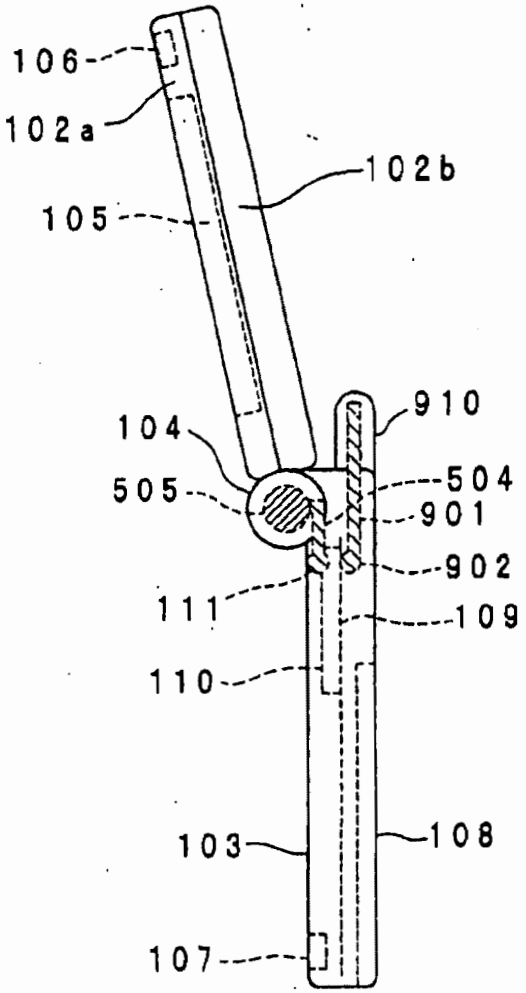


Fig. 37A

EIGHTH PREFERRED EMBODIMENT

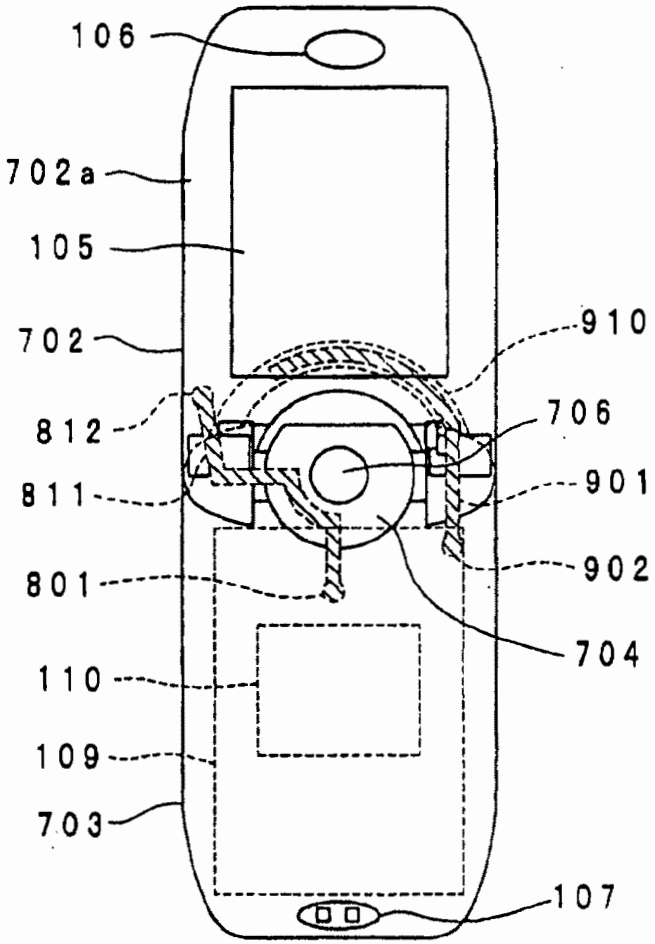


Fig. 37B

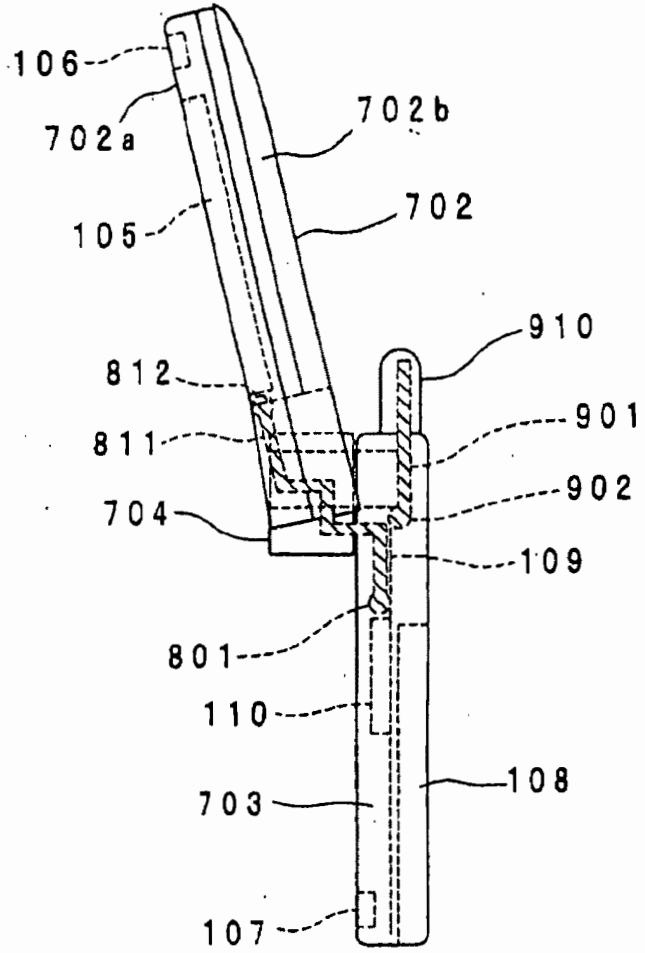


Fig. 38A

MODIFIED PREFERRED EMBODIMENT
OF EIGHTH PREFERRED EMBODIMENT

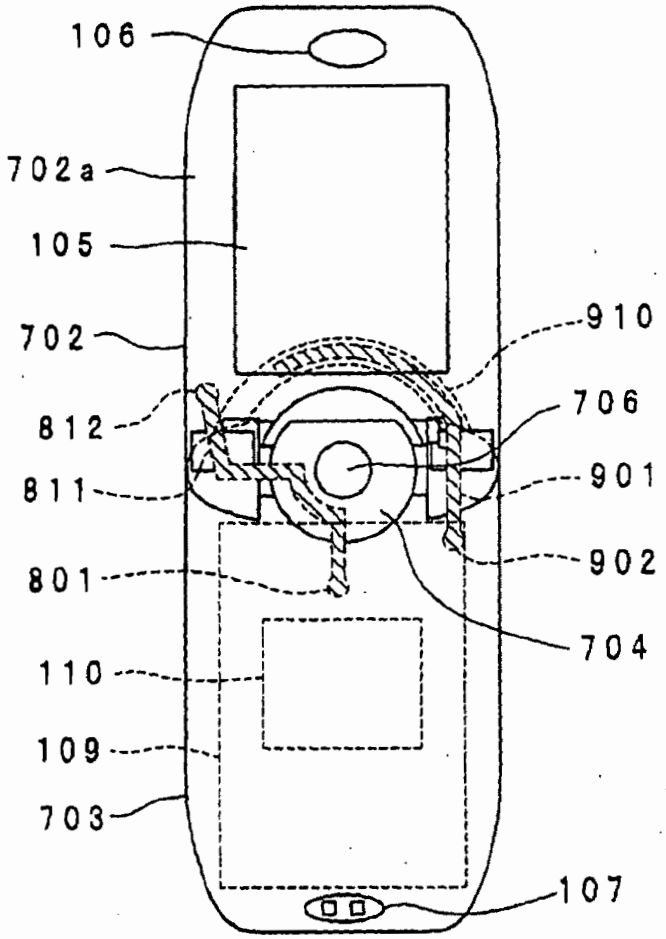


Fig. 38B

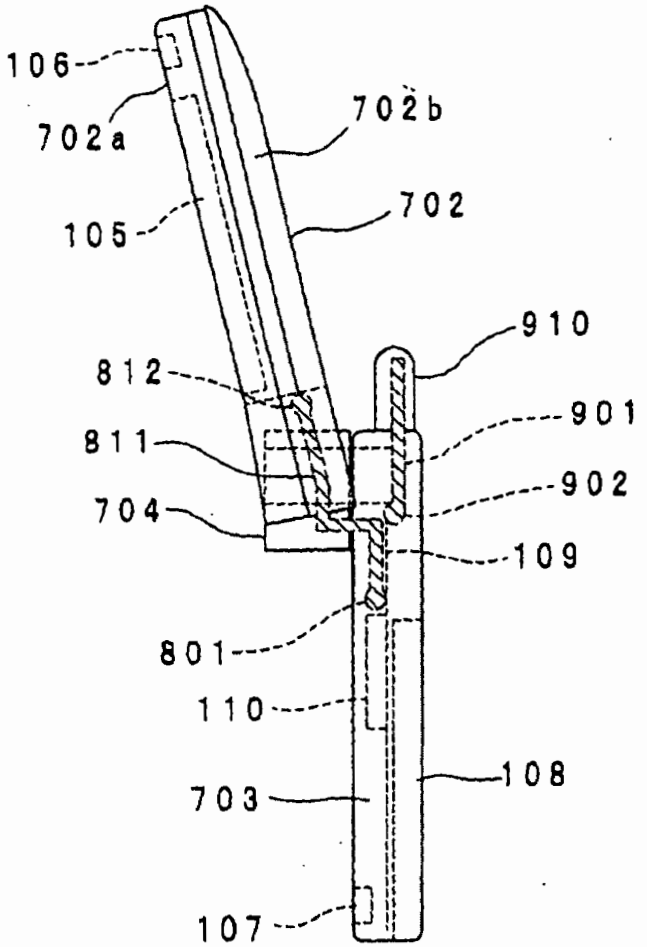


Fig. 39A

NINTH PREFERRED EMBODIMENT

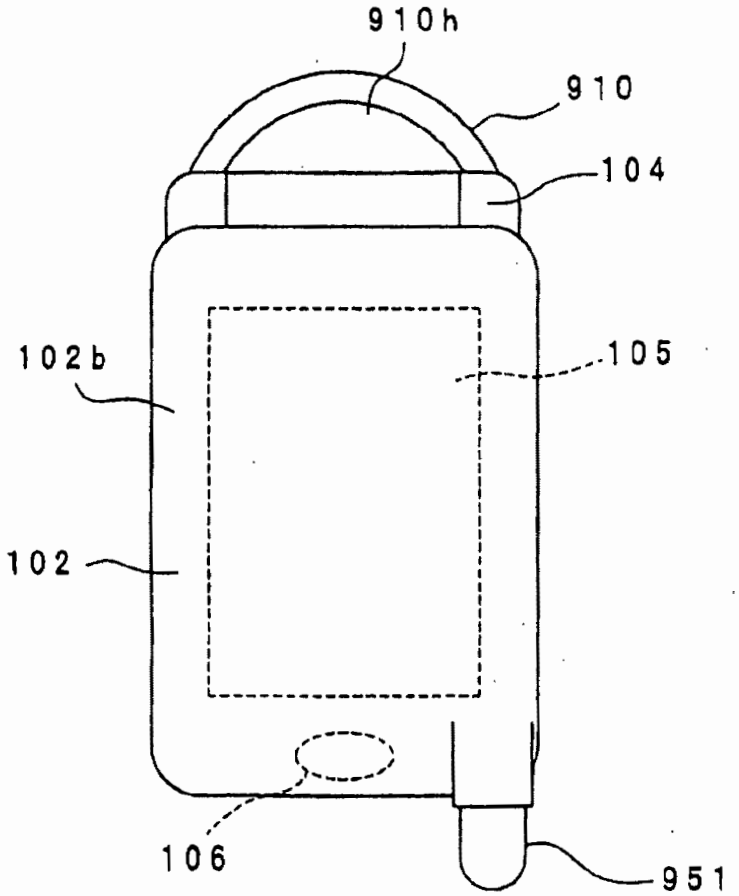


Fig. 39B

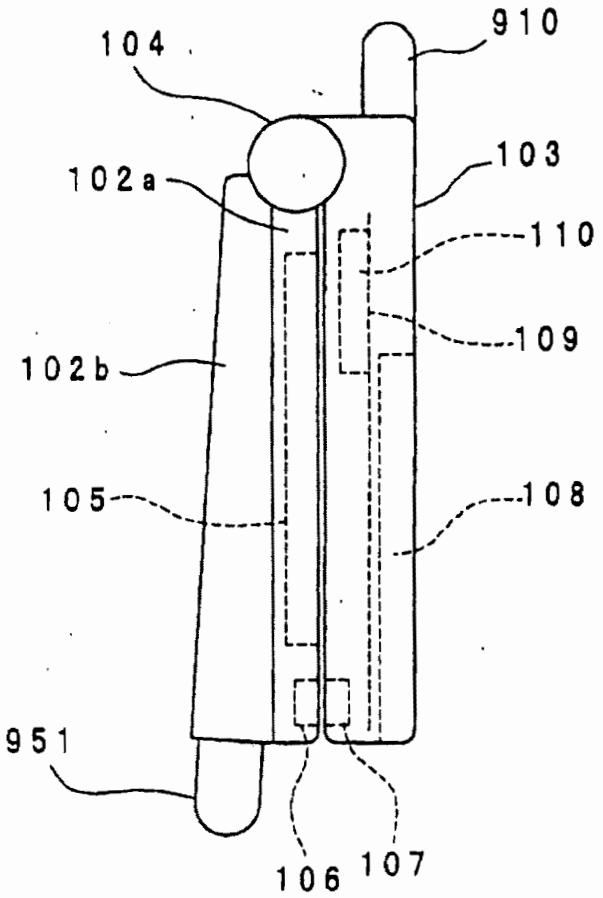


Fig. 40A

TENTH PREFERRED EMBODIMENT

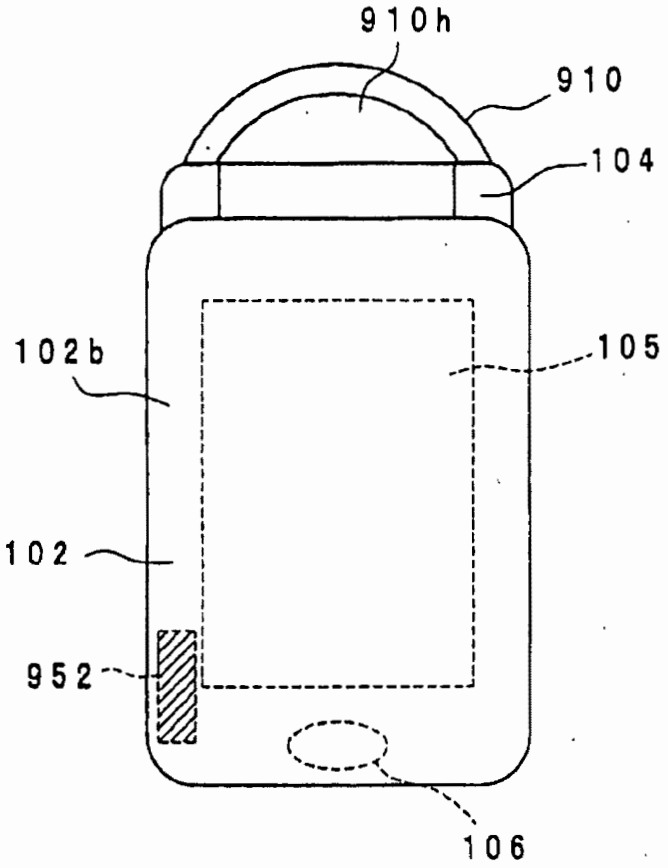


Fig. 40B

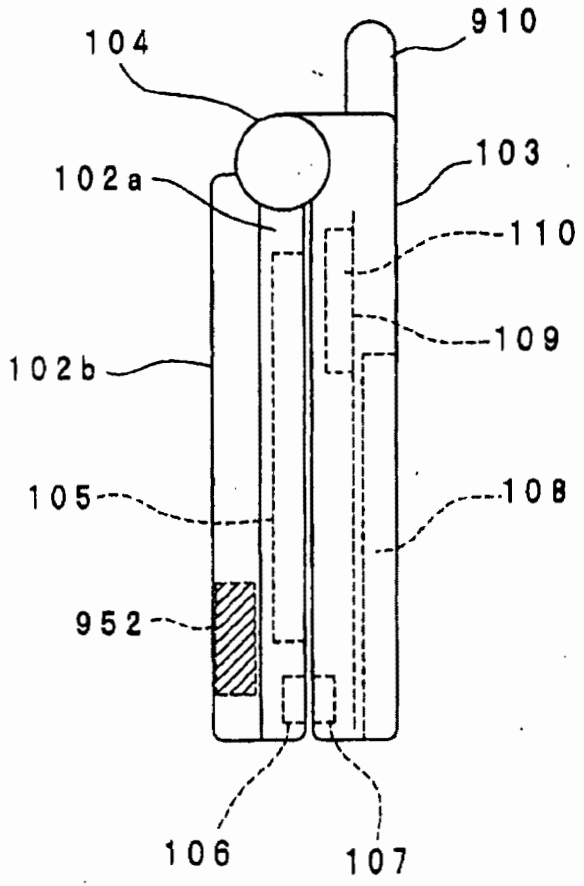


Fig. 41A

MODIFIED PREFERRED EMBODIMENT
OF TENTH PREFERRED EMBODIMENT

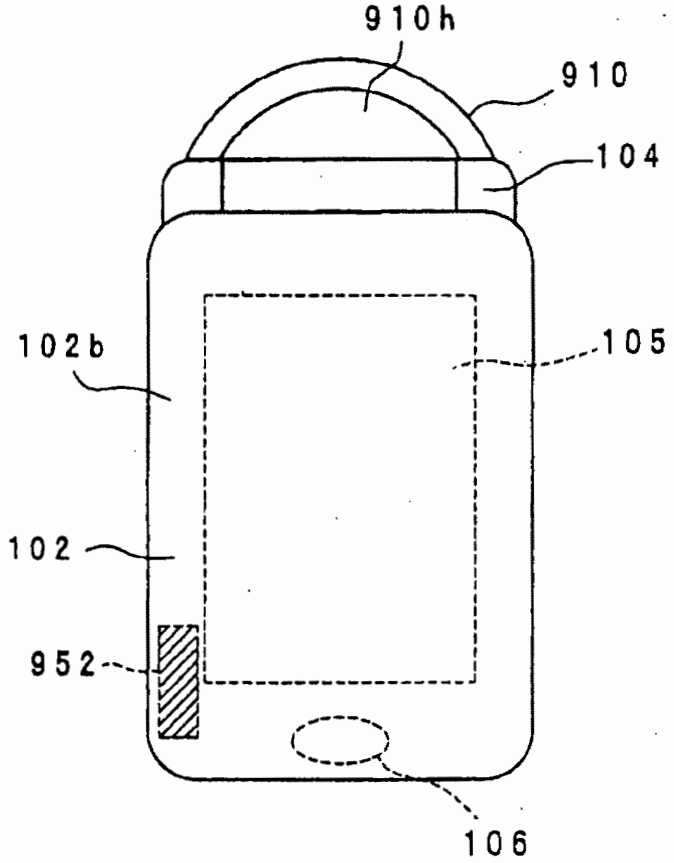


Fig. 41B

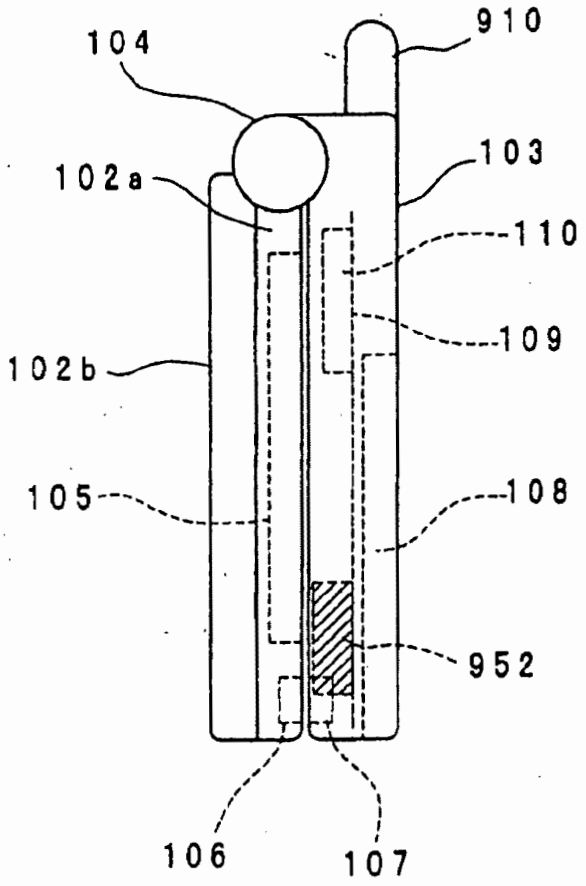


Fig. 42A

ELEVENTH PREFERRED EMBODIMENT

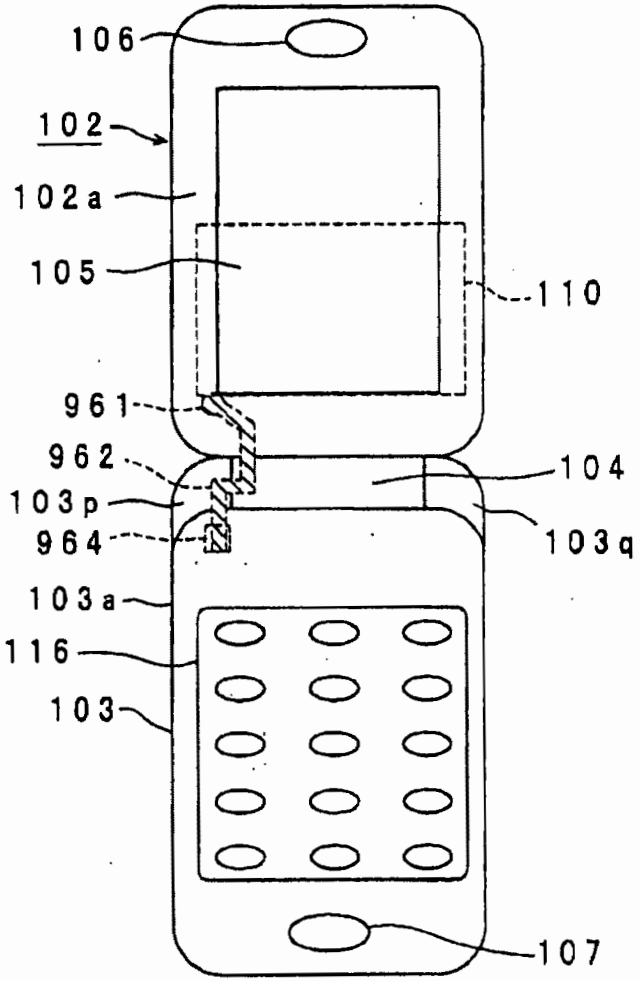


Fig. 42B

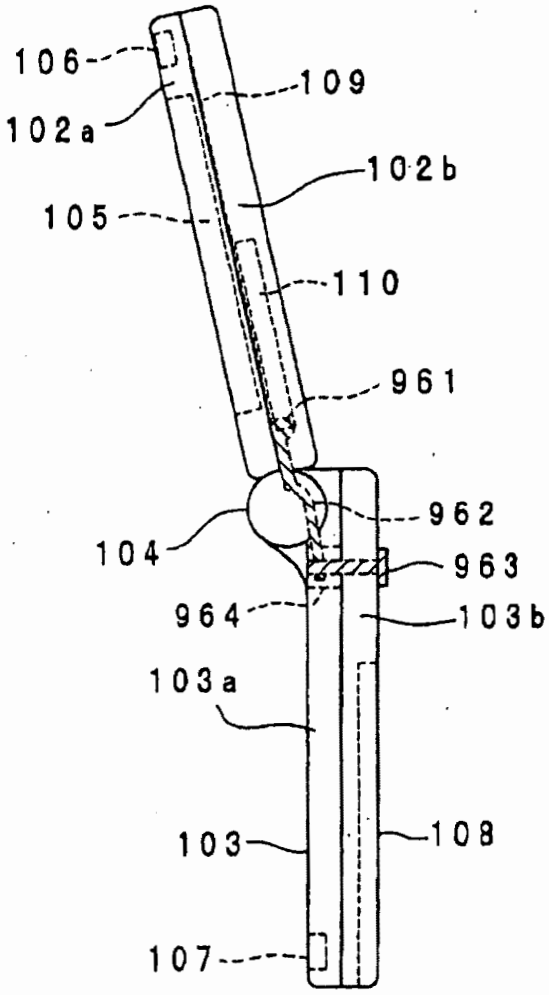


Fig. 43

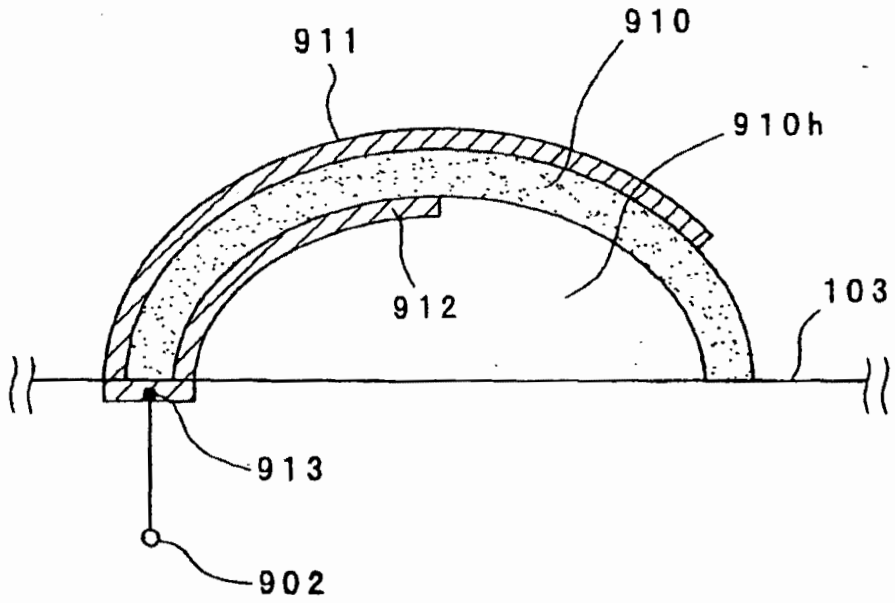


Fig. 44A

TWELFTH PREFERRED EMBODIMENT

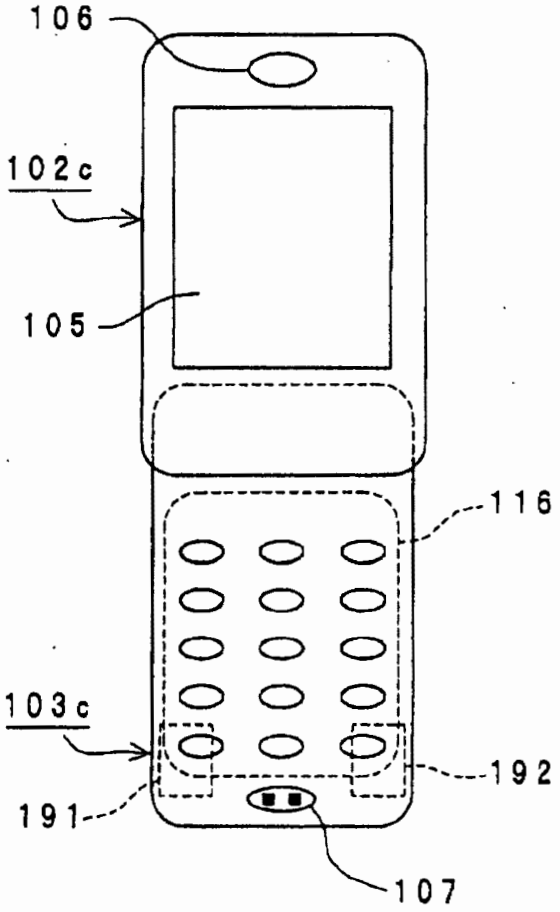


Fig. 44B

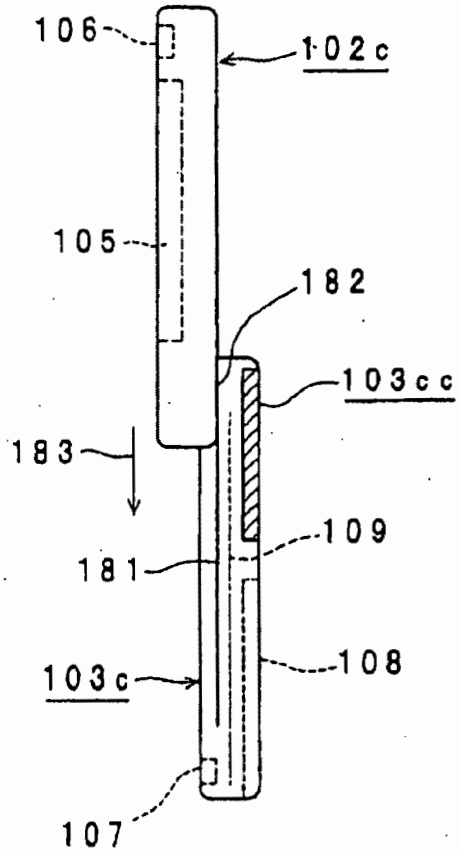


Fig. 45A

MODIFIED PREFERRED EMBODIMENT
OF TWELFTH PREFERRED EMBODIMENT

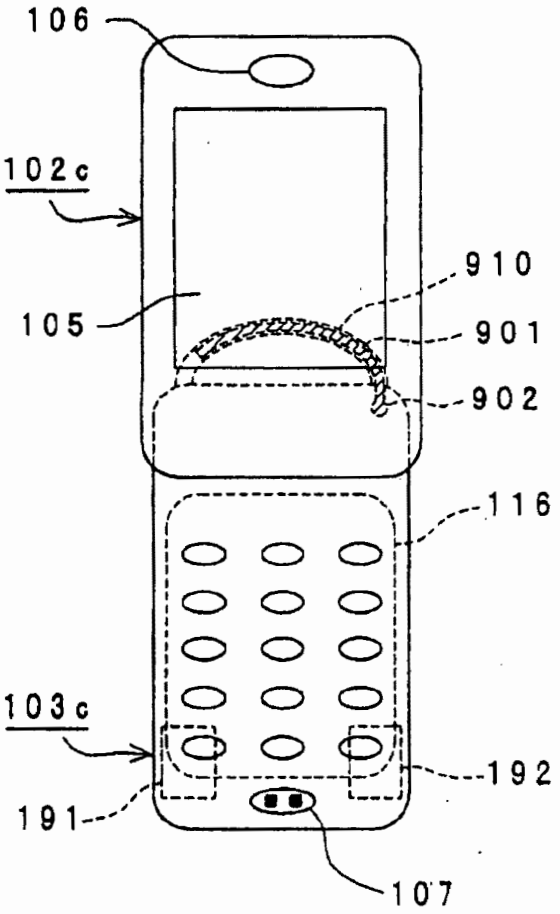


Fig. 45B

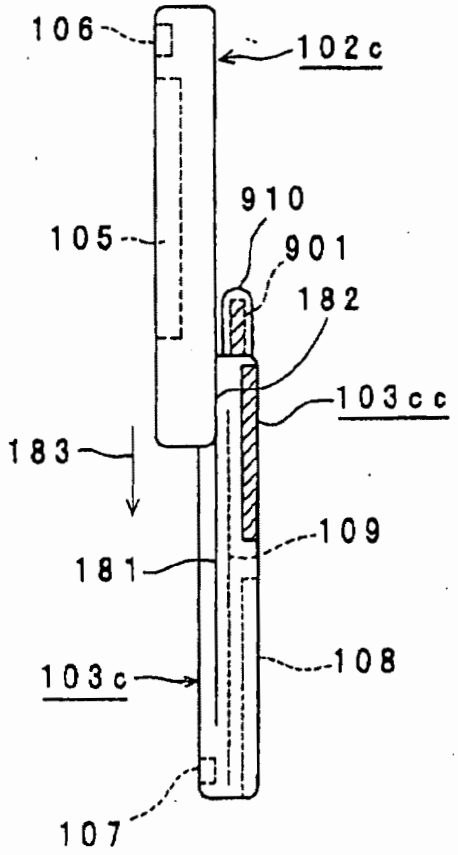


Fig. 46A

THIRTEENTH PREFERRED EMBODIMENT

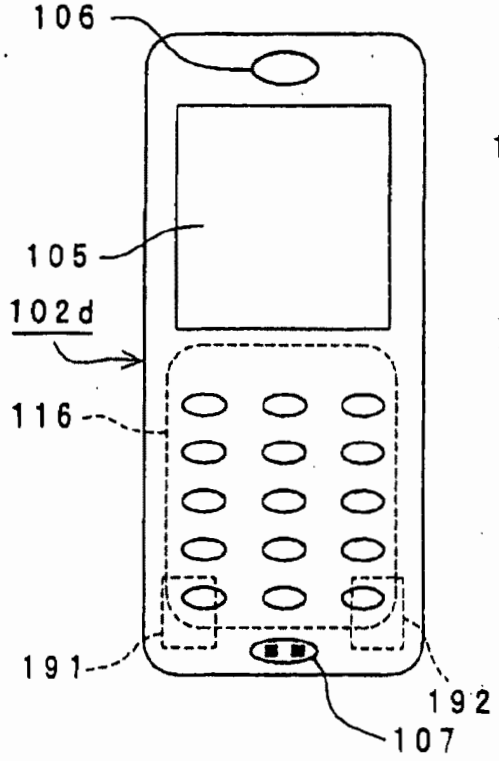


Fig. 46B

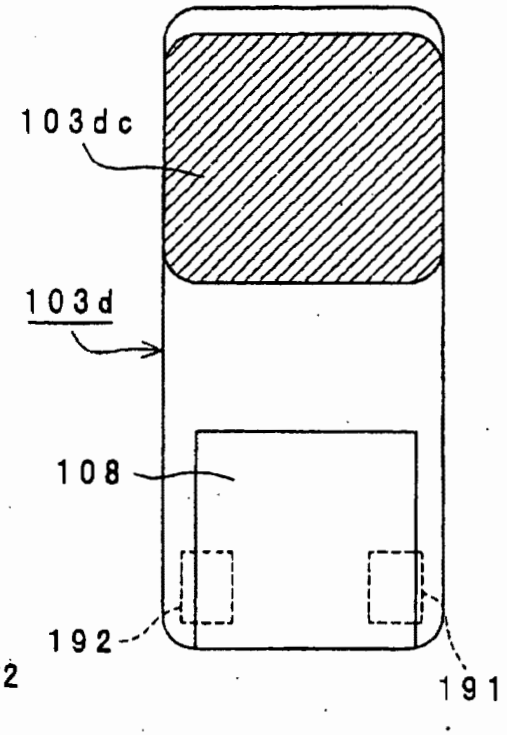


Fig. 46C

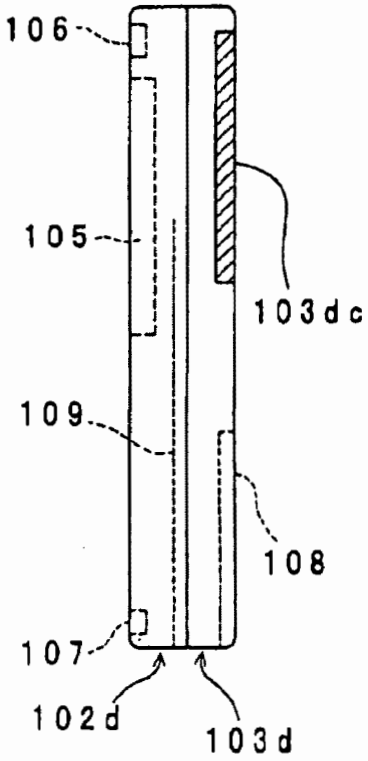


Fig. 47A

MODIFIED PREFERRED EMBODIMENT OF THIRTEENTH PREFERRED EMBODIMENT

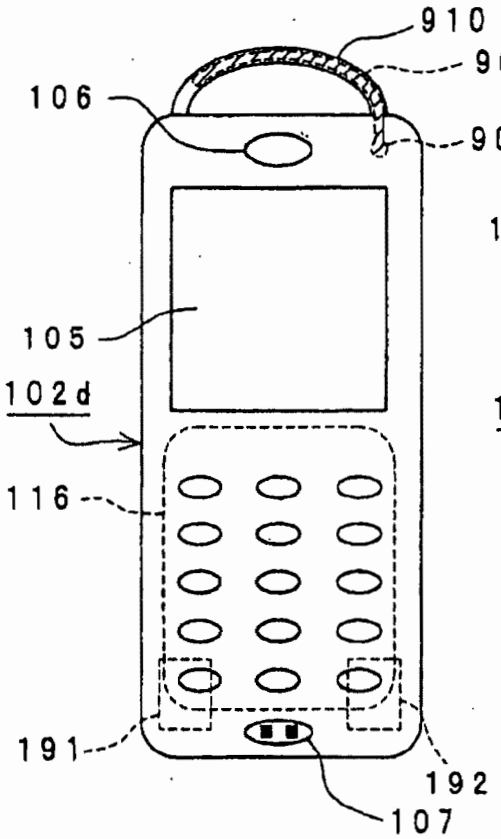


Fig. 47B

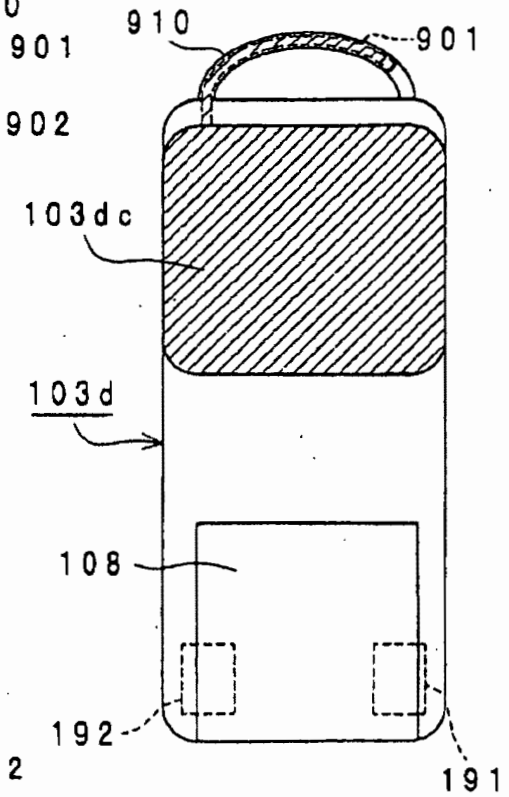
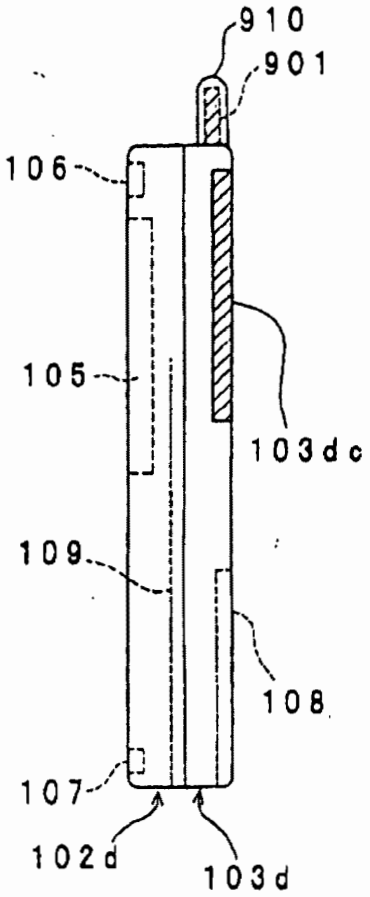


Fig. 47C



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 00 2024

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	DE 100 53 817 A (SOFT EDV GMBH H) 2 May 2002 (2002-05-02) * the whole document *	1,24-27 1,32,33	H01Q1/22 H01Q1/24 H01Q1/27 H01Q1/38
Y	US 5 760 747 A (GARAY OSCAR M ET AL) 2 June 1998 (1998-06-02) * the whole document *	1,32,33	H01Q5/00
A	US 6 255 996 B1 (WALLACE RAYMOND C) 3 July 2001 (2001-07-03) * the whole document *	1,24-33	
A	US 6 307 520 B1 (LIU DUIXAN) 23 October 2001 (2001-10-23) * abstract *	1,2,5,6, 10	
A	WO 99/04500 A (HOFMANN JUERGEN ; SIEMENS AG (DE)) 28 January 1999 (1999-01-28) * abstract *	1,4	
A	US 5 903 821 A (ISHIKZUKA SEIJIRO) 11 May 1999 (1999-05-11) * abstract *	1,3,6-9, 17,20,21	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01Q
A	US 5 649 306 A (DAILEY KIRK W ET AL) 15 July 1997 (1997-07-15) * abstract *	1,5,7, 11,12, 17,19,20	
P,X	US 6 625 469 B1 (HWANG SUNG-GUL ET AL) 23 September 2003 (2003-09-23) * abstract *	1,24-27	
E	EP 1 388 910 A (MATSUSHITA ELECTRIC IND CO LTD) 11 February 2004 (2004-02-11) * the whole document *	1-33	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 May 2004	Wattiaux, V

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 00 2024

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-05-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10053817 A	02-05-2002	DE 10053817 A1	02-05-2002
		WO 0237599 A1	10-05-2002
US 5760747 A	02-06-1998	NONE	
US 6255996 B1	03-07-2001	NONE	
US 6307520 B1	23-10-2001	CN 1341979 A	27-03-2002
		EP 1176667 A2	30-01-2002
		JP 2002084128 A	22-03-2002
		US 2002011959 A1	31-01-2002
WO 9904500 A	28-01-1999	AU 8205398 A	10-02-1999
		WO 9904500 A1	28-01-1999
US 5903821 A	11-05-1999	JP 9093322 A	04-04-1997
US 5649306 A	15-07-1997	BR 9504678 A	08-10-1996
		CA 2156967 A1	17-03-1996
		CN 1123476 A ,B	29-05-1996
		DE 19533247 A1	28-03-1996
		FR 2724773 A1	22-03-1996
		GB 2293277 A ,B	20-03-1996
		IT RM950612 A1	18-03-1996
		JP 8102609 A	16-04-1996
US 6625469 B1	23-09-2003	NONE	
EP 1388910 A	11-02-2004	CN 1479408 A	03-03-2004
		EP 1388910 A2	11-02-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

IFW

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: June 5, 2008 Signature: Tracie London
(Tracie London)

OIPE
JUN 09 2008
PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

A full translation, partial translation or summary/abstract of the Non – English References is enclosed.

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: June 4, 2008

Respectfully submitted,

By _____

Stanley R. Moore
Registration No.: 26,958
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

OIPE
JUN 09 2008
IAP67
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-05-12
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6281848	B1	2001-08-21	NAGUMO ET AL	
	2	6262495	B1	2001-07-17	YABLONOVITCH ET AL	
	3	6509882	B2	2003-01-21	MCKIVERGAN ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	00/35048	WO	A1	2000-06-15	QUALCOMM INCORPORATED		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-05-12
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	2	05-090824	JP		1993-04-09	MATSUSHITA ELECTRIC IND CO LTD		☒
	3	2001-007639	JP		2001-01-12	MURATA MFG CO LTD		☒

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	TAYLOR, C. D. ; ARONSON, E. A. ; HARRISON, C.W. JR., Theory of coupled monopoles, IEEE Transactions on antennas and propagation, Vol. AP-18, No. 3, May 1970	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H01Q 1/24, 9/16, H01P 5/10, H03H 7/42 — A1

(11) International Publication Number: WO 00/35048

(43) International Publication Date: 15 June 2000 (15.06.00)

(21) International Application Number: PCT/US99/29095

(22) International Filing Date: 7 December 1999 (07.12.99)

(30) Priority Data:
09/206,538 7 December 1998 (07.12.98) US

(71) Applicant: QUALCOMM INCORPORATED [US/US]; 5775 Morehouse Drive, San Diego, CA 92121-1714 (US).

(72) Inventors: WALLACE, Raymond, C.; 4065 Lark Street, San Diego, CA 92103 (US). OZAKI, Ernest, T.; 13844 Lark Street, San Diego, CA 92064 (US). TRAN, Allen, Minh-Triet; 7579 Flower Meadow Drive, San Diego, CA 91216 (US). KLEMENS, Guy; 11088 Caminito Alvarez, San Diego, CA 92126 (US). LEE, Chung-Yi; 6455 Lusk Boulevard, San Diego, CA 92121 (US).

(74) Agents: MILLER, Russell, B. et al.; Qualcomm Incorporated, 5775 Morehouse Drive, San Diego, CA 92121-1714 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

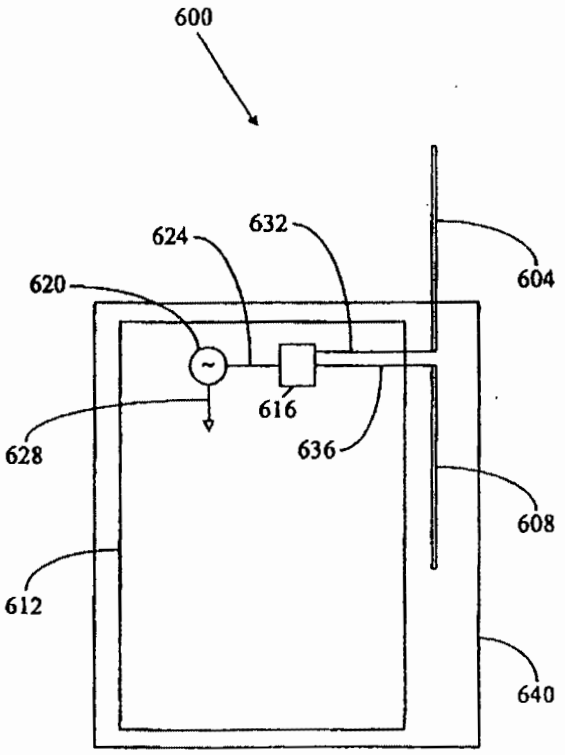
With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: BALANCED DIPOLE ANTENNA FOR MOBILE PHONES

(57) Abstract

A balanced dipole antenna (600) for a mobile phone comprises a radiator element (604) and a counterpoise (608), both formed of a conducting material. The counterpoise is electrically isolated from the ground plane of a printed wire board (PWB) (612) of the mobile phone. A matching network, for example, a balun (616, 900, 1000, 1100), provides balanced current to the dipole antenna, resulting in a symmetric radiation pattern. The balanced dipole antenna (600) allows superior performance over conventional antennas found in mobile phones today by enabling a user of a mobile phone to communicate effectively and uniformly in all directions, that is, 360 degrees.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

BALANCED DIPOLE ANTENNA FOR MOBILE PHONES

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates generally to antennas. More specifically, the present invention relates to a balanced dipole antenna for mobile phones.

II. Description of the Related Art

Recent advancements in electronics have significantly improved the performance of mobile phones. For example, advancements in integrated circuit technology have led to high performance radio frequency (RF) circuits. The RF circuits are used to construct transmitters, receivers and other signal processing components typically found in mobile phones. Also, advancements in integrated circuit technology have led to a reduction in the size of RF circuits, thereby leading to a reduction in the overall size of a mobile phone.

Similarly, advancements in battery technology have resulted in smaller, lighter and longer lasting batteries used in mobile phones. These advancements have resulted in smaller and lighter mobile phones that operate for a longer period of time on a single charge.

Generally, a user of a mobile phone must be able to communicate with another user or a ground station that can be located in any direction from the user. For this reason, the antenna in the user's mobile phone must be able to receive and transmit signals from and in all directions. Consequently, it is desirable that the antenna exhibit a symmetric radiation pattern having a uniform gain in the azimuth.

Unfortunately, antennas found in today's typical mobile phones do not exhibit a symmetric radiation pattern. Mobile phones generally utilize monopole antennas (for example, a whip antenna) that, due to the presence of unbalanced currents, exhibit asymmetric radiation patterns. This is primarily due to the fact that the shape and dimension of a monopole are not equivalent to the shape and dimension of a ground plane of a printed wire board (PWB)

used as a counterpoise, resulting in an unequal current distribution in the monopole and in the ground plane.

As a result, it has been recognized that there is a need for an antenna for a mobile phone that exhibits a symmetric radiation pattern.

SUMMARY OF THE INVENTION

The present invention is directed to a balanced dipole antenna for mobile phones, such as cellular and PCS phones. The balanced dipole antenna comprises a radiator element and a counterpoise formed of a conducting material. The counterpoise is electrically isolated from a printed wire board (PWB) of the mobile phone.

A balun couples the balanced dipole antenna to a signal source. The balun has a single input terminal and two output terminals. The input terminal is connected to the signal source. The first and second output terminals are connected to the radiator element and the counterpoise, respectively. The balun receives a single ended unbalanced signal from the signal source and provides the radiator element and the counterpoise with first and second signals, respectively. The first and second signals have equal magnitude but are out of phase by 180 degrees. The first and second signals produce balanced currents that are circulated in the radiator element and the counterpoise, thereby producing a symmetric radiation pattern.

Further features and advantages of the invention, as well as the structure and operation of various embodiments of the invention, are described in detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the reference number.

The present invention will be described with reference to the accompanying drawings, wherein:

FIG. 1 illustrates a monopole antenna used in a typical mobile phone;

FIG. 2 shows current vectors in a monopole antenna;

FIG. 3 illustrates a dipole antenna;

FIG. 4 shows current distributions in dipole antennas of different lengths;

FIG. 5A illustrates the radiation patterns of a half wavelength dipole antenna;

FIG. 5B illustrates the radiation pattern of a full wavelength dipole antenna;

FIG. 6 illustrates a balanced dipole antenna according to one embodiment of the present invention;

FIGS. 7A and 7B illustrate computer simulated field patterns of a conventional antenna;

FIGS. 8A and 8B illustrate computer simulated field patterns of a balanced dipole antenna according to one embodiment; and

FIGS. 9, 10 and 11 illustrate baluns in accordance with three embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I. Overview of the Present Invention

As noted before, antennas found in today's typical mobile phones do not exhibit a symmetric radiation pattern. Mobile phones generally utilize monopole antennas that, due to the presence of unbalanced currents, exhibit asymmetric radiation patterns. This is illustrated further in FIGS. 1 and 2.

FIG. 1 illustrates a monopole antenna 100 used in a typical mobile phone 101. The phone 101 contains transmit/receive circuits and other ancillary electronic and mechanical components needed to send and receive calls and to perform all other normal phone operations. These components are well known and are not shown or described further as they form no part of the present invention. Monopole antenna 100 comprises a radiator (a monopole) 104, a printed wire board (PWB) 108, a reactive matching network 112 and a signal source 116. Reactive matching network 112 comprises first and second outputs 120 and 124. First output 120 is connected to monopole 104 and second output

124 is connected to ground plane 128 of PWB 108. Ground plane 128 acts as a counterpoise in order to provide a return path for currents in antenna 100.

Reactive matching network 112 forms an unbalanced feed to monopole 104. The unbalanced feed causes unbalanced currents to flow along ground plane 128. This is primarily due to the fact that the shape and dimension of monopole 104 are not equivalent to the shape and dimension of ground plane 128, resulting in unequal current distribution in monopole 104 and in ground plane 128. As a result, monopole 104 and ground plane 128 form an asymmetric dipole, thereby causing an asymmetric radiation pattern (that is, a distorted radiation pattern).

FIG. 2 shows the current vectors I_1 and I_2 in monopole 104 and ground plane 128, respectively. The horizontal component I_{2x} of the current I_1 in ground plane 128 is balanced by the horizontal component I_{1x} of the current I_1 in monopole 104. However, the vertical component I_{2y} of the current I_2 in ground plane 128 remains unbalanced, because of a lack of an opposing vertical component in monopole 104. The shape and dimension of monopole 104 prevent the formation of a vertical component of the current vector I_1. As a result, unbalanced currents flow along ground plane 128, causing a distorted radiation pattern.

Furthermore, monopole antenna 100 provides less flexibility as its radiation pattern is driven by the size and /or shape of PWB 108. Since the size and/or shape of PWB 108 are driven in large part by the size and/or shape of the mobile phone's case that houses PWB 108, designers are often handicapped in their selection of a radiation pattern by the pre-existing size and/or shape of a mobile phone's case.

The present invention provides a solution to the aforementioned problems. The present invention is a balanced dipole antenna for a mobile phone, for example, a PCS phone or a cellular phone. The present invention advantageously incorporates a balanced dipole antenna in a mobile phone that significantly improves the radiation pattern of a mobile phone. Furthermore, the present invention allows designers to select desired radiation patterns for mobile phones without being constrained by the shape of PWBs.

Briefly stated, the balanced dipole antenna comprises a radiator element and a counterpoise, both formed of a conducting material. The counterpoise is

electrically isolated from the ground plane of a printed wire board (PWB) of the mobile phone. A matching network, for example, a balun, provides balanced current to the dipole antenna, resulting in a symmetric radiation pattern. The balanced dipole antenna allows superior performance over conventional antennas found in mobile phones today by enabling a user of a mobile phone to communicate uniformly in all directions, that is, 360 degrees.

As noted above, the present invention incorporates the advantages of a dipole antenna in a mobile phone. Simply stated, a dipole antenna is a diverging two-wire transmission line. FIG. 3 illustrates a dipole antenna 300. Dipole antenna 300 comprises first and second radiators 304 and 308, respectively, connected to a signal source 312 by a two-wire transmission line 316.

Dipole antenna 300 can be of any length L, such as $L = \lambda, \lambda/2, \lambda/4$, where λ corresponds to the wavelength of the operating frequency f of dipole antenna 300. The current distributions in first and second radiators 304 and 308 are sinusoidal provided that the diameter of each radiator is less than $\lambda/100$. Examples of the approximate current distributions in a number of dipole antennas of different lengths are illustrated in FIG. 4.

Dipole antenna 300 exhibits a symmetric radiation pattern. A symmetric radiation pattern provides uniform gain in 360 degrees, thereby allowing equally effective communication in all directions. FIGS. 5A and 5B illustrate the radiation pattern of dipole antenna 300 having selected lengths. The current distribution in dipole antenna 300 is assumed to be sinusoidal.

FIG. 5A illustrates the radiation pattern of a dipole antenna having a length $L=\lambda/2$. The radiation pattern for $L=\lambda/2$ is given by the following equation.

$$E=\cos[(\pi/2)\cos\theta]/\sin\theta$$

FIG. 5B illustrates the radiation pattern of a dipole antenna having a length $L=\lambda$. The radiation pattern for $L=\lambda$ is given by the following equation.

$$E=\cos(\pi\cos\theta)+1/\sin\theta$$

II. The Invention

FIG. 6 illustrates a balanced dipole antenna 600 according to one embodiment of the present invention. Antenna 600 comprises a radiator 604, a counterpoise 608, a PWB 612 and a balun 616.

A signal source 620 is connected to balun 616. Signal source 620 has first and second terminals 624 and 628, respectively. First terminal 624 is connected to balun 616, whereas second terminal 628 is grounded. In one embodiment, signal source 620 is mounted on PWB 612. In operation, signal source 620 provides a single ended RF signal to balun 616 by first terminal 624.

In addition to signal source 620, PWB 612 supports on board circuitry, such as, a receiver, a transmitter, and other signal processing circuitry needed for a mobile phone's operation. PWB 612 has a ground plane 644 that provides a ground for all on board circuitry.

In general, the purpose of a balun is to connect a balanced antenna to an unbalanced source (or an unbalanced transmission line). In this embodiment, balun 616 connects radiator 604 and counterpoise 608 to an unbalanced source, that is, signal source 620. Since the output of signal source 620 is single ended, it is unbalanced. If the single ended output from signal source 620 is directly coupled to radiator 604 and counterpoise 608, it would result in unbalanced currents in antenna 600. Thus, balun 616 is used to convert an unbalanced source to a balanced source.

Balun 616 has first and second output terminals 632 and 636, respectively. First and second output terminals 632 and 636 are connected to radiator 604 and counterpoise 608, respectively. Balun 616 converts the single ended signal to first and second signals that are provided to radiator 604 and counterpoise 608, respectively. First and second signals have equal magnitudes, but are out of phase by 180 degrees. The operation of balun 616 is described in detail later.

In order for antenna 600 to operate satisfactorily, counterpoise 608 must be electrically isolated from ground plane 644 of PWB 612. Isolation of counterpoise 608 ensures that current will not flow from counterpoise 608 to ground plane 644. If counterpoise 608 is not electrically isolated from ground plane 644, unbalanced currents will flow along ground plane 644, thereby resulting in a distorted radiation pattern. Isolation for counterpoise 608 can be

provided by maintaining a gap between PWB 612 and counterpoise 608. For example, counterpoise 608 can be placed parallel to PWB 612 as shown in FIG. 6. Alternatively, counterpoise 608 can be constructed on PWB 612 by various known techniques described later. In that case, counterpoise 608 is generally separated from ground plane 644 by a dielectric material.

When radiator 604 and counterpoise 608 are excited by a first and a second signal, respectively, having equal magnitude, but which are out of phase by 180 degrees, balanced currents circulate in the radiator and the counterpoise. As a result, antenna 600 produces a symmetric radiation pattern.

Counterpoise 608 will generally be enclosed inside the mobile phone's housing 640. In other words, counterpoise 608 will not be visible from the outside. Radiator 604, on the other hand, will generally extend out of mobile phone's housing 640. Thus, from the exterior, the present invention will not alter a mobile phone's appearance.

In one embodiment, radiator 604 and counterpoise 608 have substantially similar dimensions and/or shapes. However, radiator 604 and counterpoise 608 may have dissimilar shapes and/or dimensions. Counterpoise 608 may be printed on PWB 612. Alternatively, counterpoise 608 may be a metallic strip embedded in a mobile phone's case. Counterpoise 608 may be constructed using other techniques known in the art.

Although, the balanced dipole antenna according to the present invention has been described as a linear dipole antenna, it will become apparent to one skilled in the art, that the underlying concept behind the present invention can be adapted to other antennas in mobile phones as well. In fact, the concept of the present invention can be advantageously utilized in other types of antennas in mobile phones to thereby provide balanced currents.

In one embodiment, the length of antenna 600 is λ, where λ is a wavelength corresponding to an operating frequency. The length of the antenna is the total length of radiator 604 and counterpoise 608. Other lengths can be used, such as, $\lambda/2$, $\lambda/4$, etc. In one embodiment, antenna 600 is sized to operate over a cellular frequency band (approximately 900 MHz). In another embodiment, antenna 600 is sized to operate over a PCS frequency band (approximately 1.9 GHz).

FIGS. 7A and 7B illustrate computer simulated field patterns of antenna 100, that is, a conventional whip antenna used in a typical mobile phone, operating at 1.99 GHz. FIG. 7A illustrates a front face pattern 702 (measured from the front of the mobile phone) and FIG. 7B illustrates a side view pattern 704 (measured from the side of the mobile phone). In both cases, the field patterns of antenna 100 are asymmetric. As a result, antenna 100 does not transmit or receive signals uniformly in all directions.

FIGS. 8A and 8B illustrate computer simulated electric field patterns of balanced dipole antenna 600 operating at 1.99 GHz. FIG. 8A illustrates a front face pattern and FIG. 8B illustrates a side view pattern. In both cases, the field patterns are quite symmetric. In the case of the front face pattern, the maximum electric field is 2.08 dB at -5.38 degrees, while in the case of the side view pattern, the maximum electric field is 1.94 dB at 0 degree. FIGS. 8A and 8B clearly demonstrate the improvements in field patterns exhibited by the balanced dipole antenna according to the present invention over a conventional antenna.

FIG. 9 illustrates a balun 900 in accordance with one embodiment. Balun 900 receives a single ended, unbalanced signal from a signal source and outputs a balanced signal to a dipole antenna. Balun 900 comprises two inductors 904, 908 and two capacitors 912, 116. Inductor 904 and capacitor 912 are connected at one end to a signal source 920. Inductor 908 is connected at one end to capacitor 912 while the other end of inductor 908 is grounded. Capacitor 916 is connected at one end to inductor 904 while the other end of capacitor 916 is grounded. Output signals 924 and 928 are balanced and are phase shifted from each other by 180 degrees.

FIG. 10 illustrates a balun 1000 in accordance with another embodiment. Balun 1000 comprises a power splitter 1004 that receives a single ended output from a signal source 1024 and outputs a balanced signal at output terminals 1008 and 1012. An inductor or choke 1016 is connected in series to an output terminal 1012. Output terminal 1008 is connected to a radiator 1030, while output 1012 is connected to a counterpoise 1020 through inductor 1016.

The function of the power splitter 1004 is to split a signal from signal source 1024 into two signals each having an equal magnitude. The first signal is provided to radiator 1030. The second signal is phase shifted 180° by inductor

1016 and the phase shifted signal is then provided to counterpoise 1020. Baluns 900 and 1000 are described as illustrative examples only.

FIG. 11 illustrates a folded balun 1100 that allows direct connection of a coaxial line 1102 to a dipole antenna 1108. A coax outer conductor 1112 is connected to a pole 1116 fed from a center conductor 1120. Coax 1112 runs alongside a feeder coax 1104 for a quarter wavelength. Another pole 1128 connects directly to the shield of feeder coax 1104. While a few selected baluns have been described, it will become apparent to persons skilled in the art that other types of baluns can be easily used in the present invention.

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

WHAT IS CLAIMED IS:

1. A balanced dipole antenna for a mobile phone having a signal source, transmit and receive circuits, and a printed wire board (PWB) having a ground plane formed thereon for the signal source and for the transmit and receive circuits, comprising:

a radiator element formed of a conducting material;

a counterpoise formed of a conducting material and electrically isolated from the PWB ground plane; and

a signal balancing means coupled between the signal source and said radiator element and counterpoise to generate first and second signals, respectively, that are substantially equal in magnitude but out of phase by 180 degrees,

wherein balanced currents are circulated in said radiator element and said counterpoise to thereby produce a symmetric radiation pattern.

2. The balanced dipole antenna as recited in claim 1, wherein said signal balancing means comprises:

an input terminal connected to the signal source; and

first and second output terminals connected to said radiator element and said counterpoise, respectively,

wherein said signal balancing means receives a single ended unbalanced signal from the signal source and outputs said first and second signals.

3. The balanced dipole antenna as recited in claim 1, wherein said signal balancing means comprises:

a first capacitor having a first end connected to said input terminal and a second end connected to said first output terminal;

a first inductor having a first end connected to said first output terminal and a second end connected to said ground plane;

a second inductor having a first end connected to said input terminal and a second end connected to said second output terminal, and

a second capacitor having a first end connected to said second output terminal and a second end connected to said ground plane.

4. The balanced dipole antenna as recited in claim 1, wherein said signal balancing means comprises:

a power splitter having an input terminal and first and second output terminals, said input terminal being connected to the signal source and said first output terminal being connected to said radiator element; and

an inductor connected in series between said second output terminal and said counterpoise.

5. The balanced dipole antenna as recited in claim 1, wherein said radiator element and said counterpoise have substantially equal dimensions.

6. The balanced dipole antenna as recited in claim 1, wherein said radiator element and said counterpoise have substantially similar shapes.

7. The balanced dipole antenna as recited in claim 1, wherein said counterpoise is printed on the PWB.

8. The balanced dipole antenna as recited in claim 1, wherein said counterpoise is a conducting wire.

9. The balanced dipole antenna as recited in claim 1, wherein said counterpoise is a metallic strip.

10. The balanced dipole antenna as recited in claim 1, wherein said first and second signals are in cellular frequency band.

11. The balanced dipole antenna as recited in claim 1, wherein said first and second signals are in PCS frequency band.

12. The balanced dipole antenna as recited in claim 1, wherein the total length of said radiator element and said counterpoise is λ, where λ is the wavelength corresponding to an operating frequency.

13. The balanced dipole antenna as recited in claim 1, wherein the total length of said radiator element and said counterpoise is $\lambda/2$, where λ is the wavelength corresponding to an operating frequency.

14. A balanced dipole antenna for a mobile phone having a signal source, transmit and receive circuits, and a printed wire board (PWB) having a ground plane formed thereon for the signal source and for the transmit and receive circuits, comprising:

a first dipole element formed of a conducting material and electrically isolated from the PWB ground plane;

a second dipole element formed of a conducting material and electrically isolated from the PWB ground plane; and

a signal balancing means coupled between the signal source and said first and second dipole elements to generate first and second signals, respectively, that are substantially equal in magnitude but out of phase by 180 degrees, wherein said signal balancing means comprises a coaxial cable having an inner conductor and an outer conductor, said outer conductor having first and second branches,

said inner conductor extending coaxially within said first outer conductor branch, said first outer conductor branch being electrically coupled to said first dipole element, and said inner conductor being electrically coupled to said second dipole element, and

said second outer conductor branch being electrically connected to said second dipole element;

wherein balanced currents are circulated in said first and second dipole elements to thereby produce a symmetric radiation pattern.

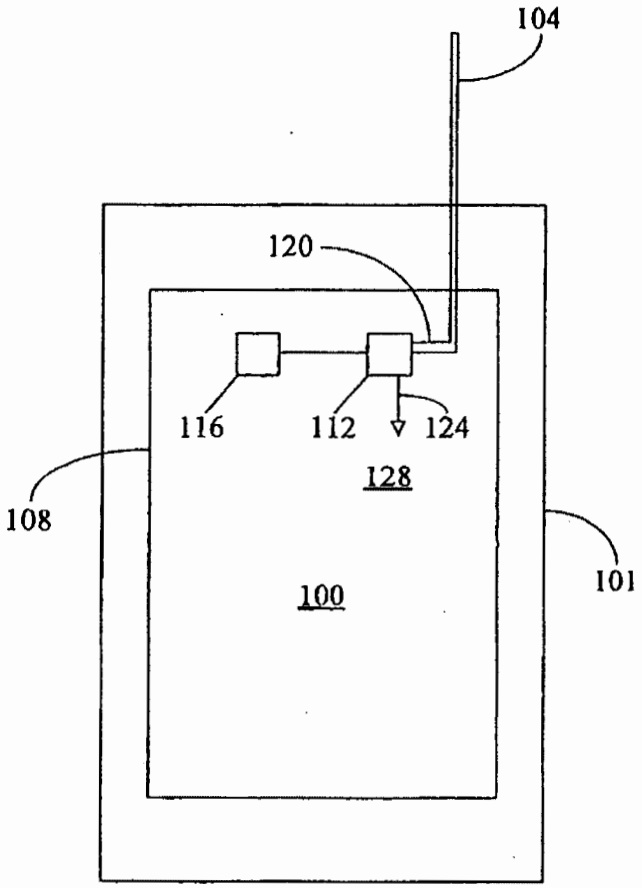


FIG. 1

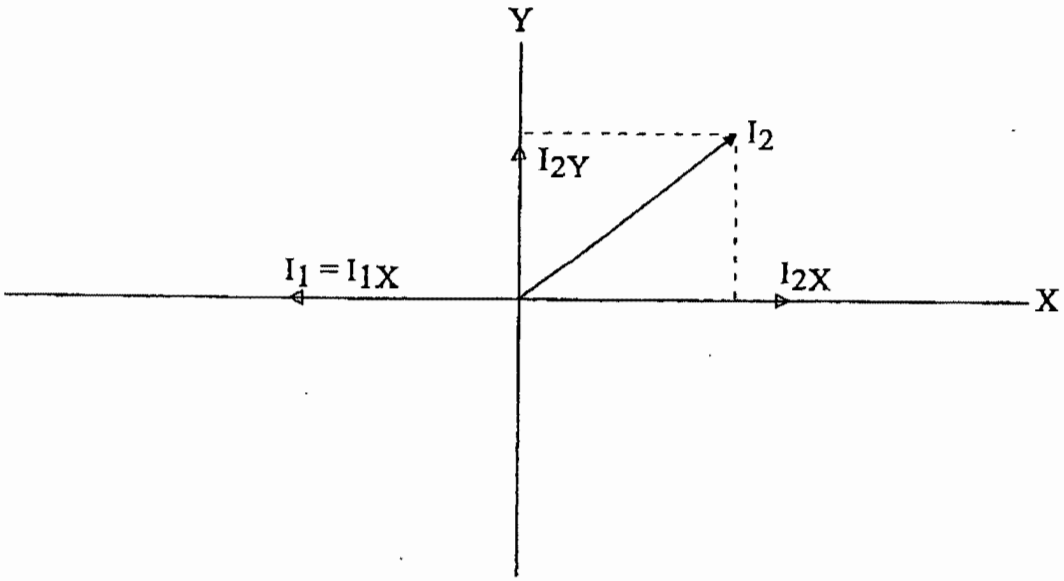


FIG. 2

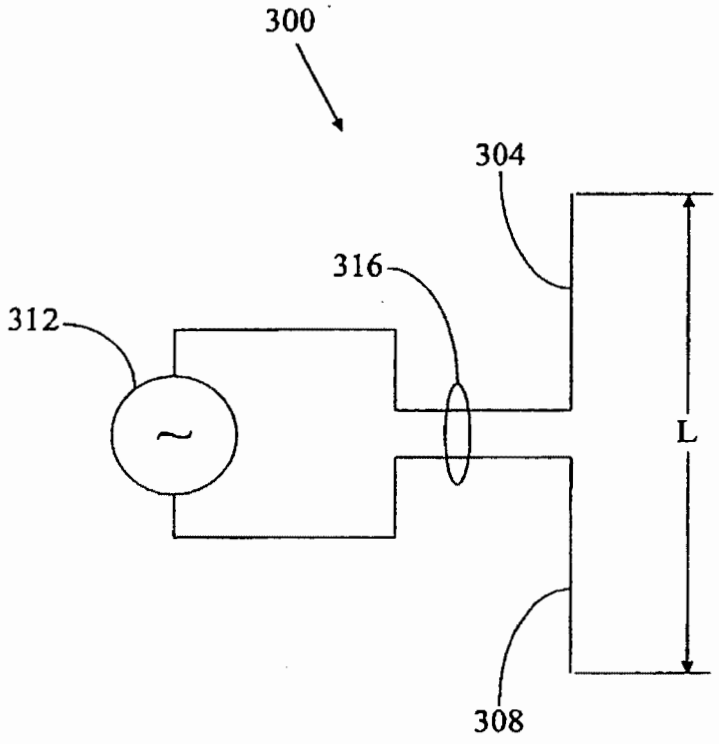


FIG. 3

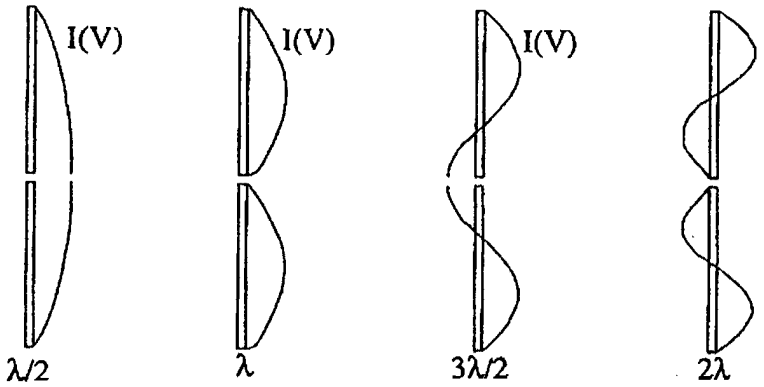


FIG. 4

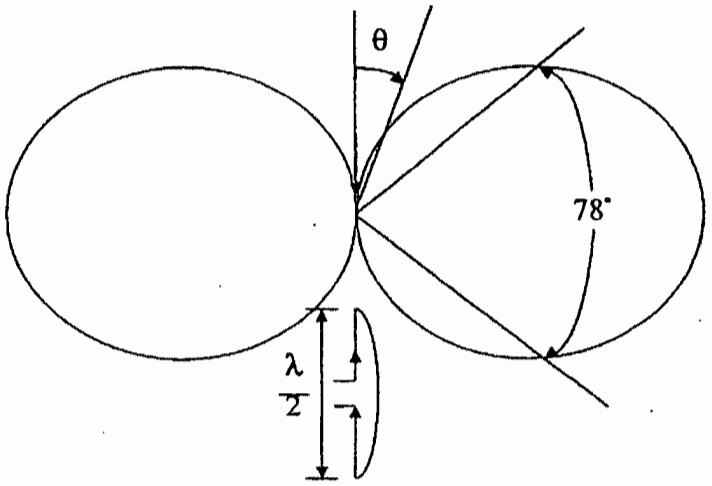


FIG. 5A

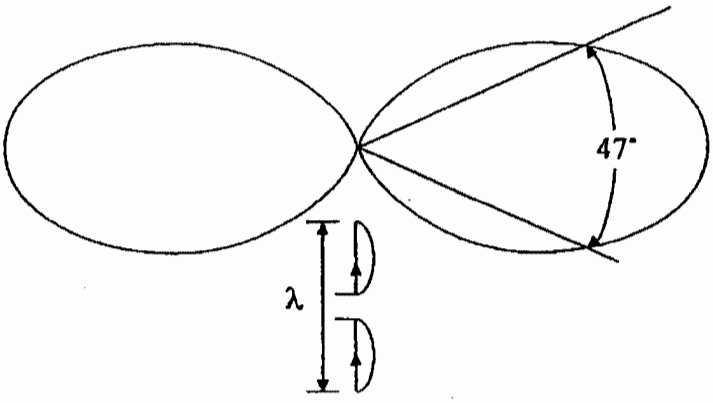


FIG. 5B

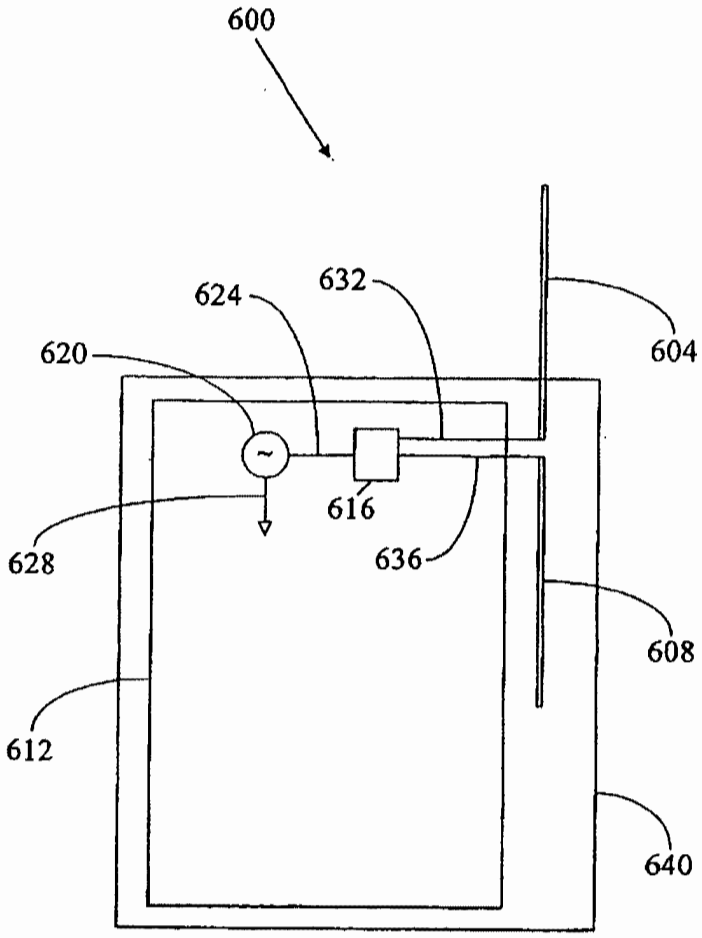


FIG. 6

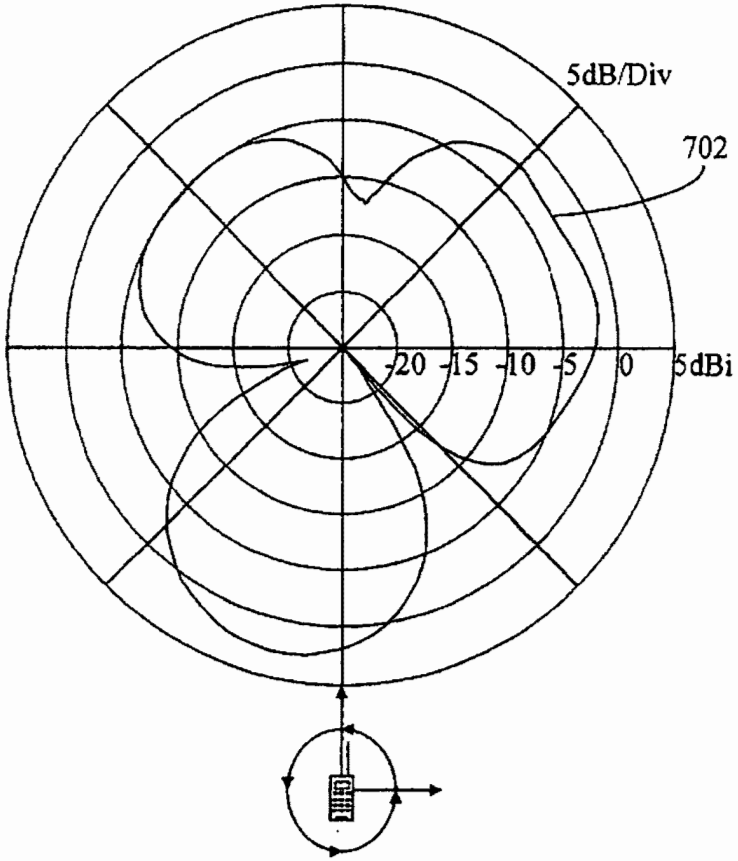


FIG. 7A

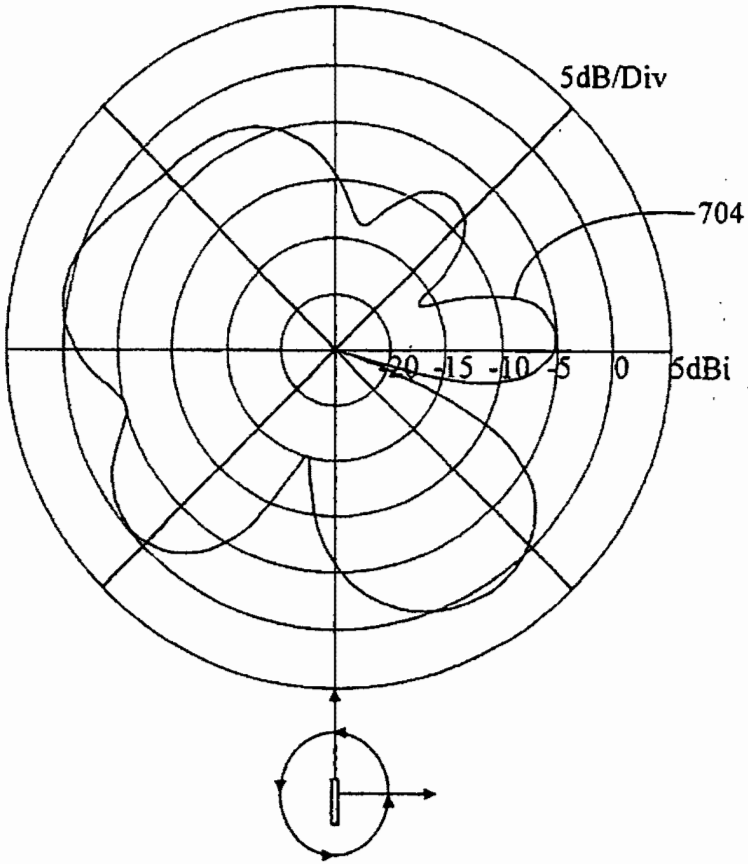


FIG. 7B

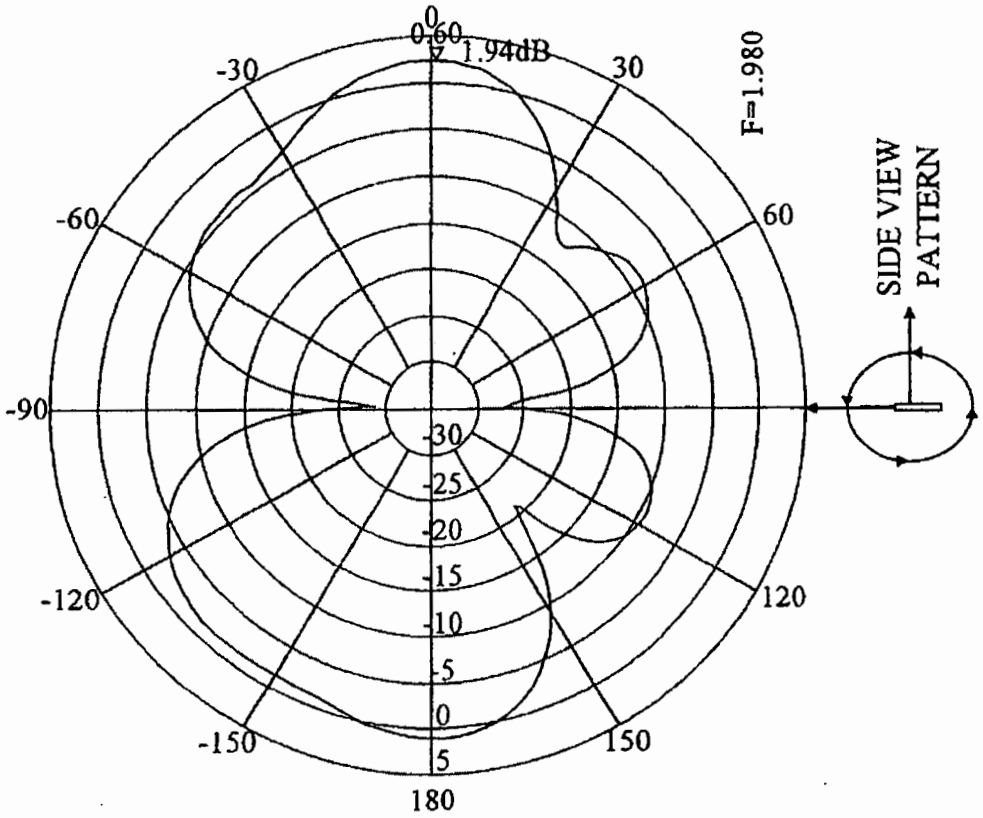

0
0.60
1.94dB
30
60
-30
-60
-90
-120
-150
180
150
120
-30
-25
-20
-15
-10
-5
0
5
F=1.980
SIDE VIEW
PATTERN

FIG. 8B

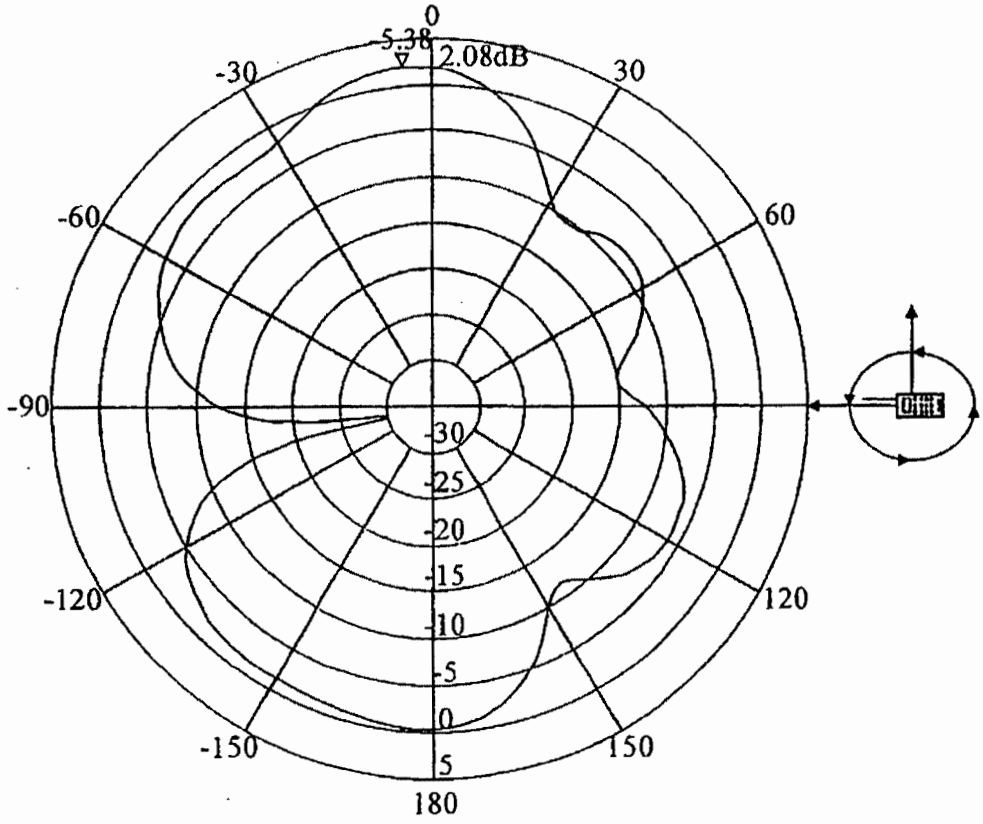

0
5.38
2.08dB
30
60
-30
-60
-90
-120
-150
180
150
120
-30
-25
-20
-15
-10
-5
0
5
OMNI

FIG. 8A

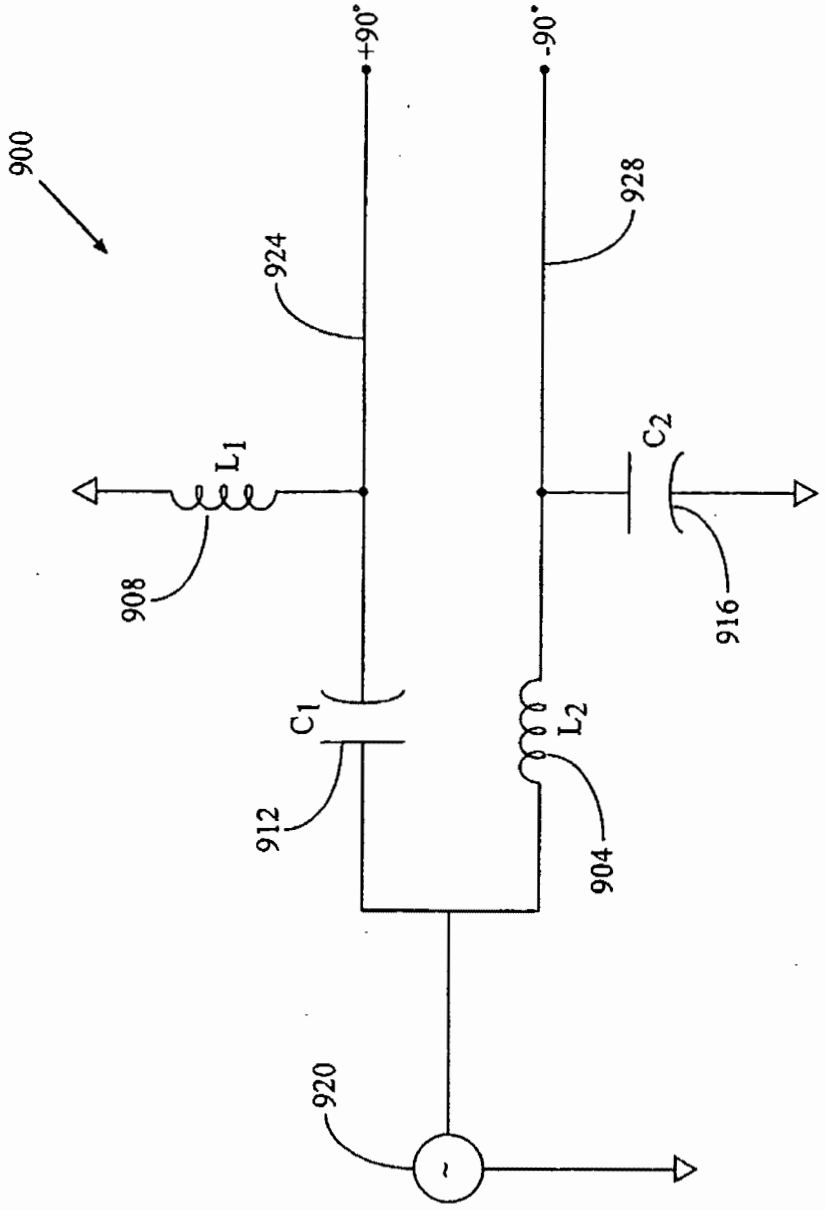


FIG. 9

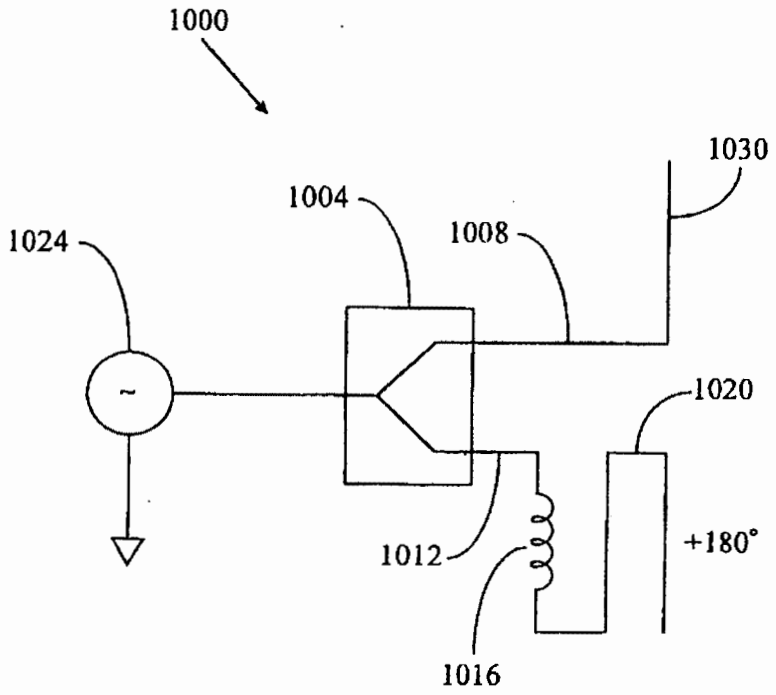


FIG. 10

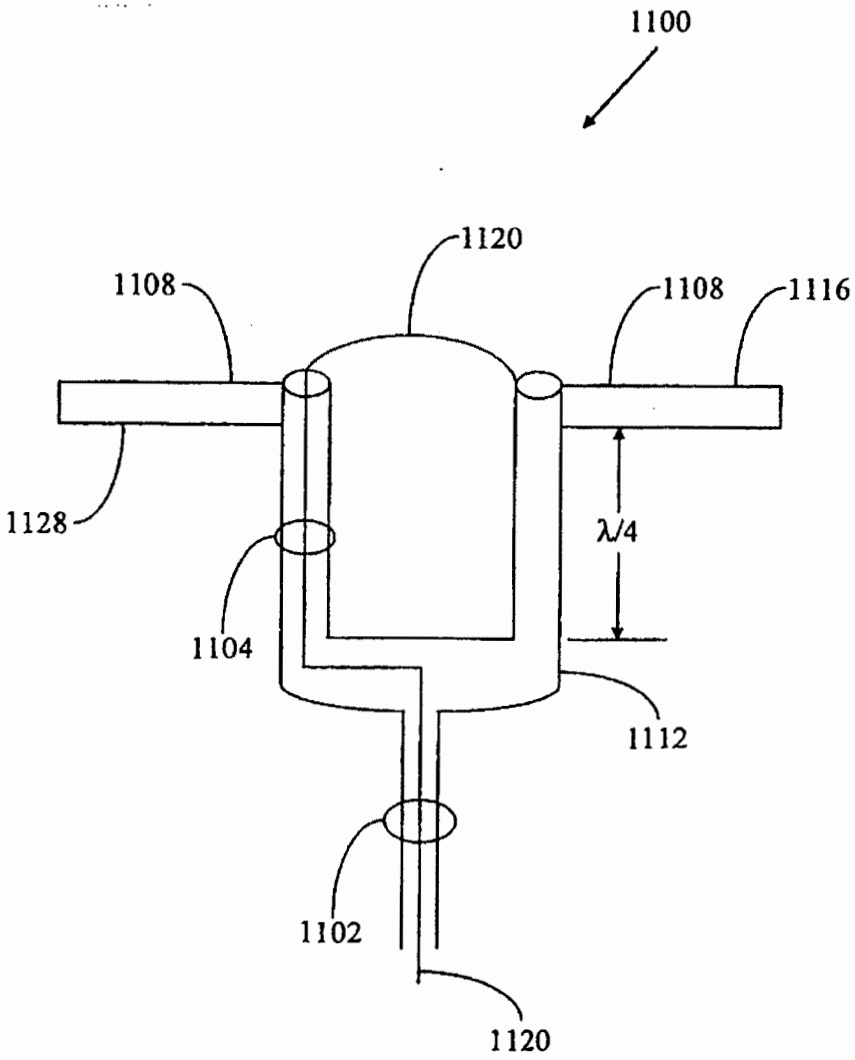


FIG. 11

INTERNATIONAL SEARCH REPORT

Inte ›nal Application No
PCT/US 99/29095

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01Q1/24 H01Q9/16 H01P5/10 H03H7/42

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01Q H01P H03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 010, no. 099 (E-396), 16 April 1986 (1986-04-16) -& JP 60 240201 A (MATSUSHITA DENKO KK), 29 November 1985 (1985-11-29) abstract; figures 1,2	1,2,5-10
Y		3,4,14
X	US 5 703 602 A (CASEBOLT MATTHEW PHILLIP) 30 December 1997 (1997-12-30) column 1, line 4-21 column 2, line 37 -column 4, line 40 column 7, line 1-32; figures 1A-3	1,2,5,6, 8,10,13

-/--

[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2000	25/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ribbe, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 99/29095

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	"PRINTED DIPOLE WITH PRINTED BALUN" IBM TECHNICAL DISCLOSURE BULLETIN,US,IBM CORP. NEW YORK, vol. 40, no. 6, 1 June 1997 (1997-06-01), pages 127-130, XP000728361 ISSN: 0018-8689 the whole document	1,2,5,6, 9,10,13
Y	EP 0 852 428 A (TDK CORP) 8 July 1998 (1998-07-08) column 4, line 11-23; figure 1C	3
Y	US 5 148 130 A (DIETRICH JAMES L) 15 September 1992 (1992-09-15) column 3, line 15 -column 4, line 11; figure 1	4
Y	ROLLEMA D W: "EENVOUDIGE BALUN" ELECTRON, vol. 29, no. 5, 1 May 1974 (1974-05-01), pages 193-196, XP002134963 Rotterdam,NL figure 3	14
P,X	US 5 949 383 A (HORTON ROBERT RAY ET AL) 7 September 1999 (1999-09-07) column 1, line 5-29 column 2, line 52 -column 3, line 31 column 4, line 9,10,26-29; figures 1A,3A	1,2,5, 9-13

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/US 99/29095

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 60240201 A	29-11-1985	NONE	
US 5703602 A	30-12-1997	NONE	
EP 0852428 A	08-07-1998	JP 10200360 A US 5949299 A	31-07-1998 07-09-1999
US 5148130 A	15-09-1992	NONE	
US 5949383 A	07-09-1999	AU 1073699 A WO 9921245 A	10-05-1999 29-04-1999

Form PCT/ISA/210 (patent family annex) (July 1992)

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **05-090824**
(43)Date of publication of application : **09.04.1993**

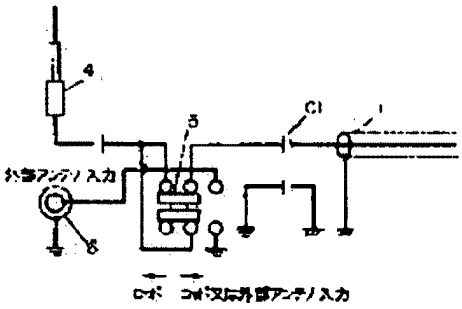
(51)Int.Cl. H01Q 1/50
H01Q 9/30

(21)Application number : **03-249002**
(22)Date of filing : **27.09.1991**

(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**
(72)Inventor : **TODA AKITOSHI**

(54) ANTENNA INPUT CIRCUIT

(57)Abstract:
PURPOSE: To provide an antenna input circuit which can satisfactorily back up an antenna over a wide range covering the VHF band through the UHF band.
CONSTITUTION: When a changeover switch 5 which performs the switching between an antenna 4 and an external antenna is switched to the side of an external antenna input terminal 6, the antenna 4 is connected to the earth. Thus the circuit earth is connected to a shileld sheath of a coaxial cable 1 and the antenna 4 is connected to the seath. When the switch 5 is set at the side of the antenna 4, the antenna 4 is connected to the core wire of the cable 1. Thus it is possible to reduce the change of reactance of an antenna input circuit even if the receiving frequency changes according to the operation of a switch means. Then a satisfactory antenna back-up function is secured over a wide covering the VHF band through the UFH band. In particular, the receiving sensitivity of the UHF band is improved.



CLAIMS

[Claim(s)]
[Claim 1]An antenna input circuit being about a switching means which changes an antenna to a core wire of a coaxial cable, and a shielded wire of said coaxial cable.
[Claim 2]The antenna input circuit according to claim 1 characterized by carrying out the switching action of the switching means according to rotation of said antenna while constituting an antenna, enabling free rotation.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the antenna input circuit used for a portable television set etc.
[0002]
[Description of the Prior Art]Television broadcasting is performed by the zone of both a UHF band and a VHF band, and the antenna input circuit of the television set is made so that it may correspond to the zone of the both. And many dipole antennas matched with a with an impedance [300 ohm] balanced input circuit as an antenna attached to a portable television set were used from before. However, a dipole antenna needs two cylindrical antenna bodies, it is user-unfriendly for a user, and the monopole antenna which has a with an impedance [75 ohm] unbalanced input circuit has come to be used for the reasons of a price becoming high.
[0003]The example of such a conventional antenna input circuit is shown in 3 figure and 4 figure. This conventional antenna input circuit is sharing the input terminal of the zone of both a UHF band and a VHF band. In order to obtain sensitivity equivalent to a dipole antenna or a loop antenna using a monopole antenna, such a conventional antenna input circuit, He adds the lead 3 of specified length in front of the ground capacitor 2 of the input line 1 of a tuner, and was trying for not only the antenna 4 but the lead 3 to receive a broadcasting electric-wave.
[0004]
[Problem(s) to be Solved by the Invention]Since the lead 3 with which an antenna operation is assisted in the above conventional composition is formed in the inside of a television set, The lead 3 received the various restrictions resulting from the structure of a television set, and the lead 3 was difficult to cross to the position and length from a VHF band in response to restrictions in the broadband of a UHF band, and to demonstrate an auxiliary operation of enough antennas.
[0005]This invention solves an aforementioned problem and it aims at providing the antenna input circuit which crosses to the broadband of a UHF band from a VHF band, and demonstrates an auxiliary operation of enough antennas.
[0006]
[Means for Solving the Problem]This invention establishes a switching means which changes an antenna to a core wire of a coaxial cable, and a shielded wire of a coaxial cable to achieve the above objects.
[0007]
[Function]By composition which described this invention above, even if an antenna is connected to the core wire of a coaxial cable, and the shielded wire of a coaxial cable and received frequency changes according to change operation of a switching means, change of the reactance of an antenna input circuit can be lessened.
[0008]
[Example]Hereafter, it explains, referring to drawing 1 and drawing 2 for the antenna input circuit of this invention.
[0009]Drawing 1 is a circuit diagram of the 1st example of this invention. 4 is an antenna and is connected to the changeover switch 5 here. 6 is an external antenna input terminal and this external antenna input terminal 6 is also connected to the changeover switch 5. 1 is a coaxial cable, one end of the core wire is connected to the changeover switch 5 via the capacitor C1, and the other end of a core wire is connected to a tuner

(not shown), and the shielded wire is connected to the circuit ground. And it is connected to the antenna 4 by the switch 5, or the end of the coaxial cable 1 is changed by it so that it may be connected to the external antenna input terminal 6. And if it changes so that the end of the coaxial cable 1 may be connected to the external antenna input terminal 6, the antenna 4 is constituted so that it may be connected to a circuit ground.

[0010]The antenna input circuit of this invention consists of the above composition, and explains the operation below.

[0011]First, when the broadcasting electric-wave of a VHF band is received, it is operated so that the changeover switch 5 may be connected with the antenna 4 in the core wire of the coaxial cable 1. Then, it is received by the antenna 4 and the broadcasting electric-wave of a VHF band is inputted into a tuner through the core wire of the coaxial cable 1.

[0012]And when receiving the broadcasting electric-wave of a UHF band, it is operated so that the changeover switch 5 may be connected with the antenna 4 in a circuit ground. Then, the broadcasting electric-wave of the received UHF band is inputted into a tuner through the shielded wire of the coaxial cable 1.

[0013]The reactance over a resisted part becomes large so that frequency is generally high, but the shielded wire of the coaxial cable 1 has large surface area as compared with a core wire, and a reactance does not become so large. Therefore, if it is operated so that the changeover switch 5 may be connected with the antenna 4 in a circuit ground when receiving the broadcasting electric-wave of a UHF band, the impedance of the antenna 4 seen from the tuner side will not increase greatly. A signal can be received in FUREKISHIFURU by changing the length of an antenna, and a position by taking out the lead linked to the ground side outside.

[0014]Drawing 2 is a circuit diagram of the 2nd example of this invention. The number same about the members forming same here as the 1st above-mentioned example is given, and explanation is omitted.

[0015]7 is the plug provided in the root of the antenna 4, it is divided into two along the shaft orientations, and while it was divided (slash part in a figure), it comprises an insulating material. 8 is a receptacle in which the plug 7 is inserted, and is the composition that the semicircular state metal of the couple countered and the insulating material intervened between them. And one metal piece of the receptacle 8 is connected to the core wire of the coaxial cable 4 via the capacitor C1, and the metal piece of another side is connected to the circuit ground via the capacitor C2.

[0016]When the thing of this example rotates the antenna 4 180 degrees, it is connected to the core wire of the coaxial cable 1, or the antenna 4 is connected to a circuit ground.

[0017]Thus, the same effect as the case where the changeover switch 5 of the thing of the 1st above-mentioned example is changed is acquired.

[0018]

[Effect of the Invention]In order that the antenna input circuit of this invention may establish the switching means which changes an antenna to the core wire of a coaxial cable, and the shielded wire of a coaxial cable as mentioned above, If change operation of a changeover switch is performed according to received frequency, an antenna will be connected to the core wire of a coaxial cable, and the shielded wire of a coaxial cable according to change operation of a switching means, Even if received frequency changes, change of the reactance of an antenna input circuit can be lessened, it can cross to the broadband of a UHF band from a VHF band, an auxiliary operation of enough antennas can be demonstrated, and especially the receiving sensitivity of a UHF band

can be raised.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The circuit diagram of the antenna input circuit in the 1st example of this invention
[Drawing 2]The circuit diagram of the antenna input circuit in the 2nd example of this invention
[Drawing 3]The circuit diagram of the conventional antenna input circuit
[Drawing 4]The circuit diagram of the conventional antenna input circuit
[Description of Notations]
1 Coaxial cable
4 Antenna
5 Changeover switch
6 External antenna input terminal
7 Plug
8 Receptacle

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（A）　(11)特許出願公開番号

特開平5－90824

(43)公開日　平成５年(1993)４月９日

(51)Int.Cl.⁵		識別記号	庁内整理番号	Ｆ Ｉ	技術表示箇所
Ｈ０１Ｑ	1/50		7046－5Ｊ		
	9/30		7046－5Ｊ		

審査請求　未請求　請求項の数２(全　４　頁)

(21)出願番号　特願平3－249002

(22)出願日　平成３年(1991)９月27日

(71)出願人　000005821
松下電器産業株式会社
大阪府門真市大字門真1006番地

(72)発明者　戸田　明利
大阪府門真市大字門真1006番地　松下電器産業株式会社内

(74)代理人　弁理士　小鍜治　明　(外２名)

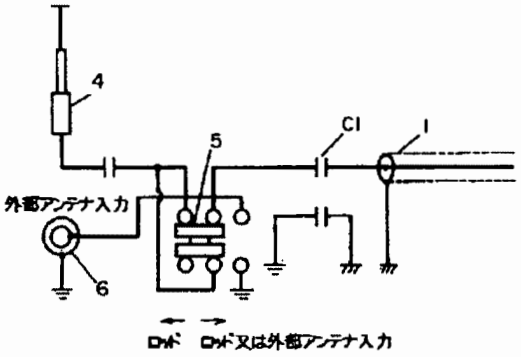
(54)【発明の名称】　アンテナ入力回路

(57)【要約】

【目的】　本発明は、ＶＨＦ帯からＵＨＦ帯の広帯域に渡って十分なアンテナの補助作用を発揮するアンテナ入力回路を提供することを目的とする。

【構成】　アンテナ４と外部アンテナとの切り替えを行う切り替えスイッチ５を有し、切り替えスイッチ５を外部アンテナ入力端子６側に切り替えるとアンテナ４と回路アースとが接続される。これによって回路アースは同軸ケーブル１のシールド線に接続され、アンテナ４と同軸ケーブル１のシールド線が接続されるようにしたものである。切り替えスイッチ５をアンテナ４側に切り替えるとアンテナ４と同軸ケーブル１の芯線が接続される。

【効果】　切り替え手段の操作に応じて、受信周波数が変化してもアンテナ入力回路のリアクタンスの変化を少なくすることができ、ＶＨＦ帯からＵＨＦ帯の広帯域に渡って十分なアンテナの補助作用を発揮することができ、特にＵＨＦ帯の受信感度を向上させることができる。



1

【特許請求の範囲】

【請求項1】アンテナを同軸ケーブルの芯線と前記同軸ケーブルのシールド線とに切り替えを行う切り替え手段を有することを特徴とするアンテナ入力回路。

【請求項2】アンテナを回動自在に構成するとともに、切り替え手段は前記アンテナの回転に応じて切り替え動作するようにしたことを特徴とする請求項1記載のアンテナ入力回路。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はポータブルのテレビジョンセット等に用いられるアンテナ入力回路に関するものである。

【0002】

【従来の技術】テレビジョン放送はUHF帯とVHF帯の両方の帯域で行われており、テレビジョンセットのアンテナ入力回路はその両方の帯域に対応するように作られている。そして従来より、ポータブルのテレビジョンセットに取り付けられるアンテナとしてはインピーダンス300Ωの平衡入力回路にマッチングするダイポールアンテナが多く用いられていた。しかし、ダイポールアンテナは棒状のアンテナ本体を2本必要とし、使用者にとって使い勝手が悪く、また価格が高くなる等の理由により、インピーダンス75Ωの不平衡入力回路を有するモノポールアンテナが用いられるようになって来た。

【0003】このような従来のアンテナ入力回路の例を3図および4図に示す。この従来のアンテナ入力回路は、UHF帯とVHF帯の両方の帯域の入力端子を共用している。このような従来のアンテナ入力回路は、モノポールアンテナを用いてダイポールアンテナやループアンテナと同等の感度を得るために、チューナの入力線路1の接地コンデンサ2の前に所定長の導線3を付加し、アンテナ4のみでなく導線3によっても放送電波を受けるようにしていた。

【0004】

【発明が解決しようとする課題】上記のような従来の構成においてはアンテナ作用を補助する導線3をテレビジョンセットの内部に設けているため、導線3はテレビジョンセットの構造に起因する種々の制約を受け、導線3はその位置や長さに制約を受けてVHF帯からUHF帯の広帯域に渡って十分なアンテナの補助作用を発揮することは困難であった。

【0005】本発明は上記課題を解決するもので、VHF帯からUHF帯の広帯域に渡って十分なアンテナの補助作用を発揮するアンテナ入力回路を提供することを目的とする。

【0006】

【課題を解決するための手段】本発明は上記目的を達成するために、アンテナを同軸ケーブルの芯線と同軸ケーブルのシールド線とに切り替えを行う切り替え手段を設けたものである。

2

【0007】

【作用】本発明は上記した構成により、切り替え手段の切り替え操作に応じてアンテナは同軸ケーブルの芯線と同軸ケーブルのシールド線に接続され、受信周波数が変化してもアンテナ入力回路のリアクタンスの変化を少なくすることができる。

【0008】

【実施例】以下、本発明のアンテナ入力回路について図1、図2を参照しながら説明する。

【0009】図1は本発明の第1実施例の回路図である。ここで4はアンテナであり、切り替えスイッチ5に接続されている。6は外部アンテナ入力端子であり、この外部アンテナ入力端子6も切り替えスイッチ5に接続されている。1は同軸ケーブルであり、その芯線の一端はコンデンサC1を介して切り替えスイッチ5に接続され、また芯線の他端はチューナ（図示せず）に接続され、シールド線は回路アースに接続されている。そしてスイッチ5によって同軸ケーブル1の一端はアンテナ4に接続されたり、外部アンテナ入力端子6に接続されるように切り替えられる。そして同軸ケーブル1の一端が外部アンテナ入力端子6に接続されるように切り替えられると、アンテナ4は回路アースに接続されるように構成されている。

【0010】本発明のアンテナ入力回路は以上のような構成よりなり、以下その動作について説明をする。

【0011】まず、VHF帯の放送電波を受信している場合、切り替えスイッチ5をアンテナ4と同軸ケーブル1の芯線が接続されるように操作する。すると、VHF帯の放送電波はアンテナ4で受信され、同軸ケーブル1の芯線を通ってチューナに入力される。

【0012】そしてUHF帯の放送電波を受信する場合、切り替えスイッチ5をアンテナ4と回路アースが接続されるように操作する。すると、受信されたUHF帯の放送電波は同軸ケーブル1のシールド線を通ってチューナに入力される。

【0013】一般に周波数が高い程、抵抗分に対するリアクタンスは大きくなるが、同軸ケーブル1のシールド線は芯線と比較して表面積が大きく、リアクタンスはそれ程大きくならない。従ってUHF帯の放送電波を受信する場合、切り替えスイッチ5をアンテナ4と回路アースが接続されるように操作すると、チューナ側から見たアンテナ4のインピーダンスは大きく増加することはない。更にアース側に接続している導線を外部に取り出すことでアンテナの長さ、位置を変えることにより、フレキシフルに信号を受けることができる。

【0014】図2は本発明の第2実施例の回路図である。ここで上記の第1実施例と同じ構成部材については同一の番号を付与して説明を省略する。

【0015】7はアンテナ4の根元に設けられたプラグ

3

であり、その軸方向に沿って2分割されており、分割された一方（図中斜線部）は絶縁物で構成されている。8はプラグ7の挿入されるプラグ受けであり、一対の半円状の金属が対向し、その間に絶縁物が介在した構成である。そしてプラグ受け8の一方の金属片はコンデンサC1を介して同軸ケーブル4の芯線に接続され、他方の金属片はコンデンサC2を介して回路アースに接続されている。

【0016】この実施例のものは、アンテナ4を180度回転させることにより、アンテナ4は同軸ケーブル1の芯線に接続されたり、回路アースに接続される。

【0017】このように、上記の第1実施例のものの切り替えスイッチ5を切り替えた場合と同様の効果が得られる。

【0018】

【発明の効果】以上のように本発明のアンテナ入力回路は、アンテナを同軸ケーブルの芯線と同軸ケーブルのシールド線とに切り替えを行う切り替え手段を設けたものであるため、受信周波数に応じて切り替えスイッチの切り替え操作を行うと、アンテナは切り替え手段の切り替え操作に応じて同軸ケーブルの芯線と同軸ケーブルのシールド線に接続され、受信周波数が変化してもアンテナ入力回路のリアクタンスの変化を少なくすることができ、VHF帯からUHF帯の広帯域に渡って十分なアンテナの補助作用を発揮することができ、特にUHF帯の受信感度を向上させることができる。

4

【図面の簡単な説明】

【図1】本発明の第1の実施例におけるアンテナ入力回路の回路図

【図2】本発明の第2の実施例におけるアンテナ入力回路の回路図

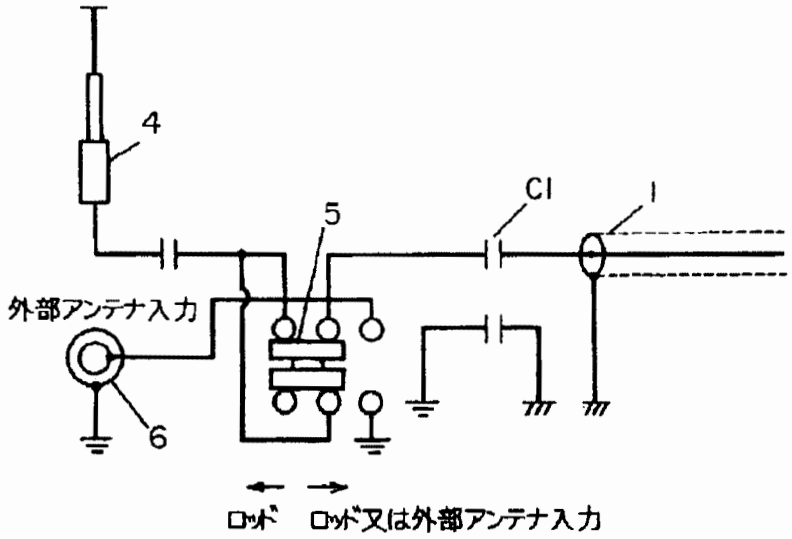
【図3】従来のアンテナ入力回路の回路図

【図4】従来のアンテナ入力回路の回路図

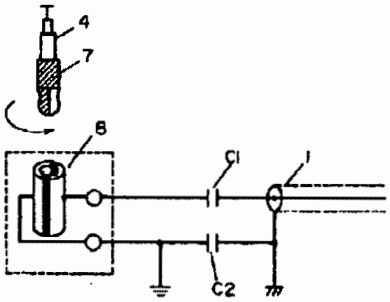
【符号の説明】

1　同軸ケーブル
4　アンテナ
5　切り替えスイッチ
6　外部アンテナ入力端子
7　プラグ
8　プラグ受け

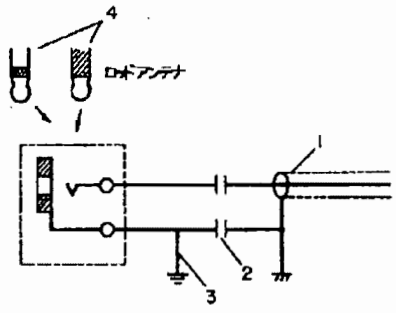
【図1】



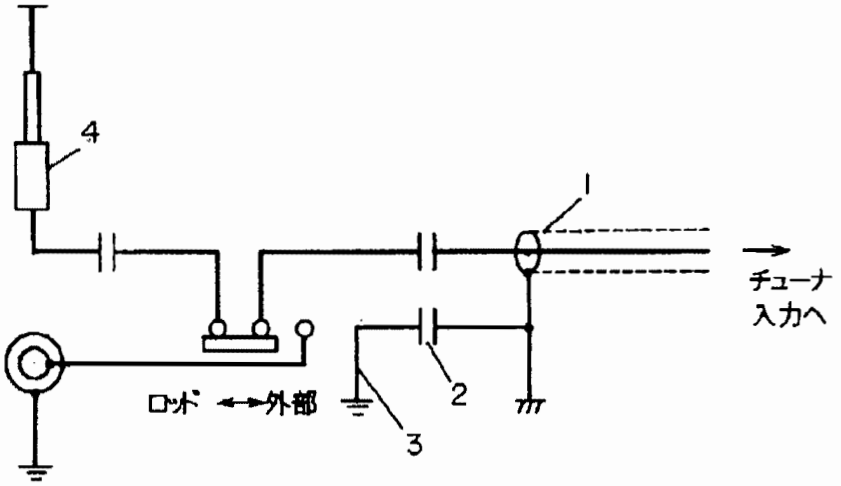
【図2】



【図4】



【図3】



(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2001－7639
（P2001－7639A）
(43)公開日　平成13年１月12日(2001.1.12)

(51)Int.Cl.⁷	識別記号	Ｆ Ｉ		テーマコード（参考）
Ｈ０１Ｑ　21/30		Ｈ０１Ｑ　21/30		５Ｊ０２０
1/24		1/24	Ｚ	５Ｊ０２１
1/38		1/38		５Ｊ０４５
13/08		13/08		５Ｊ０４６
19/26		19/26		５Ｊ０４７

審査請求　有　請求項の数９　ＯＬ　（全 11 頁）　最終頁に続く

(21)出願番号　特願平11－179676

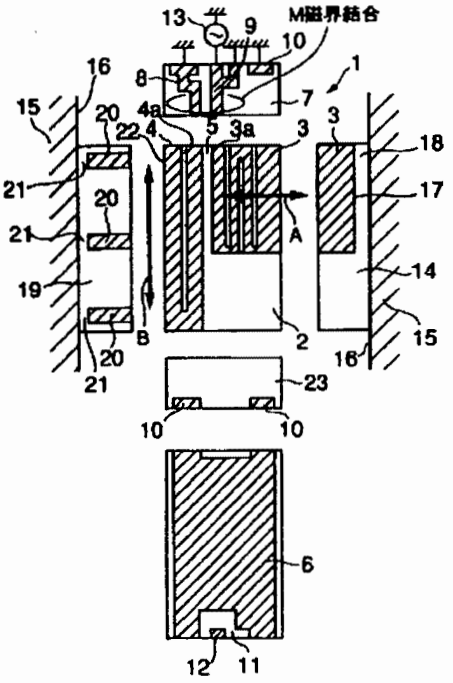
(22)出願日　平成11年６月25日(1999.6.25)

(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者　南雲　正二
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(72)発明者　椿　信人
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(74)代理人　100093894
弁理士　五十嵐　清

最終頁に続く

(54)【発明の名称】　アンテナ装置およびそれを用いた通信装置

(57)【要約】
【課題】　２つの周波数に対応した１チップタイプのアンテナ装置を提供する。
【解決手段】　長方体の誘電体基体１の上面２に給電側放射電極３と無給電側放射電極４を励振方向Ａ、Ｂが直交するように形成する。共通側面７には電磁界結合するショート部８、９を近接形成する。ショート部８は無給電側放射電極４に接続する。ショート部９の一端は給電側放射電極３に接続し、他端は信号源１３に接続する。給電側放射電極３の開放端２２は側面１９の開放端電極２０を介して接地面１６と容量結合する。側面１９と反対側の側面１４に給電側放射電極３の開放端１７を形成し、開放端１７は接地面１６と容量結合する。信号源１３の信号を給電側放射電極３に直接給電して設定周波数で共振させる。また、信号源１３の信号はショート部８、９の電磁界結合を介して無給電側放射電極４に給電して異なる設定周波数で共振させる。



【特許請求の範囲】
【請求項１】 誘電体基体の表面に給電側放射電極と無給電側放射電極とが分離して形成され、誘電体基体の一側面には給電側放射電極のショート部と無給電側放射電極のショート部とが互いに近接位置に配置されており、給電側放射電極の開放端と無給電側放射電極の開放端は誘電体基体の前記ショート部の形成面を避けた互いに異なる側面がわに形成されていることを特徴とするアンテナ装置。
【請求項２】 給電側放射電極の開放端と無給電側放射電極の開放端は誘電体基体の互いに反対となる側面がわに形成されていることを特徴とする請求項１記載のアンテナ装置。
【請求項３】 給電側放射電極と無給電側放射電極は、給電側放射電極の励振方向と無給電側放射電極の励振方向が互いにほぼ直交する方向となる配置としたことを特徴とする請求項１又は請求項２記載のアンテナ装置。
【請求項４】 誘電体基体は直方体と成し、誘電体基体の上面には給電側放射電極と無給電側放射電極の一方側電極が上面の一端側寄りに当該一端側のほぼ全幅を含む四角形領域に形成され、他方側電極は上面の残りの領域中に形成され、この他方側電極は前記一方側電極の形成領域に対して反対側となる上面の他端側のほぼ全幅の区間を開放端側と成し、前記一方側電極に対面する側の他方側電極の周縁は前記一方側電極の四角形領域幅の一端側から他端側に向かうにしたがい一方側電極から離れる方向に湾曲した形状と成していることを特徴とする請求項１又は請求項２又は請求項３記載のアンテナ装置。
【請求項５】 給電側放射電極と無給電側放射電極の少なくとも一方はミアンダ状に形成されていることを特徴とする請求項１乃至請求項４の何れか１つに記載のアンテナ装置。
【請求項６】 誘電体基体は内部に穴が開けられるか又は底部側が開口されて内部が中空となっていることを特徴とする請求項１乃至請求項５の何れか１つに記載のアンテナ装置。
【請求項７】 給電側放射電極と無給電側放射電極が形成された誘電体基体は四角形状の実装基板面の隅部に実装されており、誘電体基体に形成される前記給電側放射電極と無給電側放射電極は実装基板の端面辺に沿わせて配置されていることを特徴とする請求項１乃至請求項６の何れか１つに記載のアンテナ装置。
【請求項８】 実装基板は長四角形と成し、無給電側放射電極は実装基板の長辺側の端面辺に沿わせて配置されていることを特徴とする請求項７記載のアンテナ装置。
【請求項９】 請求項１乃至請求項８の何れか１つに記載のアンテナ装置が装備されて成ることを特徴とする通信装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は２つの周波数帯での通信を可能とする表面実装タイプのアンテナ装置およびそれを用いた携帯電話等の通信装置に関するものである。
【０００２】
【従来の技術】図９に、２つの周波数帯での通信に対応した従来のアンテナ装置を示す。同図において、アンテナ装置１００は２つの互いに共振周波数の異なるパッチアンテナ１０１、１０２を一定間隔をあけて並べて配置し、容量を介してともに１つの信号源１０３に接続したものである。このように、互いに周波数の異なるパッチアンテナを２個並べて配置することによって２つの周波数帯域に対応したアンテナ装置を構成することができる。
【０００３】
【発明が解決しようとする課題】しかしながら、この種のアンテナ装置は、２つのパッチアンテナ１０１と１０２の間隔が小さいと、パッチアンテナ間で不要な干渉が生じ、必要な特性が得られないことがある。２つのパッチアンテナの相互の干渉を無視できる程度まで小さくするためには、両者の間隔を０．３波長以上に広げる必要があり、アンテナ装置全体が大型化してしまうという問題がある。
【０００４】最近においては、アンテナ装置を搭載する携帯電話等の通信装置の小型化が進んでおり、２つのパッチアンテナを並べて配置する方式では、通信装置の小型化をさらに進める上で支障となる。そこで、本発明者は通信装置の小型化に対応するものとして、アンテナをチップ化する技術開発に取り組んできた。
【０００５】本発明者は、２つの周波数帯をもつ表面実装型アンテナ装置の開発の第１段階として、第１の周波数で動作する第１の表面実装型アンテナと、第２の周波数で動作する第２の表面実装型アンテナとを用意し、この２つの表面実装型アンテナを実装基板上に近接配置することを試みた。
【０００６】しかしながら、２つの表面実装型アンテナを用意することは装置の生産効率が悪く、通信装置の小型化を大幅に進める上で限界が生じる。また、アンテナを表面実装型にするために小型化すると、利得が低下するという問題が新たに発生する。この新たな問題は、アンテナ間隔を狭くすることにより抑制できるが、アンテナ間隔を狭くするとアンテナ間の干渉の問題が生じてしまうことになる。
【０００７】本発明者は開発研究の試行錯誤を繰り返すうちに、利得の低下を抑制でき、さらに、２つのアンテナ電極パターンを１つの誘電体表面に隣接配置するにも拘らず相互電極間信号の干渉を抑制し得る、２つの周波数に対応し得る画期的な１チップタイプの特有なアンテナ電極構造を解明するに至った。本発明は上記事情に鑑み成されたものであり、その目的は、上記特有なアンテ

ナ電極構造を備え、2つの周波数に対応した高性能の1チップタイプの小型アンテナ装置およびそれを用いた通信装置を提供することにある。

【0008】

【課題を解決するための手段】本発明は上記目的を達成するために、次にような手段をもって、課題を解決する手段としている。すなわち、第1の発明のアンテナ装置は、誘電体基体の表面に給電側放射電極と無給電側放射電極とが分離して形成され、誘電体基体の一側面には給電側放射電極のショート部と無給電側放射電極のショート部とが互いに近接位置に配置されており、給電側放射電極の開放端と無給電側放射電極の開放端は誘電体基体の前記ショート部の形成面を避けた互いに異なる側面がわに形成されている構成をもって課題を解決する手段としている。

【0009】また、第2の発明のアンテナ装置は、前記第1の発明のアンテナ装置の構成を備えた上で、給電側放射電極の開放端と無給電側放射電極の開放端は誘電体基体の互いに反対となる側面がわに形成されている構成をもって課題を解決する手段としている。

【0010】さらに、第3の発明のアンテナ装置は、前記第1又は第2の発明のアンテナ装置の構成を備えた上で、給電側放射電極と無給電側放射電極は、給電側放射電極の励振方向と無給電側放射電極の励振方向が互いにほぼ直交する方向となる配置とした構成をもって課題を解決する手段としている。

【0011】さらに、第4の発明のアンテナ装置は、前記第1又は第2又は第3の発明のアンテナ装置の構成を備えた上で、誘電体基体は直方体と成し、誘電体基体の上面には給電側放射電極と無給電側放射電極の一方側電極が上面の一端側寄りに当該一端側のほぼ全幅を含む四角形領域に形成され、他方側電極は上面の残りの領域中に形成され、この他方側電極は前記一方側電極の形成領域に対して反対側となる上面の他端側のほぼ全幅の区間を開放端側と成し、前記一方側電極に対面する側の他方側電極の周縁は前記一方側電極の四角形領域幅の一端側から他端側に向かうにしたがい一方側電極から離れる方向に湾曲した形状と成していることをもって課題を解決する手段としている。

【0012】さらに、第5の発明のアンテナ装置は、前記第1乃至第4の何れか1つの発明のアンテナ装置の構成を備えた上で、給電側放射電極と無給電側放射電極の少なくとも一方はミアンダ状に形成されている構成をもって課題を解決する手段としている。

【0013】さらに、第6の発明のアンテナ装置は、前記第1乃至第5の何れか1つの発明のアンテナ装置の構成を備えた上で、誘電体基体は内部に穴が開けられるか又は底部側が開口されて内部が中空となっている構成としたことをもって課題を解決する手段としている。

【0014】さらに、第7の発明のアンテナ装置は、前記第1乃至第6の何れか1つの発明のアンテナ装置の構成を備えた上で、給電側放射電極と無給電側放射電極が形成された誘電体基体は四角形状の実装基板面の隅部に実装されており、誘電体基体に形成される前記給電側放射電極と無給電側放射電極は実装基板の端面辺に沿わせて配置されている構成もって課題を解決する手段としている。

【0015】さらに、第8の発明のアンテナ装置は、前記第7の発明のアンテナ装置の構成を備えた上で、実装基板は長四角形と成し、無給電側放射電極は実装基板の長辺側の端面辺に沿わせて配置されている構成もって課題を解決する手段としている。さらに、本発明の通信装置は上記第1乃至第8の発明の何れか1つの発明のアンテナ装置を装備したものであることを特徴とする。

【0016】本発明においては、誘電体基体の側面がわに給電側放射電極と無給電側放射電極の開放端を形成しているので、誘電体基体を実装基板に実装したとき、これら開放端と実装基板側の接地電極（接地面）との間に高い電磁界結合を達成できる。このことにより、開放端での電界の強度が高まり、アンテナをチップ化して小型化するにもかかわらず利得の低下が抑制される。

【0017】また、給電側放射電極と無給電側放射電極の開放端は誘電体基体の例えば反対側の側面という如く、異なる側面がわに形成されているので、ショート部と開放端を直線で結ぶ方向（共振電流の方向）によって表される、給電側放射電極の励振方向と無給電側放射電極の励振方向とが直交等の交叉する方向となる（給電側放射電極から放射される電波の偏波面と無給電側放射電極から放射される電波の偏波面とが直交等の交叉する方向となる）ので、給電側放射電極と無給電側放射電極を1つの誘電体基体の表面に近接配置しても両電極間の信号の干渉が効果的に抑制でき、2つの周波数を使用した高品質の通信が可能となるものである。

【0018】なお、本明細書においては、給電側放射電極と無給電側放射電極の各ショート部とはそれぞれの放射電極中で流れる電流が最大となる導体電極部を意味している。

【0019】

【発明の実施の形態】以下、本発明の実施形態例を図面に基づき説明する。なお、以下の各実施形態例の説明において、共通する構成部分には共通の符号を付し、その重複説明は省略又は簡略化する。図1は本発明に係るアンテナ装置の第1の実施形態例の要部構成を示す。この図1は各種電極が形成されている誘電体基体1の表面を模式的な6面図の態様で示したものである。

【0020】図1において、誘電体基体1はセラミックスや樹脂等の誘電率の高い材料によって形成され、長方体の形態を成している。誘電体基体1の上面2には給電側放射電極3と無給電側放射電極4とがそれぞれミアンダ状に形成されている。無給電側放射電極4は長方形を

した上面2の左端側の四辺形領域に形成されており、その四辺形領域は上面2の左側長辺の全区間を含んでいる。給電側放射電極3は上面2の右上側の隅部を含む四辺形領域に形成されている。そして、これら、上面2に形成された左側の無給電側放射電極4と右上側の給電側放射電極3とは間隙5を介して分離されている。

【0021】誘電体基体1の前方側側面7には無給電側放射電極4の最内端のミアンダパターン4aに導通するショート部8と、給電側放射電極3の最内端のミアンダパターン3aに導通するショート部9と、アース部10との電極パターンが形成されている。誘電体基体1の底面にはほぼ全面にわたって接地電極6が形成されており、前記ショート部8とアース部10は接地電極6に導通している。また、誘電体基体1の底面には前記接地電極6に対する絶縁領域11が形成され、この絶縁領域11内に給電接続電極12が設けられている。この給電接続電極12は前記ショート部9に導通している。この給電接続電極12に信号源13が接続されるようになっており、信号源13から直接的に給電側放射電極3への給電が行われるようになっている。

【0022】本実施形態例においては、前記ショート部8と9は互いに電磁界結合（電磁結合）する近接配置となっており、信号源13から給電側放射電極3に加えられる信号は電磁界結合を介して無給電側放射電極4にも加えられ、信号源13からの給電によって、給電側放射電極3と無給電側放射電極4とが共に給電された信号の波長にしたがって1／4波長で共振してアンテナ動作を行う構成となっている。なお、給電側放射電極3のアンテナ動作の周波数と無給電側放射電極4のアンテナ動作の周波数は互いに異なる周波数となるように設定されている。

【0023】誘電体基体1の右側面14には給電側放射電極3が高さ方向の中間位置まで伸長されている。なお、誘電体基体1は実装基板15の接地面（接地電極）16上に実装されるようになっており、この給電側放射電極3の開放端17と接地面16とは容量結合し、この右側面14の容量結合部が給電側放射電極3の強電界部18と成している。

【0024】誘電体基体1の左側側面19には無給電側放射電極4の開放端22に導通する開放端電極20が無給電側放射電極4側から下方の接地面16に向けて伸長形成されており、この開放端電極20の下端と接地面16との間には間隔が設けられて、開放端電極20と接地面16とは容量結合し、この左側面19の容量結合部が無給電側放射電極4の強電界部21と成している。この図1の例では給電側放射電極3の開放端17と無給電側放射電極4の開放端（符号20および22の部分）とは誘電体基体1の互いに反対となる側面14、19側に形成されている。

【0025】誘電体基体1の後方側面23の底部近傍にはアース部10が形成されており、このアース部10は底面の接地電極6に導通されている。

【0026】第1実施形態例のアンテナ装置における誘電体基体1の電極構造は上記のように構成されおり、アンテナ動作を次のように行う。信号源13から供給される信号によって給電側放射電極3が直接的に給電される一方、電流が最大となるショート部8と9の電磁界結合によって、無給電側放射電極4も信号源13の信号によって給電される。給電側放射電極3に供給された信号の電流は、ショート部9から開放端17に向かって流れ、設定周波数f_1でもって共振して矢印Aの方向に励振する。他方において、無給電側放射電極4に供給された信号の電流は、ショート部8から開放端20に向かって流れ、f_1とは異なる設定周波数f_2でもって共振して矢印Bの方向（矢印Aの方向に対して略直交する方向）に励振する。

【0027】このように、信号源13からの給電信号によって、周波数f_1によるアンテナ動作と周波数f_2よるアンテナ動作とが行われる。なお、給電側放射電極3に流れる電流の向きは励振方向のAの向きと同じであり、無給電側放射電極4に流れる電流の向きは励振方向のBの向きと同じである。したがって、給電側放射電極3に流れる電流（共振電流）の向きと無給電側放射電極4に流れる電流（共振電流）の向きは略直交関係となる。

【0028】本実施形態例によれば、1つのチップの誘電体基体1の表面にそれぞれ異なる周波数でアンテナ動作を行う放射電極3、4を近接して設けたものであるから、アンテナ装置の大幅な小型化が可能となる。しかも、誘電体基体1は誘電率が高いので、信号の管内波長（放射電極を伝搬するときの信号の波長）の短縮効果が大きく、このこともアンテナ装置の小型化に寄与することとなる。

【0029】また、給電側放射電極3の開放端17と無給電側放射電極4の開放端電極（開放端）20、22は誘電体基体1の互いに反対となる側面14、19側に形成されているので、給電側放射電極3と無給電側放射電極4の共振電流の向きは直交し、その結果、両放射電極3、4の励振方向（偏波方向）A，Bも直交関係となるので、給電側放射電極3と無給電側放射電極4とを誘電体基体1の上面に近接配置しても、給電側放射電極3側の信号と無給電側放射電極4側の信号との干渉が抑制され、高性能のアンテナ動作を行うことが可能である。特に給電側放射電極3と無給電側放射電極4の開放端が誘電体基体1の反対の側面がわにもうけられているので、給電側放射電極3と無給電側放射電極4の強電界部相互の信号干渉をほぼ完璧に防止できる。

【0030】さらに、前記のように給電側放射電極3側の信号と無給電側放射電極4側の信号との干渉が抑制されて各放射電極3、4の共振動作が行われる上に、各放

射電極３、４の開放端１７、２０を実装基板１５の接地面１６と静電結合するようにしたので、この開放端１７、２０において、電界集中することができ、このことにより、アンテナ装置を小型にするにも拘らず、放射電極間の干渉を抑えることが可能であり、利得の低下を抑制して品質の高い通信を行うことができるものである。

【００３１】図２は本発明に係るアンテナ装置の第２の実施形態例を示す。この第２実施形態例は給電側放射電極３を誘電体基体１の上面２の前方側の四角形領域（上面２の長方形の上側短辺の全幅を含む四辺形領域）に形成し、無給電側放射電極４を上面２の左下がわ隅部を含む四角形領域に形成したものである。この放射電極３、４の配置構成に合わせて、給電側放射電極３の開放端１７の電極を誘電体基体１の前方側側面７に伸長形成し、ショート部８、９の電極を誘電体基体１の左側側面１９に形成し、無給電側放射電極４の開放端電極（開放端）２０を誘電体基体１の後方側面２３に形成している。それ以外の構成は前記第１の実施形態例と同様である。

【００３２】この第２の実施形態例も前記第１の実施形態例と同様に動作し、第１の実施形態例と同様の効果を奏するものである。

【００３３】図３は本発明の第３の実施形態例を示す。この第３の実施形態例は給電側放射電極３への給電を容量を介して行うようにしたことを特徴とする。この第３の実施形態例の誘電体基体１における上面２の給電側放射電極３と無給電側放射電極４の配置構成は図１の第１の実施形態例と同様であり、また、誘電体基体１の上面２と、左側面１９の電極パターンも図１に示すものと同様である。図３に示すアンテナ装置は容量給電の構成とするために、誘電体基体１の右側面１４に給電接続電極１２を底面側から伸長形成し、その給電接続電極１２の伸長先端（上端）と給電側放射電極３との間に間隔２４を介して給電接続電極１２と給電側放射電極３とを容量結合させている。

【００３４】また、信号源１３は左側面１４の給電接続電極１２に接続し、前方側側面７のショート部８、９は共に実装基板１５の接地面１６に導通するようにしている。

【００３５】この第３の実施形態例においては、信号源１３からの信号は給電接続電極１２を介して給電側放射電極３に容量給電され、給電側放射電極３の共振電流は開放端１７とショート部９を直線で結ぶＡ方向に流れる。また、ショート部８と９に流れる電流は最大となって、近接配置のショート部８と９は電磁界結合し、信号源１３からの信号はこの電磁界結合によって無給電側放射電極４に給電され、無給電側放射電極４にはショート部８と開放端２２（開放端電極２０）とを直線で結ぶＢ方向に共振電流が流れる。

【００３６】このように、第３の実施形態例も、前記第１の実施形態例と同様に給電側放射電極３の共振電流の方向と無給電側放射電極４の共振電流の方向とが略直交し、前記第１の実施形態例と同様の動作によって、第１の実施形態例と同様の効果を奏する。

【００３７】図４は本発明に係るアンテナ装置の第４の実施形態例を示す。この実施形態例も給電側放射電極３への給電を容量給電としたものであり、図２に示す第２の実施形態例の直接励振給電タイプの装置を容量給電式にしたものである。この図４に示す実施形態例のアンテナ装置は、誘電体基体１の上面２と左側面１９の電極パターンは図２のものと同様であり、図４に示すものは、容量給電方式とするために、誘電体基体１の右側面１４に底面側の給電接続電極１２を上方に伸長して設け、この給電接続電極１２の伸長先端（上端）と給電側放射電極３の開放端１７間に間隔２４を介して給電接続電極１２と給電側放射電極３とを容量結合している。

【００３８】また、この第４の実施形態例においては、給電側放射電極３の開放端１７は誘電体基体１の右側面１４側に形成され、無給電側放射電極４の開放端（開放端電極２０）は後方側面２３がわに形成されており、給電側放射電極３と無給電側放射電極４の開放端は互いに直角となる異なる側面１４、２３側に形成されている。したがって、給電側放射電極３と無給電側放射電極４の強電界部相互の信号干渉をほぼ完璧に防止できる。

【００３９】また、誘電体基体１の左側面１９のショート部８と給電部９は共に実装基板１５の接地面１６に接続されるようになっている。この第４の実施形態例は前記第３の実施形態例と同様に、信号源１３から供給される信号は給電接続電極１２を介して給電側放射電極３に容量給電され、無給電側放射電極４へはショート部８と給電部９の電磁界結合を介して給電されて、前記各実施形態例と同様にアンテナ動作を行う。

【００４０】このアンテナ動作に際して、給電側放射電極３の共振電流の方向（Ａ方向）と無給電側放射電極４の共振電流の方向（Ｂ方向）は前記各実施形態例の場合と同様に直交方向となり、前記各実施形態例と同様の動作による同様の効果を奏するものである。

【００４１】図５は上記各実施形態例のアンテナ装置のアンテナ特性をさらに改善した形態例を示す。図５の（ａ）は第１の実施形態例（図１）の装置の改善例を示し、図５の（ｂ）は第２の実施形態例（図２）の装置の改善例を示し、図５の（ｃ）は第３の実施形態例（図３）の装置の改善例を示し、図５の（ｄ）は第４の実施形態例（図４）の装置の改善例を示している。この図５に示す各改善例は、誘電体基体１の上面２に放射電極３、４が形成されていないデッドスペースの領域に放射電極３又は４のパターンを拡張形成してアンテナ特性をさらにアップさせるものである。

【００４２】図５の（ａ）は、無給電側放射電極４に対面する側の給電側放射電極３の周縁２５を、前方側側面７側から後方側面２３に向かうに連れ、無給電側放射電

極4に対する対向間隔距離が離れる方向に湾曲させ、反対側側面23に至るまで伸長させて、給電側放射電極3の面積を拡張したものである。このことによって、給電側放射電極3の開放端17は誘電体基体1の右側面14のほぼ全幅区間にわたって形成されている。そして、誘電体基体1の右側面14において、給電側放射電極3のパターンには前方側側面7の近傍位置に実装基板15の接地面16に向けた突き出し部3bが設けられ、給電側放射電極3と接地面16との容量結合が局部的に強化されている。

【0043】この図5の（a）の例では、給電側放射電極3の電極面積が拡張されたことで、アンテナ体積が増加し、その分、給電側放射電極3のアンテナ特性が改善される。また、給電側放射電極3の開放端17の領域が誘電体基体1の右側面14の全幅区間に拡張されるので、強電界領域が拡大し、利得をアップできるとともにアンテナ特性を向上することができる。さらに、給電側放射電極3の周縁25は無給電側放射電極4に対し離間する湾曲状に形成されているので、給電側放射電極3と無給電側放射電極4の信号干渉が抑制される方向となり、この干渉抑制効果による特性改善が図れるとともに、両放射電極3、4のマッチング調整を容易にすることができ、放射電極3、4間の干渉を抑え、アンテナ特性劣化を防止することができる。

【0044】図5の（b）は無給電側放射電極4の電極面積を誘電体基体1の上面2のデッドスペースに拡張したものである。すなわち、給電側放射電極3に対面する側の無給電側放射電極4の周縁25を、左側側面19側から右側面14に向かうに連れ、給電側放射電極3からの対向間隔の距離が離れる方向に湾曲させ、反対側側面14に至るまで伸長させて、無給電側放射電極4の面積を拡張したものである。このことによって、無給電側放射電極4の開放端21は誘電体基体1の後方側面23の全幅区間にわたって形成されている。

【0045】この図5の（b）の例では、無給電側放射電極4の電極面積が拡張されたことで、アンテナ体積が増加し、その分、無給電側放射電極4のアンテナ特性が改善される。また、無給電側放射電極4の開放端21の領域が誘電体基体1の後方側面23の全幅区間に拡張されるので、強電界領域が拡大し、利得をアップできるとともにアンテナ特性を向上することができる。さらに、無給電側放射電極4の周縁25は給電側放射電極3に対し離間する湾曲状に形成されているので、給電側放射電極3と無給電側放射電極4の信号干渉が抑制される方向となり、この干渉抑制効果による特性改善が図れるとともに、放射電極間の干渉を抑え、アンテナ特性劣化を防止することができる。

【0046】図5の（c）は同図の（a）の場合と同様に給電側放射電極3の電極面積を拡張したものであり、同図の（a）の場合と同様な効果を奏するものである。また、同図の（d）は同図の（b）の場合と同様に無給電側放射電極4の電極面積を拡張したものであり、同図の（b）の場合と同様な効果を奏するものである。

【0047】図6は上述した各実施形態例における誘電体基体1の変形例を示す。この図6に示す実施形態例は誘電体基体1の内部に空間部を形成したことを特徴とする。図6の（a）に示すものは、誘電体基体1に2個の偏平状の穴26を間隔を介して並設したものであり、同図の（b）は1個の広幅の偏平状の穴26を誘電体基体1に設けたものである。これらの穴26は誘電体基体1の右側面14と左側側面間に貫通して設けられている。図6の（c）に示すものは、誘電体基体1の底面側を開口とする中空部27が内部に形成されて底面開口の箱状の誘電体基体1と成したものである。

【0048】このように、誘電体基体1の内部に穴26や、中空部27を設けることにより、誘電体基体1を軽量化できる上に、誘電体基体1の実効誘電率が下がって、両放射電極とグランド電極間の電界集中が緩和され、広帯域化、高利得化が実現できる。また、各放射電極3、4の開放端での容量結合が大となって電界強度が強まるので、利得が向上し、アンテナ特性をさらにアップすることができる。

【0049】図7は実装基板15への誘電体基体1の実装配置構成を示す。図7の（a）は第1の実施形態例（図1）に示した誘電体基体1の実装配置構成を示し、図7の（b）は第2の実施形態例（図2）に示した誘電体基体1の実装配置構成を示し、図7の（c）は第3の実施形態例（図3）に示した誘電体基体1の実装配置構成を示し、図7の（d）は第4の実施形態例（図4）に示した誘電体基体1の実装配置構成を示している。これら誘電体基体1の実装構成において特徴的なことは、誘電体基体1を実装基板15の長四角形をした実装面（接地面16）の隅部に実装したことと、無給電側放射電極4を実装基板15の長辺側の端面辺28に沿わせ、給電側放射電極3を実装基板15の短辺側の端面辺29に沿わせる形態で、誘電体基体1を実装基板15に実装したことである。

【0050】この実施形態例では、誘電体基体1を実装基板15の長四角形をした実装面（接地面16）の隅部に実装し、給電側放射電極3と無給電側放射電極4をともに実装基板15の端面辺28、29に沿わせて配置したので、基板端実装による端効果により電界集中が緩和されることで狭帯域化を防止でき、また、実装基板に流れるイメージ電流を実装基板辺方向に乗せることで利得劣化を防止できる。

【0051】また、無給電側放射電極4を実装基板15の長辺側の端面辺28に沿わせ、給電側放射電極3を実装基板15の短辺側の端面辺29に沿わせる形態としたので、両放射電極3、4の利得劣化を防止するとともに、給電側放射電極3側と無給電側放射電極4側との感

度のバランスをとることができる。この点をさらに説明すれば、アンテナ動作においては、放射電極３、４を実装基板１５の端面辺側に配置した方が感度がよくなり、その端面辺のうち、長辺側が短辺側よりも感度がよくなる。

【００５２】本実施形態例では、給電側放射電極３と無給電側放射電極４を共に感度のよくなる実装基板１５の端面辺に沿わせているので、給電側放射電極３と無給電側放射電極４の利得劣化を共に防止することができる。また、給電側放射電極３と無給電側放射電極４の感度を比較した場合、信号源１３により直接的に（一次的に）励振される給電側放射電極３の方が間接的に（二次的に）励振される無給電側放射電極４よりも感度が高くなる。この点において、本実施形態例では、二次的励振によって感度が落ちる側の無給電側放射電極４を感度が高くなる方の実装基板１５の長辺側に配置し、一次励振によって感度が高い方の給電側放射電極３を感度が低くなる側の実装基板１５の短辺側に配置することによって、両放射電極３、４間の感度のバランスをとって良好なアンテナ動作が行われることになる。

【００５３】図８は本実施形態例のアンテナ装置の使用例（通信装置への搭載例）を示す。同図において、携帯電話等の通信装置３０のケース３１の中には実装基板１５が設けられ、実装基板１５には給電回路３２が形成されている。この実装基板１５の接地面（接地電極）１６の上に給電側放射電極３と無給電側放射電極４等の電極パターンが形成された誘電体基体１が表面実装型アンテナとして実装され、給電側放射電極３は信号源１３を備えた給電回路３２に直接又は容量結合によって接続され、さらに、この給電回路３２は切換回路３３を介して送信回路３４および受信回路３５に接続されている。この通信装置３０においては、給電回路３２の信号源１３の給電信号が誘電体基体１のアンテナに供給されて、前述した所望のアンテナ動作が行われ、切換回路３３の切換動作によって、信号の送受信が円滑に行われるものである。

【００５４】なお、本発明は上記各実施形態例に限定されることなく様々な実施の形態を採り得る。例えば上記各実施形態例では、誘電体基体１を長方体形状（上面２が長四角の直方体形状）としたが、上面２が正方形の直方体形状でもよく、さらには、上面２が多角形（例えば、６角形、８角形等）のものであってもよく、円柱体等のものであってもよい。

【００５５】また、上記各実施形態例では、給電側放射電極３と無給電側放射電極４をミアンダ状のパターンに形成したが、必ずしもミアンダ状に形成する必要はない。ただ、ミアンダ状にすることにより、使用周波数を下げることができるので、低い周波数で通信を行う仕様の場合は、放射電極パターンをミアンダ状にすることが好ましい。

【００５６】

【発明の効果】本発明は２つの各周波数に対応する給電側放射電極と無給電側放射電極を１個の誘電体基体の表面に近接形成する構成としたものであるから、各周波数毎の放射電極の基板を別個に形成して並設配置する構成のものに比べ大幅なアンテナ装置の小型化を達成でき、通信装置の小型化の要求に十分に応えることができる。

【００５７】また、誘電体基体の一側面には給電側放射電極と無給電側放射電極のショート部を電磁界結合可能に近接配置し、給電側放射電極と無給電側放射電極の開放端は誘電体基体のショート部の形成面を避けた互いに異なる面側に形成したものであるから、給電側放射電極と無給電側放射電極のそれぞれに流れる共振電流の向きが略直交等の互いに交叉する向きとなり、このことにより、給電側放射電極側の信号と無給電側放射電極側の信号との励振方向（偏波方向）も略直交等の交叉する方向となるので、給電側放射電極と無給電側放射電極とを１個の誘電体基体の表面に近接形成するにも拘らず両放射電極間信号の干渉を抑制でき、給電側放射電極側と無給電側放射電極側の両側で各周波数に対応する安定した共振動作を行わせることができる。また、給電側放射電極と無給電側放射電極の開放端を誘電体基体の異なる面側に形成したので、給電側放射電極と無給電側放射電極の強電界部相互の信号干渉をほぼ完璧に防止できる。さらに、前記干渉抑制効果により、一方側放射電極の調整の影響が他方側の放射電極の特性におよぶことが抑制されるので、給電側放射電極と無給電側放射電極の両側の共振周波数特性のマッチング調整を容易に行うことが可能であり、放射電極間の干渉の抑制により、広帯域化、高利得化を実現できる。

【００５８】その上、前記の給電側放射電極側の信号と無給電側放射電極側の信号との干渉防止効果に加え、電界が最大となる給電側放射電極と無給電側放射電極の開放端を誘電体基体の異なる側面がわに配置したので、開放端側同士の電界干渉を防止でき、アンテナ特性の向上が図れる上に、給電側放射電極側と無給電側放射電極側のアンテナ動作の利得をも向上させることができ、アンテナ装置を小型にするにも拘らず通信に必要な充分な性能を確保することができる。

【００５９】さらに、誘電体基体は直方体と成し、誘電体基体の上面には給電側放射電極と無給電側放射電極の一方側電極が上面の一端側寄りに当該一端側のほぼ全幅を含む四角形領域に形成され、他方側電極は上面の残りの領域中に形成され、この他方側電極は前記一方側電極の形成領域に対して反対側となる上面の他端側のほぼ全幅の区間を開放端側と成し、前記一方側電極に対面する側の他方側電極の周縁は前記一方側電極の四角形領域幅の一端側から他端側に向かうにしたがい一方側電極から離れる方向に湾曲した形状と成した発明にあっては、湾曲形状側の放射電極の面積を拡張形成して、誘電体基体

の上面のほぼ全面にわたって給電側放射電極と無給電側放射電極とを形成することができる。

【００６０】このように湾曲形状側の放射電極の面積を拡張形成しても、その湾曲形状は対面する側の放射電極から離れる方向に湾曲しているので、両放射電極間信号の干渉が抑制されることとなり、このことにより、放射電極の面積が拡張した分、アンテナ体積が増加し、アンテナ特性を向上させることができる。

【００６１】さらに、給電側放射電極と無給電側放射電極の一方又は両方をミアンダ状に形成することにより、ミアンダ状に形成する放射電極の共振周波数を下げることができ、低周波数の信号を用いて通信を支障なく行うことができる。また、使用する２つの周波数が離れているときには、一方の放射電極はミアンダ状にせずに高い周波数に設定し、他方の放射電極はミアンダ状に形成して低い周波数に設定することにより、１つの誘電体基体の表面に高い周波数で共振する放射電極と低い周波数で共振する放射電極を支障なく配置できるという効果が得られる。

【００６２】さらに、誘電体基体の内部に穴を開けるか又は底部側を開口して内部を中空にした誘電体基体の構成にあっては、アンテナ装置の軽量化が図れる上に、誘電体基体の実効誘電率が低下し、両放射電極とグランド電極間の電界集中が緩和され、広帯域化、高利得化が可能となる。また、誘電体基体の実効誘電率が低下することで、誘電体基体の上面に形成されている放射電極面上の電界が分散効果により弱められる一方において、その逆に放射電極の開放端側においては、容量結合（接地面との容量結合）が大となって電界強度が強くなるので、アンテナ特性がさらに向上できるという効果が得られる。

【００６３】さらに、給電側放射電極と無給電側放射電極が形成された誘電体基体を実装基板面の隅部に実装した構成のものは、給電側放射電極と無給電側放射電極のアンテナ動作の利得をいっそう向上する（利得劣化を防止する）ことができる。また、無給電側放射電極を感度が一番良くなる長四角形状の実装基板の長辺に沿わせることにより、一次給電の給電側放射電極よりも感度が低下する二次給電側の無給電側放射電極の感度を相対的にアップすることができ、これにより、給電側放射電極と無給電側放射電極との感度のバランスがとれて好適なアンテナ動作を行うことができることとなる。

【００６４】さらに、本発明の通信装置によれば、このような小型の表面実装型アンテナ（アンテナ装置）を通信装置に実装することにより、通信装置の小型化が図れるとともに、アッセンブル費用の削減も実現できるものである。

【図面の簡単な説明】

【図１】本発明の第１の実施形態例の要部構成説明図である。

【図２】本発明の第２の実施形態例の要部構成説明図である。

【図３】本発明の第３の実施形態例の要部構成説明図である。

【図４】本発明の第４の実施形態例の要部構成説明図である。

【図５】放射電極面積を拡張した各種タイプアンテナ装置の実施形態例の説明図である。

【図６】内部に中空部を形成した誘電体基体の各種実施形態例の説明図である。

【図７】誘電体基体の実装構成を示す実施形態例の説明図である。

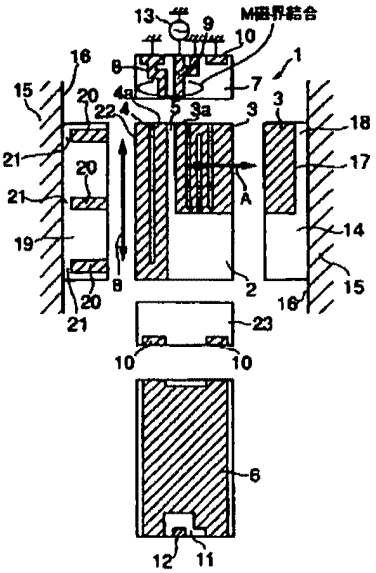
【図８】本発明に係るアンテナ装置の使用例（通信装置への搭載例）の説明図である。

【図９】従来のアンテナ装置の説明図である。

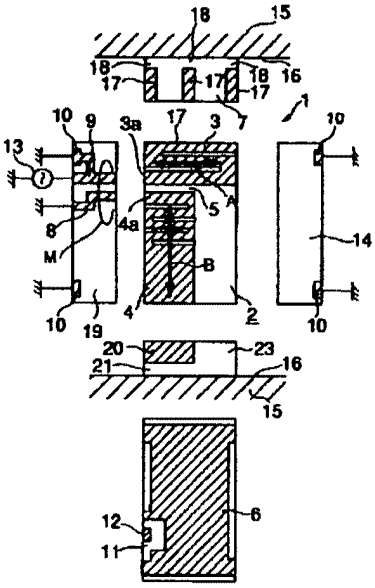
【符号の説明】

１　誘電体基体
２　上面
３　給電側放射電極
４　無給電側放射電極
８、９　ショート部
１３　信号源
１５　実装基板
１６　接地面
１７、２２　開放端

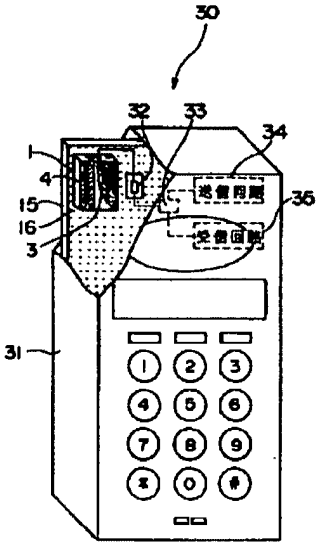
【図1】



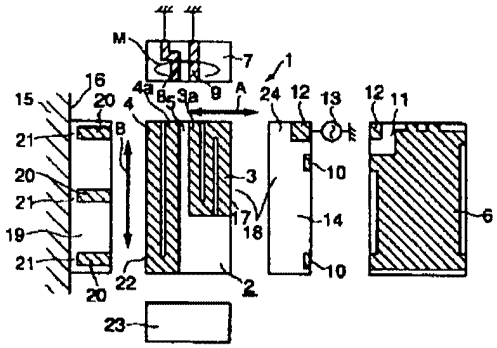
【図2】



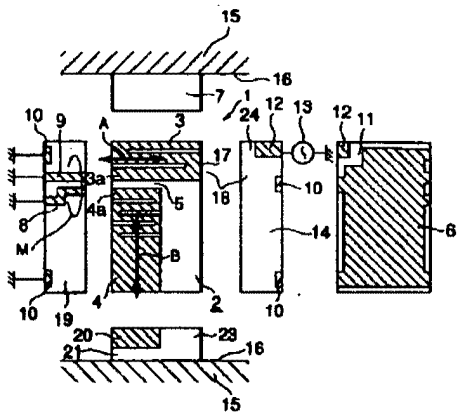
【図8】



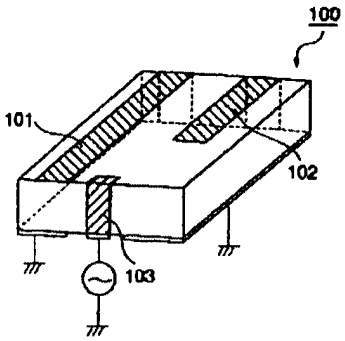
【図3】



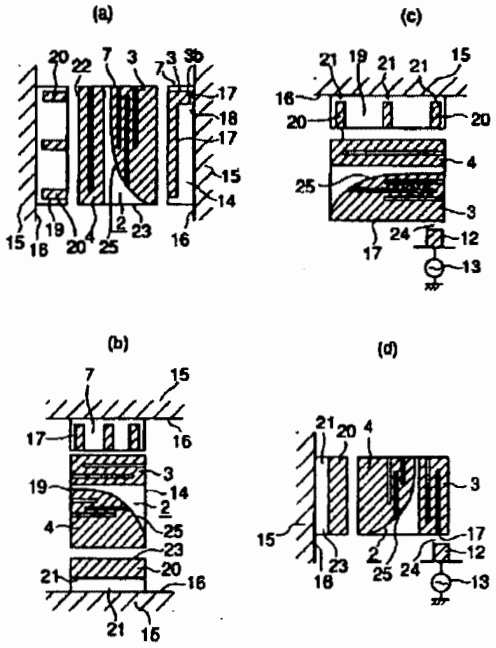
【図4】



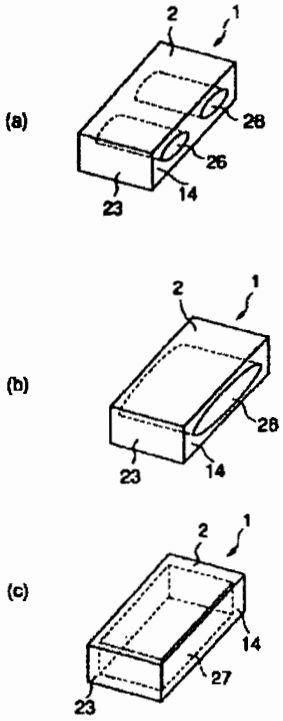
【図9】



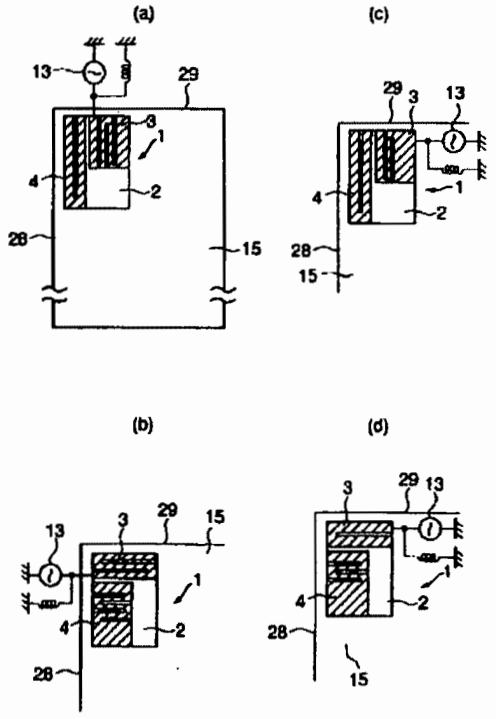
【図5】



【図6】



【図7】



(51)Int.Cl.[7]	識別記号	FI	テーマコード（参考）
H04B 1/38		H04B 1/38	5K011

(72)発明者 川端 一也
京都府長岡京市天神二丁目26番10号 株式会社村田製作所内

Fターム(参考) 5J020 BC01 BC03 BC13 CA04 DA08
5J021 AA02 AA09 AA13 AB06 CA03
CA04 HA10 JA03 JA07
5J045 AA03 AB05 CA01 DA08 GA01
HA02 JA11 LA01 NA03
5J046 AA02 AA07 AA12 AB00 AB13
PA01 PA04
5J047 AA02 AA07 AA12 AB00 AB13
FD01 FD06
5K011 AA06 DA02 KA00

PATENT ABSTRACTS OF JAPAN

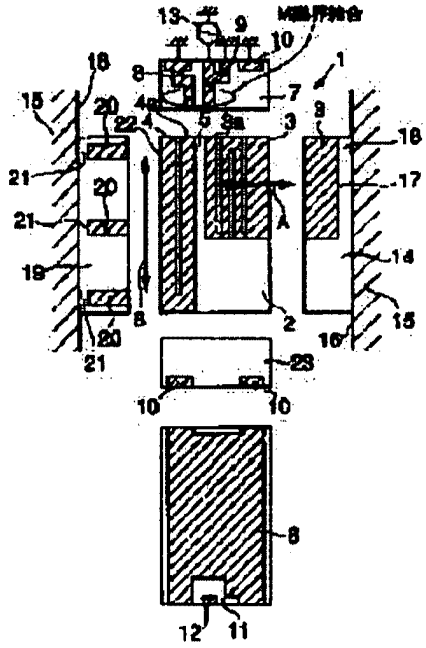
(11)Publication number : **2001-007639**
(43)Date of publication of application : **12.01.2001**

(51)Int.Cl. **H01Q 21/30**
H01Q 1/24
H01Q 1/38
H01Q 13/08
H01Q 19/26
H04B 1/38

(21)Application number : **11-179676**
(22)Date of filing : **25.06.1999**

(71)Applicant : **MURATA MFG CO LTD**
(72)Inventor : **NAGUMO SHOJI**
TSUBAKI NOBUHITO
KAWABATA KAZUYA

(54) ANTENNA SYSTEM AND COMMUNICATION DEVICE USING THE SAME



(57)Abstract:
PROBLEM TO BE SOLVED: To provide an antenna system of one-chip type that copes with two frequencies.
SOLUTION: A feeder side radiation electrode 3 and a parasitic side radiation electrode 4 are formed on an upper face 2 of a rectangular dielectric base 1 of the antenna system, so that exciting directions A, B are orthogonal to each other. Short- circuit sections 8, 9 electromagnetically coupled are formed to a common side face 7. The short-circuit section 8 is connected to the parasitic side radiation electrode 4. One end of the short-circuit section 9 is connected to the feeder side radiation electrode 3, and the other end is connected to a signal source 13. An open end 22 of the feeder side radiation electrode 3 is capacitively coupled with a ground face 16 via an open end electrode 20 of a side face 19. An open end 17 of the feeder side radiation electrode 3 is formed to a side face 14, opposite to the side face 19 and the open end 17, is capacitively coupled with the ground face 16. A signal from a signal source 13 is fed directly to the feeder side radiation electrode 3 to resonate the dielectric base 1 at a set frequency. Furthermore, the signal from the signal source 13 is fed to the parasitic side radiation electrode 4 via electromagnetic field coupling of the

short-circuit sections 8, 9 to resonate the dielectric base 1 at the other setting frequency.

CLAIMS

[Claim(s)]

[Claim 1]On the surface of a dielectric substrate, a feeder side radiation electrode and a parasitic side radiation electrode dissociate, and are formed, A shorting part of a feeder side radiation electrode and a shorting part of a parasitic side radiation electrode are arranged mutually in a one side face of a dielectric substrate at an adjacent position, An antenna system, wherein alligator formation of the mutually different side where an open end of a feeder side radiation electrode and an open end of a parasitic side radiation electrode avoided a forming face of said shorting part of a dielectric substrate is carried out.

[Claim 2]The antenna system according to claim 1 with which an open end of a feeder side radiation electrode and an open end of a parasitic side radiation electrode are characterized by carrying out alligator formation of the side which becomes opposite mutually [a dielectric substrate].

[Claim 3]The antenna system according to claim 1 or 2, wherein an excitation direction of a feeder side radiation electrode and an excitation direction of a parasitic side radiation electrode consider a feeder side radiation electrode and a parasitic side radiation electrode as arrangement used as a direction which intersects perpendicularly mostly mutually.

[Claim 4]A dielectric substrate accomplishes with a rectangular parallelepiped and a one side electrode of a feeder side radiation electrode and a parasitic side radiation electrode is formed in the end side slippage of the upper surface in a square type region by the side of the end concerned which contains overall width mostly at the upper surface of a dielectric substrate, the other end side of Kamitsura from whom an other side electrode is formed all over a field of the remainder on top, in addition a direction lateral electrode serves as an opposite hand to a formation area of said one side electrode -- the section of overall width being accomplished the open end side, and mostly, The antenna system according to claim 1, 2, or 3 having accomplished a periphery of an other side electrode of a side which meets said one side electrode with shape which curved in the direction which separates from a lateral electrode on the other hand as it goes to the other end side from the one end side of square type region width of said one side electrode.

[Claim 5]An antenna system of any one statement of claim 1, wherein at least one side of a feeder side radiation electrode and a parasitic side radiation electrode is formed in the shape of a meander thru/or claim 4.

[Claim 6]An antenna system of any one statement of claim 1 thru/or claim 5 with which a hole can open a dielectric substrate in an inside, or the opening of the pars-basilaris-ossis-occipitalis side is carried out, and an inside is characterized by being hollow.

[Claim 7]A dielectric substrate in which a feeder side radiation electrode and a parasitic side radiation electrode were formed is mounted in a corner of a mounting board side of quadrangular shape, An antenna system of any one statement of claim 1, wherein it makes said feeder side radiation electrode and a parasitic side radiation electrode which are formed in a dielectric substrate meet an end face neighborhood of a mounting board and they are arranged thru/or claim 6.

[Claim 8]The antenna system according to claim 7 which accomplishing a mounting board with a long quadrangle, making a parasitic side radiation electrode meet an end face neighborhood by the side of a long side of a mounting board, and arranging.

[Claim 9]A communication apparatus equipping an antenna system of any one statement of claim 1 thru/or claim 8, and changing.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to communication apparatus, such as an antenna system of the surface mount type which enables communication with two frequency bands, and a cellular phone using it.
[0002]
[Description of the Prior Art]The conventional antenna system corresponding to communication with two frequency bands is shown in drawing 9. In the figure, the antenna system 100 opens, puts in order and arranges a constant interval, and connects to the one signal source 103 the two patch antennas 101 and 102 with which resonance frequency differs mutually via [both] capacity. Thus, the antenna system corresponding to two frequency bands can be constituted by arranging two patch antennas with which frequency differs mutually side by side.
[0003]
[Problem(s) to be Solved by the Invention]However, if this kind of antenna system has a small interval of the two patch antennas 101 and 102, an unnecessary interference arises between patch antennas and the required characteristic may not be obtained. In order to make interference between two patch antennas small to the grade which can be disregarded, it is necessary to extend both interval to 0.3 or more waves, and there is a problem that the whole antenna system will be enlarged.
[0004]In these days, the miniaturization of communication apparatus, such as a cellular phone carrying an antenna system, is progressing, and by the method which arranges two patch antennas side by side, when advancing the miniaturization of a communication apparatus further, it becomes trouble. Then, this invention person has tackled the technical development which carries out chip making of the antenna as a thing corresponding to the miniaturization of a communication apparatus.
[0005]this invention person as the 1st step of development of a surface mounted type antenna device with two frequency bands, The 1st surface mounted type antenna that operates on the 1st frequency, and the 2nd surface mounted type antenna that operates on the 2nd frequency were prepared, and it tried to carry out close arrangement of these two surface mounted type antennas on a mounting board.
[0006]However, preparing two surface mounted type antennas has the bad productive efficiency of a device, and when advancing the miniaturization of a communication apparatus substantially, a limit produces. If it miniaturizes in order to use an antenna as a surface mount type, the problem that a profit falls will newly occur. Although this new problem can be controlled by narrowing an antenna interval, when an antenna interval is narrowed, the problem of interference between antennas will arise.
[0007]While this invention person repeats trial and error of research and development, he can control the fall of a profit, In spite of having carried out adjacent arranging of the two antenna electrode patterns to one dielectric surface, it came to solve a characteristic antenna electrode structure of one epoch-making chip type which can respond to two frequency which can control interference of a mutual inter-electrode signal. This invention is accomplished in view of the above-mentioned situation, the purpose is provided with an antenna electrode structure peculiar to the above, and it is in providing the miniaturized antenna device of one highly efficient chip type corresponding to two

frequency, and the communication apparatus using it.
[0008]
[Means for Solving the Problem]This invention has a means [like / next] to achieve the above objects, and makes it a means to solve a technical problem. Namely, a feeder side radiation electrode and a parasitic side radiation electrode dissociate on the surface of a dielectric substrate, and an antenna system of the 1st invention is formed, A shorting part of a feeder side radiation electrode and a shorting part of a parasitic side radiation electrode are arranged mutually in a one side face of a dielectric substrate at an adjacent position, The mutually different side which avoided a forming face of said shorting part of a dielectric substrate makes an open end of a feeder side radiation electrode, and an open end of a parasitic side radiation electrode a means to solve a technical problem with composition by which alligator formation is carried out.
[0009]An antenna system of the 2nd invention makes an open end of a feeder side radiation electrode, and an open end of a parasitic side radiation electrode a means by which the side in which a dielectric substrate becomes opposite mutually solves a technical problem with composition by which alligator formation is carried out, after being provided with the 1st composition of an antenna system of an invention.
[0010]After an antenna system of the 3rd invention is provided with composition of an antenna system of said 1st [the] or the 2nd invention, a feeder side radiation electrode and a parasitic side radiation electrode, An excitation direction of a feeder side radiation electrode and an excitation direction of a parasitic side radiation electrode are considering it as a means to solve a technical problem with composition considered as arrangement used as a direction which intersects perpendicularly mostly mutually.
[0011]After an antenna system of the 4th invention is provided with composition of an antenna system of said 1st [the], the 2nd, or the 3rd invention, A dielectric substrate accomplishes with a rectangular parallelepiped and a one side electrode of a feeder side radiation electrode and a parasitic side radiation electrode is formed in the end side slippage of the upper surface in a square type region by the side of the end concerned which contains overall width mostly at the upper surface of a dielectric substrate, the other end side of the upper surface from which an other side electrode is formed all over a field of the remainder on top, in addition a direction lateral electrode serves as an opposite hand to a formation area of said one side electrode -- the section of overall width being accomplished the open end side, and mostly, A periphery of an other side electrode of a side which meets said one side electrode is made into a means to solve a technical problem with having accomplished with shape which curved in the direction which separates from a lateral electrode on the other hand as it goes to the other end side from the one end side of square type region width of said one side electrode.
[0012]After an antenna system of the 5th invention is provided with composition of an antenna system of said 1st [the] thru/or any 4th one invention, at least one side of a feeder side radiation electrode and a parasitic side radiation electrode is taken as a means to solve a technical problem with composition currently formed in the shape of a meander.
[0013]After an antenna system of the 6th invention is provided with composition of an antenna system of said 1st [the] thru/or any 5th one invention, a dielectric substrate is taken as a means to solve a technical problem with having had composition from which a hole can open in an inside, or the opening of the pars-basilaris-ossis-occipitalis side is carried out, and an inside serves as hollow.
[0014]After an antenna system of the 7th invention is provided with composition of an antenna system of said 1st [the] thru/or any 6th one invention, A dielectric substrate in which a feeder side radiation electrode and a parasitic side radiation electrode were

formed is mounted in a corner of a mounting board side of quadrangular shape, and said feeder side radiation electrode and a parasitic side radiation electrode which are formed in a dielectric substrate are made into a means to solve composition, with a technical problem which make meet an end face neighborhood of a mounting board, and are arranged.

[0015]After an antenna system of the 8th invention is provided with the 7th composition of an antenna system of an invention, a mounting board is accomplished with a long quadrangle and a parasitic side radiation electrode is made into a means to solve composition, with a technical problem which make meet an end face neighborhood by the side of a long side of a mounting board, and are arranged. A communication apparatus of this invention equips an antenna system of any one invention of the above 1st thru/or the 8th invention.

[0016]In this invention, since the side of a dielectric substrate forms an open end of an alligator feeder side radiation electrode and a parasitic side radiation electrode, when a dielectric substrate is mounted in a mounting board, high electromagnetic field coupling can be attained between these open ends and an earth electrode (sidewall) by the side of a mounting board. A fall of a profit is controlled, in spite of intensity of an electric field in an open end increasing, carrying out chip making of the antenna and miniaturizing by this.

[0017]Since alligator formation of the different side is carried out like [an open end of a feeder side radiation electrode and a parasitic side radiation electrode] side of a dielectric substrate, for example, an opposite hand, . Are expressed by direction (the direction of the resonance current) which connects an open end to a shorting part in a straight line. By that used as crossing directions, such as a rectangular cross (plane of polarization of an electric wave emitted from a feeder side radiation electrode and plane of polarization of an electric wave emitted from a parasitic side radiation electrode serve as crossing directions, such as a rectangular cross), an excitation direction of a feeder side radiation electrode and an excitation direction of a parasitic side radiation electrode. Even if it carries out close arrangement of a feeder side radiation electrode and the parasitic side radiation electrode to the surface of one dielectric substrate, interference of a signal between two electrodes can control effectively, and quality communication of it which uses two frequency is attained.

[0018]Each shorting part of a feeder side radiation electrode and a parasitic side radiation electrode as used herein means a conductor electrode part from which current which flows in each radiation electrode serves as the maximum.

[0019]

[Embodiment of the Invention]Hereafter, the example of an embodiment of this invention is explained based on a drawing. In explanation of each following example of an embodiment, common numerals are given to common component part, and the duplication explanation is omitted or simplified. Drawing 1 shows the important section composition of the 1st example of an embodiment of the antenna system concerning this invention. This drawing 1 shows the surface of the dielectric substrate 1 in which various electrodes are formed in the typical mode of a 6th page figure.

[0020]In drawing 1, the dielectric substrate 1 was formed with material with a high dielectric constant of ceramics, resin, etc., and has constituted the gestalt of the long direction object. The feeder side radiation electrode 3 and the parasitic side radiation electrode 4 are formed in the upper surface 2 of the dielectric substrate 1 in the shape of a meander, respectively. The parasitic side radiation electrode 4 is formed in the quadrilateral field by the side of the left end of the upper surface 2 which carried out the rectangle, and the quadrilateral field contains the entire interval of the left-hand side

long side of the upper surface 2. The feeder side radiation electrode 3 is formed in the quadrilateral field including the corner by the side of the upper right of the upper surface 2. And the parasitic side radiation electrode 4 of the left-hand side formed in these upper surfaces 2 and the feeder side radiation electrode 3 by the side of the upper right are separated via the gap 5.

[0021]The electrode pattern of the shorting part 8 through which it flows to the meander pattern 4a of the most inner edge of the parasitic side radiation electrode 4, the shorting part 9 through which it flows to the meander pattern 3a of the most inner edge of the feeder side radiation electrode 3, and the earth part 10 is formed in the front-sides side 7 of the dielectric substrate 1. The earth electrode 6 is formed in the bottom of the dielectric substrate 1 almost over the whole surface, and it has flowed through said shorting part 8 and the earth part 10 in the earth electrode 6. The insulating region 11 to said earth electrode 6 is formed in the bottom of the dielectric substrate 1, and the supply connection electrode 12 is formed in this insulating region 11. This supply connection electrode 12 has flowed in said shorting part 9. The signal source 13 is connected to this supply connection electrode 12, and electric supply to the feeder side radiation electrode 3 is directly performed from the signal source 13.

[0022]In this example of an embodiment, said shorting parts 8 and 9 serve as close arrangement which carries out electromagnetic field coupling (inductive coupling) mutually, From the signal source 13, via electromagnetic field coupling, the signal added to the feeder side radiation electrode 3 is added also to the parasitic side radiation electrode 4, and by electric supply from the signal source 13. It has the composition of resonating with 1/4 wave according to the wavelength of the signal with which electric power was supplied to both the feeder side radiation electrode 3 and the parasitic side radiation electrode 4, and performing antenna operation. The frequency of antenna operation of the feeder side radiation electrode 3 and the frequency of antenna operation of the parasitic side radiation electrode 4 are set up become mutually different frequency.

[0023]The feeder side radiation electrode 3 is elongated by the right lateral 14 of the dielectric substrate 1 to the mid-position of a height direction. The dielectric substrate 1 was mounted on the sidewall (earth electrode) 16 of the mounting board 15, and carried out capacitive coupling of the open end 17 and the sidewall 16 of this feeder side radiation electrode 3, and the capacitive coupling part of this right lateral 14 has accomplished it with the strong electric field part 18 of the feeder side radiation electrode 3.

[0024]Extension formation of the open end electrode 20 which flows in the open end 22 of the parasitic side radiation electrode 4 is carried out towards the downward sidewall 16 at the left side face 19 of the dielectric substrate 1 from the parasitic side radiation electrode 4 side, The interval was established between the lower end of this open end electrode 20, and the sidewall 16, capacitive coupling of the open end electrode 20 and the sidewall 16 was carried out, and the capacitive coupling part of this left lateral 19 has accomplished them with the strong electric field part 21 of the parasitic side radiation electrode 4. In the example of this drawing 1, the open end 17 of the feeder side radiation electrode 3 and the open end (portion of the numerals 20 and 22) of the parasitic side radiation electrode 4 are formed in the side 14 and 19 side of the dielectric substrate 1 which becomes opposite mutually.

[0025]The earth part 10 is formed near the pars basilaris ossis occipitalis of the rear side 23 of the dielectric substrate 1, and it has flowed through this earth part 10 in the earth electrode 6 at the bottom.

[0026]The electrode structure of the dielectric substrate 1 in the antenna system of the

example of a 1st embodiment is constituted as mentioned above, is, and performs antenna operation as follows. While electric power is directly supplied to the feeder side radiation electrode 3 by the signal supplied from the signal source 13, electric power is supplied also to the parasitic side radiation electrode 4 by the electromagnetic field coupling of the shorting parts 8 and 9 from which current serves as the maximum with the signal of the signal source 13. The current of the signal supplied to the feeder side radiation electrode 3 flows toward the open end 17 from the shorting part 9, resonates that it is also at set frequency f_1, and is excited in the direction of the arrow A. In another side, the current of the signal supplied to the parasitic side radiation electrode 4 flows toward the open end 20 from the shorting part 8, resonates that f_1 is also at different set frequency f_2, and is excited in the direction of the arrow B (direction which abbreviated-intersects perpendicularly to the direction of the arrow A).

[0027]Thus, the antenna operation and frequency f_2 **** antenna operation by frequency f_1 are performed by the feeding signal from the signal source 13. The direction of current which flows into the feeder side radiation electrode 3 is the same as direction of A of an excitation direction, and the direction of current which flows into the parasitic side radiation electrode 4 is the same as direction of B of an excitation direction. Therefore, direction of the current (resonance current) which flows into the feeder side radiation electrode 3, and the direction of current (resonance current) which flows into the parasitic side radiation electrode 4 serve as abbreviated orthogonality relation.

[0028]According to this example of an embodiment, since the radiation electrodes 3 and 4 which perform antenna operation are approached and formed in the surface of the dielectric substrate 1 of one chip on frequency different, respectively, the large miniaturization of an antenna system is attained. And since the dielectric constant is high, the dielectric substrate 1 has the large shortening effect of the guide wave length (wavelength of a signal when spreading a radiation electrode) of a signal, and this will also be contributed to the miniaturization of an antenna system.

[0029]Since the open end 17 of the feeder side radiation electrode 3 and the open end electrodes (open end) 20 and 22 of the parasitic side radiation electrode 4 are formed in the side 14 and 19 side of the dielectric substrate 1 which becomes opposite mutually, Since direction of the resonance current of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 intersects perpendicularly and the excitation directions (polarization direction) A and B of both the radiation electrodes 3 and 4 serve as orthogonality relation as a result, Even if it carries out close arrangement of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 to the upper surface of the dielectric substrate 1, it is possible for interference with the signal by the side of the feeder side radiation electrode 3 and the signal by the side of the parasitic side radiation electrode 4 to be controlled, and to perform highly efficient antenna operation. Since the opposite side of the dielectric substrate 1 can also be receiving the alligator, especially the open end of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 can prevent nearly perfectly the signal interference between strong electric field parts of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4.

[0030]Interference with the signal by the side of the feeder side radiation electrode 3 and the signal by the side of the parasitic side radiation electrode 4 is controlled as mentioned above, and resonance operation of each radiation electrodes 3 and 4 is performed, and also. Since it was made to carry out the electrostatic bond of the open ends 17 and 20 of each radiation electrodes 3 and 4 to the sidewall 16 of the mounting board 15, In these open ends 17 and 20, electric field concentrates can be carried out, it

is possible to suppress interference between radiation electrodes by this, in spite of making an antenna system small, the fall of a profit can be controlled and high communication of quality can be performed.

[0031]Drawing 2 shows the 2nd example of an embodiment of the antenna system concerning this invention. This example of a 2nd embodiment forms the feeder side radiation electrode 3 in the square type region (quadrilateral field containing the overall width of the upper part shorter side of the rectangle of the upper surface 2) of the front sides of the upper surface 2 of the dielectric substrate 1, and forms the parasitic side radiation electrode 4 in the square type region where the lower left of the upper surface 2 contains ******. To compensate for the arrangement configuration of these radiation electrodes 3 and 4, extension formation of the electrode of the open end 17 of the feeder side radiation electrode 3 is carried out on the front-sides side 7 of the dielectric substrate 1, The electrode of the shorting parts 8 and 9 is formed in the left side face 19 of the dielectric substrate 1, and the open end electrode (open end) 20 of the parasitic side radiation electrode 4 is formed in the rear side 23 of the dielectric substrate 1. The other composition is the same as that of said 1st example of an embodiment.

[0032]This 2nd example of an embodiment as well as said 1st example of an embodiment operates, and does so the same effect as the 1st example of an embodiment.

[0033]Drawing 3 shows the 3rd example of an embodiment of this invention. This 3rd example of an embodiment was made to perform electric supply to the feeder side radiation electrode 3 via capacity. The arrangement configuration of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 of the upper surface 2 in the dielectric substrate 1 of this 3rd example of an embodiment is the same as that of the 1st example of an embodiment of drawing 1, and the electrode pattern of the upper surface 2 of the dielectric substrate 1 and the left lateral 19 of it is the same as that of what is shown in drawing 1. In order to consider the antenna system shown in drawing 3 as the composition of capacity electric supply, extension formation of the supply connection electrode 12 is carried out from the bottom side at the right lateral 14 of the dielectric substrate 1, Capacitive coupling of the supply connection electrode 12 and the feeder side radiation electrode 3 is carried out via the interval 24 between the extension tip (upper bed) of the supply connection electrode 12, and the feeder side radiation electrode 3.

[0034]He connects with the supply connection electrode 12 of the left lateral 14, and is trying for the signal source 13 to flow through both the shorting parts 8 and 9 of the front-sides side 7 in the sidewall 16 of the mounting board 15.

[0035]In this 3rd example of an embodiment, capacity electric supply of the signal from the signal source 13 is carried out via the supply connection electrode 12 at the feeder side radiation electrode 3, and the resonance current of the feeder side radiation electrode 3 flows in the direction of A which connects the open end 17 and the shorting part 9 in a straight line. The current which flows into the shorting parts 8 and 9 serves as the maximum, and electromagnetic field coupling of the shorting parts 8 and 9 of close arrangement is carried out, Electric power is supplied to the signal from the signal source 13 by the parasitic side radiation electrode 4 by this electromagnetic field coupling, and the resonance current flows in the direction of B which connects the shorting part 8 and the open end 22 (open end electrode 20) to the parasitic side radiation electrode 4 in a straight line.

[0036]Thus, the direction of the resonance current of the feeder side radiation electrode 3 and the direction of the resonance current of the parasitic side radiation electrode 4 as well as said 1st example of an embodiment abbreviated-intersect perpendicularly, and the 3rd example of an embodiment also does so the same effect as the 1st example of an

embodiment by the same operation as said 1st example of an embodiment.
[0037]Drawing 4 shows the 4th example of an embodiment of the antenna system concerning this invention. This example of an embodiment also considers electric supply to the feeder side radiation electrode 3 as capacity electric supply, and the direct excitation electric supply type device of the 2nd example of an embodiment shown in drawing 2 is made into a capacity electric supply type. The antenna system of the example of an embodiment shown in this drawing 4, What that of the electrode pattern of the upper surface 2 and the left lateral 19 of the dielectric substrate 1 is the same as that of the thing of drawing 2, and is shown in drawing 4, In order to consider it as a capacity feed system, it elongates to the right lateral 14 of the dielectric substrate 1 up, the supply connection electrode 12 by the side of the bottom is formed in it, and capacitive coupling of the supply connection electrode 12 and the feeder side radiation electrode 3 is carried out via the interval 24 between the extension tip (upper bed) of this supply connection electrode 12, and the open end 17 of the feeder side radiation electrode 3.
[0038]In this 4th example of an embodiment, the open end 17 of the feeder side radiation electrode 3 is formed in the right lateral 14 side of the dielectric substrate 1, As for the open end (open end electrode 20) of the parasitic side radiation electrode 4, alligator formation of the rear side 23 is carried out, and the open end of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 is formed in the different side 14 and 23 side which becomes right-angled mutually. Therefore, the signal interference between strong electric field parts of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 can be prevented nearly perfectly.
[0039]Both the shorting parts 8 and feed parts 9 of the left lateral 19 of the dielectric substrate 1 are connected to the sidewall 16 of the mounting board 15. As for this 4th example of an embodiment, capacity electric supply of the signal supplied from the signal source 13 is carried out via the supply connection electrode 12 like said 3rd example of an embodiment at the feeder side radiation electrode 3, Electric power is supplied via the electromagnetic field coupling of the shorting part 8 and the feed part 9 to the parasitic side radiation electrode 4, and antenna operation is performed like said each example of an embodiment.
[0040]On the occasion of this antenna operation, the direction of the resonance current of the feeder side radiation electrode 3 (the direction of A) and the direction of the resonance current of the parasitic side radiation electrode 4 (the direction of B) turn into direction crossing at a right angle like the case of each of said example of an embodiment, and do so the same effect by the same operation as said each example of an embodiment.
[0041]Drawing 5 shows the example of a gestalt which has improved further the antenna characteristic of the antenna system of each above-mentioned example of an embodiment. (a) of drawing 5 shows the example of an improvement of the device of the 1st example of an embodiment (drawing 1), (b) of drawing 5 shows the example of an improvement of the device of the 2nd example of an embodiment (drawing 2), (c) of drawing 5 shows the example of an improvement of the device of the 3rd example of an embodiment (drawing 3), and (d) of drawing 5 shows the example of an improvement of the device of the 4th example of an embodiment (drawing 4). Each example of an improvement shown in this drawing 5 carries out extended formation of the radiation electrode 3 or the pattern of 4 to the field of a dead space to which the radiation electrodes 3 and 4 are not formed in the upper surface 2 of the dielectric substrate 1, and makes an antenna characteristic raise further.
[0042](a) of drawing 5 the periphery 25 of the feeder side radiation electrode 3 of the

side which meets the parasitic side radiation electrode 4, Take toward the rear side 23 from the front-sides side 7 side, and make it curve in the direction which the opposed interval distance over the parasitic side radiation electrode 4 leaves, it is made to elongate until it reaches the opposite hand side 23, and the area of the feeder side radiation electrode 3 is extended. this -- the open end 17 of the feeder side radiation electrode 3 -- the right lateral 14 of the dielectric substrate 1 -- it is mostly formed over the overall-width section. And in the right lateral 14 of the dielectric substrate 1, the toe wall 3b turned to the sidewall 16 of the mounting board 15 in the near position of the front-sides side 7 is formed in the pattern of the feeder side radiation electrode 3, and the capacitive coupling of the feeder side radiation electrode 3 and the sidewall 16 is strengthened locally.

[0043]In the example of (a) of this drawing 5, by the electrode area of the feeder side radiation electrode 3 having been extended, an antenna body product increases and the antenna characteristic of that part and the feeder side radiation electrode 3 is improved. Since the field of the open end 17 of the feeder side radiation electrode 3 is extended to the overall-width section of the right lateral 14 of the dielectric substrate 1, a strong electric field field is expanded, and an antenna characteristic can be improved while being able to raise a profit. Since the periphery 25 of the feeder side radiation electrode 3 is formed in the curvature shape estranged to the parasitic side radiation electrode 4, While becoming a direction by which the signal interference of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 is controlled and being able to aim at the characteristic improvement by this interference depressor effect, matching adjustment of both the radiation electrodes 3 and 4 can be made easy, interference between the radiation electrodes 3 and 4 can be suppressed, and antenna characteristic degradation can be prevented.

[0044](b) of drawing 5 extends the electrode area of the parasitic side radiation electrode 4 to the dead space of the upper surface 2 of the dielectric substrate 1. Namely, the periphery 25 of the parasitic side radiation electrode 4 of the side which meets the feeder side radiation electrode 3, Take toward the right lateral 14 from the left side face 19 side, and make it curve in the direction which the distance of the opposed interval from the feeder side radiation electrode 3 leaves, it is made to elongate until it reaches the opposite hand side 14, and the area of the parasitic side radiation electrode 4 is extended. Of this, the open end 21 of the parasitic side radiation electrode 4 is formed over the overall-width section of the rear side 23 of the dielectric substrate 1.

[0045]In the example of (b) of this drawing 5, by the electrode area of the parasitic side radiation electrode 4 having been extended, an antenna body product increases and the antenna characteristic of that part and the parasitic side radiation electrode 4 is improved. Since the field of the open end 21 of the parasitic side radiation electrode 4 is extended to the overall-width section of the rear side 23 of the dielectric substrate 1, a strong electric field field is expanded, and an antenna characteristic can be improved while being able to raise a profit. Since the periphery 25 of the parasitic side radiation electrode 4 is formed in the curvature shape estranged to the feeder side radiation electrode 3, While becoming a direction by which the signal interference of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 is controlled and being able to aim at the characteristic improvement by this interference depressor effect, interference between radiation electrodes can be suppressed and antenna characteristic degradation can be prevented.

[0046](c) of drawing 5 extends the electrode area of the feeder side radiation electrode 3 like the case of (a) of the figure, and does so the same effect as the case of (a) of the figure. (d) of the figure extends the electrode area of the parasitic side radiation

electrode 4 like the case of (b) of the figure, and does so the same effect as the case of (b) of the figure.

[0047]Drawing 6 shows the modification of the dielectric substrate 1 in each example of an embodiment mentioned above. The example of an embodiment shown in this drawing 6 formed the space part in the inside of the dielectric substrate 1. What is shown in (a) of drawing 6 installs the two flat state holes 26 in the dielectric substrate 1 side by side via an interval, and (b) of the figure establishes the one flat state double-width hole 26 in the dielectric substrate 1. These holes 26 are penetrated and formed between the right lateral 14 of the dielectric substrate 1, and the left side face. The centrum 27 which uses the bottom side of the dielectric substrate 1 as an opening is formed in an inside, and what is shown in (c) of drawing 6 accomplishes with the box-like dielectric substrate 1 of a bottom opening.

[0048]Thus, by forming the hole 26 and the centrum 27 in the inside of the dielectric substrate 1, the weight saving of the dielectric substrate 1 can be carried out, and also the effective dielectric constant of the dielectric substrate 1 falls, both radiation electrodes and grand inter-electrode electric field concentrates are eased, and broadband-izing and high gain-ization can be realized. Since the capacitive coupling in the open end of each radiation electrodes 3 and 4 becomes large and field intensity becomes strong, a profit can improve and an antenna characteristic can be raised further.

[0049]Drawing 7 shows the mounting arrangement configuration of the dielectric substrate 1 to the mounting board 15. (a) of drawing 7 shows the mounting arrangement configuration of the dielectric substrate 1 shown in the 1st example of an embodiment (drawing 1), (b) of drawing 7 shows the mounting arrangement configuration of the dielectric substrate 1 shown in the 2nd example of an embodiment (drawing 2), (c) of drawing 7 shows the mounting arrangement configuration of the dielectric substrate 1 shown in the 3rd example of an embodiment (drawing 3), and (d) of drawing 7 shows the mounting arrangement configuration of the dielectric substrate 1 shown in the 4th example of an embodiment (drawing 4). That it is characteristic in the mount configuration of these dielectric substrates 1, The dielectric substrate 1 was mounted in the corner of the component side (sidewall 16) which carried out the long quadrangle of the mounting board 15, It is a gestalt which the parasitic side radiation electrode 4 is made to meet the end face neighborhood 28 by the side of the long side of the mounting board 15, and the feeder side radiation electrode 3 is made to meet the end face neighborhood 29 by the side of the shorter side of the mounting board 15, and is having mounted the dielectric substrate 1 in the mounting board 15.

[0050]Since mounted the dielectric substrate 1 in the corner of the component side (sidewall 16) which carried out the long quadrangle of the mounting board 15 in this example of an embodiment, both the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 were made to meet the end face neighborhoods 28 and 29 of the mounting board 15 and it has arranged, Profit degradation can be prevented by putting the image current which can prevent narrow-band-ization by electric field concentrates being eased by the end effect by board edge mounting, and flows into a mounting board on a mounting board side direction.

[0051]Since it was considered as the gestalt which the parasitic side radiation electrode 4 is made to meet the end face neighborhood 28 by the side of the long side of the mounting board 15, and the feeder side radiation electrode 3 is made to meet the end face neighborhood 29 by the side of the shorter side of the mounting board 15, While preventing profit degradation of both the radiation electrodes 3 and 4, the sensitivity by the side of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 can be balanced. If this point is explained further, in antenna operation, in the

direction which has arranged the radiation electrodes 3 and 4 to the end face neighborhood side of the mounting board 15, sensitivity will become good, and, in the long side side, sensitivity will become good rather than the shorter side side among that end face neighborhood.

[0052]In this example of an embodiment, since the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 are made to meet the end face neighborhood of the mounting board 15 which becomes good [both sensitivity], both profit degradation of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 can be prevented. When the sensitivity of the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 is measured, sensitivity becomes high rather than the parasitic side radiation electrode 4 in which the direction of the feeder side radiation electrode 3 excited directly (primarily) by the signal source 13 is excited indirectly (secondarily). In this point, the near parasitic side radiation electrode 4 to which sensitivity falls by secondary excitation is arranged in this example of an embodiment to the long side side of the mounting board 15 of the direction where sensitivity becomes high, When sensitivity arranges the feeder side radiation electrode 3 with higher sensitivity by primary excitation to the shorter side side of the mounting board 15 of the side which becomes low, the sensitivity between both the radiation electrodes 3 and 4 will be balanced, and good antenna operation will be performed.

[0053]Drawing 8 shows the example of use of the antenna system of this example of an embodiment (example of **** to a communication apparatus). In the figure, the mounting board 15 is formed into the case 31 of the communication apparatus 30, such as a cellular phone, and the feeder circuit 32 is formed in the mounting board 15. The dielectric substrate 1 in which the feeder side radiation electrode 3 and the electrode pattern of the parasitic side radiation electrode 4 grade were formed is mounted as a surface mounted type antenna on the sidewall (earth electrode) 16 of this mounting board 15, The feeder side radiation electrode 3 is connected to the feeder circuit 32 provided with the signal source 13 by direct or capacitive coupling, and this feeder circuit 32 is further connected to the sending circuit 34 and the receiving circuit 35 via the switch circuit 33. In this communication apparatus 30, the feeding signal of the signal source 13 of the feeder circuit 32 is supplied to the antenna of the dielectric substrate 1, desired antenna operation mentioned above is performed, and transmission and reception of a signal are smoothly performed by the switch operation of the switch circuit 33.

[0054]This invention can take various embodiments, without being limited to each above-mentioned example of an embodiment. For example, although the dielectric substrate 1 was made into the shape of a long direction bodily shape (the upper surface 2 is the rectangular parallelepiped shape of a long rectangular head) in each above-mentioned example of an embodiment, square rectangular parallelepiped shape may be sufficient as the upper surface 2, and further, the upper surface 2 may be a thing of polygons (for example, a hexagon, an octagon, etc.), and may be things, such as a column body.

[0055]In each above-mentioned example of an embodiment, although the feeder side radiation electrode 3 and the parasitic side radiation electrode 4 were formed in the meander-like pattern, it is not necessary to necessarily form in the shape of a meander. However, since using frequency can be lowered by using the shape of a meander, in the case of the specification which communicates on low frequency, it is preferred to make a radiation electrode pattern into the shape of a meander.

[0056]

[Effect of the Invention]Since this invention considers the feeder side radiation

electrode and parasitic side radiation electrode corresponding to each two frequency as the composition which carries out contiguity formation on the surface of one dielectric substrate, The miniaturization of a large antenna system can be attained compared with the thing of composition of forming the substrate of the radiation electrode for every frequency separately, and carrying out side-by-side installation arrangement, and the demand of a miniaturization of a communication apparatus can fully be met.

[0057]Close arrangement of the electromagnetic field coupling of the shorting part of a feeder side radiation electrode and a parasitic side radiation electrode is made possible to the one side face of a dielectric substrate, Since the open end of a feeder side radiation electrode and a parasitic side radiation electrode is formed in the mutually different field side which avoided the forming face of the shorting part of a dielectric substrate, The direction of the resonance current which flows into each of a feeder side radiation electrode and a parasitic side radiation electrode turns into direction of an abbreviated rectangular cross etc. which crosses mutually, and by this. Since the excitation direction (polarization direction) of the signal by the side of a feeder side radiation electrode and the signal by the side of a parasitic side radiation electrode also turns into a direction which an abbreviated rectangular cross etc. intersect, In spite of carrying out contiguity formation of a feeder side radiation electrode and the parasitic side radiation electrode on the surface of one dielectric substrate, interference of the signal between both radiation electrodes can be controlled, and the stable resonance operation corresponding to each frequency can be made to perform on both sides by the side of a feeder side radiation electrode and a parasitic side radiation electrode. Since the open end of a feeder side radiation electrode and a parasitic side radiation electrode was formed in the field side where dielectric substrates differ, the signal interference between strong electric field parts of a feeder side radiation electrode and a parasitic side radiation electrode can be prevented nearly perfectly. Since it is controlled that the influence of adjustment of a one side radiation electrode attains to the characteristic of the radiation electrode of the other side according to said interference depressor effect, It is possible to perform easily matching adjustment of the resonance frequency characteristic of the both sides of a feeder side radiation electrode and a parasitic side radiation electrode, and control of interference between radiation electrodes can realize broadband-izing and high gain-ization.

[0058]Since the side in which dielectric substrates differed moreover carried out alligator arrangement of the open end of the feeder side radiation electrode and parasitic side radiation electrode in which an electric field serves as the maximum in addition to the interference prevention effect of the signal by the side of the aforementioned feeder side radiation electrode, and the signal by the side of a parasitic side radiation electrode, The electric field interference by the side of an open end can be prevented, improvement in an antenna characteristic can be aimed at, and also the profit of the antenna operation by the side of a feeder side radiation electrode and a parasitic side radiation electrode can also be raised, and in spite of making an antenna system small, sufficient performance required for communication is securable.

[0059]A dielectric substrate accomplishes with a rectangular parallelepiped and the one side electrode of a feeder side radiation electrode and a parasitic side radiation electrode is formed in the end side slippage of the upper surface in the square type region by the side of the end concerned which contains overall width mostly at the upper surface of a dielectric substrate, the other end side of the upper surface from which an other side electrode is formed all over the field of the remainder on top, in addition a direction lateral electrode serves as an opposite hand to the formation area of said one side electrode -- the section of overall width being accomplished the open end side, and

mostly, If the periphery of the other side electrode of the side which meets said one side electrode is in the shape which curved in the direction which separates from a lateral electrode on the other hand, and the accomplished invention as it goes to the other end side from the one end side of the square type region width of said one side electrode, Extended formation of the area of the radiation electrode by the side of curved shape can be carried out, and a feeder side radiation electrode and a parasitic side radiation electrode can be formed almost over the whole surface of the upper surface of a dielectric substrate.

[0060]Thus, since the curved shape is curving in the direction which separates from the radiation electrode of the side which meets even if it carries out extended formation of the area of the radiation electrode by the side of curved shape, Interference of the signal between both radiation electrodes will be controlled, by this, the part and antenna body product which the area of the radiation electrode extended can increase, and an antenna characteristic can be raised.

[0061]By forming both a feeder side radiation electrode, and both [one side or] in the shape of a meander, the resonance frequency of the radiation electrode formed in the shape of a meander can be lowered, and it can communicate convenient using the signal of low frequency. When two frequency to be used is separated, The effect that the radiation electrode which resonates on high frequency on the surface of one dielectric substrate, and the radiation electrode which resonates on low frequency can be arranged convenient is acquired by forming the radiation electrode of another side in the shape of a meander, and setting it as low frequency by setting one radiation electrode as high frequency, without using the shape of a meander.

[0062]If it is in the composition of the dielectric substrate which made the hole in the inside of a dielectric substrate, or carried out the opening of the pars-basilaris-ossis-occipitalis side, and made the inside hollow, the weight saving of an antenna system can be attained, the effective dielectric constant of a dielectric substrate falls, and both radiation electrodes and grand inter-electrode electric field concentrates are eased, and also broadband-izing and high gain-ization are attained. The electric field on the radiation electrode side currently formed in the upper surface of a dielectric substrate can weaken according to a dispersion effect, while it sets because the effective dielectric constant of a dielectric substrate falls, The effect that an antenna characteristic can improve further since capacitive coupling (capacitive coupling with sidewall) becomes large and field intensity becomes strong conversely at the open end side of a radiation electrode is acquired.

[0063]What (profit degradation is prevented) is further improved in the profit of antenna operation of a feeder side radiation electrode and a parasitic side radiation electrode can do the thing of composition of having mounted the dielectric substrate in which the feeder side radiation electrode and the parasitic side radiation electrode were formed in the corner of a mounting board side. By making a parasitic side radiation electrode there be along the long side of the mounting board of long quadrangular shape where sensitivity becomes the best, Rather than the feeder side radiation electrode of primary electric supply, the sensitivity of the parasitic side radiation electrode by the side of the secondary electric supply to which sensitivity falls can be raised relatively, by this, the sensitivity of a feeder side radiation electrode and a parasitic side radiation electrode can be balanced, and suitable antenna operation can be performed.

[0064]While being able to attain the miniaturization of a communication apparatus by mounting such a small surface mounted type antenna (antenna system) in a communication apparatus according to the communication apparatus of this invention, reduction of assembling expense is also realizable.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an important section composition explanatory view of the 1st example of an embodiment of this invention.
[Drawing 2]It is an important section composition explanatory view of the 2nd example of an embodiment of this invention.
[Drawing 3]It is an important section composition explanatory view of the 3rd example of an embodiment of this invention.
[Drawing 4]It is an important section composition explanatory view of the 4th example of an embodiment of this invention.
[Drawing 5]It is an explanatory view of the example of an embodiment of the various type antenna systems which extended radiation electrode area.
[Drawing 6]It is an explanatory view of the various examples of an embodiment of the dielectric substrate which formed the centrum in the inside.
[Drawing 7]It is an explanatory view of the example of an embodiment showing the mount configuration of a dielectric substrate.
[Drawing 8]It is an explanatory view of the example of use of the antenna system concerning this invention (example of **** to a communication apparatus).
[Drawing 9]It is an explanatory view of the conventional antenna system.
[Description of Notations]
1 Dielectric substrate
2 Upper surface
3 Feeder side radiation electrode
4 Parasitic side radiation electrode
8, 9 shorting parts
13 Signal source
15 Mounting board
16 Sidewall
17 and 22 Open end

OIPE IAP67
JUN 09 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-05-12
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6281848	B1	2001-08-21	NAGUMO ET AL	
	2	6262495	B1	2001-07-17	YABLONOVITCH ET AL	
	3	6509882	B2	2003-01-21	MCKIVERGAN ET AL	

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	00/35048	WO	A1	2000-06-15	QUALCOMM INCORPORATED		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-05-12
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	47005-P015WUSC1

	2	05-090824	JP		1993-04-09	MATSUSHITA ELECTRIC IND CO LTD		☒
	3	2001-007639	JP		2001-01-12	MURATA MFG CO LTD		☒

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	TAYLOR, C. D. ; ARONSON, E. A. ; HARRISON, C.W. JR., Theory of coupled monopoles, IEEE Transactions on antennas and propagation, Vol. AP-18, No. 3, May 1970	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: June 5, 2008 Signature: Tracie London
(Tracie London)

OIPE
JUN 09 2008
PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

A full translation, partial translation or summary/abstract of the Non – English References is enclosed.

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: June 4, 2008

Respectfully submitted,

By _____
Stanley R. Moore
Registration No.: 26,958
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1

CONFIRMATION NO. 7241

23932
JENKENS & GILCHRIST, PC
1445 ROSS AVENUE
SUITE 3200
DALLAS, TX75202

Title: COUPLED MULTIBAND ANTENNAS

Publication No. US-2008-0129630-A1
Publication Date: 06/05/2008

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Pre-Grant Publication Division, 703-605-4283

USPTO
APR 08 2008
PATENT & TRADEMARK OFFICE

RFW

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: April 4, 2008 Signature: Tracie London
(Tracie London)

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this

Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: April 3, 2008

Respectfully submitted,

By _____

Stanley R. Moore
Registration No.: 26,958
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

USPTO APR 08 2008 PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1011167	EP	A1	2000-06-21	Matsushita Electric Industrial		☐
	2	06334421	JP		1994-12-02	Mitsubishi Heavy Ind		☒

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

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

OIPE
APR 08 2008
PATENT & TRADEMARK OFFICE

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 06334421
PUBLICATION DATE : 02-12-94

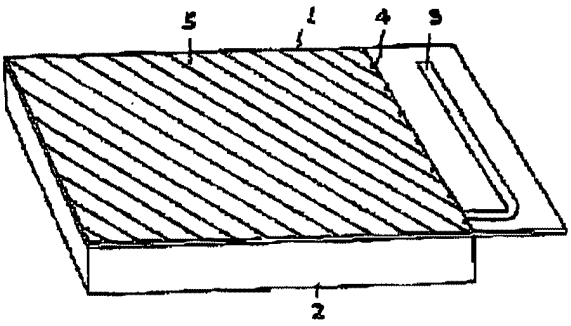
APPLICATION DATE : 21-05-93
APPLICATION NUMBER : 05119697

APPLICANT : MITSUBISHI HEAVY IND LTD;

INVENTOR : FUJIE TAKESHI;

INT.CL. : H01Q 1/38 H04B 1/03 H04B 1/08

TITLE : RADIO COMMUNICATION PRODUCT WITH BOARD MOUNT ANTENNA



ABSTRACT : PURPOSE: To facilitate mass-production of the radio communication products, to reduce cost, to make the profile thin, to prevent illegal revamping and to facilitate the design change by providing an antenna made by the multi-layer board technology onto a board.

CONSTITUTION: A component mount side of a multi-layer board 1 with the electric function of the radio communication product is covered by a shield box 2. On the other hand, a print pattern of an inverted-L shaped antenna 3 is formed to an over-hang part of an optional layer other than the front surface by the multi-layer board technology such as etching and a pattern for electric connection is also formed. A throughhole 4 is used to form the surface of a conductor foil as an earth side 5. The throughhole 4 prevent noise invasion in the box 2 due to a gap formed to the shield and forms the earth side of the antenna 3.

COPYRIGHT: (C)1994,JPO

(19)日本国特許庁（ＪＰ） (12) 公開特許公報（A） (11)特許出願公開番号

特開平6－334421

(43)公開日 平成6年(1994)12月2日

(51)Int.Cl.⁵		識別記号	庁内整理番号	FI	技術表示箇所
H01Q	1/38		7037－5J		
H04B	1/03	Z	2116－5K		
	1/08	Z			

審査請求 未請求 請求項の数1 OL （全 4 頁）

(21)出願番号 特願平5－119697

(22)出願日 平成5年(1993)5月21日

(71)出願人 000006208
三菱重工業株式会社
東京都千代田区丸の内二丁目5番1号

(72)発明者 藤江 壮
愛知県名古屋市港区大江町10番地 三菱重工業株式会社名古屋航空宇宙システム製作所内

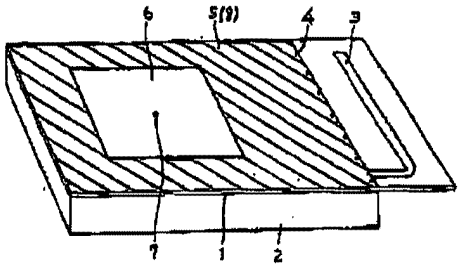
(74)代理人 弁理士 光石 俊郎 （外1名）

(54)【発明の名称】 基板実装アンテナを有する無線通信製品

(57)【要約】

【目的】 無線通信製品の量産，コスト低減，薄型化，違法改造防止及び設計変更の容易さを達成する。

【構成】 多層基板1上のシールドボックス2から出た部分にプリントパターンにより逆Ｌ型アンテナ3や平面アンテナ6を形成する。



BNSDOCID: <JP_____406334421A_I_>

【0010】図1に示した同様に、逆L型アンテナ3の代りに、M型アンテナ、モノポールアンテナ、T型アンテナ等も実装することができる。いずれの場合も、多層基板1の水平面にシールドからオーバハングさせてアンテナのパターンを形成することにより、任意のアンテナ高さが得られる。

【0011】図2，図3は本発明をマイクロストリップ型平面アンテナに適用した場合の実施例を示す。図3は図2中のIII －III線断面図である。本実施例では、多層基板1の表面にマイクロストリップ型平面アンテナ6のプリントパターンをエッチング等の多層基板技術により形成してある。シールドボックス2は多層基板1の部品実装面を覆っている。この平面アンテナ6の給電は、図3から判るようにスルーホール7によって行っている。この給電点の位置の設定により、インピーダンスマッチングを行うことができる。なお、スルーホール7の代りに、マイクロストリップ線路で給電することもできる。

【0012】図3から判るように、アンテナ面の下層にアース面8を形成してある。本実施例のように平面アンテナ6を多層基板1に実装する場合は、アンテナのプリントパターンの直下の層に全面のアース面8を用意する。また、このアース面8とシールドボックス2との間の電気的接続は、全ての辺で確実に行ってある。

【0013】図2，図3に示した同様に、平面アンテナの数や形を設定することにより、アンテナアレイや偏波面の変更、また利得や指向性等の特性を任意に設計することができる。

【0014】更に、図1に示した実施例と図2，図3に示した実施例とを組み合わせて、ダイバーシティ等に適用したアンテナを基板1に実装することも可能である。図4にダイバーシティ用の一例を示す。但し、図4中で図1，図2中の部材と同一機能のものには同一符号を付してある。

【0015】

【発明の効果】本発明によれば、基板上にアンテナが多層基板技術によってプリントパターンとして実装されたことにより、下記のような効果がある。

（1）量産とコスト低減の達成：基板を作製するための工数と資源でアンテナが出来上がるので、コストが低減する。また、多層基板技術のエッチングだけで精度の高いアンテナが出来るので、量産性が良い。

（2）薄型化の達成：個別部品としてのアンテナ及び給電部がなくなり、必要部品はシールドボックスと基板になるから、薄型になり、カード型無線通信機に適している。なお、アンテナ形成のための基板の多層化によって、基板の厚さが多少増加するが、これはたかだか0．2～0．4mm程度であるから、効果の大きさに比べて問題とはならない。

（3）違法改造等の防止：アンテナが基板上にプリントパターンで形成されているため、利得向上を目的としたアンテナ形状の変更はほぼ不可能である。また、アンテナが基板上で給電されることになるため、外部アンテナを接続することも技術的に非常に困難であり、素人には不可能である。

（4）設計変更の容易さ：アンテナがプリントパターンで作られているため、アンテナ形状や給電位置等を変更することにより、利得，放射パターン，インピーダンス，周波数，指向性等を変更することが設計者にとって簡単である。

【図面の簡単な説明】

【図1】本発明の一実施例を示す図。

【図2】本発明の他の実施例を示す図。

【図3】図2中のIII －III 線断面図。

【図4】本発明の更に他の実施例を示す図。

【図5】従来例を示す図。

【符号の説明】

1 多層基板

2 シールドボックス

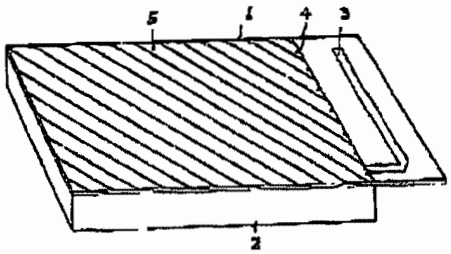
3 逆L型アンテナ

4，7 スルーホール

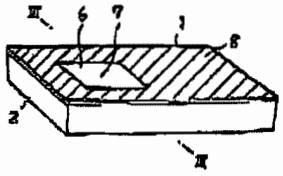
5，8 アース面

6 平面アンテナ

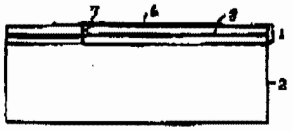
【図1】



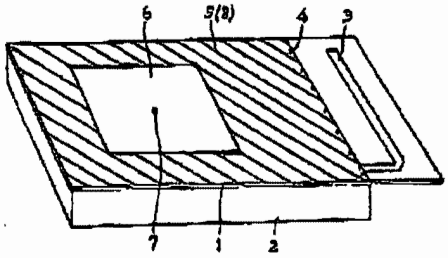
【図2】



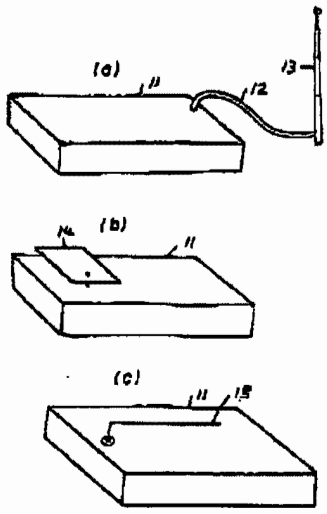
【図3】



【図4】



【図6】



1

【特許請求の範囲】

【請求項1】 無線通信製品の基板上に多層基板技術により形成されたアンテナが備えられていることを特徴とする基板実装アンテナを有する無線通信製品。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は無線通信製品の空中線電力変換部に適用される基板実装アンテナに関する。

【0002】

【従来の技術】従来の無線通信製品の空中線電力変換部には、図5（a）～（c）に示すようなものがある。

（a）：図5（a）においては、無線通信製品の電気機能の基板（図示省略）をシールドボックス11内に納め、外部のロッドアンテナ13に、基板から同軸線12で給電する。

（b）：図5（b）においては、基板を収納したシールドボックス11の表面に直接、逆L型アンテナ14等の外部アンテナを取り付け、端子や給電線を介して基板から給電する。

（c）：図5（c）においては、基板を収納したシールドボックス11の構造の一部として、マイクロストリップアンテナ15等の平面アンテナを形成し、端子や給電線を介して基板から給電する。

【0003】図5に示した各種従来例に共通した特徴として、下記事項があげられる。

（1）基板は完全にシールドボックス11によって覆われており、アンテナ13，14，15とは分離・独立している。

（2）基板とアンテナ13，14，15とは、同軸線12もしくはそれに類似した給電線で接続されている。

（3）アンテナ13，14，15は基板とはほぼ無関係に設計され、またシールドボックス11に設置されるため、ユーザによる変更や改造が容易である。

【0004】

【発明が解決しようとする課題】上述した如く、従来はアンテナと基板の設計では、それぞれが別々のものとして設計されていたため、下記のような問題点が生じていた。

（1）工数及び資源がかかる。即ち、アンテナと基板を別々に製作し、これらを組み合わせるために、取り付け強度の確保等を含めて不要な工数及び資源を要する。

（2）無線通信製品のカード化等、薄型化が困難である。即ち、アンテナへの給電部が同軸型となるので、その分厚みが増加し、アンテナの取付方法及びアンテナ寸法等の制約を受けることになり、薄型化が困難となる。

（3）違法改造が容易である。即ち、無線通信機器では通常、アンテナや出力、波長等を変更することを電波法令で制限されているが、アンテナと基板が別体で給電線を用いて接続していると、素人でも任意のアンテナに簡単に変更あるいは改造することが可能である。

2

【0005】本発明は上述した従来技術の問題点を解消した無線通信製品を提供することを目的とする。

【0006】

【課題を解決するための手段】上記目的を達成する本発明の無線通信製品は、無線通信製品の基板上に多層基板技術により形成されたアンテナが備えられていることを特徴とするものである。アンテナの形態としては、逆L型アンテナ，M型アンテナ，モノポールアンテナ，あるいはマイクロストリップ等の平面アンテナ等，種々のものがある。

【0007】

【作用】基板そのものにアンテナが多層基板技術によりプリントパターンとして形成されていることにより、下記のような作用がある。

（1）基板とアンテナを結ぶための、同軸線等の個別部品が全て省略できる。

（2）アンテナが基板にプリント化され，これにより，薄型化が達成される。即ち，カード型無線通信装置が実現する。

（3）アンテナと基板が一体化し、アンテナ取付に関する工数や資源を省略できる。

（4）基板自体が電波の放射源となる。

（5）アンテナはエッチングにより容易に所望のものが得られる。

（6）逆L型アンテナ等では、基板の水平面にオーバハングさせてアンテナを形成すること等により、任意のアンテナ高さを得ることができる。

【0008】

【実施例】以下、本発明を図面に示す実施例とともに説明する。図1は本発明を逆L型アンテナに適用した場合の実施例を示し、無線通信製品の電気機能を有する多層基板1の部品実装面をシールドボックス2で覆ってある。一方，エッチング等の多層基板技術により表面以外の任意の層のオーバハング部に逆L型アンテナ3のアンテナプリントパターンを形成し，また電気的接続のパターンも形成してある。部品実装面以外の任意の層にアンテナのプリントパターンを形成しても，これによる電磁的性能の劣化はない。

【0009】図1の実施例を更に説明すると、スルーホール4は導体箔の表面をアース面5として形成するためのものである。スルーホール4の代りにシールドボックス2の爪（図示省略）を用いることもできるが、シールドの間隔が使用電波のλ／4よりはるかに小さい必要があり、周波数が高い場合には、間隔が狭くできるスルーホール4が好ましい。即ち、スルーホール4は、シールドに隙間が出来ることによってシールドボックス2内に雑音が侵入するのを防止すると共に、逆L型アンテナ3のアース面5を形成する役目を果す。アース面5を図1に示したようにシールドボックス2の一部を包うように設計した場合、アンテナ面をより外側にする。

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 011 167 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(43) Date of publication:
21.06.2000 Bulletin 2000/25

(21) Application number: **98959147.4**

(22) Date of filing: **10.12.1998**

(51) Int. Cl.[7]: **H01Q 21/30**, H01Q 21/28, H01Q 1/32, H01Q 5/00, H01Q 9/26, H01Q 9/42, H01Q 23/00, H04N 5/44, H01Q 3/26

(86) International application number:
PCT/JP98/05577

(87) International publication number:
WO 00/02287 (13.01.2000 Gazette 2000/02)

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **02.07.1998 JP 18796798**

(71) Applicant:
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
Kadoma-shi, Osaka 571-8501 (JP)

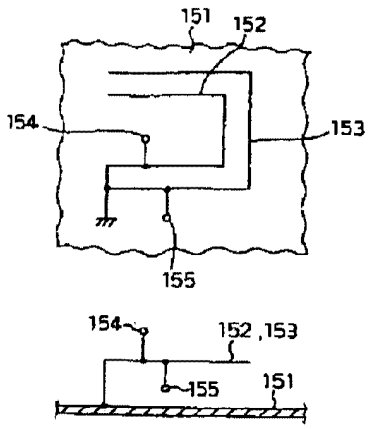
(72) Inventors:
- **KANE, Joji**
  Nara-shi, Nara 631-0804 (JP)
- **YOSIDA, Takasi**
  Ikoma-shi, Nara 630-0213 (JP)
- **NOMURA, Noboru**
  Kyoto-shi, Kyoto 612-0889 (JP)
- **SASAKI, Michio**
  Yokohama-shi, Kanagawa 226-0027 (JP)
- **YANASE, Akinori**
  Yokohama-shi, Kanagawa 241-0085 (JP)
- **YAMADA, Satoshi,**
  Room 303, Stork-Isezaki-Sbankan
  Yokohama-shi, Kanagawa 231-0045 (JP)

(74) Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) ANTENNA UNIT, COMMUNICATION SYSTEM AND DIGITAL TELEVISION RECEIVER

(57) An antenna device comprising a conductive earth substrate, a receiving element located in the proximity of said conductive earth substrate and having a receiving terminal, and a transmitting element located in the proximity of said receiving element and having a transmitting terminal, characterized in that an end of said receiving element and an end of said transmitting element are connected to said conductive earth substrate for grounding through a common portion and the frequency band of said receiving element is different from that of said transmitting element.

Fig. 1



EP 1 011 167 A1

Printed by Xerox (UK) Business Services
2.16.7 (HRS)/3.6

Description

Technical Field

[0001] The present invention relates, in particular, to an antenna device to be attached to a body of an automobile for receiving, for example, AM, FM, or TV broadcasting or wireless telephone, etc. and to a communication system using such an antenna device.

Background Art

[0002] With the advance of the car multimedia era, in addition to an AM/FM radio, various radio equipments such as a TV receiver, a wireless telephone set, and a navigation system have been recently installed in the automobile. Also hereafter, information and services may be increasingly provided through radio wave and the importance of an antenna will grow accordingly.

[0003] Generally, in the wireless telephone set or any other communication devices which are used for mobile communication and are capable of transmitting and receiving, the antenna is used for both transmitting and receiving and a single terminal connected to that antenna performs a double function of an input terminal for the receiving section and an output terminal for the transmitting section through a common component such as a divider, a mixer, a circulator, or a switch or the like. During the receiving operation, such a common component prevents a received signal from entering the transmitting section through the antenna and allows it to enter the receiving section properly. On the contrary, during the transmitting operation, that component prevents a transmission signal from entering the receiving section from the transmitting section and allows it to be emitted through the antenna.

[0004] As described above, however, when an antenna is used for both transmitting and receiving with a common component in a communication device, it may generally require a high cost common component and the communication device itself may become very expensive. In addition, there is a problem that the reception sensitivity may be degraded with an increased transmission loss by using a single antenna with a common component.

[0005] Moreover, since a receiving amplifier and a transmitting amplifier are certainly installed at the side of the communication device, there is a problem that a cable connecting between the antenna and the communication device may degrade the reception level and the transmission power.

Disclosure of the Invention

[0006] In view of these problems of conventional antennas, the present invention aims to provide an antenna device and a communication system which can improve the reception sensitivity with a reduced transmission loss and which can be implemented at a lower cost.

[0007] Also, the present invention aims to provide an antenna device which can further improve its gain.

[0008] In addition, the present invention aims to provide a digital television broadcasting receiving device and a receiving method which can reduce reception disturbance during the mobile reception of digital data.

[0009] A 1st invention of the present invention (corresponding to claim 1) is an antenna device comprising:

a conductive earth substrate;
a receiving element located in the proximity of said conductive earth substrate and having a receiving terminal; and
a transmitting element located in the proximity of said receiving element and having a transmitting terminal,
characterized in that an end of said receiving element and an end of said transmitting element are connected to said conductive earth substrate for grounding through a common portion and the frequency band of said receiving element is different from that of said transmitting element.

[0010] A 2nd invention of the present invention(corresponding to claim 2) is an antenna device comprising:

a conductive earth substrate;
a receiving element located in the proximity of said conductive earth substrate and having a receiving terminal; and
a transmitting element located in the proximity of said receiving element and having a transmitting terminal,
characterized in that an end of said receiving element and an end of said transmitting element are connected to said conductive earth substrate for grounding at separate locations and the frequency band of said receiving element is different from that of said transmitting element.

[0011] A 3rd invention of the present invention(corresponding to claim 12) is an antenna device comprising:

a conductive earth substrate;
an antenna element having an end connected to said conductive earth substrate for grounding and formed on a common circuit board; and
a feeding terminal pulled out of said antenna element,
characterized in that a resonant circuit is inserted between said feeding terminal and the other end of said antenna element which is not grounded.

[0012] A 4th invention of the present invention (cor-

responding to claim 18) is a communication system comprising:

an antenna device having a conductive earth substrate, an antenna element formed on a common circuit board located in the proximity of said conductive earth substrate, and a receiving amplifier provided on said common circuit board between said antenna element and a feeding terminal;
a receiver having a power supply section to supply electric power to said receiving amplifier of said antenna device; and
a feeding line for connecting said feeding terminal of said antenna device to a signal input section of said receiver,
characterized in that a direct-current blocking capacitor is provided between said receiving amplifier of said antenna device and said feeding terminal and at the input terminal of a receiving amplifier of said receiver, respectively, and electric power is supplied by said power supply section to said receiving amplifier of said antenna device through said feeding line.

[0013] A 5th invention of the present invention (corresponding to claim 20) is a communication system comprising:

an antenna device of the present invention (corresponding to claim 15);
a receiver having a receiving channel setting circuit which generates a bias voltage for said voltage-variable capacitor element of said antenna device; and
a feeding line for connecting a signal input section of said receiver to a feeding terminal of said antenna device,
characterized in that said voltage-variable capacitor element of said antenna device is connected to said feeding terminal, a direct-current blocking capacitor is provided between said antenna element and said feeding terminal and at the input terminal of a receiving amplifier of said receiver, respectively, and a receiving channel is established by varying the bias voltage generated by said receiving channel setting circuit.

[0014] A 6th invention of the present invention (corresponding to claim 21) is a communication system comprising:

an antenna device of the present invention(corresponding to any one of claims 1 through 10);
a communication device having a receiving amplifier and a transmitting amplifier;
a receiving connection line for connecting the receiving terminal of said antenna device to said receiving amplifier of said communication device; and
a transmitting connection line for connecting the transmitting terminal of said antenna device to said transmitting amplifier of said communication device.

[0015] A 7th invention of the present invention (corresponding to claim 22) is a communication system comprising:

an antenna device having a conductive earth substrate, a receiving element having a receiving terminal formed on a common circuit board located in the proximity of said conductive earth substrate, a transmitting element having a transmitting terminal formed on said common circuit board located in the proximity of said receiving element, and a transmitting/receiving changeover circuit provided on said common circuit board and capable of switching said receiving terminal and said transmitting terminal;
a feeding line connected to said transmitting/receiving changeover circuit; and
a communication device connected to said feeding line and capable of both transmitting and receiving,
characterized in that said transmitting/receiving changeover circuit of said antenna device is controlled by using a switch signal to change over to the transmission operation in said communication device.

[0016] A 8th invention of the present invention (corresponding to claim 23) is a communication system comprising:

an antenna device of the present invention corresponding to claim 11);
a communication device having a power supply section to supply electric power to said receiving amplifier of said antenna device and capable of both transmitting and receiving; and
a feeding line for connecting a common terminal of said antenna device to a signal input/output section of said communication device, characterized in that a direct-current blocking capacitor is provided between a common component of said antenna element and said common terminal and at the input/output terminal of said communication device, respectively, and electric power is supplied by said power supply section to a receiving amplifier of said antenna device through said feeding line.

[0017] A 9th invention of the present invention(corresponding to claim 30) is an antenna device comprising:

a conductive earth substrate;
a main antenna element connected to said conductive earth substrate through a first ground connection to be substantially parallel to said conductive

earth substrate; and

a passive element connected to said conductive earth substrate through a second ground connection along said main antenna element.

[0018] A 10th invention of the present invention(corresponding to claim 38) is a digital television broadcasting receiving device comprising:

input means which is an antenna device of the present invention(corresponding to any one of claims 1 through 37) and converts electromagnetic waves into electric signals;
delay means for receiving a signal from said input means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said input means;
reception means for performing frequency conversion on a signal from said synthesis means; and
demodulation means for converting a signal from said reception means into a baseband signal, characterized in that the delay time used in said delay means and the synthesis ratio used in said synthesis means can be established arbitrarily.

[0019] A 11th invention of the present invention(corresponding to claim 39) is a digital television broadcasting receiving device comprising:

input means which is an antenna device of the present invention(corresponding to any one of claims 1 through 37) and converts electromagnetic waves into electric signals;
delay means for receiving a signal from said input means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said input means;
reception means for performing frequency conversion on a signal from said synthesis means;
demodulation means for converting a signal from said reception means into a baseband signal;
delayed wave estimation means for receiving a signal indicating the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and
synthesis control means for controlling said synthesis means and said delay means in accordance with a signal from said delayed wave estimation means, characterized in that either the signal synthesis ratio used in said synthesis means or the delay time used in said delay means can be controlled in accordance with a signal from said synthesis control means.

[0020] A 12th invention of the present invention(corresponding to claim 40) is a digital television broadcasting receiving device comprising:

input means which is an antenna device of the present invention (corresponding to any one of claims 1 through 37) and converts electromagnetic waves into electric signals;
reception means for performing frequency conversion on a signal from said input means;
delay means for receiving a signal from said reception means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said reception means; and
demodulation means for converting a signal from said synthesis means into a baseband signal, characterized in that the delay time used in said delay means and the synthesis ratio used in said synthesis means can be established arbitrarily.

[0021] A 13th invention of the present invention(corresponding to claim 41) is a digital television broadcasting receiving device comprising:

input means which is an antenna device of the present invention(corresponding to any one of claims 1 through 37) and converts electromagnetic waves into electric signals, a reception means for performing frequency conversion on a signal from said input means;
delay means for receiving a signal from said reception means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said reception means;
demodulation means for converting a signal from said synthesis means into a baseband signal;
delayed wave estimation means for receiving a signal indicating the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and
synthesis control means for controlling said synthesis means and said delay means in accordance with a signal from said delayed wave estimation means, characterized in that either the signal synthesis ratio used in said synthesis means or the delay time used in said delay means can be controlled in accordance with a signal from said synthesis control means.

[0022] A 14th invention of the present invention(corresponding to claim 42) is a digital television broadcasting receiving device comprising:

input means which is an antenna device of the present invention(corresponding to any one of claims 1 through 37) and converts electromagnetic waves into electric signals;
reception means for performing frequency conversion on a signal from said input means;

demodulation means for converting a signal from said reception means into a baseband signal;

delayed wave estimation means for receiving information on the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and

demodulation control means for controlling said demodulation means based on delayed wave information from said delayed wave estimation means, characterized in that a transfer function to be handled by said demodulation means is controlled based on a control signal from said demodulation control means.

Brief Description of the Drawings

[0023]

Figure 1 is a schematic diagram showing an example of an antenna device according to a first embodiment of the present invention;

Figure 2 is a schematic diagram showing frequency bands achieved in the antenna device according to the first embodiment;

Figure 3 is a schematic diagram showing another example of the antenna device according to the first embodiment;

Figure 4 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 5 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 6 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 7 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 8 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 9 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 10 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 11 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 12 is a schematic diagram showing still another example of the antenna device according to the first embodiment;

Figure 13 is a schematic diagram showing an example of an antenna device according to a second embodiment of the present invention;

Figure 14 is a schematic diagram showing another example of the antenna device according to the second embodiment;

Figure 15 is a schematic diagram showing still another example of the antenna device according to the second embodiment;

Figure 16 is a schematic diagram showing still another example of the antenna device according to the second embodiment;

Figure 17 is a schematic diagram showing still another example of the antenna device according to the second embodiment;

Figure 18 is a schematic diagram showing an example of an antenna device according to a third embodiment of the present invention;

Figure 19 is a schematic diagram for explaining the frequency characteristics of the antenna device shown in Figure 18;

Figure 20 is a schematic diagram showing another example of the antenna device according to the third embodiment;

Figure 21 is a schematic diagram for explaining the frequency characteristics of the antenna device shown in Figure 20;

Figure 22 is a schematic diagram showing an example of the main components in an antenna device according to a fourth embodiment of the present invention;

Figure 23 is a schematic diagram for explaining the frequency characteristics of the antenna device shown in Figure 22;

Figure 24 is a schematic diagram showing another example of the main components in the antenna device according to the fourth embodiment;

Figure 25 is a schematic diagram showing an example of the main components in an antenna device according to a fifth embodiment of the present invention;

Figure 26 is a schematic diagram for explaining the frequency characteristics of the antenna device shown in Figure 25;

Figure 27 is a schematic diagram showing the configuration of an example of a communication system which uses an antenna device according to a sixth embodiment of the present invention;

Figure 28 is a schematic diagram showing the configuration of another example of a communication system which uses the antenna device according to the sixth embodiment;

Figure 29 is a schematic diagram showing the configuration of an example of a communication system which uses an antenna device according to a seventh embodiment of the present invention;

Figure 30 is a schematic diagram showing the configuration of an example of a communication system which uses an antenna device according to an eighth embodiment of the present invention;

Figure 31 is a schematic diagram showing the con-

figuration of another example of a communication system which uses the antenna device according to the eighth embodiment;

Figure 32 is a schematic diagram showing the configuration of still another example of a communication system which uses the antenna device according to the eighth embodiment;

Figure 33 is a schematic diagram showing the configuration of an example of a communication system which uses an antenna device according to a ninth embodiment of the present invention;

Figure 34 is a schematic diagram showing the configuration of an example of a communication system which uses an antenna device according to the tenth embodiment of the present invention;

Figure 35 is a schematic diagram showing the configuration of another example of a communication system which uses the antenna device according to a tenth embodiment;

Figure 36 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 37 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 38 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 39 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 40 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 41 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 42 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 43 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 44 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 45 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 46 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 47 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 48 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 49 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 50 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 51 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 52 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 53 shows the positional relationship between an antenna and a conductive earth substrate according to the present invention;

Figure 54 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 55 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 56 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 57 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 58 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 59 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 60 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 61 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 62 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 63 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 64 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 65 is a perspective diagram showing possible locations where an antenna device according to the present invention is to be installed;

Figure 66 is a schematic diagram showing an example of a mobile communication device with an antenna device according to the present invention;

Figure 67 is a schematic diagram showing an example of a portable telephone with an antenna device according to the present invention;

Figure 68 shows an example of band synthesis

according to the present invention;

Figure 69 shows an example of gain accumulation according to the present invention;

Figure 70 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 71 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 72 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 73 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 74 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 75 is a perspective diagram showing a possible automobile application of an antenna device according to the present invention;

Figure 76 is a perspective diagram showing possible locations where an antenna according to the present invention is to be installed for each part of the automobile;

Figure 77 is a diagram for explaining the properties of an antenna according to the present invention;

Figure 78 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 79 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 80 is a perspective diagram showing possible locations where an antenna according to the present invention is to be installed for each part of the automobile;

Figure 81 is a perspective diagram showing a possible application to a portable telephone of an antenna according to the present invention;

Figure 82 is a perspective diagram showing a possible application to an ordinary house of an antenna according to the present invention;

Figure 83 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 84 (a) is a schematic diagram showing the configuration of an example of an antenna according to the present invention and Figure 84 (b) is an explanatory drawing therefor;

Figure 85 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 86 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 87 is a schematic diagram showing an example of an antenna device according to the present invention;

Figures 88 (a) and 88 (b) are schematic diagrams showing the configuration of an example of an antenna according to the present invention and Figure 88 (c) is a graph for explaining the frequency characteristics thereof;

Figures 89 (a) and 89 (b) are schematic diagrams showing the configuration of an example of an antenna according to the present invention and Figure 89 (c) is a graph for explaining the frequency characteristics thereof;

Figures 90 (a) and 90 (b) are schematic diagrams showing the configuration of an example of an antenna according to the present invention and Figure 90 (c) is a graph for explaining the frequency characteristics thereof;

Figure 91 shows an application of an antenna device according to the present invention;

Figure 92 shows an application of an antenna device according to the present invention;

Figure 93 shows an application of an antenna device according to the present invention;

Figure 94 shows an application of an antenna device according to the present invention;

Figure 95 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 96 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 97 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 98 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 99 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 100 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 101 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 102 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 103 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 104 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 105 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 106 is a schematic diagram showing various

element patterns according to the present invention;

Figure 107 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 108 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 109 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 110 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 111 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 112 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 113 is a perspective view showing a specific configuration of an antenna device according to the present invention;

Figure 114 shows the impedance and VSWR characteristics of the antenna shown in Figure 113;

Figure 115 shows the directional gain characteristics of the antenna shown in Figure 113;

Figure 116 shows the VSWR characteristics of an element for explaining band synthesis in a 4-element antenna;

Figure 117 shows the VSWR characteristics of another element for explaining band synthesis in the 4-element antenna;

Figure 118 shows the VSWR characteristics of another element for explaining band synthesis in the 4-element antenna;

Figure 119 shows the VSWR characteristics of another element for explaining band synthesis in the 4-element antenna;

Figure 120 shows the VSWR characteristics after band synthesis of the 4-element antenna shown in Figures 116 through 119;

Figure 121 shows the VSWR characteristics when the range of ordinates in Figure 120 is extended;

Figure 122 shows the directional gain characteristics when the antenna ground is located at different distances from the device ground in the antenna of Figure 72 (b);

Figure 123 shows the directional gain characteristics in the antenna of Figure 83 (a);

Figure 124 shows the directional gain characteristics in the antenna of Figure 83 (b);

Figure 125 (a) shows that a low-pass circuit is provided near a feeding terminal in an antenna device according to the present invention and Figure 125 (b) shows that a high-pass circuit is provided near a feeding terminal in a similar manner;

Figure 126 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 127 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 128 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 129 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 130 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 131 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 132 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 133 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 134 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 135 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 136 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 137 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 138 is a schematic diagram showing an example of an antenna device according to the present invention;

Figure 139 shows the gain characteristics of an example of an antenna device according to the present invention;

Figure 140 shows the gain characteristics of an example of an antenna device according to the present invention;

Figure 141 is a block diagram showing the configuration of a digital television broadcasting receiving device according to an embodiment of the present invention;

Figure 142 is a block diagram showing the configuration of a digital television broadcasting receiving device according to another embodiment of the present invention;

Figure 143 is a block diagram showing the configuration of a digital television broadcasting receiving device according to another embodiment of the present invention;

Figure 144 is a block diagram showing the configuration of a digital television broadcasting receiving

device according to another embodiment of the present invention;

Figure 145 is a block diagram showing the configuration of a digital television broadcasting receiving device according to another embodiment of the present invention;

Figure 146 is a block diagram showing the configuration of a digital television broadcasting receiving device according to another embodiment of the present invention;

Figure 147 is a conceptual diagram showing the result of frequency analysis performed on a received signal which is affected by disturbance of a delayed wave;

Figure 148 is a conceptual diagram showing the gain control performed by a synthesis means;

Figure 149 is a conceptual diagram showing the delay time and error rate of a delayed wave; and

Figure 150 is a flow chart for explaining antenna switching conditions for changing over from one antenna to another.

[Description of Symbols]

[0024]

101, 104	Antenna element (linear conductor)
102	Feeding terminal
151	Antenna ground
152	Receiving element
153	Transmitting element
205	Conductive earth substrate
356	Common circuit board
502, 504	Reactance element
1304	Printed circuit board
1357	Receiving amplifier
1458	Transmitting amplifier
1505	Recess
1655	Common component
1806	Multilayer printed circuit board
1853	Resonant circuit loading section
1901	Feeding point
2760	Direct-current power supply section
2961	Receiving channel setting circuit
3003	Dielectric
3203	Coil
3355	Transmitting/receiving element changeover relay switch
3362	Handset
3365	Voice modulator
3503	Diversity changeover switch
3804	Communication device
3805	Body
3902	Shielding case
4603	High-permittivity material
5603, 5606	Ferroelectric
4001	Main element
4002	Passive element
4003	Conductive earth substrate
4004	Ground connection
4005	Ground connection
4006	Feeding terminal
6001	Input means
6002	Delay means
6003	Synthesis means
6004	Reception means
6005	Demodulation means
6006	Synthesis control means
6007	Delayed wave estimation means
6008	Positional information determination means
6009	Vehicle information detection means
6011	Antenna
6012	Amplification means
6061	Gain control means
6062	Delay time control means
6091	Speed detection means
6092	Position detection means

Best Mode for Carrying Out the Invention

[0025] Now, the present invention will be described below with respect to the accompanying drawings which show embodiments thereof.

(Embodiment 1)

[0026] Figure 1 includes a plan view and a sectional view showing an antenna device according to a first embodiment of the present invention. The antenna device comprises a receiving element 152 and a transmitting element 153 with their antenna planes facing an antenna ground (conductive earth substrate) 151, and the receiving element 152 is provided with a receiving terminal 154 and the transmitting element 153 is provided with a transmitting terminal 155. As shown in Figure 2, the resonance frequencies of the receiving element 152 and the transmitting element 153 are different from each other, depending on the element lengths, and thus, the isolation between a received signal and a transmission signal can be improved. In addition, the receiving element 152 and the transmitting element 153 have an end connected to the antenna ground 151 for grounding, respectively. Since the receiving element 152 and the transmitting element 153 operate separately from each other, the antenna device can be optimized for receiving and transmitting, respectively and the reception sensitivity and the transmission efficiency can be improved.

[0027] It should be noted that in the Figure, the words in parentheses indicate the case where the resonance frequencies for transmission and reception are set inversely but the setting of those frequencies may be accomplished optionally. This may apply to succeeding examples.

[0028] Figure 3 shows that in an antenna device

having the configuration similar to that described above, a receiving element 352 and a transmitting element 353 are formed on a common circuit board 356 provided to face an antenna ground 351, by using a printed-wiring technique or the like. This antenna device is functionally equivalent to the antenna device described above, but the stability can be improved because the elements are fixed on the common circuit board 356.

[0029] Figure 4 shows an example that in the configuration of Figure 3, a receiving element 452 is formed on the opposite side of a common double-sided circuit board 456 to a transmitting element 453, that is, on the side closer to an antenna ground 451. Of course, it should be noted that the receiving element 452 and the transmitting element 453 may be formed inversely.

[0030] Figure 5 shows an example that in the configuration of Figure 3, a receiving element 552 and a transmitting element 553 are connected to an antenna ground 551 through separate ground connections (at different locations) 557. In this example, the receiving element 552 and the transmitting element 553 are separately grounded at one of their ends farther from each other. Such a configuration can improve the isolation between a received signal and a transmission signal as compared with an antenna device with a common ground. Figure 6 also shows that separate ground connections are provided but in this configuration, a receiving element 652 and a transmitting element 653 are separately grounded at one of their ends closer to each other.

[0031] Figure 7 shows that an antenna device comprises a receiving element 752 and a transmitting element 753 arranged so that their antenna planes do not overlap one another, and these elements are separately grounded at one of their ends closer to each other. The isolation can be further improved depending on the locations of these elements. Figure 8 shows that in the configuration of Figure 7, a receiving element 852 and a transmitting element 853 are separately grounded at one of their ends farther from each other. Moreover, Figure 9 shows an example that a receiving element 952 and a transmitting element 953 are arranged in the same direction and this antenna device can have the same functions as those described above.

[0032] Figure 10 shows an example that a receiving element 1052 and a transmitting element 1053 are arranged symmetrically with respect to a predetermined point and these elements are separately grounded at one of their ends farther from each other. Figure 11 shows that in the configuration of Figure 10, a receiving element and a transmitting element are separately grounded at one of their ends closer to each other. Moreover, Figure 12 shows that in the configuration of Figure 10, a receiving element 1252 is grounded at its inner end and a transmitting element 1253 is grounded at its outer end.

(Embodiment 2)

[0033] Figure 13 includes a plan view and a sectional view showing an antenna device according to a second embodiment of the present invention. The antenna device has the configuration of Figure 3 and a receiving amplifier 1357 is connected between a receiving element 1352 and a receiving terminal 1354. Since the receiving amplifier 1357 is provided near the receiving element 1352 on a common circuit board 1356, it can amplify a received signal and then provide it to the appropriate section through the receiving terminal 1354. The antenna device can withstand any noise coming into the feeder and enjoy an improved reception sensitivity.

[0034] Figure 14 shows an example that in addition to the components shown in Figure 13, a transmitting amplifier 1458 is provided between a transmitting element 1453 and a transmitting terminal 1455 on a common circuit board 1456. This configuration can provide an improved reception sensitivity as well as a reduced power loss in the feeder and an improved transmission efficiency.

[0035] Figure 15 shows that in the configuration similar to that of Figure 13, a common double-sided circuit board 1556 is used to form a receiving amplifier 1557 on the opposite side of that board to antenna elements 1552 and 1553 and the receiving amplifier 1557 is connected to the receiving element 1552 by the cable running through a through-hole 1558. This configuration can save the space because the receiving amplifier 1557 is located between the common double-sided circuit board 1556 and an antenna ground 1551.

[0036] Figure 16 shows that a common component 1655 is used to provide a common terminal 1654 which performs a double function of a receiving terminal and a transmitting terminal and the common component 1655 such as a divider, mixer, circulator, or switch is provided on a common circuit board 1656 so that the common terminal 1654 can operate as a feeding terminal for both a receiving element 1652 and a transmitting element 1653. Figure 17 shows an example that in addition to the components described above, a receiving amplifier 1757 is inserted between a receiving element 1752 and a common component 1755. This configuration can allow simple connection to a communication device through a single cable because only one feeding terminal is required.

(Embodiment 3)

[0037] Figure 18 includes a plan view and a sectional view showing an antenna device according to a third embodiment of the present invention. In the antenna device, an antenna element 1852 having an end connected to an antenna ground 1851 for grounding and also having a feeding terminal 1854 connected thereto is formed on a common circuit board 1855

located parallel to the antenna ground 1851 and a resonant circuit 1853 is inserted within the antenna element 1852. The resonant circuit 1853 has an appropriate inductor 1856 and a capacitor 1857 connected in parallel so that the circuit can have an impedance jX1 ~ jX2 for a frequency f1 ~ f2. As shown in Figure 19, the resonant circuit 1853 can provide an antenna which has a bandwidth of f1 ~ f2, because the circuit has an impedance varying within the range of jX1 ~ jX2 and a gain peak at a frequency f1 ~ f2 when the L/C resonance frequency is set to f0.

[0038] Figure 20 shows that the capacitor of the resonant circuit in Figure 18 is replaced by a series connection of a fixed direct-current blocking capacitor 2055 and a voltage-variable capacitance element (varicap) 2057. As shown in the right of the figure, the voltage-variable capacitance element 2057 has a capacitance Cv varying with the bias voltage V and the capacitance and thus the resonance frequency can be controlled by varying the bias voltage. As shown in Figure 21, at a lower bias voltage of the varicap, the L/C resonance frequency is lowered (f01), the loading reactance jX increases (jX21 ~ jX22), and the antenna tuning frequency is lowered (f1). On the contrary, at a higher bias voltage of the varicap, the L/C resonance frequency is raised (f02), the loading reactance jX decreases (jX11 ~ jX12), and the antenna tuning frequency is raised (f2). Like this, according to the present embodiment, the tuning frequency can be changed by controlling the bias voltage of the voltage-variable capacitance element (varicap) 2057.

(Embodiment 4)

[0039] Figure 22 is a schematic diagram showing the configuration of the main components in an antenna device according to a fourth embodiment of the present invention. Namely, in the present embodiment, a resonant circuit (trap circuit) having a predetermined resonance frequency is inserted in an antenna element and near a feeding terminal in each antenna device described above. In Figures 22 and 23, a trap circuit 1 (f1) 2252 inserted in an antenna element 2251 and a trap circuit 3 (f1) 2254 inserted near a feeding terminal 2255 have a resonance frequency in the transmission band and another trap circuit 2 (f2) 2253 inserted in the antenna element 2251 has a resonance frequency in the other band f2 opposite to the transmission band f1 with respect to the reception band f0. Therefore, the isolation between antenna elements within a certain band can be improved by providing trap circuits each having a resonance frequency in the frequency band on each side of the reception frequency.

[0040] The trap circuit near the feeding terminal is inserted between the feeding terminal and the antenna element in Figure 22 but as shown in Figures 24 (a) and (b), a feeding terminal 2453 may be pulled out of a point between capacitors or in an inductor of a trap circuit 2452 or 2462 inserted in an antenna element 2451. Also, as shown in Figure 24 (c), a trap circuit 2472 may be inserted between a feeding terminal 2453 and an antenna ground and at a location closer to the ground. Therefore, when the trap circuit is located closer and closer to the ground, the inductor value and thus the size of the trap circuit can be reduced and thereby, a more compact and lightweight antenna can be provided.

(Embodiment 5)

[0041] Figure 25 is a schematic diagram showing the configuration of the main components in an antenna device according to a fifth embodiment of the present invention. Namely, in the present embodiment, a band-pass circuit having the same resonance frequency as that of the resonance frequency of the antenna (f0) is inserted in an antenna element and near a feeding terminal in each antenna device described above. The band-pass circuit comprises a series connection of an inductor and a capacitor and both a band-pass circuit 1 (f0) 2552 inserted in an antenna element 2551 and a band-pass circuit 2 (f0) 2553 inserted near a feeding terminal 2554 have a reactance characteristic as shown in Figure 26 (a). Thus, as shown in Figure 26 (b), when a band-pass circuit is inserted, the selectivity of the antenna can be improved as compared with the antenna having antenna elements alone and thereby, a higher selectivity can be achieved.

[0042] As shown in Figures 125(a) and (b), a low-pass circuit or a high-pass circuit may be inserted between an antenna element and a feeding terminal.

[0043] In Figure 125 (a), a low-pass circuit 102 is provided between an antenna element 101 and a feeding terminal 103. When the low-pass circuit 102 passes signals of lower frequencies including a tuning frequency of the antenna and blocks signals of frequencies higher than the tuning frequency of the antenna, the antenna can be protected against any interference with those signals of frequencies higher than the tuning frequency of the antenna. Therefore, any interference can be avoided if the tuning frequency of another element located in the proximity of the above-mentioned element is higher than that of the latter element. In Figure 125(b), a high-pass circuit 105 is provided between an antenna element 101 and a feeding terminal 103. When the high-pass circuit 105 passes signals of higher frequencies including a tuning frequency of the antenna and blocks signals of frequencies lower than the tuning frequency of the antenna, the antenna can be protected against any interference with those signals of frequencies lower than the tuning frequency of the antenna. Therefore, any interference can be avoided if the tuning frequency of another element located in the proximity of the above-mentioned element is lower than that of the latter element.

[0044] It should be noted that the low-pass circuit or

the high-pass circuit comprises a capacitor and an inductor in Figure 125 but other configurations may be used if similar characteristics can be accomplished.

(Embodiment 6)

[0045] Figure 27 is a schematic diagram showing the configuration of a communication system which uses an antenna device according to a sixth embodiment of the present invention. In the antenna device of Figure 27, an antenna element 2752 is formed on a common circuit board 2755 located parallel to an antenna ground 2751 and a receiving amplifier 2754 and a direct-current blocking capacitor 2757 are provided between the antenna element 2752 and a feeding terminal 2753 on the common circuit board 2755. The feeding terminal 2753 and the power terminal of the receiving amplifier 2754 are connected through a direct-current power supply line 2756.

[0046] On the other hand, in a receiver 2759 which is a communication device, a direct-current power supply section 2760, a receiving amplifier 2761 and the like are provided to supply a direct-current power to the receiving amplifier 2754 of the antenna and a direct-current blocking capacitor 2762 is provided near the input terminal of the receiving amplifier 2761. The feeding terminal 2753 of the antenna and the receiver 2759 are connected through a coaxial cable 2758.

[0047] In this configuration, a DC signal 2764 is supplied by the direct-current power supply section 2760 of the receiver 2759 to the receiving amplifier 2754 of the antenna through the coaxial cable 2758. At this time, the direct-current blocking capacitors 2757 and 2762 prevent any DC signal from going into the output terminal of the receiving amplifier 2754 and the input terminal of the receiving amplifier 2761, respectively. A wave received by the antenna element 2752 is amplified by the receiving amplifier 2754 and its RF signal 2763 is supplied to the receiving amplifier 2761 of the receiver 2759 through the coaxial cable 2758.

[0048] From the foregoing, since the received signal is amplified by the receiving amplifier 2754 before being supplied to the receiver, the RF signal passing through the coaxial cable 2758 will have a sufficient strength and any influence of outside noise can be reduced to improve the receiving sensitivity. In addition, since the antenna has the receiving amplifier 2754, the amplifier of the receiver 2759 can be simplified.

[0049] Figure 28 shows that in addition to the components shown in Figure 27 described above, a receiving amplifier controller 2861 is provided to control the power supply from a direct-current power supply section 2860 to a receiving amplifier 2854 of the antenna. Other components are identical to those shown in Figure 27. Therefore, since the power supply from the direct-current power supply section 2860 to the receiving amplifier 2854 of the antenna can be controlled by the receiving amplifier controller 2861 to continue or stop, this configuration can prevent an undesired jamming signal, if any, from being amplified and supplied to the receiver 2859.

(Embodiment 7)

[0050] Figure 29 is a schematic diagram showing the configuration of a communication system which uses an antenna device according to a seventh embodiment of the present invention. In the antenna device of Figure 29, an antenna element 2952 is formed on a common circuit board 2957 located parallel to an antenna ground 2951 and a variable resonant circuit loading section 2954 consisting of an inductor 2955, a (voltage) variable capacitance element 2956 and the like (see Figure 20) are inserted in the antenna element 2952. The cathode of the variable capacitance element 2956 and a feeding terminal 2953 are connected and a direct-current blocking capacitor 2958 is provided near the feeding terminal 2953.

[0051] On the other hand, in a receiver 2960 which is a communication device, a receiving channel setting circuit (tuning channel control direct-current voltage generator) 2961, a tuner 2962 and the like are provided to supply a bias voltage to the variable capacitance element 2956 of the antenna and a direct-current blocking capacitor 2963 is provided near the input terminal of the tuner 2962. The feeding terminal 2953 of the antenna and the receiver 2960 are connected through a coaxial cable 2959. It should be noted that the receiving channel setting circuit 2961 has a function to generate a voltage corresponding to a capacitance which can provide a desired tuning frequency and that, for example, it has a predetermined voltage setting for each channel to generate a voltage according to a selected channel.

[0052] In such a configuration, a variable capacitance element bias voltage 2965 determined for each channel is applied by the receiving channel setting circuit 2961 to the variable capacitance element 2956 through the coaxial cable 2959. Thus, as described above for Figure 21, the capacitance varies and the tuning frequency of the antenna is adjusted to the frequency of the selected channel. Then a channel signal matching the tuning frequency of the antenna is supplied to the receiver 2960 through the coaxial cable 2959 as a received RF signal 2964 at the maximum gain.

(Embodiment 8)

[0053] Figure 30 is a schematic diagram showing the configuration of a communication system which uses an antenna device according to an eighth embodiment of the present invention. The antenna device of Figure 30 is identical to that of Figure 3 described above. Namely, in the antenna device, a receiving element 3052 and a transmitting element 3053 are formed on a common circuit board 3056 located parallel to an

antenna ground 3051 and the receiving element 3052 and the transmitting element 3053 are provided with a receiving terminal 3054 and a transmitting terminal 3055, respectively.

[0054] On the other hand, a communication device 3059 comprises receiving amplifier 3060, a transmitting amplifier 3061 and the like and the receiving terminal 3054 of the antenna and the receiving amplifier 3060 are connected through a receiving coaxial cable 3057 as well as the transmitting terminal 3055 and the transmitting amplifier 3061 are connected through a transmitting coaxial cable 3058.

[0055] This configuration can eliminate a generally expensive and heavy common component which may cause a large passage loss and it can provide a lightweight and sensitive device at a lower cost.

[0056] Figure 31 shows that in the configuration similar to that of Figure 30 described above, a receiving amplifier is provided near a receiving terminal in an antenna device and other components are identical to those of Figure 30. Namely, this example uses the same antenna device as shown in Figure 13 to use no common component. In addition, the receiving sensitivity can be improved (for example, more than approximately 6 dB) and a receiving amplifier which would be otherwise provided at the initial stage of a communication device can be eliminated.

[0057] Figure 32 shows that in the configuration of Figure 31 described above, a transmitting amplifier is provided near a transmitting terminal in an antenna device and other components are identical to those of Figure 31. Namely, this example uses the same antenna device as shown in Figure 14 to use no common component. In addition, the receiving sensitivity can be improved (for example, more than approximately 6 dB) and a receiving amplifier which would be otherwise provided at the initial stage of a communication device can be eliminated. Moreover, a reduced transmission loss can be achieved and a transmitting amplifier in the communication device can be also eliminated.

(Embodiment 9)

[0058] Figure 33 is a schematic diagram showing the configuration of a communication system which uses an antenna device according to a ninth embodiment of the present invention. The antenna device of Figure 33 is basically identical to that of Figure 3 described above but a transmitting/receiving element changeover relay switch 3355 is additionally provided. Namely, in the antenna device, a receiving element 3352 and a transmitting element 3353 are formed on a common circuit board 3356 located parallel to an antenna ground 3351 and the receiving terminal of the receiving element 3352 and the transmitting terminal of the transmitting element 3353 are connected to a feeding terminal 3354 through the transmitting/receiving element changeover relay switch 3355.

[0059] On the other hand, a communication device 3358 comprises a voice modulator 3365, a common component 3361, a receiving amplifier 3359, a transmitting amplifier 3061[sic] and the like, and it has also a handset 3362 used for transmission. The handset 3362 comprises a microphone 3364 and a press-to-talk switch 3363, which is connected to the voice modulator 3365 and a drive coil of the transmitting/receiving element changeover relay switch 3355 in the antenna and which is pressed to connect to a direct-current power supply 3368. The feeding terminal 3354 of the antenna and an input/output terminal of the communication device 3358 (a common terminal of the common component 3361) are connected through a coaxial cable 3357.

[0060] In this configuration, the transmitting/receiving element changeover relay switch 3355 is connected to the receiving element 3352 during a receiving operation and it becomes the transmitting element 3353 during a transmitting operation, that is, when the press-to-talk switch 3363 is pressed to energize the coil of the transmitting/receiving element changeover relay switch 3355. Since both a received RF signal 3366 and a transmission RF signal 3367 pass through the coaxial cable 3357, the antenna and the communication device can be connected through such a single coaxial cable. It should be noted that the common component 3361 of the communication device 3358 may be implemented by a switch similar to the transmitting/receiving element changeover relay switch 3355 for interlocking. It should be also noted that a general signal input device (such as a digital signal input device) and a modulator (such as a digital modulator) may be substituted for the microphone 3364 and the voice modulator 3365.

(Embodiment 10)

[0061] Figure 34 is a schematic diagram showing the configuration of a communication system which uses an antenna device according to a tenth embodiment of the present invention. The antenna device of Figure 34 is basically identical to that of Figure 17 described above. Namely, in the antenna device, a receiving element 3452 and a transmitting element 3453 are formed on a common circuit board 3456 located parallel to an antenna ground 3451 and the transmitting terminal of the transmitting element 3453 is connected to a common component 3457 provided on the common circuit board 3456. Similarly, the receiving element 3452 is connected to the common component 3457 through a receiving amplifier 3455 provided on the common circuit board 3456. In addition, the common terminal of the common component 3457 is connected to a feeding terminal 3454 through a direct-current blocking capacitor 3459. The power terminal of the receiving amplifier 3455 is connected to the feeding terminal 3454 through a direct-current power supply line 3458.

[0062] On the other hand, a communication device 3461 comprises a common component 3465, a receiving amplifier 3462 and a transmitting amplifier 3463 connected to the common component 3465, a modulator 3464 connected to the transmitting amplifier 3463, a receiving amplifier direct-current power supply section 3467 and the like, and a direct-current blocking capacitor 3468 is provided between the common terminal of the common component 3465 and the input/output terminal of the communication device 3461. The feeding terminal 3454 of the antenna and the communication device 3461 are connected through a coaxial cable 3460.

[0063] In this configuration, receiving amplifier direct-current power 3470 of the receiving amplifier 3455 of the antenna is supplied from the receiving amplifier direct-current power supply section 3467 through the coaxial cable 3460. A received RF signal 3468 amplified by the receiving amplifier 3455 is supplied to the communication device 3461 through the coaxial cable 3460 and then to the receiving amplifier 3462 of the communication device 3461 through the common component 3465. A transmission RF signal 3469 from the transmitting amplifier 3463 of the communication device 3461 is supplied to the feeding terminal 3454 of the antenna through the common component 3465 and then emitted by the transmitting element 3453 through the common component 3457.

[0064] Figure 35 shows that a handset 3565 used for transmission is added to the configuration of Figure 34 described above and the handset 3565 comprises a microphone 3567 and a press-to-talk switch 3566, which is connected to a voice modulator 3564 and a receiving amplifier direct-current power supply section 3568 and which is pressed to connect to a direct-current power supply 3574.

[0065] In this configuration, during a receiving operation, receiving amplifier direct-current power 3573 is supplied from the receiving amplifier direct-current power supply section 3568 to a receiving amplifier 3555 of the antenna to operate the receiving amplifier 3555. During a transmitting operation, when the press-to-talk switch 3566 is pressed, the power supply from the receiving amplifier direct-current power supply section 3568 is stopped or decreased to a lower level to stop the operation of the receiving amplifier 3555 of the antenna or to reduce the degree of amplification. This can prevent the power from being supplied when unnecessary and the like.

[0066] It should be noted that, according to the present embodiment, the area of the antenna ground facing the antenna elements is shown to be smaller than the external area of the antenna elements but it is preferable that the area of the antenna ground is almost equal to the external area of the antenna elements.

[0067] It should be also noted that, according to the present embodiment, how or where the antenna device is to be installed is not described above. However, the antenna device may be installed with the antenna ground located in the proximity of and facing the body ground of any of various stationary devices, mobile devices, automotive vehicles or the like as long as appropriate insulation can be kept. For example, stationary devices include a house or a building, a fixed communication device and the like, mobile devices include a portable communication device, a portable telephone set and the like, and automotive vehicles include an automobile, a train, an airplane, a ship and the like.

[0068] It should be further noted that the shape and number of elements in the antenna device described above according to the present embodiment are shown for exemplary purpose only and they are not limited to those shown in the figures.

[0069] Now, how and where the antenna devices described above are to be installed or the shape, number of antennas and the like applicable to the antenna devices according to the present invention will be specifically described below with reference to the drawings.

[0070] Figure 36 (a) shows an antenna device which comprises an antenna element 201 configured by a linear conductor with two bends and located in the proximity to a conductive earth substrate 205 with the antenna plane parallel to the substrate, a feeding terminal 202 provided in place on the antenna element 201, and an end 203 connected to the conductive earth substrate 205 for grounding. Figure 36 (b) shows another antenna device which comprises an antenna element 204 configured by a linear conductor with four bends and located in the proximity to a conductive earth substrate 205 with the antenna plane parallel to the substrate, a feeding terminal 202 provided in place on the antenna element 204, and an end 203 connected to the conductive earth substrate 205 for grounding. In this way, the antenna devices can reduce the installation area as well as improve their directional gain performance because the antenna devices are located in the proximity to the conductive earth substrates 205 with their antenna planes parallel to the conductive earth substrates 205. It should be noted that the number of bends in an antenna element is not limited to that described with respect to the above example. This may also apply to succeeding embodiments described below.

[0071] A specific configuration of the antenna device of Figure 36 (a) is shown in Figure 113. In Figure 113, an antenna element 8501 configured by a linear conductor with two bends is located at a distance from a conductive earth substrate 8504 with the antenna plane almost parallel to the substrate and an end of the antenna element 8501 is connected to an end of a conductive plate 8503 provided almost perpendicular to the conductive earth substrate 8504 for antenna grounding. It should be noted that, in this case, the area formed by the antenna element 8501 is almost equal to that of the

conductive earth substrate 8504. It should be also noted that a feeding section 8502 is provided in the way of the antenna element 8501.

[0072] The conductive plate 8503 has a width sufficiently larger than that of the antenna element 8501, that is, a width which may not be practically affected by any reactance determined from the tuning frequency of the antenna element 8501. This allows the conductive plate to serve as a ground. A smaller width may cause the conductive plate to couple to the antenna element 8501 and thus to form a single antenna element as a whole together with the antenna element 8501, which will deviate from the scope of the present invention. The antenna element 8501 is, for example, 220 mm long and 2 mm wide for a wavelength of 940 mm and this may make the antenna device more compact. It should be noted that the antenna plane and the conductive earth substrate plane may be tilted to the extent that there exists an effective potential difference between the antenna element and the substrate. It should be also noted that if the area of the conductive earth substrate is larger than that of the antenna plane (for example, by quadruple), the gain may remain unchanged for a vertically polarized wave but decrease for a horizontally polarized wave.

[0073] The antenna described above differs from conventional antennas in that, for example, a smaller distance between the antenna element and the ground plate may degrade the performance of a conventional inverted F-shaped antenna, while such a smaller distance may improve the performance of the antenna device according to the present invention.

[0074] The impedance and VSWR characteristics of the antenna of Figure 113 are shown in Figure 114. Its directional gain characteristics are shown in Figure 115. As shown in Figure 115, the antenna of Figure 113 has a generally circular directivity with respect to a vertically polarized wave.

[0075] Needless to say, the shape and number of antenna elements are not limited to those described with respect to the above example.

[0076] It should be more preferable that the distance between the conductive earth substrate and the antenna element is a fortieth of the wavelength or more.

[0077] Figure 37 (a) shows an antenna device which comprises an antenna element 401 configured to be a dipole antenna configured by a linear conductor with four bends and located in the proximity to a conductive earth substrate 405 with the antenna plane parallel to the substrate, a feeding terminal 402 provided in place on the antenna element 401, and a point 403 connected to the conductive earth substrate 405 for grounding. Figure 37 (b) shows another antenna device which comprises an antenna element 404 configured by being be a dipole antenna configured by a linear conductor with eight bends and located in the proximity to a conductive earth substrate 405 with the antenna plane parallel to the substrate, a feeding terminal 402 provided in place on the antenna element 401, and a point 403 connected to the conductive earth substrate 405 for grounding. In this way, the antenna devices according to the present embodiment can reduce the installation area as well as further improve their directional gain performance when the antenna devices are located in the proximity to the conductive earth substrates with their antenna planes parallel to the conductive earth substrates 405, respectively.

[0078] Figure 38 (a) shows an antenna device which comprises three monopole antenna elements 601a, 601b, and 601c having two bends and different lengths and being located on the same plane in the proximity to a conductive earth substrate 607, and reactance elements 602a, 602b, 602c, and 604 connected between the taps of the antenna elements 601a, 601b, and 601c and a feeding terminal 603 and between the feeding terminal 603 and a ground terminal 605, respectively, to adjust their impedance. Figure 38 (b) shows another antenna device which substitutes antenna elements 606a, 606b, and 606c having four bends for the antenna elements 601a, 601b, and 601c of the antenna device of Figure 38 (a) described above.

[0079] With the configurations described above, an antenna device having a desirable bandwidth can be implemented by setting the tuning frequencies of the antenna elements at regular intervals. Figure 68 shows an example of band synthesis performed by an antenna having seven antenna elements and it may be seen from the figure that a broadband frequency characteristic can be achieved through such band synthesis even when each antenna element has only a small bandwidth.

[0080] Specific examples of such band synthesis are described with respect to the VSWR characteristics shown in Figures 116 through 121. Namely, these examples use four antenna elements with different tuning frequencies, that is, 196.5 MHz (Figure 116), 198.75 MHz (Figure 117), 200.5 MHz (Figure 118), and 203.75 MHz (Figure 119), respectively. Figure 120 shows the VSWR characteristics after band synthesis of these antenna elements and it can be seen that the band has become wider than before. Figure 121 shows the VSWR characteristics when the range of ordinates in Figure 120 is extended (by quintuple).

[0081] Figure 39 (a) shows that additional reactance elements 808a and 808b for band synthesis are provided between antenna elements 801a, 801b, and 801c in an antenna device having the configuration similar to that of Figure 38 (a) described above. Figure 39 (b) shows that additional reactance elements 808a and 808b for band synthesis are provided between antenna elements 806a, 806b, and 806c in an antenna device having the configuration similar to that of Figure 38 (b) described above.

[0082] Figure 40 (a) shows an antenna device which comprises three dipole antenna elements 1001, 1002, and 1003 having four bends and different lengths

and being located on the same plane in the proximity to a conductive earth substrate 1007, and reactance elements 1004, 1005, 1006, and 1009 connected between the taps of the antenna elements 1001, 1002, and 1003 and a feeding terminal 1008 and between the feeding terminal 1008 and a ground terminal 1010, respectively, to adjust their impedance. Figure 40 (b) shows another antenna device which substitutes antenna elements 1011, 1012, and 1013 having eight bends for the antenna elements 1001, 1002, and 1003 of the antenna device of Figure 40 (a) described above.

[0083] Figure 41 (a) shows that additional reactance elements 1214, 1215, 1216, and 1217 for band synthesis are provided between antenna elements 1201, 1202, and 1203 at two separate locations in an antenna device having the configuration similar to that of Figure 40 (a) described above. Figure 41 (b) shows that additional reactance elements 1214, 1215, 1216, and 1217 for band synthesis are provided between antenna elements 1211, 1212, and 1213 at two separate locations in an antenna device having the configuration similar to that of Figure 40 (b) described above.

[0084] Figure 42 (a) shows an antenna device which comprises three dipole antenna elements 1301, 1302, and 1303 having different lengths and being formed on a printed circuit board 1304. Figure 42 (b) shows another antenna device of the configuration similar to that of Figure 42 (a) described above, which has a conductive earth substrate 1308 formed on the opposite side of the printed circuit board 1304 to the antenna element 1320. Such a configuration where a printed circuit board is used to form the antenna elements 1301, 1302, and 1303 (1305, 1306, 1307) and the conductive earth substrate 1308 can save the space necessary for an antenna device as well as allow easy fabrication of the antenna device with improved performance reliability and stability.

[0085] Figure 43 shows that antenna devices of the configurations similar to those of Figure 42 (a) described above have a conductor for band analysis formed on the opposite side of a printed circuit board to antenna elements in a direction perpendicular to the antenna elements. Namely, Figure 43 (a) shows an antenna device which comprises three dipole antenna elements 1401, 1402, and 1403 having different lengths and being formed on a printed circuit board 1404 and two conductors 1405 formed on the opposite side of the printed circuit board 1404 to the antenna element 1410 in a direction perpendicular to the antenna element. Figure 43 (b) shows another antenna device of the configuration similar to that of Figure 43 (a) described above, which has a conductive earth substrate 1406 located in close proximity on the opposite side to the antenna element 1410. This conductive earth substrate 1406 may be formed on the printed circuit board by using a multilayer printing technique. The configuration described above can allow easy fabrication of elements for band synthesis.

[0086] Figure 44 shows an antenna device which has antenna elements 1501, 1502, and 1503 located within a recess 1505 in a conductive earth substrate 1504. This configuration can eliminate any protrusion from an automobile body and improve the directional gain performance through interaction between the edge of the antenna element 1510 and the conductive earth substrate 1504.

[0087] The antenna device of Figure 45 (a) comprises an antenna 1610 consisting of antenna elements 1601, 1602, and 1603 and an antenna 1620 consisting of antenna elements 1606, 1607, and 1608 and these antennas 1610 and 1620 are located in the same plane and within a recess 1605 in a conductive earth substrate 1604. It should be noted that the antennas 1610 and 1620 of this example are different from each other in size and shape but they may be of the same size and shape. Feeding sections of these antennas are located in the proximity of each other. Figure 45 (b) shows that a similar antenna is located in the proximity of a planar conductive earth substrate 1609.

[0088] The antenna device of Figure 46 (a) comprises an upper antenna 1710 consisting of antenna elements 1701, 1702, and 1703 and a lower antenna 1720 also consisting of antenna elements 1701, 1702, and 1703 and these antennas 1710 and 1720 are located at two levels and within a recess 1705 in a conductive earth substrate 1704. It should be noted that the antennas 1710 and 1720 of this example are of the same size and shape but they may be different from each other in size and shape. Figure 46 (b) shows that a similar antenna is located in the proximity of a planar conductive earth substrate 1706. If the antennas are of the same size, they will have the same tuning frequency. Therefore, the band width of the whole antenna device is the same as that of a single element but this example can implement a high-gain and high-selectivity antenna because the overall gain of the antenna element can be improved as compared with a single-element implementation by accumulating the gain of each antenna element, as shown Figure 69.

[0089] The antenna device of Figure 47 (a) comprises three antennas 1801, 1802, and 1803 each having one or more bends and a plurality of dipole antenna elements and these antennas are formed to be a multilayer printed circuit board 1806 and located within a recess 1805 in a conductive earth substrate 1804. It should be noted that the three antennas 1801, 1802, and 1803 of this example are of the same size and shape but they may be different from each other in size and shape. It should be also noted that the three antennas are layered in this example but four or more antennas maybe layered. Figure 47 (b) shows that a similar antenna is located in the proximity of a planar conductive earth substrate 1807. As described above, a high-gain and high-selectivity antenna can be implemented easily by forming a plurality of antennas as a multilayer printed circuit board.

[0090] The antenna of Figure 48 has two linear conductors each having four bends and these conductors are located opposite to each other with respect to a feeding section. Namely, Figure 48 (a) shows an antenna device which has two linear conductors 1902 and 1903 bending in opposite directions to each other with respect to a feeding point 1901 and Figure 48 (b) shows another antenna device which has two linear conductors 1904 and 1905 bending in the same direction with respect to a feeding point 1901. This shape can allow implementation of a compact planar nondirectional antenna.

[0091] On the other hand, Figure 49 (a) shows an antenna device having an antenna element 2002 in which the length between a feeding section 2001 and a first bend P is relatively longer than the length between the first bend P and a second bend Q. Figure 49 (b) shows an antenna device having an antenna element 2002 in which the length between a feeding section 2001 and a first bend P is relatively shorter than the length between the first bend P and a second bend Q. This shape can allow the antenna device to be installed in a narrow area.

[0092] It should be noted that this example has two linear conductors located opposite to each other with respect to a feeding section but the number of linear conductors is not limited to that of this example and may be only one. In addition, the number of bends is not limited to that of this example.

[0093] It should be noted that this example has two linear conductors located opposite to each other with respect to a feeding section but the number of linear conductors is not limited to that of this example and may be only one. In addition, the number of bends is not limited to that of this example.

[0094] It should be also noted that the linear conductors in this example are bent but they may be curved or spiralled. For example, as shown in Figure 50 (a), this example may have two linear conductors 2102 and 2103 curving in opposite directions to each other with respect to a feeding section 2101 or two linear conductors 2104 and 2105 curving in the same direction with respect to a feeding section 2101. Also, as shown in Figure 50 (b), this example may have two linear conductors 2106 and 2107 spiralling in opposite directions to each other with respect to a feeding section 2101 or two linear conductors 2108 and 2109 spiralling in the same direction with respect to a feeding section 2101.

[0095] When an antenna of this example is fabricated, an antenna element can be formed, of course, by working metal members but it may be formed through printed-wiring on a circuit board. Such a printed-wiring technique can allow greatly easy fabrication of an antenna, thereby to expect reducing cost, providing a more compact antenna, improving reliability and the like.

[0096] The antenna device of Figure 51 is located in the proximity of a conductive earth substrate with its ground terminal connected to the substrate. For example, as shown in Figure 51(a), an antenna element 2201 is located in the proximity of a substrate 2204 with its ground terminal 2203 connected to the substrate 2204. It should be noted that this antenna device is similar to that of Figure 3 (b) described above but differs therefrom in that a feeding terminal 2202 is provided on the opposite side of the conductive earth substrate 2204 to the antenna device by running the cable through the substrate. Such a configuration can provide a desired impedance characteristic and directivity.

[0097] Figure 51 (b) shows that a switching element is provided between a ground terminal and a conductive earth substrate in the antenna. As shown in the figure, a switching element 2205 is provided between a ground terminal 2203 of an antenna element 2201 and a conductive earth substrate 2204 to select which state, that is, whether or not the ground terminal is connected to the conductive earth substrate can effect the optimum radio-wave propagation. For this purpose, the switching element 2205 may be remotely operated to control the antenna device depending on the state of a received wave. The antenna device of this example is used for a vertically polarized wave if the ground terminal 2203 is connected to the substrate, while it is used for a horizontally polarized wave if the ground terminal is not connected to the substrate.

[0098] It should be noted that the feeding terminal 2202 penetrates the conductive earth substrate 2204 in Figure 51 (b) but its location is not limited to this example and that, as shown in Figure 52, a feeding terminal 2302 and a ground terminal 2303 may be not to penetrate the conductive earth substrate 2304.

[0099] Figure 53 shows the positional relationship between the antenna and the conductive earth substrate in the antenna device described above. As shown in Figure 53 (a), a conductive earth substrate 2402 and an antenna 2401 are located parallel to each other at a distance of h. The directivity of the antenna 2401 can be changed to a desired direction by controlling the distance h. The tuning frequency is raised if the antenna 2401 is closer to the conductive earth substrate 2402, while the tuning frequency is lowered if the antenna is more distant from the substrate. Therefore, the antenna device may be configured to control the distance h depending on the state of a received wave. The control of the distance h may be accomplished, for example, by using a feed or slide mechanism (not shown) to move the antenna 2401 in a direction perpendicular to the antenna plane or by inserting an insulation spacer (not shown) between the antenna 2401 and the conductive earth substrate 2402 and moving the spacer in a direction parallel to the antenna plane to adjust the length of the spacer insertion. Also, the size of the spacer may be determined to obtain a desired antenna performance during the fabrication of the antenna. It should be noted that a spacer between the substrate and the antenna may be made of a low-permittivity material such as

expanded styrol.

[0100] As shown in Figure 53 (b), the conductive earth substrate 2402 and the antenna 2403 may be located to form a predetermined angle θ (in this case, 90 degrees) between them. The directivity of the antenna 2403 can be controlled by adjusting the angle θ through a hinge mechanism and the like.

[0101] It should be further noted that the number of antenna elements is one according to the present embodiment but it is not limited to this example and may be two or more. It should be also noted that the substrate consists of a single conductor in this example but the body of an automobile and the like may be used as the substrate.

[0102] Figure 54 shows that an antenna consists of a plurality of antenna elements arranged in a predetermined range and served by a single feeding mechanism. As shown in Figure 54 (a), a plurality of antenna elements 2501, 2502, and 2503 are served by a single feeding mechanism to provide an antenna consisting of the group of antenna elements. For example, a broadband antenna which covers a desired bandwidth as a whole can be implemented by covering a different bandwidth with each of the antenna elements. Particularly, in the arrangement of Figure 54 (a), the outer antenna element 2501 is necessarily longer than the inner antenna element 2503 and it is easy to set the longer antenna element 2501 to a lower tuning frequency and the shorter antenna element 2503 to a higher tuning frequency, so that a desired antenna covering a broad band as a whole can be implemented.

[0103] As shown in Figure 54 (b), a plurality of antenna elements may be separately arranged in an antenna plane without winding round each other.

[0104] If each of the antenna elements covers the same band, the efficiency of the antenna can be improved.

[0105] To provide isolation between the antenna elements, a distance between them may be determined to keep them in predetermined isolation or an isolator or reflector may be connected to each of the antenna elements.

[0106] It should be noted that the number of antenna elements is two or three according to this example but it is not limited to this example and may be any number equal to or more than two.

[0107] The antenna device of Figure 55 differs from those in the preceding examples in that as shown in Figure 55 (a), antenna elements 2601, 2602, and 2603 or antenna elements 2604, 2605, and 2606 are layered in a direction perpendicular to the reference plane. It should be noted that the antenna elements may be arranged so that they are all exactly overlaid on the surface of projection as shown in the left of the figure or so that they are partially overlaid as shown in the right of the figure or so that they are separate from each other. Figure 55 (b) is a partial broken view showing an application of the present embodiment, in which antennas 2611 and 2612 are formed on a multilayer printed circuit board 2609 through a printed-wiring technique and the antennas are arranged to be partially overlaid on the horizontal plane. Both elements can be coupled in place by running a conductor through a through-hole 2610.

[0108] Figure 56 (a) shows an example of a single antenna feeding section for serving a plurality of antenna elements. As shown in Figure 56 (a), antenna elements 2701, 2702, and 2703 have taps 2704, 2705, and 2706 formed in place thereon, respectively, to connect them to a feeding terminal 2707. It should be noted that the direction for tapping is identical for all the antenna elements but it may be arbitrarily determined for each of them.

[0109] Figure 56 (b) shows an antenna having a common electrode between the tap of each antenna element and a feeding terminal. As shown in the figure, taps 2704, 2705, and 2706 are formed in place on antenna elements 2701, 2702, and 2703, respectively and a common electrode 2708 is provided between the taps and a feeding terminal 2707. This makes the configuration very simple and in addition, more space can be saved by placing the electrode 2708, for example, parallel to the outermost antenna element 2701.

[0110] Figure 57 shows an antenna with each antenna element tapped through a reactance element. As shown in Figure 57 (a), antenna elements 2801, 2802, and 2803 may be separately connected to a feeding terminal 2807 through reactance elements 2804, 2805, and 2806, respectively, or as shown in Figure 57 (b), a reactance element 2809 may be provided within a common electrode 2808 between a feeding terminal 2807 and taps. In the latter case, a reactance element may be provided between the feeding terminal and a ground terminal. By using a proper reactance element in this way, a desired impedance, band, and maximum efficiency can be achieved. It should be noted that a variable reactance element may be used as such a reactance element for adjustment.

[0111] Figure 58 shows that an antenna consists of a plurality of antenna elements arranged in a predetermined range in the proximity of a conductive earth substrate and served by a single feeding mechanism, a ground terminal of which is connected to the conductive earth substrate. As shown in Figure 58, a plurality of antenna elements 2901, 2902, and 2903 are served by a single feeding terminal 2907 provided on the opposite side of a conductive earth substrate 2909 to the antenna elements to provide an antenna consisting of the group of antenna elements and a ground terminal 2908 of the feeding section is connected to the conductive earth substrate 2909. This configuration can allow a compact high-gain antenna to be provided in a plane in the proximity of the conductive earth substrate.

[0112] In the antenna of Figure 59 (a), the tuning frequency is controlled by setting a distance between opposed portions 3001 and 3002 of an antenna element near its open terminals to a predetermined value

to control the coupling between them.

[0113] The coupling between the opposed portions 3001 and 3002 of the antenna element near its open terminals can be established by providing a dielectric 3003 as shown in Figure 59 (b) or by connecting them through a reactance element 3004 as shown in Figure 59 (c). For this purpose, the dielectric 3003 may be movably provided to control the coupling or the reactance element 3004 may be implemented with a variable reactance to control the coupling.

[0114] It should be noted that the number of antenna elements is one in this example but it is not limited to this example and may be two or more like the antenna shown in Figure 54 described above.

[0115] In the antenna of Figure 60 (a), the tuning frequency is controlled by setting a distance between open-terminal portions 3101 and 3102 of an antenna element and the neutral point 3103 or their opposed portions 3111 and 3112 near the neutral point to a predetermined value.

[0116] The coupling between the open-terminal portions of the antenna element and the neutral point or their opposed portions near the neutral point can be established, as shown in Figures 60 (b) and (c), by providing a dielectric 3104 or by connecting them through a reactance element 3105 or 3106. For this purpose, like the thirteenth embodiment described above, the dielectric 3104 may be movably provided to control the coupling or the reactance element 3101 or 3102 may be implemented with a variable reactance to control the coupling.

[0117] It should be noted that the number of antenna elements is one also in this example but it is not limited to this example and may be two or more like the antenna shown in Figure 54 described above.

[0118] In the antenna device of Figure 61, at least one linear conductor is connected to each end of a coil, a ground terminal is pulled out of the neutral point of the coil, and a tap is formed in place on the linear conductor or the coil to provide a feeding terminal at the end of the tapping cable. As shown in Figure 61 (a), a coil 3203 has a linear conductor 3201 or 3202 at each end of the coil, a ground terminal 3206 is pulled out of the neutral point of the coil 3203, and a tap 3204 is formed in place on the linear conductor (in this case, 3202) to provide a feeding terminal 3205 at the end of the tapping cable. As shown in Figure 61 (b), a tap 3204 may be formed in place on a coil 3203 to provide a feeding terminal 3205.

[0119] This configuration can allow the tuning frequency of the antenna to be adjusted by controlling the number of turns of coil winding and in addition, it can allow the implementation of a more compact and broadband antenna.

[0120] Figure 62 shows that an antenna device has a plurality of linear conductors connected to a coil. As shown in Figure 62 (a), a coil 3307 has a plurality of linear conductors 3301, 3302, and 3303 or 3304, 3305, and 3306 at each end of the coil, a ground terminal 3311 is pulled out of the neutral point 3310 of the coil 3307, and a tap 3308 is formed in place on the linear conductors (in this case, 3304, 3305, and 3306) to provide a feeding terminal 3309 at the end of the tapping cable. As shown in Figure 62 (b), a tap 3312 may be formed in place on a coil 3307 to provide a feeding terminal 3309. It should be noted that the three linear conductors are provided on each side of the coil in this example but the number of conductors is not limited to this example and may be any number equal to or more than two.

[0121] It should be also noted that the conductors used as antenna elements in this example are all linear but the shape of each conductor is not limited to this example and any conductor may have at least one bend or curve or may be spiral.

[0122] The antenna device of Figure 63 has one or two groups of linear conductors and each group of them is connected to a feeding section through a coil. As shown in Figure 63, a group of linear conductors 3401, 3402, and 3403 and another group of linear conductors 3404, 3405, and 3406 are connected to common electrodes 3407 and 3408, respectively, and these electrodes are connected to a feeding section 3411 through coils 3409 and 3410, respectively. This configuration can allow the tuning frequency of the antenna to be adjusted by controlling the number of turns of coil winding and in addition, it can allow the implementation of a more compact and broadband antenna.

[0123] The antenna device of Figure 64 comprises a plurality of antennas consisting of a plurality of antenna element groups and these antennas are provided within a predetermined range for diversity reception to select one of them which can achieve the optimum receiving state. For example, in Figure 64, two antennas 3501 and 3502 are switched by a diversity changeover switch 3503 connected to a feeding section of each antenna to select one of the antennas which can achieve the optimum radio-wave propagation. It should be noted that the number of antennas is not limited to two as described for this example but it may be three or more. It should be also noted that the type of antennas is not limited to that shown in Figure 64 but other types of antennas as described for the preceding embodiments, different types of antennas or the like may be used.

[0124] In addition, controlling of selection of the optimum antenna from a plurality of antennas may be accomplished by controlling selection of one which can achieve the maximum receiver input or by controlling selection of one which can achieve the minimum level of multipath disturbance.

[0125] It should be further noted that a feeding section for serving each antenna element or each antenna consisting of a plurality of antenna element groups as described above may have a balance-to-unbalance transformer, a mode converter, or an impedance converter connected to it.

[0126] If each antenna described above is to be installed on an automobile in a vertical position, for example, it may be installed on the end 3703 of an automobile spoiler 3701 or 3702, the end 3703 of a sun visor or the like as shown in Figure 65 (a) or on a pillar section 3704 as shown in Figure 65 (b). Of course, installation locations are not limited to those described here and the antenna may be installed on any other locations which are tilted to some extent with respect to any horizontal plane. Therefore, the reception of a desired polarized wave can be made very easy by positioning the antenna at such locations.

[0127] As described above, each antenna device described above can be installed without any portion protruding from the body plane of an automobile because it can be located with its antenna plane parallel to and in the proximity of the body plane which is a conductive earth substrate and in addition, it can be installed even in a narrow space because it takes up only a small area. Therefore, its appearance can be improved with little wind soughing brought about around it and in addition, some other problems such as a risk of its being stolen and labors involved in removing it before car wash can be eliminated.

[0128] Figure 66 is a schematic diagram showing an example of a mobile communication device with an antenna device. As shown in Figure 66, an antenna 3801 according to any one of the preceding embodiments described above is installed on the ceiling of an automobile body 3805. In this case, if the antenna 3801 is located within a recess 3806 in the ceiling, any portion of the antenna will not protrude from the outline of the body 3805. The antenna 3801 is connected to a communication device 3804 which is installed inside the body 3805 and consists of an amplifier 3802, a modem 3803 and the like.

[0129] Figure 67 (a) shows an example in which a conductive shielding case 3902 provided inside a resinous case 3901 of a portable telephone is used as a conductive earth substrate and an antenna 3903 is located along the inner side of the case 3901 to be parallel to the shielding case 3902. Figure 67 (b) shows another example in which an antenna 3904 is located on the top surface outside a resinous case 3901 of a portable telephone and a conductive earth substrate 3905 is provided on the inner wall of the case 3901 opposite to the antenna 3904. In the latter case, the top of a shielding case 3902 is too small to be used as a conductive earth substrate. The antennas used in Figures 67 (a) and (b) are preferably those having more bends or more turns of winding which can easily allow the implementation of a compact antenna.

[0130] With these configurations, the directional gain on the conductive earth substrate side is very small to the antenna and therefore, possible influence of electromagnetic waves on human body can be reduced without any degradation of antenna efficiency if the antenna device is used with the conductive earth substrate side turned to the user.

[0131] It should be noted that the antenna device is installed on an automobile in the above description but it may be installed on other vehicles such as an airplane or ship. Alternatively, it may be installed not only on such vehicles but also on the roadbed, shoulder, tollgate, or tunnel wall of any expressway such as highway, or on the wall, window or the like of any building.

[0132] It should be also noted that the antenna device is used with a mobile communication device in the above description but it may be used with any other device which receives or transmits radio waves, such as a television set, a radio-cassette player, or a radio set, for example.

[0133] It should be further noted that the antenna device is implemented in a portable telephone in the above description but it may apply to other portable radio sets, such as a PHS (Personal Handy Phone system) device, a pager, or a navigation system, for example.

[0134] Figure 70 (a) shows a monopole-type broadband antenna which comprises a main antenna element 4202 having an end connected to a ground 4204, an antenna element 4201 located in the proximity of the main antenna element 4202 and having a length longer than the antenna element 4202 and no end connected to a ground, and an antenna element 4203 having a length shorter than the antenna element 4202 and no end connected to a ground. The main antenna element 4202 is provided with a tap which is connected to a feeding point 4206 through a reactance element 4205 for impedance adjustment. Figure 70 (b) shows another antenna device which is obtained by forming on a printed circuit board 4207 antenna elements 4201, 4202, and 4203 of the antenna device of Figure 70 (a) described above through a printed-wiring technique.

[0135] Figure 71 shows a dipole-type antenna device of the configuration described above. Namely, Figure 71 (a) shows a dipole-type broadband antenna which comprises a main antenna element 4302 having the center connected to a ground 4304, an antenna element 4301 located in the proximity of the main antenna element 4302 and having a length longer than the antenna element 4302 and no portion connected to a ground, and an antenna element 4303 having a length shorter than the antenna element 4302 and no portion connected to a ground. The main antenna element 4302 is provided with a tap which is connected to a feeding point 4306 through a reactance element 4305 for impedance adjustment. Figure 71 (b) shows another antenna device which is obtained by forming on a printed circuit board 4307 antenna elements 4301, 4302, and 4303 of the antenna device of Figure 71 (a) described above through a printed-wiring technique.

[0136] These configurations can implement a broadband and high-gain antenna device which is very simple and easy to adjust.

[0137] It should be noted that a shorter antenna

element and a longer antenna element are located in the proximity of a main antenna element in this example but two or more antenna elements may be located on each side of the main antenna.

[0138] Figure 72 (a) shows an antenna device similar to those shown in . Figure 40 or other figures described above, in which a conductive earth substrate is located in the proximity of antenna elements and the antenna device of this example differs from those devices in that a conductive earth substrate 4404 located in the proximity of antenna elements 4401, 4402, and 4403 is almost equal in size to or smaller than the outermost antenna element 4401. Such a configuration can improve the gain for horizontally polarized waves as compared with the case where a conductive earth substrate is larger than an antenna element.

[0139] Figure 72 (b) shows that the antenna device of Figure 72 (a) described above is located within a recess in a vehicle body, the case of a communication device, the wall of a house, any other device case, or the like and that an antenna ground (conductive earth substrate) 4404 is not connected to a ground for such a case. This configuration can provide a higher gain for both horizontally and vertically polarized waves. The directional gain characteristics of this antenna device are shown in Figure 122 for vertically polarized waves. As seen from the figure, when the distance (that is, separation) between an antenna ground and a case ground is (a) 10 mm, (b) 30 mm, (c) 80 mm, or (d) 150 mm, the shorter distance can provide the higher gain. Namely, when the antenna ground is closer to the case ground, the better performance can be obtained. It should be noted that in the example, the antenna ground 4404 is located within a recess in a vehicle body, the case of a communication device, the wall of a house, any other device case, or the like to prevent the antenna from popping out of the outer case but the antenna ground may be located in the proximity of the flat plane of the case ground at a distance, resulting in similar effects. Even in the latter case, the antenna falls within the scope of the present invention.

[0140] It should be also noted that an antenna element of balanced type is used in this example but an antenna element of unbalanced type may result in similar effects.

[0141] Figure 73 shows how proximate to a conductive earth substrate an antenna element is to be located and Figure 73 (a) is an example where a single antenna element is located. Namely, the distance h between an antenna element 4501 (to speak properly, an antenna grounding connection) and a conductive earth substrate 4502 is set to a value within 0.01 to 0.25 times as large as a wavelength λ for the resonance frequency f of the antenna (that is, 0.01λ to 0.25λ). This configuration can implement a high-gain antenna which is very easy to adjust.

[0142] Figure 73 (b) is another example where four antenna elements 4503, 4504, 4505, and 4506 are located at different distances from a conductive earth substrate 4507, respectively. As shown in Figure 73 (b), when the antenna elements have different lengths, the shorter element can have the higher resonance frequency and the shorter wavelength. Therefore, the distance h1 for the shortest antenna element 4506 may be set to the smallest value, the distance h2 for the longest antenna element 4503 may be set to the largest value, and the distances for the medium antenna elements 4504 and 4505 may be set to values depending on the wavelengths at their resonance frequencies, respectively. Then, the distance between each of the antenna elements 4503, 4504, 4505, and 4506 and the conductive earth substrate 4507 must satisfy the condition that it falls within the range of 0.01 to 0.25 times as large as a wavelength λ for the resonance frequency f of each antenna element (that is, 0.01λ to 0.25λ).

[0143] Figure 74 shows that a high-permittivity material is provided between an antenna element 4601 and a conductive earth substrate 4602. Therefore, this configuration can apply to any other antenna device described above where a conductive earth substrate is located in the proximity of an antenna element. It should be also noted that the distance between the antenna element and the conductive earth substrate can be reduced equivalently by providing such a high-permittivity material between them.

[0144] Figure 75 shows that any one of the antenna devices described above is installed at five locations in total, that is, one on each of the four pillars 4701 and one on the roof, to provide a diversity configuration of these flat antennas. This configuration can offer a good capability of receiving and transmitting both horizontally and vertically polarized waves. It should be noted that the antenna device is installed at five locations in this example but it may be installed at more or less locations.

[0145] Figure 76 shows that any one of the antenna devices described above is installed at any one or more locations on the roof panel, hood, pillars, side faces, bumpers, wheels, floor, or other surface portions of an automobile body 4801. In Figure 76, an antenna 4802 is installed at a location where the antenna plane is almost in a horizontal position, an antenna 4803 is installed at a location where the antenna plane is in a tilted position, and an antenna 4804 is installed at a location where the antenna plane is almost in a vertical position. It should be noted that this figure shows possible locations for antenna installation by way of example and all the locations shown are not provided with antennas. Of course, it should be also noted that an antenna may be installed at any location other than those shown. It should be further noted that the automobile type is not limited to such a passenger car as shown and an antenna according to the present invention may be installed on a bus, truck, or any other type of automobile.

[0146] In addition, since an antenna 4805 is installed at a location where the antenna plane is in a

horizontal position, and specifically, on the back (undersurface) of the floor with its directivity facing the roadbed, it is suitable for communication with a wave source installed on the road (or embedded therein) which is to be used for communication or detection of vehicle positions.

[0147] Generally, airwaves for TV or FM broadcasting mainly consist of horizontally polarized waves, while waves for portable telephone, radio communication, or the like mainly consist of vertically polarized waves. Whether an antenna is suitable for horizontally polarized waves or vertically polarized waves depends on the direction of its installation. As shown in Figure 77(a), an antenna 4902 which is installed parallel to a conductive earth substrate 4901, that is, a vertical surface portion of an automobile body 4801 and comprises three antenna elements of unbalanced type with their grounded ends connected together is effective for horizontally polarized waves, since its sensitivity to horizontally polarized waves can be raised because of the horizontal electric field as shown in the right of the figure. This can be accomplished by installing an antenna 4804 as shown in Figure 76. On the other hand, an antenna 4802 which is installed parallel to a horizontal surface portion of the automobile body 4801 is effective for vertically polarized waves, since its sensitivity to vertically polarized waves can be raised because of the vertical electric field. In addition, an antenna 4803 which is installed in a tilted position can be used regardless of the direction of polarization, since its sensitivity is balanced between horizontally and vertically polarized waves depending on the degree of tilt. Figure 77(b)shows an example of antenna of balanced type, which is effective for horizontally polarized waves in a similar manner to that described above.

[0148] The antenna device of Figure 78 differs from the antenna devices described above in that it receives or transmits waves from the side of its conductive earth substrate rather than from the side of its antenna elements. As shown in Figure 78 (a), an antenna 5002 of three antenna elements is installed parallel to a conductive earth substrate 5001 at a distance and a grounded end of the antenna 5002 is connected to the conductive earth substrate 5001, which faces toward the outside. This antenna has symmetrical directional characteristics on the upper region of the conductive earth substrate 5001 corresponding to the area covered by the antenna 5002 (on the opposite side to the antenna 5002) and on the lower region thereof as shown in Figure 78(b). Therefore, even if the antenna 5002 and the conductive earth substrate 5001 are located inversely, it can achieve the same effect as those of the antennas described above. In addition, even if a conductive earth substrate 5003 is formed as a sealed case as shown in Figure 78 (c), an antenna 5002 inside the conductive earth substrate 5003 can have similar characteristics and communicate with the outside through the conductive earth substrate 5003 when it is fed.

[0149] Figure 79 shows an example of an antenna device of balanced type which can achieve the same effect as those described above, while Figure 78 shows an antenna device of unbalanced type.

[0150] Figure 80 is a schematic diagram showing possible locations where the antenna device according to the present embodiment is to be installed for automobile applications similar to those of Figure 76. In Figure 80, like in Figure 76, an antenna 5202 is installed at a location where the antenna plane is almost in a horizontal position, an antenna 5203 is installed at a location where the antenna plane is in a tilted position, and an antenna 5204 is installed at a location where the antenna plane is almost in a vertical position. In addition, since an antenna 5205 is installed at a location where the antenna plane is in a horizontal position, and specifically, on the inner surface of the floor, it is suitable for communication with a wave source installed on the road in a similar manner to that of Figure 76. Although these antennas shown are all installed inside an automobile body 5201, they can achieve the same performance as that for the antennas installed on the outer surface of the automobile body for the reasons described above and in addition, they are very advantageous in appearance, damages, or risk of being stolen because they are not exposed to the outside of the body. Moreover, as shown in Figure 80, the antenna device may be installed on a rearview mirror, in-car sun visor, number plate, or any other location where it cannot be otherwise installed on the outer surface, by embedding it within the inside space of such a component.

[0151] Figure 81 is a schematic diagram showing a possible application to a portable telephone of any of the antenna devices described above, in which an antenna 5302 is installed inside a conductive grounded case 5301 with an antenna ground connected thereto. This configuration can allow the antenna to be used in a similar manner to the case where the antenna is installed outside the grounded case 5301 and it can make the antenna very advantageous in handling because the antenna is not exposed to the outside. It should be noted that the antenna is used with a portable telephone in this example but it can also apply to a TV, PHS, or other radio set.

[0152] Figure 82 is a schematic diagram showing a possible application to an ordinary house of any of the antenna devices described above. Namely, an antenna 5402 is installed inside a conductive door of a house 5401, an antenna 5403 is installed inside a conductive window (for example, storm window), an antenna 5404 is installed inside a conductive wall, and an antenna 5405 is installed inside a conductive roof. Therefore, when an antenna is installed inside a conductive structure of the house 5401 in this way, the antenna can be protected against weather-induced damage or degradation with an elongated service life because it is not exposed to the outside.

[0153] It should be further noted that even if a house consists of nonconductive structures, such an antenna can be installed at any location by attaching a conductor to the outer surface thereof.

[0154] Figure 83 shows that a conductive earth substrate 5501 and an antenna 5502 installed parallel to and in the proximity of the substrate can be turned (or rotated) together on the axis as shown by a dash-dot line. As shown in Figure 83 (a), when an antenna 5502 is in a vertical position, the electric field is horizontal as shown in the right of the figure and its sensitivity for horizontally polarized waves becomes high. As shown in Figure 83 (b), when the antenna 5502 is in a horizontal position, the electric field is in turn vertical as shown in the right of the figure and its sensitivity for vertically polarized waves becomes high and therefore, the antenna can be directed in the optimum position depending on the state of polarized waves. Of course, it may be directed in a tilted position. The directional gain characteristics of the antenna installed as shown in Figure 83 (a) are shown in Figure 123 and the directional gain characteristics of the antenna installed as shown in Figure 83 (b) are shown in Figure 124. As apparent from these figures, an antenna in a vertical position can exhibit a high sensitivity to horizontally polarized waves, while an antenna in a horizontal position can exhibit a high sensitivity to vertically polarized waves.

[0155] It should be noted that the conductive earth substrate 5501 and the antenna 5502 can be turned manually by operating the handle by hand or automatically by using a motor or any other drive.

[0156] Figure 84 (a) is a schematic diagram showing the configuration of another antenna device which can achieve the same effects as those described above without turning the antenna. Namely, a ferroelectric 5603 is located between a conductive earth substrate 5601 and an antenna 5602 so that it can sandwich the antenna 5602. As shown in the right of Figure 84 (b), this configuration can allow the electric field between a conductive earth substrate 5604 and an antenna 5605 to be extended in a horizontal direction through a ferroelectric 5606, so that the vertical component is decreased and the horizontal component is increased as compared with the case where no ferroelectric is used as shown in the left of the figure. The antenna can be set for vertically polarized waves or horizontally polarized waves depending on whether a ferroelectric is used or not. It should be noted that if the antenna is installed in a vertical position, such a ferroelectric will have an inverse effect on the antenna. It should be further noted that the ferroelectric 5603 may be installed during the manufacture or not and it may be made easily removable by providing grooves for this purpose.

[0157] Although the antenna devices described above use bent elements which can be installed even in a narrow space, each of the antenna devices of Figure 85 uses a linear element which can be installed on an elongate component of an automobile or an element shaped to a component.

[0158] Figure 85 (a) shows that a linear antenna 5702 with three elements is located in the proximity of the surface of an elongate platelike conductive earth substrate 5701. Figure 85 (b) shows that a linear antenna 5704 with three elements is located in the proximity of the surface of a cylindrical conductive earth substrate 5703 so that each element is at the same distance from the conductive earth substrate 5703. Figure 85 (c) shows that a linear antenna 5706 with three elements is located in the proximity of the surface of a quadrangular-prism conductive earth substrate 5705 so that each element is at the same distance from the conductive earth substrate 5705.

[0159] Figure 86 shows variations of the antennas shown in Figure 85, in which elements are curved or bent in accordance with a curved or bent conductive earth substrate. Figure 86 (a) shows that an antenna 5802 with three curved elements is located in the proximity of the surface of a curved cylindrical conductive earth substrate 5801 so that each element is at the same distance from the conductive earth substrate 5801. Figure 86 (b) shows that an antenna 5804 with three bent elements is located in the proximity of the surface of a bent quadrangular-prism conductive earth substrate 5803 so that each element is at the same distance from the conductive earth substrate 5803. Figure 86 (c) shows that an antenna 5806 with three bent elements is located in the proximity of the surface of a bent platelike conductive earth substrate 5805.

[0160] In addition, Figure 87 (a) shows that an antenna 5902 is located along the surface of a cylindrical conductive earth substrate 5901 and Figure 87(b) shows that an antenna 5904 is located along the surface of a spherical conductive earth substrate 5903.

[0161] It should be noted that the antenna in this example is located outside a component which constitutes a conductive earth substrate but it is not limited to this example and it may be located inside a platelike component or on the inner surface of a cylindrical component.

[0162] Figures 91 and 93 show applications of the antenna device according to the present embodiment. Figure 91 shows that an antenna 6302 is installed on the surface of an elongate roof rail 6303 on the roof of an automobile body 6301 and Figure 93 shows that an antenna 6502 is installed inside an elongate roof rail 6503 on the roof of an automobile body 6501.

[0163] Moreover, Figures 92 and 94 show other applications of the antenna device according to the present embodiment. Figure 92 shows that an antenna 6403 is installed on the surface of an elongate roof box 6402 on the roof of an automobile body 6401 and Figure 94 shows that an antenna 6603 is installed inside an elongate roof box 6602 on the roof of an automobile body 6601.

[0164] The antenna device shown in Figures 88 (a) and 88 (b) comprises an antenna 6002 with three longer

elements and an antenna 6003 with three shorter elements with respect to a grounded point connected to a conductive earth substrate 6001 and feeding points A 6005 and B 6004 are provided for these antennas 6002 and 6003, respectively. As shown in Figure 88 (c), the shorter antenna 6003 is tuned to the A band of relatively higher frequencies and the longer antenna 6002 is tuned to the B band of relatively lower frequencies, and thus, such a single antenna device can accommodate two tuning bands. It should be noted that the feeding points A 6005 and B 6004 may be connected to each other.

[0165] Figures 89 (a) and 89 (b) show another example of the antenna of unbalanced type having two tuning bands. This antenna is a four-element antenna having an end connected to a conductive earth substrate 6101 and located in the proximity of the conductive earth substrate 6101 and in addition, an antenna 6102 with two relatively longer elements is provided with a feeding point B 6104 and an antenna 6103 with two relatively shorter elements is provided with a feeding point A 6105. As shown in Figure 8 [sic](c),this configuration can accommodate two tuning bands, that is, the A band of relatively higher frequencies and the B band of relatively lower frequencies in a similar manner to that of the preceding example. It should be also noted that the feeding points A 6005 and B 6004 may be connected to each other.

[0166] Figures 90 (a) and 90 (b) show still another example of the antenna of balanced type having two tuning bands. This antenna is a four-element antenna having the midpoint connected to a conductive earth substrate 6201 and located in the proximity of the conductive earth substrate 6201 and in addition, an antenna 6202 with two relatively longer elements is provided with a feeding point B 6204 and an antenna 6203 with two relatively shorter elements is provided with a feeding point A 6205. As shown in Figure 90 (c), this configuration can accommodate two tuning bands, that is, the A band of relatively higher frequencies and the B band of relatively lower frequencies in a similar manner to that of the preceding examples. It should be also noted that the feeding points A 6005 and B 6004 may be connected to each other.

[0167] Like this, the antenna described above can provide an advanced antenna device which requires a minimum space for installation and which is capable of accommodating a plurality of tuning bands, and thus, such an antenna can be applicable in a narrow space such as an automobile or a portable telephone.

[0168] It should be noted that this example assumes two tuning bands but it may accommodate three or more bands. The latter case can be accomplished by providing a plurality of antennas each of which has an element length corresponding to each tuning band and providing a feeding point for each antenna.

[0169] In the antenna device of Figure 95, a coil 6703 is provided in place on a three-edge antenna element 6701 located in the proximity of a conductive earth substrate 6702 and an end of the antenna element 6701 is connected to the conductive earth substrate 6702. In addition, a feeding section 6704 is provided on the antenna element 6701 between the coil 6703 and the conductive earth substrate 6702. This configuration can allow an electric current to concentrate in the coil and thus the antenna device can be reduced in size with the gain unchanged. For example, if the antenna element consists of a strip line, the area for the antenna can be reduced to a quarter. Moreover, its bandwidth can be narrowed with a sharp band characteristic.

[0170] Figure 96 shows that two antenna elements having the configuration of Figure 95 are connected in parallel for band synthesis. Namely, two antenna elements 6801a and 6801b having different bands (lengths) and coils 6803a and 6803b provided in place on the elements, respectively, are located in parallel and an end of each element is connected to a conductive earth substrate 6802. In addition, the antenna elements 6801a and 6801b are connected to a common feeding section 6804 through reactance elements 6805a and 6805b, respectively. This configuration can synthesize the bands of the two antenna elements and thus, a broadband antenna device with the same effects as those described above can be implemented.

[0171] In the antenna device of Figure 97, a coil 6903 is provided between an end of a three-edge antenna element 6901 located in the proximity of a conductive earth substrate 6902 and the conductive earth substrate 6902 and the other end of the coil 6903 is connected to the conductive earth substrate 6902 for grounding. In addition, a feeding section 6904 is provided in place on the antenna element 6901. This configuration can allow an electric current to concentrate in the coil in a similar manner to that for the thirty-second embodiment described above and thus the antenna device can be reduced in size with the gain unchanged.

[0172] Figure 98 shows that two antenna elements having the configuration of Figure 97 are connected in parallel for band synthesis. Namely, two antenna elements 7001a and 7001b having different bands (lengths) are located in parallel with an end connected to an end of a common coil 7003 and the other end of the coil 7003 is connected to a conductive earth substrate 7002. In addition, the antenna elements 7001a and 7001b are connected to a common feeding section 7004 through reactance elements 7005a and 7005b, respectively. This configuration can synthesize the bands of the two antenna elements and thus, a broadband antenna device with the same effects as those described above can be implemented. It should be noted that the single coil which is shared by the two antenna elements can contribute to a simple configuration.

[0173] The antenna of Figure 99 differs from that of Figure 97 described above in that as shown in Figure

99, an insulator 7105 is provided on a conductive earth substrate 7102 and an antenna element 7101 and a coil 7103 are connected on the insulator 7105. This configuration can allow easy installation of a coil 7103, which is useful for its implementation, and thus the coil can be stably installed. Figure 100 shows the configuration of two antenna elements 7201a and 7201b arranged for band synthesis. As shown in the figure, although the connection between a coil 7203 and the antenna elements becomes more complex because of the more antenna elements as compared with the preceding case, a connection point provided on an insulator 7205 on a conductive earth substrate 7202 can make the connection between the antenna elements and the coil much easier.

[0174] In the antenna device of Figure 101, two coil sections are separately provided and two insulators 7305a and 7305b are provided on a conductive earth substrate 7302 to connect antenna elements and coils. Namely, an end of a three-edge antenna element 7301 provided in the proximity of a conductive earth substrate 7302 and an end of a coil 7303a are connected together on an insulator 7305a, the other end of the coil 7303a and an end of another coil 7303b and a feeding section 7304 are connected together on another insulator 7305a, and the other end of the coil 7303b is connected to the conductive earth substrate 7302 for grounding. Figure 102 shows an antenna device having two antenna elements 7401a and 7401b arranged for band synthesis and the antenna elements, coils, and a feeding section are connected in a similar manner to that shown in Figure 101.

[0175] These configurations can allow easy connection to other circuit components because the feeding terminal is provided on a circuit board.

[0176] In the antenna device of Figure 103, a zigzag pattern 7503 is inserted in an antenna element 7501 in place of the coil for the configuration of Figure 95. Although the configuration having a coil can three-dimensionally extend, the configuration with this pattern 7503 can be formed on the same plane as the antenna element 7501 and fabricated through a printed-wiring technique. Figure 104 shows an antenna device having two antenna elements 7601a and 7601b arranged for band synthesis and zigzag patterns 7603a and 7603b are inserted in antenna elements 7601a and 7601b, respectively. It should be noted that the zigzag patterns may be sawtoothed ones as shown in Figure 106 (c).

[0177] In the antenna device of Figure 105, the whole antenna element 7701 located in the proximity of a conductive earth substrate 7702 is formed in a zigzag pattern and an end of the antenna element 7701 is connected to an end of a coil 7703 which is grounded at the other end. In addition, a feeding section 7704 is provided in place on the zigzag antenna element. This configuration can allow the antenna device to be further reduced in size, for example, to 1/6 or 1/8, although possible losses may be increased. It should be noted that the antenna element may be formed in other patterns, for example, those shown in Figures 106 (b) and (c). The pattern shown in Figure 106 (b) is a three-dimensional coil.

[0178] In the antenna device of Figure 107, an insulator 7904 is provided on a conductive earth substrate 7902 and a lead 7905 from an antenna element 7901 and a feeding section 7903 are connected together on the insulator 7904. This configuration can allow easy connection with other circuit components because the feeding section 7903 is provided on a circuit board.

[0179] Figure 108 shows that a through-hole 8005 is formed in a conductive earth substrate 8002 to provide an insulator 8004 on the opposite side of the conductive earth substrate 8002 to an antenna element 8001. A lead 8006 from the antenna element 8001 passes through the through-hole 8005 and the insulator 8004 and connects to a feeding section 8003 on the insulator 8004. This configuration can make it much easier than that of Figure 107 described above to connect other circuit components to the feeding section 8003 because such circuit components can be connected on the back of the 8002.

[0180] Figure 109 shows that in addition to the configuration of Figure 108 described above, another conductive plate is provided on the back of a conductive earth substrate (on the opposite side to an antenna element) to mount various circuit components thereon. Namely, a through-hole 8104 is formed in both a conductive earth substrate 8102 and a conductive plate 8105 to run a lead 8111 from an antenna element 8101 therethrough and an insulator 8103 is provided on the conductive plate 8105 over the through-hole 8104. In addition, a required number of insulators 8106 are provided on the conductive plate 8105 to connect various circuit components. The lead 8111 passes through the through-hole 8104 to the insulator 8103 and circuit components 8107 to 8110 are connected on the insulators 8103 and 8106.

[0181] This configuration can allow location of the circuit in the proximity of the antenna and easy shielding between the antenna and the circuit through the conductive plate, and thus, it can facilitate implementing a compact device.

[0182] Figure 110 shows still another example of the antenna in which circuit components are located on the same side as an antenna element. Namely, an insulator 8203 to connect a lead 8205 from an antenna element 8201 and a required number of insulators 8206 to connect various circuit components are provided on a conductive earth substrate 8202. In addition, a conductive shielding case 8204 is provided on the conductive earth substrate 8202 to shield the circuit components on the conductive earth substrate 8202 from the antenna element 8201 and a through-hole 8207 is formed for running the lead 8205 therethrough. The lead 8205 passes through the through-hole 8207 to connect to the insulator 8203 and circuit components

8208 to 8210 are connected on the insulators 8203 and 8206. An end of the antenna element 8201 is connected to the shielding case 8204 for grounding.

[0183] This configuration can allow the whole circuit to be held between the antenna element and the conductive earth substrate and to be shielded by the shielding case, and thus, it can facilitate implementing a more compact device than the configuration of Figure 109 described above.

[0184] In the antenna device of Figure 111, an antenna element 8301 is formed on one side of an insulation plate 8305 and one end 8307 of the antenna element 8301 passes through the insulation plate 8305. A lead 8303 from a point in the antenna element 8301 also passes through the insulation plate 8305 and another lead 8306 formed on the opposite side of the insulation plate 8305 and parallel to the antenna element 8305 [sic] is connected to the lead 8303 for connecting a feeding section 8304 to the lead 8306. It should be noted that the feeding section 8304 is provided in the proximity of the end 8307 of the antenna element 8301. In addition, the insulation plate 8305 is located parallel to a conductive earth substrate 8302, to which the end 8307 of the antenna element 8301 is connected.

[0185] This configuration can facilitate connecting coaxial cables because the grounded end of the antenna element is close to the feeding section.

[0186] In the antenna device of Figure 112, a conductive earth substrate 8404 is provided on another broader conductive earth substrate 8402 through an insulation plate 8405 and an antenna element 8401 is located in the proximity of the conductive earth substrate 8404. It should be noted that an end of the antenna element 8401 is connected to the conductive earth substrate 8404 for grounding. It should be preferable that the conductive earth substrate 8404 is equal to the antenna element 8401 in size. Specifically, the conductive earth substrate 8402 may be the body of an automobile or carriage, the metal case for a receiver or communication device, or any metal structure of a house and it may be installed inside or outside the room or compartment.

[0187] This configuration can achieve a nearly horizontal elevation angle with the maximum gain and thus, it will be suitable for receiving communication waves (vertically polarized waves) which come from a lateral direction.

[0188] It should be noted that any of the antenna devices shown in Figures 95 through 112 can be installed at such locations as shown in Figures 65, 75, 76, 80, 81, and 82 to operate properly.

[0189] It should be also noted that one or two antenna elements are used in any of the antenna devices shown in Figures 95 through 112 but of course, three or more antenna elements may be used.

[0190] It should be further noted that antenna elements used in any of the antenna devices shown in Figures 95 through 112 are in a three-edge shape but they may be in a loop or any other shape.

[0191] It should be further noted that insulators used to provide connection points in any of the antenna devices shown in Figures 107 through 112 may apply to any other antenna devices according to the preceding embodiments described above.

[0192] Next, other embodiments of the present invention which are devised mainly to improve the gain will be described below.

[0193] Figure 126 is a perspective view showing an embodiment according to the present invention.

[0194] In the figure, the reference numeral 4003 designates a conductive earth substrate, to which a main element 4001 is connected through a first ground connection 4005 so that it is substantially parallel to the substrate. The connection between the main element 4001 and the first ground connection 4005 is connected to another ground 4007. In addition, a feeding terminal 4006 is connected to a point in the main element 4001 and a grounding terminal of the feeding terminal 4006 is connected to the ground 4007.

[0195] A passive element 4002 is also connected to the conductive earth substrate 4003 through a second ground connection 4004 along the main element 4001.

[0196] As seen from the graphs shown in Figures 139 and 149[sic], the gain can be improved by providing such a passive element 4002 in this way. In the figure, the line with white squares indicates an ideal monopole antenna, the line with black squares indicates a one-element antenna, and the line with black circles indicates an embodiment according to the present invention. It can be seen from the figure that the gain characteristics are improved for a specific narrow-band.

[0197] Figure 127 shows another embodiment according to the present invention, which differs from the embodiment of Figure 126 in that a feeding terminal 4006 is grounded with a conductive earth substrate 4003. It should be noted that the embodiment of Figure 126 can achieve a better gain than this embodiment.

[0198] Figure 128 shows still another embodiment according to the present invention and a main element 4001 and a passive element 4002 are both formed in a circular shape in this embodiment, while they are formed in a straight shape in the embodiment of Figure 126. It should be noted that the passive element 4002 may be located inside or outside the main element 4001.

[0199] Figure 129 shows various types of the main element 4001 and the passive element 4002 as plan views taken in a direction perpendicular to the conductive earth substrate 4003. Specifically, Figure 129 (a) shows a straight type, Figures 129 (b) through (d) show bent types, and Figures 129 (e) and (f) show circular types. In addition, the reference numeral 4010 designates the directivity of each type. As seen from the figures, such an approximately circular type as shown in Figure 129 (f) can achieve the best omnidirection. Con-

versely, if a specific directivity is desired, another type of elements which can achieve that directivity may be selected.

[0200] Figure 130 shows a circular type, in which a feeding terminal 4006 is grounded with a conductive earth substrate 4003.

[0201] Figure 131 shows another circular type, in which a feeding terminal 4006 is grounded with a specifically provided ground 4007 rather than a conductive earth substrate 4003.

[0202] Figure 132 shows another embodiment according to the present invention, in which a larger ground 4012 such as an automobile body is provided under a conductive earth substrate 4003 through an insulator 406011[sic]. It should be preferable that the size and shape of the insulator 4011 are equal to those of the outer main element 4001. If a passive element 4002 is provided as the outer element, it should be preferable that the size and shape of the passive element 4002 are equal to those of the insulator 4011. It should be also preferable that the distance between the main element 4001 and the passive element 4002 is approximately 1/600λ, the distance between both elements 4001 and 4002 and the conductive earth substrate 4003 is approximately 1/20λ, and the thickness of the insulator 4011 is approximately 1/60λ. Figure 133 shows that the ground connections 4004 and 4005 in Figure 128 can be formed as a single connection plate 4013. This configuration can provide a simpler antenna device for a narrower band.

[0203] Figure 134 shows that two passive elements 4002, 4002[sic] are provided, one on each side of a main element 4001. This configuration can provide two gain peaks as shown in Figure 134 (b).

[0204] Figure 135 shows that two circular main elements 4001 are provided in parallel and a common feeding terminal 4006 is connected to them through a capacitor 4014. This configuration can accomplish band synthesis. Figure 135 (b) shows the result of such band synthesis.

[0205] Figure 136 shows that two passive elements 4003[sic], 4003 are provided, one on each side of the two main elements 4001 shown in Figure 135. This configuration can provide such an improved band synthesis gain as shown in Figure 136 (b) as compared with the example of Figure 135.

[0206] Figure 137 shows that a passive element 4003 is provided between the two main elements 4001, 4001[sic] shown in Figure 135.

[0207] Figure 138 shows that a circular main element 4001 is provided on the top surface of a printed circuit board 4015 and a passive element 4002 is provided on the undersurface of the printed circuit board 4015. The main element 4001 and the passive element 4002 are located in opposed positions with respect to each other. A conductive earth substrate 4003 as described above is provided parallel to the printed circuit board 4015.

[0208] Next, several embodiments of a digital television broadcasting receiving device, in which any of the above-mentioned antenna devices according to the present invention is used, will be described below.

(Embodiment 10)

[0209] Figure 138[sic] is a block diagram showing the configuration of a digital television broadcasting receiving device according to the embodiment 10 of the present invention. In Figure 138[sic], the reference numeral 6001 designates an input means, 6002 designates a delay means, 6003 designates a synthesis means, 6004 designates a reception means, 6005 designates a demodulation means, 6007 designates a delayed wave estimation means, 6008 designates a positional information determination means, and 6009 designates a vehicle information detection means. The operation for receiving digital television broadcasting at a vehicle will be described below with reference to Figure 141.

[0210] A television broadcasting wave is converted to an electric signal by the input means 6001 such as a receiving antenna and then supplied to the delay means 6002 and the synthesis means 6003. The television broadcasting wave converted to such an electric signal is delayed by the delay means 6002 in accordance with a delay control signal from a synthesis control means 6006 and then supplied to the synthesis means 6003. In the synthesis means 6003, in accordance with a synthesis control signal from the synthesis control means 6006, a signal from the input means 6001 and another signal from the delay means 6002 are provided with a predetermined gain for each signal and synthesized together and then supplied to the reception means 6004. As a synthesis technique used for this purpose, addition, maximum selection, or other simple operations can be used.

[0211] The reception means 6004 extracts only signals within a necessary band from those supplied by the synthesis means 6003 and converts them to signals of frequencies which can be handled by the demodulation means 6005. Thus converted signals are supplied to the demodulation means 6005, which in turn demodulates them for output. The demodulation means 6005 supplies demodulation information to the delayed wave estimation means 6007, which estimates a delayed wave contained in the received wave based on the demodulation information supplied by the demodulation means 6005.

[0212] The operations for demodulation and delayed wave estimation will be described below. In the ground wave digital broadcasting which is now being standardized in Japan, orthogonal frequency-division multiplexing (OFDM) is used for modulation and the demodulation means 6005 performs OFDM demodulation to decode transmitted codes. During the decoding process, frequency analysis is performed through an

operation such as FFT. The transmission characteristics of a received signal can be estimated by using various pilot signals contained in the received signal for data demodulation. For example, a delay time can be detected by detecting dip locations and the number of dips in frequency components which are obtained from the FFT frequency analysis.

[0213] Figure 147 shows an example of the frequency analysis performed for OFDM and the frequency characteristics may be flat when no delayed wave exists, while the frequency components may have some dips as shown in Figure 147 when some delayed waves exist. Alternatively, a delayed wave can be detected by observing any variation in or lack of pilot signals. The delay time of a disturbance wave can be estimated based on erroneous data positional information obtained through an error correction process performed after the FFT operation. It should be noted that the Japanese digital broadcasting has been described in the above paragraphs but this technique may apply also to analog broadcasting or foreign digital broadcasting.

[0214] Next, the operations for synthesis control and delay control will be described below. The synthesis control means 6006 provides a signal to control the delay means 6002 and the synthesis means 6003 based on estimated delayed wave information supplied by the delayed wave estimation means 6007. The configuration of the synthesis control means 6006 which comprises a gain control means 6061 and a delay time control means 6062 will be described below. The gain control means 6061 establishes a synthesis gain in the synthesis means 6003 based on delayed wave information supplied by the delayed wave estimation means 6007. This establishing operation will be described below with reference to Figure 148. In Figure 148, the axis of abscissas shows the magnitude of a delayed wave and the axis of ordinates shows a ratio of the gain of a signal supplied by the input means 6001 (signal A gain) to the gain of a signal supplied by the delay means 6002 (signal B gain) (= signal A gain/signal B gain). The synthesis gain is controlled so that both gains can be identical when the level of a delayed wave is large and in particular, it is equal to the level of a direct wave or so that a difference between both gains can be obtained by decreasing the gain of a signal supplied by the delay means or that of a signal supplied by the input means when the level of a delayed wave is small or, when the level of a delayed wave is larger than that of a direct wave. In addition, if the gain control is accomplished based on the delay time of a delayed wave supplied by the delayed wave estimation means 6007, the gain difference becomes larger for the case of a large delay time (the curve a in Figure 148) than the case of a small delay time (the curve b in Figure 148).

[0215] Next, the operation of the delay time control means 6062 will be described below. It controls the establishment of a delay time to be used by the delay means 6002 so that the delay means 6002 delays the time by a length almost equal to the delay time estimated by the delayed wave estimation means 6007. For example, the relationship between error rates of a delayed wave and a demodulated signal is shown in Figure 149. As shown in the figure, because the error rate may deteriorate abruptly when a delay time is small (point B: approximately 2.5 μs or less) , such a deterioration in error rate can be effectively avoided by using a fixed delay time, for example, a delay time exceeding the point B in Figure 149, rather than a delay time estimated by the delayed wave estimation means 6007 when the estimated delay time is small. It should be noted that such a delay time to be established here must be at most shorter than a guard period added to an OFDM signal. In order to prevent such a deterioration in error rate from occurring due to the small delay time of a delayed wave, the delay means 6002 can always establish a predetermined delay time. For this purpose, any influence of a short delay time can be eliminated by setting such a delay time to a value nearly twice as large as the point B. If a signal is received by a single antenna as shown in Figure 141, a delay time smaller than the reciprocal of the bandwidth of a received signal can be added to the signal to decrease the noise level of the received signal with an improved error rate. This is because dips caused by the added signal will appear outside the signal bandwidth. For example, if the signal bandwidth is 500 kHz, an added delay time must be established to be 2 μs or less. The operation for adding a signal with a short delay time as described above can be effective in improving the reception level of signal bandwidth for narrowband broadcasting which is used as broadcasting services for mobile reception.

[0216] Next, the usage of the vehicle information detection means 6009 will be described below. The vehicle information detection means 6009 detects information on a moving reception vehicle. For example, this means may consist of a speed (vehicle speed) detection means 6091 which detects the speed of a moving reception vehicle and a position detection means 6092 which detects the position of such a vehicle. It goes without saying that the vehicle information detection means 6009 can be implemented by a navigation system and that the position detection means can be implemented by using a GPS system or by detecting locations through a PHS, a portable telephone set, or a traffic control system such as VICS. Detected vehicle information is supplied to the positional information determination means 6008.

[0217] The positional information determination means 6008 checks which broadcast station covers the current location and estimates the delay time and the strength of a wave received at the receiving location, taking account of the distance from such a station as well as possible reflections from mountains and buildings. To this end, this means has previously obtained

information including the transmission frequency and location or transmission power of each transmitting station such as a broadcast station or relay station or downloaded it through any communication means such as broadcasting or telephone into its storage to compare it with the positional information supplied by the vehicle information detection means 6009. From this information, the delay time and magnitude of a wave received at that receiving location can be estimated.

[0218] Moreover, the delay time and magnitude of a received wave can be obtained more accurately, by marking in a map information including the location, magnitude, and height of each building located near the receiving location in addition to the location of each broadcasting station and taking account of possible reflections therefrom. It goes without saying that a navigation system can be used to handle such information on the transmitting stations, buildings, and mountains. It should be also noted that a delayed wave can be tracked more quickly because the following delayed wave can be estimated by knowing the speed of a moving reception vehicle through the speed detection means 6091.

[0219] The synthesis control means 6006 controls the synthesis gain and the delay time based on the delayed wave information supplied by the positional information determination means 6008 as described above. These control operations can be performed in a similar manner to those based on the delayed wave information supplied by the delayed wave estimation means 6007. In addition, the information from the delayed wave estimation means 6007 can be used in combination with that from the positional information determination means 6008 and then the gain and delay time may be controlled only if these two kinds of delay information are similar to each other or they may be controlled to remain unchanged or they may be controlled in accordance with the information containing a larger level of delayed wave if these two kinds of delay information are quite different from each other. It should be noted that in the description above, the vehicle information detection means 6009 is provided for mobile reception but both mobile and stationary reception can be accomplished by using the position detection means 6092 only.

[0220] The configuration described above has only one input means as shown in Figure 141 but another configuration shown in Figure 142 which has a plurality of input means and a plurality of delay means corresponding to the input means, respectively, is also effective for mobile reception. Each input means of this configuration is provided with a different input signal because it is affected by a different level of multipath interference even when it receives the same broadcasting wave. This may cause dips at different locations (frequencies) and different depths as shown in Figure 147. Therefore, a plurality of different input signals can be added together to provide another dip at a different location and depth, resulting in a lower signal error rate. The reception operation of the device shown in Figure 142 is almost identical to that described for Figure 141. Under the control of the delay means 6002 and the synthesis means 6003, a desired delay time is established with the delay means 1 through N in a relative manner and the gain can be set in accordance with the delayed signal. If the distance between a plurality of antenna locations is sufficiently shorter than the wavelength of the baseband, the level of received signals can be improved by adding a plurality of input signals within the baseband.

[0221] As described above, the digital television broadcasting receiving device according to the embodiment 10 can reduce signal dips through synthesis of signals, resulting in an improved error rate of digital data. Any deterioration in error rate can be avoided by establishing a delay time to prevent any influence of a signal with a shorter delay time. In addition, signal dips can be avoided more accurately by producing an accurate delayed wave through the delayed wave estimation means, the vehicle information detection means, and the positional information determination means and thus, the error rate can be further improved.

[0222] Signals received through a plurality of antennas can be switched depending on their error conditions. The antenna switching conditions for changing over from one antenna to another will be described below with reference to Figure 150. First, the C/N ratio of an input signal and the length of a past period such as a frame period thereof are determined and antenna switching is not performed if the C/N ratio is large and the error rate is low. If an error is a burst one of very short period and does not continue for a while even when the error rate is high, antenna switching is not performed. If the C/N level of an input signal is lowered or if a high error rate continues for a while, antenna switching is performed. The timing for antenna switching may be set to a guard interval appended to an OFDM signal. Alternatively, such an antenna switching timing may be calculated from a combination of vehicle speed information and positional information. It should be noted that the timing for antenna switching may be set to a guard interval appended to an OFDM signal. This can allow optimum antenna switching in accordance with varying reception conditions during the mobile reception. It should be also noted that by providing an antenna 6011 and an amplification means 6012 as components of the input means shown in Figures 141 and 142, any signal attenuation or matching loss due to distribution can be avoided to perform the succeeding operation accurately.

(Embodiment 11)

[0223] Figure 143 is a block diagram showing the configuration of a digital television broadcasting receiving device according to the embodiment 11 [sic] of the present invention. In Figure 143, the reference numeral

6001 designates an input means, 6002 designates a delay means, 6003 designates a synthesis means, 6004 designates a reception means, 6005 designates a demodulation means, 6007 designates a delayed wave estimation means, 6008 designates a positional information determination means, and 6009 designates a vehicle information detection means. The configuration of the embodiment 11 as shown in Figure 143 differs from that of the embodiment 10 described above in that the reception means 6004 is connected directly to the input means 6001. The operation for receiving digital television broadcasting at a vehicle according to the embodiment 11 will be described below.

[0224] A television broadcasting wave is converted to an electric signal by the input means 6001 such as a receiving antenna and then supplied to the reception means 6004. The reception means 6004 extracts only signals within a necessary band from those supplied by the input means 6001 and supplies them to the delay means 6002 and the synthesis means 6003. Those signals supplied by the reception means 6004 are delayed by the delay means 6002 in accordance with a delay control signal from a synthesis control means 6006 and then supplied to the synthesis means 6003. In the synthesis means 6003, in accordance with a synthesis control signal from the synthesis control means 6006, a signal from the reception means 6004 and another signal from the delay means 6002 are weighted with a predetermined gain added to each signal and synthesized together and then supplied to the demodulation means 6005. As a synthesis technique used for this purpose, addition, maximum selection, or other simple operations can be used in a similar manner to that for the embodiment 10 described above. The demodulation means 6005 demodulates them for output.

[0225] In a similar manner to that for the embodiment 10, a delayed wave is estimated in the delayed wave estimation means 6007 and the positional information determination means 6008 from demodulation information supplied by the demodulation means 6005 and mobile reception information supplied by the vehicle information detection means 6009, respectively, and then supplied to the synthesis control means 6006, which in turn controls the delay and synthesis operations by producing control signals to be supplied to the delay means 6002 and the synthesis means 6003. The detailed operations of the synthesis control means and the vehicle information detection means performed during the reception operation described above are identical to those for the embodiment 10. In the receiving device according to the embodiment 11, the operations of the delay means 6002 and the synthesis means 6003 can be simplified because the frequencies and bands are limited by the reception means 1, but the same effects as those of the embodiment 10 can be achieved.

[0226] As shown in Figure 144, a plurality of input means 6001, a plurality of reception means 6004, and a plurality of delay means 6002 can be provided for reception. The operation of this configuration shown in Figure 144 is identical to that for the preceding embodiment described above and will not be described here in detail. Because a plurality of input means 6001, a plurality of reception means 6004, and a plurality of delay means 6002 are provided, each input means of this configuration is provided with a different input level due to a different condition of interference even when it receives the same broadcasting wave. This may cause dips at different locations (frequencies) and different depths as shown in Figure 147. Therefore, a plurality of different input signals can be added together to provide another dip at a different location and depth, resulting in a lower signal error rate.

(Embodiment 12)

[0227] Figure 145 is a block diagram showing the configuration of a digital television broadcasting receiving device according to the embodiment 12 [sic] of the present invention. In Figure 145, the reference numeral 6001 designates an input means, 6004 designates a reception means, 6005 designates a demodulation means, 6007 designates a delayed wave estimation means, 6055 designates a demodulation control means, 8 [sic] designates a positional information determination means, and 9 [sic] designates a vehicle information detection means. The operation for receiving digital television broadcasting at a moving vehicle or a fixed location will be described below with reference to Figure 145.

[0228] A television broadcasting wave is converted to an electric signal by the input means 6001 such as a receiving antenna and then supplied to the reception means 6004. The reception means 6004 extracts only signals within a necessary band from those supplied by the input means 6001 and supplies them to the demodulation means 6005. The demodulation means demodulates the signals supplied by the reception means 6004 to provide digital signals for output and supplies the demodulation conditions to the delayed wave estimation means 6007.

[0229] Now, the operation of the demodulation means 6005 will be described below. More specifically, the operation of the demodulation means 6005 consisting of a frequency analysis means 6051, an adjustment means 6052, and a decoding means 6053 will be described. A signal supplied by the reception means 6004 is frequency-analyzed by the frequency analysis means 6051 which performs an FFT, real FFT, DFT, or FHT frequency analysis technique to convert it to a signal on the frequency axis and such a converted signal is supplied to the adjustment means 6052. The adjustment means 6052 operates on the signal on the frequency axis from the frequency analysis means 6051 based on a control signal supplied by the demodulation adjustment means [sic] 6055. That operation may be accomplished by performing a transfer function on a sig-

nal supplied by the frequency analysis means 6051 based on the signal from the demodulation control means 6055, by performing an arithmetic operation through filtering, by emphasizing a specific frequency component, or by interpolating a possibly missing frequency component. The signal supplied by the adjustment means 6052 is decoded by the decoding means 6053 into a digital code. The delayed wave estimation means 6007 estimates a delayed wave based on a signal from the demodulation means 6005. Such reference signals include a frequency spectrum supplied by the frequency analysis means 6051 and a pilot signal obtained during the decoding process in the decoding means 6053. The frequency spectrum of a received signal has dips or the like in response to the presence of delayed waves as shown in Figure 147. Since the frequency spectrum becomes flat in the ODFM modulation which is usually used for digital television broadcasting, the magnitude of a delayed wave and the delay time can be estimated. The magnitude of a delayed wave and the delay time also can be estimated from any change in phase or missing of a pilot signal. The demodulation control means 6055 controls the adjustment means 6052 based on delayed wave information supplied by the delayed wave estimation means 6007 or the positional information determination means 6008. Such a control can be accomplished by supplying a control parameter determined in accordance with the adjustment means 6052 and for example, by supplying a transfer function determined by the demodulation control means 6055 in accordance with a delayed wave when the transfer function is to be applied to the adjustment means 6052. Alternatively, a filter factor is supplied when filtering is to be performed or an interpolation value is supplied when interpolation is to be performed. The positional information determination means 6008 and the vehicle information detection means 6009 are identical to those for the embodiments 10 and 11 described above and will not be described here in detail.

[0230] As described above, according to the present embodiment, accurate decoding can be accomplished with an improved error rate of received digital signals, since the adjustment means 6052 serves to reduce any influence of delayed waves.

[0231] Figure 146 shows the configuration having a plurality of input means 6001. This configuration requires the same number of reception means as that of the input means as well as a plurality of frequency analysis means. However, it does not necessarily require a plurality of adjustment means nor a plurality of decoding means and it may do with a single adjustment means and a single decoding means by selecting signals to be processed thereby. It should be noted that for simplicity, only a single frequency analysis means 6051, a single adjustment means 6052, and a single decoding means 6053 are shown in Figure 146 but the present embodiment actually comprises the same number of these means as that of the input means as described above.

[0232] In the configuration of Figure 146, the magnitude of a delayed wave and the delay time can be estimated for each input means because a frequency analysis operation is performed for each input means. Therefore, the adjustment means 6052 can select a signal of the best reception conditions. In addition, an appropriate adjustment can be performed on each signal through such a transfer function, filtering, or interpolation technique as described above to decode such a signal in the decoding means 6053. The decoding means 53 [sic] or the adjustment means 6052 can select only signals having a frequency spectrum of good reception conditions among the frequency-analyzed signals from these input means and thus, satisfactory decoding of digital codes can be accomplished. From the foregoing, the configuration of Figure 146 can correct reception errors by providing a plurality of input means.

[0233] It should be noted that in the different digital television broadcasting receiving devices according to the present invention, the maximum gain can be achieved with respect to a wave having a different plane of polarization by designing each antenna element to have a different angle when an antenna consists of a plurality of antenna elements.

Industrial Applicability

[0234] As apparent from the foregoing, the present invention provides an antenna device and a communication system with such an antenna which can improve the reception sensitivity with a reduced transmission loss and which can be implemented at a lower cost.

[0235] Also, the present invention provides an antenna device which has better gain characteristics.

[0236] In a digital television broadcasting receiving device according to the present invention (such as claim 38), disturbance due to delayed waves contained in input signals can be reduced with an improved error rate after demodulation by delaying input signals immediately after the input or after the reception and then synthesizing them.

[0237] Also, in a digital television broadcasting receiving device according to the present invention (such as claim 39), disturbance due to delayed waves can be eliminated properly with an improved error rate after demodulation by estimating the delay time and magnitude of delay from a demodulated signal or a signal being demodulated to control such delay and synthesis operations and then controlling the delay and synthesis operations based on the estimated delay time and magnitude of delay.

Claims

1. An antenna device comprising:

a conductive earth substrate;
a receiving element located in the proximity of said conductive earth substrate and having a receiving terminal; and
a transmitting element located in the proximity of said receiving element and having a transmitting terminal,
characterized in that an end of said receiving element and an end of said transmitting element are connected to said conductive earth substrate for grounding through a common portion and the frequency band of said receiving element is different from that of said transmitting element.

2. An antenna device comprising:

a conductive earth substrate;
a receiving element located in the proximity of said conductive earth substrate and having a receiving terminal; and
a transmitting element located in the proximity of said receiving element and having a transmitting terminal,
characterized in that an end of said receiving element and an end of said transmitting element are connected to said conductive earth substrate for grounding at separate locations and the frequency band of said receiving element is different from that of said transmitting element.

3. The antenna device according to claim 1 or 2, characterized in that said receiving element and/or said transmitting element consists of a plurality of elements.

4. The antenna device according to claim 1, 2, or 3, characterized in that said receiving element and said transmitting element are formed together on one side of a common circuit board.

5. The antenna device according to claim 1, 2, or 3, characterized in that said receiving element and said transmitting element are formed separately on opposite sides of a common circuit board.

6. The antenna device according to claim 4 or 5, characterized in that a receiving amplifier is provided on said common circuit board between said receiving element and said receiving terminal.

7. The antenna device according to claim 4 or 5, characterized in that a transmitting amplifier is provided on said common circuit board between said transmitting element and said transmitting terminal.

8. The antenna device according to claim 4 or 5, characterized in that a receiving amplifier and a transmitting amplifier are provided on said common circuit board between said receiving element and said receiving terminal and between said transmitting element and said transmitting terminal, respectively.

9. The antenna device according to claim 6 or 7, characterized in that said receiving amplifier is provided on the opposite side of said common circuit board to said receiving element and said receiving amplifier is connected to said receiving element via a through-hole provided in said common circuit board.

10. The antenna device according to claim 6 or 7, characterized in that said transmitting amplifier is provided on the opposite side of said common circuit board to said transmitting element and said transmitting amplifier is connected to said transmitting element via a through-hole provided in said common circuit board.

11. The antenna device according to claim 4, 5, or 6, characterized in that said receiving terminal and said transmitting terminal are implemented as a single common terminal by using a common component.

12. An antenna device comprising:

a conductive earth substrate;
an antenna element having an end connected to said conductive earth substrate for grounding and formed on a common circuit board; and
a feeding terminal pulled out of said antenna element,
characterized in that a resonant circuit is inserted between said feeding terminal and the other end of said antenna element which is not grounded.

13. The antenna device according to claim 12, characterized in that said antenna element consists of a plurality of elements and said resonant circuit is inserted within each of said plurality of elements in a similar manner.

14. The antenna device according to claim 12 or 13, characterized in that said resonant circuit is a parallel circuit having an inductor and a capacitor section.

15. The antenna device according to claim 14, characterized in that said capacitor section is a series circuit having a capacitor and a voltage-variable capacitor element.

16. The antenna device according to any one of claims 1 through 5, characterized in that said receiving element and/or said transmitting element and/or said receiving terminal and/or said transmitting terminal is provided with a trap circuit having a predetermined resonance frequency.

17. The antenna device according to any one of claims 1 through 5, characterized in that said receiving element and/or said transmitting element and/or said receiving terminal and/or said transmitting terminal is provided with a band-pass circuit having a resonance frequency substantially equal to that of the antenna.

18. A communication system comprising:

an antenna device having a conductive earth substrate, an antenna element formed on a common circuit board located in the proximity of said conductive earth substrate, and a receiving amplifier provided on said common circuit board between said antenna element and a feeding terminal;
a receiver having a power supply section to supply electric power to said receiving amplifier of said antenna device; and
a feeding line for connecting said feeding terminal of said antenna device to a signal input section of said receiver,
characterized in that a direct-current blocking capacitor is provided between said receiving amplifier of said antenna device and said feeding terminal and at the input terminal of a receiving amplifier of said receiver, respectively, and electric power is supplied by said power supply section to said receiving amplifier of said antenna device through said feeding line.

19. The communication system according to claim 18, characterized in that said receiver comprises a power control section for controlling said power supply section to turn on/off.

20. A communication system comprising:

an antenna device according to claim 15;
a receiver having a receiving channel setting circuit which generates a bias voltage for said voltage-variable capacitor element of said antenna device; and
a feeding line for connecting a signal input section of said receiver to a feeding terminal of said antenna device,
characterized in that said voltage-variable capacitor element of said antenna device is connected to said feeding terminal, a direct-current blocking capacitor is provided between said antenna element and said feeding terminal and at the input terminal of a receiving amplifier of said receiver, respectively, and a receiving channel is established by varying the bias voltage generated by said receiving channel setting circuit.

21. A communication system comprising:

an antenna device according to any one of claims 1 through 10;
a communication device having a receiving amplifier and a transmitting amplifier;
a receiving connection line for connecting the receiving terminal of said antenna device to said receiving amplifier of said communication device; and
a transmitting connection line for connecting the transmitting terminal of said antenna device to said transmitting amplifier of said communication device.

22. A communication system comprising:

an antenna device having a conductive earth substrate, a receiving element having a receiving terminal formed on a common circuit board located in the proximity of said conductive earth substrate, a transmitting element having a transmitting terminal formed on said common circuit board located in the proximity of said receiving element, and a transmitting/receiving changeover circuit provided on said common circuit board and capable of switching said receiving terminal and said transmitting terminal;
a feeding line connected to said transmitting/receiving changeover circuit; and
a communication device connected to said feeding line and capable of both transmitting and receiving,

characterized in that said transmitting/receiving changeover circuit of said antenna device is controlled by using a switch signal to change over to the transmission operation in said communication device.

23. A communication system comprising:

an antenna device according to claim 11;
a communication device having a power supply section to supply electric power to said receiving amplifier of said antenna device and capable of both transmitting and receiving; and
a feeding line for connecting a common terminal of said antenna device to a signal input/out-

put section of said communication device, characterized in that a direct-current blocking capacitor is provided between a common component of said antenna element and said common terminal and at the input/output terminal of said communication device, respectively, and electric power is supplied by said power supply section to a receiving amplifier of said antenna device through said feeding line.

24. The communication system according to claim 23, characterized in that said power supply section is controlled to turn on/off by using a switch signal to change over to the transmission operation in said communication device.

25. The antenna device according to any one of claims 1 through 5, characterized in that at said receiving terminal and/or said transmitting terminal, a low-pass circuit is provided to pass signals of lower frequencies including a tuning frequency of the antenna and to block signals of frequencies higher than the tuning frequency of the antenna.

26. The antenna device according to any one of claims 1 through 5, characterized in that at said receiving terminal and/or said transmitting terminal, a high-pass circuit is provided to pass signals of higher frequencies including a tuning frequency of the antenna and to block signals of frequencies lower than the tuning frequency of the antenna.

27. The antenna device according to any one of claims 1 through 26, characterized in that the area of said conductive earth substrate is substantially equal to the external area of said antenna element.

28. The antenna device according to any one of claims 1 through 27, characterized in that said conductive earth substrate is provided in the proximity of and facing the body earth substrate of a stationary device, mobile device, or automotive vehicle, while appropriate insulation is kept.

29. The antenna device according to any one of claims 1 through 28, characterized in that the antenna body is provided at various important locations on an automobile, train, or airplane.

30. An antenna device comprising:

a conductive earth substrate;
a main antenna element connected to said conductive earth substrate through a first ground connection to be substantially parallel to said conductive earth substrate; and
a passive element connected to said conductive earth substrate through a second ground connection along said main antenna element.

31. The antenna device according to claim 30, characterized in that said main antenna element and said passive element are in a circular shape when they are taken in a direction substantially perpendicular to said conductive earth substrate.

32. The antenna device according to claim 30, characterized in that a ground terminal of a feeding terminal for said main element is connected to the connection between said main element and said ground connection.

33. The antenna device according to claim 30, characterized in that said conductive earth substrate is fixed on a conductive structure larger than said conductive earth substrate through an insulator and the size and shape of said conductive earth substrate are equal to those of said main element or said passive element whichever is outer.

34. The antenna device according to claim 30, characterized in that said first ground connection connected to said main element and said second ground connection connected to said passive element constitute a single plate-like ground connection.

35. The antenna device according to claim 30, characterized in that two passive elements are provided, one on each side of said main element.

36. An antenna device according to any one of claims 30 through 35, characterized in that a plurality of main elements are provided and a common feeding terminal is connected to said plurality of main elements to enable band synthesis.

37. The antenna device according to any one of claims 30 through 35, characterized in that said main element and said passive element are patterned at opposite locations on the face and the back of a printed circuit board, respectively.

38. A digital television broadcasting receiving device comprising:

input means which is an antenna device according to anyone of claims 1 through 37 and converts electromagnetic waves into electric signals;
delay means for receiving a signal from said input means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said input means;
reception means for performing frequency con-

version on a signal from said synthesis means; and

demodulation means for converting a signal from said reception means into a baseband signal, characterized in that the delay time used in said delay means and the synthesis ratio used in said synthesis means can be established arbitrarily.

39. A digital television broadcasting receiving device comprising:

input means which is an antenna device according to any one of claims 1 through 37 and converts electromagnetic waves into electric signals;
delay means for receiving a signal from said input means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said input means;
reception means for performing frequency conversion on a signal from said synthesis means;
demodulation means for converting a signal from said reception means into a baseband signal;
delayed wave estimation means for receiving a signal indicating the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and
synthesis control means for controlling said synthesis means and said delay means in accordance with a signal from said delayed wave estimation means,

characterized in that either the signal synthesis ratio used in said synthesis means or the delay time used in said delay means can be controlled in accordance with a signal from said synthesis control means.

40. A digital television broadcasting receiving device comprising:

input means which is an antenna device according to any one of claims 1 through 37 and converts electromagnetic waves into electric signals;
reception means for performing frequency conversion on a signal from said input means;
delay means for receiving a signal from said reception means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said reception means; and
demodulation means for converting a signal from said synthesis means into a baseband signal, characterized in that the delay time used in said delay means and the synthesis ratio used in said synthesis means can be established arbitrarily.

41. A digital television broadcasting receiving device comprising:

input means which is an antenna device according to any one of claims 1 through 37 and converts electromagnetic waves into electric signals;
reception means for performing frequency conversion on a signal from said input means;
delay means for receiving a signal from said reception means and delaying it;
synthesis means for synthesizing a signal from said delay means and a signal from said reception means;
demodulation means for converting a signal from said synthesis means into a baseband signal;
delayed wave estimation means for receiving a signal indicating the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and
synthesis control means for controlling said synthesis means and said delay means in accordance with a signal from said delayed wave estimation means,

characterized in that either the signal synthesis ratio used in said synthesis means or the delay time used in said delay means can be controlled in accordance with a signal from said synthesis control means.

42. A digital television broadcasting receiving device comprising:

input means which is an antenna device according to any one of claims 1 through 37 and converts electromagnetic waves into electric signals;
reception means for performing frequency conversion on a signal from said input means;
demodulation means for converting a signal from said reception means into a baseband signal;
delayed wave estimation means for receiving information on the demodulation conditions from said demodulation means and estimating a delayed wave contained in a signal from said input means; and
demodulation control means for controlling said demodulation means based on delayed wave information from said delayed wave esti-

mation means, characterized in that a transfer function to be handled by said demodulation means is controlled based on a control signal from said demodulation control means.

43. The digital television broadcasting receiving device according to any one of claims 38 through 42, characterized in that said device has a plurality of antenna elements and each antenna element is installed so that it can have the maximum gain for an electric wave of different polarization planes.

Fig. 1

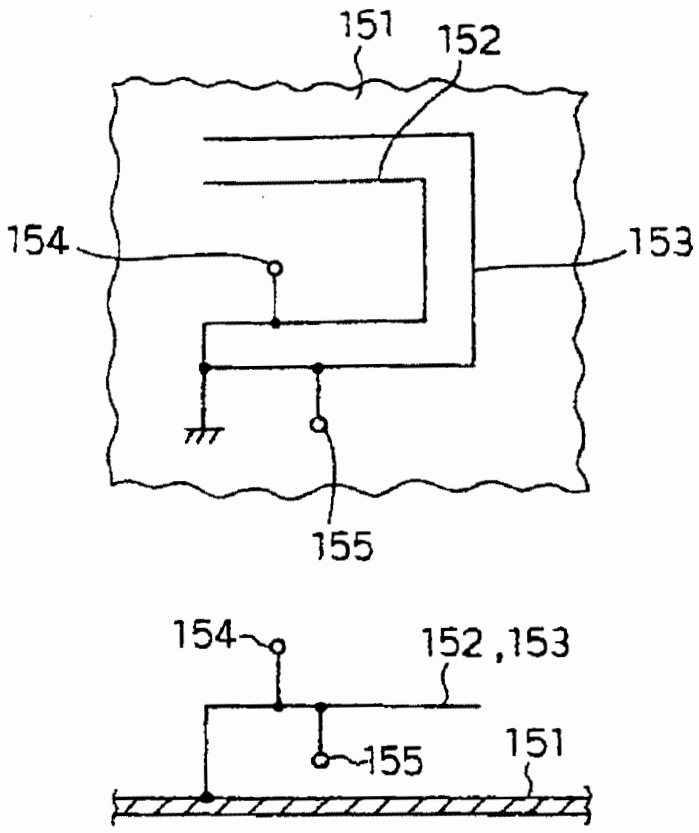


Fig. 2

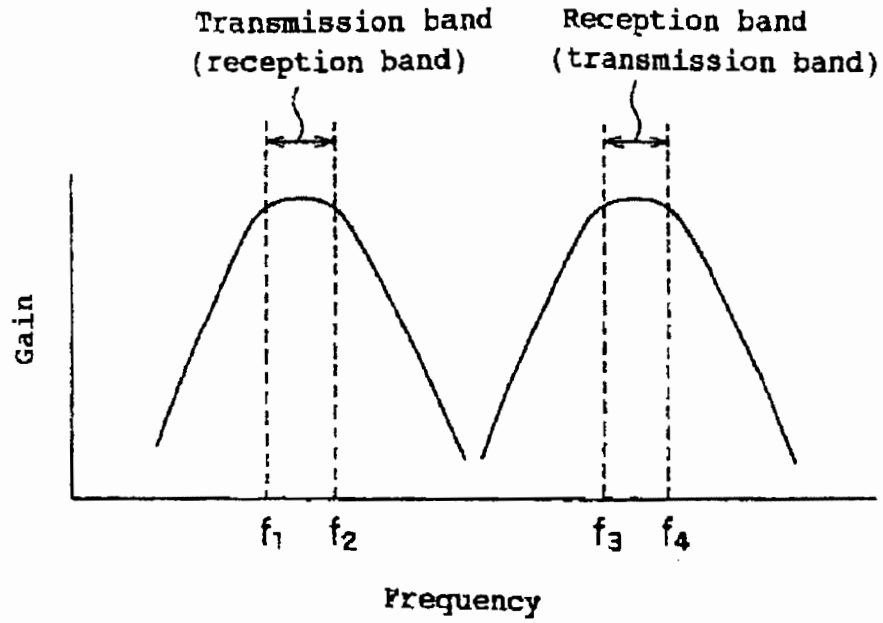

Transmission band
(reception band)
Reception band
(transmission band)
Gain
f1
f2
f3
f4
Frequency

Fig. 3

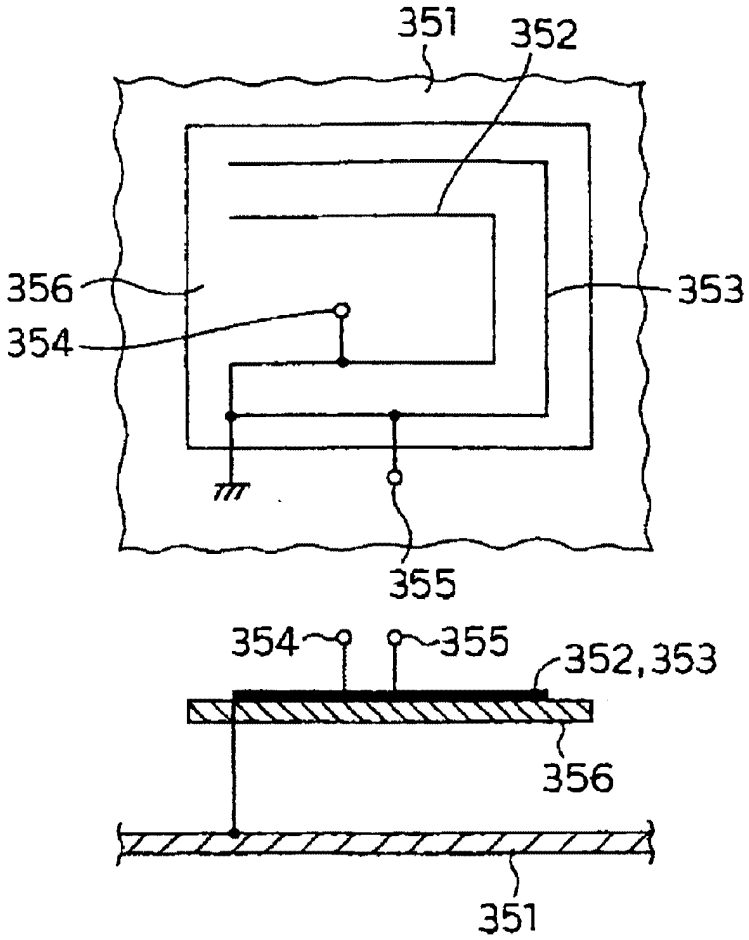


Fig. 4

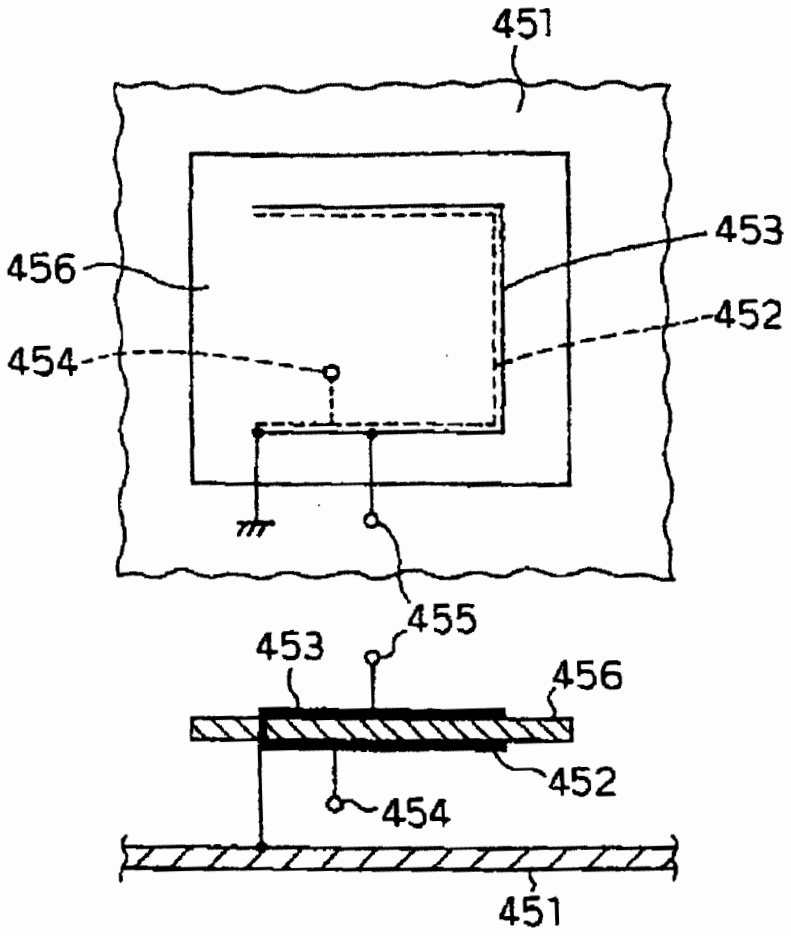


Fig. 5

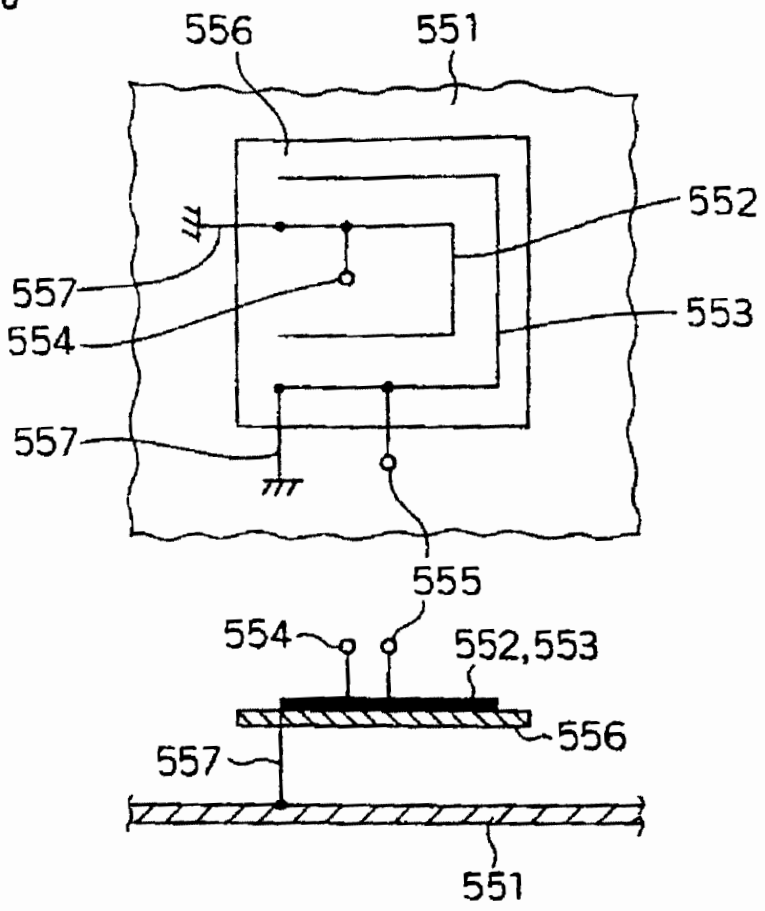


Fig. 6

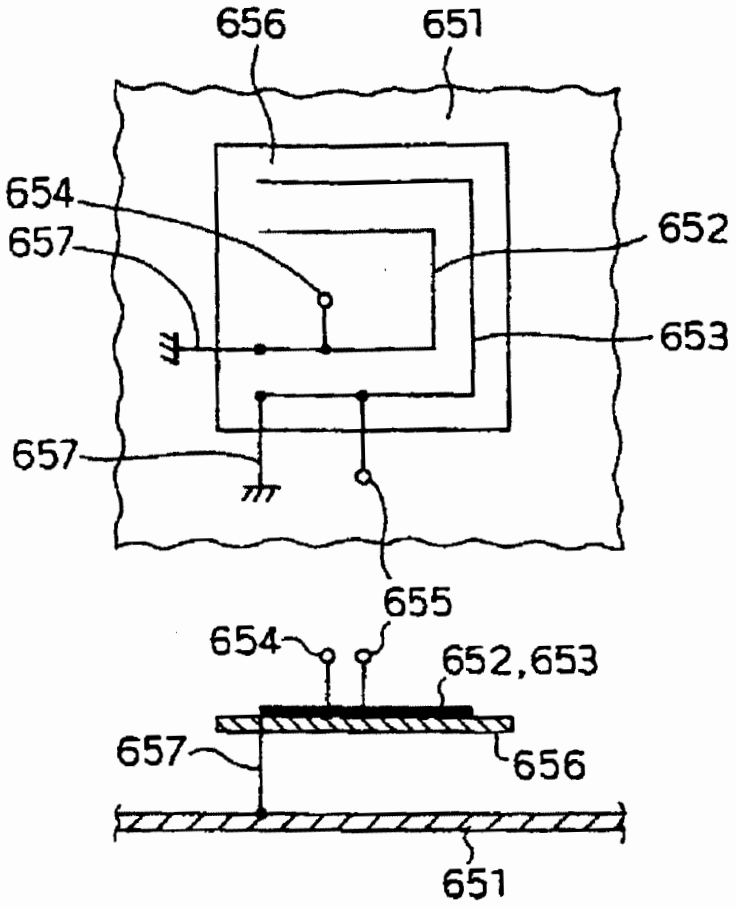


Fig. 7

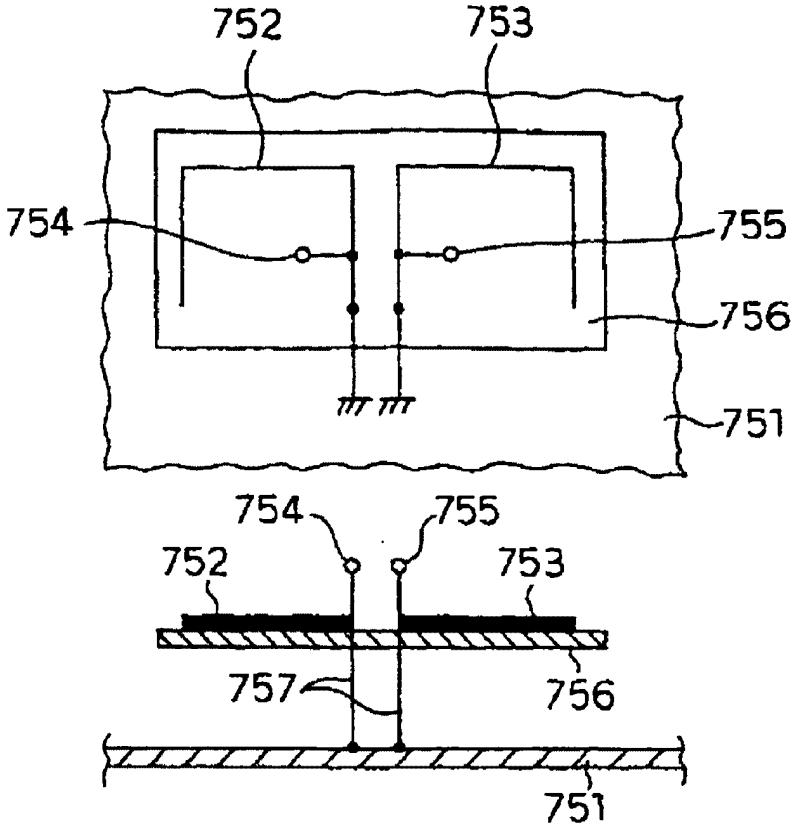


Fig. 8

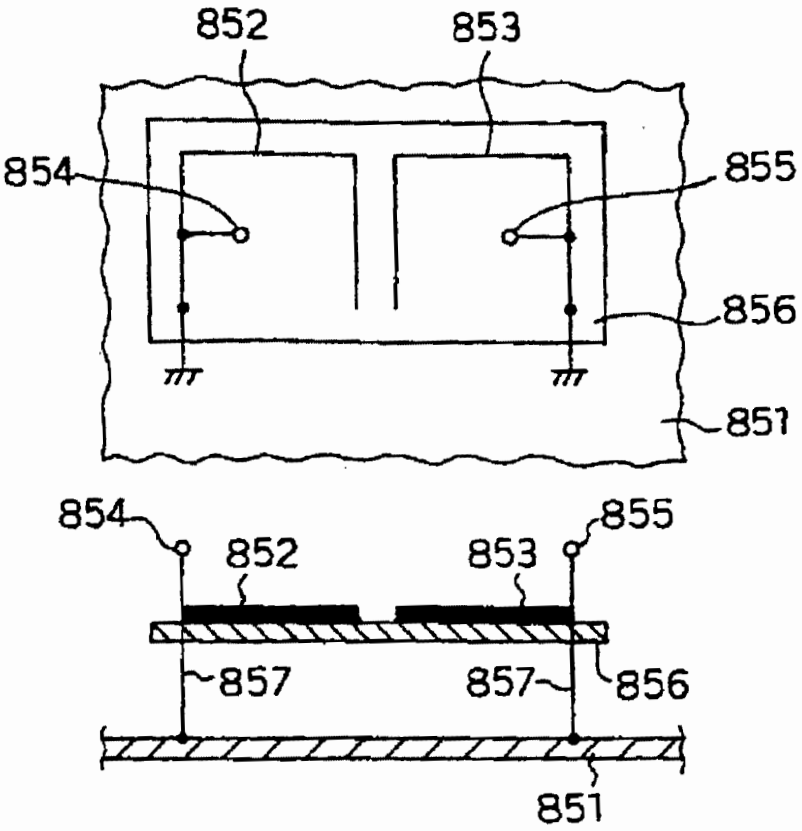


Fig. 9

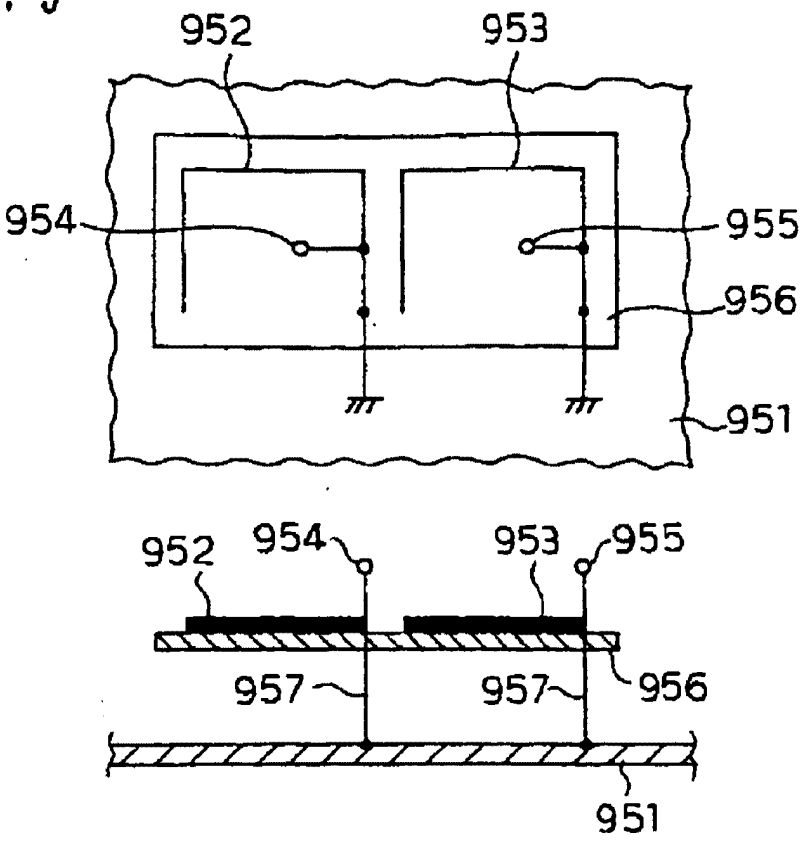


Fig. 10

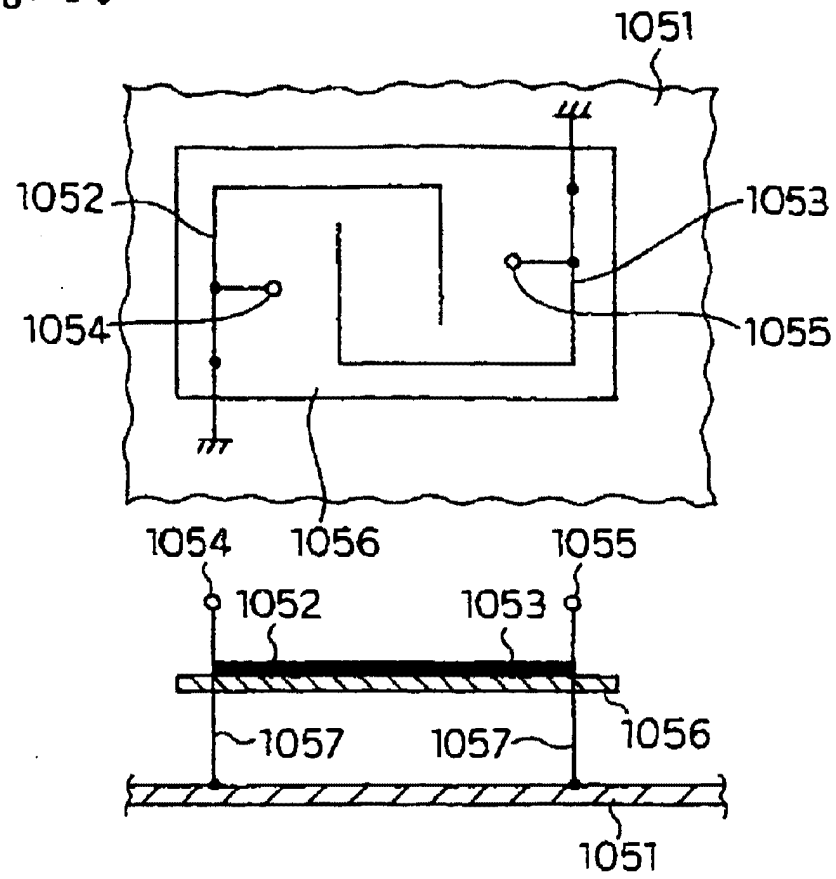


Fig. 11

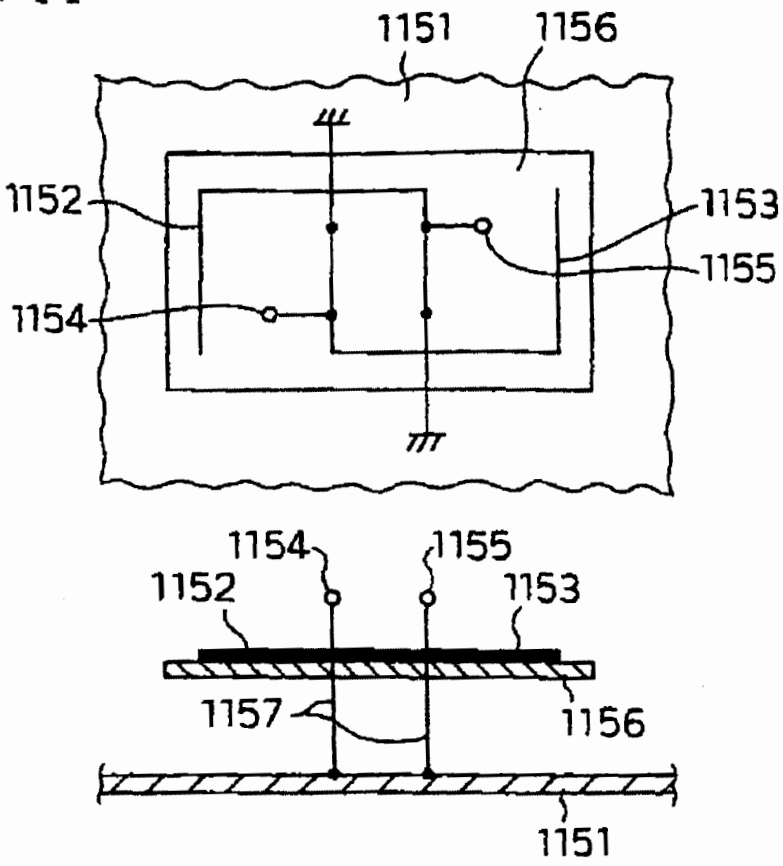

1151
1156
1152
1153
1155
1154
1154
1155
1152
1153
1157
1156
1151

Fig. 12

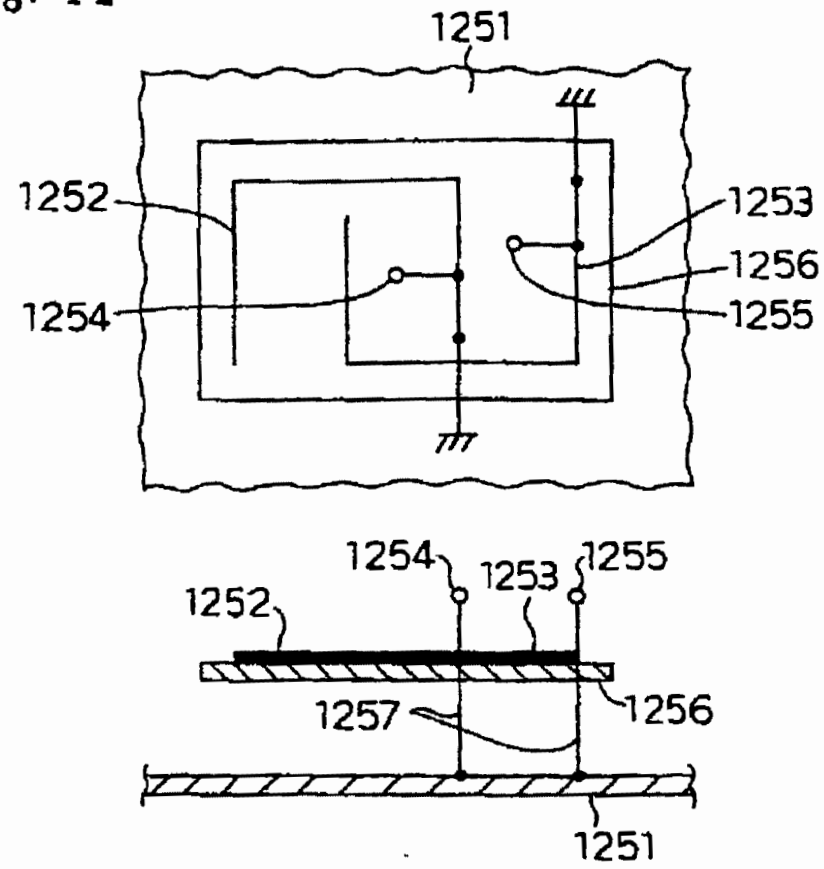

1251
1252
1253
1254
1255
1256
1254
1253
1255
1252
1257
1256
1251

Fig. 13

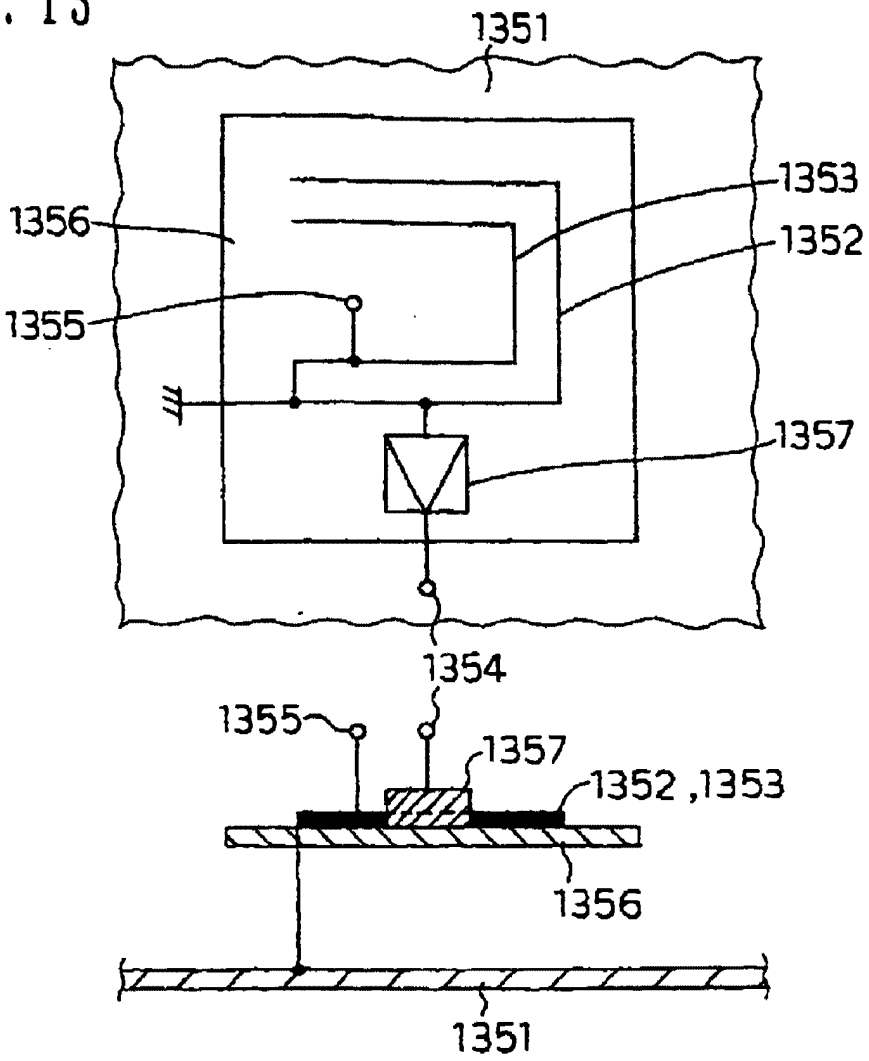

1351
1353
1356
1352
1355
1357
1354
1355
1357
1352 ,1353
1356
1351

Fig. 14

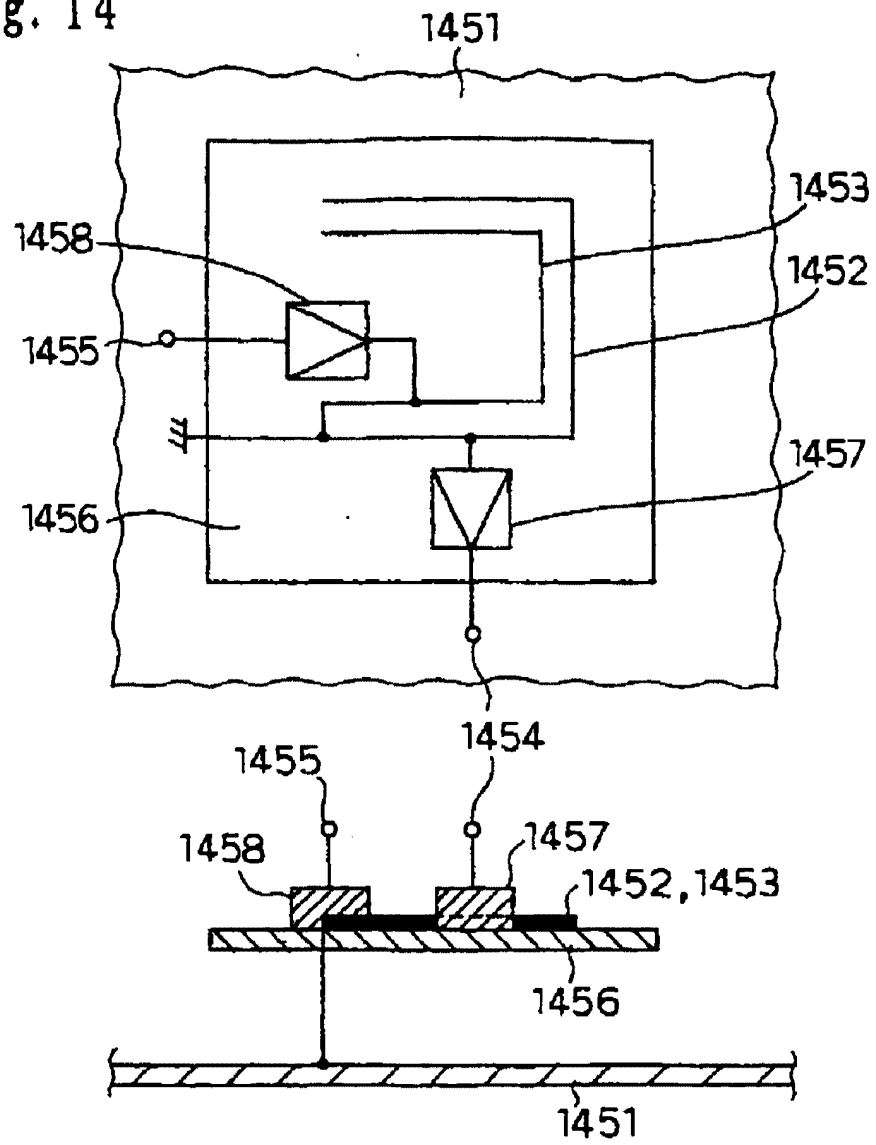

1451
1453
1458
1452
1455
1457
1456
1454
1455
1458
1457
1452,1453
1456
1451

Fig. 15

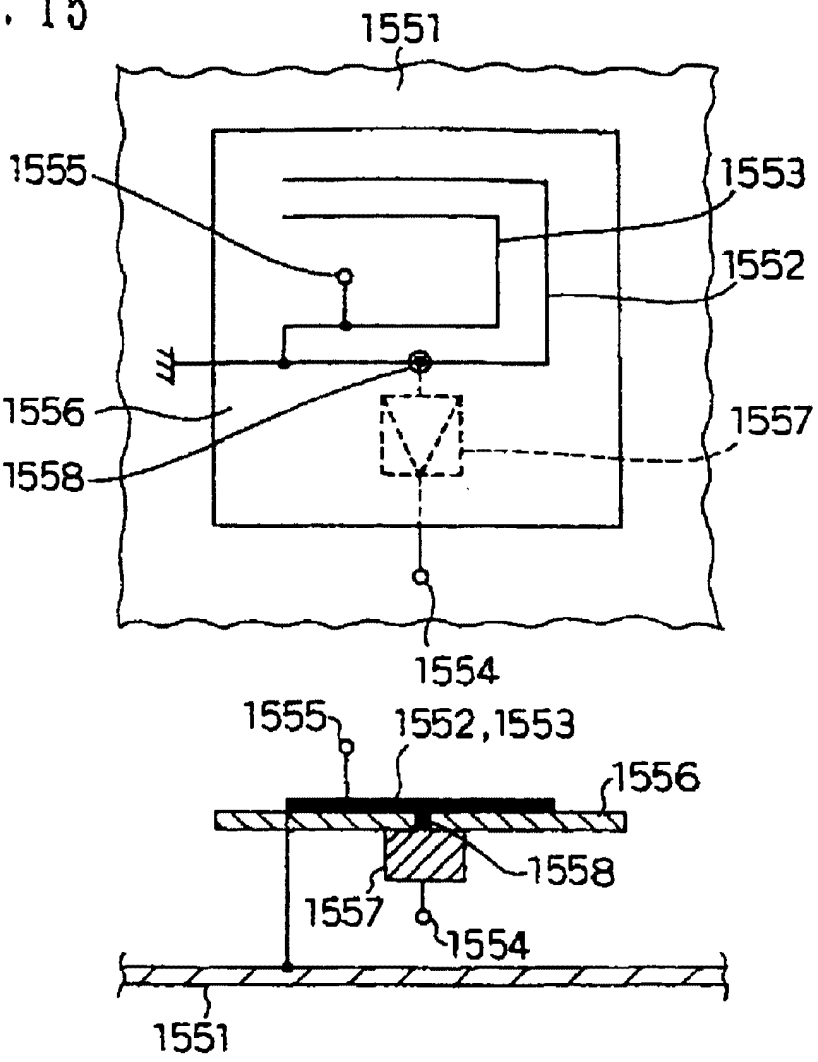

1551
1555
1553
1552
1556
1558
1557
1554
1555
1552,1553
1556
1558
1557
1554
1551

Fig. 16

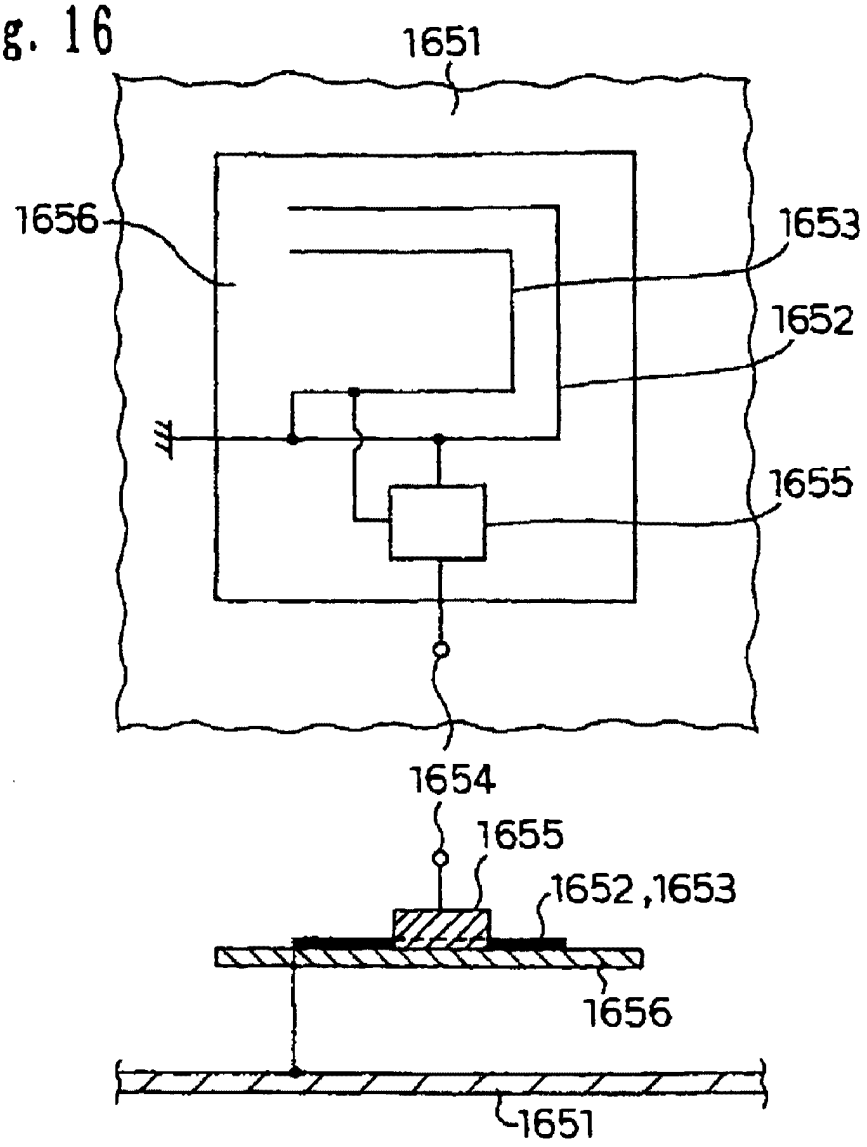


Fig. 17

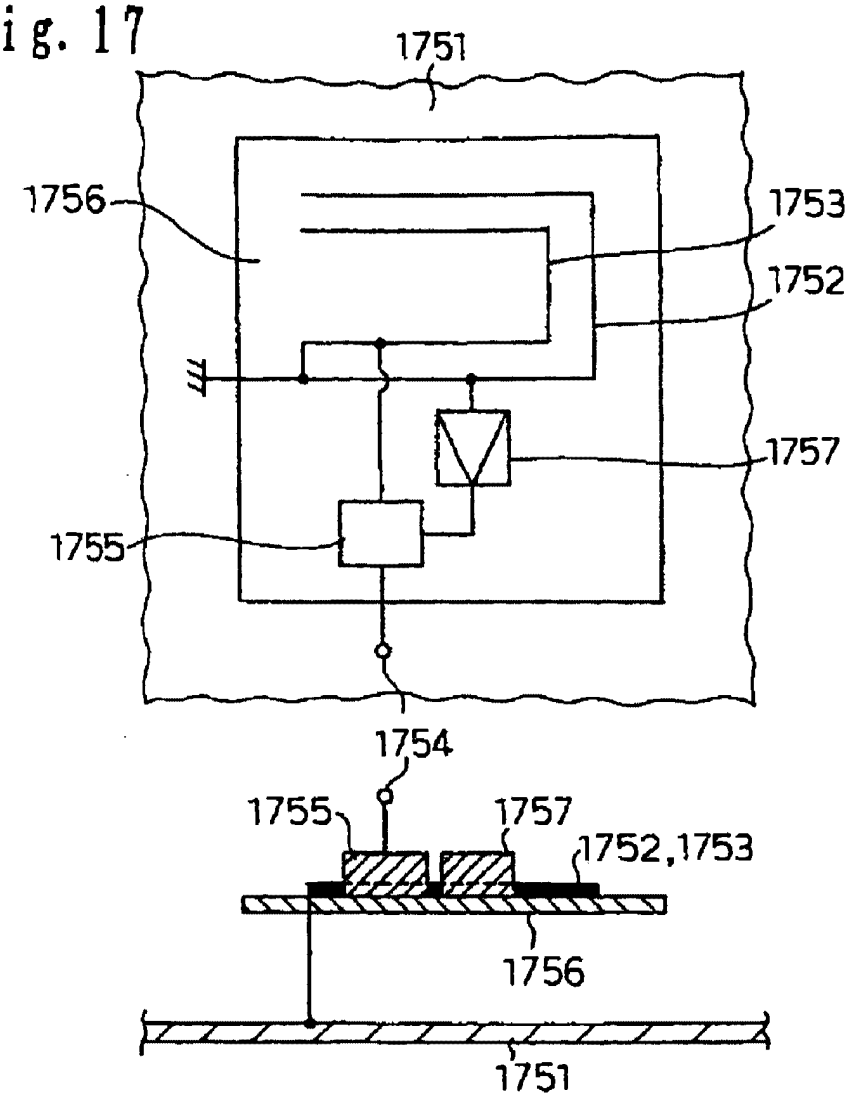

1751
1756
1753
1752
1757
1755
1754
1755
1757
1752,1753
1756
1751

Fig. 18

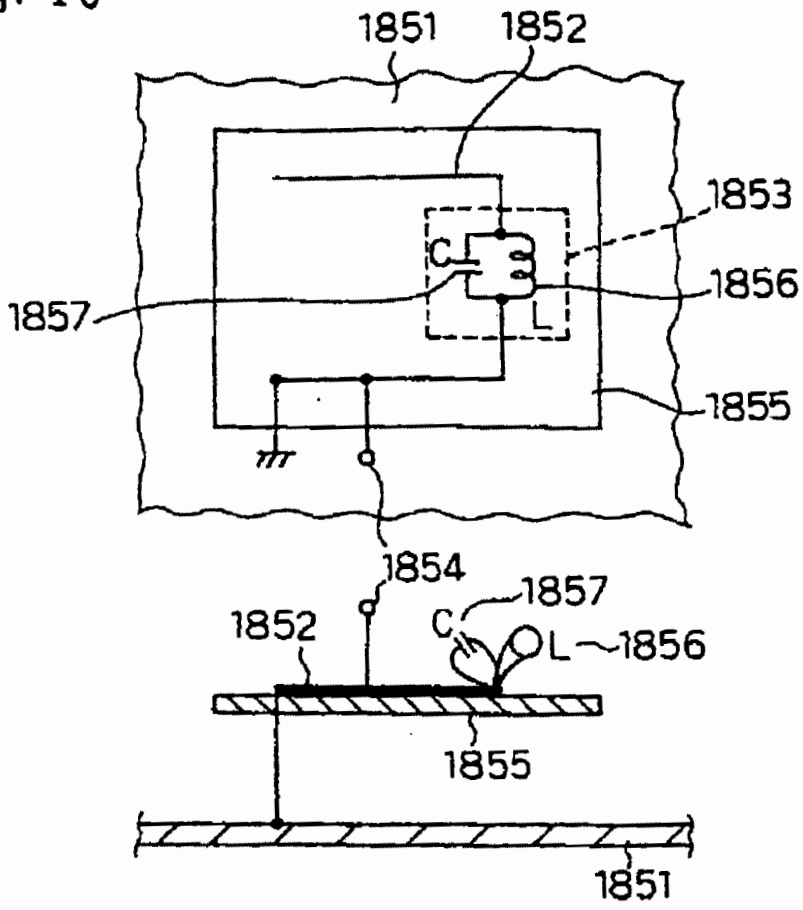

1851
1852
1853
C
1856
1857
L
1855
1854
1857
1852
C
L
1856
1855
1851

Fig. 19

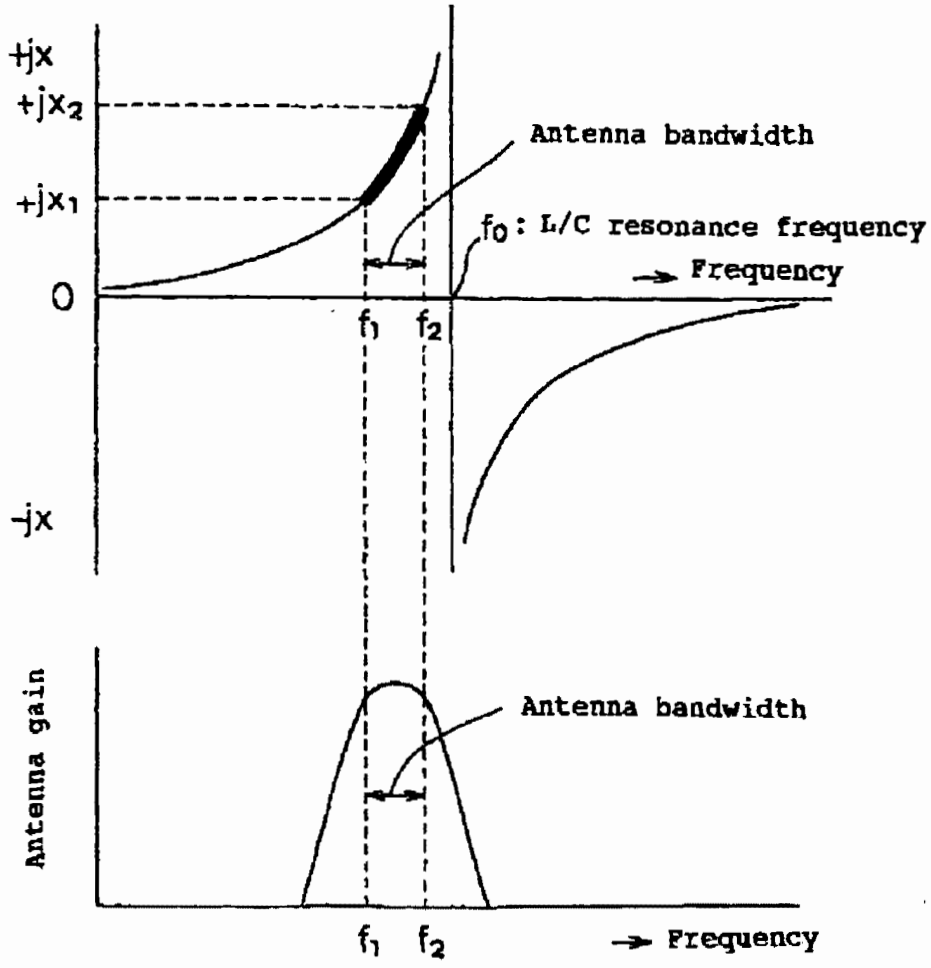
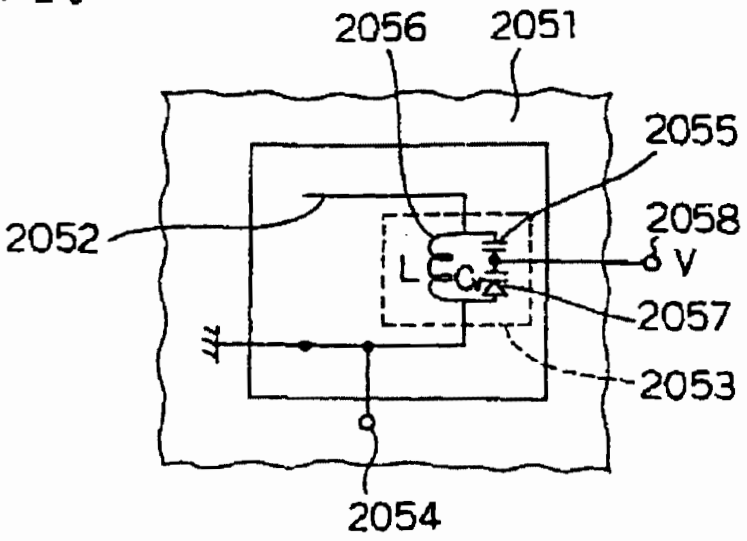

+jx
+jx2
+jx1
0
-jx
Antenna bandwidth
f0 : L/C resonance frequency
Frequency
f1
f2
Antenna gain
Antenna bandwidth
f1
f2
Frequency

Fig. 20


2056
2051
2055
2052
2058
V
L
Cv
2057
2053
2054

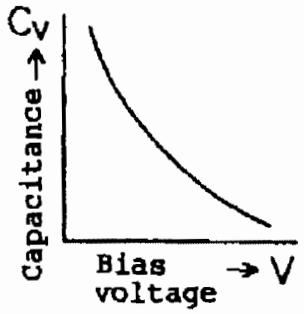

Cv
Capacitance
Bias voltage
V

Fig. 21

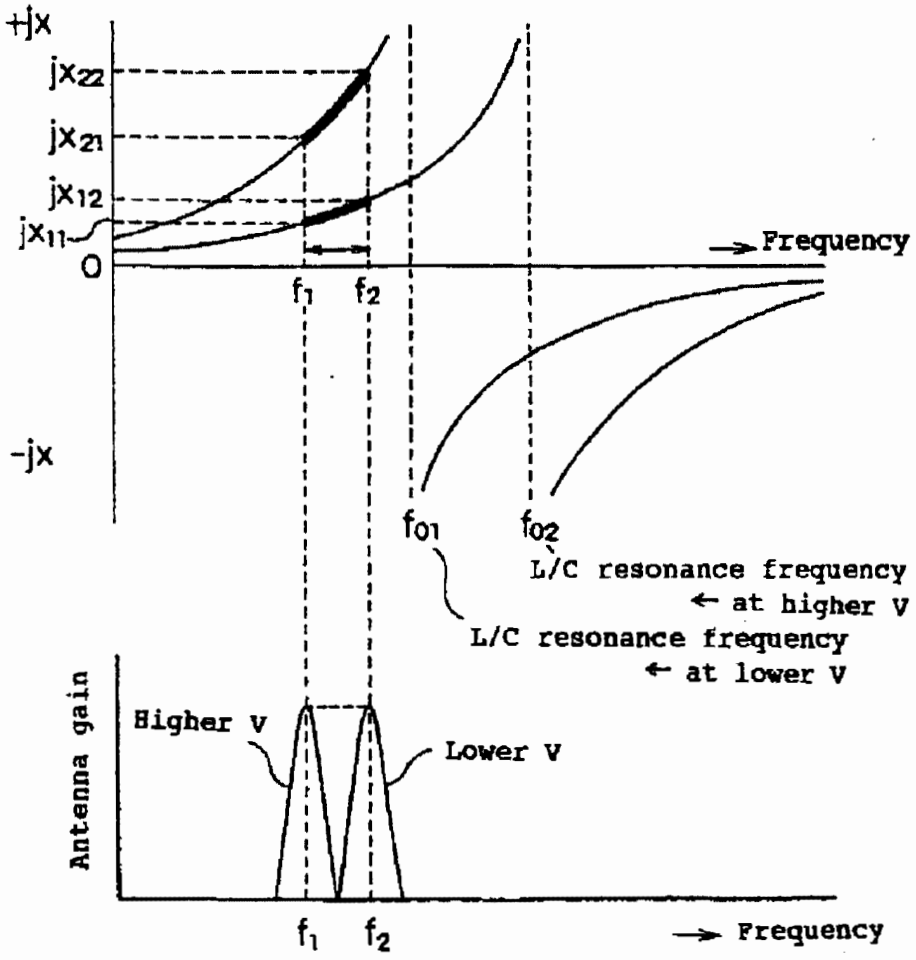
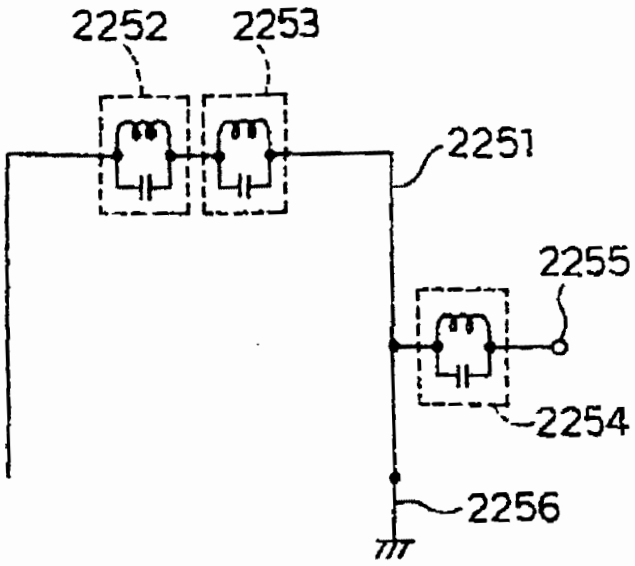

+jx
jx22
jx21
jx12
jx11
0
Frequency
f1
f2
-jx
fo1
fo2
L/C resonance frequency
← at higher V
L/C resonance frequency
← at lower V
Antenna gain
Higher V
Lower V
f1
f2
Frequency

Fig. 22



(Only the element circuit is shown.)

Fig. 23

Example of receiving element

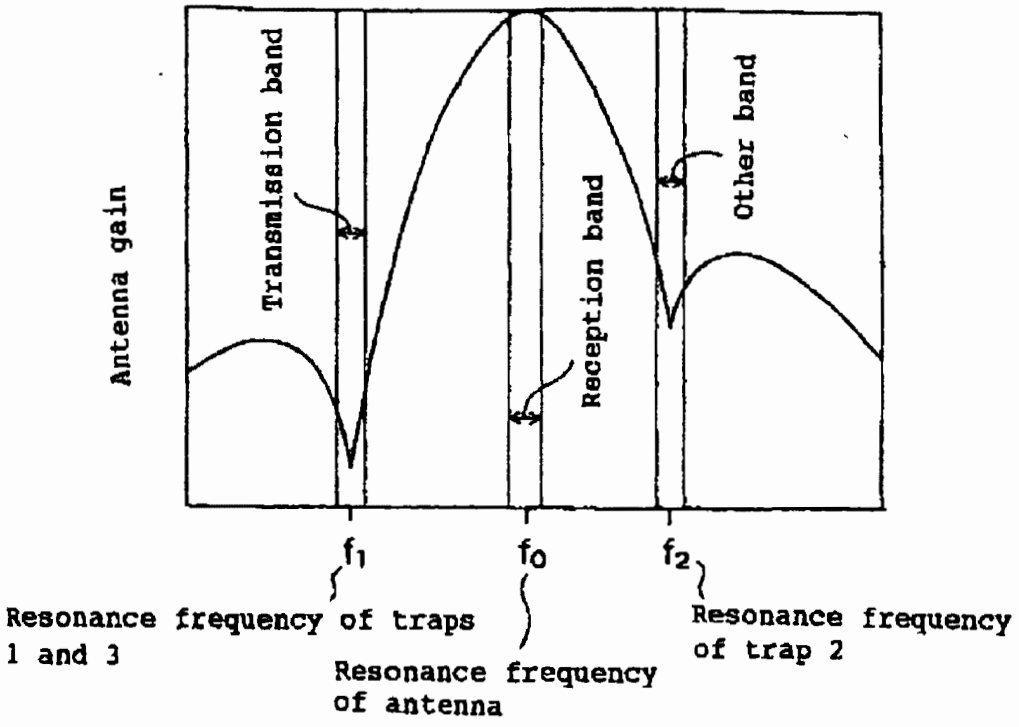


Fig. 24 (a)

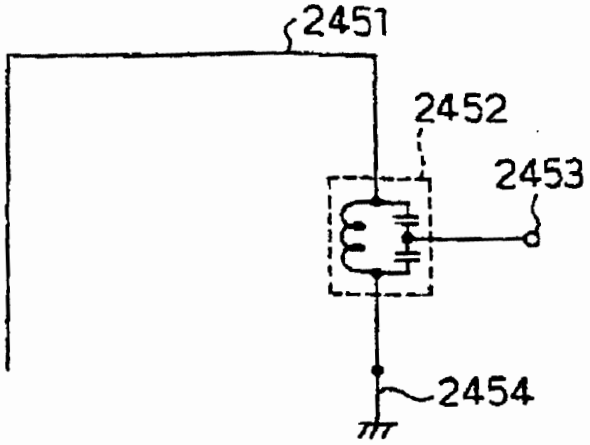


Fig. 24 (b)

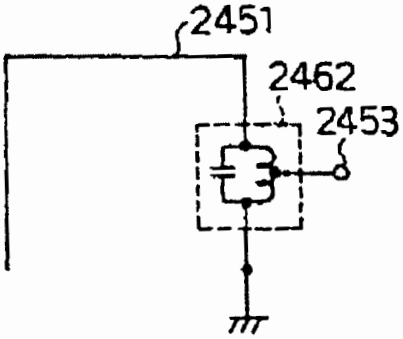


Fig. 24 (c)

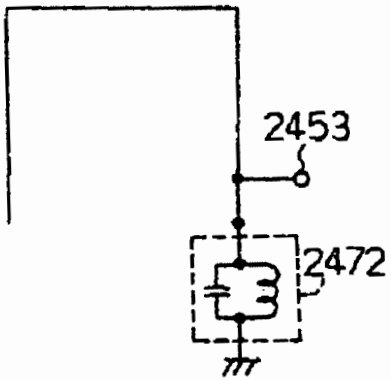


Fig. 25

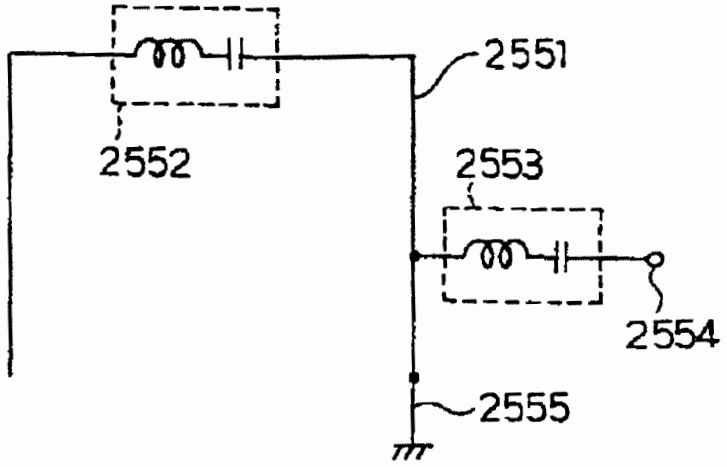


Fig. 26 (a)

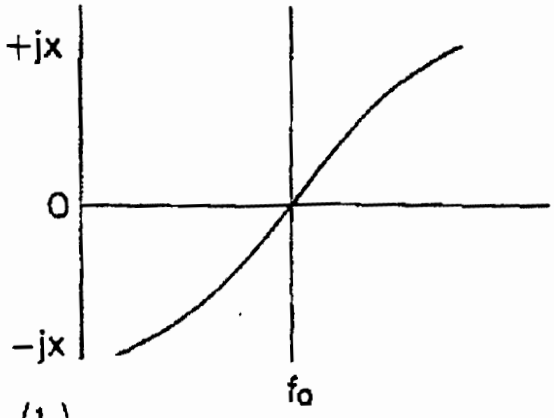


Fig. 26 (b)

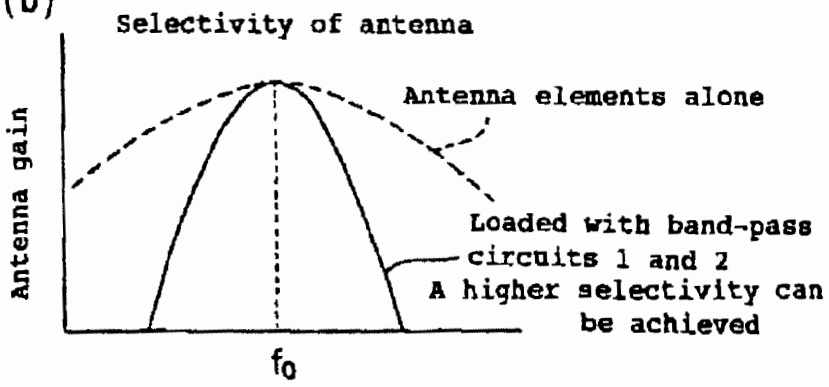


Fig. 27

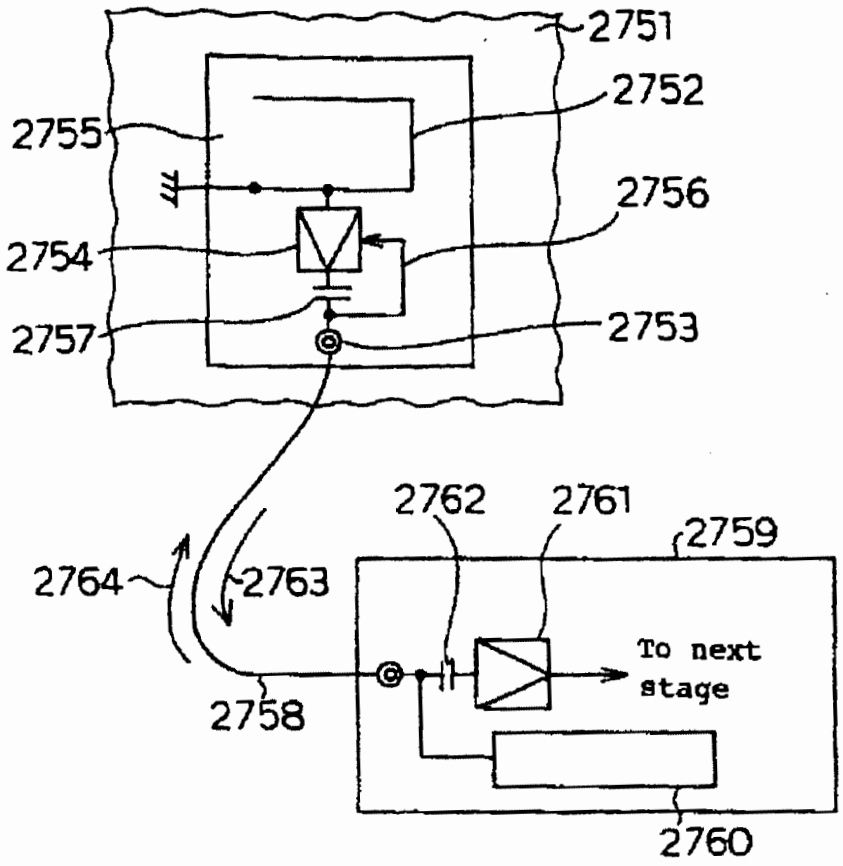

2751
2752
2755
2756
2754
2757
2753
2762
2761
2759
2764
2763
To next stage
2758
2760

Fig. 28

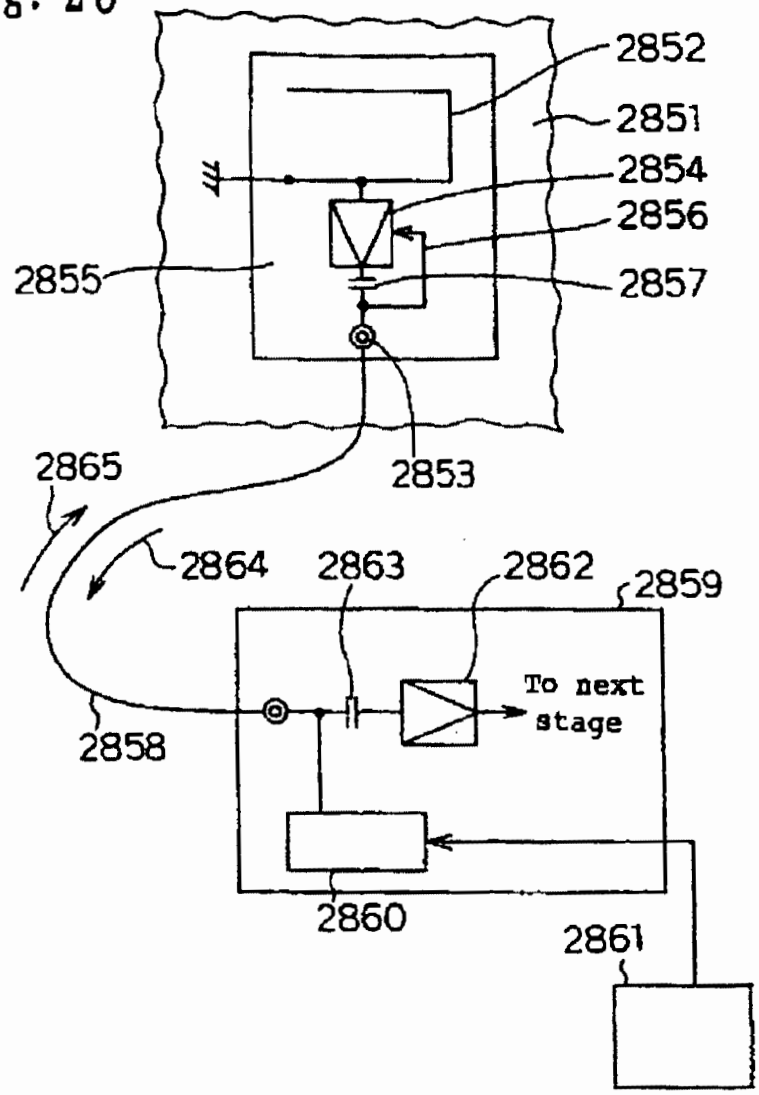

2852
2851
2854
2856
2855
2857
2853
2865
2864
2863
2862
2859
To next stage
2858
2860
2861

Fig. 29

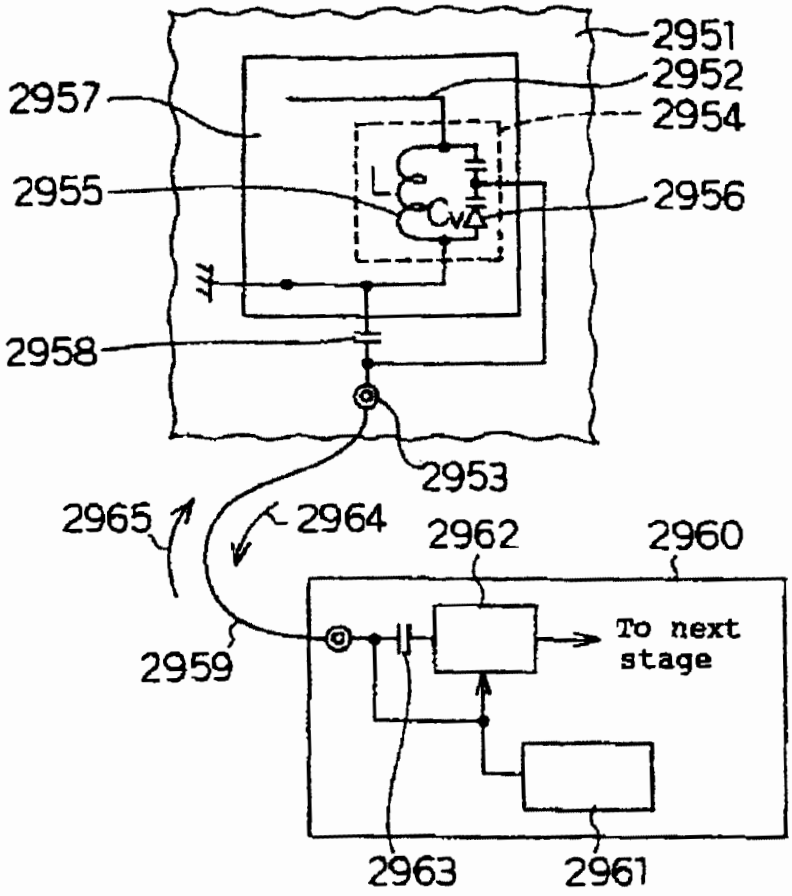

2951
2952
2954
2957
2955
L
Cv
2956
2958
2953
2965
2964
2962
2960
To next stage
2959
2963
2961

Fig. 30

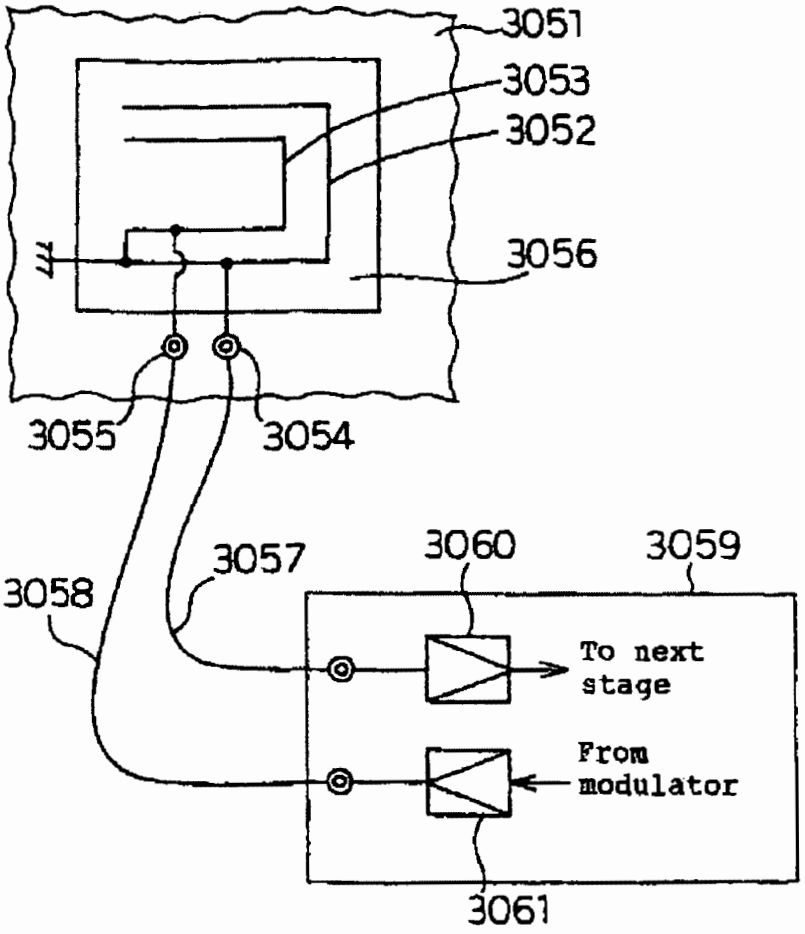

3051
3053
3052
3056
3055
3054
3057
3060
3059
3058
To next stage
From modulator
3061

Fig. 31

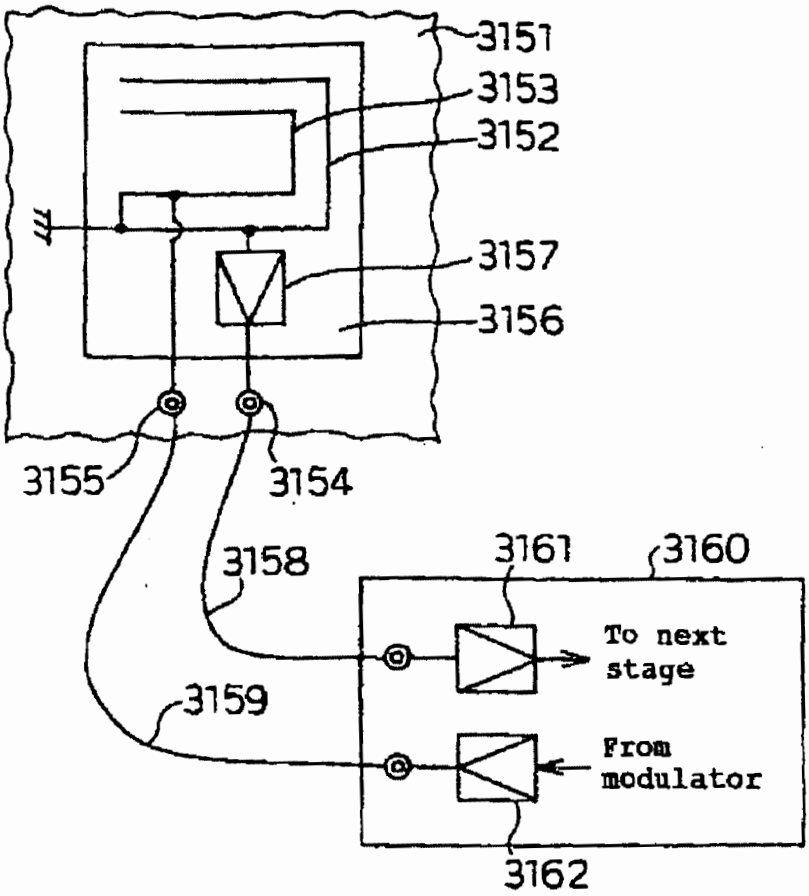

3151
3153
3152
3157
3156
3155
3154
3158
3161
3160
To next stage
3159
From modulator
3162

Fig. 32

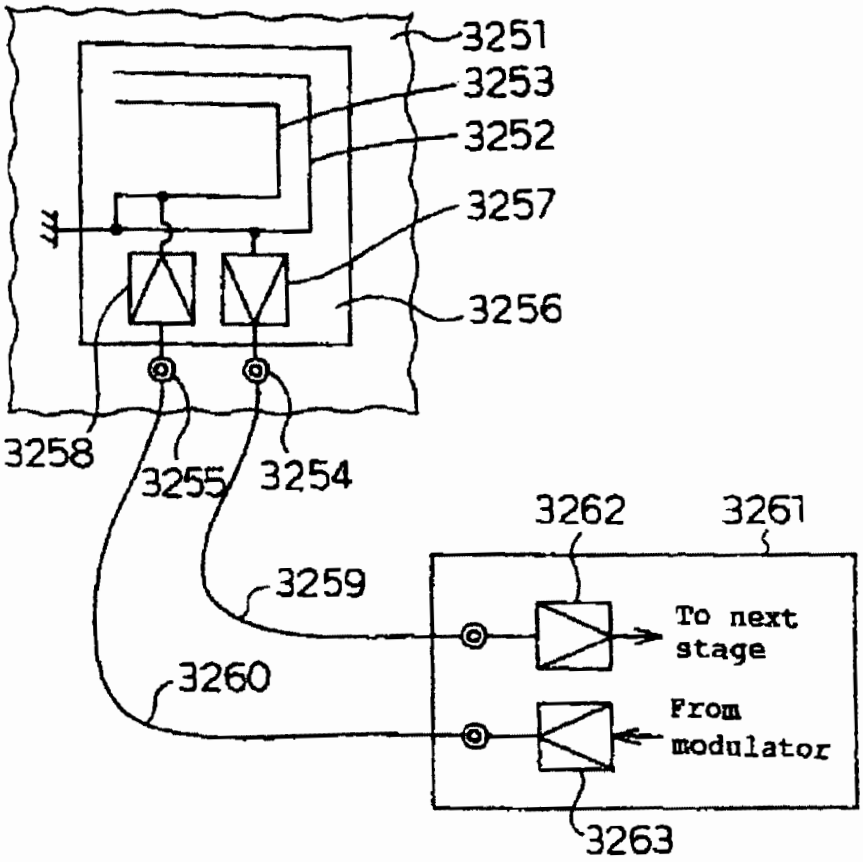

3251
3253
3252
3257
3256
3258
3255
3254
3262
3261
3259
To next stage
3260
From modulator
3263

Fig. 33

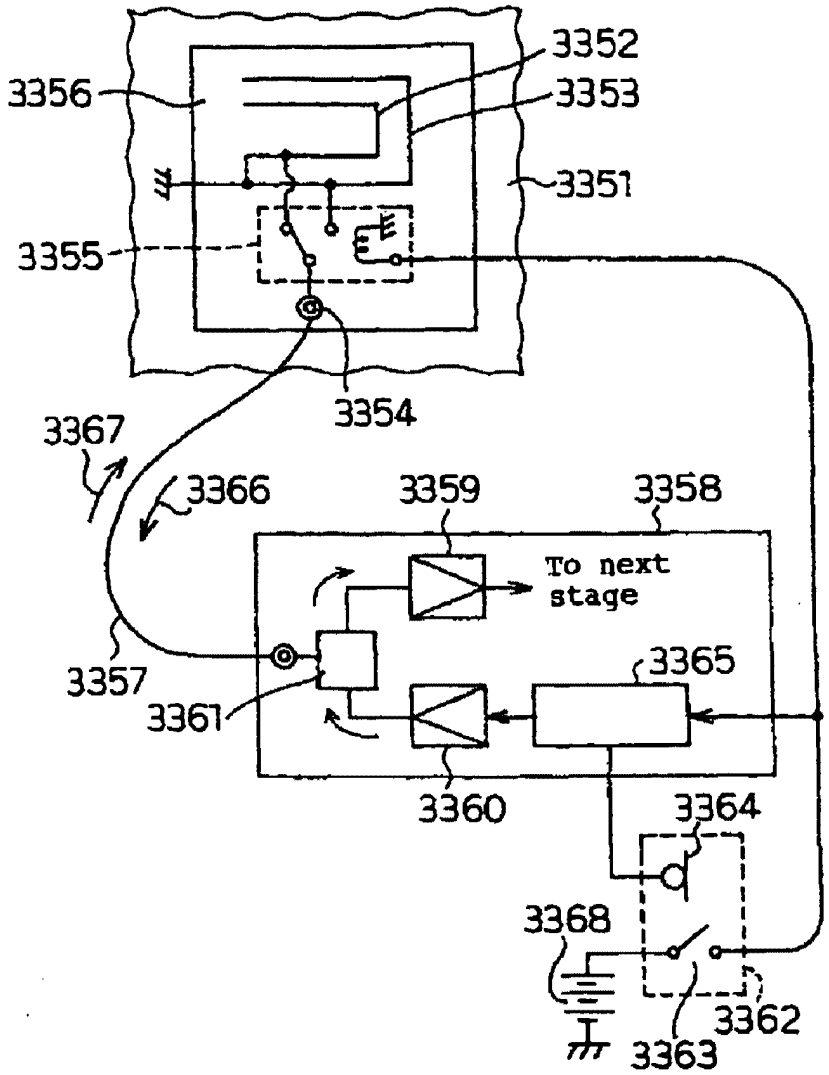

3352
3356
3353
3351
3355
3354
3367
3366
3359
3358
To next stage
3357
3365
3361
3360
3364
3368
3362
3363

Fig. 34

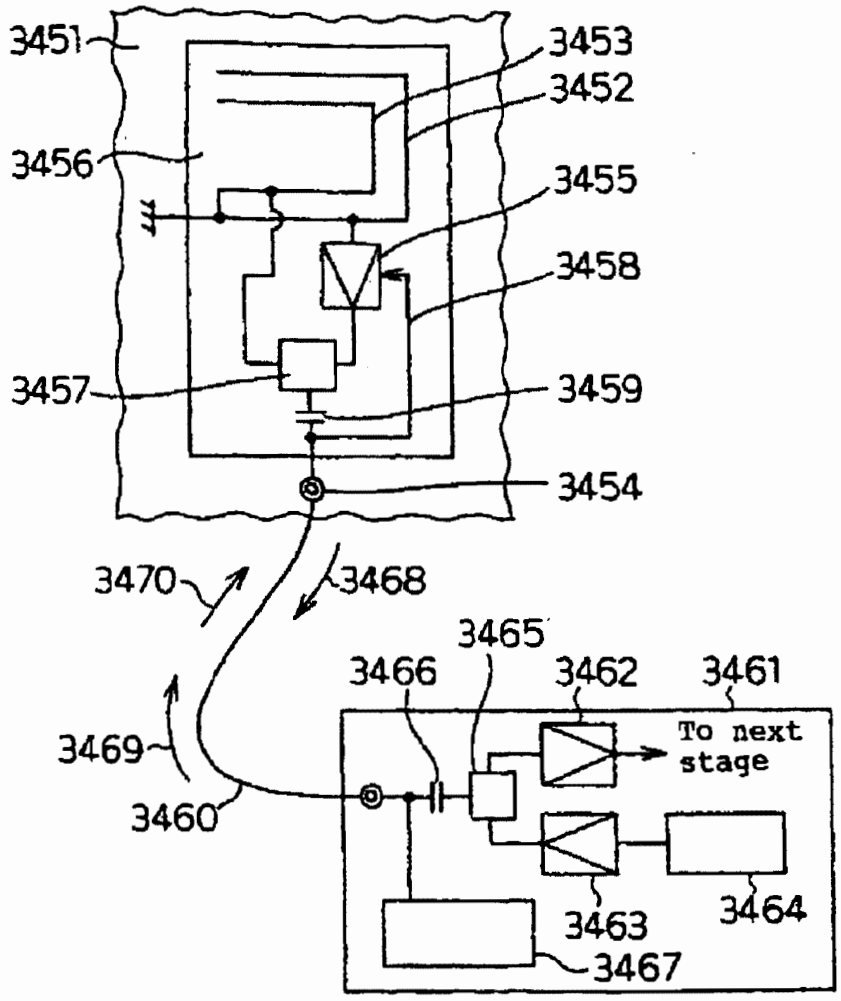

3451
3453
3452
3456
3455
3458
3457
3459
3454
3470
3468
3465
3466
3462
3461
To next stage
3469
3460
3463
3464
3467

Fig. 35

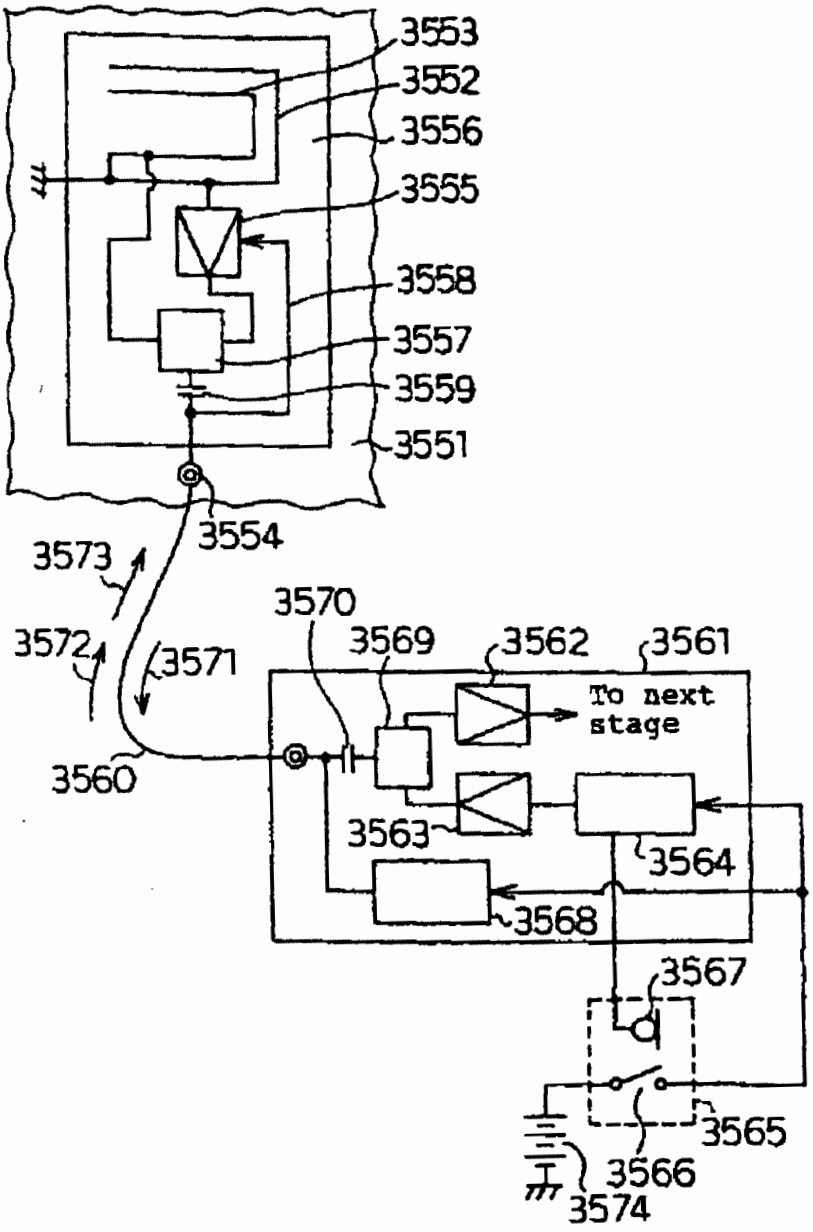

3553
3552
3556
3555
3558
3557
3559
3551
3554
3573
3572
3571
3570
3569
3562
3561
To next stage
3560
3563
3564
3568
3567
3565
3566
3574

Fig. 36 (a)

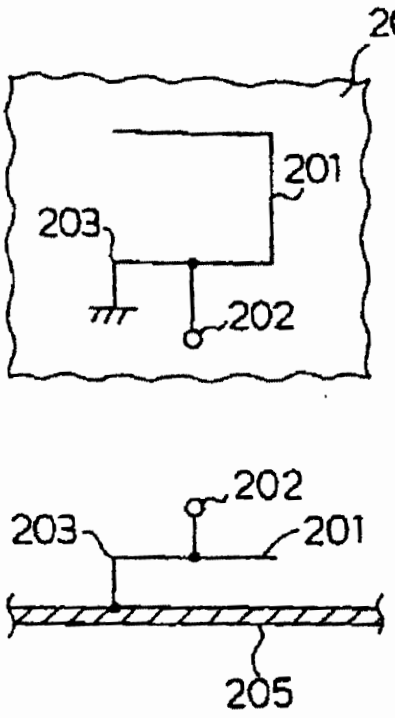


Fig. 36 (b)

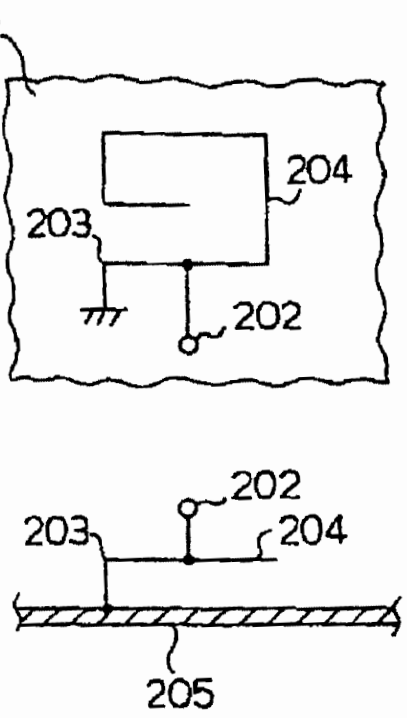


Fig. 37 (a)

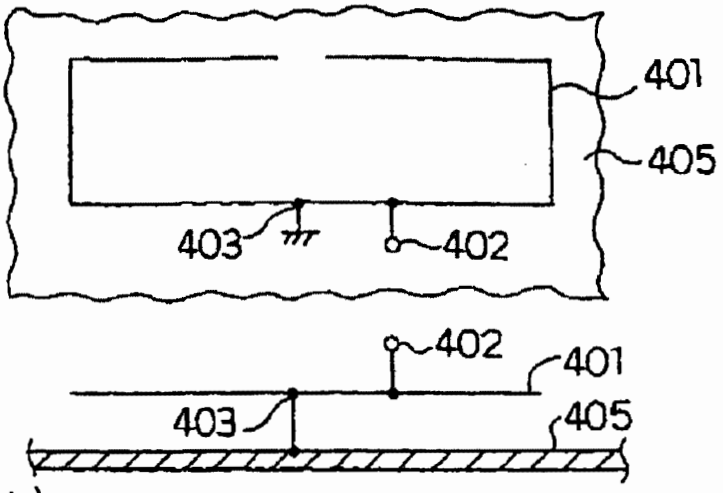


Fig. 37 (b)

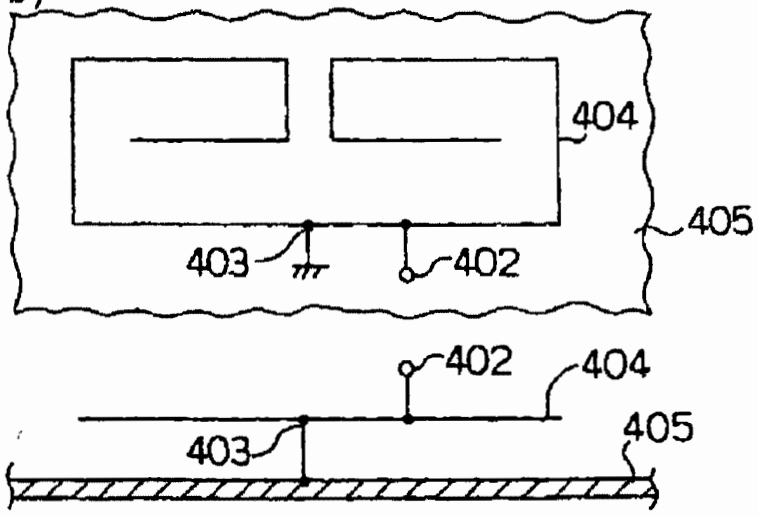


Fig. 38 (a)

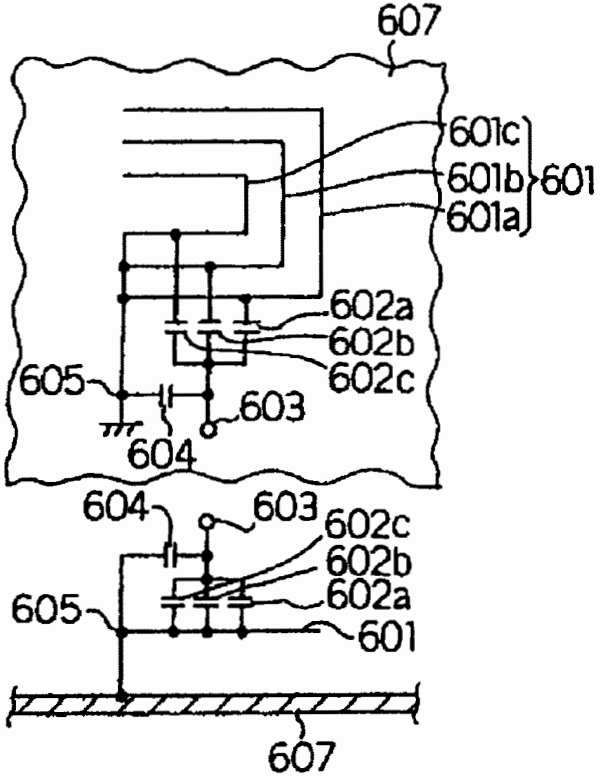


Fig. 38 (b)

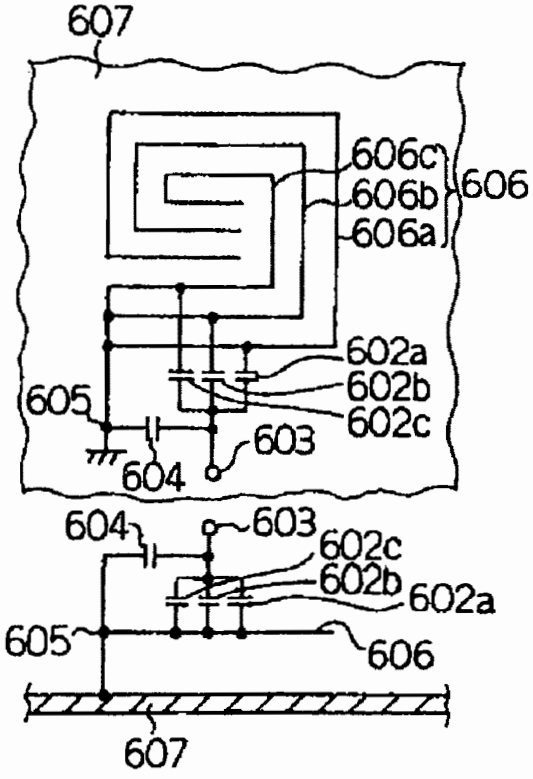


Fig. 39 (a)

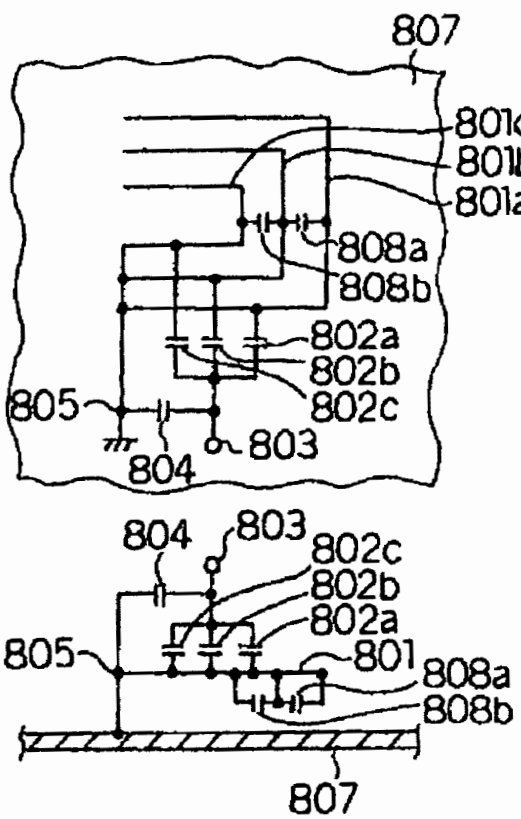
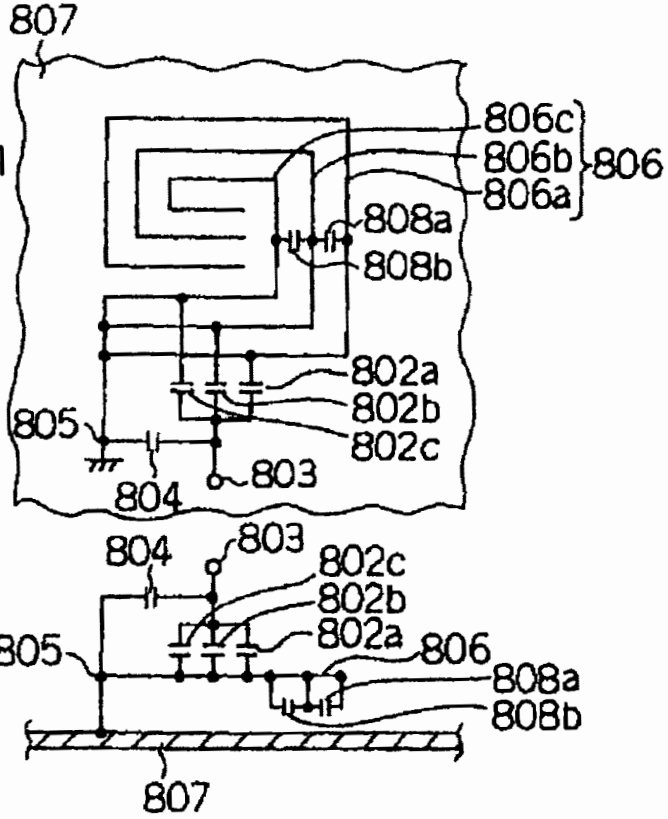


Fig. 39 (b)



EP 1 011 167 A1

Fig. 40 (a)

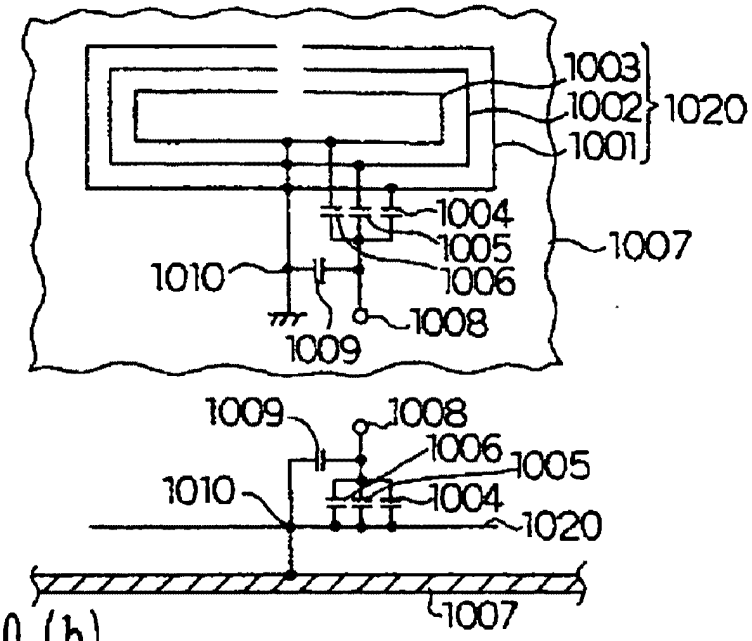


Fig. 40 (b)

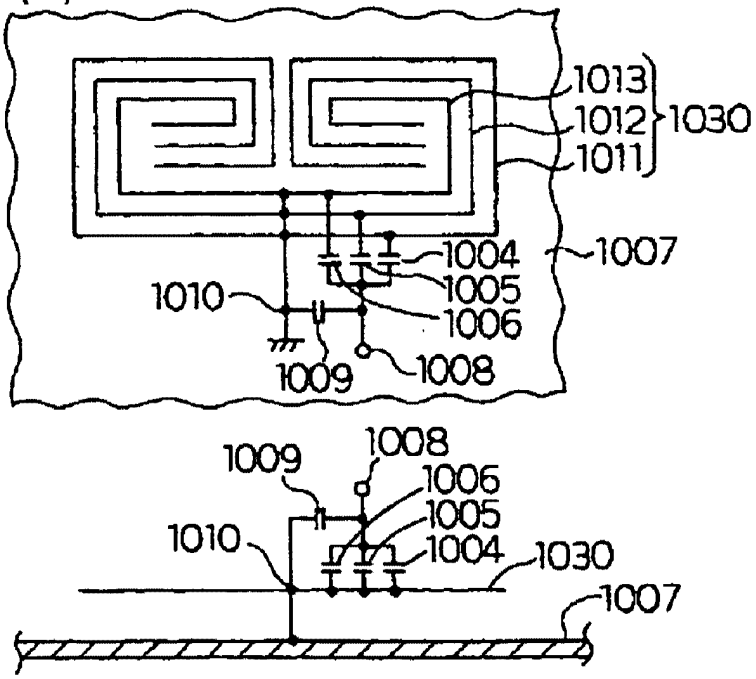


Fig. 41 (a)

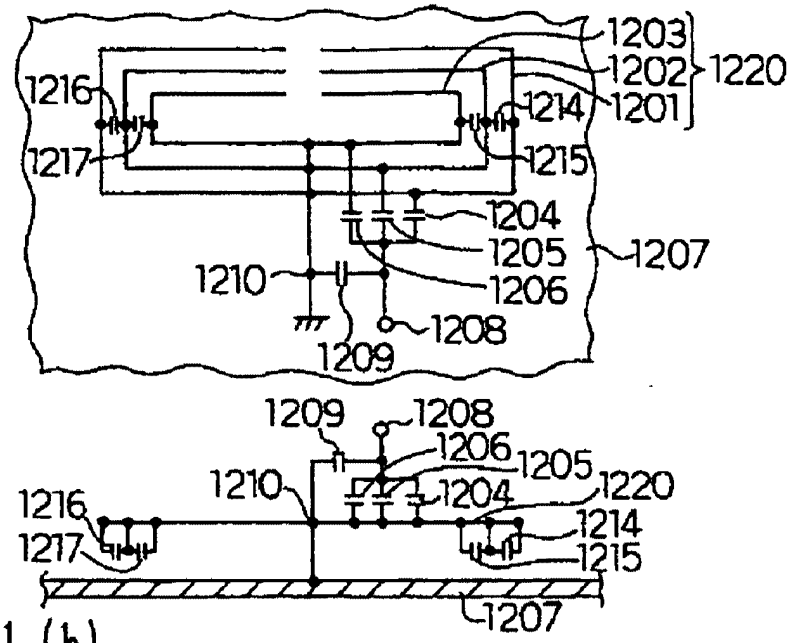


Fig. 41 (b)

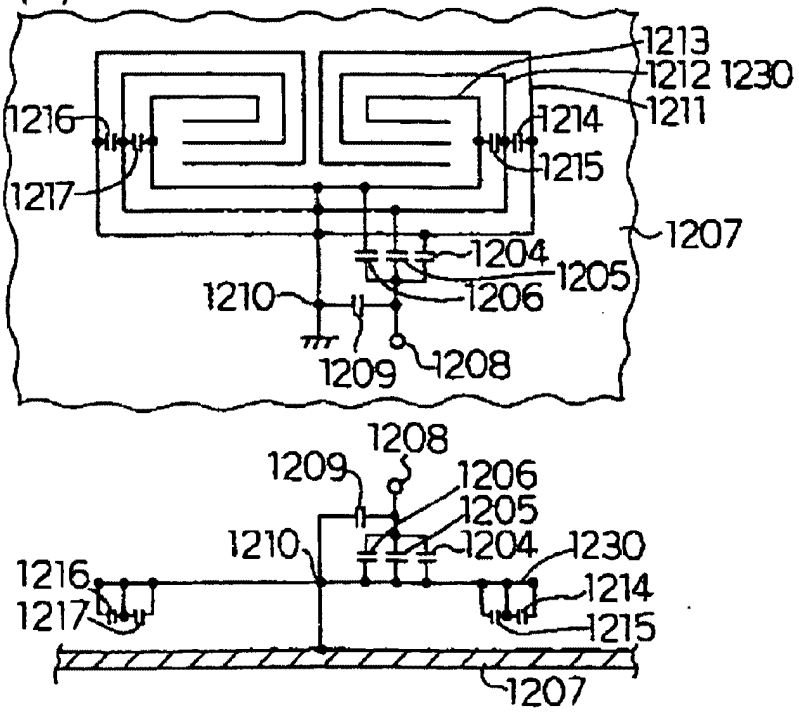


Fig. 42 (a)

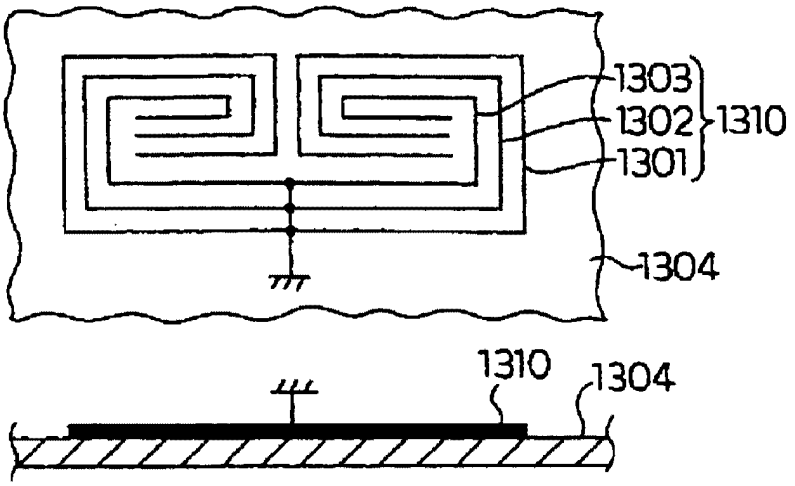


Fig. 42 (b)

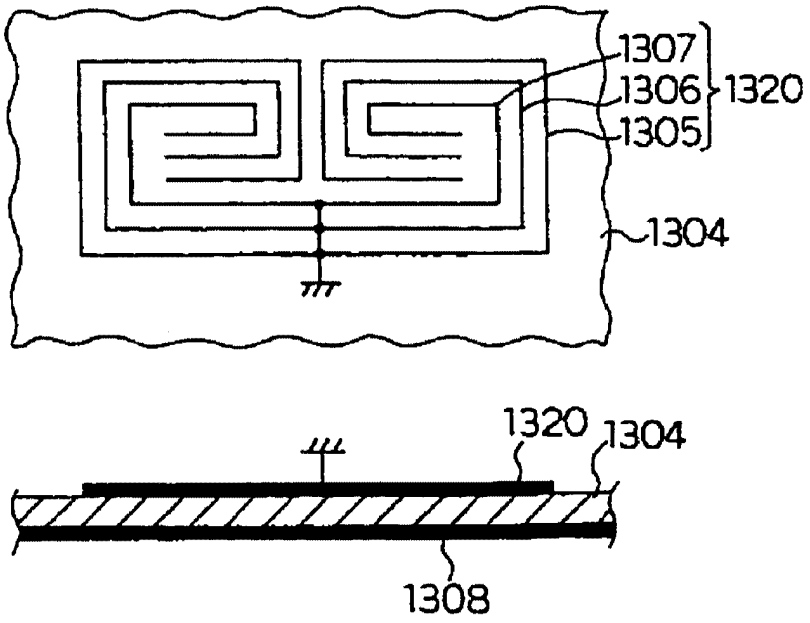


Fig. 43 (a)

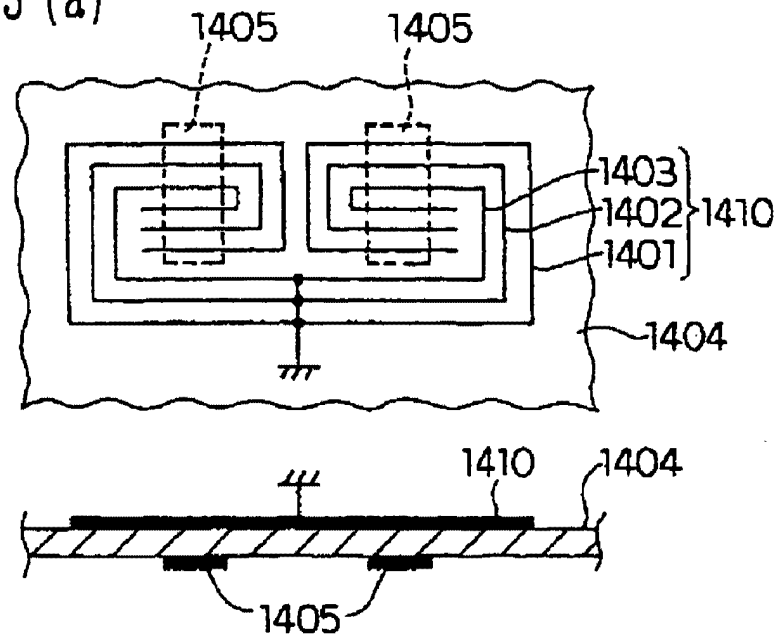


Fig. 43 (b)

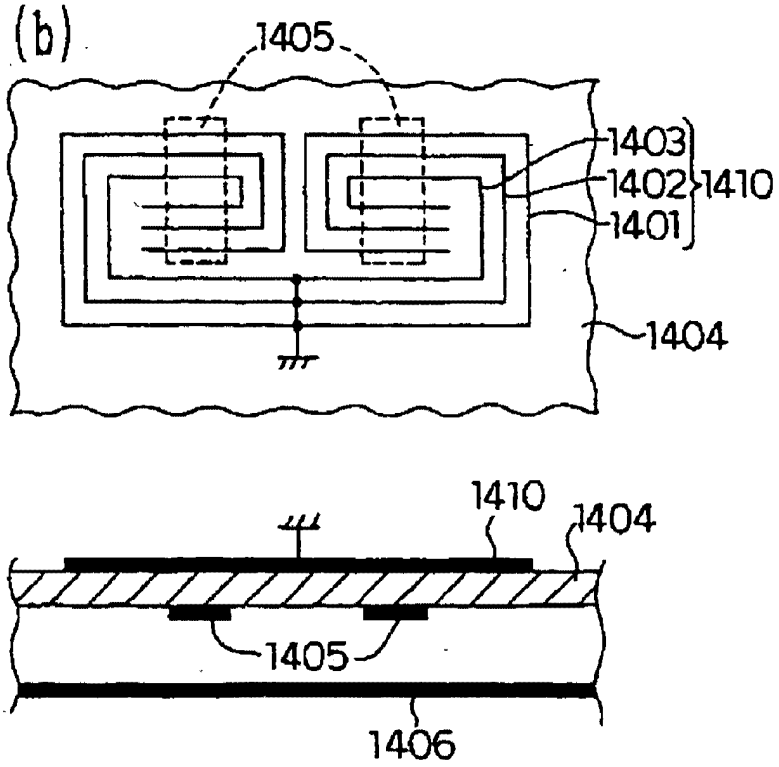


Fig. 44

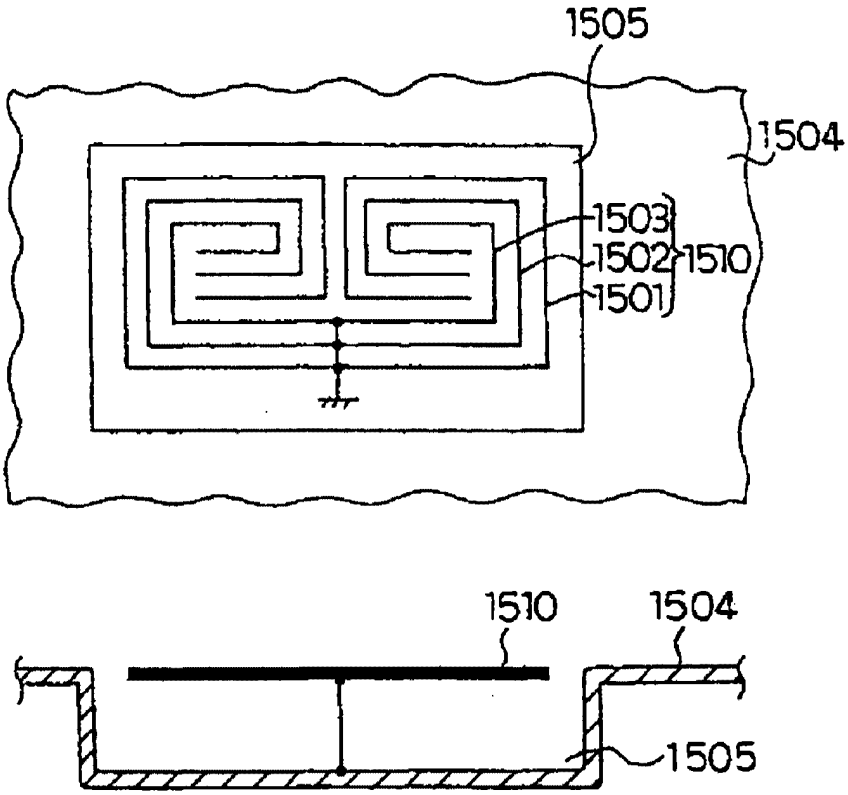


Fig. 45 (a)

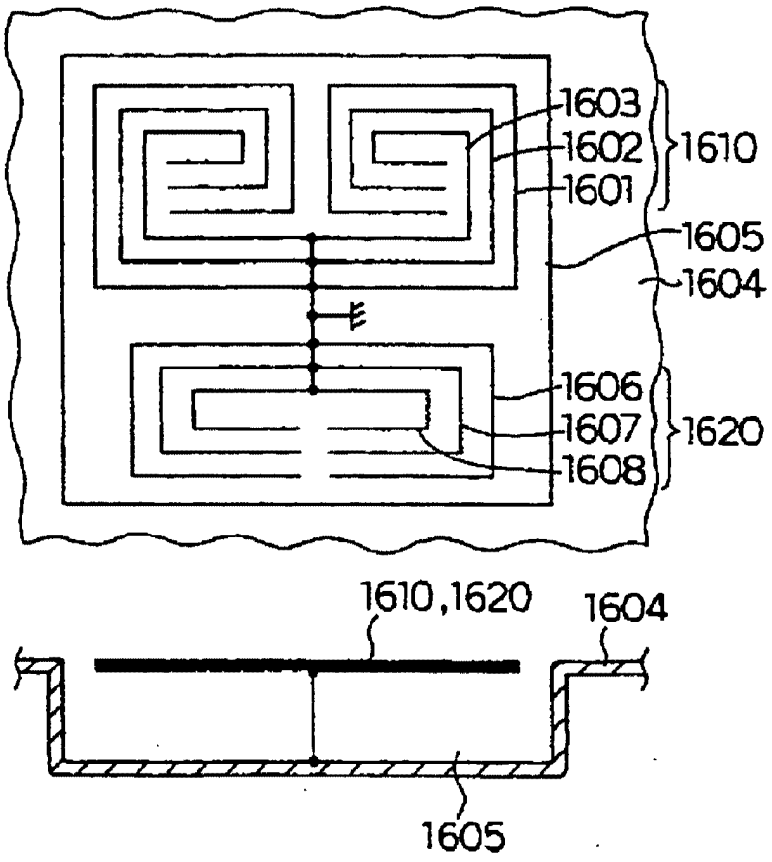


Fig. 45 (b)

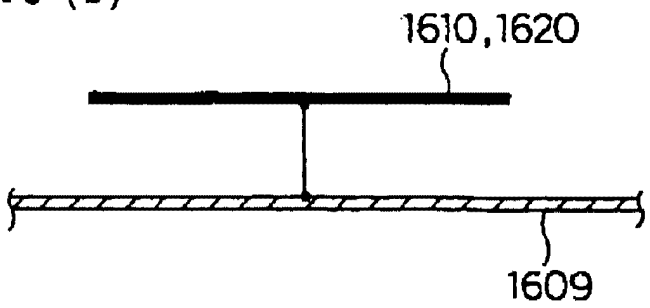


Fig. 46 (a)

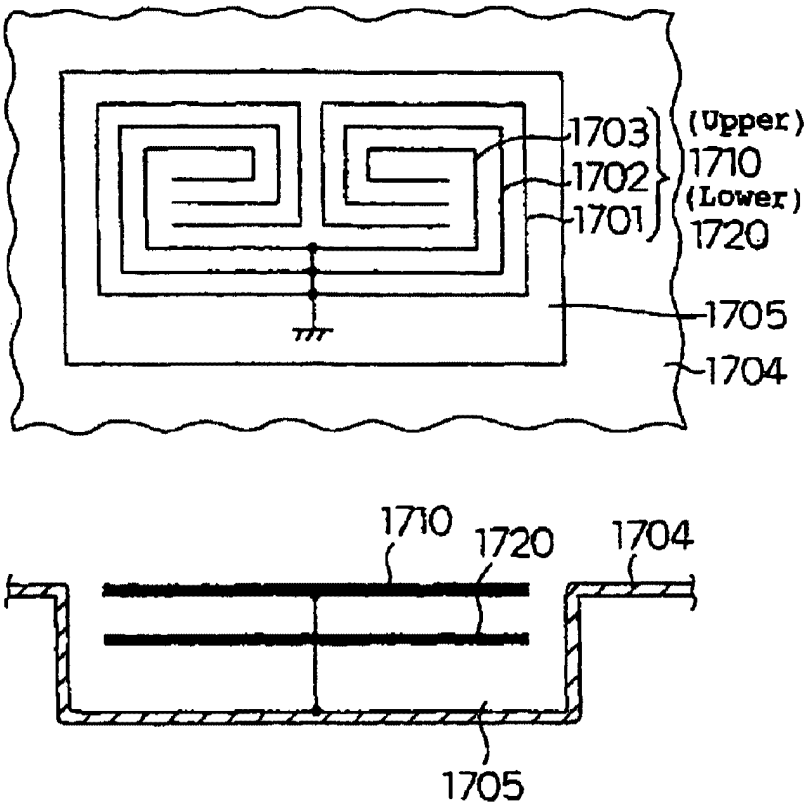


Fig. 46 (b)

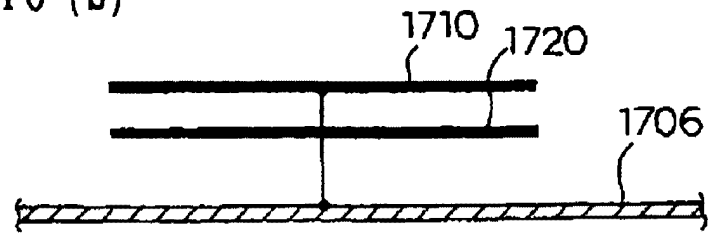


Fig. 47 (a)

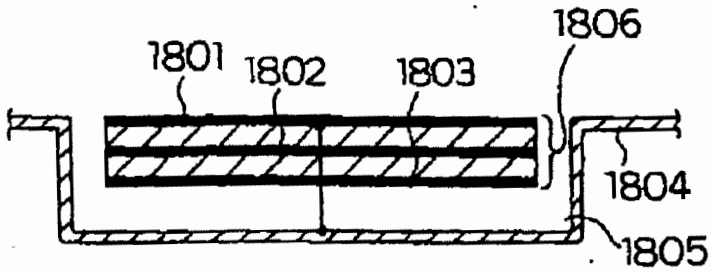


Fig. 47 (b)

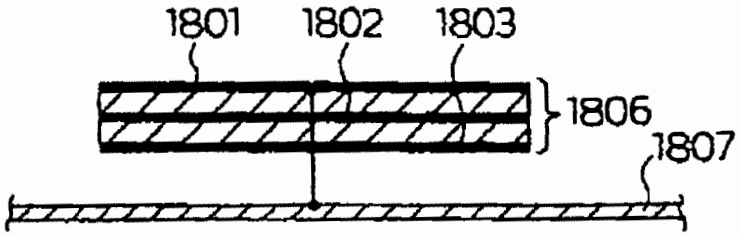


Fig. 48 (a)

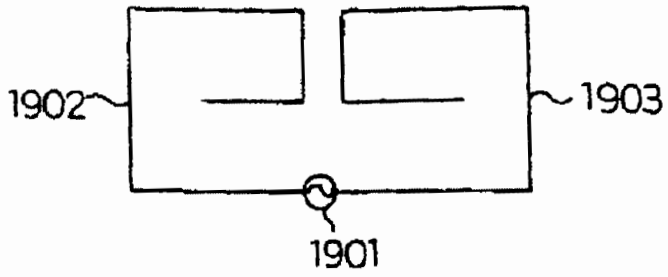


Fig. 48 (b)

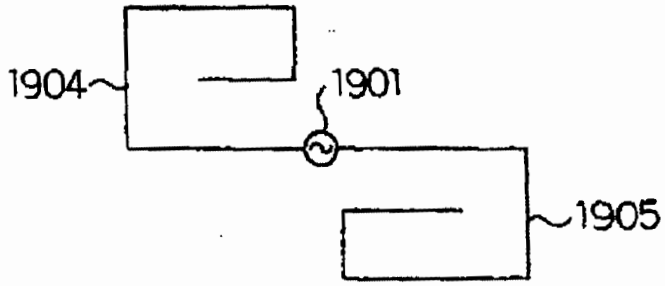


Fig. 49 (a)

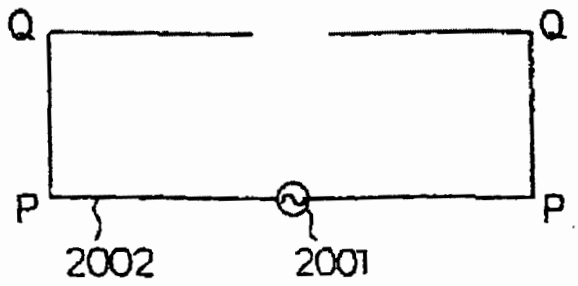


Fig. 49 (b)

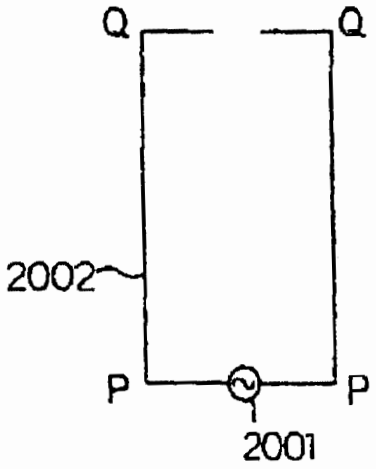


Fig. 50 (a)

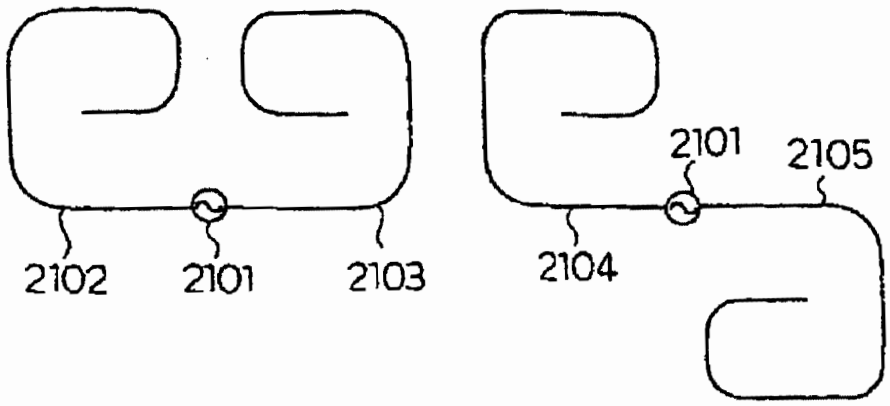


Fig. 50 (b)

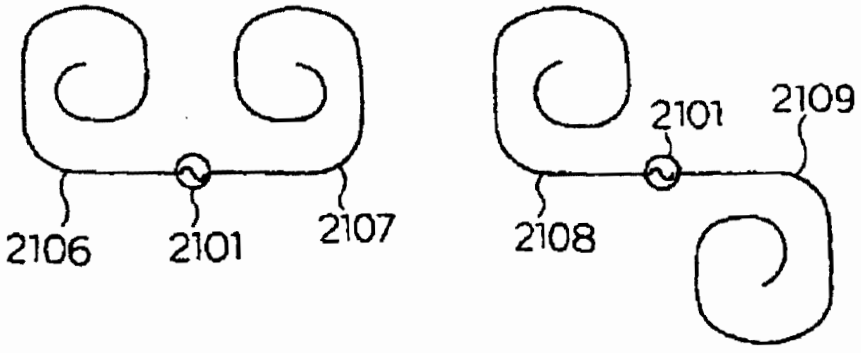


Fig. 51 (a)

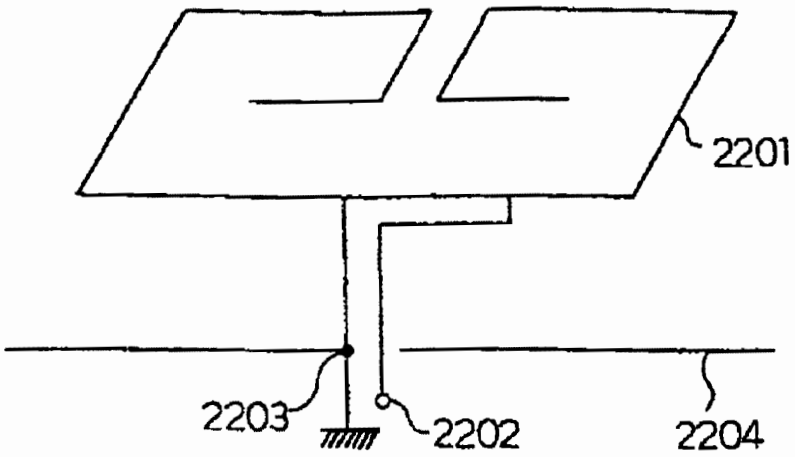


Fig. 51 (b)

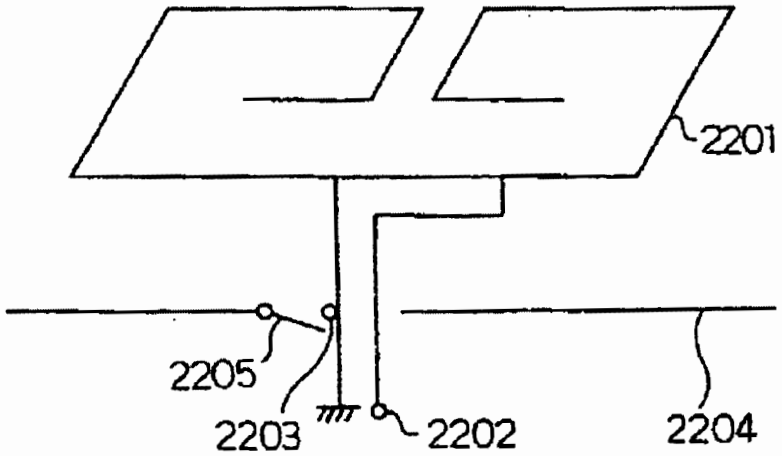


Fig. 52

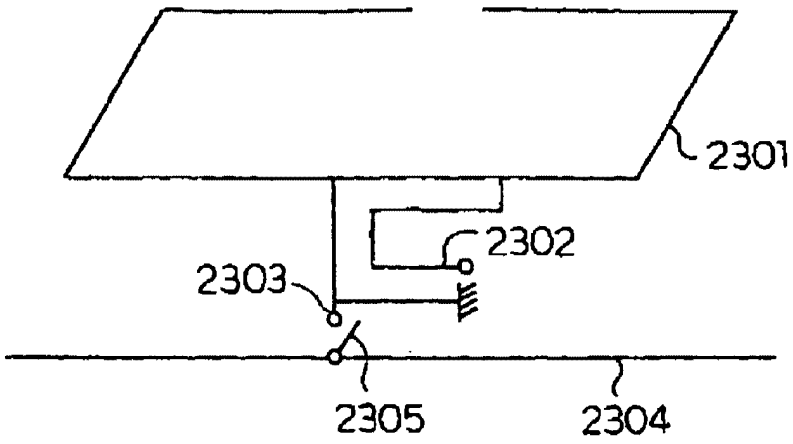


Fig. 53 (a)

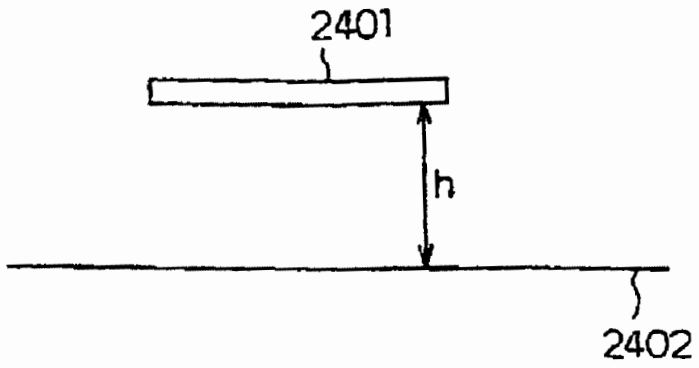


Fig. 53 (b)

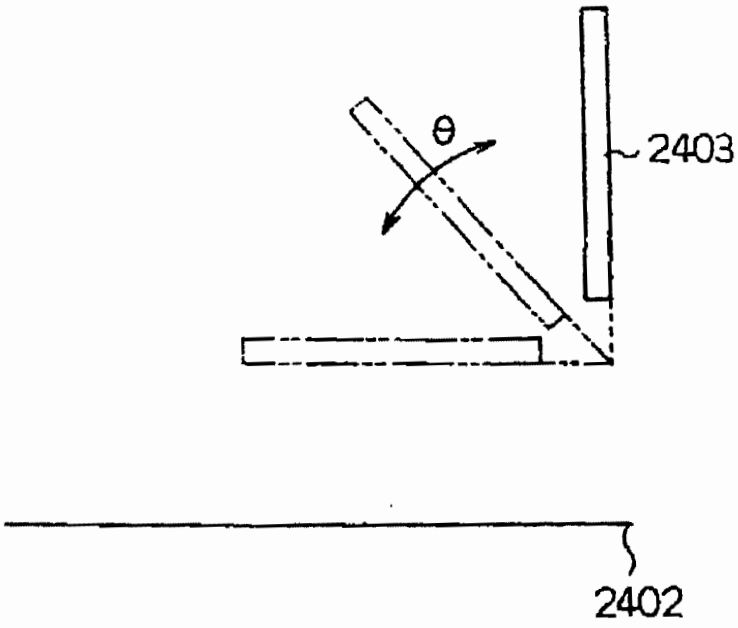


Fig. 54 (a)

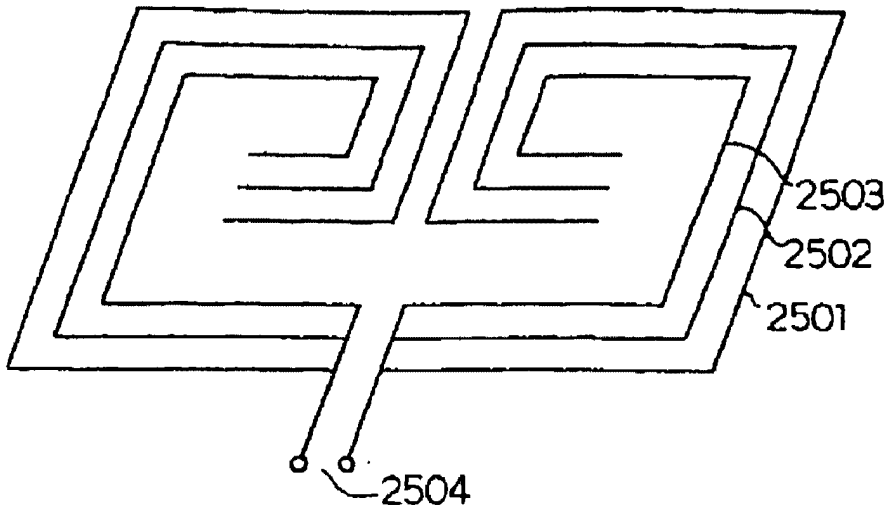


Fig. 54 (b)

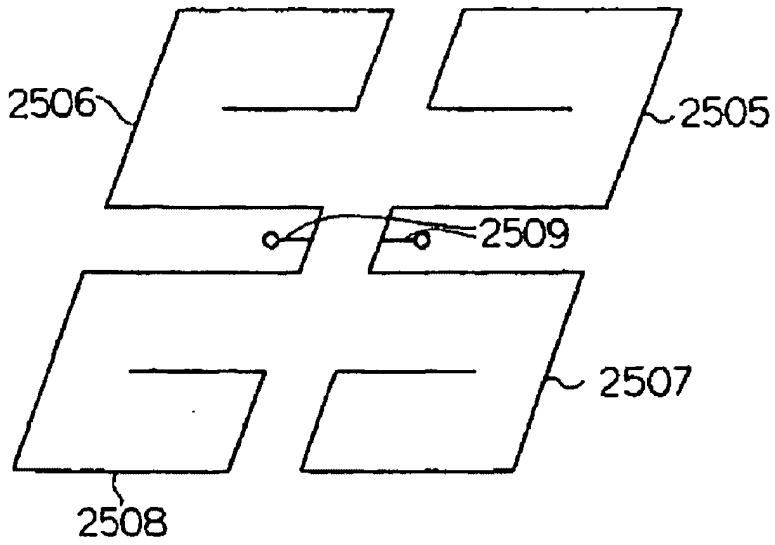


Fig. 55 (a)

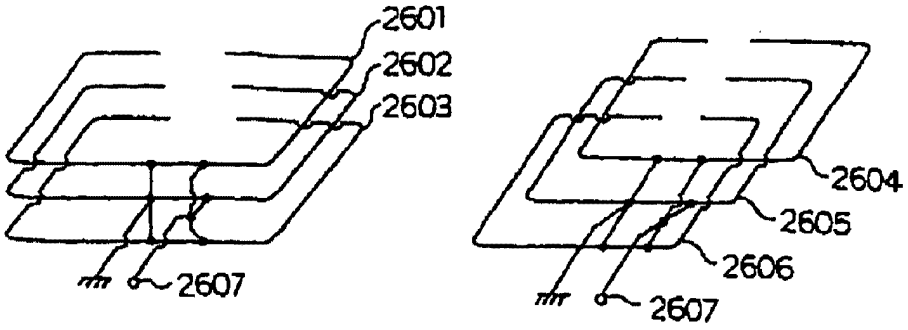


Fig. 55 (b)

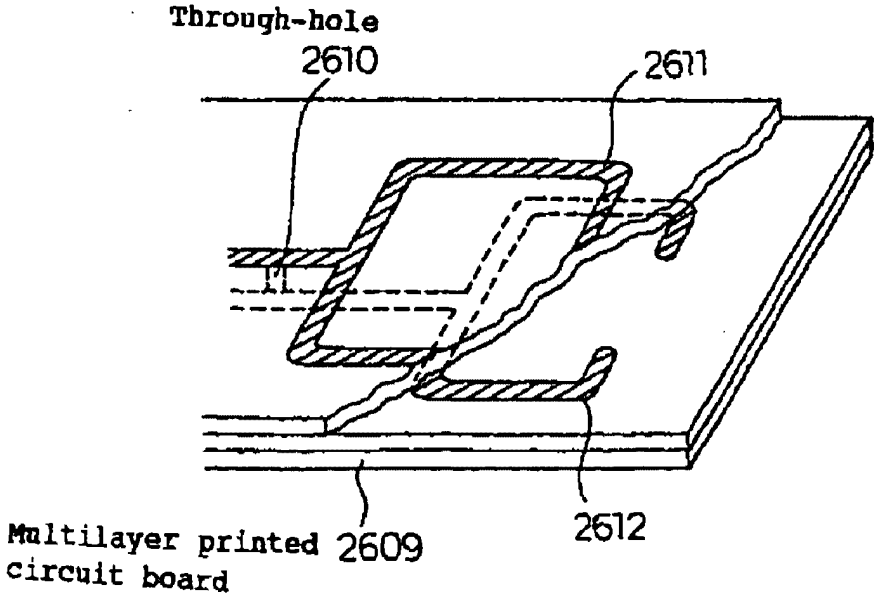


Fig. 56 (a)

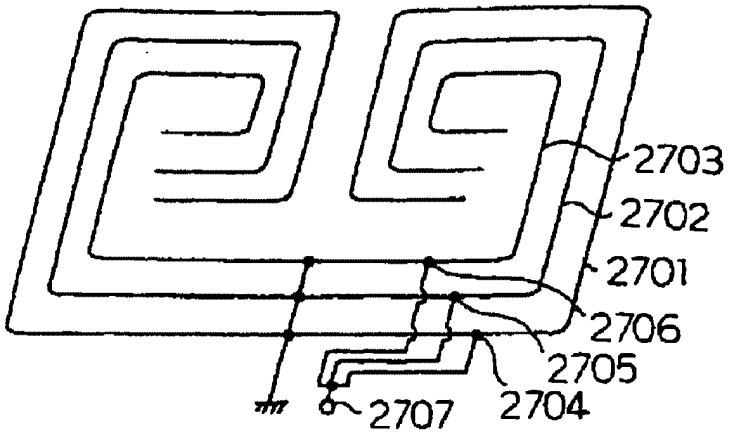


Fig. 56 (b)

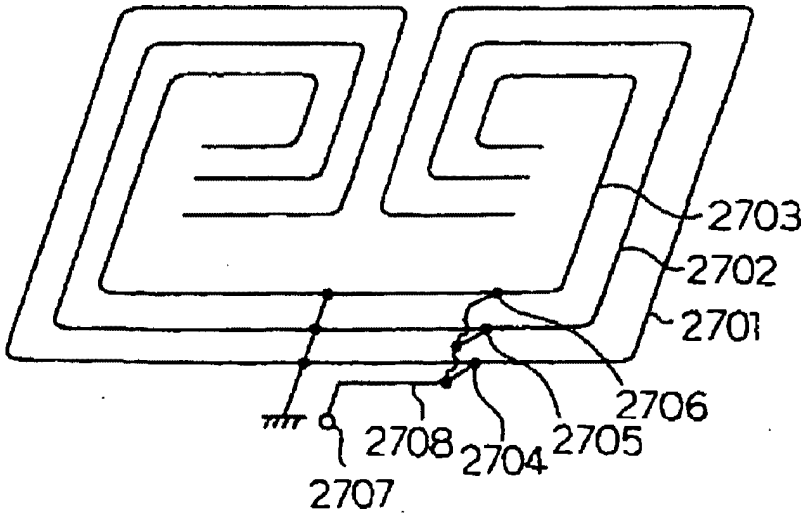


Fig. 57 (a)

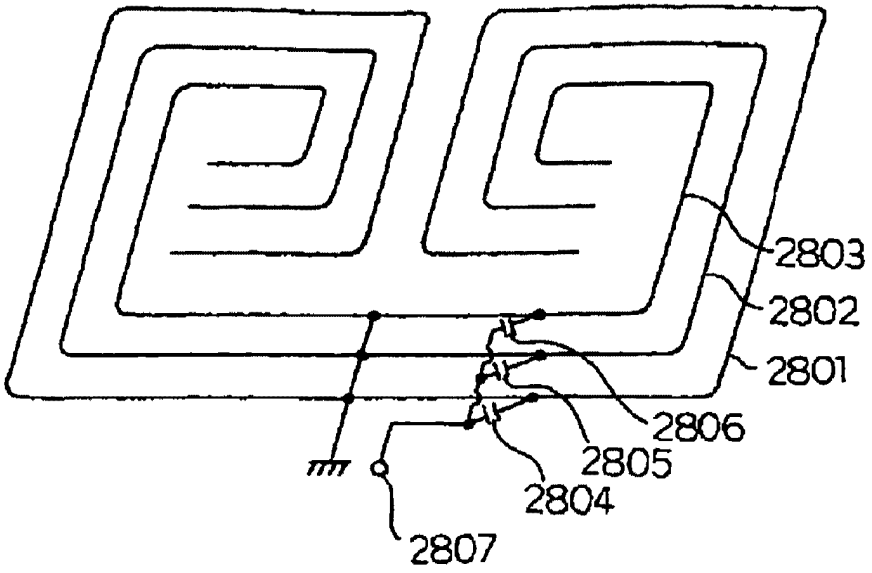
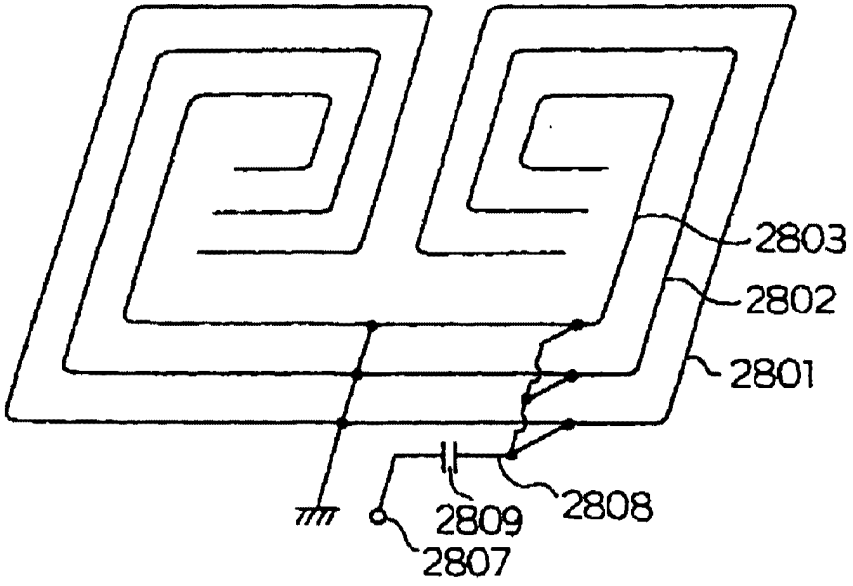


Fig. 57 (b)



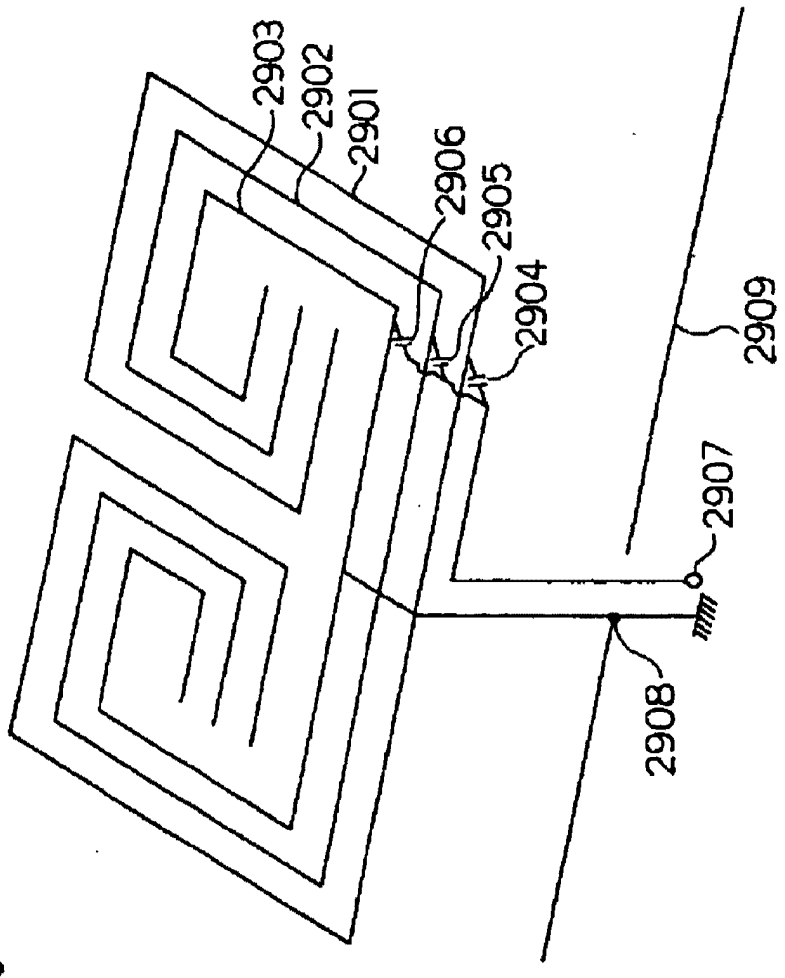


Fig. 58

Fig. 59 (a)

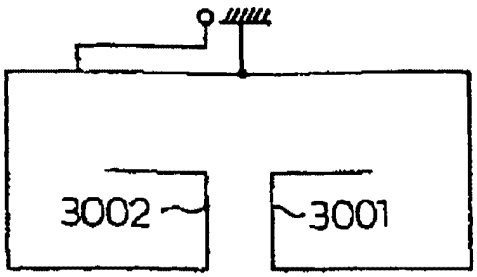


Fig. 59 (b)

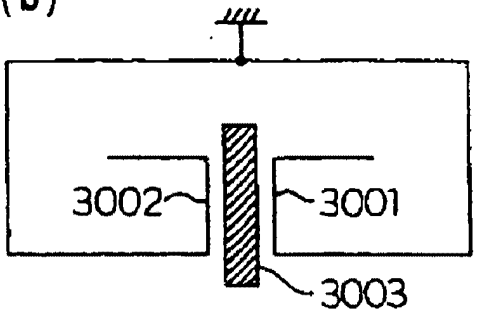


Fig. 59 (c)

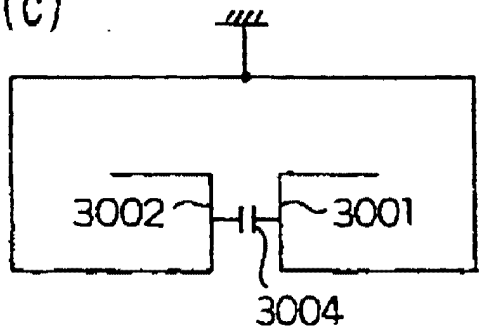


Fig. 60 (a)

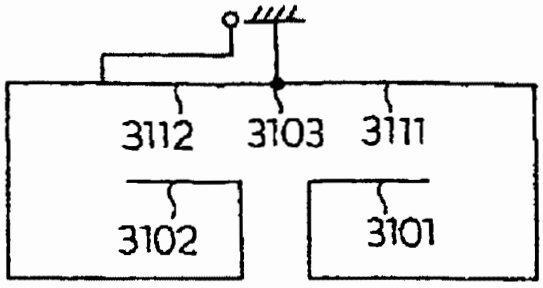


Fig. 60 (b)

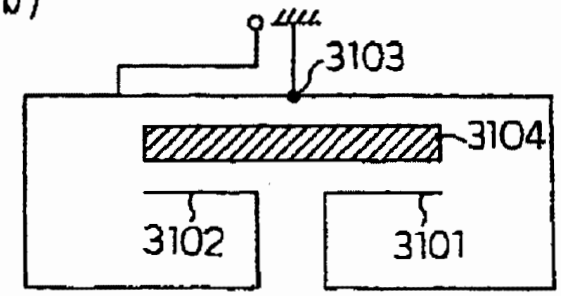


Fig. 60 (c)

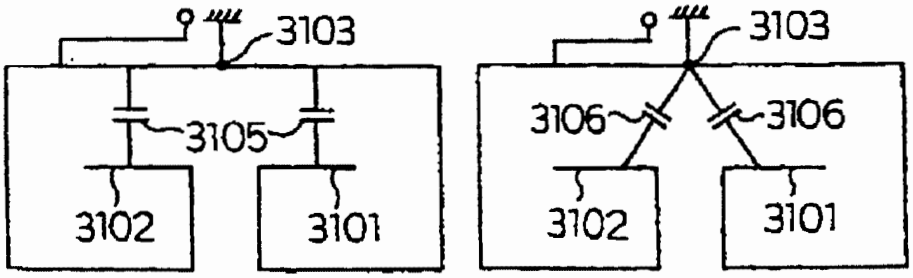


Fig. 61 (a)

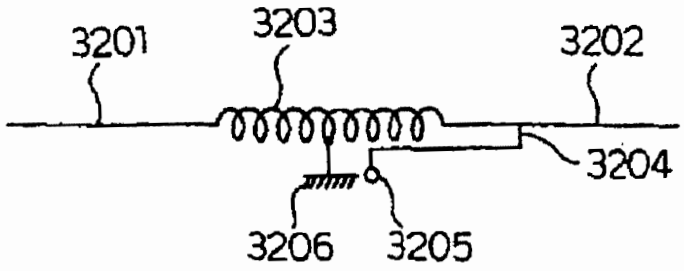


Fig. 61 (b)

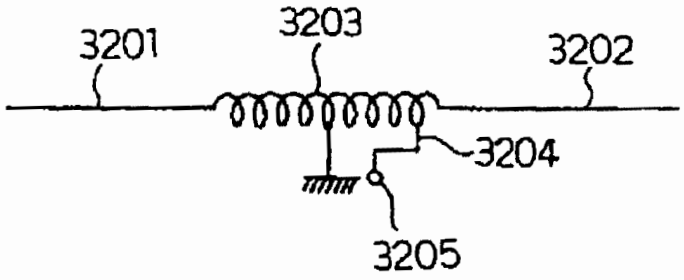


Fig. 62 (a)

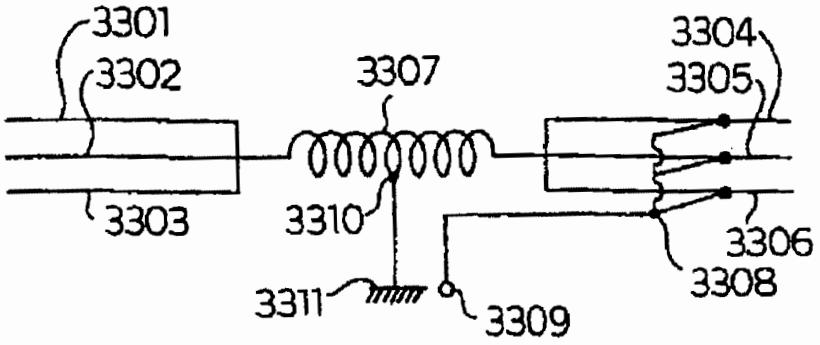


Fig. 62 (b)

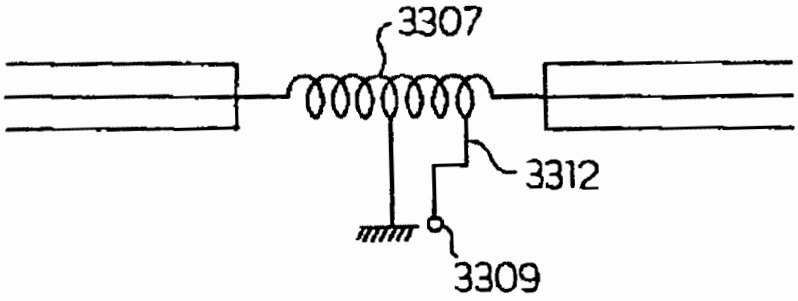


Fig. 63

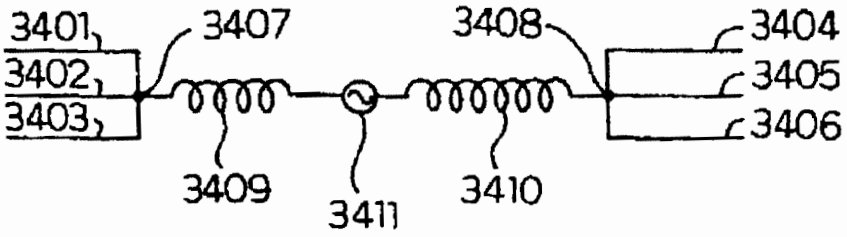


Fig. 64

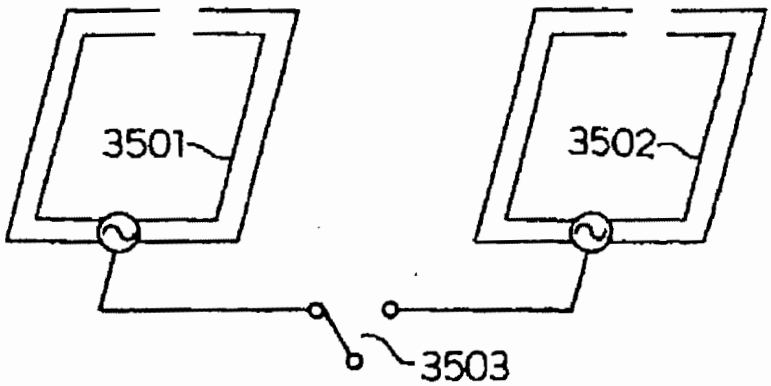


Fig. 65 (b)

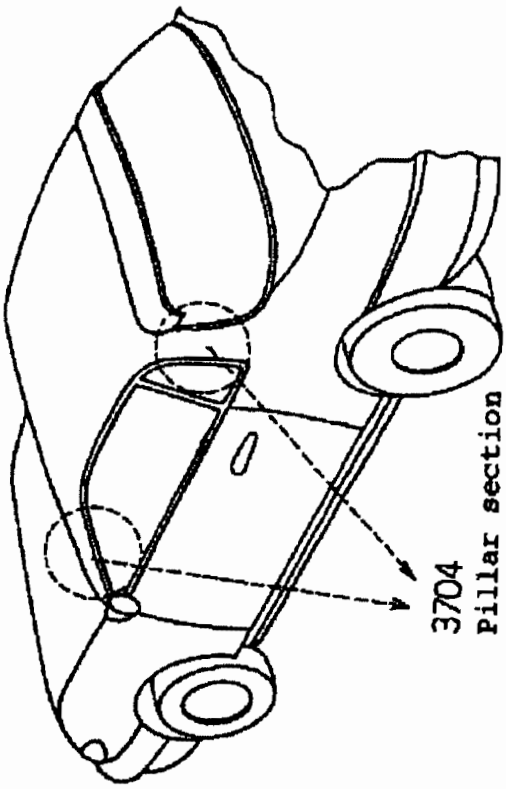


Fig. 65 (a)

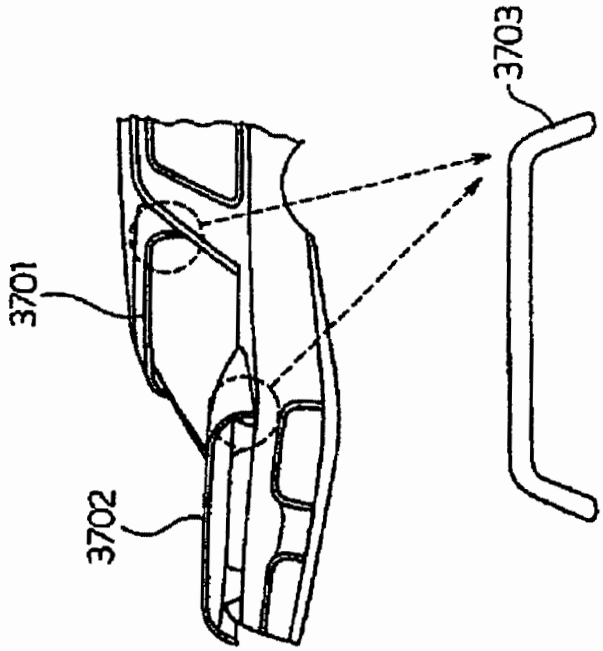


Fig. 66

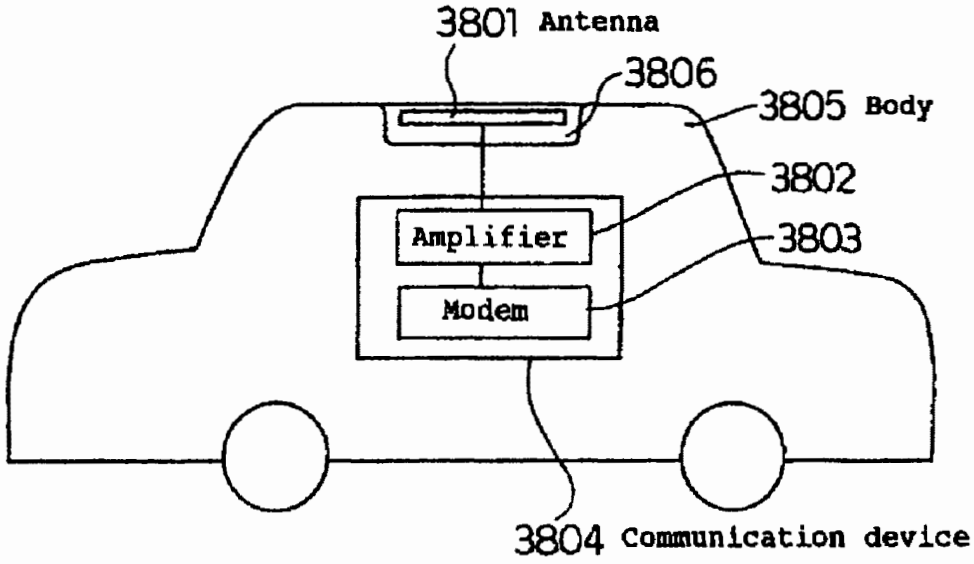

3801 Antenna
3806
3805 Body
3802
Amplifier
3803
Modem
3804 Communication device

Fig. 67 (a)

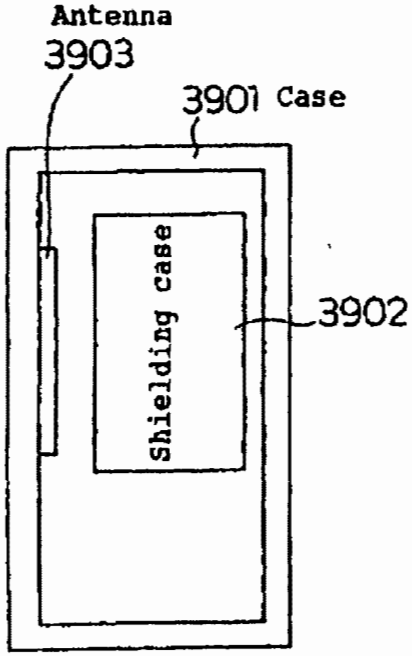


Fig. 67 (b)

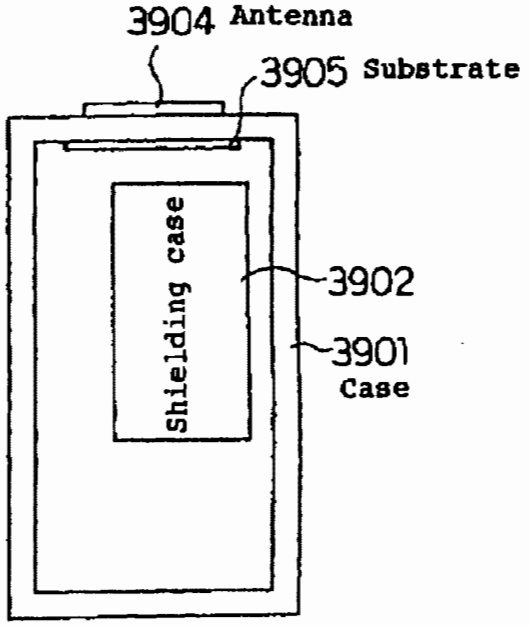


Fig. 68

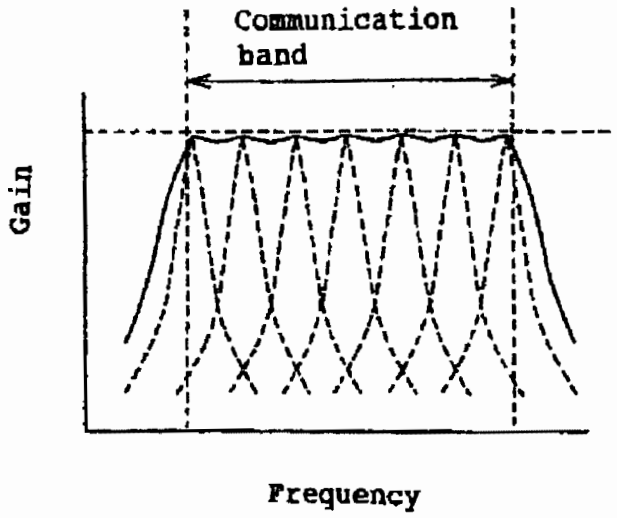


Fig. 69

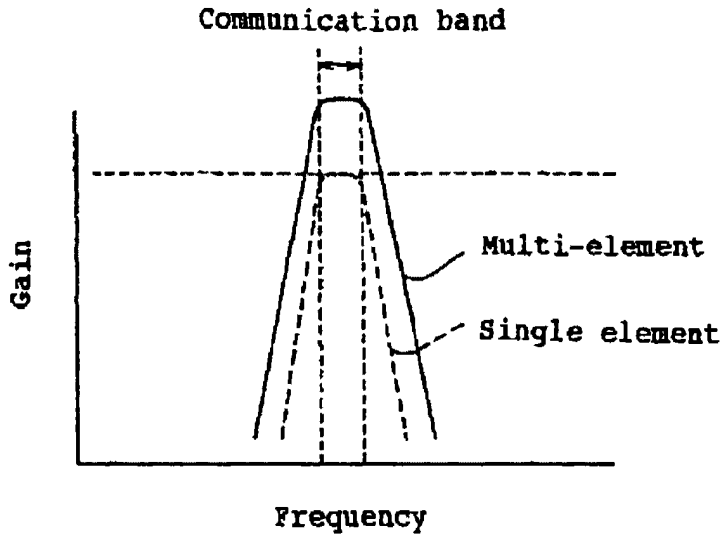

Communication band
Gain
Multi-element
Single element
Frequency

Fig. 70 (a)

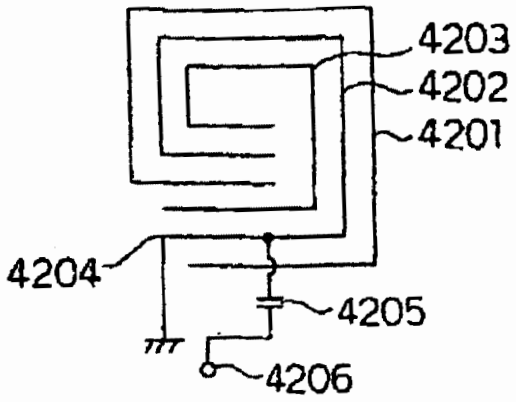


Fig. 70 (b)

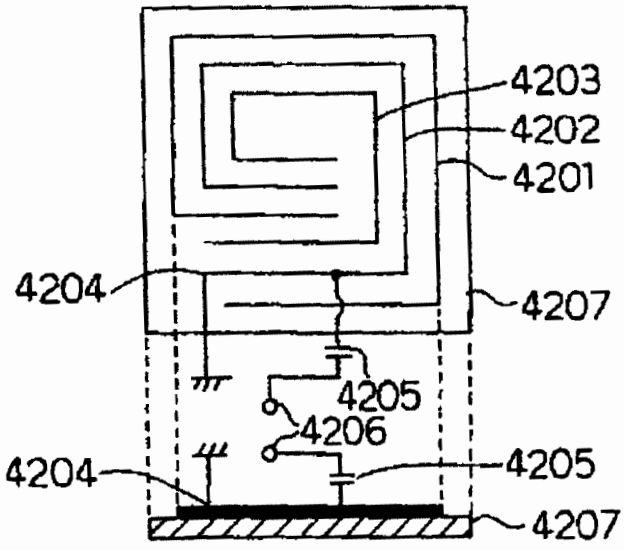


Fig. 71 (a)

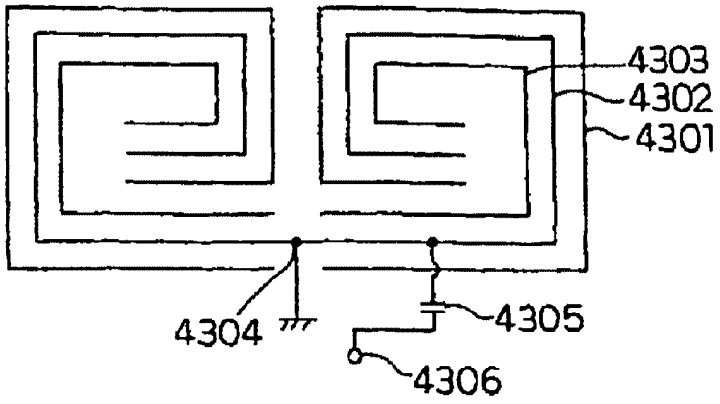


Fig. 71 (b)

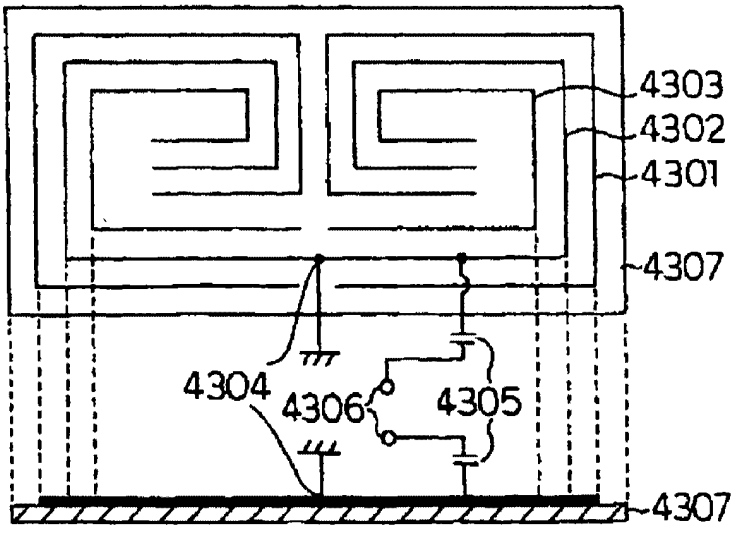


Fig. 72 (a)

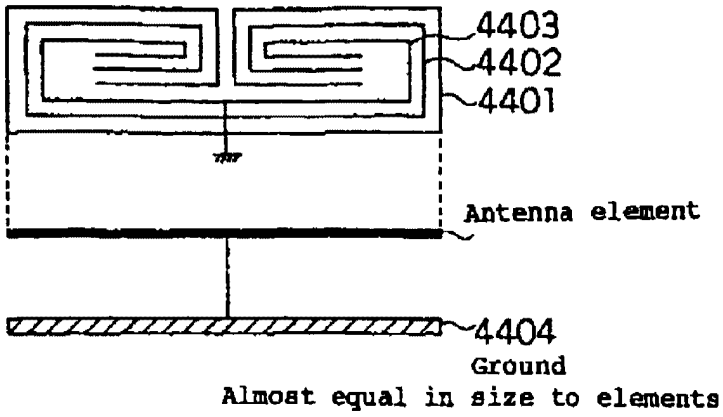


Fig. 72 (b)

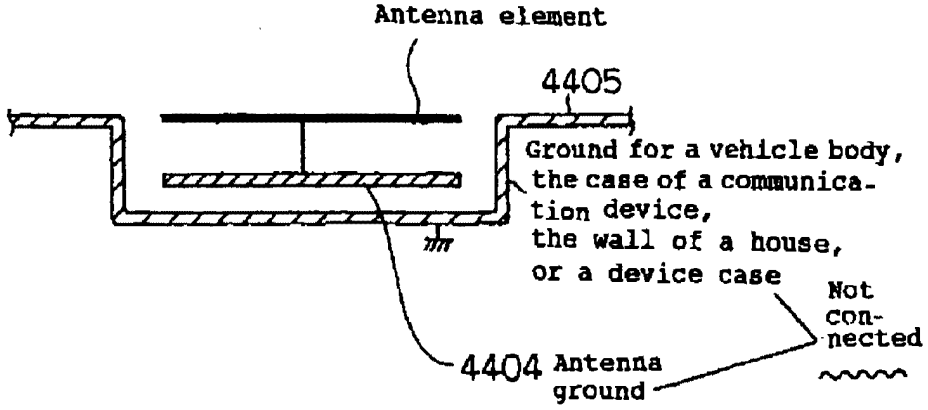


Fig. 73 (a)

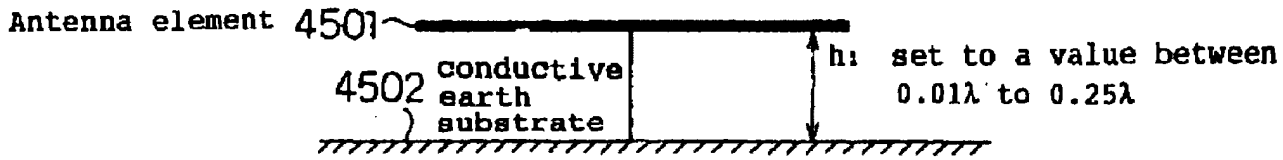


Fig. 73 (b)

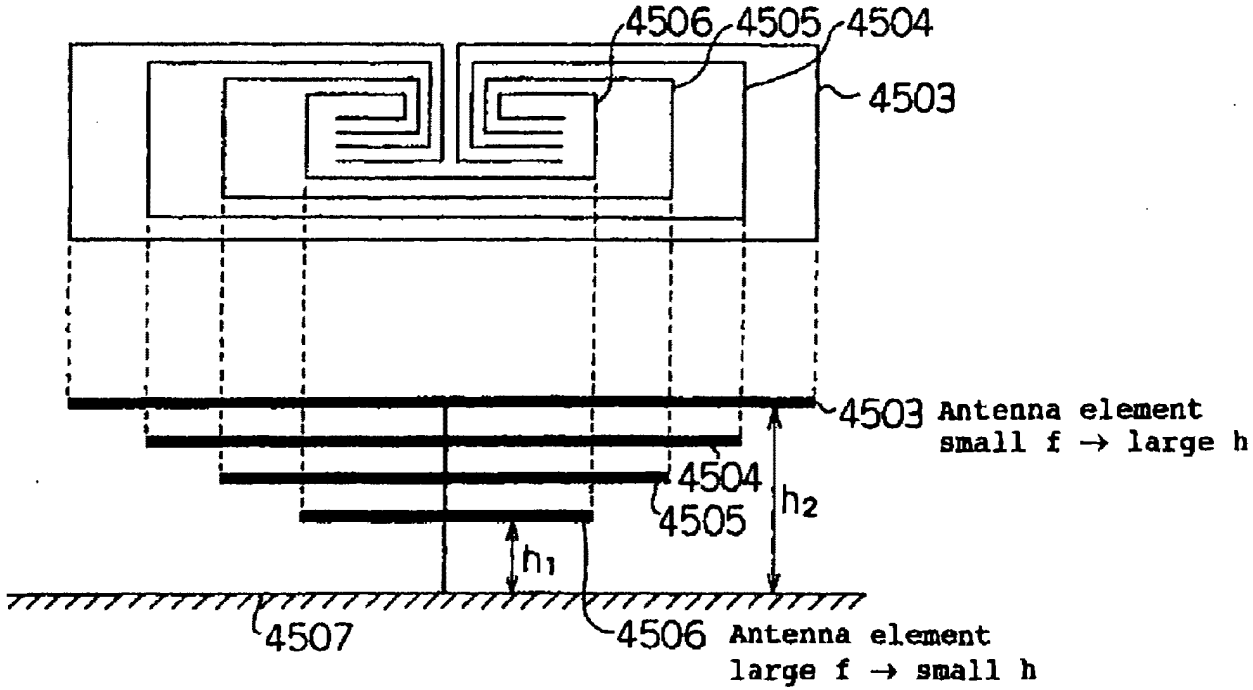


Fig. 74

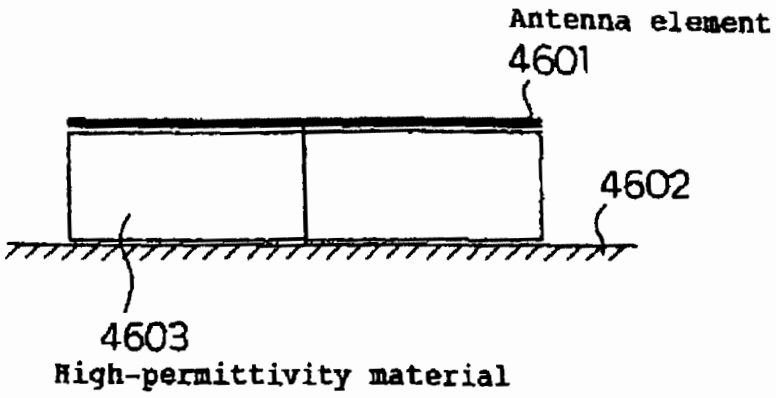

Antenna element
4601
4602
4603
High-permittivity material

Fig. 75

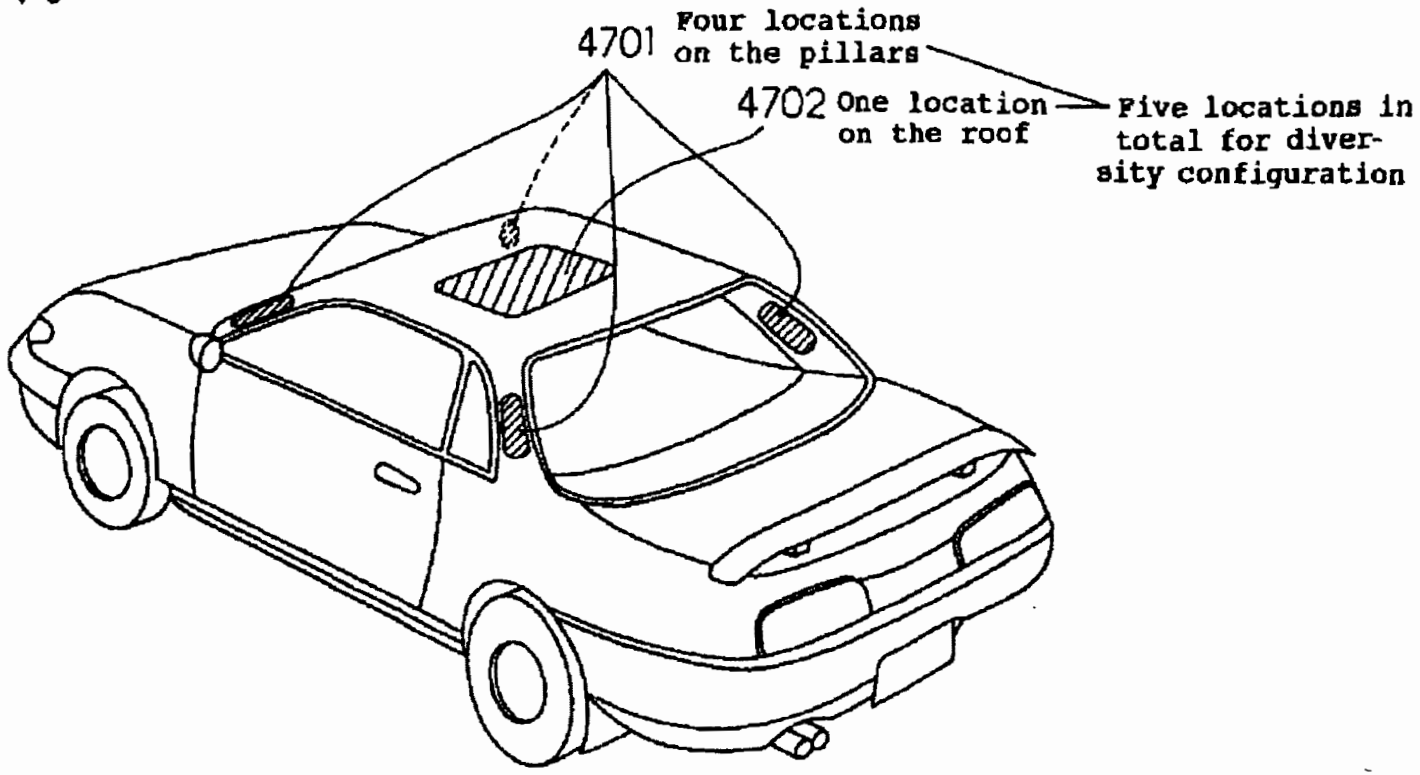

4701
Four locations on the pillars
4702
One location on the roof
Five locations in total for diversity configuration

Fig. 76

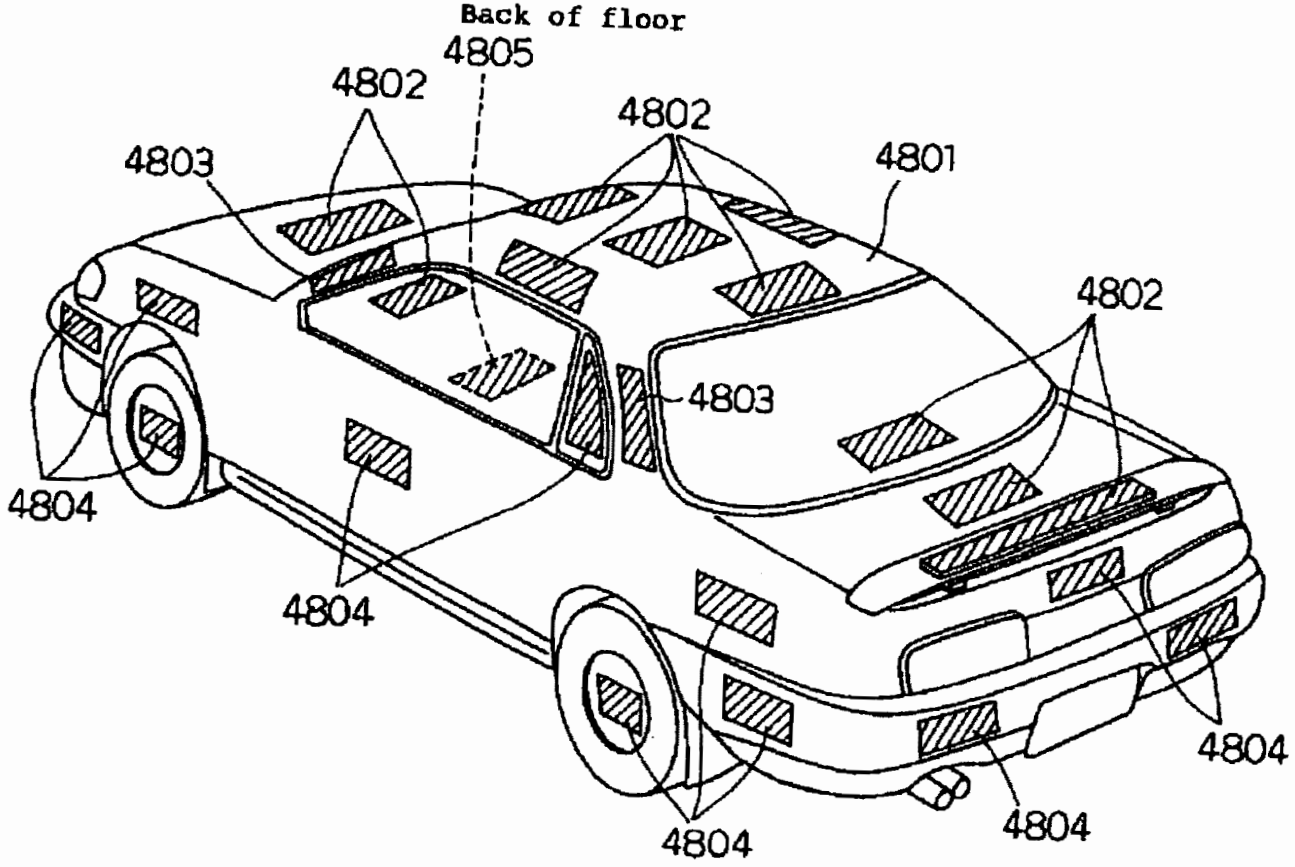

Back of floor
4805
4802
4802
4803
4801
4802
4803
4804
4804
4804
4804
4804

Fig. 77 (a)

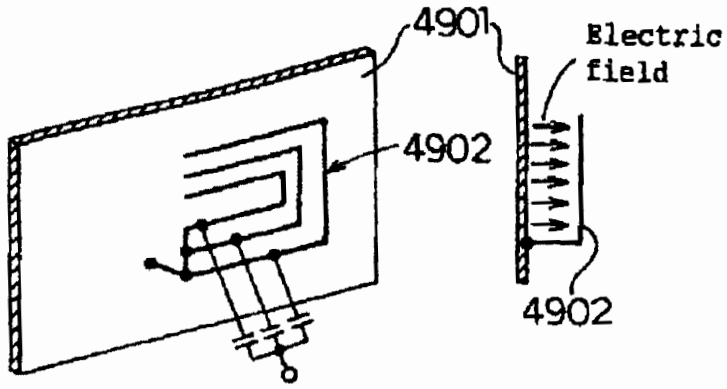


Fig. 77 (b)

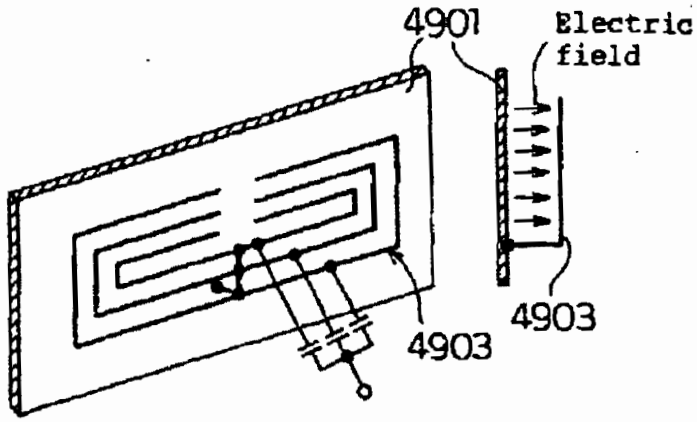


Fig. 78 (a)

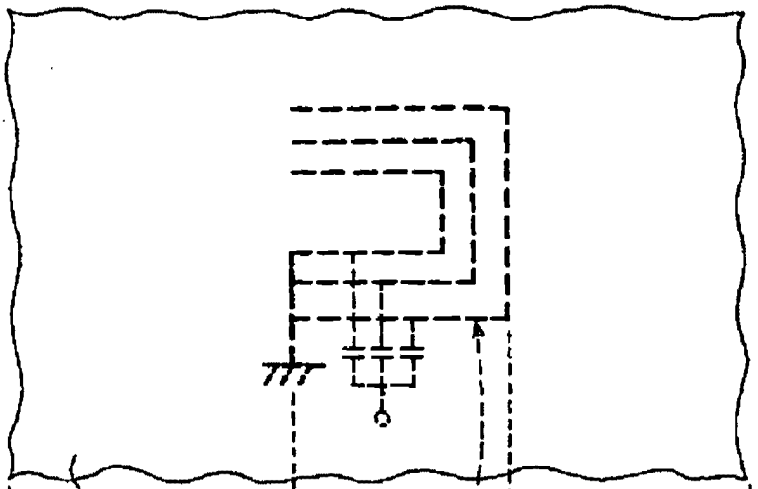


Fig. 78 (b)

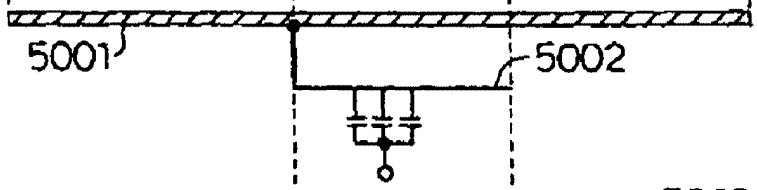


Fig. 78 (c)

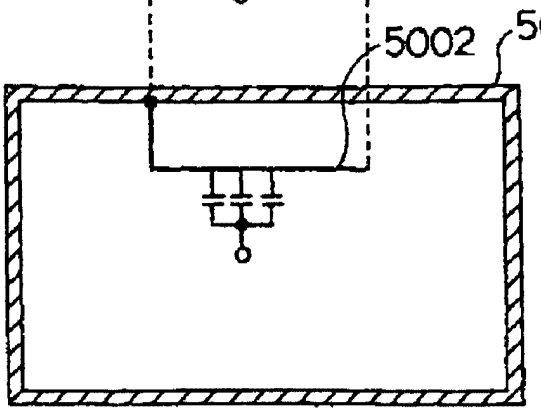


Fig. 79 (a)

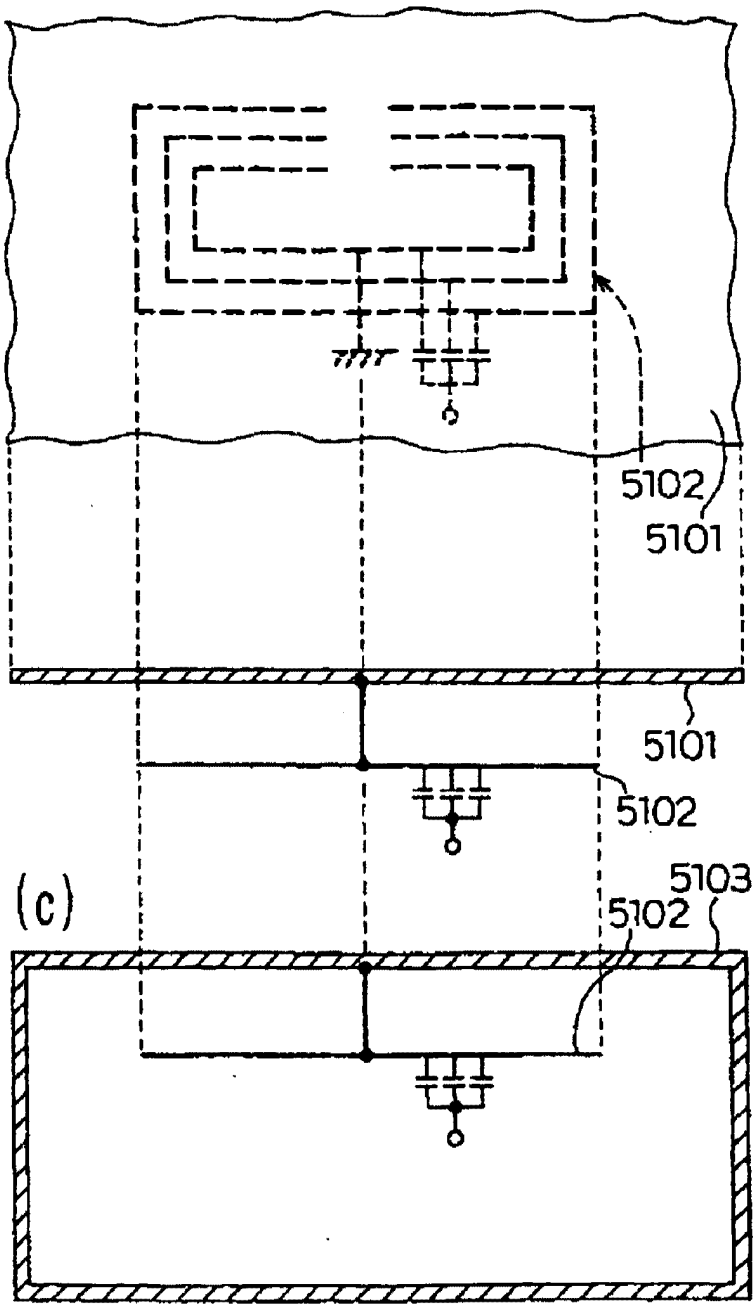


Fig. 79 (b)

Fig. 79 (c)

Fig. 80

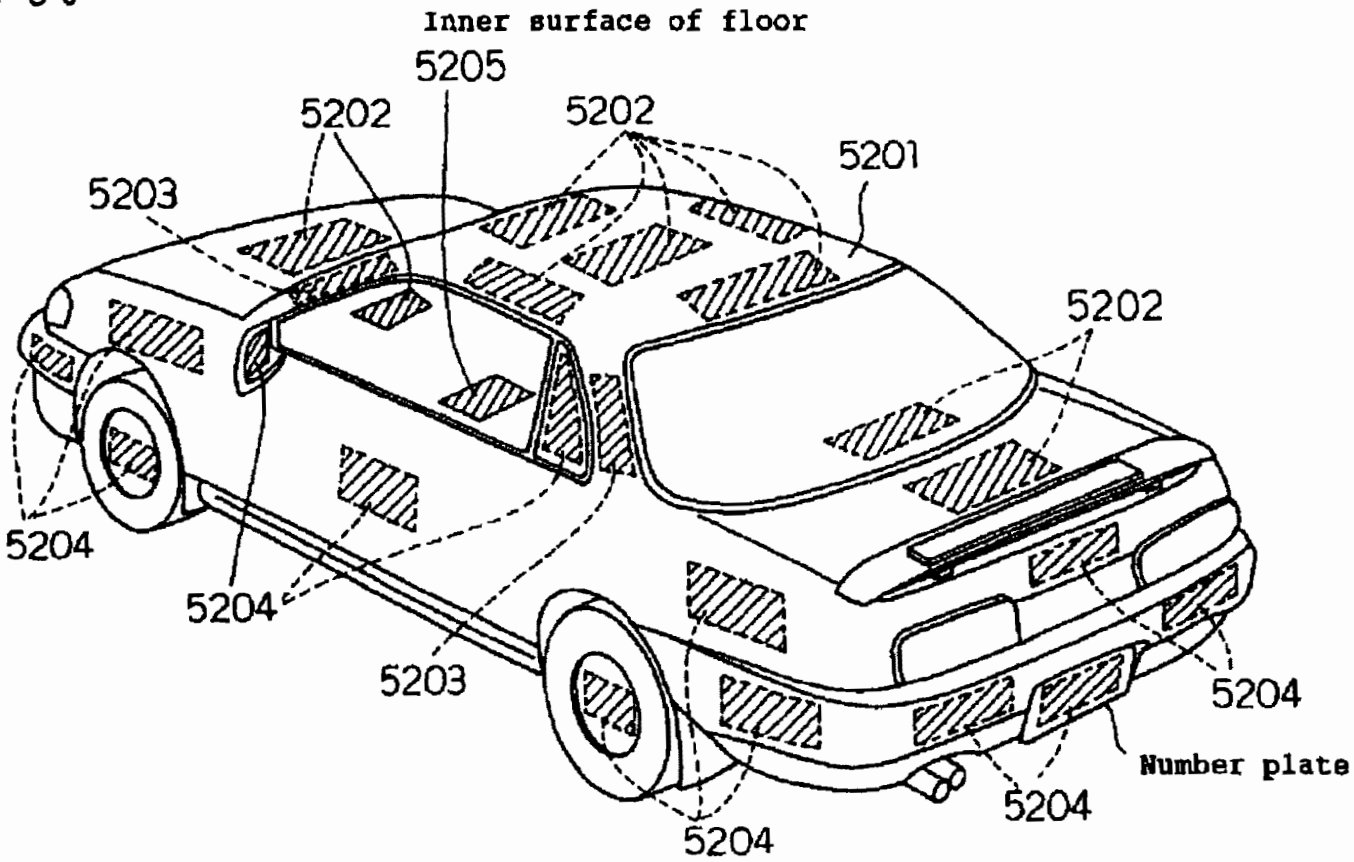

Inner surface of floor
5205
5202
5202
5201
5203
5202
5204
5204
5203
5204
Number plate
5204
5204

Fig. 81

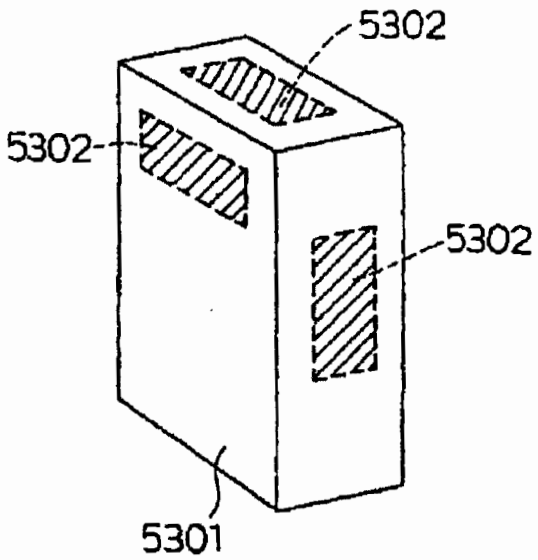


Fig. 82

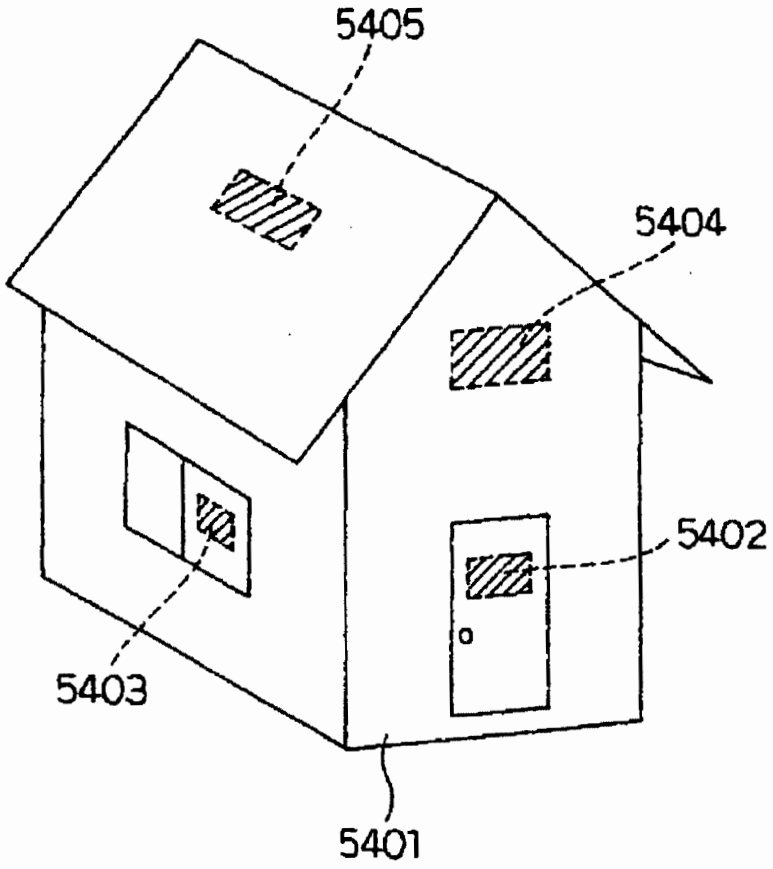


Fig. 83 (a)

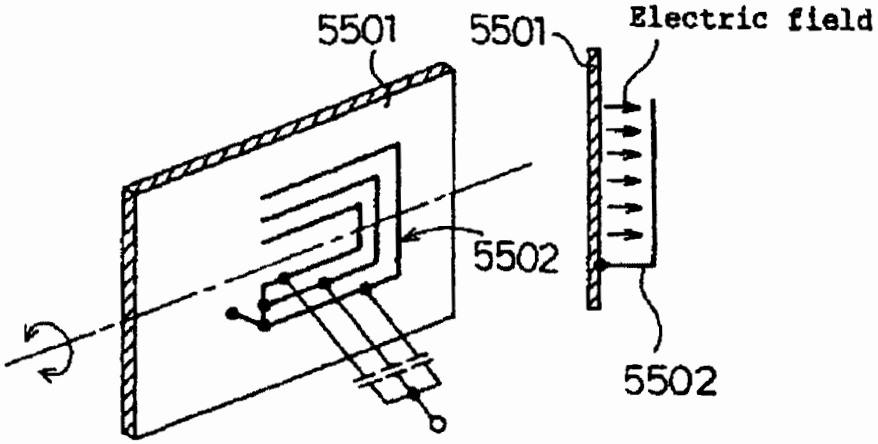


Fig. 83 (b)

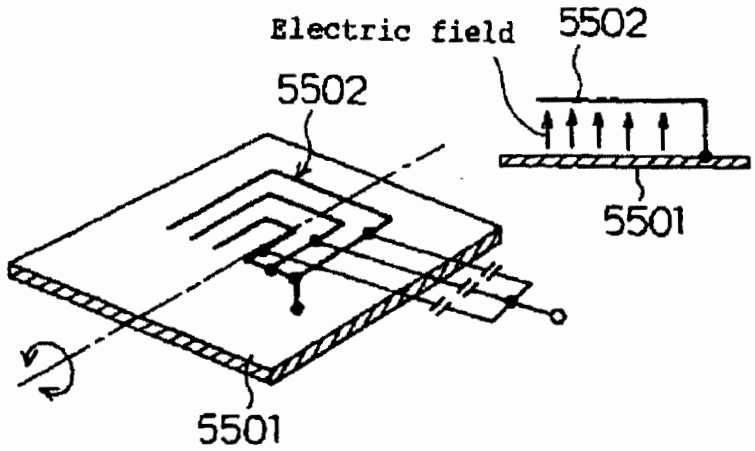


Fig. 84 (a)

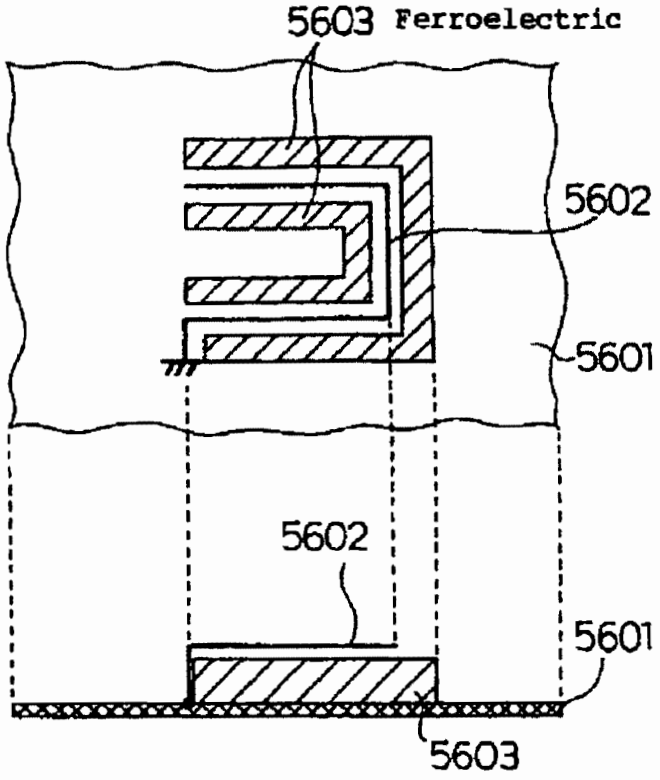


Fig. 84 (b)

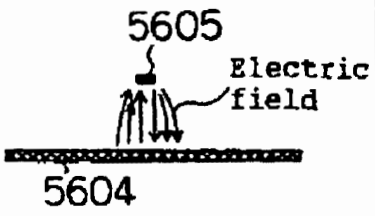
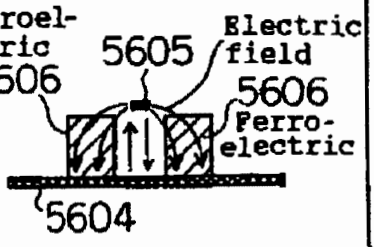
Without ferroelectric	With ferroelectric
• Vertical component → large • Horizontal component → small 	• Vertical component → small • Horizontal component → large 

Fig. 85 (a)

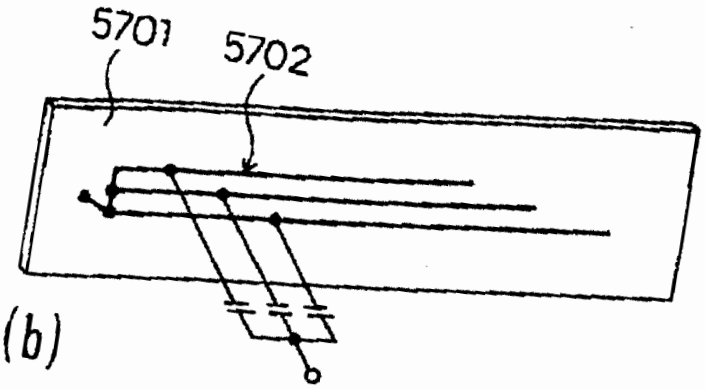


Fig. 85 (b)

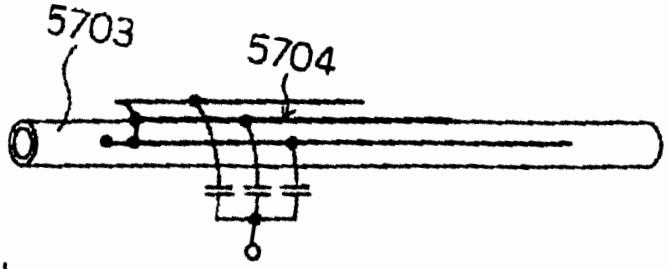


Fig. 85 (c)

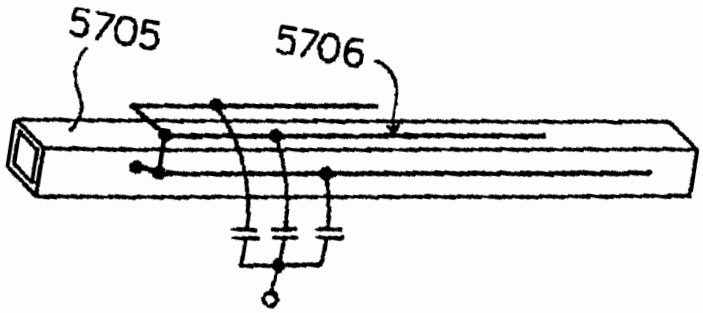


Fig. 86 (a)

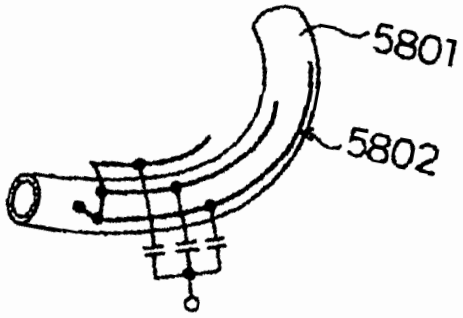


Fig. 86 (b)

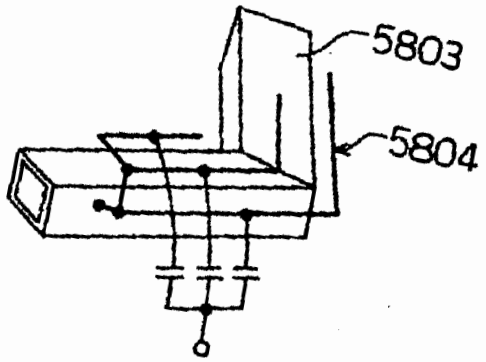


Fig. 86 (c)

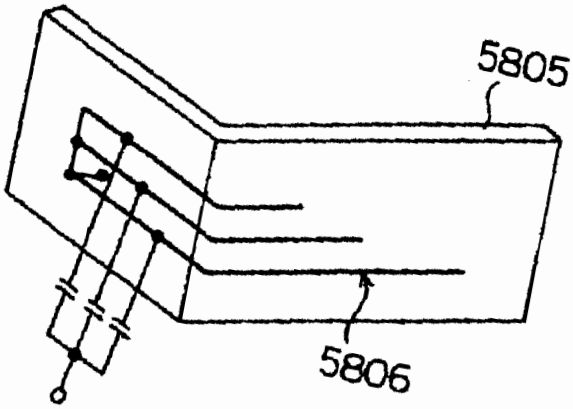


Fig. 87 (a)

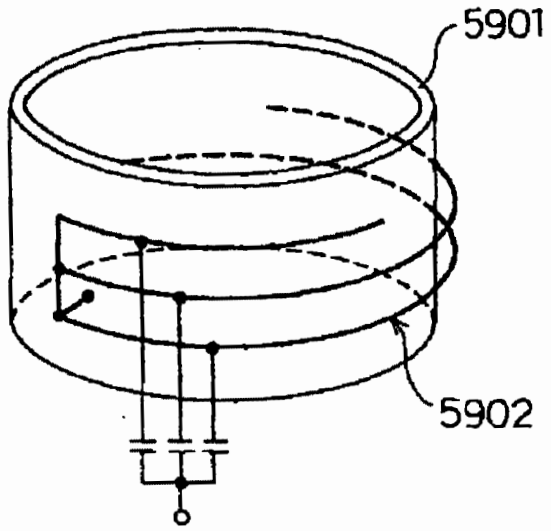


Fig. 87 (b)

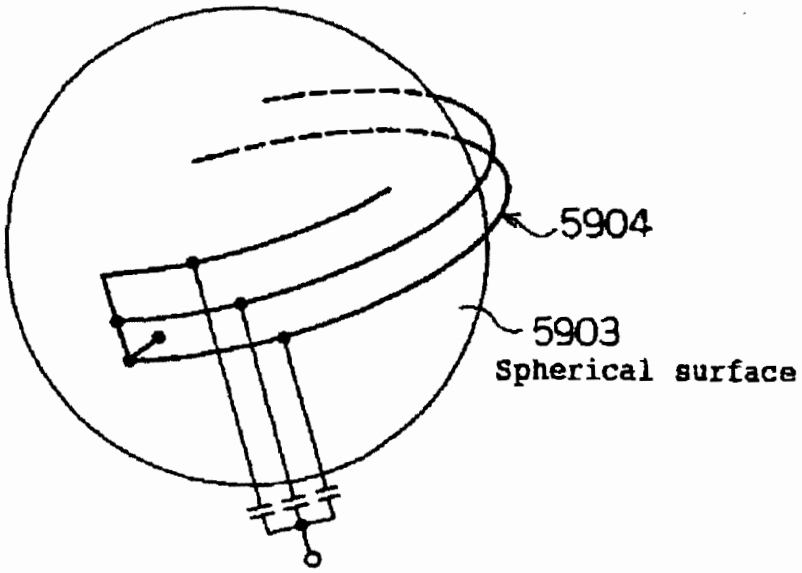


Fig. 88 (a)

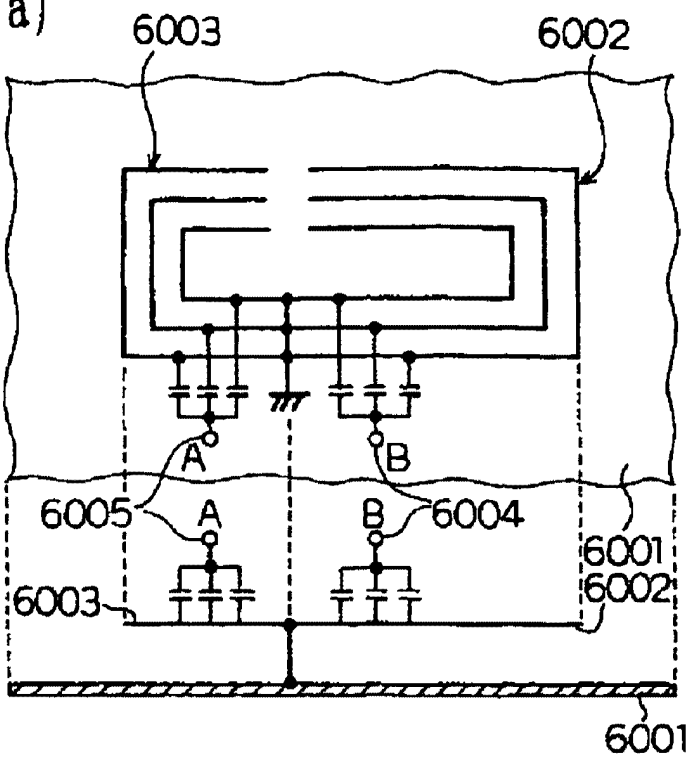


Fig. 88 (b)

Fig. 88 (c)

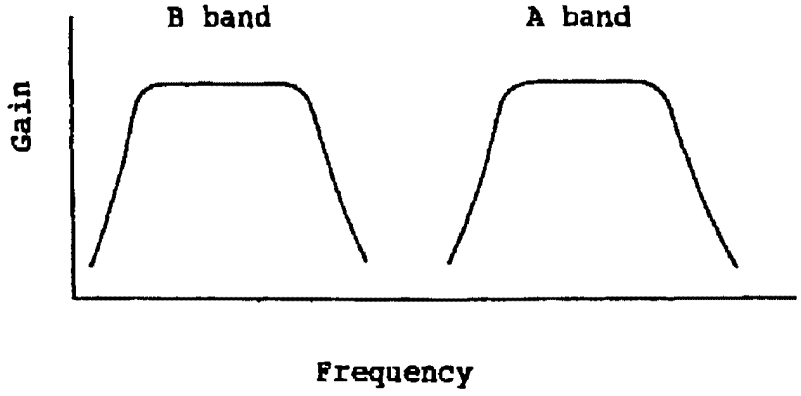


Fig. 89 (a)

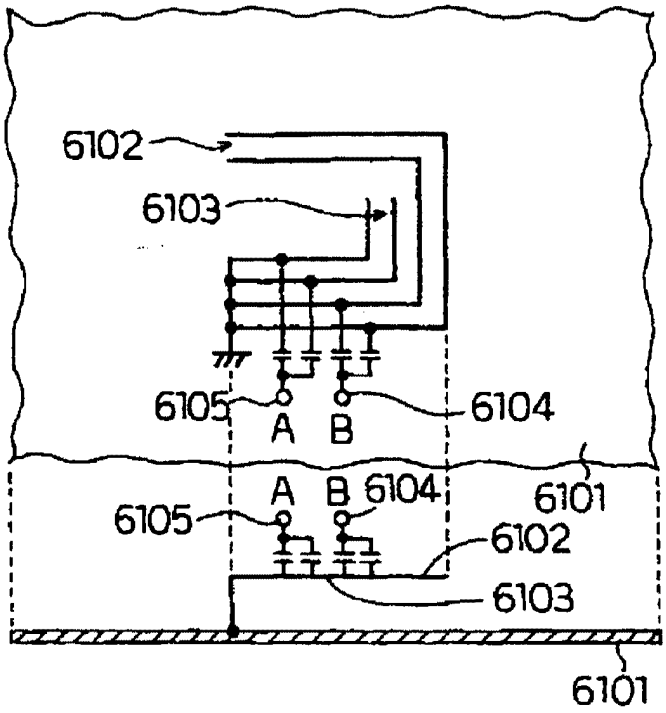


Fig. 89 (b)

Fig. 89 (c)

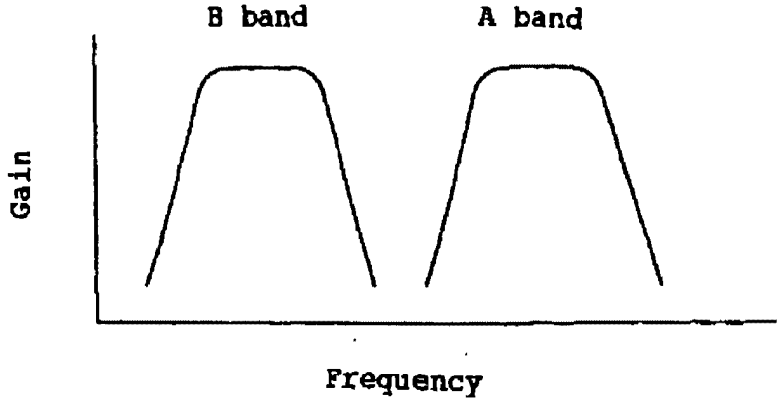


Fig. 90 (a)

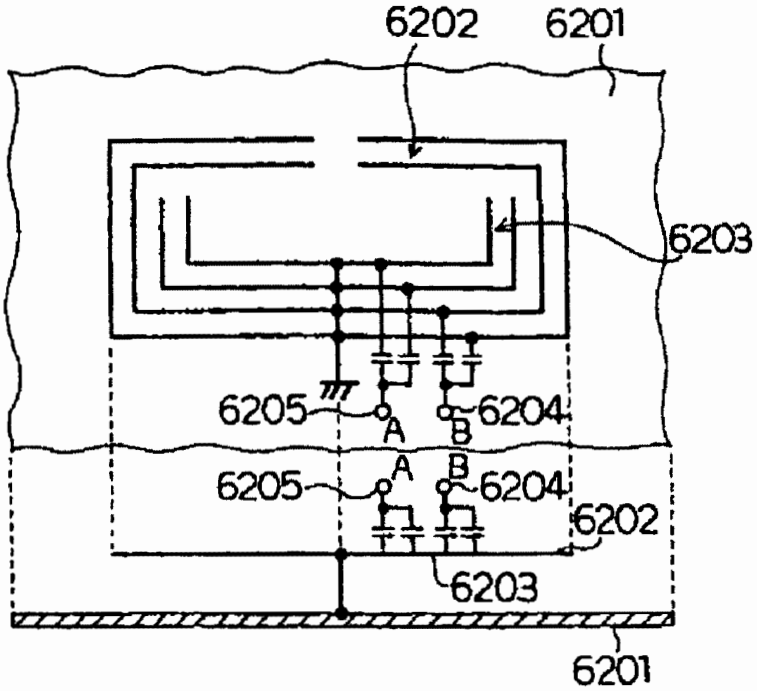
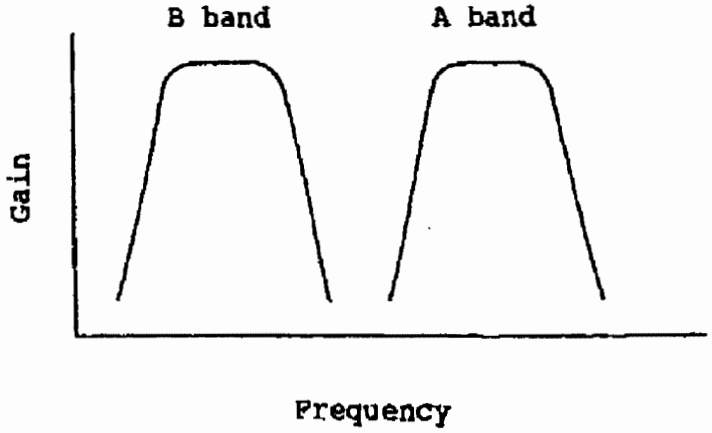


Fig. 90 (b)

Fig. 90 (c)



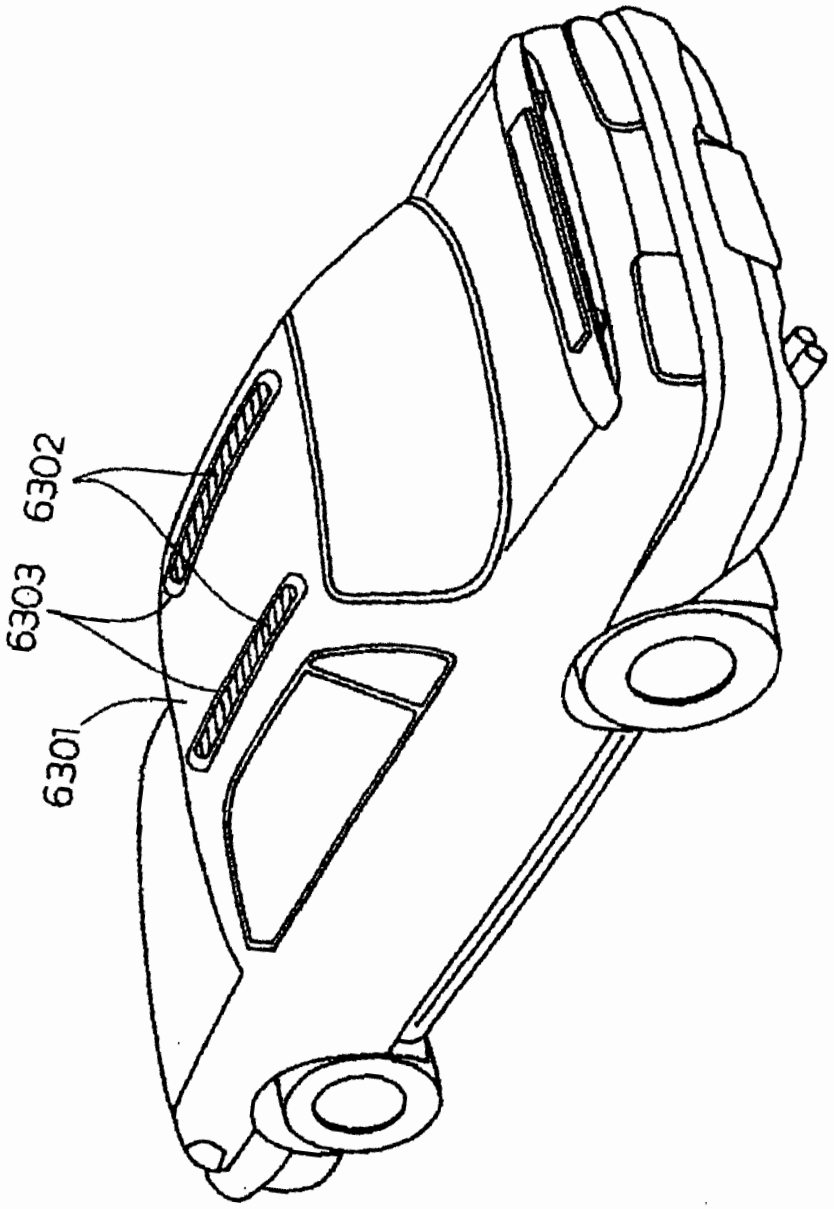


Fig. 91

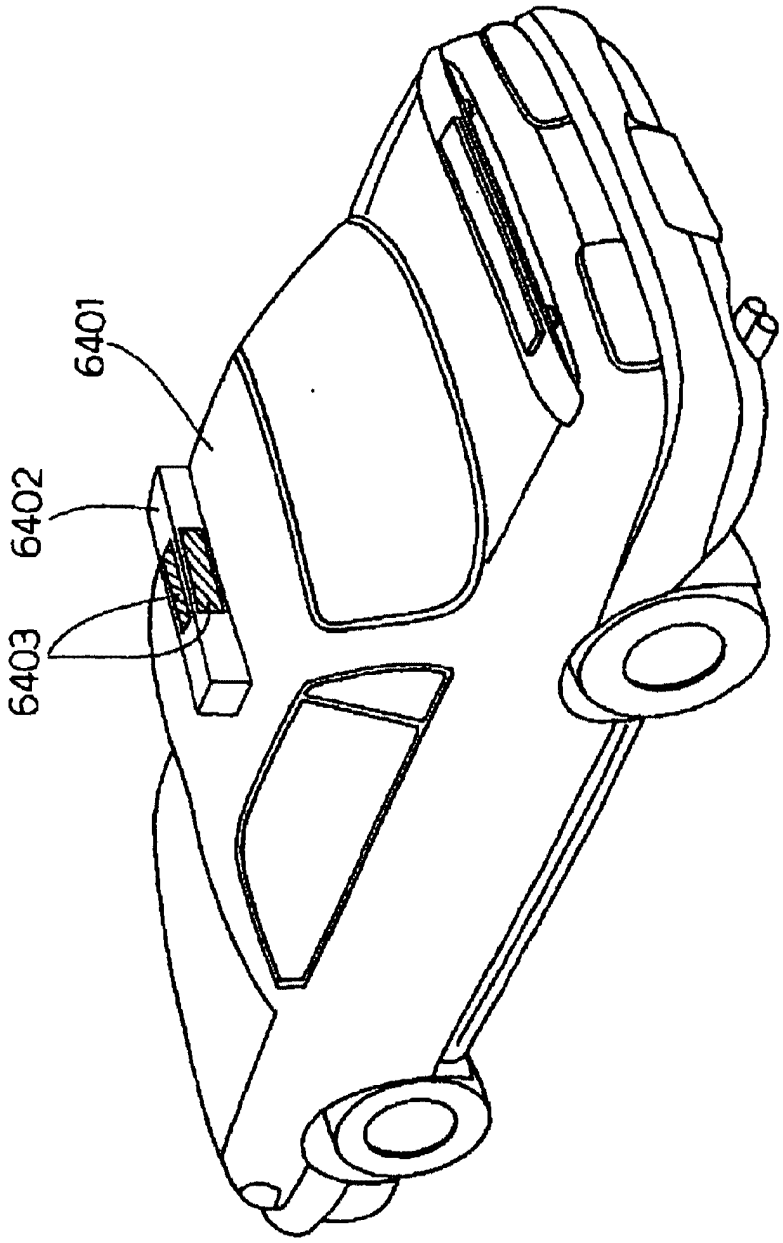


Fig. 92

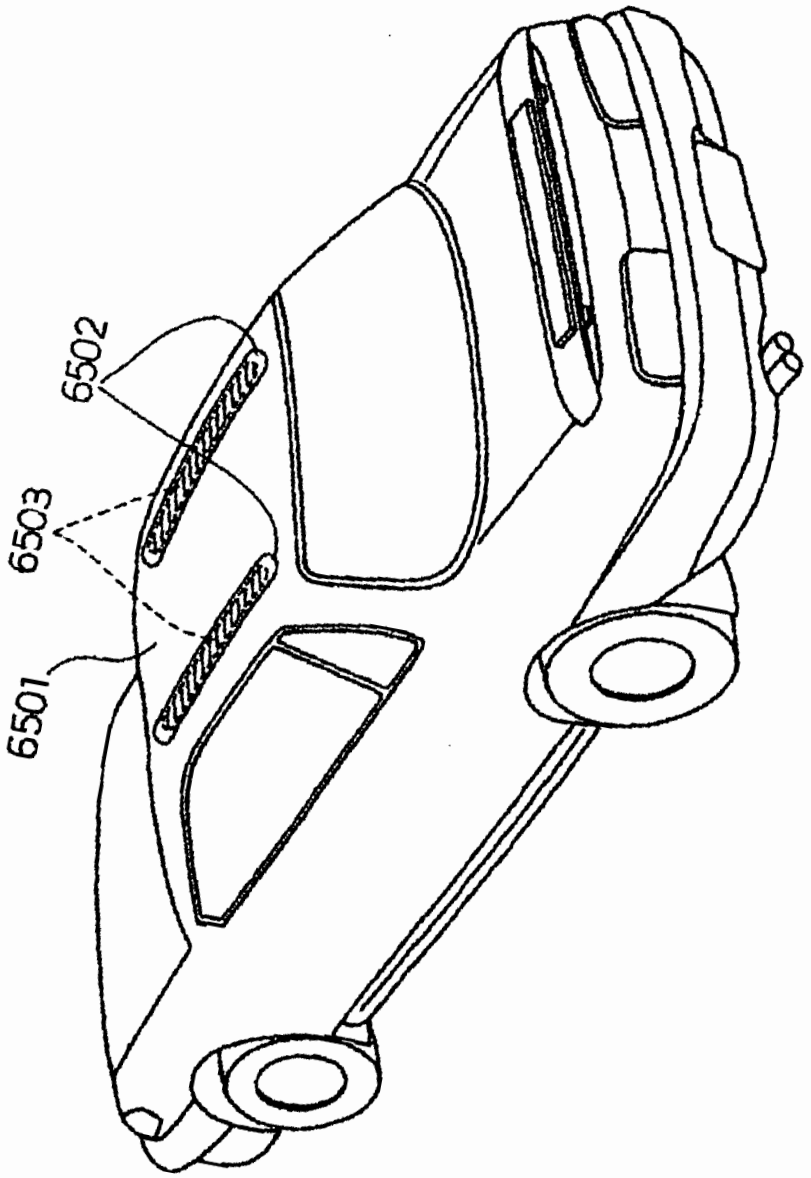


Fig. 93

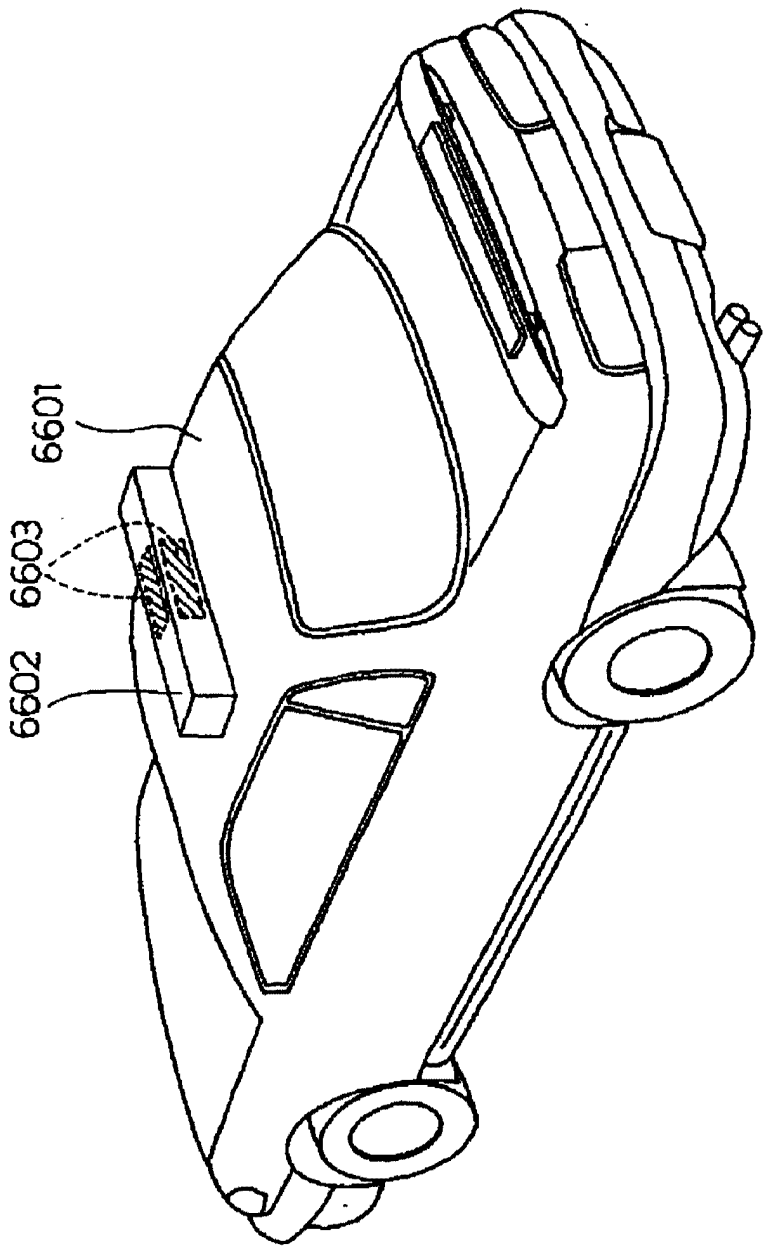


Fig. 94

Fig. 95

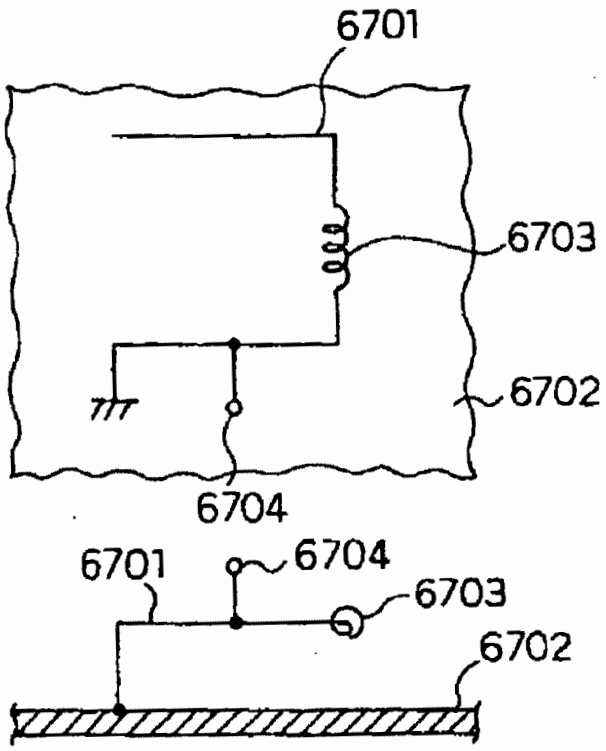


Fig. 96

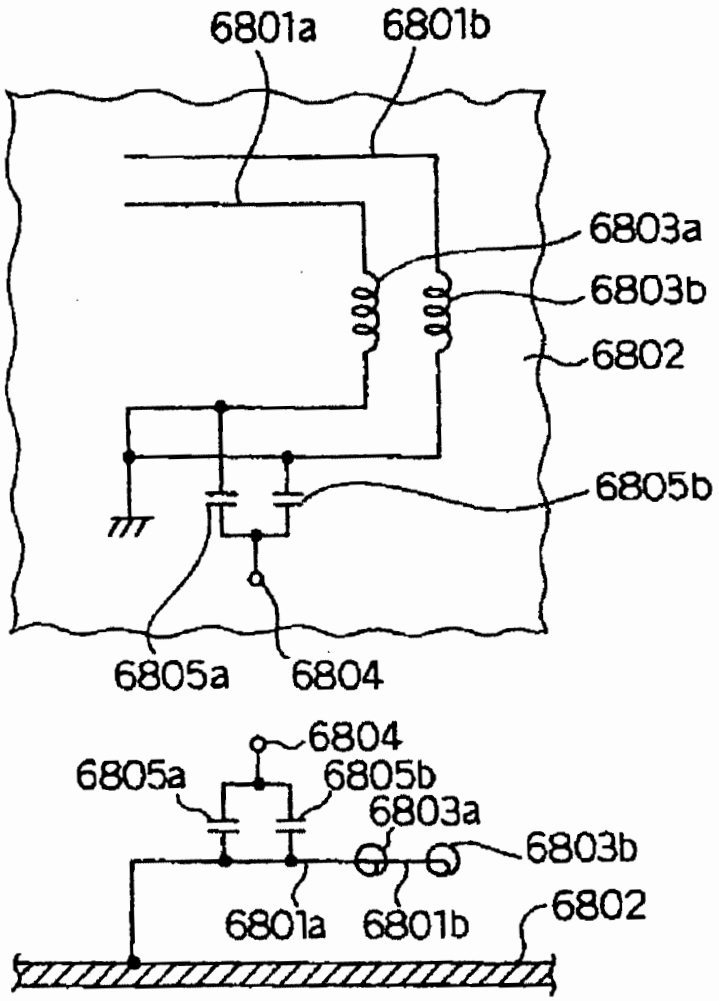

6801a
6801b
6803a
6803b
6802
6805b
6805a
6804
6804
6805a
6805b
6803a
6803b
6801a
6801b
6802

Fig. 97

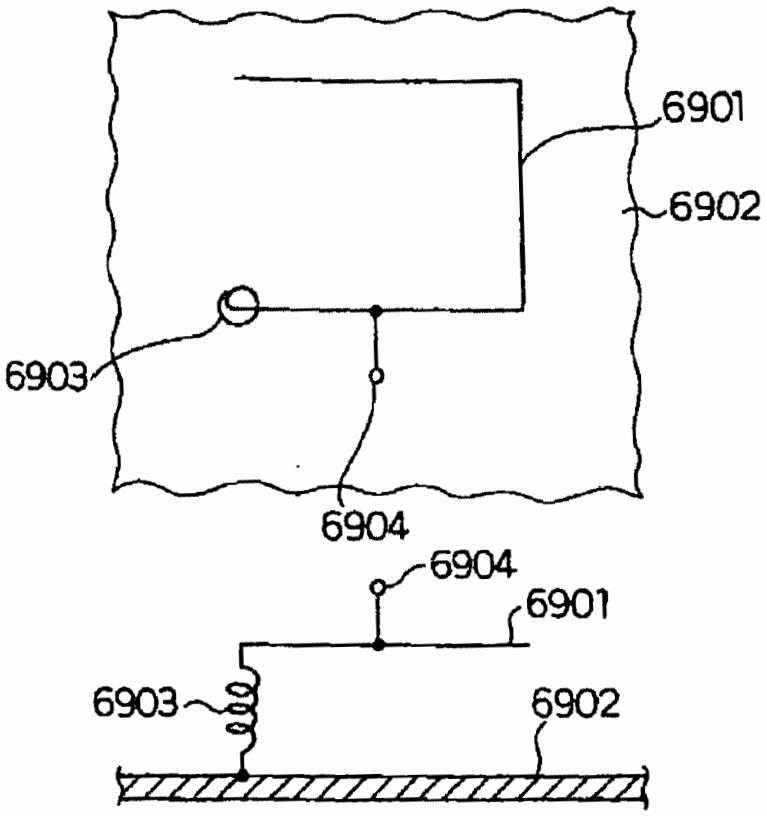


Fig. 98

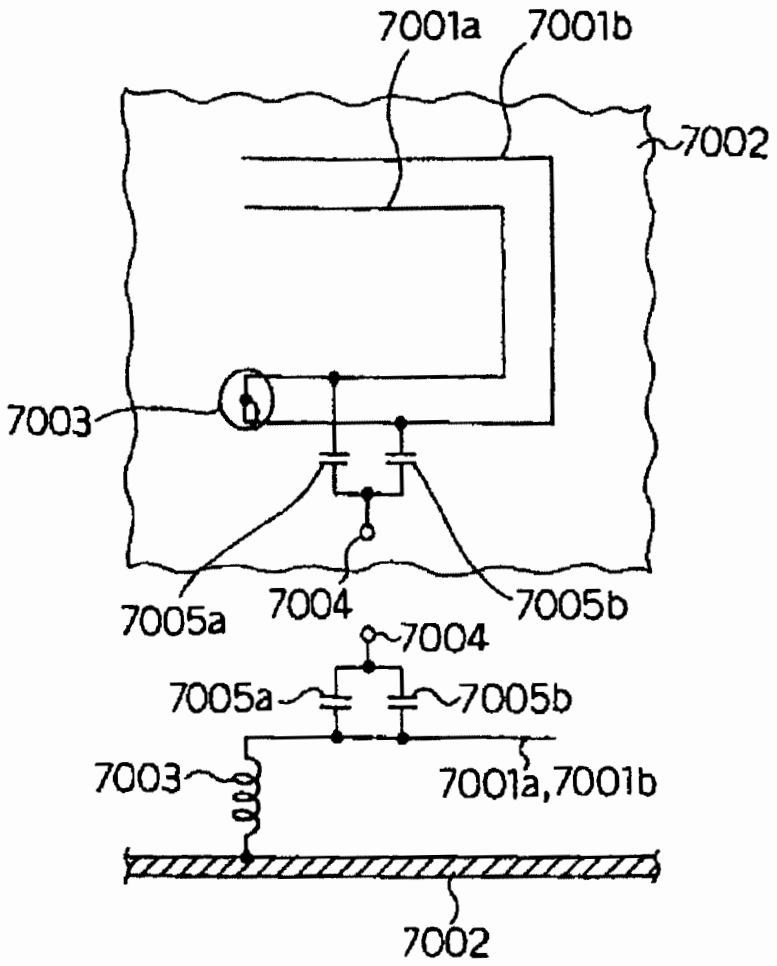

7001a
7001b
7002
7003
7005a
7004
7005b
7004
7005a
7005b
7003
7001a,7001b
7002

Fig. 99

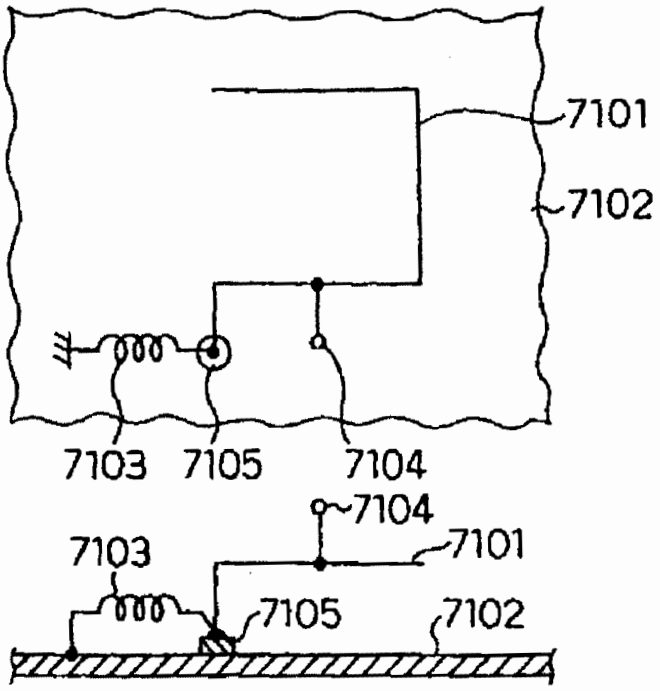


Fig. 100

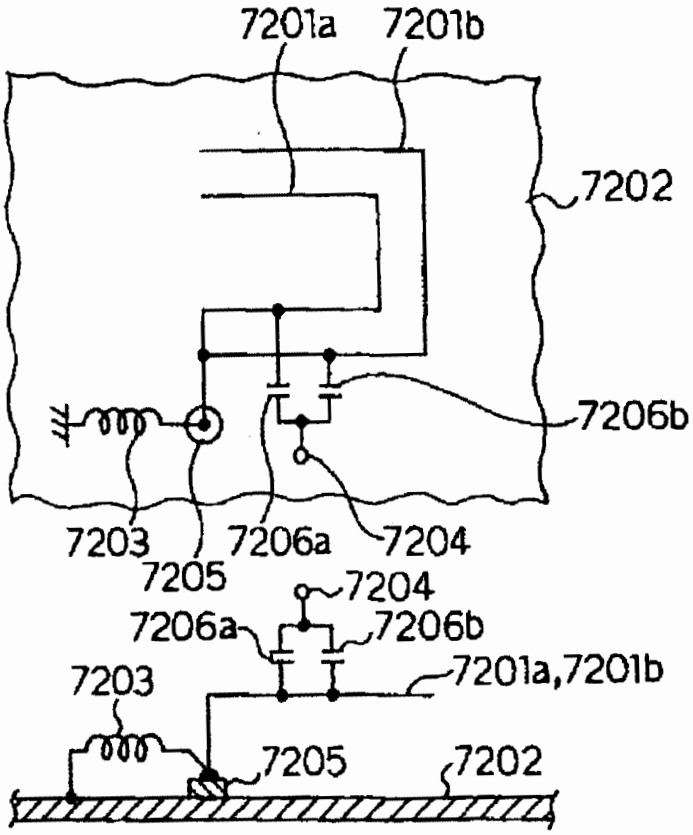

7201a
7201b
7202
7206b
7203
7205
7206a
7204
7204
7206a
7206b
7201a,7201b
7203
7205
7202

Fig. 101

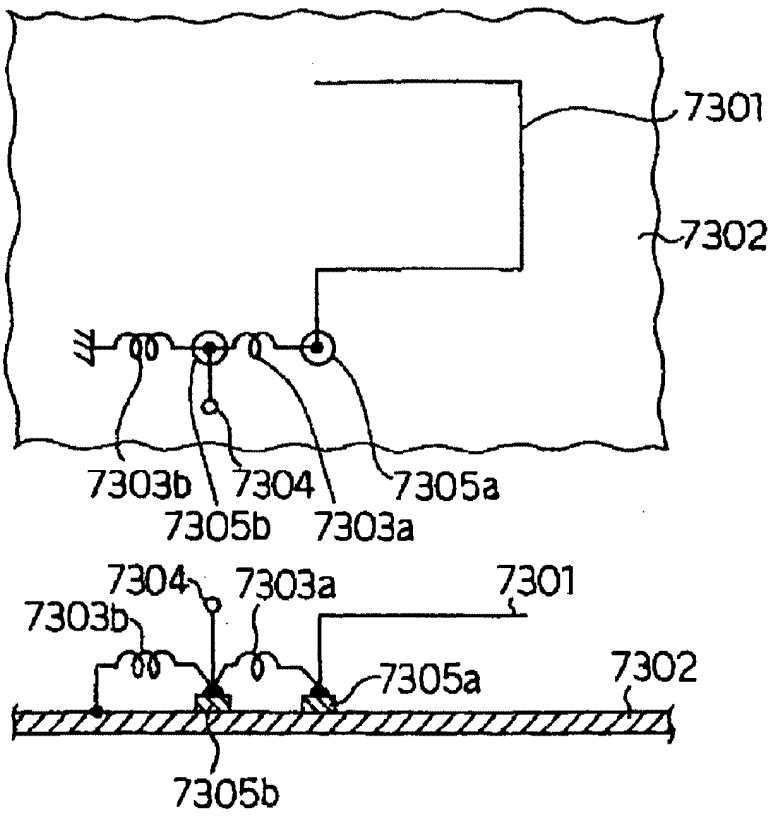

7301
7302
7303b
7304
7305a
7305b
7303a
7304
7303a
7301
7303b
7305a
7302
7305b

Fig. 102

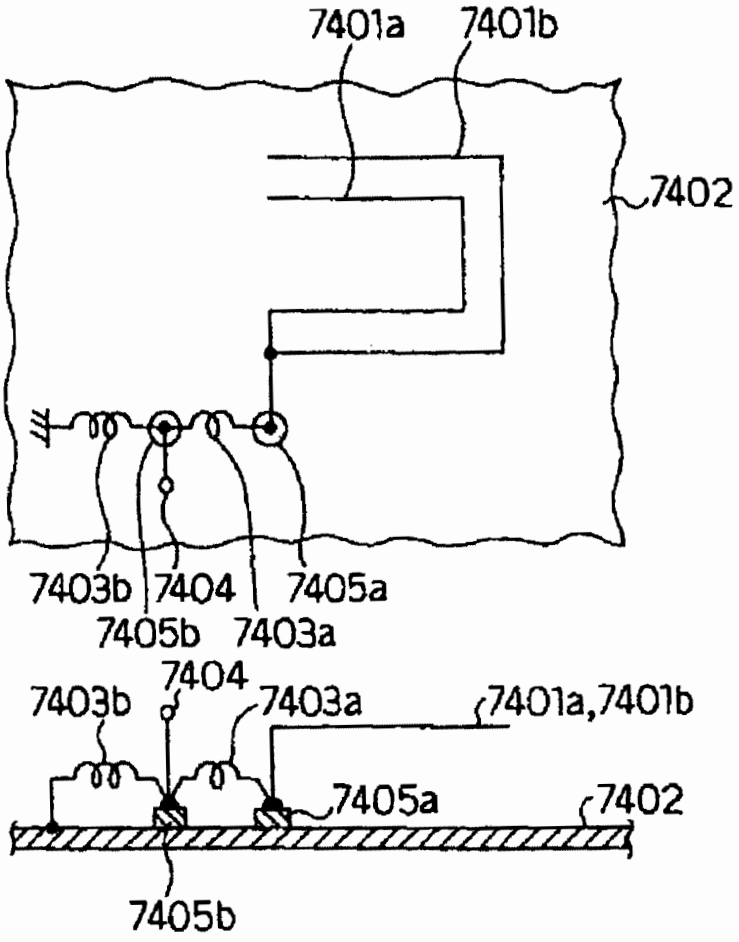

7401a
7401b
7402
7403b
7404
7405a
7405b
7403a
7404
7403b
7403a
7401a,7401b
7405a
7402
7405b

Fig. 103

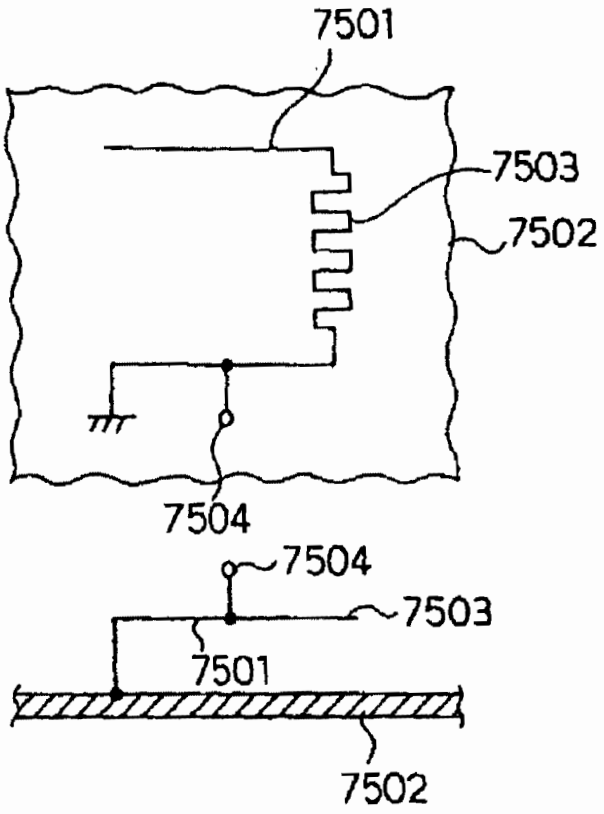


Fig. 104

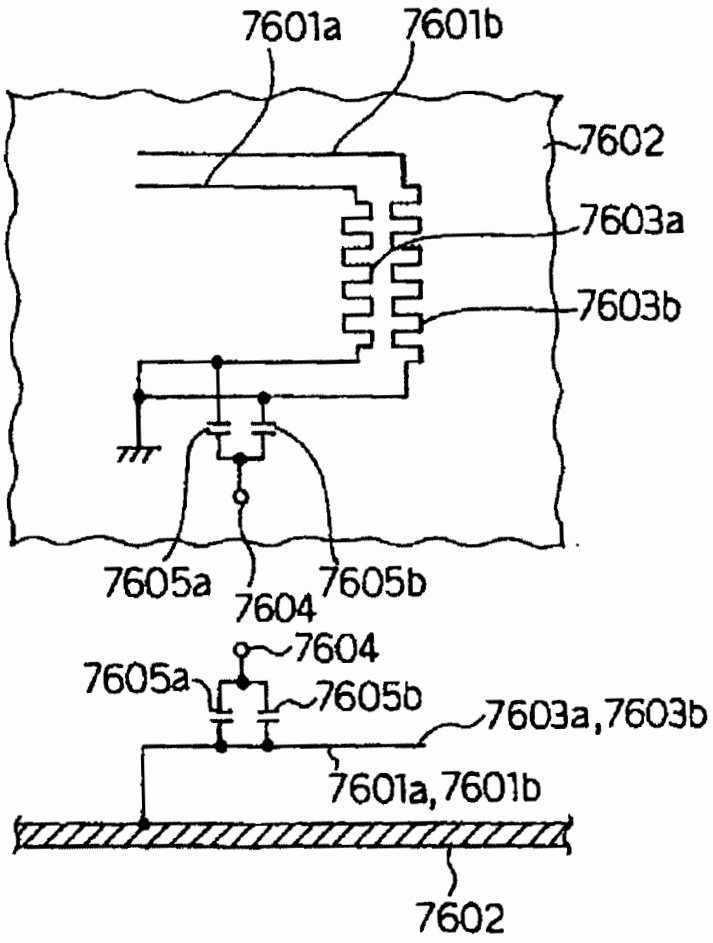

7601a
7601b
7602
7603a
7603b
7605a
7604
7605b
7604
7605a
7605b
7603a,7603b
7601a,7601b
7602

Fig. 105

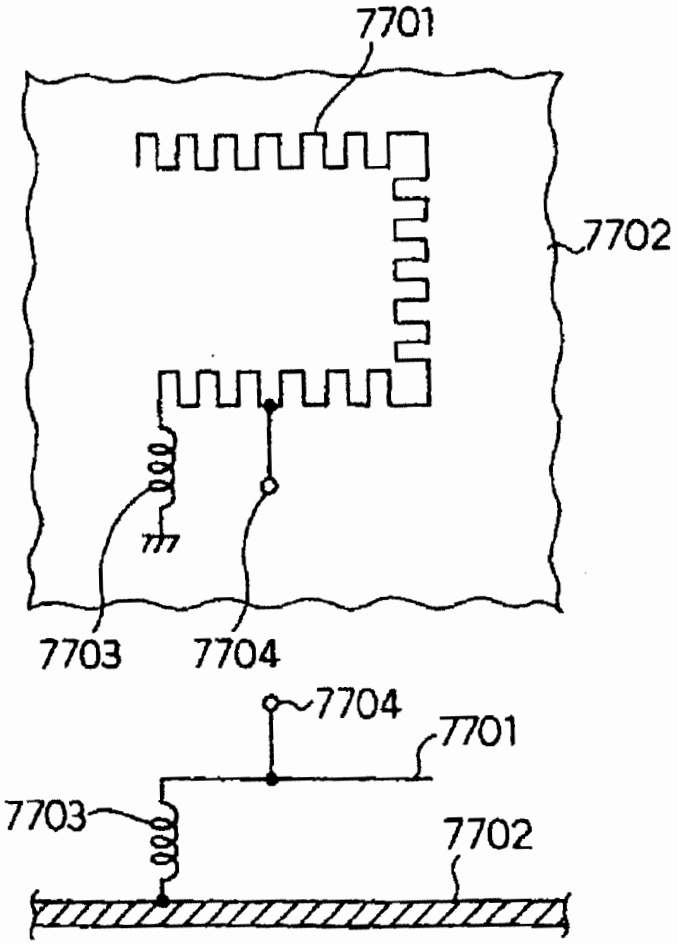


Fig. 106 (a)

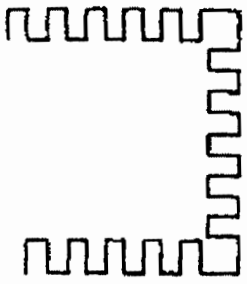


Fig. 106 (b)

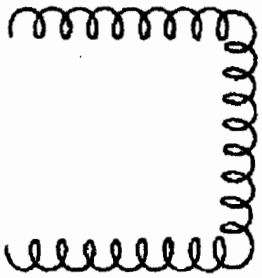


Fig. 106 (c)

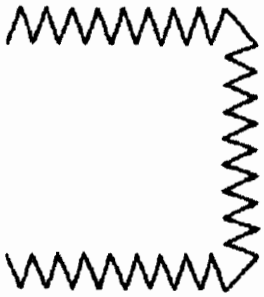


Fig. 107

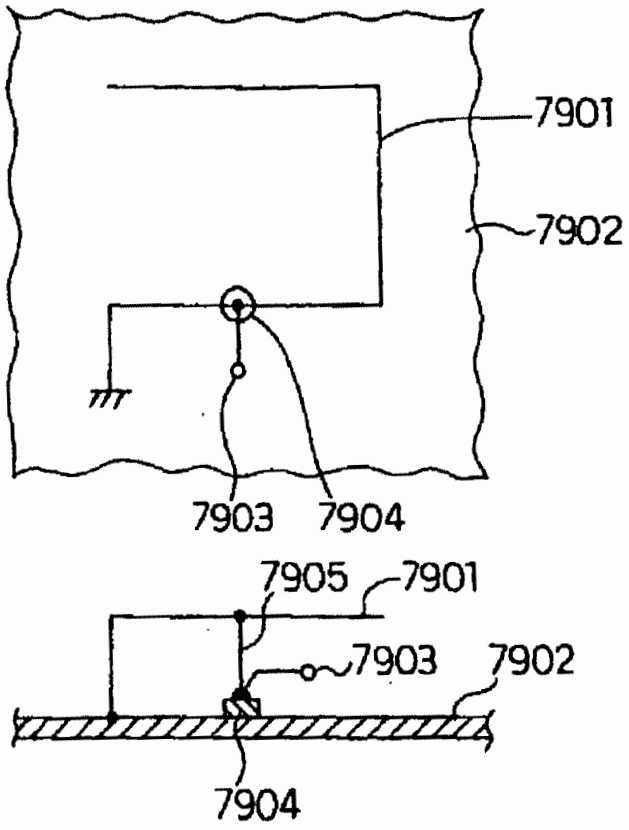


Fig. 108

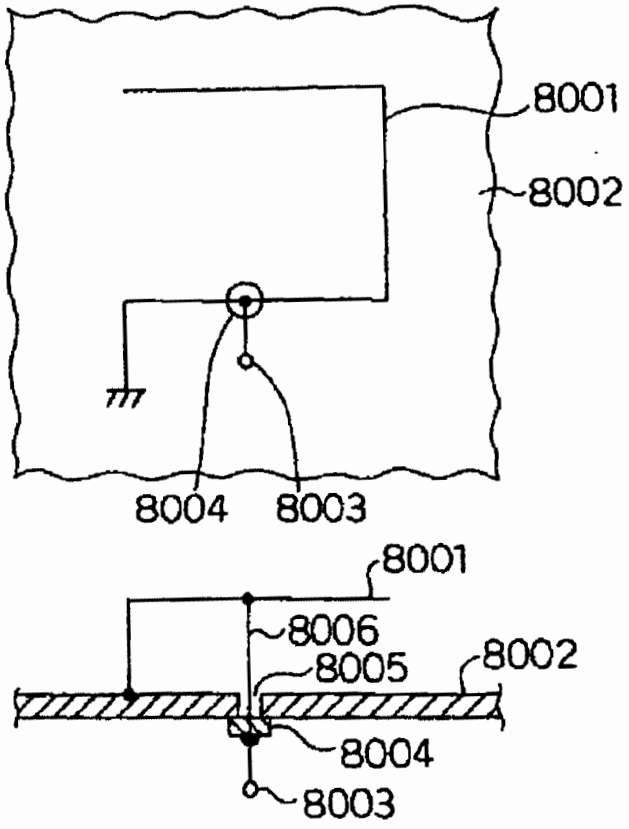


Fig. 109

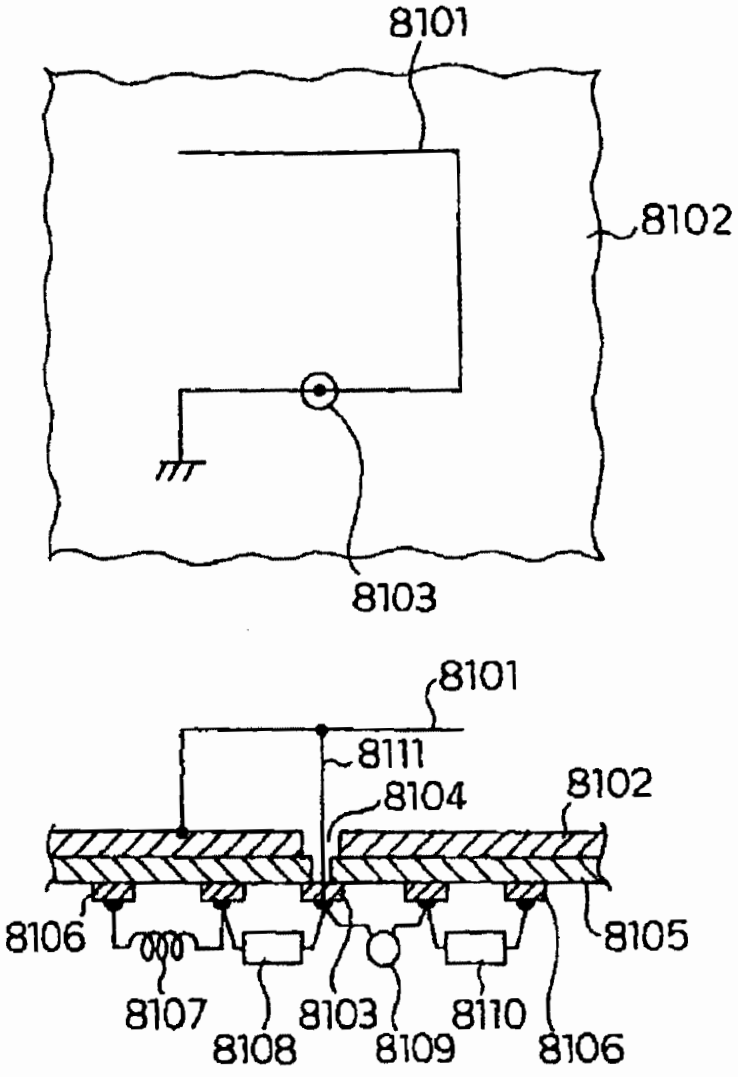

8101
8102
8103
8101
8111
8104
8102
8106
8105
8107
8103
8110
8108
8109
8106

Fig. 110

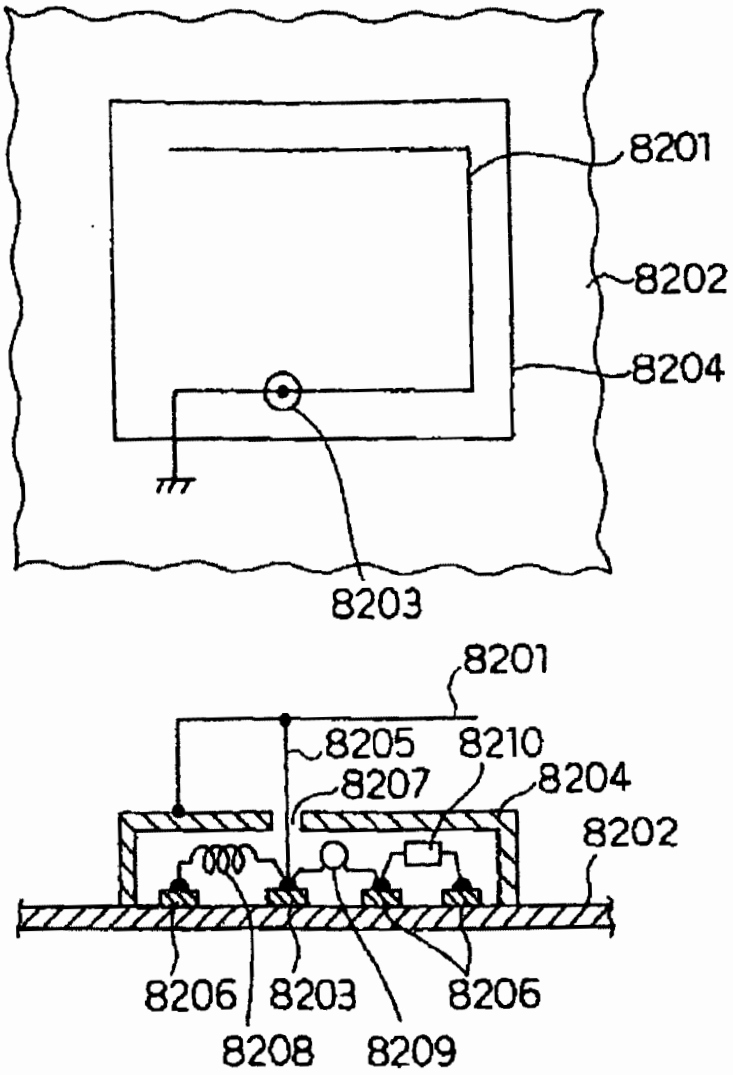

8201
8202
8204
8203
8201
8205
8210
8207
8204
8202
8206
8203
8206
8208
8209

Fig. 111

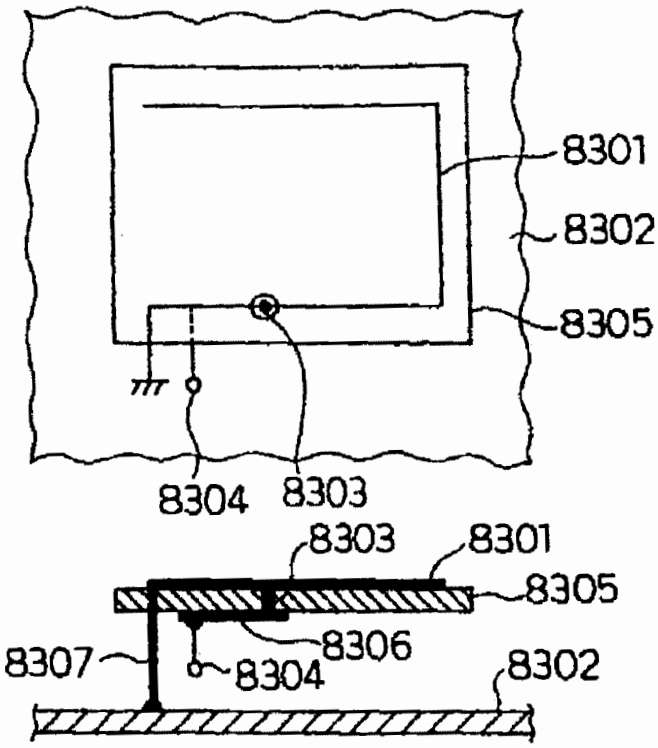


Fig. 112

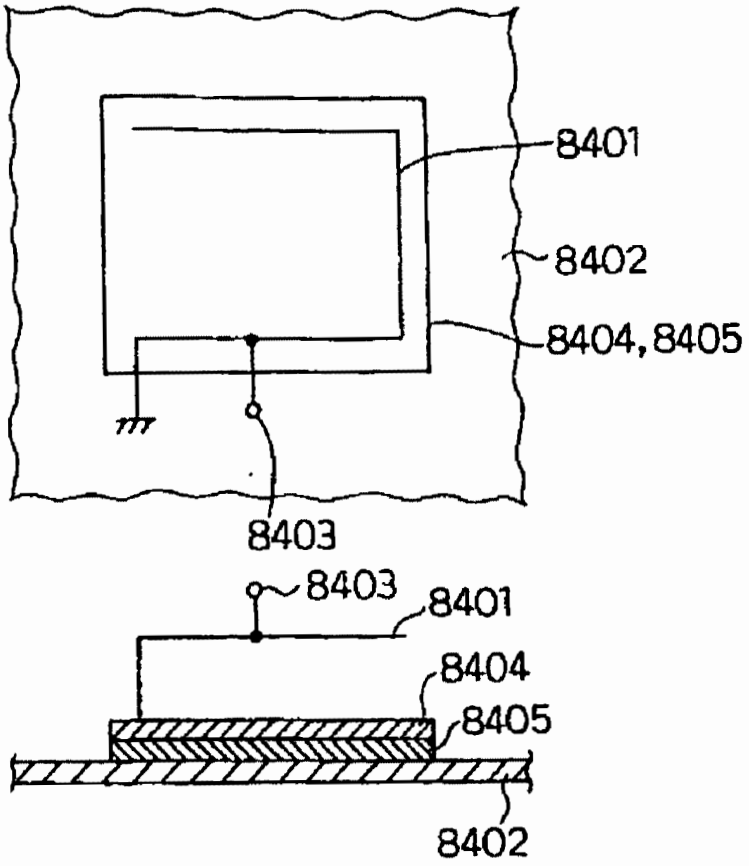


Fig. 113

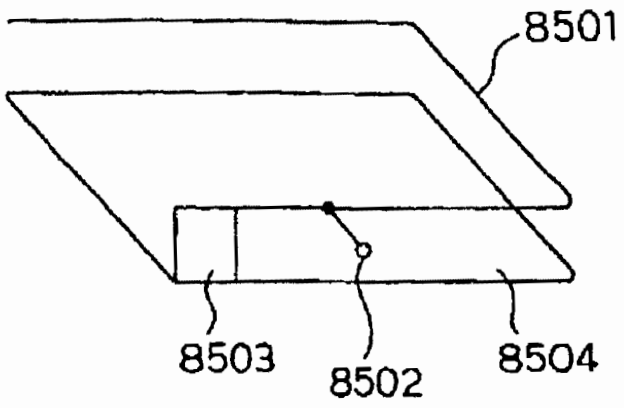
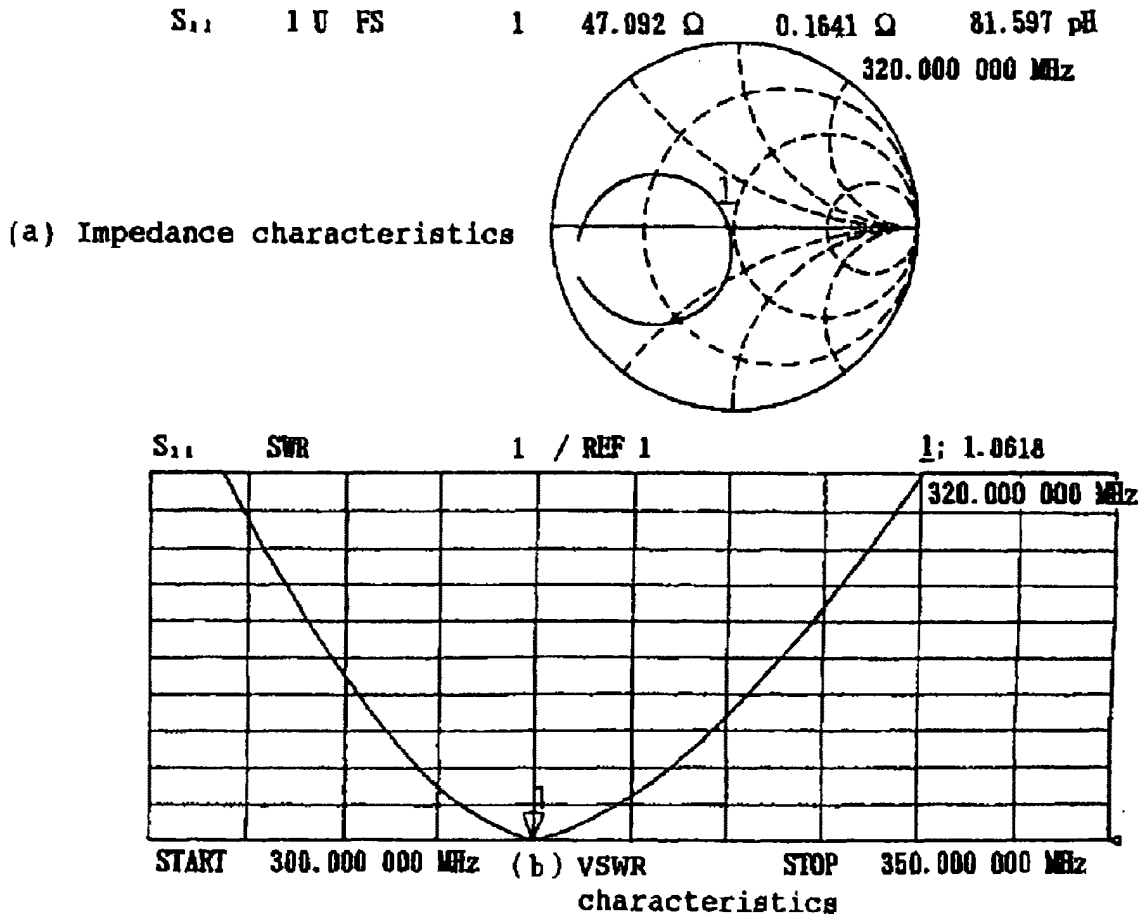


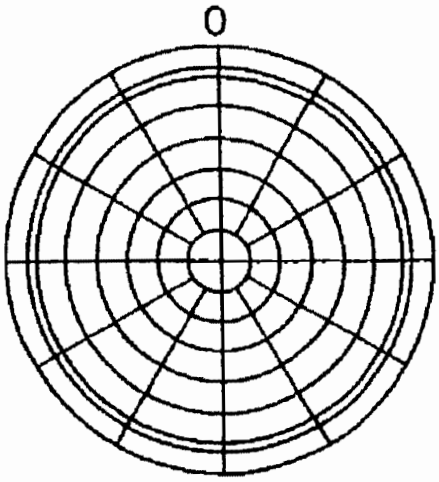
Fig. 114



150

EP 1 011 167 A1

Fig. 115



Vertically polarized wave

Fig. 116

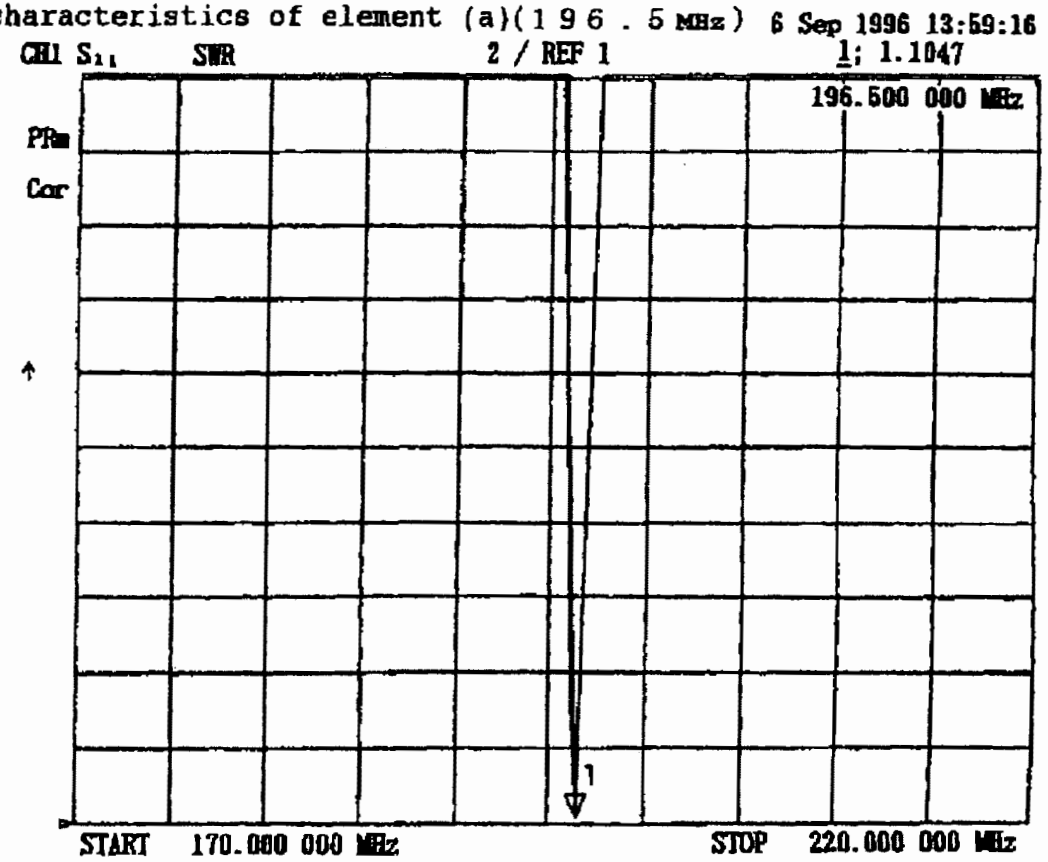

VSWR characteristics of element (a)(196.5 MHz) 6 Sep 1996 13:59:16
CH1 S11 SWR
2 / REF 1
1; 1.1047
196.500 000 MHz
PRm
Cor
START 170.000 000 MHz
STOP 220.000 000 MHz

Fig. 117 VSWR characteristics of element (b)(198.75 MHz) Sep 1996 12:57:34

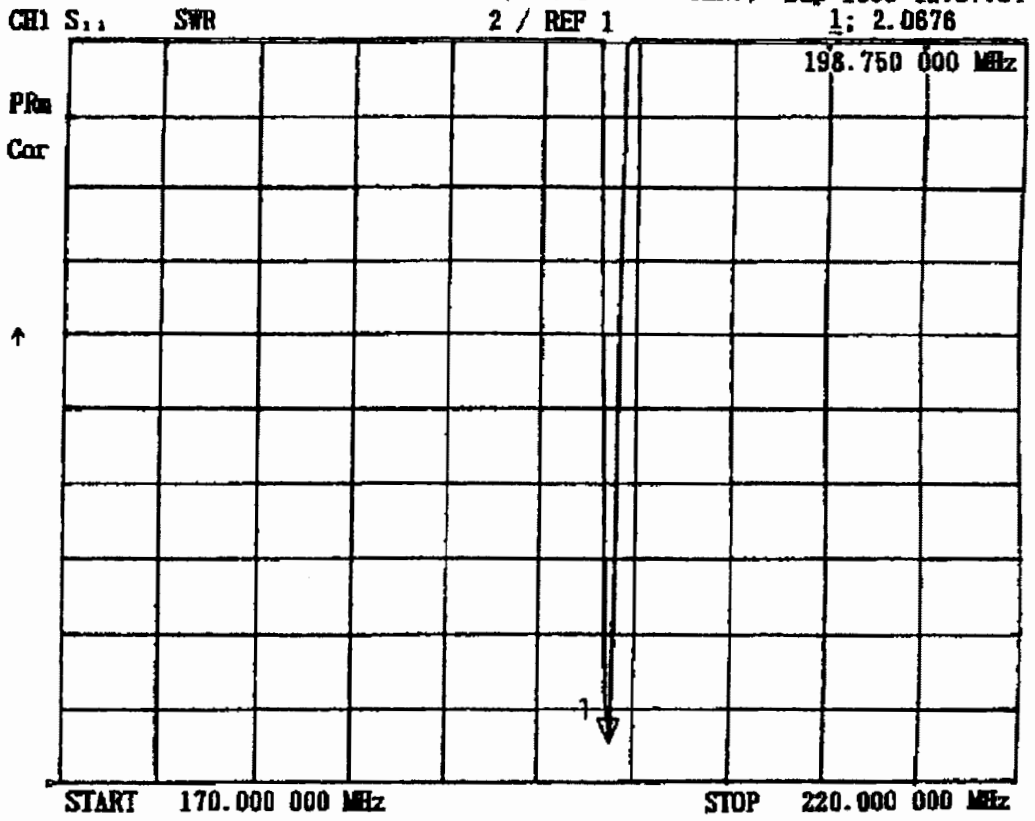


Fig. 118 VSWR characteristics of element (C)(200.5 MHz)

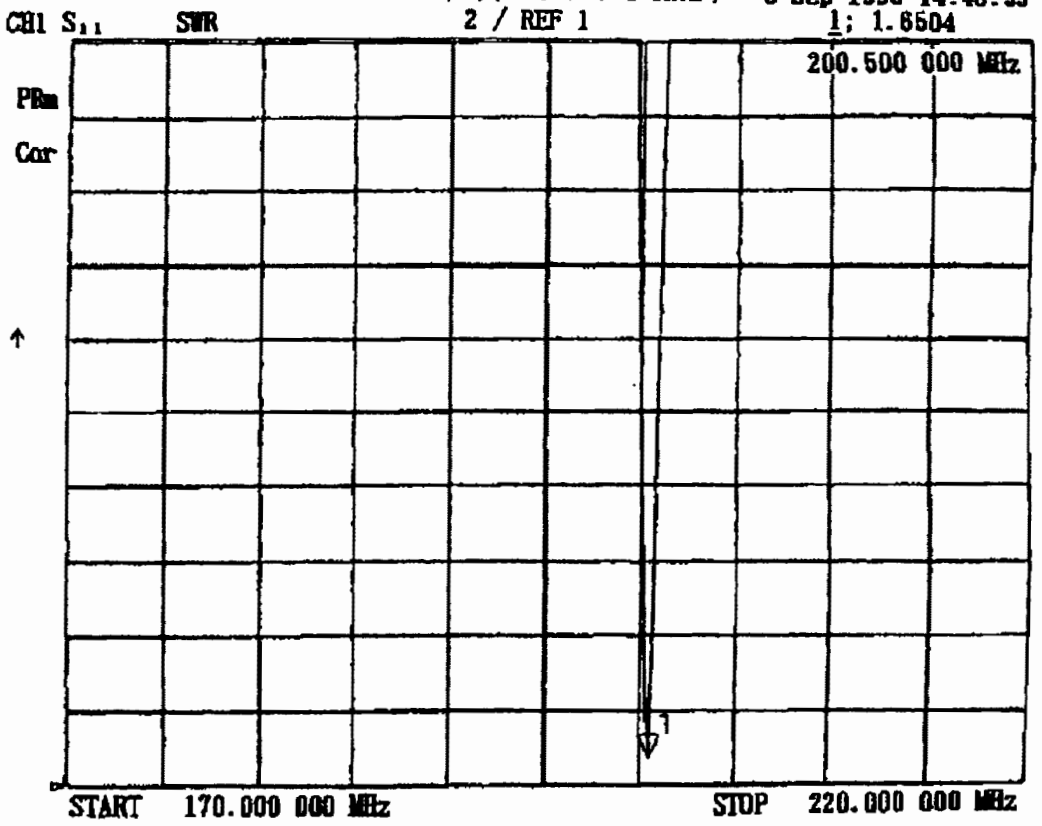


Fig. 119

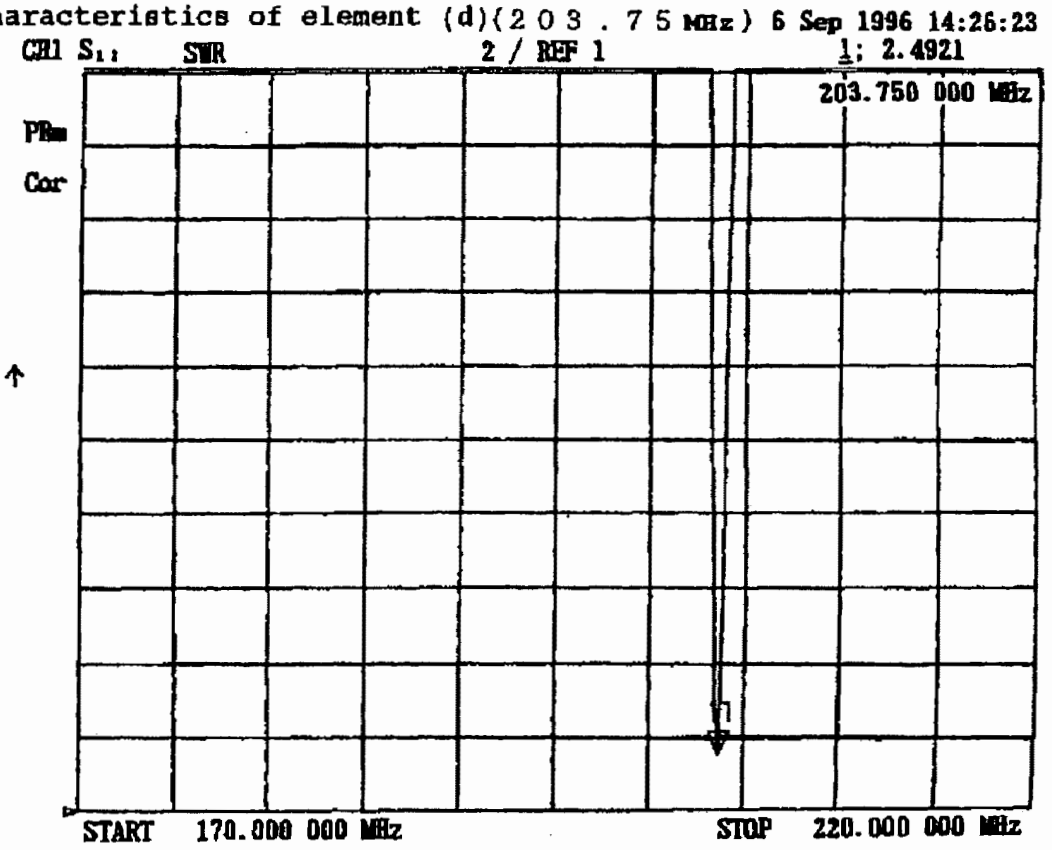

VSWR characteristics of element (d)(203.75 MHz) 6 Sep 1996 14:26:23
CH1 S11 SWR
2 / REF 1
1: 2.4921
203.750 000 MHz
PRm
Cor
START 170.000 000 MHz
STOP 220.000 000 MHz

Fig. 120

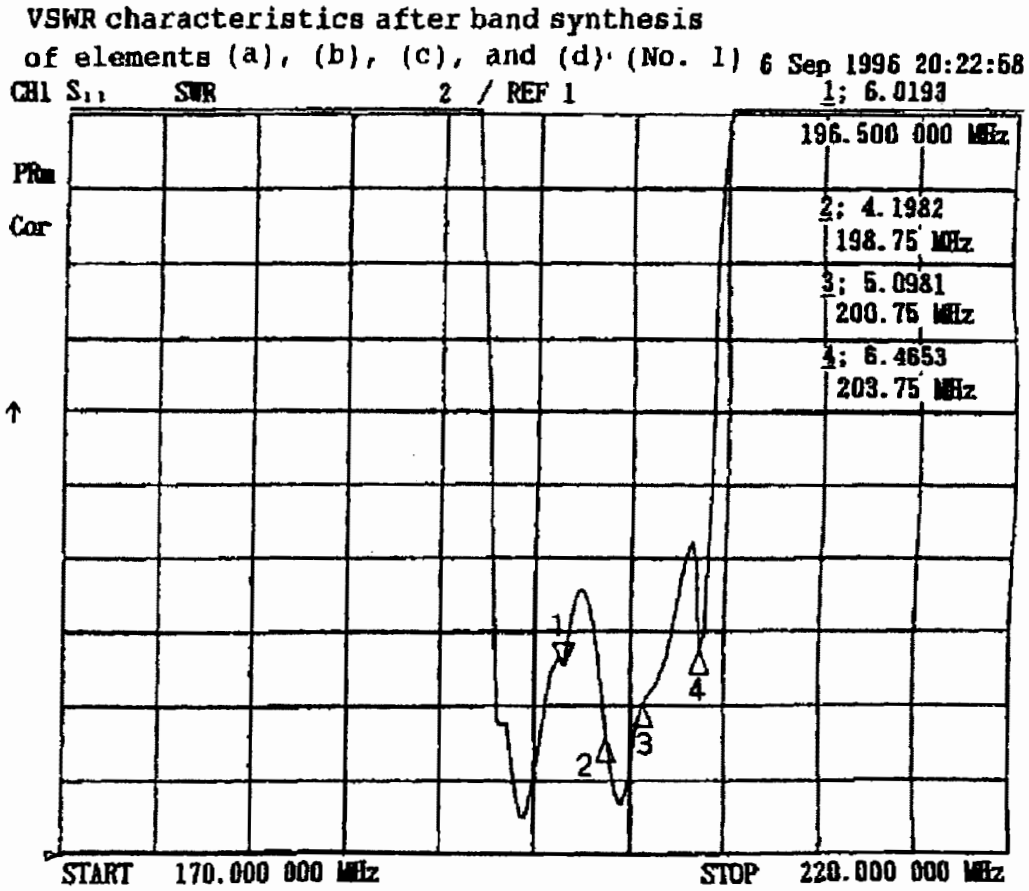

VSWR characteristics after band synthesis
of elements (a), (b), (c), and (d) (No. 1)
6 Sep 1996 20:22:58
CH1 S11 SWR
2 / REF 1
1; 6.0193
196.500 000 MHz
PRm
Cor
2; 4.1982
198.75 MHz
3; 5.0981
200.75 MHz
4; 6.4653
203.75 MHz
1
2
3
4
START 170.000 000 MHz
STOP 220.000 000 MHz

Fig. 121

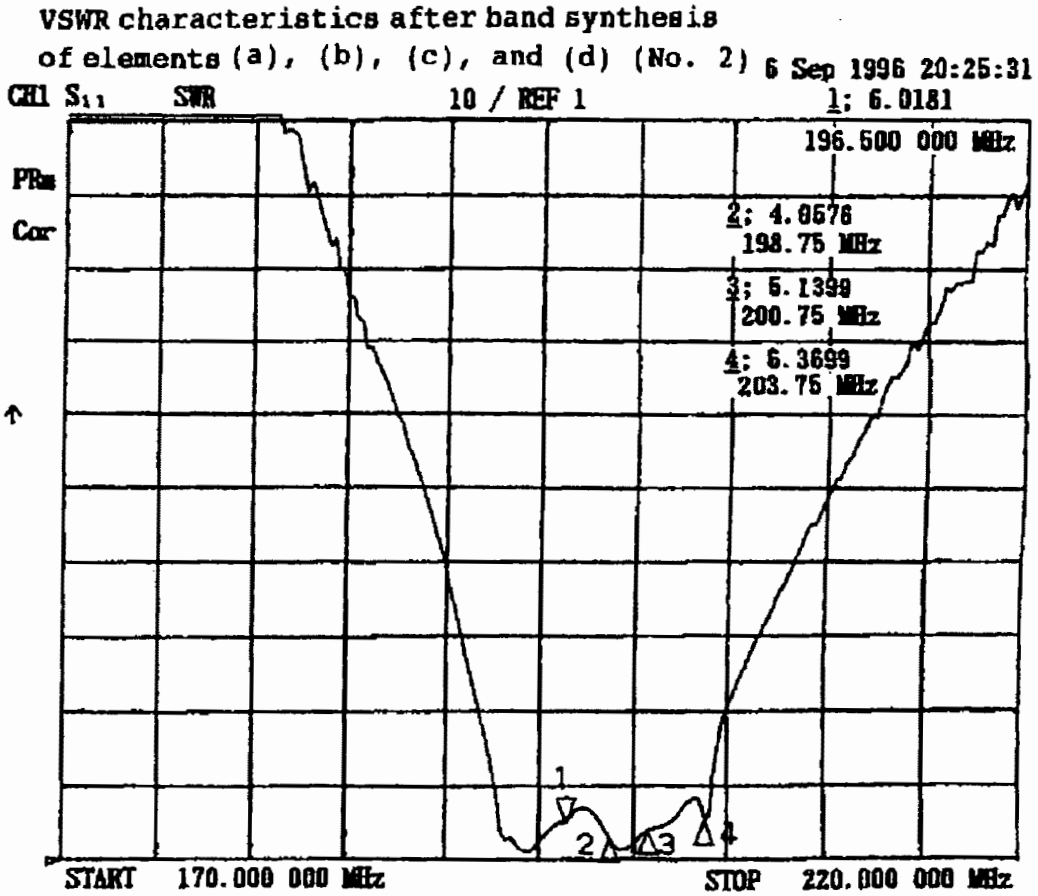
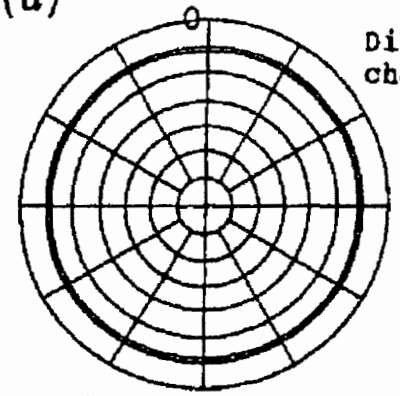

VSWR characteristics after band synthesis
of elements (a), (b), (c), and (d) (No. 2)
6 Sep 1996 20:25:31
CH1 S11 SWR
10 / REF 1
1: 6.0181
196.500 000 MHz
PRm
Cor
2: 4.0676
198.75 MHz
3: 5.1399
200.75 MHz
4: 6.3699
203.75 MHz
START 170.000 000 MHz
STOP 220.000 000 MHz

Fig. 122 (a)

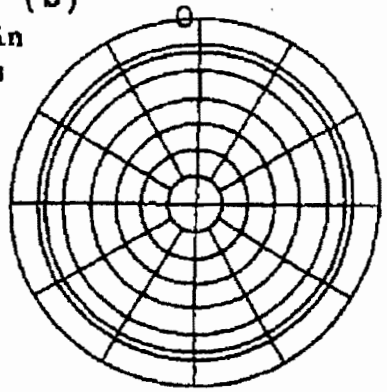


Distance 10mm

Fig. 122 (b)

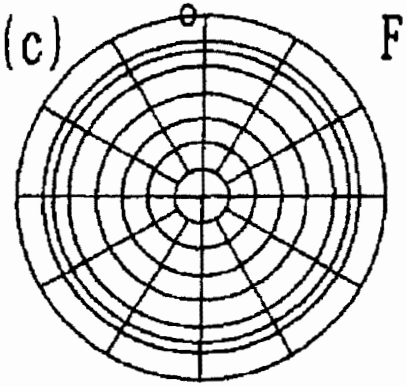
Directional gain characteristics

Vertically polarized waves



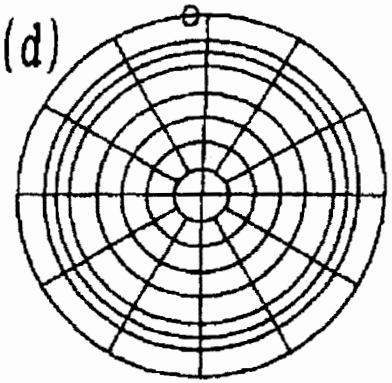
Distance 30mm

Fig. 122 (c)



Distance 80mm

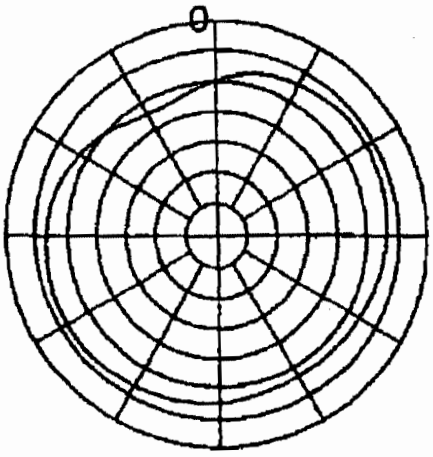
Fig. 122 (d)



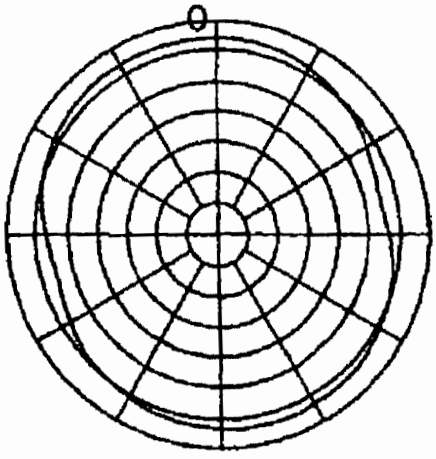
Distance 150mm

Fig. 123

Directional gain characteristics



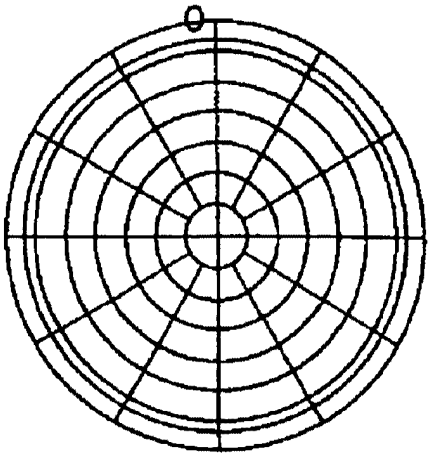
Vertically polarized waves



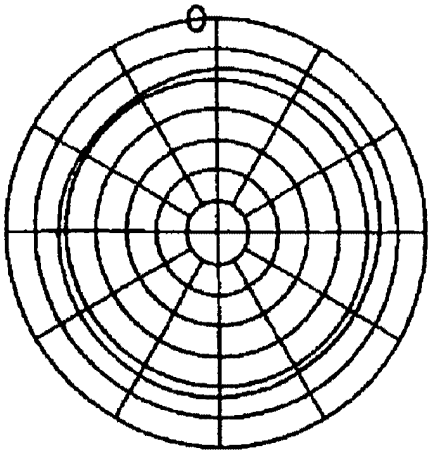
Horizontally polarized waves

Fig. 124

Directional gain characteristics



Vertically polarized waves



Horizontally polarized waves

Fig. 125 (a)

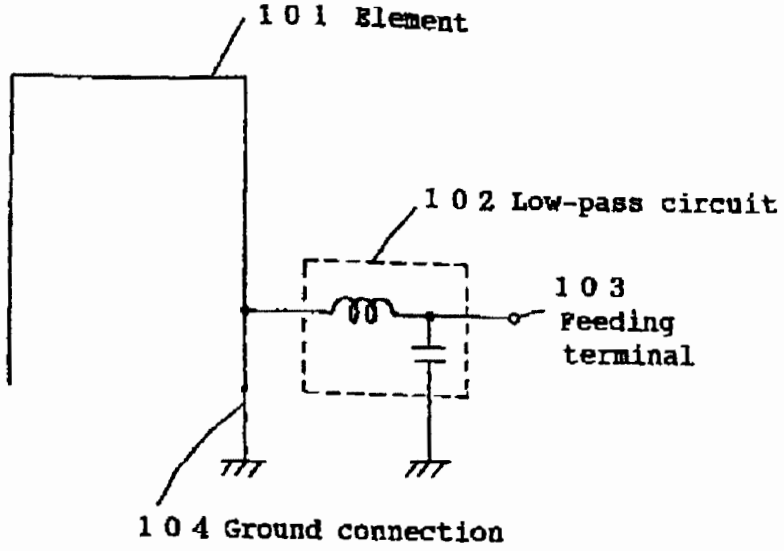


Fig. 125 (b)

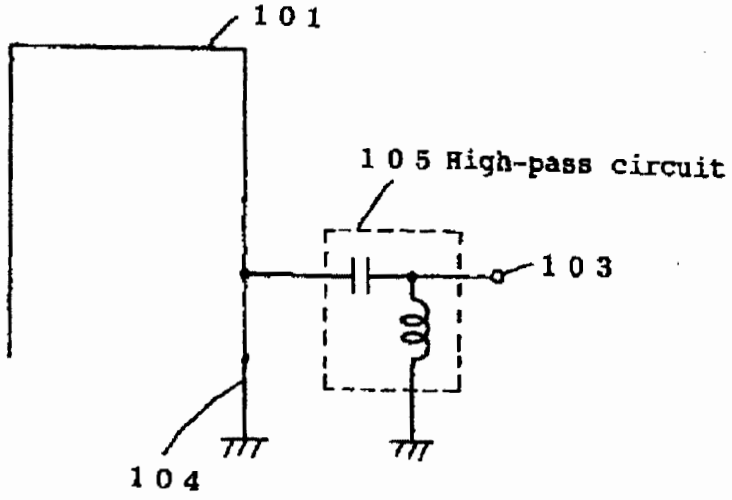


Fig. 126

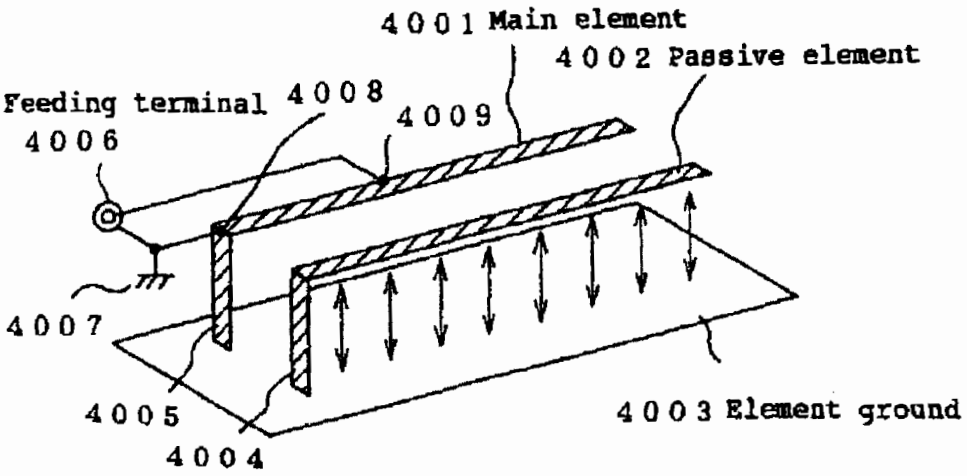

4001 Main element
4002 Passive element
Feeding terminal
4008
4009
4006
4007
4005
4004
4003 Element ground

Fig. 127

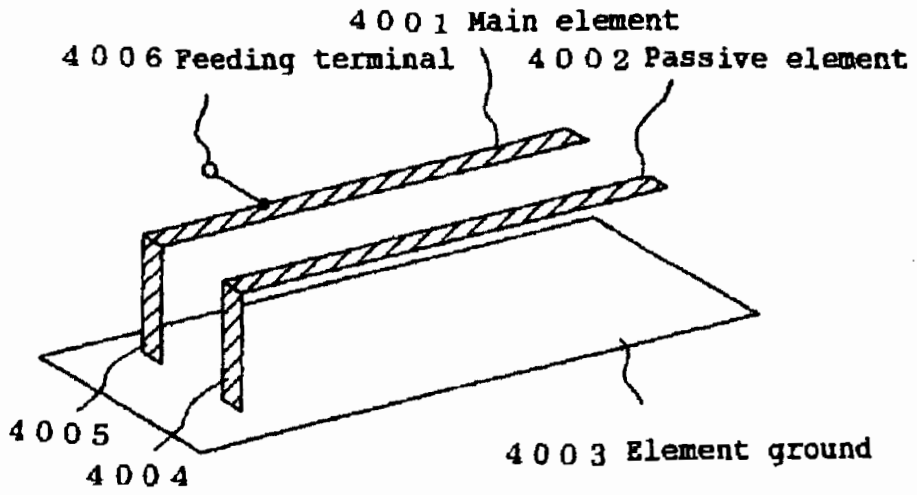

4001 Main element
4006 Feeding terminal
4002 Passive element
4005
4004
4003 Element ground

Fig. 128

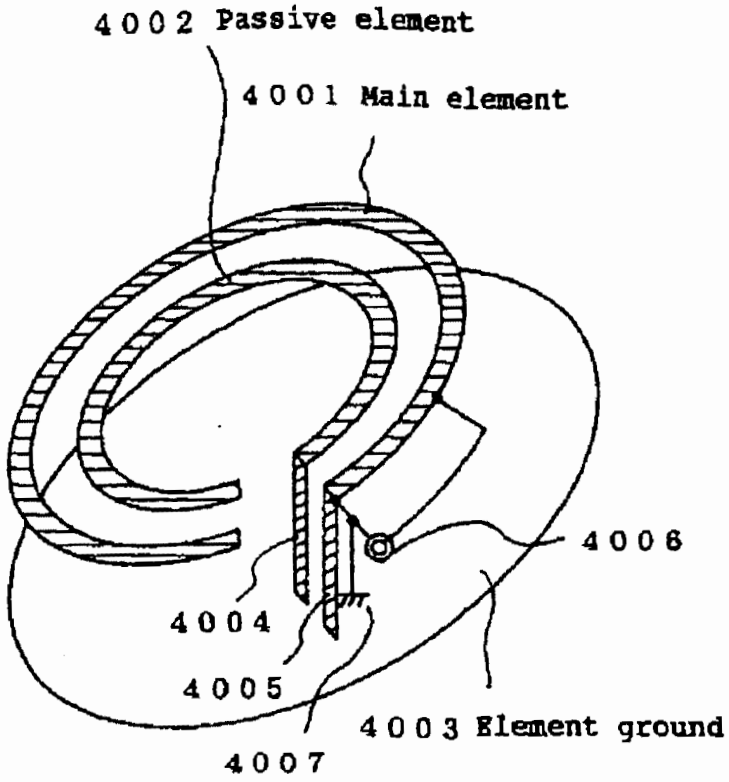

4002 Passive element
4001 Main element
4006
4004
4005
4003 Element ground
4007

Fig. 129 (a)

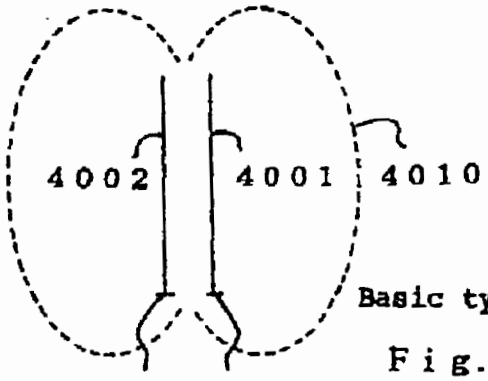


Fig. 129 (b)

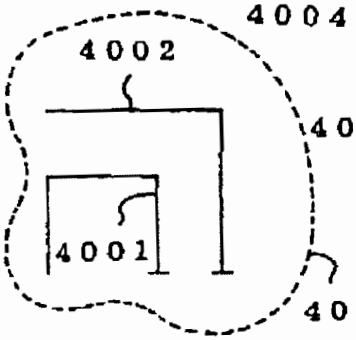


Fig. 129 (c)

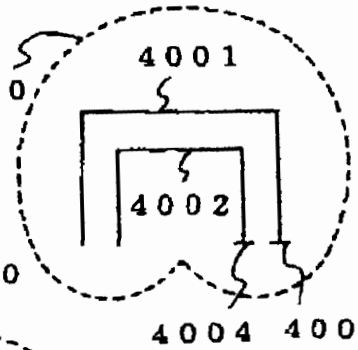


Fig. 129 (d)

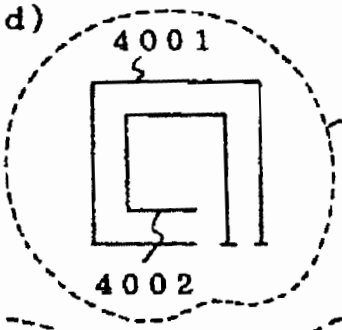


Fig. 129 (e)

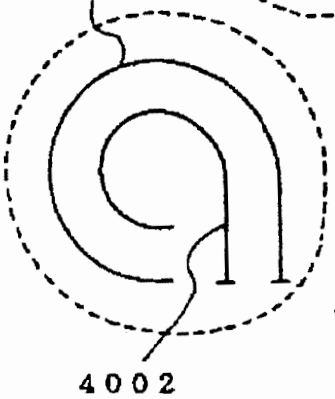


Fig. 129 (f)

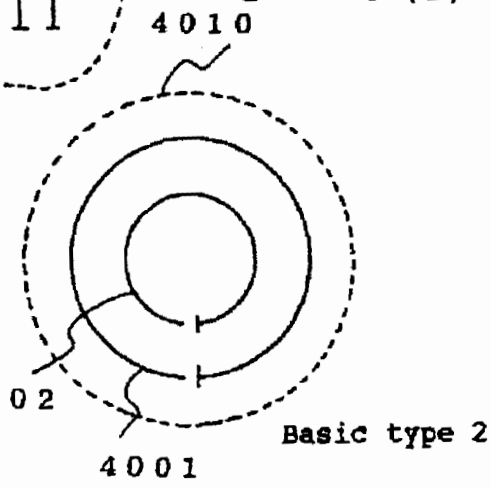


Fig. 130

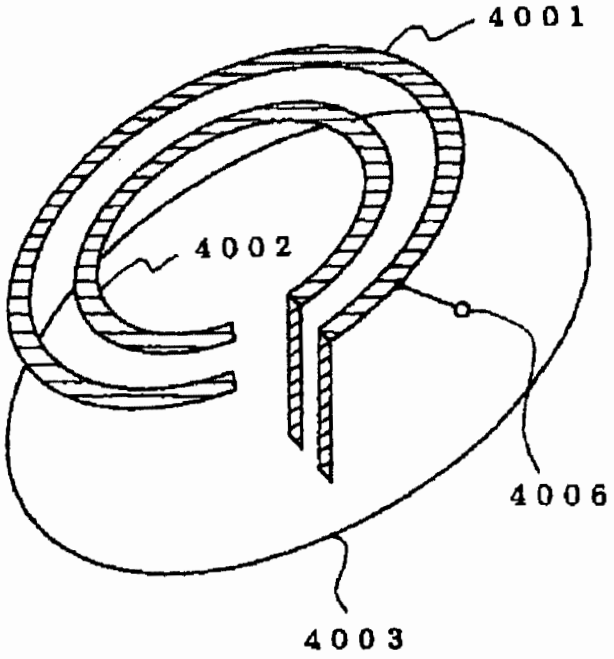


Fig. 131

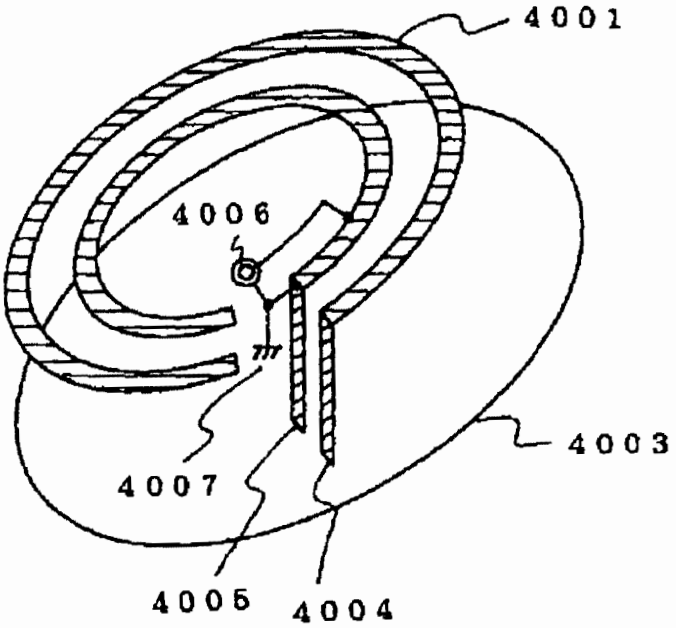


Fig. 132

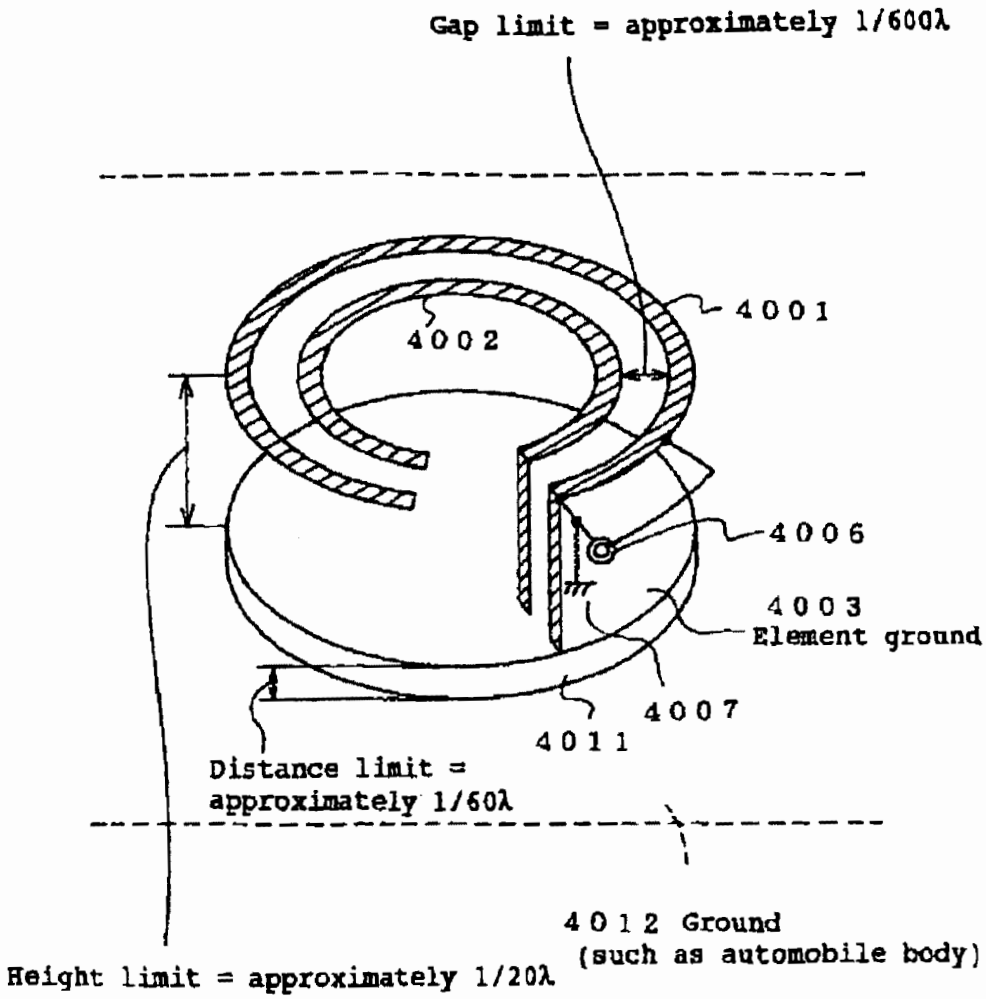
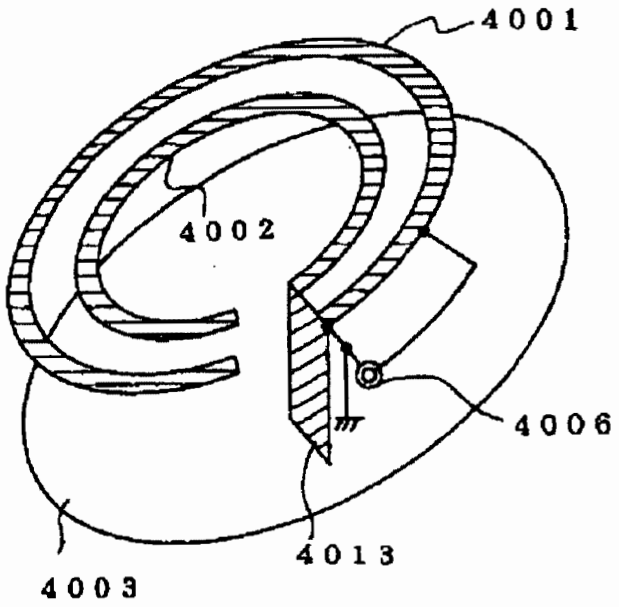

Gap limit = approximately 1/600λ
4001
4002
4006
4003
Element ground
4007
4011
Distance limit =
approximately 1/60λ
4012 Ground
(such as automobile body)
Height limit = approximately 1/20λ

Fig. 133



The structure can be simplified by using a single vertical portion to connect both of the elements and the conductive earth substrate

Fig. 134 (a)

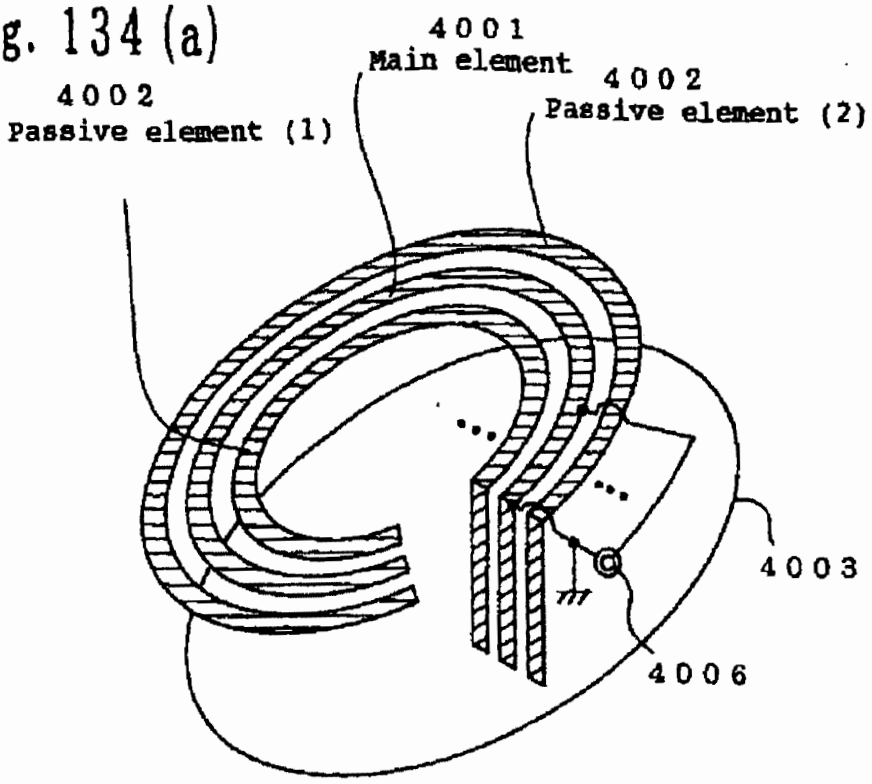


Fig. 134 (b)

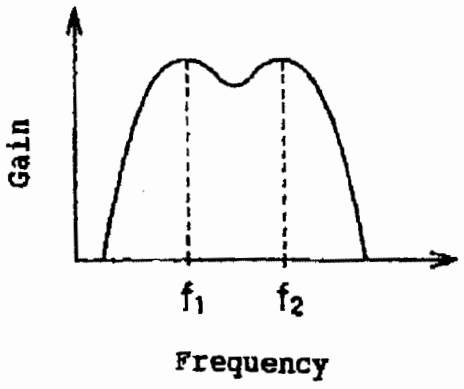


Fig. 135 (a)

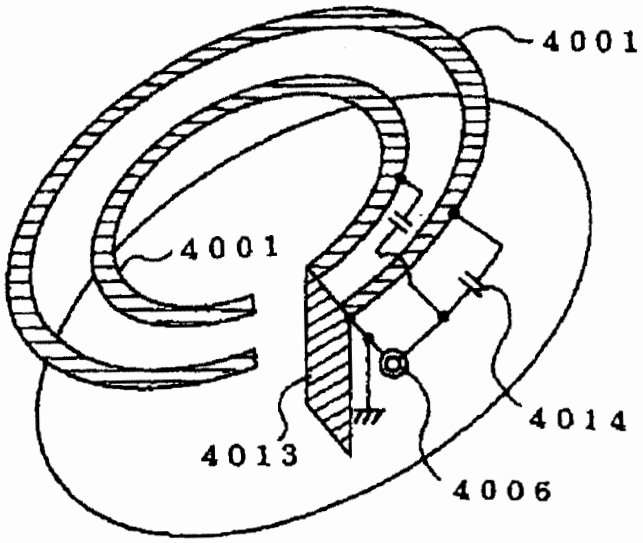


Fig. 135 (b)

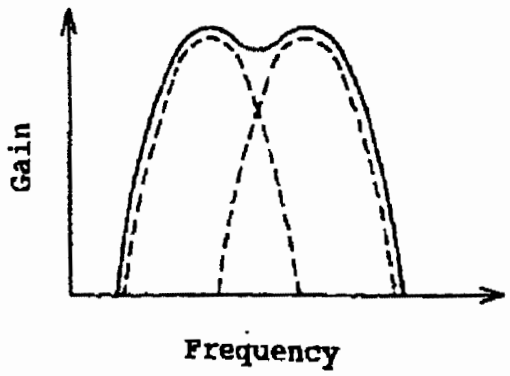


Fig. 136 (a)

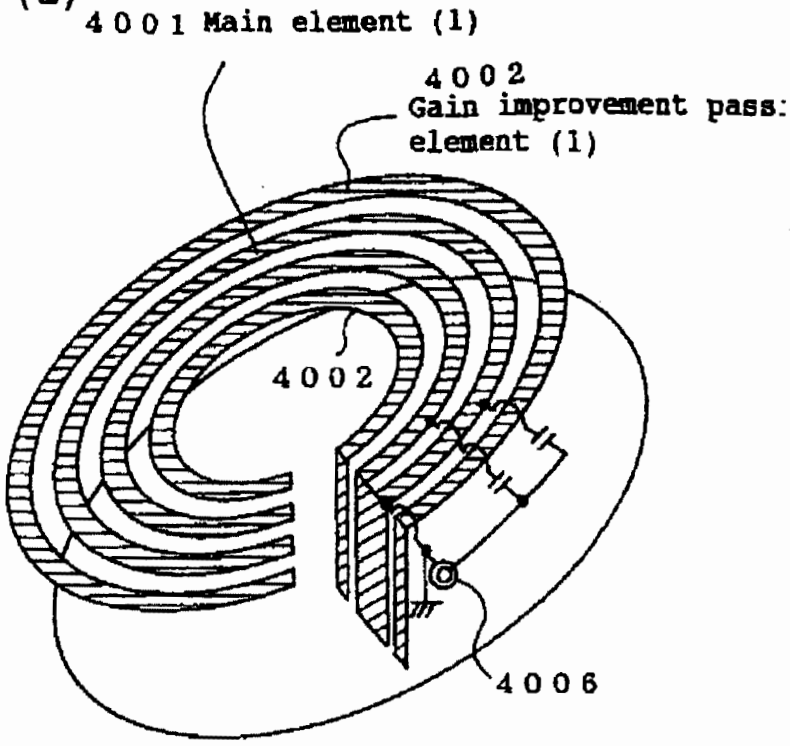


Fig. 136 (b)

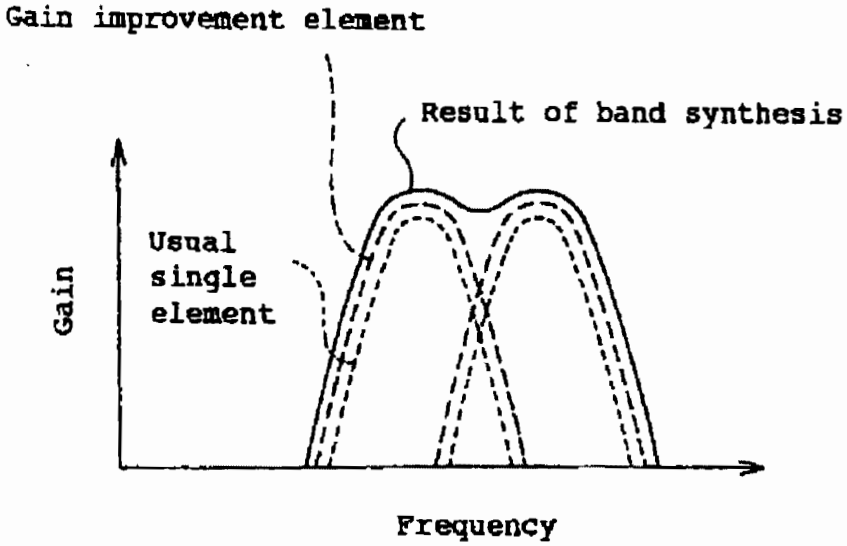


Fig. 137

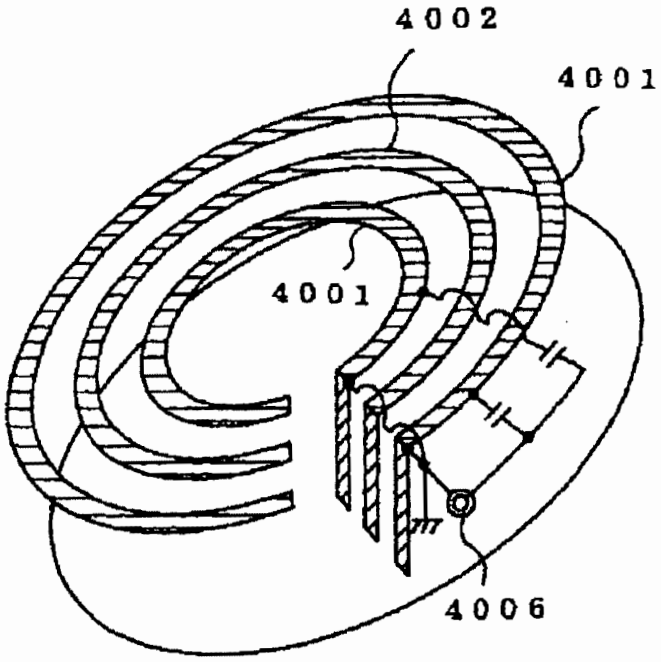
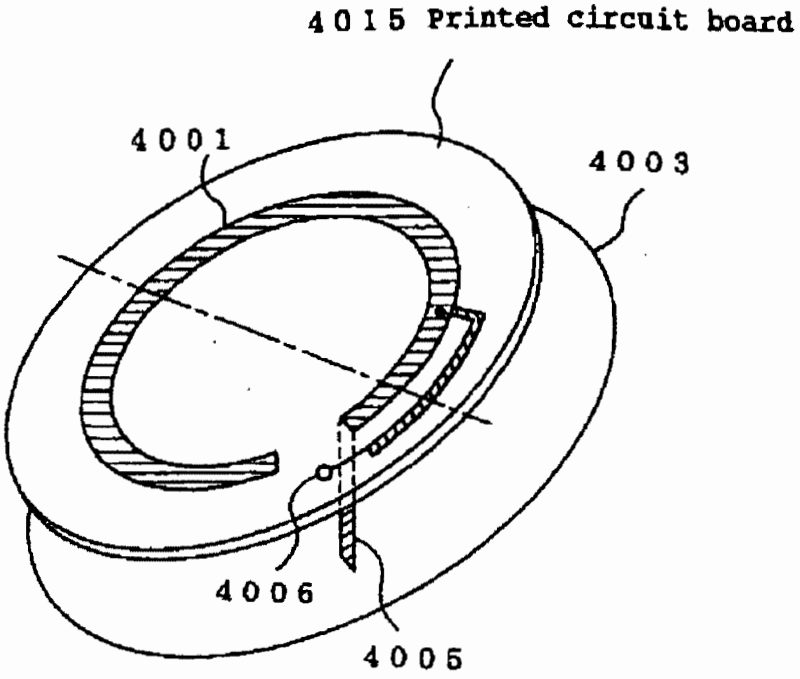


Fig. 138


4015 Printed circuit board
4001
4003
4006
4005

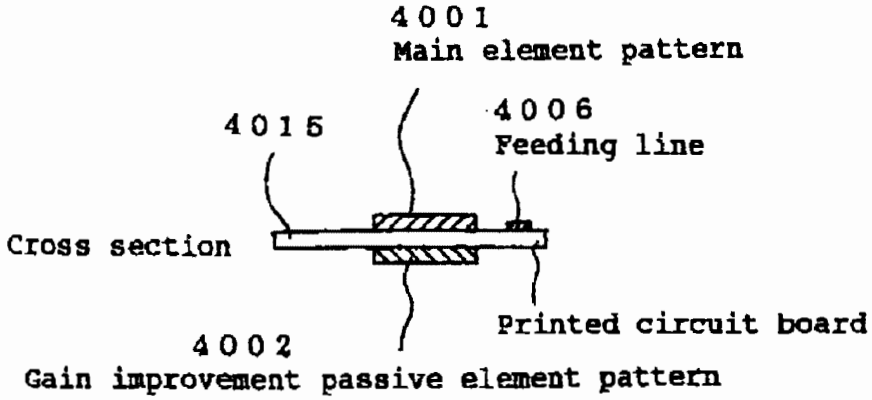

4001
Main element pattern
4015
4006
Feeding line
Cross section
Printed circuit board
4002
Gain improvement passive element pattern

Fig. 139

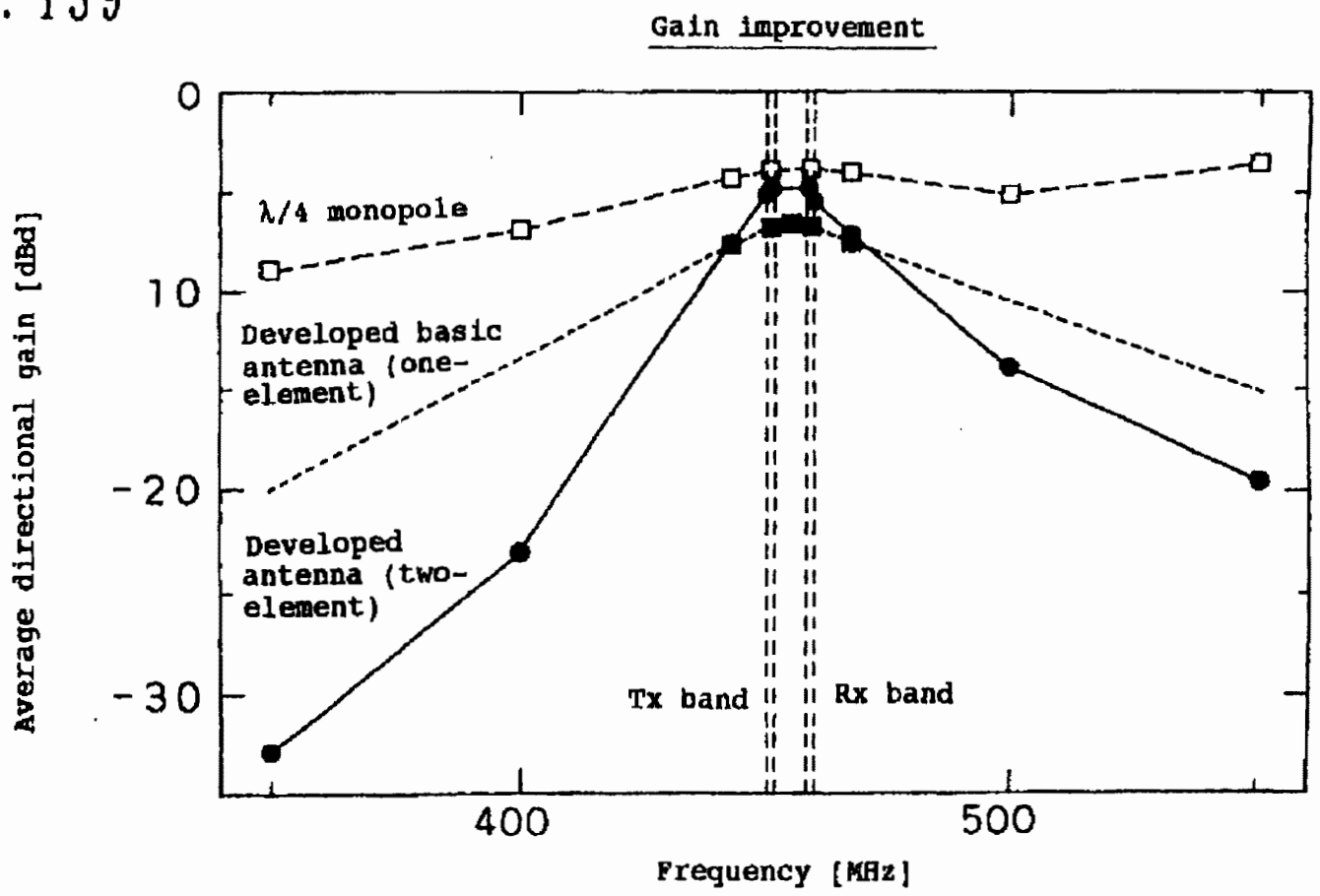
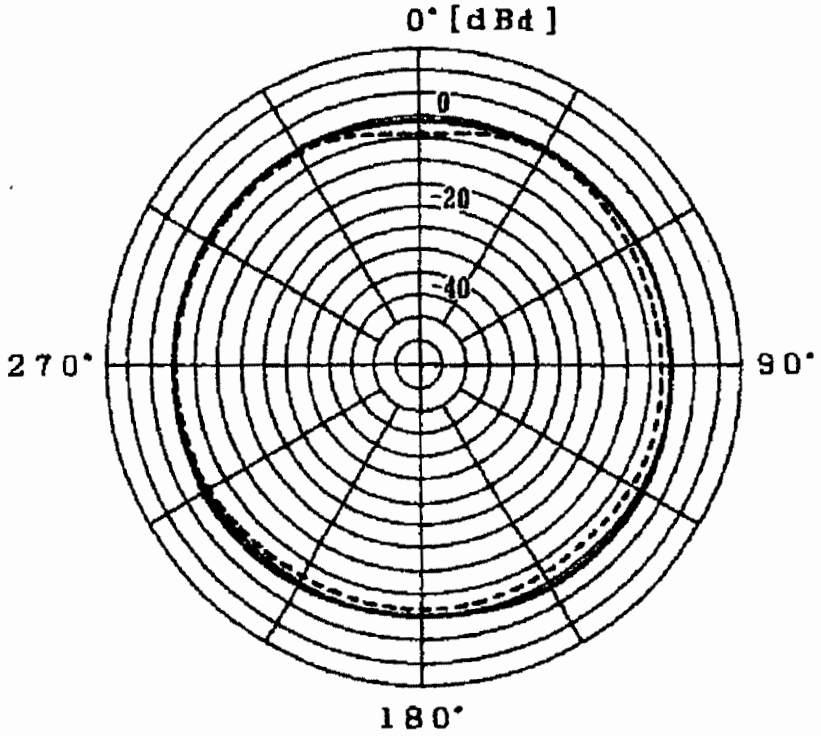

Gain improvement
0
-10
-20
-30
λ/4 monopole
Developed basic antenna (one-element)
Developed antenna (two-element)
Tx band
Rx band
400
500
Frequency [MHz]
Average directional gain [dBd]

Fig. 140

Gain improvement

——— Developed antenna (two-element)

------ Developed basic antenna (one-element)



Tx (451MHz)

Fig. 141

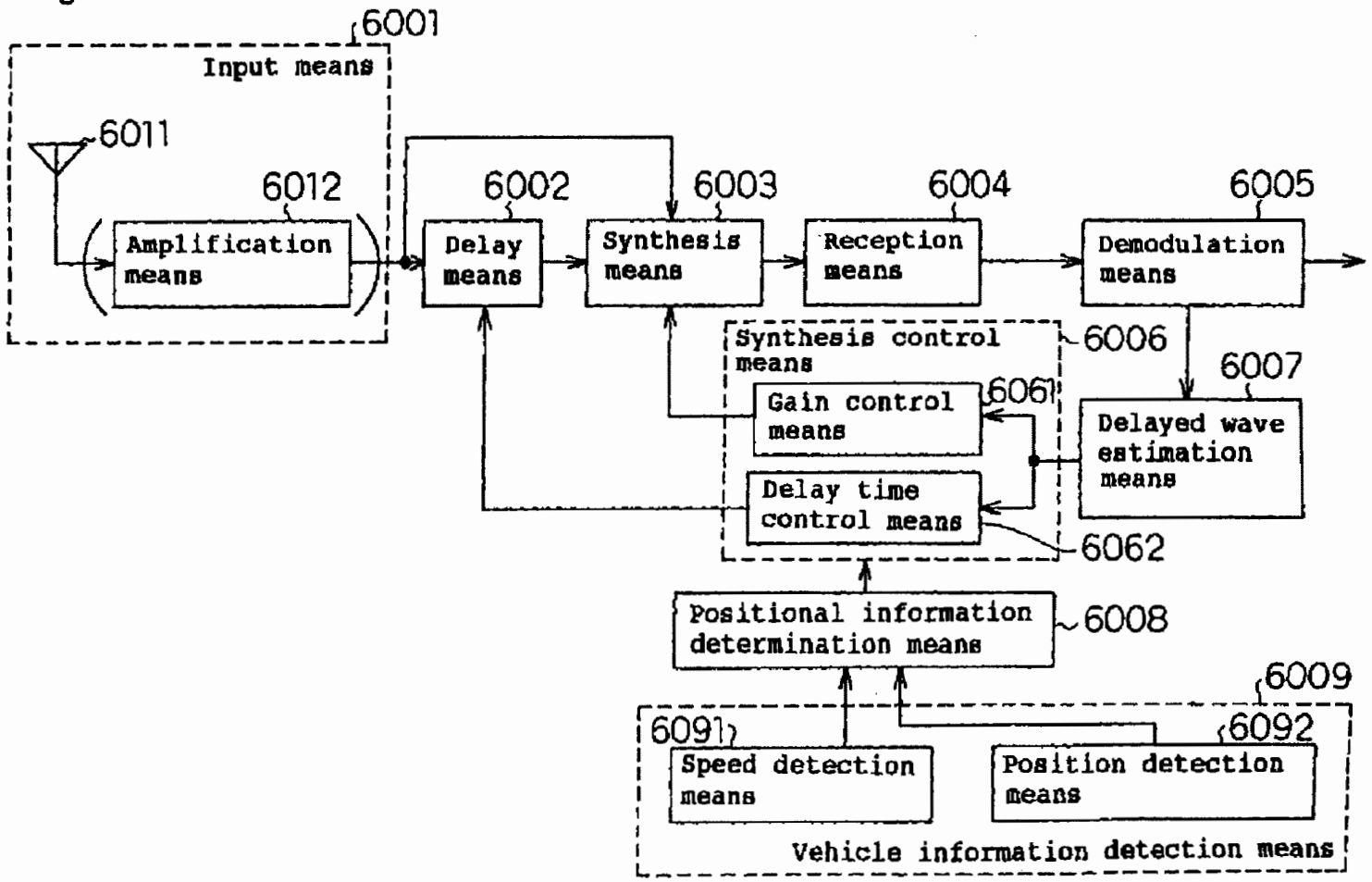

6001
Input means
6011
6012
Amplification means
6002
Delay means
6003
Synthesis means
6004
Reception means
6005
Demodulation means
Synthesis control means
6006
Gain control means
6061
Delay time control means
6062
6007
Delayed wave estimation means
Positional information determination means
6008
6009
6091
Speed detection means
6092
Position detection means
Vehicle information detection means

Fig. 142

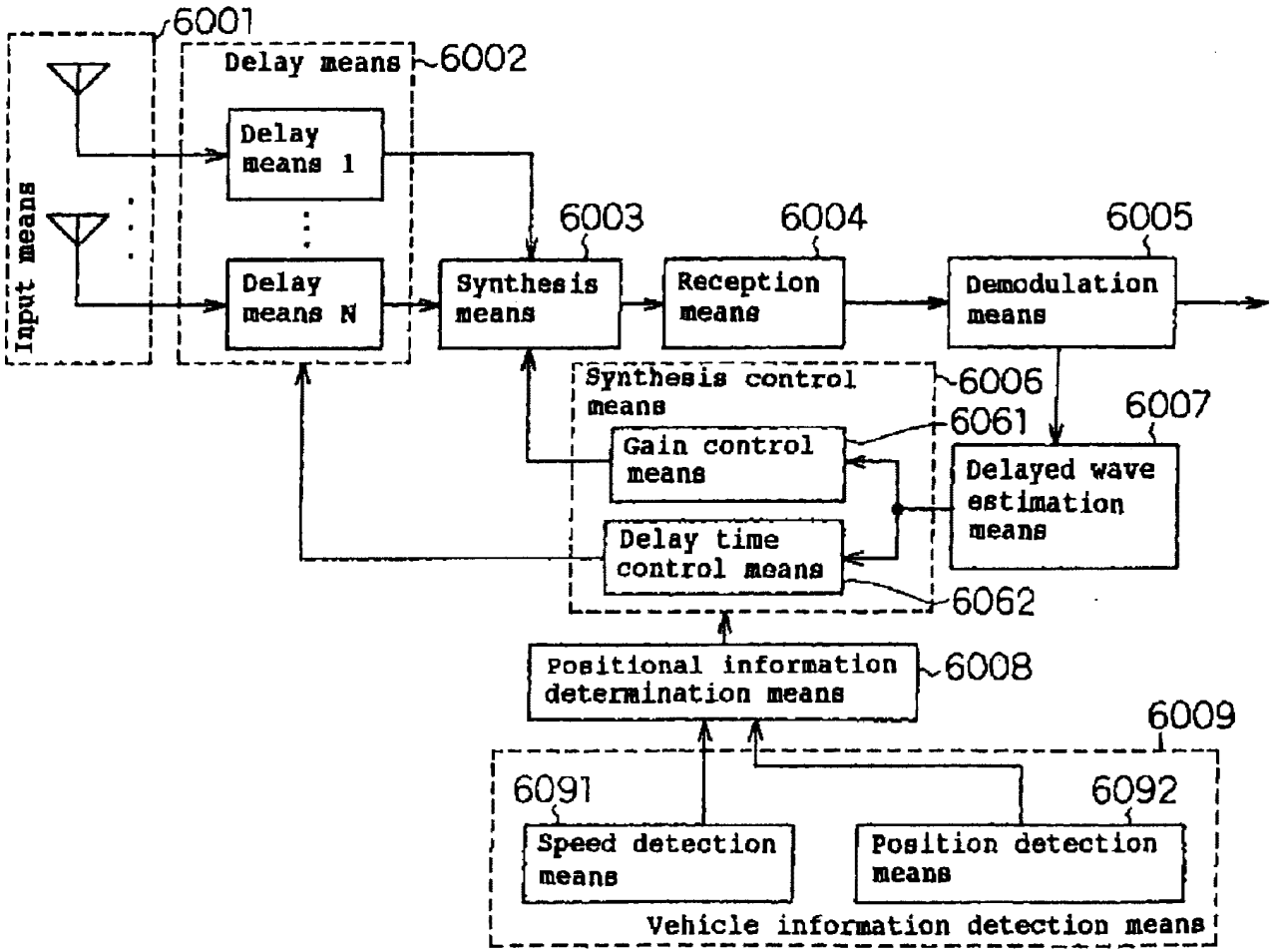
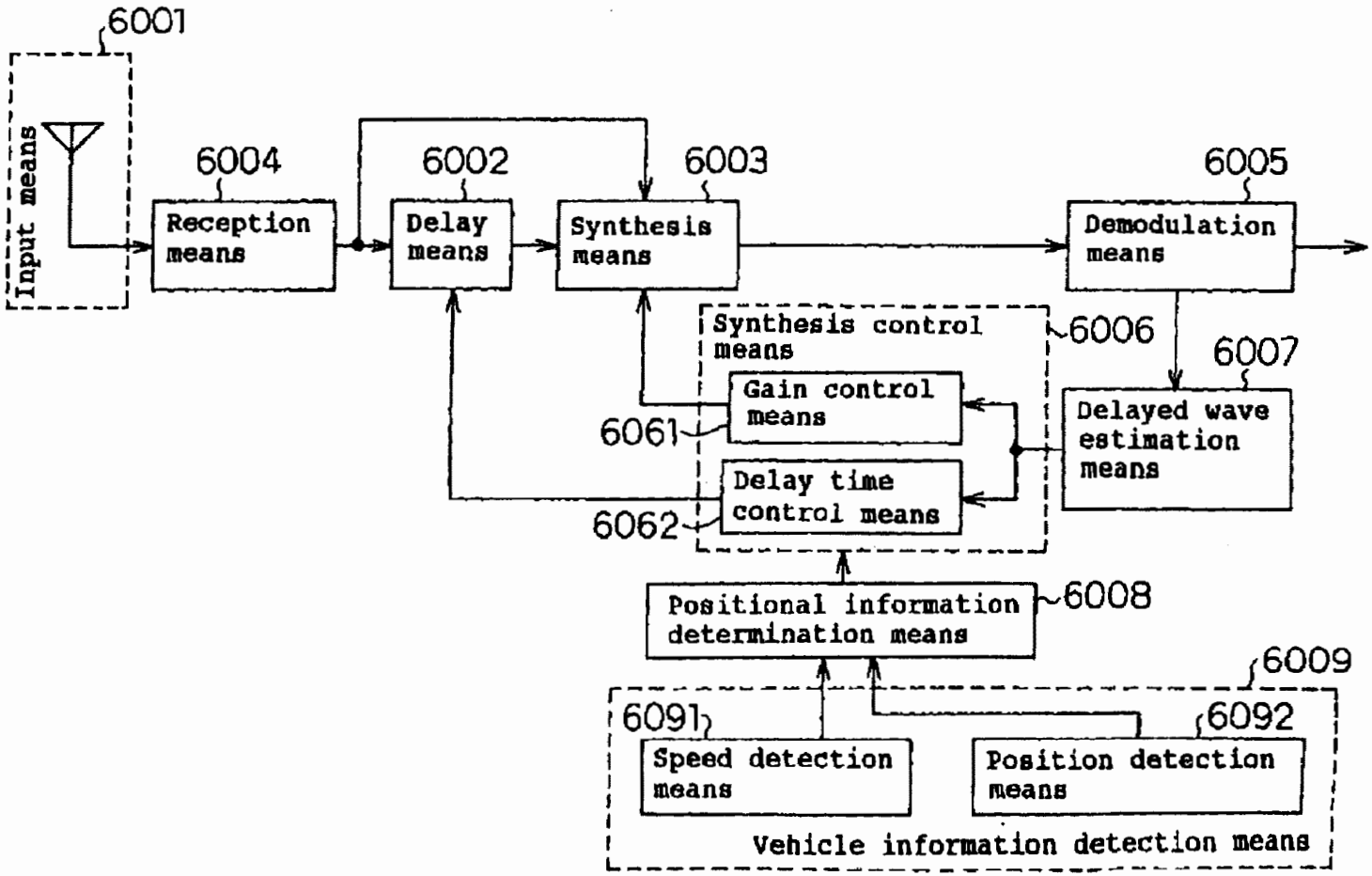
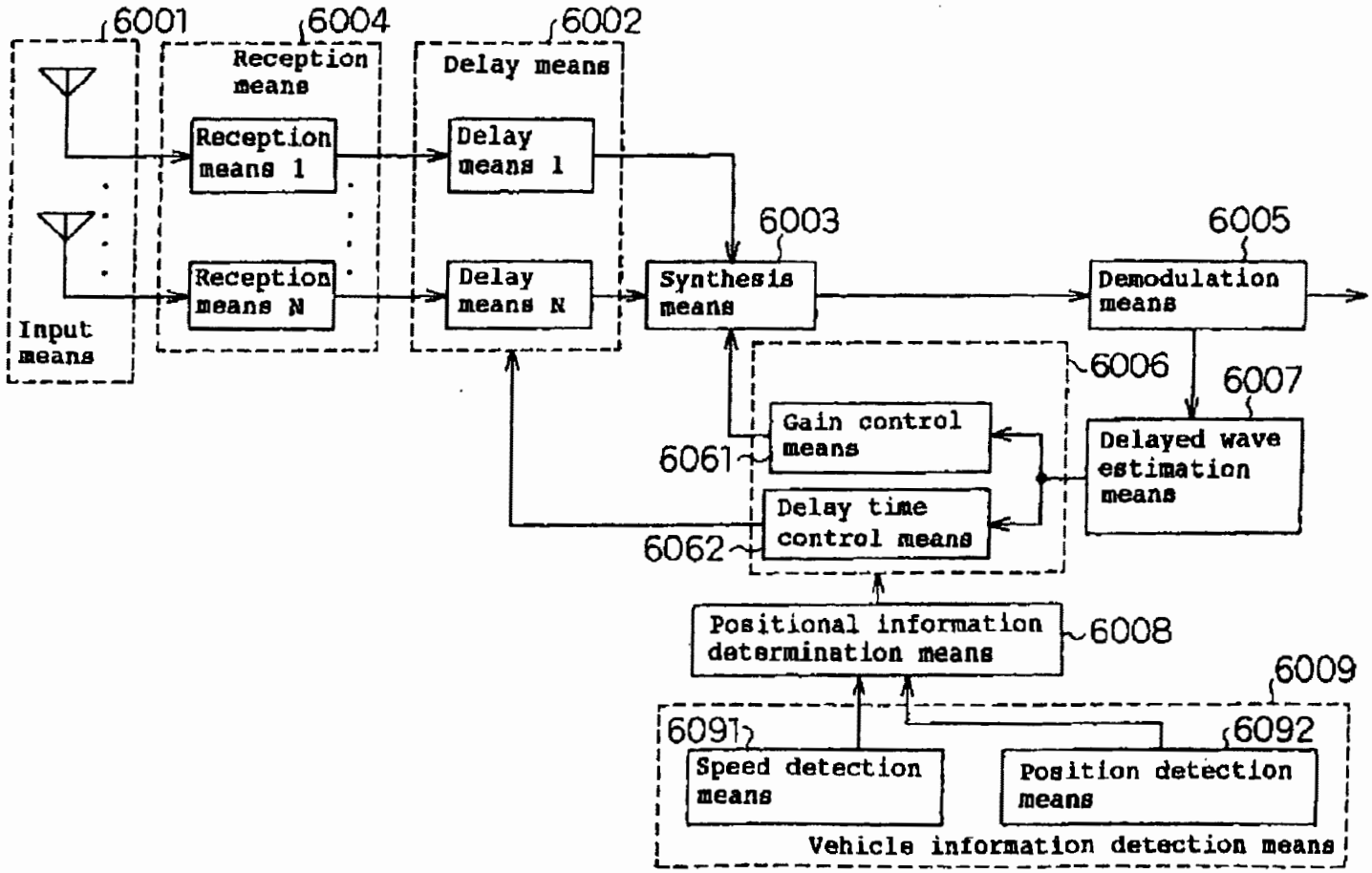

6001
Delay means
6002
Input means
Delay means 1
Delay means N
6003
Synthesis means
6004
Reception means
6005
Demodulation means
Synthesis control means
6006
6061
Gain control means
6007
Delayed wave estimation means
Delay time control means
6062
Positional information determination means
6008
6009
6091
Speed detection means
6092
Position detection means
Vehicle information detection means

Fig. 143



EP 1 011 167 A1

Fig. 144



EP 1 011 167 A1

Fig. 145

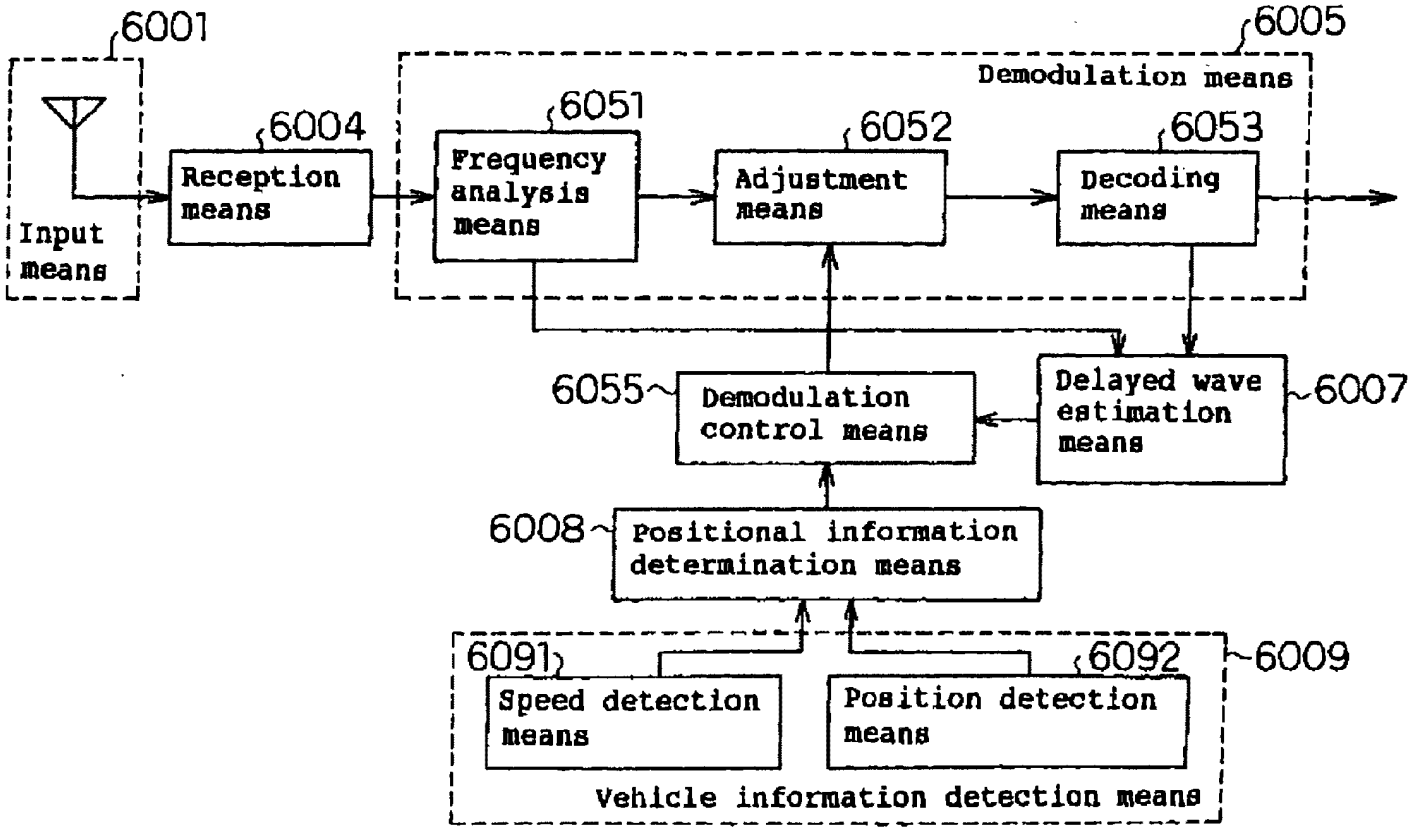
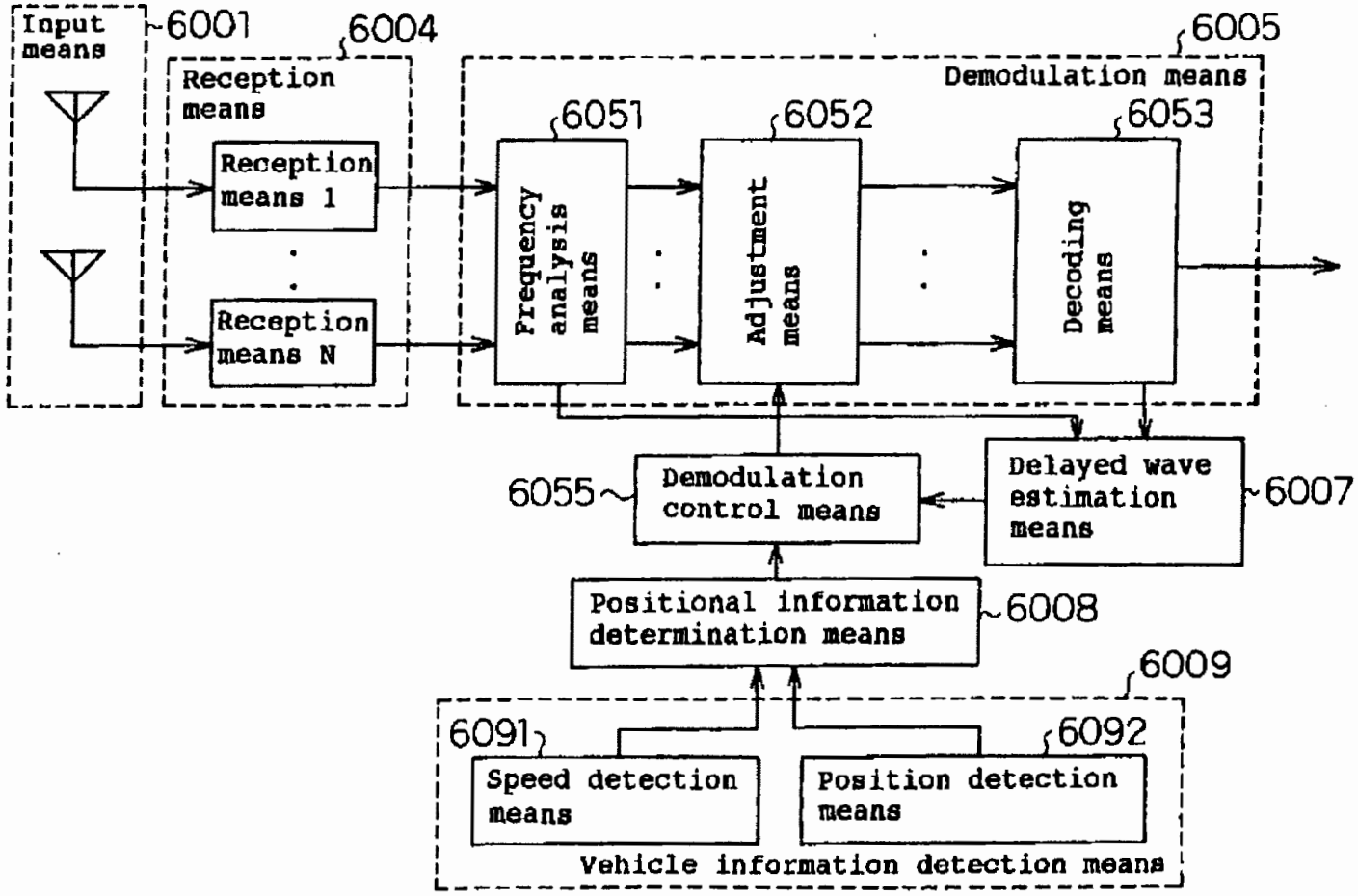

6001
Input means
6004
Reception means
6005
Demodulation means
6051
Frequency analysis means
6052
Adjustment means
6053
Decoding means
6055
Demodulation control means
6007
Delayed wave estimation means
6008
Positional information determination means
6091
Speed detection means
6092
Position detection means
6009
Vehicle information detection means

Fig. 146



EP 1 011 167 A1

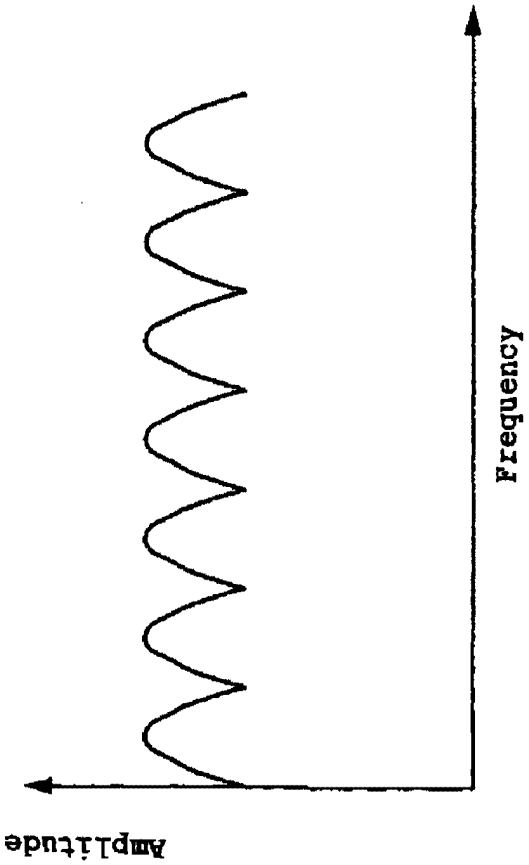
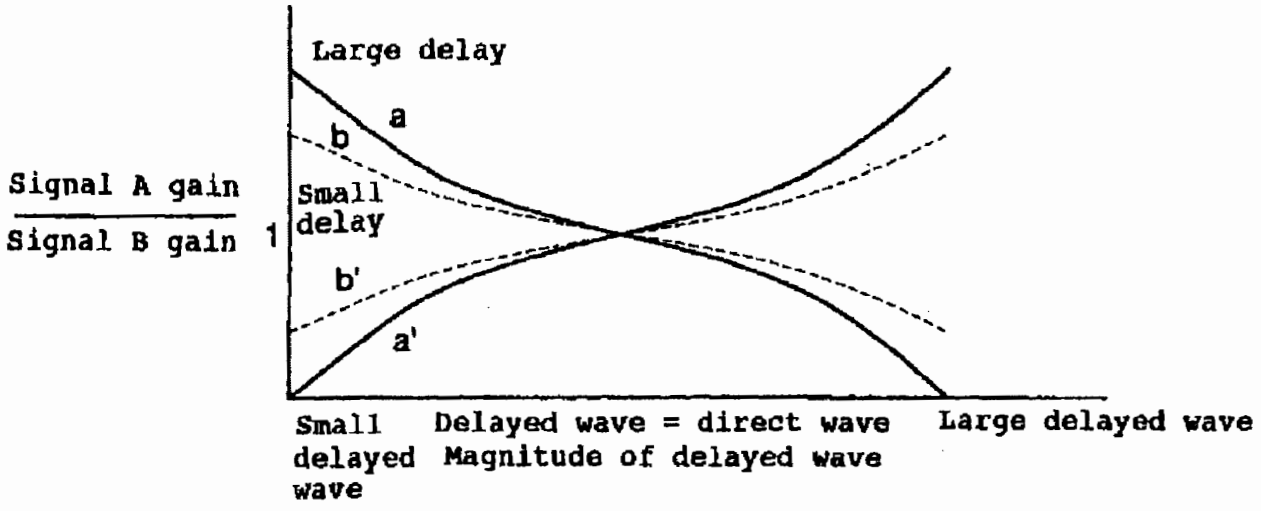


Fig. 147

Fig. 148


Large delay
a
b
Small delay
b'
a'
Signal A gain / Signal B gain
1
Small delayed wave
Delayed wave = direct wave
Magnitude of delayed wave
Large delayed wave

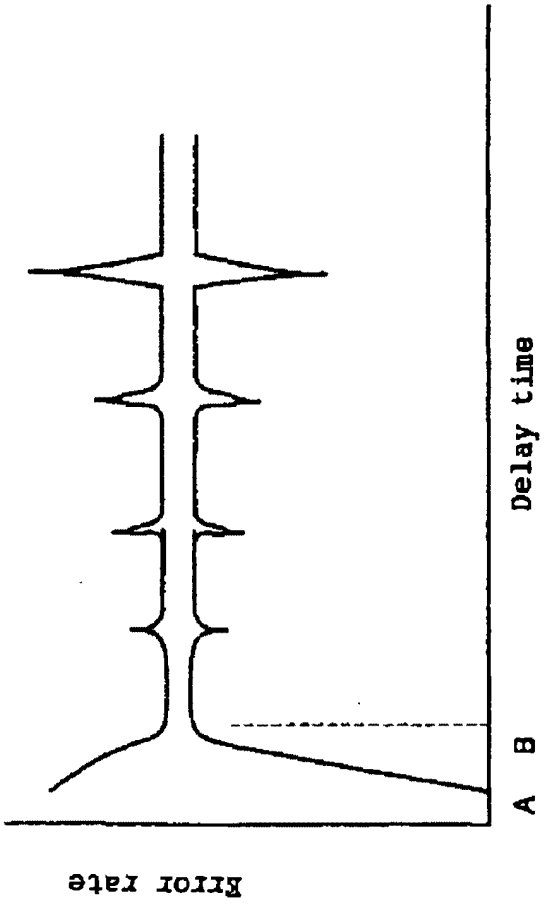
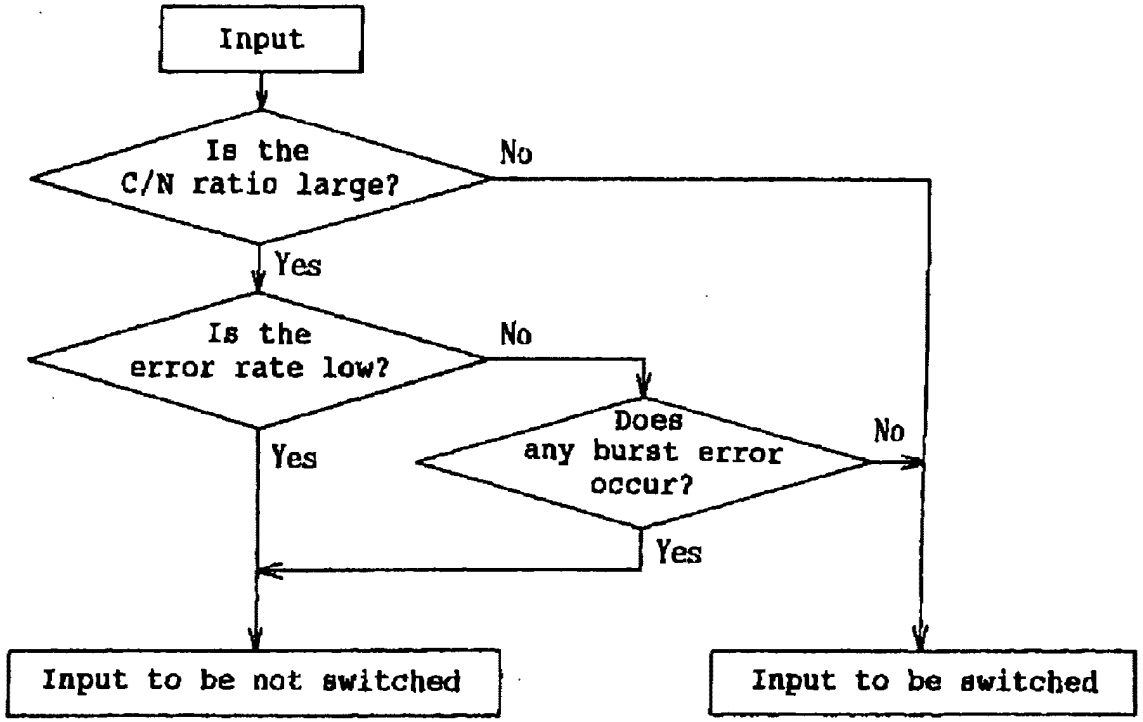


Fig. 149

Fig. 150


Input
Is the C/N ratio large?
No
Yes
Is the error rate low?
No
Yes
Does any burst error occur?
No
Yes
Input to be not switched
Input to be switched

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/05577

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] H01Q21/30, H01Q21/28, H01Q1/32, H01Q5/00, H01Q9/26, H01Q9/42, H01Q23/00, H04B5/44, H01Q3/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] H01Q21/30, H01Q21/28, H01Q1/32, H01Q5/00, H01Q9/26, H01Q9/42, H01Q23/00, H04B5/44, H01Q3/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 5-175727, A (ATR Optical and Radio Communications), 13 July, 1993 (13. 07. 93), Full text ; all drawings (Family: none)	1, 3-29
Y	JP, 9-260925, A (Matsushita Electric Industrial Co., Ltd.), 3 October, 1997 (03. 10. 97), Full text ; all drawings & EP, 797268, A2	1-29, 36, 37
X	JP, 8-78943, A (Nihon Dengyo Kosaku Co., Ltd.), 22 March, 1996 (22. 03. 96), Full text ; all drawings (Family: none)	30, 35
Y		1-29, 31-43
Y	JP, 4-282903, A (Mitsubishi Electric Corp.), 8 October, 1992 (08. 10. 92), Full text ; all drawings (Family: none)	3-11, 13, 16, 17, 21, 23-29, 38-43

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 April, 1999 (20. 04. 99)	18 May, 1999 (18. 05. 99)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/950,835	12/05/2007	2821	1030	47005-P015WUSC1	19	1

CONFIRMATION NO. 7241

UPDATED FILING RECEIPT

23932
JENKENS & GILCHRIST, PC
1445 ROSS AVENUE
SUITE 3200
DALLAS, TX 75202



Date Mailed: 02/27/2008

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Carles Puente Baliarda, San Cugat del Valles (Barcelona), SPAIN;
Jaume Anguera Pros, Vinaros (Castellon), SPAIN;
Jordi Soler Castany, Mataro (Barcelona), SPAIN;
Antonio Condes Martinez, Esplugues de Llobregat (Barcelona), SPAIN;

Power of Attorney: The patent practitioners associated with Customer Number 23932

Domestic Priority data as claimed by applicant

This application is a CON of 11/075,980 03/09/2005 PAT 7,315,289
which is a CON of PCT/EP02/11355 09/10/2002

Foreign Applications

If Required, Foreign Filing License Granted: 12/17/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 11/950,835**

Projected Publication Date: 06/05/2008

Non-Publication Request: No

Early Publication Request: No

Title

COUPLED MULTIBAND ANTENNAS

Preliminary Class

343

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
11/950,835		2821	

Correspondence Address / Fee Address Change

The following fields have been set to Customer Number 61060 on 02/22/2008

- Correspondence Address
- Maintenance Fee Address

The address of record for Customer Number 61060 is:
WINSTEAD PC
P.O. BOX 50784
DALLAS,TX 75201

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: February 11, 2008
Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda

Application No.: 11/950,835 Confirmation No.: 7241

Filed: Dec. 05, 2007 Art Unit: 2821

For: Coupled Multiband Antennas Examiner: Not Yet Assigned

RESPONSE TO NOTICE TO FILE MISSING PARTS

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

Dear Sir:

INTRODUCTORY COMMENTS

In response to the Notice To File Missing Parts and prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Drawings begin on page 2 of this paper.

Remarks/Arguments begin on page 3 of this paper.

Replacement Sheets are appended following page 3 of this paper.

Power of Attorney is appended following the Replacement Sheets of this paper.

AMENDMENT TO THE DRAWINGS

Please replace FIGS. 1-17 with new FIGS. 1-17 on the sheets marked Replacement Sheet appended to this response following the Remarks section.

REMARKS

In response to the Notice to File Missing Parts, Applicant respectfully submits the attached Replacement Sheets.

Applicant has also attached the Power of Attorney executed by the Assignee of U.S. Patent Application No. 11/075980. The present application is a continuation of U.S. Patent Application No. 11/075980. Therefore, Applicant respectfully requests that the Power of Attorney listed on the Filing Receipt be changed to reflect the attached documents.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Dated: February 11, 2008

Respectfully submitted,
Electronic signature: /Ross T. Robinson/
Ross T. Robinson
Registration No.: 47,031
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

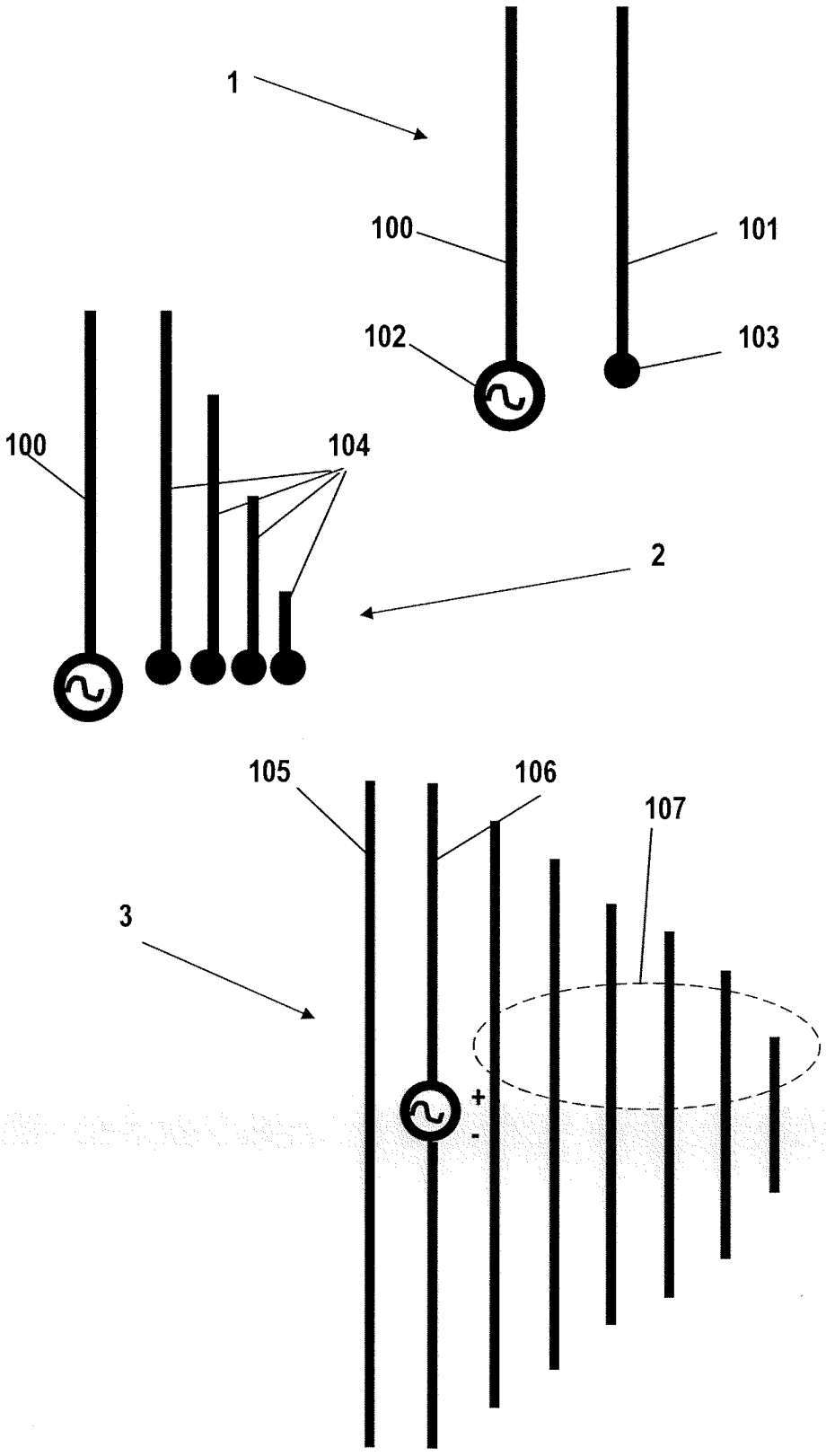
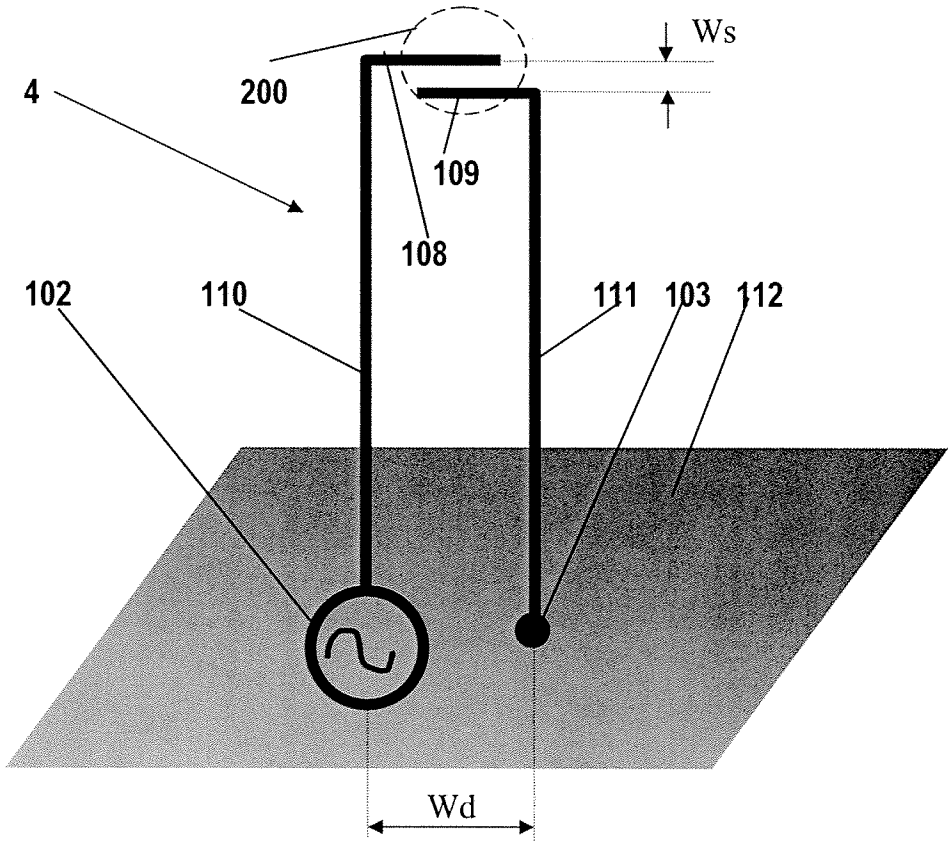


Figure 1 (Prior Art)


Ws
4
200
109
108
102
110
111
103
112
Wd

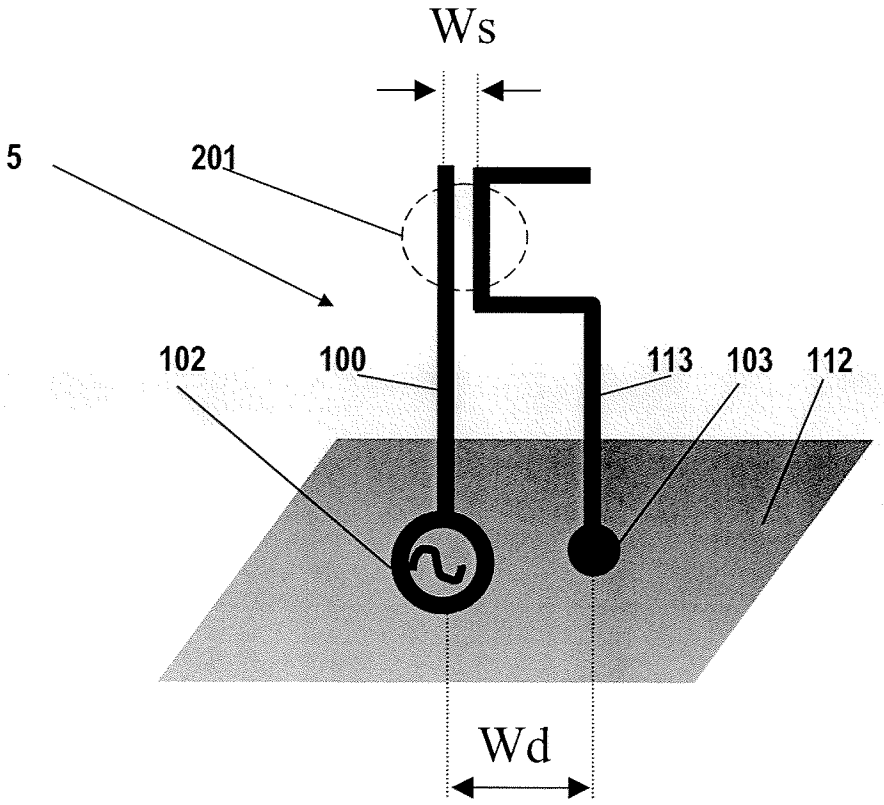

Ws
5
201
102
100
113
103
112
Wd

Figure 2

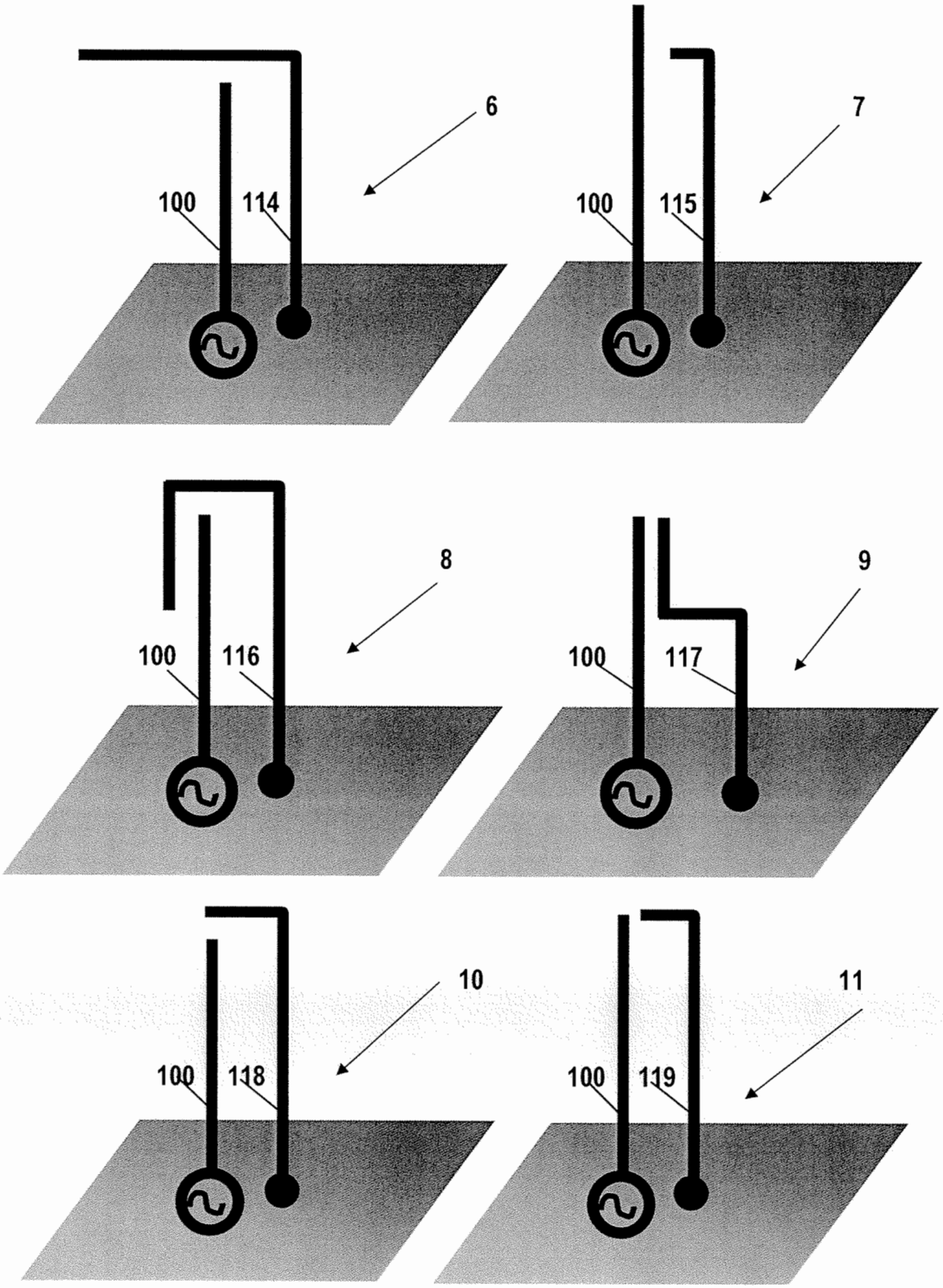


Figure 3

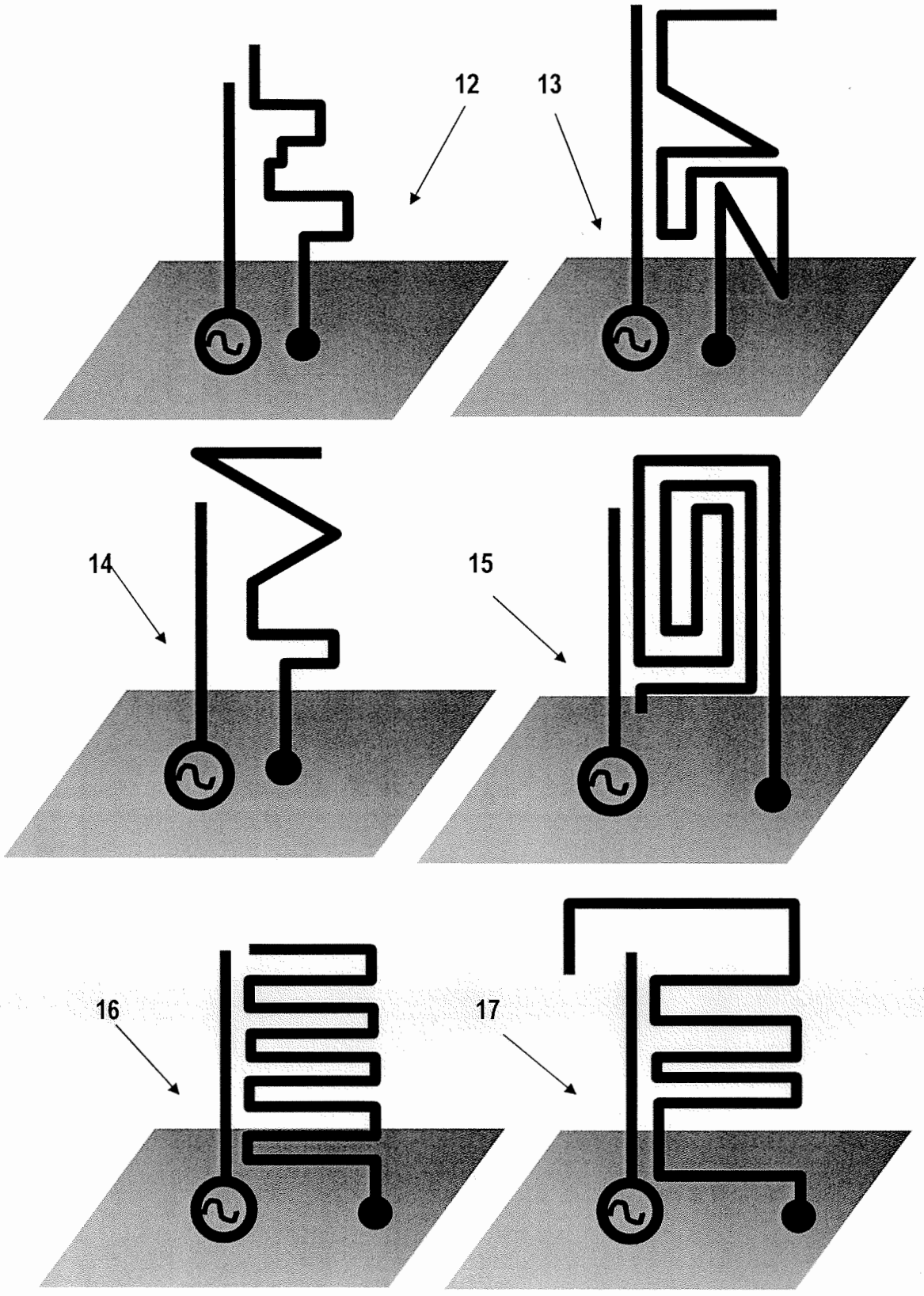


Figure 4

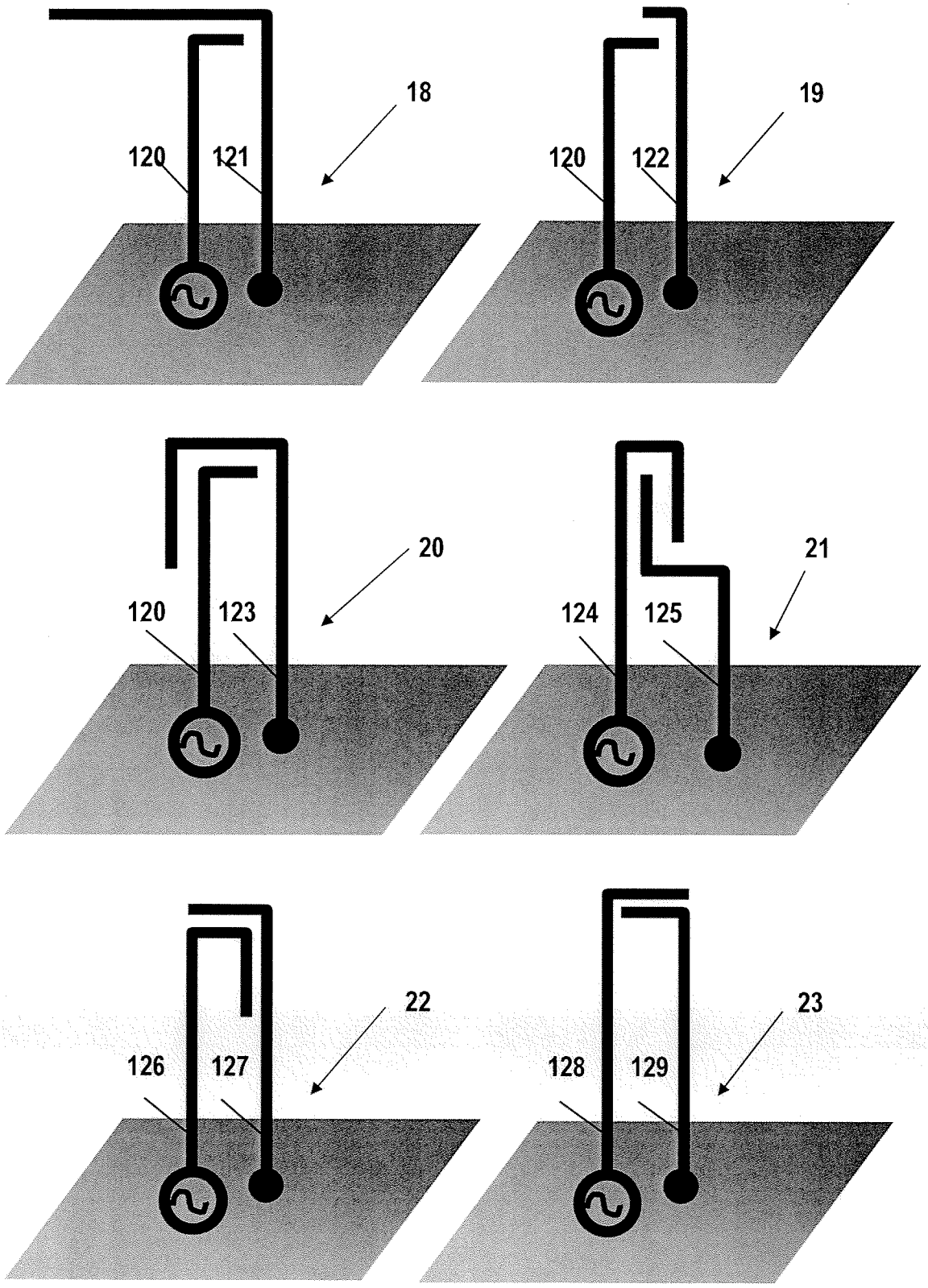


Figure 5

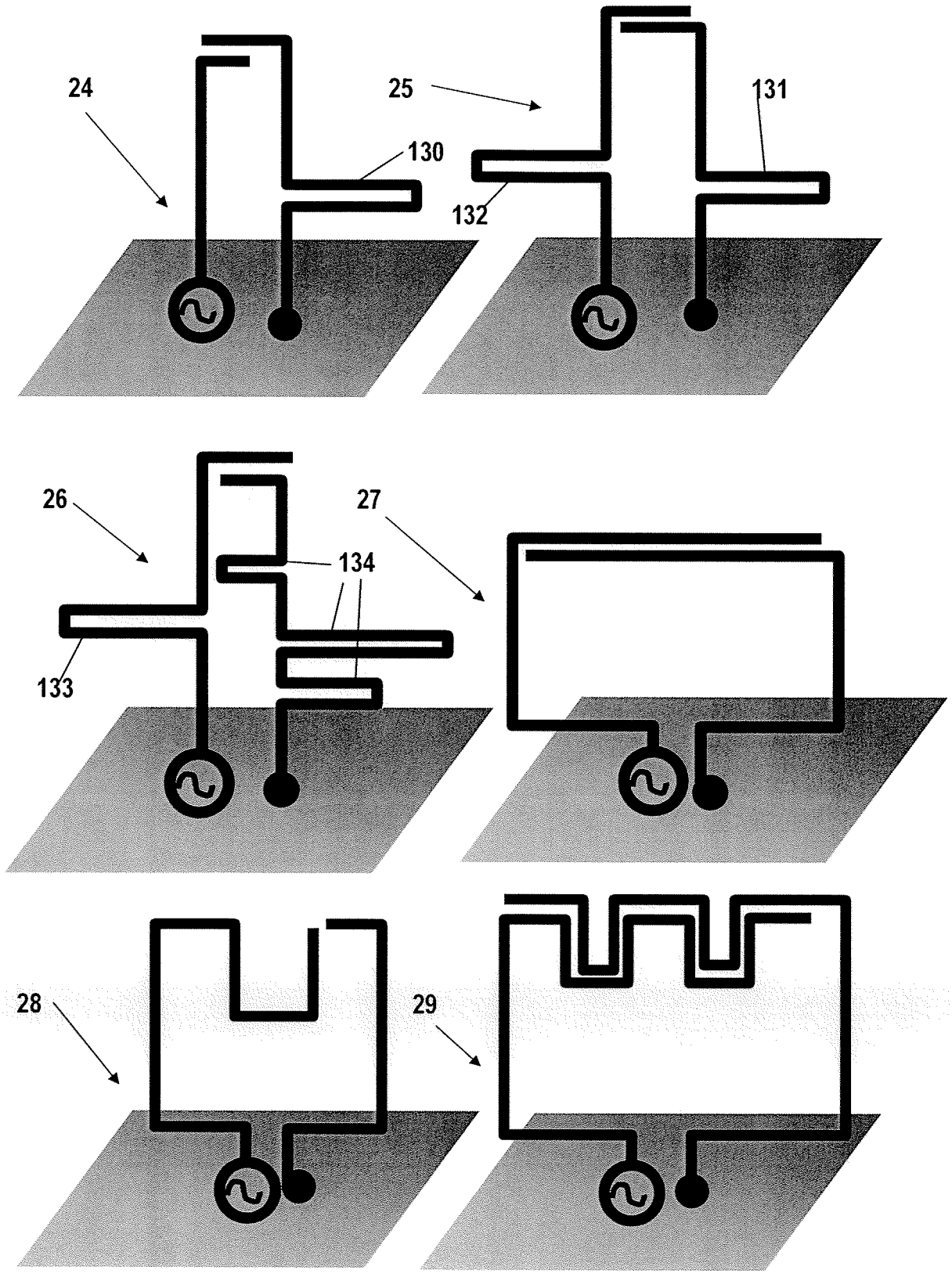


Figure 6

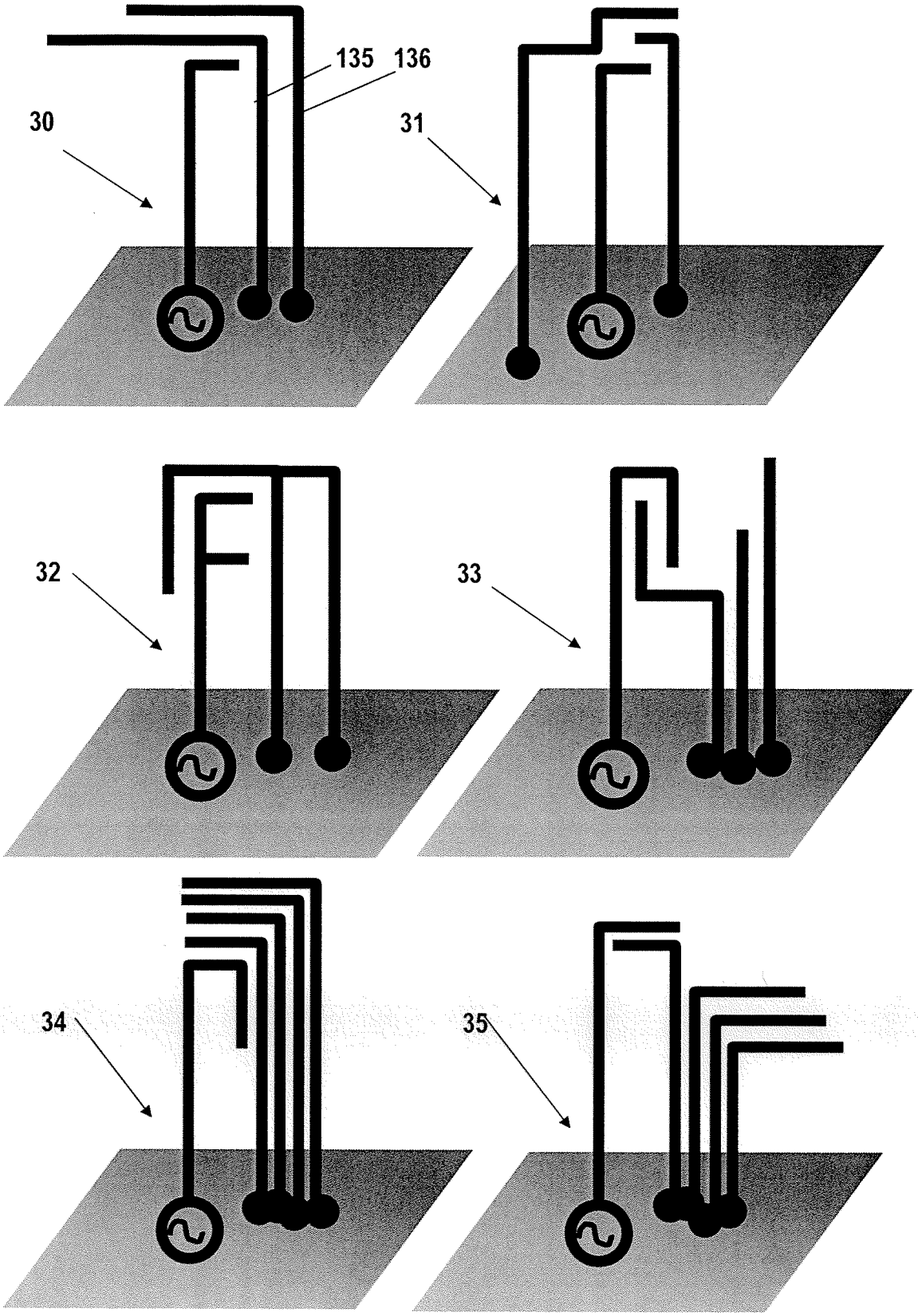


Figure 7

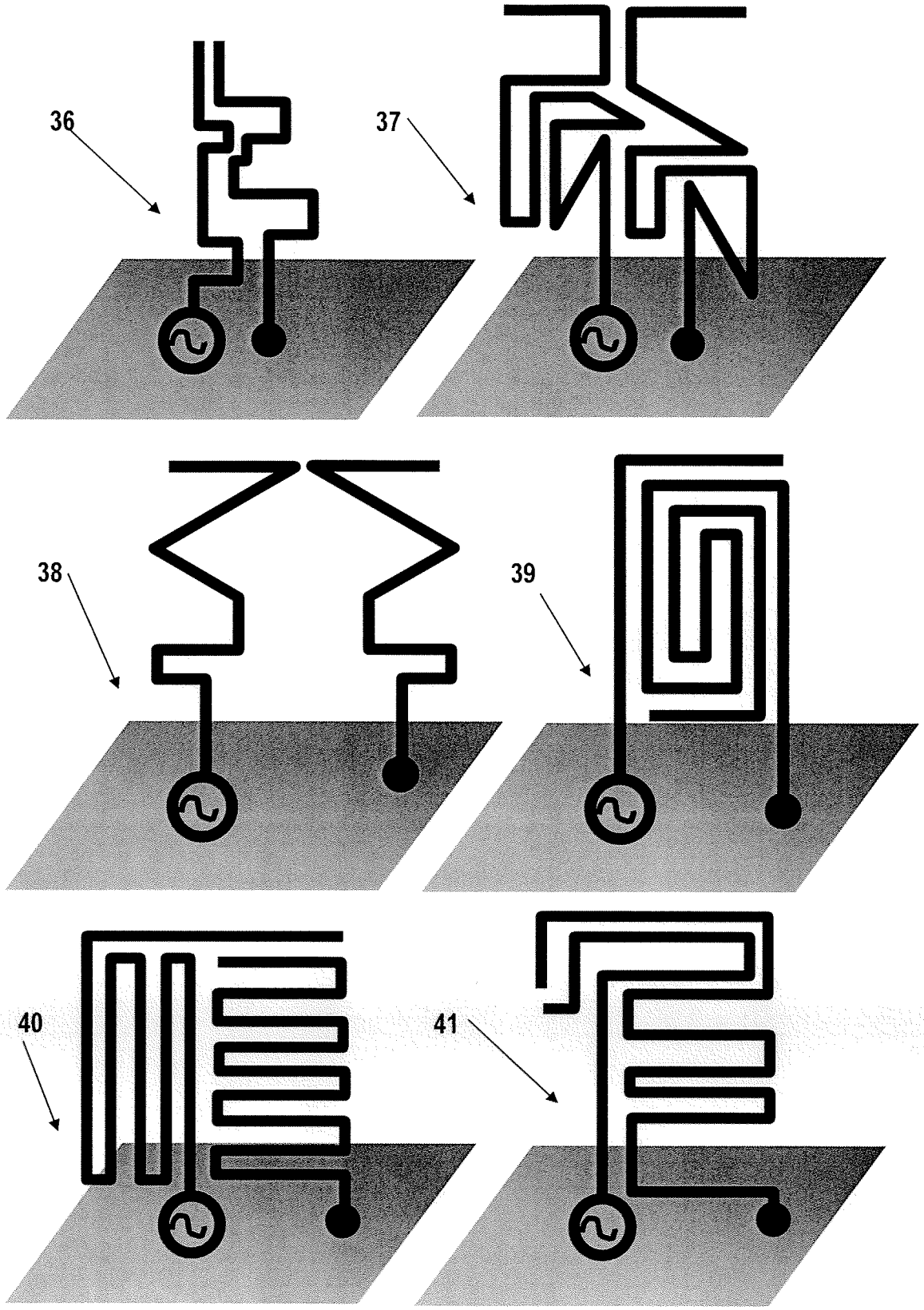


Figure 8

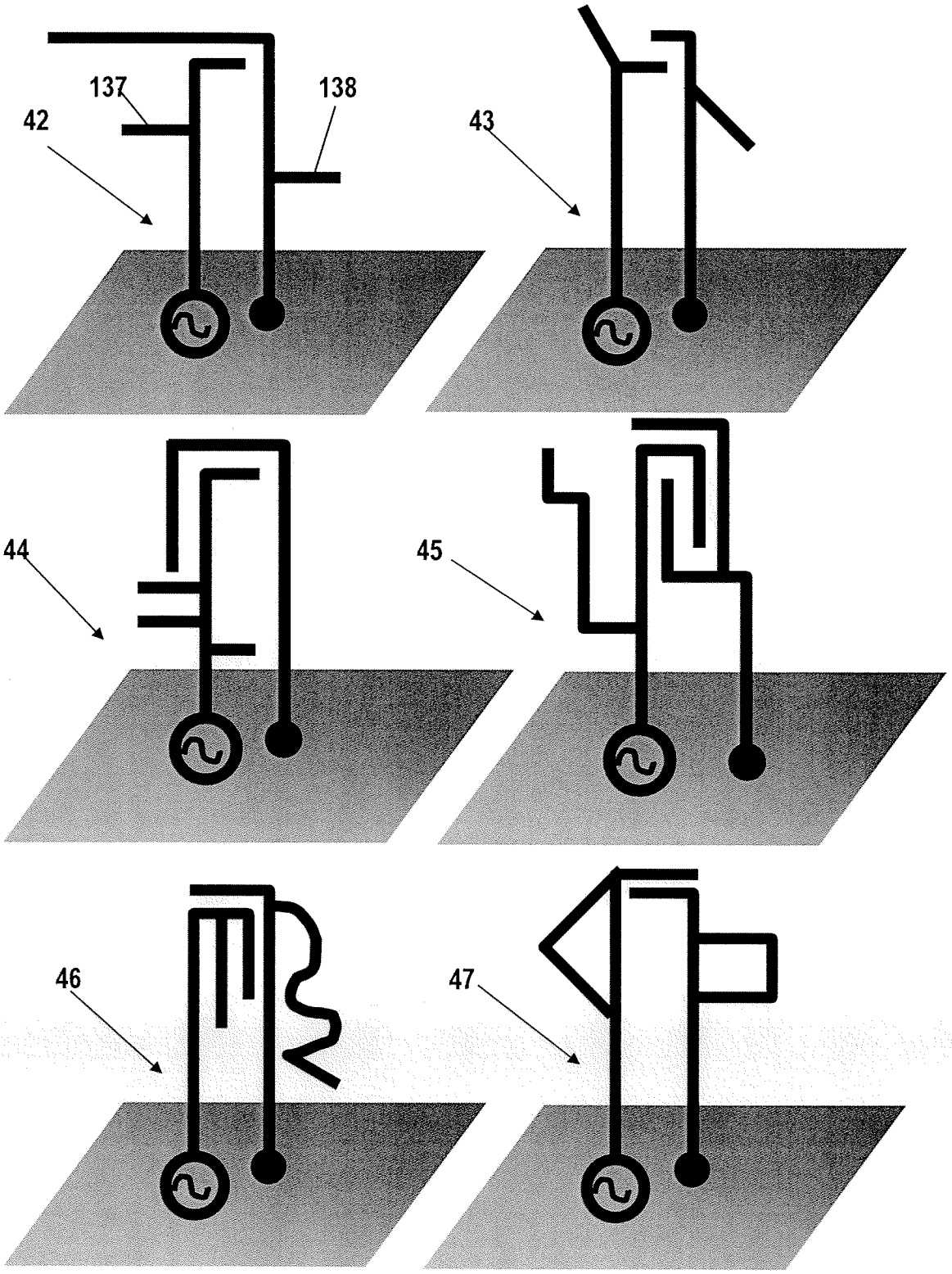


Figure 9

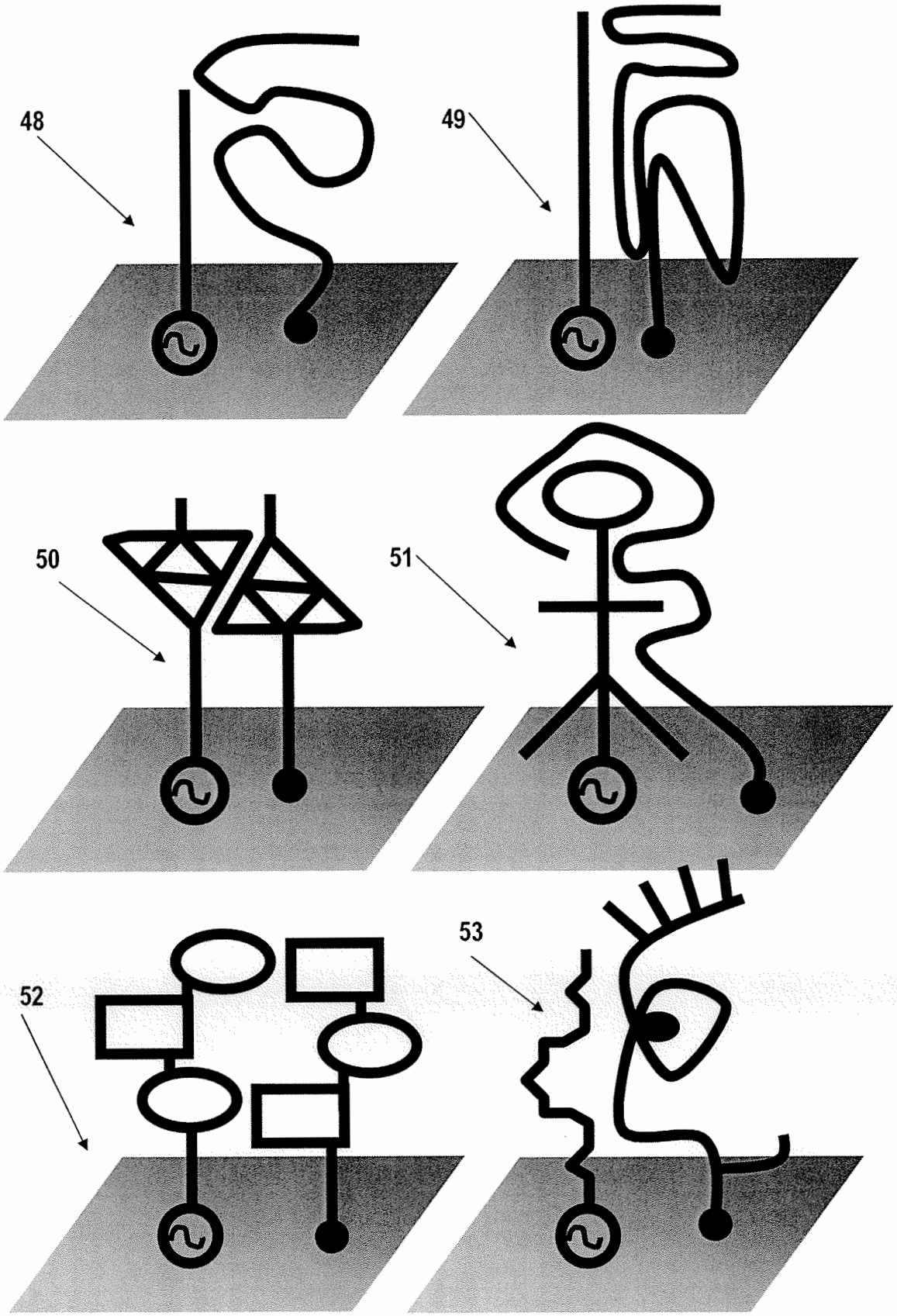


Figure 10

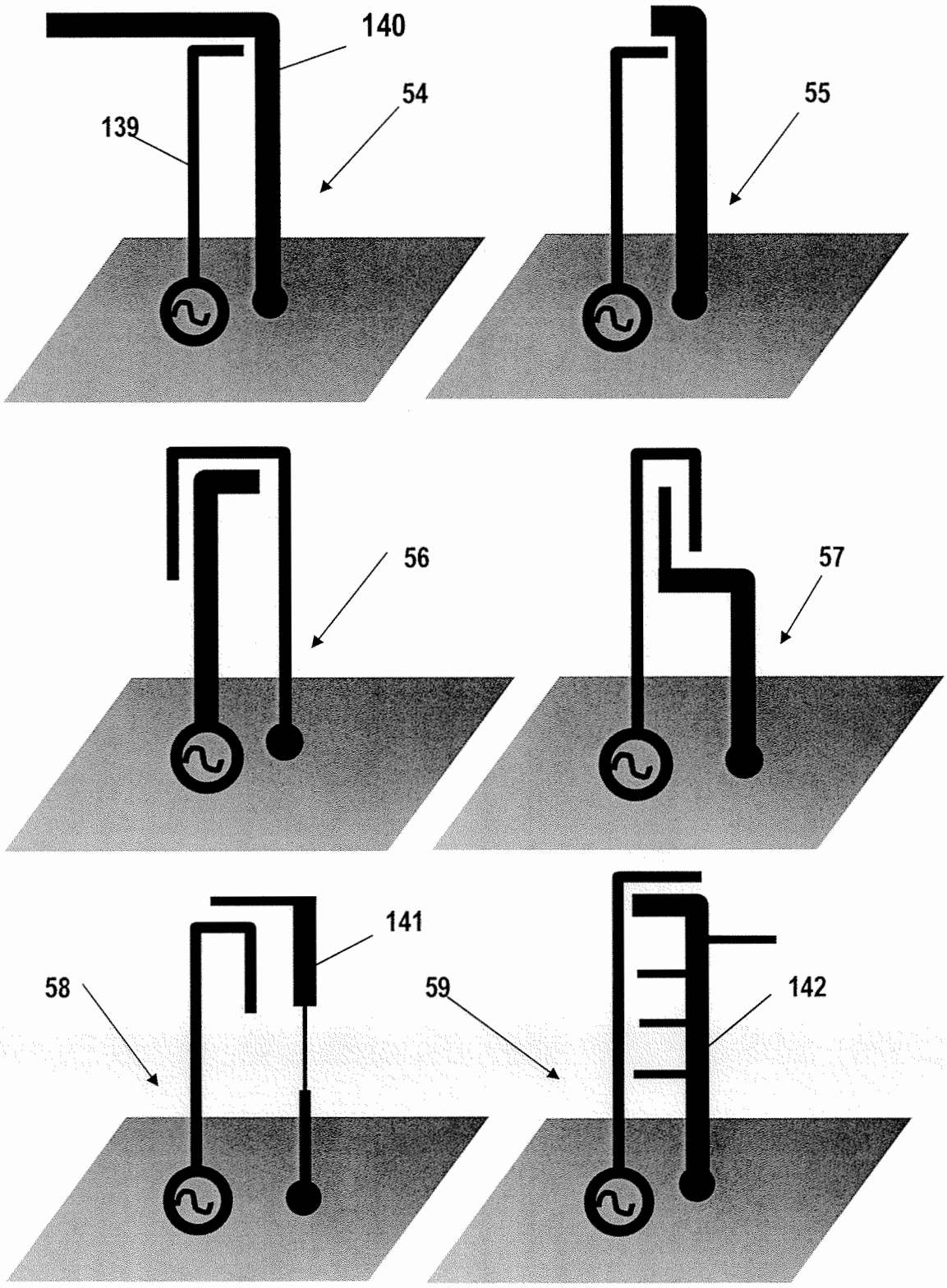


Figure 11

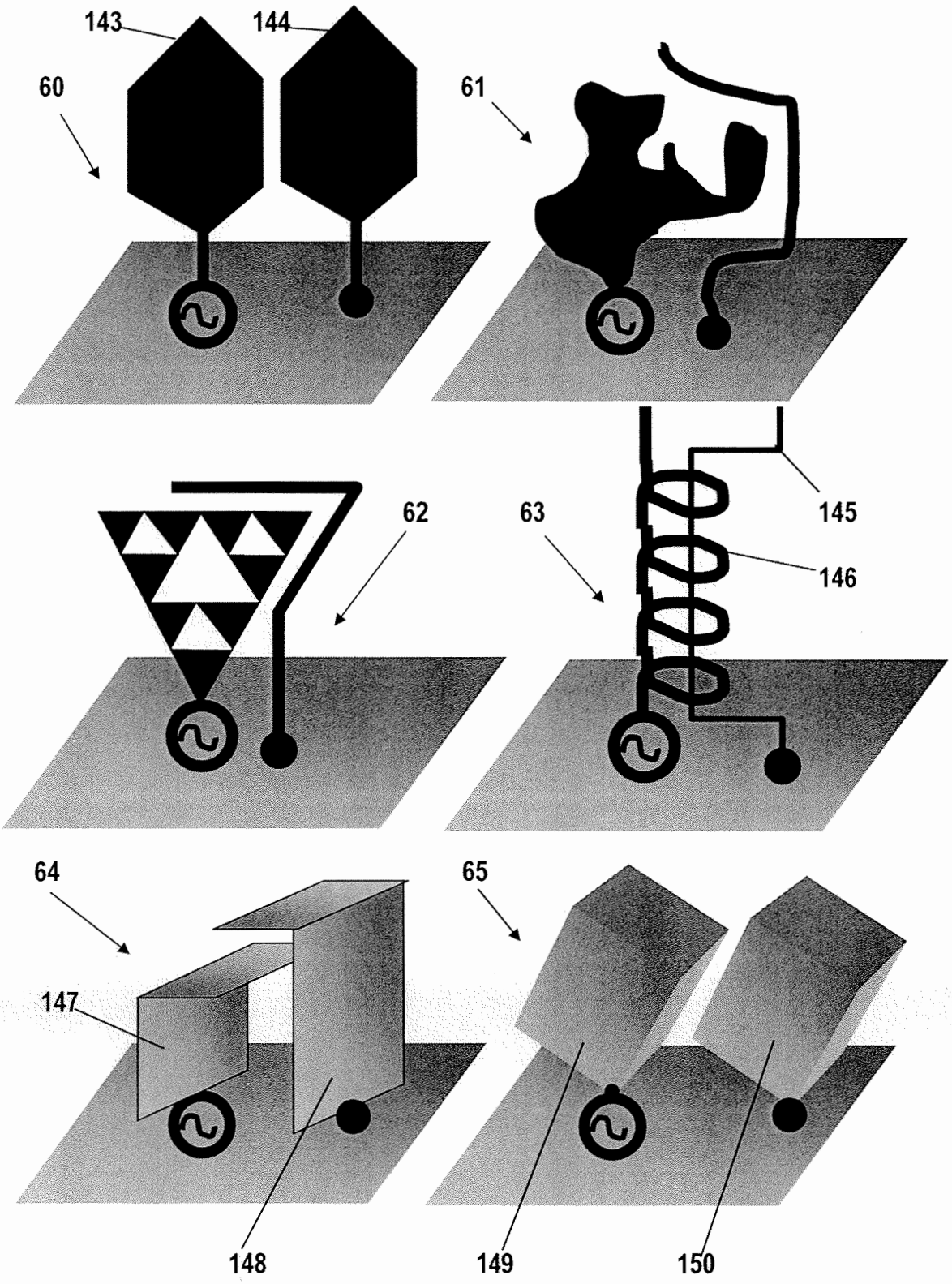


Figure 12

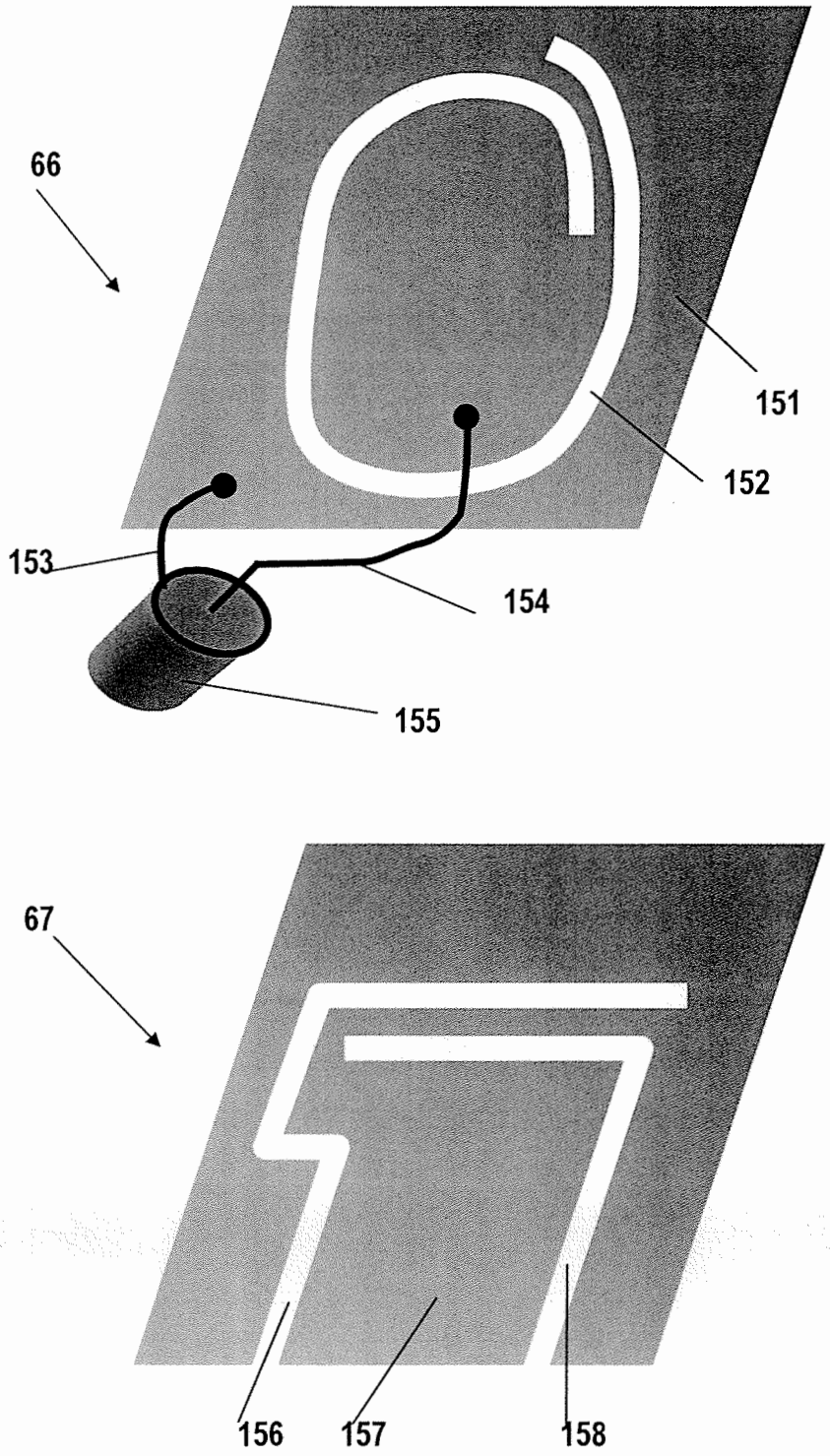


Figure 13

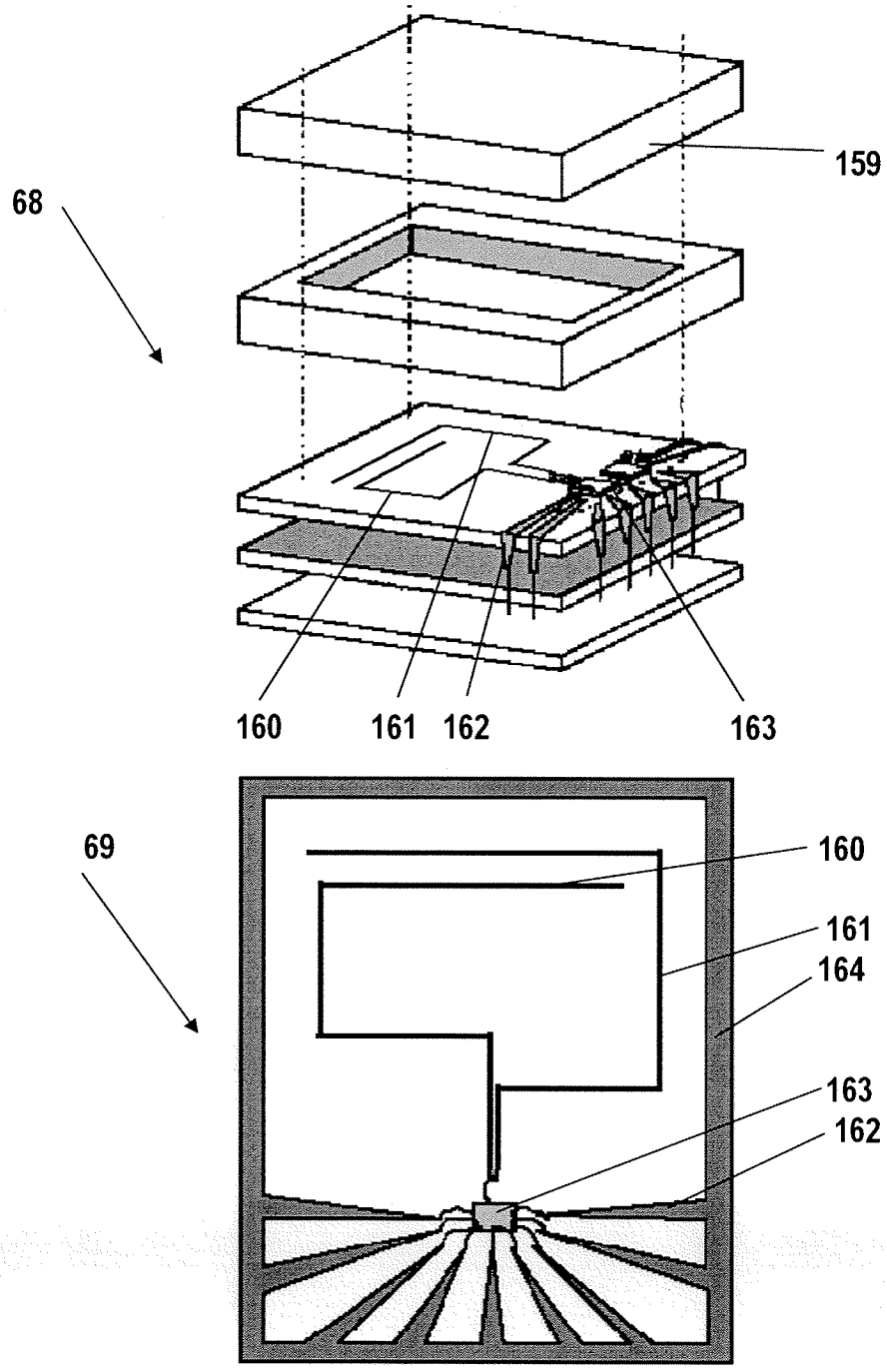


Figure 14

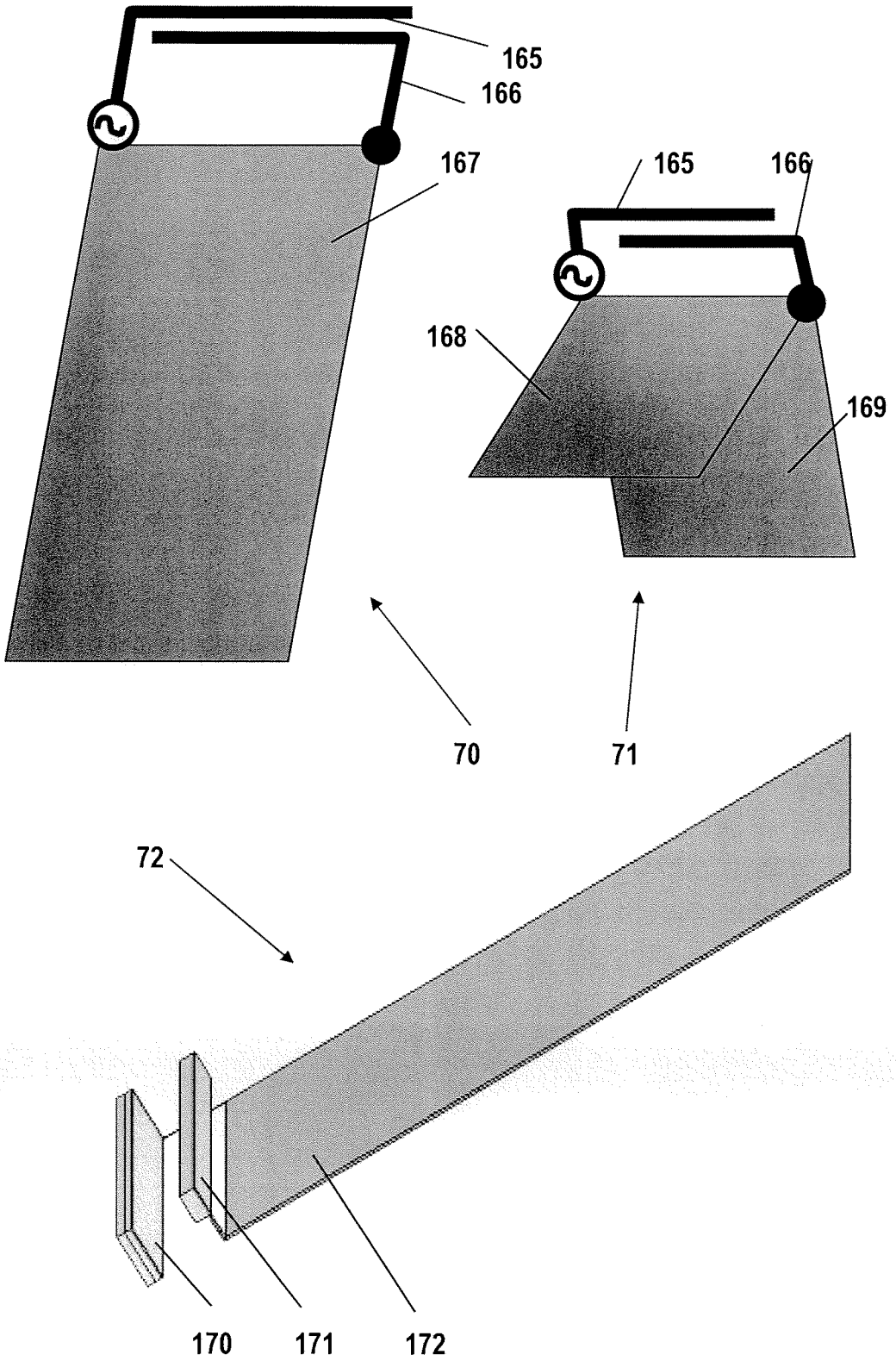


Figure 15

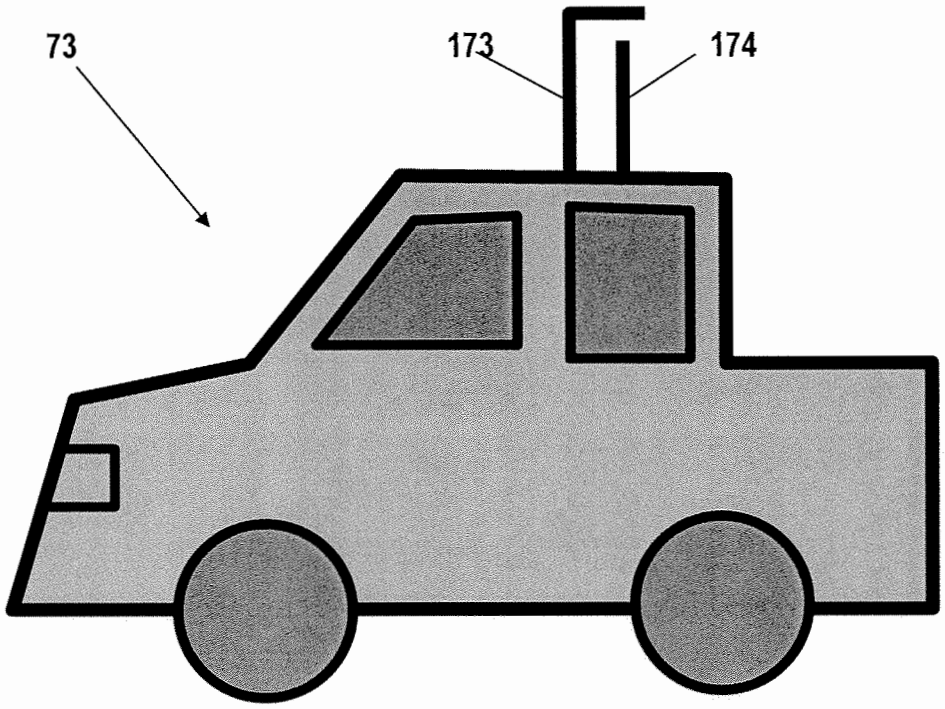


Figure 16

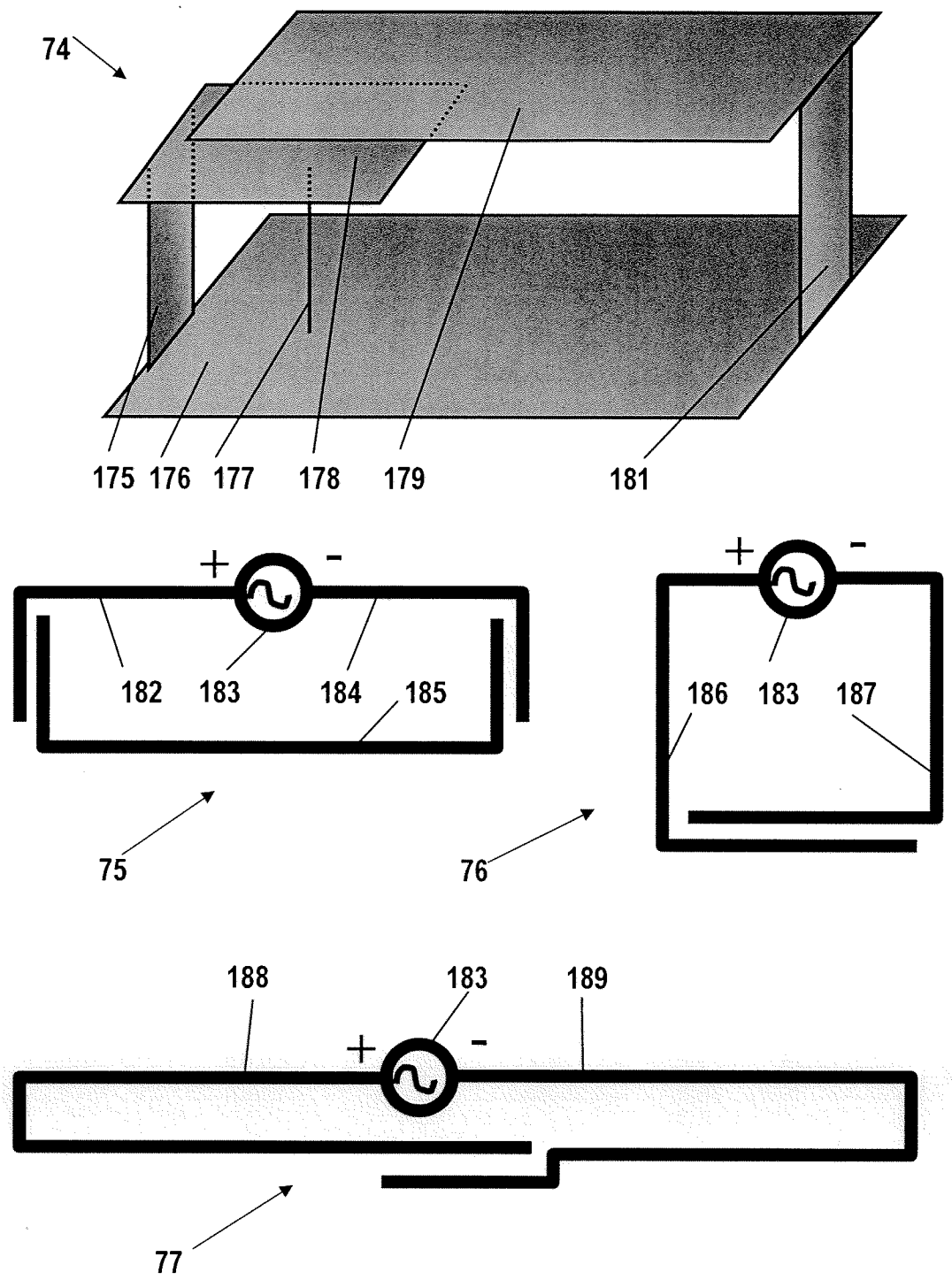

74
175
176
177
178
179
181
+
-
182
183
184
185
75
+
-
186
183
187
76
188
183
189
+
-
77

Figure 17

PTO/SB/81 (04-05)
Approved for use through 11/30/2005. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY and CORRESPONDENCE ADDRESS INDICATION FORM

Application Number	11/075980
Filing Date	March 9, 2005
First Named Inventor	Carles Puente Baliarda
Title	COUPLED MULTIBAND ANTENNAS
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket No.	68349-00018USPX

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

[x] Practitioners associated with the Customer Number: 23932

OR

[ ] Practitioner(s) named below:

Name	Registration Number	Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

[x] The address associated with the above-mentioned Customer Number:

OR

[ ] The address associated with Customer Number:

OR

[ ] Firm or Individual Name					
Address					
City		State		Zip	
Country		Telephone		Email	

I am the:

[ ] Applicant/Inventor.

[x] Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature		Date	16 September 2005
Name	Carles Puente Baliarda	Telephone	+34935442690
Title and Company	Authorized Signer, Fractus, S.A.		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[ ] *Total of 1 forms are submitted.

PTO/SB/82 (04-05)
Approved for use through 11/30/2005. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REVOCATION OF POWER OF ATTORNEY WITH NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS		
	Application Number	11/075980
	Filing Date	March 9, 2005
	First Named Inventor	Carles Puente Baliarda
	Art Unit	2821
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	68349-00018USPX

I hereby revoke all previous powers of attorney given in the above-identified application.

[X] A Power of Attorney is submitted herewith.

OR

[ ] I hereby appoint the practitioners associated with the Customer Number: [ ]

[X] Please change the correspondence address for the above-identified application to:

[X] The address associated with Customer Number: 23932

OR

[ ] Firm or Individual Name					
Address					
City					
Country		State		Zip	
Telephone		Email			

I am the:

[ ] Applicant/Inventor.

[X] Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature			
Name	Carles Puente Baliarda		
Date	16 September 2005	Telephone	+34935442690

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[ ] *Total of 1 forms are submitted.

x

PTO/SB/96 (09-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Carles Puente Baliarda et al.

Application No./Patent No.: 11/075980 Filed/Issue Date: March 9, 2005

Entitled: COUPLED MULTIBAND ANTENNAS

Fractus, S.A. (Name of Assignee) , a Corporation (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [x] the assignee of the entire right, title, and interest; or

2. [ ] an assignee of less than the entire right, title and interest.
The extent (by percentage) of its ownership interest is _____ %

in the patent application/patent identified above by virtue of either:

A. [x] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

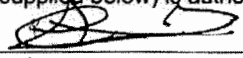
2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[ ] Copies of assignments or other documents in the chain of title are attached.
[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.



Signature

16 September 2005
Date

Carles Puente Baliarda
Printed or Typed Name

+34 935442690
Telephone Number

Authorized Signer for Assignee
Title

ASSIGNMENT

WHEREAS, one or more inventions have been made by the undersigned in

COUPLED MULTIBAND ANTENNAS

and are the subject of a patent application filed in the United States Patent and Trademark Office, which application is identified as Jones Day Docket No

WHEREAS, FRACTUS, S.A.Alcalde Barnils 64-68 Ed. TESTA mód.C3 Pque Emp Sant Joan. 08190 SANT CUGAT DEL VALLES. BARCELONA. SPAIN hereinafter referred to as "assignee", is desirous of acquiring all right, title, and interest throughout the world in, to, and under said inventions and patent rights therefor

NOW, THEREFORE, be it known that, for valuable consideration, the receipt and sufficiency of which are hereby acknowledged, all right, title, and interest, in the United States and throughout the world, in, to and under said inventions and all patents, patent applications, patent rights, and inventor's certificates thereof, therefor, and therein, including without limitation said application for patent in the United States, all divisions and continuations thereof, all patents which may be granted thereon, all reissues and extensions thereof, all right to sue for past infringement thereunder, all patents which may be granted for said inventions by states or nations other than the United States, or by other authority, entity, or organization, and all applications therefor, have been and are hereby sold, assigned, transferred, and delivered unto assignee, its successors and assigns; and it is covenanted and agreed by the undersigned, and for executors, administrators, and legal representatives of the undersigned, that at assignee's request any and all applications, affidavits, assignments, and other instruments will be made, executed, and delivered as may be necessary, or desirable to secure for or vest in assignee, its successors or assigns, inventions, right, title, interest, application, patent, patent right or other right or property covered by this assignment, and the United States Commissioner of Patents and Trademarks is hereby requested and authorized to issue any and all United States patents granted on any of said applications to assignee as owner of the entire right, title, and interest in, to, and under the same, and appropriately empowered officials of foreign countries are hereby authorized to issue any letters patent granted on any of said applications to assignee as owner of the entire right, title and interest in, to, and under the same

The undersigned hereby grants the firm of Jones Day the power to insert on this assignment any further identification which may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office for recordation of this document

IN WITNESS WHEREOF, this Assignment has been executed below by the undersigned:

Witness

Today's Date 03/03/2005

PUENTE BALIARDA, Carles
Alcalde Barnils, TESTA-Mod C,
Parque Emp St Joan / 08190 Sant
Cugat del Valles Barcelona / ES

rcedes VEGAS GRACIA (1)
vid MALGA ARTADI (2)

Witness

Today's Date 03/03/2005

ANGUERA PROS, Jaume
Pssg. Blasco Ibáñez, 15 / 12500
Vinaros (Castellón) / ES

Mercedes VEGAS GRACIA (1)
David MALGA ARTADI (2)

Witness

Today's Date 03/03/2005

SOLER CASTANY, Jordi
C. Fray Luis de León, 21 / 08302
Mataro (Barcelona) / ES

Mercedes VEGAS GRACIA (1)
David MALGA ARTADI (2)

Witness

Today's Date 03/03/2005

CONDES MARTÍNEZ, Antonio
C/ Lleialtat 40, 3-1 / 08950
Esplugues de Llobregat (Barcelona)
/ ES

Mercedes VEGAS GRACIA (1)
David MALGA ARTADI (2)

Electronic Acknowledgement Receipt

EFS ID:	2842391
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Correspondence Address:	DAVID M MAIORANA - JONES DAY North Point 901 Lakeside Avenue CLEVELAND OH 44114 US 2165863939 2165790212
Filer:	Ross Robinson/Jeffrey Tinker
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	11-FEB-2008
Filing Date:	05-DEC-2007
Time Stamp:	16:24:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		47005P015WUSC1.pdf	5528331 3ccace28a2b8d8b19c0d7223c94ce11f76d61c0e	yes	25

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Response to Pre-Exam Formalities Notice	1	3
	Drawings-only black and white line drawings	4	20
	Power of Attorney	21	25

Warnings:	
Information:	
Total Files Size (in bytes):	5528331

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

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

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

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

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

ALTERNATIVE TO PTO/SB/08A/B
(Based on PTO 01-08 version)

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket Number	47005-P015WUSC1

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA*	US-4,628,322	12-09-1986	Marko et al.	
	AB*	US-5,365,246	11-15-1994	Rasinger et al.	
	AC*	US-6,337,667	01-08-2002	Ayala et al.	
	AD*	US-5,966,097	10-12-1999	Fukasawa et al.	
	AE*	US-20020075187-A1	01-21-2003	McKivergan	
	AF*	US-6,466,176	10-15-2002	Maoz et al.	
	AG*	US-5,990,838	11-23-1999	Burns et al.	
	AH*	US-6,509,882	01-21-2003	McKivergan	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BA**	EP-0 942 488	09-15-1999	Murata Manufacturing Co., Ltd.		
	BB**	JP-56-12102	02-06-1981	Nippon Teleghraph & Telephone et al.		√
	BC**	WO-96/38881	12-05-1996	Ericsson Inc.		
	BD**	WO-01/78192	10-18-2001	Research In Motion Limited		
	BE**	WO-01/22528	03-29-2001	Fractus S.A.		√
	BF**	WO-01/54225	07-26-2001	Fractus, S.A.		

Examiner Signature		Date Considered	

*EXAMINER: Initial if information considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA**	Hisamatsu Nakano et al., "Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas", IEEE Transactions on Antennas and Propagation, vol. 46, no. 6, June 1998, pages 788-793	
	CB**	Constantine A. Balanis, "Antenna Theory: Analysis and Design", Hamilton Printing, 1982 & 1997, pages 498-502.	
	CC**	C. Puente et al., "Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition", Electronics Letters, December 5, 1996, vol. 32, no. 25, pages 2298-2299	
	CD**	Jaume Anguera et al., "Miniature WideBand Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry", IEEE, 2000, pages 1700-1703	

ALTERNATIVE TO PTO/SB/08A/B
(Based on PTO 01-08 version)

Substitute for form 1449/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				***Complete if Known***	
				Application Number	11/950,835-Conf. #7241
				Filing Date	December 5, 2007
				First Named Inventor	Carles Puente Baliarda
				Art Unit	2821
				Examiner Name	Not Yet Assigned
Sheet	2	of	2	Attorney Docket Number	47005-P015WUSC1

Examiner Signature		Date Considered	

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

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

IPE JAN 22 2008 PATENT & TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5838285		1998-11-17	TAY	

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

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040212545	A1	2004-10-28	LI	

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11950835
	Filing Date	2007-12-05
	First Named Inventor	Carles Puente Baliarda
	Art Unit	NA
	Examiner Name	NA
	Attorney Docket Number	47005-P015WUSC1

	1		☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5966097		1999-10-12	FUKASAWA	
	2	6337667	B1	2002-01-08	AYALA	
	3	4628322		1986-12-09	MARKO	
	4	5365246		1994-11-15	RASINGER	
	5	5903239		1999-05-11	TAKAHASHI	
	6	6373447	B1	2002-04-16	ROSTOKER	
	7	4907006		1990-03-06	NISHIKAWA	

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

U.S.PATENT APPLICATION PUBLICATIONS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020075187	A1	2002-06-20	MCKIVERGAN	

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	03047025	WO	A1	2003-06-05	KONINKLIJKE PHILIPS ELECTRONICS N.V.		☐
	2	2387486	GB	A	2003-10-15	SAMSUNG ELECTRO-MECHANICS CO. LTD.		☐
	3	0131747	WO	A1	2001-05-03	FRACTUS SA		☐
	4	1195847	EP	A2	2002-04-10	E-TENNA DORPORATION LAUREL		☐
	5	9950929	WO	A1	1999-10-07	THE REGENTS OF THE UNIVERSITY OF CALIFORNIA		☐
	6	200250924	JP		2002-02-15	SANSEI ELECTRIC CORP		☐
	7	2002141726	JP	A	2002-05-17	YOKOWO SEISAKUSHO KK		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

OIPE
JAN 22 2008
PATENT & TRADEMARK OFFICE

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

	8	56012102	JP		1981-02-06	NIPPON TELEGR & TELEPH CORP <NTT> DENKI KOGYO KK		☐
	9	JP5275918	JP		1993-10-22	UNAVAILABLE		☐

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

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	PAN et al. N anetnnas and their applications in portable handsets, IEEE Transactions on Antennas and Propagation, 1997, Vol. 45, No. 10	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

OIPE
JAN 22 2008
PATENT & TRADEMARK OFFICE

PTO/SB/08a (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

U.S.PATENTS

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

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

U.S.PATENT APPLICATION PUBLICATIONS

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

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

FOREIGN PATENT DOCUMENTS

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

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

NON-PATENT LITERATURE DOCUMENTS

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11950835
Filing Date	2007-12-05
First Named Inventor	Carles Puente Baliarda
Art Unit	NA
Examiner Name	NA
Attorney Docket Number	47005-P015WUSC1

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

	1	CHOW et al., A dual-frequency-mode monopole-helical antenna with a parasitic normal-mode helix, Microwave and optical Technology Letters, February 2001,	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

3FD

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as First Class Mail, in an envelope addressed to: MS Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Dated: January 15, 2008 Signature: Tracie London
(Tracie London)

OIPE IAP81 JAN 22 2008 PATENT & TRADEMARK OFFICE

Docket No.: 47005-P015WUSC1
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Carles Puente Baliarda et al.

Application No.: 11/950,835 Confirmation No.: 7241

Filed: December 5, 2007 Art Unit: 2821

For: COUPLED MULTIBAND ANTENNAS Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

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

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed within three months of the U.S. filing date (37 CFR 1.97(b)(1)).

Applicant has not submitted copies of each cited U.S. patent and U.S. patent application in accordance with 37 CFR 1.98(a)(2). Applicant submits herewith copies of any cited non-patent documents and foreign patent documents in accordance with 37 CFR 1.98(a)(2).

Those documents which are marked with a double asterisk (**) next to the Cite No. in the attached form PTO/SB/08 are not supplied because they were previously cited by or submitted to

the Office in prior application number 11/075,980 filed March 9, 2005 and relied upon in this application for an earlier filing date under 35 U.S.C. 120.

In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 23-2426, under Order No. 47005-P015WUSC1. A duplicate copy of this paper is enclosed.

Dated: January 15, 2008

Respectfully submitted,

By _____

Ross T. Robinson
Registration No.: 47,031
WINSTEAD PC
P.O. Box 50784
Dallas, Texas 75201
(214) 745-5400
Attorneys For Applicant

PTO/SB/122 (01-06)
Approved for use through 12/31/2008. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

CHANGE OF CORRESPONDENCE ADDRESS
Application

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

Application Number	11/950,835-Conf. #7241
Filing Date	December 5, 2007
First Named Inventor	Carles Puente Baliarda
Art Unit	2821
Examiner Name	Not Yet Assigned
Attorney Docket No.	47005-P015WUSC1

Please change the Correspondence Address for the above-identified application to:

[x] The address associated with Customer Number: 61060

OR

[ ] Firm *or* Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

I am the:

[ ] Applicant/Inventor

[ ] Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

[x] Attorney or agent of record. Registration Number 47,031 .

[ ] Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number _____ .

Signature	/Ross T. Robinson/
Typed or Printed Name	Ross T. Robinson
Date	January 16, 2008
Telephone	(214) 745-5185

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[ ] *Total of 1 forms are submitted.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4).

Dated: January 16, 2008 Electronic Signature for Ross T. Robinson: /Ross T. Robinson/

Dallas_1\5157832\1
47005-P015WUSC1 1/16/2008

Electronic Acknowledgement Receipt

EFS ID:	2725076
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Correspondence Address:	DAVID M MAIORANA - JONES DAY North Point 901 Lakeside Avenue CLEVELAND OH 44114 US 2165863939 2165790212
Filer:	Ross Robinson/Samuel Udovich
Filer Authorized By:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	16-JAN-2008
Filing Date:	05-DEC-2007
Time Stamp:	15:18:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Change of Address	ChangeofAddress.pdf	67288 19b9e2704b61ae6236637a0a24bcdcc47294d85f	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	67288		

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/950,835	12/05/2007	2821	1030	47005-P015WUSC1	19	1

CONFIRMATION NO. 7241

DAVID M MAIORANA
JONES DAY
North Point 901 Lakeside Avenue
CLEVELAND, OH 44114

FILING RECEIPT



Date Mailed: 12/19/2007

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Carles Puente Baliarda, San Cugat del Valles (Barcelona), SPAIN;
Jaume Anguera Pros, Vinaros (Castellon), SPAIN;
Jordi Soler Castany, Mataro (Barcelona), SPAIN;
Antonio Condes Martinez, Esplugues de Llobregat (Barcelona), SPAIN;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 11/075,980 03/09/2005 PAT 7,315,289
which is a CON of PCT/EP02/11355 09/10/2002

Foreign Applications

If Required, Foreign Filing License Granted: 12/17/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 11/950,835**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

COUPLED MULTIBAND ANTENNAS

Preliminary Class

343

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/950,835	12/05/2007	Carles Puente Baliarda	47005-P015WUSC1

CONFIRMATION NO. 7241

DAVID M MAIORANA
JONES DAY
North Point 901 Lakeside Avenue
CLEVELAND, OH 44114

FORMALITIES LETTER

OC000000027339785

Date Mailed: 12/19/2007

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 2-15.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/jmilani/

Office of Initial Patent Examination (571) 272-4000 or 1-800-PTO-9199

PTO/SB/01 (09-03)
Approved for use through 07/31/2006 OMB 0651-0032
U S Patent and Trademark Office; U S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	153454600041
First Named Inventor	PUENTE BALIARDA, Carles et al
COMPLETE IF KNOWN	
Application Number	11/075,980
Filing Date	March 9, 2005
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

COUPLED MULTIBAND ANTENNAS

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 03/09/2005 as United States Application Number or PCT International Application Number 11/075,980 and was amended on (MM/DD/YYYY) _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification including the claims as amended by any amendment specifically referred to above

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? Yes	No
PCT/EP02/11355	PCT	10/09/2002	☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

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

PTO/SB/01 (03-03)
Approved for use through 07/31/2006 OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

Direct all correspondence to: ☐ Customer Number: [ ] OR ☒ Correspondence address below

Name: DAVID M MAIORANA

Address: JONES DAY
North Point 901 Lakeside Avenue

City	State	ZIP
CLEVELAND	OH	44114

Country	Telephone	Fax
US	216-586-3939	216-579-0212

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
CARLES	PUENTE BALIARDA

Inventor's Signature: [signature] Date: 03/03/2005

Residence: City	State	Country	Citizenship
San Cugat del Valles (Barcelona)		Spain	Spanish

Mailing Address: Alcalde Ramils 64-68 Ed. TESTA mód.C3 Pque Emp. Sant Joan Despi

City	State	ZIP	Country
San Cugat del Valles (Barcelona)		08190	Spain

NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
JAUME	ANGUERA PROS

Inventor's Signature: [signature] Date: 03/03/2005

Residence: City	State	Country	Citizenship
Vinaros (Castellón)	Spain	Spanish	

Mailing Address: Pasg. Blasco Ibáñez, 15

City	State	ZIP	Country
12500 Vinaros (Castellón)		12500	Spain

☒ Additional inventors or a legal representative are being named on the 3 supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.

PTO/SB/02A (00-03)
Approved for use through 09/31/2003 OMB 0651-0032
U S Patent and Trademark Office: U S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet Page 3 of 3

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))	Family Name or Surname			
JORDI	SOLER CASTANY			
Inventor's Signature				Date 03/03/2005
Residence: City Mataro (Barcelona)	State	Country Spain		Citizenship Spanish
Mailing Address C. Fray Luis de León, 21				
Mailing Address				
City Mataro (Barcelona)	State	Zip 08302	Country Spain	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))	Family Name or Surname			
ANTONIO	CONDES MARTÍNEZ			
Inventor's Signature X				Date 03/03/2005
Residence: City Esplugues de Llobregat (Barcelona)	State	Country SPAIN		Citizenship SPANISH
Mailing Address C/ Lleialtat 40, 3-1				
Mailing Address				
City Esplugues de Llobregat (Barcelona)	State	Zip 08950	Country SPAIN	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))	Family Name or Surname			
Inventor's Signature				Date
Residence: City	State	Country		Citizenship
Mailing Address				
Mailing Address				
City	State	Zip	Country	

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2

COUPLED MULTIBAND ANTENNAS

RELATED APPLICATIONS

This patent application is a continuation of U.S. Patent Application No. 11,075,980, which is incorporated by reference. U.S. Patent Application No. 11,075,980 is a continuation of PCT patent application Serial No. PCT/EP2002/011355, which is incorporated by reference.

OBJECT AND BACKGROUND OF THE INVENTION

The present invention relates generally to a new family of characteristic antenna structures of reduced size featuring a broadband behavior, a multiband behavior of a combination of both effects. The antennas according to the present invention include at least two radiating structures or arms, said two arms being coupled through a specific region of one or both of the arms called the proximity region or close proximity region.

There exists on the prior-art some examples of antennas formed with more than one radiating structure, said structures being electromagnetically coupled to form a single radiating device. One of the first examples would be the Yagi-Uda antenna (see Figure 1, Drawing 3). Said antenna consists of an active dipole structure, said active dipole structure being fed through a conventional feeding network typically connected at its mid-point, said dipole being coupled to a series of parasitic dipoles of different lengths, said parasitic dipoles being parallel to the active dipole. The skilled in the art will notice that the present invention is essentially different from the Yagi-Uda antenna for several reasons: first of all, because in the Yagi-Uda antenna the distance between any pair of dipoles is generally constant, that is all dipoles are parallel and no proximity region is included to strengthen the coupling between dipoles. The object of such a coupled parallel dipole arrangement in the Yagi-Uda antenna is to provide an

end-fire, directive radiation pattern, while in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.

Another prior-art examples of antennas including two radiating structures coupled together are stacked microstrip patch antennas ("Miniature Wideband Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry", by Anguera, Puente, Borja, and Romeu. IEEE Antennas and Propagation Society International Symposium, Salt Lake City, USA, July 2000). In such an arrangement, an active microstrip patch of arbitrary shape placed over a ground-plane is coupled to a passive parasitic patch placed on top of said active patch. It will be noticed that said active and parasitic patches keep a constant distance between them and are not specifically coupled through a specific proximity region on any of the two patches which were closer the adjacent patch. Such a stacked microstrip patch antenna configuration provides a broadband behavior, but it is does not feature a close proximity region as described in the present invention and it does not feature a highly reduced size, since the patches are typically sized to match a half-wavelength inside the dielectric substrate of the patch, while in the present invention the antennas feature a characteristic small size below a quarter wave-length.

A prior art example of monopole and PIFA antennas which are coupled together to feature a broadband behavior are described in "Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas", by Nakano, Ikeda, Suzuki, Mimaki, and Yamauchi, IEEE Transactions on Antennas and Propagation, Vol. 46, No 6, June 1998. Again, those examples are clearly different from the antennas described in the present invention because in all of said prior-art arrangements the active elements and the parasitic ones are parallel to each other and do not get the benefit of the close proximity region as disclosed in the present invention, which

enhances the broadband behavior while contributing to the antenna miniaturization.

There are some examples of structures in the prior art that include several radiating structures that are not parallel to each other. An example is the V-dipole (see for instance "Antenna Theory, Analysis and Design", by Constantine Balanis, second edition) wherein there is a minimum distance between the two arms at the vertex of the V-shape, but it should be noticed that such a vertex is the feeding point of the structure and does not form a coupling proximity region between said arms as disclosed in the present invention. In the present invention, the feeding point is specifically excluded from the close proximity region since it does not contribute to a size reduction and/or multiband or broadband behavior as it is intended here. To form a dipole according to the present invention, at least one arm of the dipole needs to be folded such that said folded arm approaches the other arm to form the close proximity region.

Other prior-art examples of antennas with multiple radiating arms are multibranch structures (see for instance "Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition", by Puente, Claret, Sagués, Romeu, López-Salvans, and Pous. IEEE Electronics Letters, vol. 32, No. 5, pp. 2298-2299, December 1996). Again those examples are essentially different to the present invention in which all radiating arms are interconnected through direct ohmic contact to a common conducting structure, while in the present invention at least two of the radiating arms of the antenna must be disconnected and coupled only through said close proximity region.

The skilled in the art will notice that the present invention can be combined with many prior-art antenna configurations to provide new antenna arrangements with enhanced features. In particular, it should be clear that the shape of any of the radiating arms can take many forms provided that at least two arms are

included, and said arms include said close proximity region between them. In particular, in several embodiments one or several of the arms according to the present invention take the form of a Multilevel Antenna as described in the Patent Publication No. WO01/22528, a Space-Filling Antenna as described in the Patent Publication No. WO01/54225 or any other complex shape such as meander and zigzag curves. Also, in some embodiments, at least one of the arms approaches an ideal fractal curve by truncating the fractal to a finite number of iterations.

SUMMARY OF THE INVENTION

The present invention consists of an antenna comprising at least two radiating structures, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms being coupled to each other through a region on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, a multiband behavior or a combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna.

Drawings 4 and 5 from Figure 2 describe examples of antenna devices as described in the present invention. In the particular example of Drawing 4, arms (110) and (111) are L-shaped and coupled trough a close proximity region (200).

In this case, the antenna is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110), while arm (111) is directly connected to ground (103). Although in a very basic configuration, this example contains the essence of the invention (the two arms or radiating structures coupled through a close proximity region (200), defined by folded parts (108) and (109) from arms (110) and (111)). In the particular example of Drawing 5, it can be seen that the position of the proximity region (201) can be placed in other locations. Arm (100) is straight, whereas arm (113) has been folded. The antenna system is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100), whereas arm (113) is connected to ground (103). In both drawings 4 and 5 it can be seen that distance *Ws* is smaller than distance *Wd*. Other many embodiments and configurations are allowed within the scope and spirit of the present invention, as it is described in the preferred embodiments.

It must be noticed that, according to the present invention the distance between the two radiating arms cannot be constant since at least a proximity region needs to be formed in a portion of the two arms to enhance the coupling from one arm to the other, according to the present invention. In other words, the distance between said two arms in the direction that is orthogonal to any of the arms is not constant throughout all the arms. This specifically excludes any antenna made of two radiating arms that run completely in parallel at a constant distance between them (such as the examples shown in Figure 1).

The feeding mechanism of the present invention can take the form of a balanced or unbalanced feed. In an unbalanced embodiment, the feeding port (102) is defined between at least one point in a first of two said arms ((110) or (100)) and at least one point on a ground plane (112) or ground counterpoise (see for instance (102) in Figure 1). In this unbalanced case, arm (111) or (113) is shorted to said ground plane or ground counterpoise (112). Also, in this unbalanced feeding

scheme the proximity region ((200) and (201)) is clearly distinguished within the structure because the minimum distance between arms *Ws* in said proximity region is always smaller than the distance *Wd* between the feeding point (102) in said first arm ((110) or (100)) and the grounding point (103) at said second arm ((111) or (113)).

In a balanced scheme (see for instance Drawing 75 from Figure 17), one point at each of the two radiating structures or arms defines the differential input port (183) between said two arms (182, 184). In this case, the proximity region excludes such a differential feed region and it is located at a distance larger than 1/40 of the free-space operating wavelength from said feed region. Again, it must be noticed that in this arrangement the distance between said arms (182, 184) cannot be constant and will typically include two close regions: the feeding region (183) defining said differential input, and the proximity region which is characteristic of the present invention.

One important aspect of the present invention is that no contact point exists between the two radiating arms defining the antenna. Said two arms form two separated radiating elements, which are coupled by the characteristic close proximity region, but no ohmic contact between said two arms is formed. This specifically excludes from the present invention any antenna formed by a single radiating multibranch structure where two or several of the radiating arms on said multibranch structure can be coupled through a proximity region. The difference between the present invention and said multibranch structures is obvious, since in a multibranch structure all radiating arms or branches are connected in direct ohmic contact to a single conducting structure, while the present invention is specifically made of at least two separated radiating structures with no direct contact among them.

Regarding the shape of the radiating arms of the antenna, they can take any form as long as they include the characteristic proximity region between them. In some embodiments L or U shaped arms are preferred. In other embodiments the arms take the form of complex multilevel and space-filling structures, and even in some embodiments one or two of the arms approach the shape of a fractal form. In fact, the shape of the arms is not a differential aspect of the invention; the differential aspect of the invention is the proximity region that provides a strong coupling between the otherwise independent radiating arms.

It can be noticed that the scope of the present invention is not limited to structure formed by two radiating arms. Three or more radiating arms can be included within the invention as long as at least two of them define a close proximity region as described above. In some embodiments, multiple arms are coupled together through a single close proximity region. In other embodiments, the some of the several arms are coupled together through several proximity regions.

The main advantages of the present invention with respect to other prior art antennas are:

(a) A reduced size or height with respect to other quarter-wavelength resonating elements.
(b) A broadband behavior with typical bandwidths around 50% and beyond.
(c) A better return-loss and voltage standing wave ratio (VSWR) at the input port.
(d) An enhanced radiation efficiency compared to other antennas of the same size.
(e) An enhanced gain compared to other antennas of the same size.

The skilled in the art will notice that, obviously, such advantages can be combined with other features, for instance, a multiband response. The skilled in the art will

notice that such a multiband response can be obtained within the present invention by adjusting the length and size of the several-coupled arms, together with the spacing and size of the proximity region defined between the several arms. Another way of combining said advantages with a multiband behavior consists of shaping at least one of the arms as a multiband antenna, for instance by means of a multilevel structure or a space-filling structure.

Depending on the arrangement and application, the arms of the present invention can take the form of any of the prior art antennas, including monopoles, dipoles, planar inverted-F (PIFA) and inverted-F (IFA) structures, microstrip structures, and so on. Therefore, the invention is not limited to the aforementioned antennas. The antenna could be of any other type as long as the antenna includes at least two radiating arms or structures, and that those arms define a close proximity region where the distance between arms reaches a minimum value.

It will be clear that depending on the antenna embodiment included in the present invention, the resulting antenna would be suitable for several environments. In particular, the antennas can be integrated in handheld terminals (cellular or cordless telephones, PDAs, electronic pagers, electronic games, or remote controls), in cellular or wireless access points (for instance for coverage in micro-cells or pico-cells for systems such as AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, DCS, DECT, WLAN, ...), in car antennas, in integrated circuit packages or semiconductor devices, in multichip modules, and so on.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference will now be made to the appended drawings in which:

Figure 1 shows different prior-art configurations. Drawing 1 shows a conventional active monopole (unbalanced antenna connected to a feed point) with a parallel parasitic element, whereas Drawing 2 shows a conventional active monopole (unbalanced antenna connected to a feed point) with four conventional straight parasitic elements, all of them parallel to the active monopole. Drawing 3 shows a very well-known prior-art configuration known as Yagi-Uda, used mainly for terrestrial communications. With this Yagi-Uda configuration, several parasitic elements are placed in parallel to the active element and at the same distance to each other.

Figure 2 shows two basic structures for what is covered with this invention. Drawing 4 shows two arms, one of them is fed, and the other one is directly connected to ground. It can be seen that there is a close proximity region between them. Both arms are folded in this example. Drawing 5 shows another configuration for the two arms, wherein the arm that is fed is straight, whereas the parasitic arm is folded so as to form a close proximity region with said first arm.

Figure 3 shows several basic examples of different configurations for coupled antennas, where the arms that are connected to the feeding point (active arms) are straight, whereas the parasitic arms are folded so as to form a close proximity region with the active arms.

Figure 4 shows a series of more complex examples of coupled antennas, where the arms that are connected to the feeding point (active arms) are straight, whereas the parasitic arms can be folded with space-filling curves.

Figure 5 shows that not only the parasitic arms can be folded so as to form a close proximity region, but also the active arms, that is, the arms that are connected to groundplane. Basic configurations are shown in this figure.

Figure 6 shows alternative schemes of coupled antennas. Drawings 24, 25, and 26 are examples of coupled antennas where either one of two arms have parts acting as stubs, for better matching the performance of the antenna to the required specifications. Drawings 27, 28, and 29 show examples of how coupled-loop structures can be done by using the present invention.

Figure 7 shows that several parasitic arms (that is, arms that are not connected to the feeding port) can be placed within the same structure, as long as there is a close proximity region as defined in the object of the invention.

Figure 8 shows different configurations of arms formed by space-filling curves. As in previous examples, no matter how the arms are built, the close proximity region is well defined.

Figure 9 shows another set of examples where arms include one or several sub-branches to their structure, so as to better match the electrical characteristics of the antenna with the specified requirements.

Figure 10 shows several complex configurations of coupled antennas, with combinations of configurations previously seen in Figures 1-9.

Figure 11 shows that any shape of the arm can be used, as long as the coupled antennas are connected through a close proximity region.

Figure 12 shows a series of complex examples of coupled antennas. Drawings 60 and 61 show that arms can also be formed by planar structures. Drawing 62 shows an active arm formed by a multilevel structure. Drawing 63 shows a spiral active arm surrounding the parasitic arm. Drawing 64 shows another example of planar arms folded. Not only linear or planar structures are covered within the

scope of the present invention, as seen in Drawing 65, where two 3D arms are positioned so as to form a close proximity region.

Figure 13 shows that not only monopoles can feature a close proximity region, but also slot antennas, such as the ones showed in Drawings 66 and 67.

Figure 14 shows a coupled antenna mounted on a chip configuration.

Figure 15 shows more examples of applications where coupled antennas can be mounted. Drawings 70 and 72 show basic configurations of coupled antennas mounted on handheld PCBs. Drawing 71 shows a clamshell handheld configuration (folded PCB) and how the coupled antenna could be mounted on that.

Figure 16 shows another configuration for coupled antennas, where those are connected in a car environment.

Figure 17, Drawing 74 shows a PIFA structure that is also covered within the scope of the present invention, since it features a close proximity region between the two arms (in this case, two planar patches) of the structure. Drawings 75, 76, and 77 show a series of dipole structures (balanced feeding structure) that also feature a close proximity region.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to construct a coupled antenna system according to embodiments of the invention, a suitable antenna design is required. Any number of possible configurations exists, and the actual choice of antenna is dependent, for instance, on the operating frequency and bandwidth, among other antenna parameters. Several possible examples of embodiments are listed hereinafter. However, in

view of the foregoing description, it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. In particular, different materials and fabrication processes for producing the coupled antenna system may be selected, which still achieve the desired effects.

Drawing 1 from Figure 1 shows in a manner already known in prior-art an antenna system formed by two monopoles, one acting as the active monopole (100) and the other acting as the parasitic monopole (101). The feed point (102), represented with a circle in all the drawings in the present invention, can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the groundplane, and the inner conductor of which is coupled to the radiating conductive element (100). Parasitic element (101) is connected to groundplane through (103). In this configuration, there is no close proximity region, since both (100) and (101) are in parallel. The radiating conductive element (100) is usually shaped in prior art like a straight wire, but several other shapes can be found in other patents or scientific articles. Shape and dimensions of radiating element (100) and parasitic element (101) will contribute in determining the operating frequency of the overall antenna system.

Drawing 2 from Figure 1 shows also in a manner known in prior-art an antenna system formed by a radiating element (100) and several parasitic monopoles (104). In this configuration, there is no close proximity region, since both the radiating element (100) and the parasitic elements (104) are in parallel.

Drawing 3 from Figure 1 shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation

pattern, whereas in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.

Unlike the prior art structures illustrated in Figure 1, the newly disclosed coupled antenna system shown in Figure 2, Drawing 4, is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the groundplane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, *Ws* < *Wd*. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the groundplane (112), and the inner conductor of which is coupled to the radiating conductive element (110). Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in Drawing 5. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the groundplane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that *Ws* < *Wd*. It is clear to those skilled in the art that these configurations in Figure 2 could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat groundplane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the groundplanes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other groundplane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling groundplanes, or

Electromagnetic Band-Gap (EBG) groundplanes, or Photonic Band-Gap (PBG) groundplanes, or high-impedance (Hi-Z) groundplanes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by using a conductive ink.

In some preferred embodiments, such as the ones being showed in Figure 3, only the parasitic elements (114, 115, 116, 117, 118, 119) are folded so as to form a close proximity region between radiating elements (100) and parasitic elements (114, 115, 116, 117, 118, 119). Basic configurations (Drawings 6 to 11) are being illustrated in this Figure, where folding of the parasitic elements (114, 115, 116, 117, 118, 119) is formed by 90-degree angles. The described embodiments of this figure are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.

Some embodiments, like the ones being showed in Figure 4, where space-filling curves are coupled, are preferred when a multiband or broadband behavior is to be enhanced. Said space-filling arrangement allows multiple resonant frequencies which can be used as separate bands or as a broadband if they are properly coupled together. Also, said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of generality, particular configurations are being showed in this figure, where the active elements (that is, the radiating arms) are straight, whereas the space-filling properties have been utilized in the parasitic elements. However, the same space-filling principle could have been used to the radiating

elements, as it will be shown in other preferred embodiments described later in this document.

In some preferred embodiments, such as the ones being showed in Figure 5, both the parasitic elements (121, 122, 123, 125, 127, 129) and the radiating/active elements (120, 124, 126, 128) are folded so as to form a close proximity region between said radiating elements (120, 124, 126, 128) and said parasitic elements (121, 122, 123, 125, 127, 129). Basic configurations (Drawings 18 to 23) are being illustrated in this figure, where folding of the parasitic elements (121, 122, 123, 125, 127, 129) and radiating elements (120, 124, 126, 128) is formed by 90-degree angles. The described embodiments of this figure are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.

For the preferred embodiments showed in Drawings 24, 25, and 26 from Figure 6, the arms are being formed by means of using inductive stubs (130, 131, 132, 133, 134). The purpose of those is further reduce the size of the antenna system. The position of said stubs can be placed and distributed along the radiating or the parasitic arms.

In some preferred embodiments, loop configurations for the coupled antennas further help matching the operating frequencies of the antenna system, such as the ones showed in Drawings 27, 28, and 29 in Figure 6. From these drawings it can be seen that the overall shape of the antenna system forms an open loop, yet still being within the scope of the present invention without departing from the close proximity region principle.

To illustrate that several modifications of coupled antenna systems can be done based on the same principle and spirit of the present invention, other preferred embodiment examples are shown in Figure 7. Drawing 30 shows a structure where two parasitic elements (135, 136) are included, and a close proximity region is being formed between the active element and the parasitic subsystem. Drawings 31 to 35 show other preferred configurations where several parasitic elements with different shapes have been placed in different locations and distribution.

Some embodiments, like the ones being showed in Figure 8, where space-filling curves are coupled, are preferred when a multiband or broadband behavior is to be enhanced. Said space-filling arrangement allows multiple resonant frequencies which can be used as separate bands or as a broadband if they are properly coupled together. Also, said multiband or broadband behavior can be obtained by shaping said elements with different lengths within the structure. Space-filling curves is also a way to miniaturize further the size of the antenna. For the sake of clarity but without loss of generality, particular configurations are being showed in this figure, where the both the active elements (that is, the radiating arms) and the parasitic elements are being formed by means of space-filling curves.

In some preferred embodiments, sub-branches to the parasitic and the active elements need to be added so as to match the frequency response of the antenna to the required specifications. Drawing 42 in Figure 9 shows a configuration where a branch (137) has been added to the active element, and another branch (138) has been added to the parasitic element. The shape and size of the branch could be of any type, such as linear, planar or volumetric, without loss of generality. Drawings 43 to 47 in Figure 9 show other examples of coupled antennas with a branch-like configuration.

It is interesting to notice that the advantage of the coupled antenna geometry can be used in shaping the radiating elements and the parasitic elements in very complex ways. Particular examples of coupled antennas using complex configuration and designs are being showed in Drawings 48 to 53 in Figure 10, but it appears clear to any skilled in the art that many other geometries could be used instead within the same spirit of the invention.

The shape and size of the arms could be of any type, such as linear, planar or volumetric, without loss of generality. Drawings 54 to 59 in Figure 11 show several examples of coupled antennas where shape of both radiating and parasitic elements varies within the same element.

Figure 12 shows that not only linear structures can be adapted to meet the close proximity region principle defined in the scope of this invention. Drawing 60 shows an example of two planar elements (143, 144). Drawing 62 shows an example of a multilevel structure acting as the radiating element. Drawing 63 shows a spiral active arm surrounding the parasitic arm. Drawing 64 shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in Drawing 65, where two 3D arms are positioned so as to form a close proximity region.

Figure 13 shows that not only monopoles or dipoles can feature a close proximity region, but also slot antennas, such as the ones showed in Drawings 66 and 67. Both drawings are being composed by a conventional solid surface ground-plane (151) that has been cut-out so as to have some slots on it (152, 156, 158). The feedpoint (155) can be implemented in several ways, such as a coaxial cable, the sheath (153) of which is connected to the external part of (151), and the inner conductor (154) of the coaxial cable is coupled to the inner radiating conductive

element, as shown in Drawing 66. In the case of Drawing 67, the inner conductor of the coaxial cable would be connected to (157).

Another preferred embodiment of coupled antennas is the one being showed in Figure 14. The Drawing represents a coupled antenna being placed in an IC (or chip) module, and is composed by a top cover (159), by an transmit/receive IC module (163), by bond wires (162), by the lead frame of the chip (164), and by a coupled antenna, being formed by an active element and a parasitic element (160, 161). Any other type of chip technology could been used without loss of generality.

Figure 15 shows different configurations of handheld applications where coupled antennas, as described in the present invention, can be used. Drawing 70 shows a PCB (167) of a handheld device (for instance, a cell phone) that acts as groundplane. Just for the sake of clarity, the antenna system in this example is formed by two arms, one acting as active (165), that is, connected to the feeding point, and the other one acting as parasitic (166). Drawing 71 shows a clamshell configuration (also known as flip-type) for a cell phone device, and where the antenna system presented in this invention could be located at. Drawing 72 shows a PCB (172) of a handheld device (for instance, a cell phone) that acts as groundplane. The antenna system in this example is formed by two arms that are, in this specific case, 3D structures , once acting as the active arm (171) and the other one acting as the parasitic arm (170). Here, the arms (170, 171) of the antenna system are presented as a parallelepipeds, but any other structure can be obviously taken instead.

Another preferred embodiment is the one shown in Figure 16, where the coupled antenna system (173, 174) is mounted on or in a car.

Figure 17, Drawing 74 shows a PIFA structure that is being composed by an active element formed by groundplane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or

shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to groundplane as well (181). In Drawing 74 it can be clearly seen that the close proximity region is formed by elements (178) and (179). PIFA antennas have become a hot topic lately due to having a form that can be integrated into the per se known type of handset cabinets. Preferably, for this type of antenna system, the antenna, the ground-plane or both are disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by printing the antenna and the ground-plane onto the substrate using a conductive ink. A low-loss dielectric substrate (such as glass-fibre, a Teflon substrate such as Cuclad® or other commercial materials such as Rogers® 4003 well-known in the art) can be placed between said patches and ground-plane. Other dielectric materials with similar properties may be substituted above without departing from the intent of the present invention. As an alternative way to etching the antenna and the ground-plane out of copper or any other metal, it is also possible to manufacture the antenna system by printing it using conductive ink. The antenna feeding scheme can be taken to be any of the well-known schemes used in prior art patch or PIFA antennas as well, for instance: a coaxial cable with the outer conductor connected to the ground-plane and the inner conductor connected to the patch at the desired input resistance point; a microstrip transmission line sharing the same ground-plane as the antenna with the strip capacitively coupled to the patch and located at a distance below the patch, or in another embodiment with the strip placed below the ground-plane and coupled to the patch through a slot, and even a microstrip transmission line with the strip co-planar to the patch. All these mechanisms are well known from prior art and do not constitute an essential part of the present invention. The essential part of the present invention is the shape of the proximity close region, which contributes to reducing the size with respect to prior art configurations, as well as enhancing antenna bandwidth, VSWR, and radiation efficiency.

Drawings 75 to 77 in Figure 17 show configurations of coupled antennas as described in the object of the present invention, but with balanced feeding points (183).

The above-described embodiments of the invention are presented by way of example only and do not limit the invention. Having illustrated and described the principles of our invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from such principles.

CLAIMS

1.- An antenna device characterized in that it includes two or more radiating arms, a first of these radiating arms including a feeding point, wherein at least two of these radiating arms are coupled by at least a close proximity region, said proximity region being formed by a portion of said two arms in which the distance between at least a first point in said first arm and at least a second point in a second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm, and wherein the antenna does not include a contact point between said first arm and said second arm.

2.- An antenna device according to claim 1, characterized in that it includes at least a first and a second radiating arm, said first arm including a feeding point, wherein the distance between at least a first point in said first arm and a second point in said second arm is smaller than the distance between said feeding point on said first arm and any point on the second arm said distance between said first and second points being shorter than a tenth of the longer free-space operating wavelength.

3.- An antenna device according to claim 1, characterized in that a first arm includes a feeding port, said feeding port being formed by at least a point in one of the tips of said first arm and at least a point on a ground-plane or ground counterpoise, and wherein a second arm has one of its tips connected to said ground-plane or ground counterpoise.

4.- An antenna device according to claim 1, characterized in that the antenna has a differential input between a first feeding point on a first arm and a second feeding point on a second arm such that said first and second arms define the two arms of a dipole antenna.

5.- An antenna device according to claim 1, characterized in that the antenna includes a differential input between a first feeding point on a first arm and a second feeding point on a second arm, and wherein said first and second arms are coupled through two close regions that include said close first and second points on each of said first and second arms respectively, such that said first arm, said second arm and the coupling region between both arms define a loop for the current flowing through the antenna structure.

6.- An antenna device according to claim 3 characterized in that at least one of the tips in one of the arms is closer to at least a point on a second arm than the distance between the feeding point in one arm and the grounding point on the other arm.

7.- An antenna device according to claim 3 characterized in that at least one of the arms include one bend, said bend defining an angle smaller than 90º with respect to the normal direction to a plane, said plane including the feeding point in one arm and being orthogonal to the ground plane at the feeding point and said plane excluding the grounding point on a second arm of the antenna, said normal to said plane being described by a vector pointing to the semispace over said plane including said grounding point on said second arm.

8.- An antenna device according to claim 1, characterized in that at least a portion of at least one arm is formed after 2 to 9 connected segments, each of said segments forming an angle with their neighboring connected segments, said angle being smaller than 180 degrees, said segments being shorter than 1/3 of the longer free-space operating wavelength.

9.- An antenna device according to claim 1, characterized in that at least a portion of at least one arm is formed after ten or more connected segments, each of said

segments forming an angle with their neighboring connected segments, said angle being smaller than 180 degrees, said segments being shorter than 1/8 of the longer free-space operating wavelength.

10.- An antenna device according to claim 1, characterized in that at least a portion of at least one arm includes a set of conductor, superconductor or semiconductor polygons, all of said polygons featuring the same number of sides, wherein said polygons are electromagnetically coupled either by means of a capacitive coupling or ohmic contact, wherein the contact region between directly connected polygons is narrower than 50% of the perimeter of said polygons in at least 75% of said polygons defining said conducting ground-plane.

11.- An antenna device according to claim 1, characterized in that at least one of the arms is formed by a polygonal surface enclosing a conducting, superconducting or semiconducting material.

12.- An antenna device according to claim 1, characterized in that at least a portion of said first and second arms are lying on two parallel surfaces, said surfaces being spaced by a dielectric material.

13.- An antenna device according to claim 1, characterized in that at least a portion of said first and second arm have a substantially planar shape, said portions being mounted orthogonally to a rectangular or elongated ground plane at a distance smaller than 1/3 of the free-space operating wavelength from the shorter side or edge of said ground plane, said portions of said arms being substantially parallel to said edge of said ground-plane, said first arm including a feeding point, said feeding point being located near the corner of said ground plane at a distance smaller than a tenth of the free-space operating wavelength, said second arm being connected to said ground plane near the opposite corner on the same

shorter edge of said ground plane at a distance smaller than a tenth of the free-space operating wavelength.

14.- An antenna device according to claim 13, characterized in that the planar portion of said first arm is closer to the edge of said ground plane than the planar portion of said second arm, and said first arm includes the feeding point, while the second arm is shorted to the ground plane.

15.- An antenna device according to claim 1, characterized in that said first and second arms are planar and parallel to the ground plane.

16.- An antenna device according to claim 1, characterized in that said first and second arms are planar and parallel to the ground plane and are printed in any of the layers of the sides of a single layer or a multilayer printed circuit board, said board including also said ground plane.

17.- An antenna for a handheld device according to claim 1, characterized in that the antenna features a voltage standing wave ratio (VSWR) below 2 within the 800 MHz to 2500 MHz frequency range.

18.- An antenna according to claim 1, characterized in that said antenna is integrated inside the package of an integrated circuit or chip, such that at least one of the arms of said antenna is printed in one of the layers of the substrate supporting the semiconductor die.

19.- An antenna according to claim 1, characterized in that the arms and the ground plane are enclosed inside a plastic or dielectric package, said package being mounted on the glass surface of a motor vehicle, said antenna operating from 800 MHz to 2500 MHz frequency range.

ABSTRACT

The present invention consists of an antenna comprising at least two radiating structures, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms being coupled to each other through a region on first and second superconducting arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, a multiband behavior or a combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna.

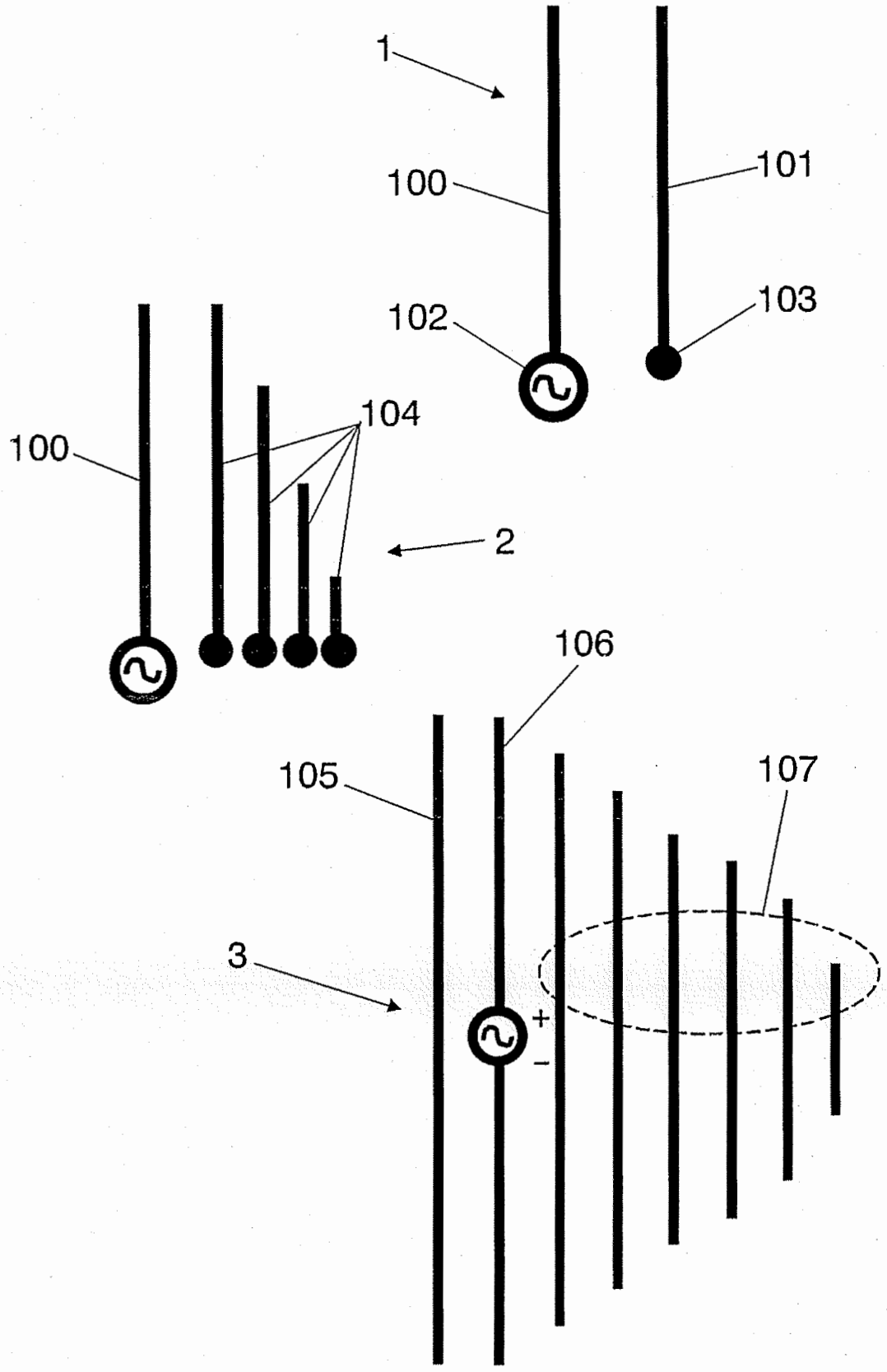


FIG.1 (Prior Art)

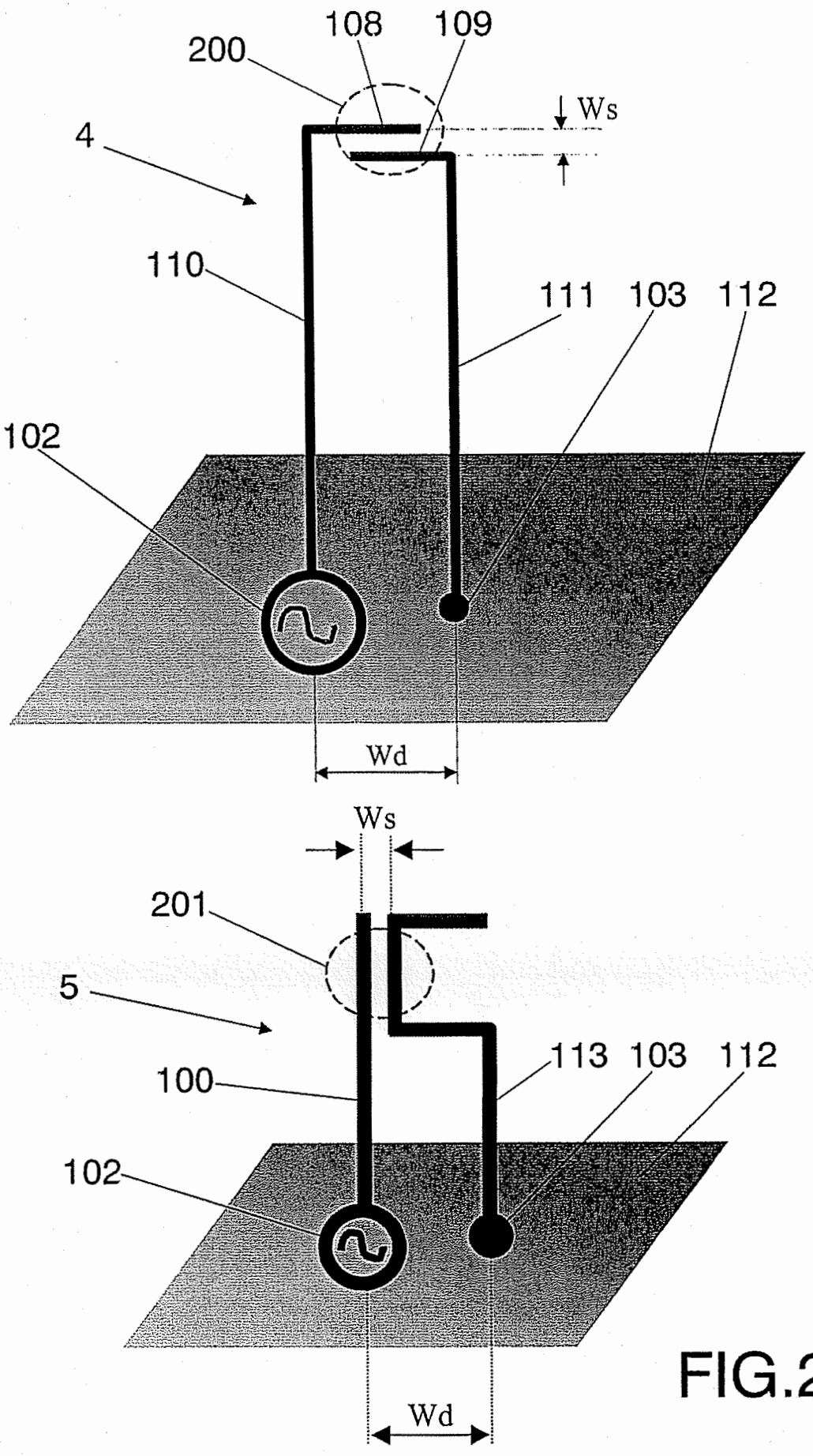

108
109
200
Ws
4
110
111
103
112
102
Wd
Ws
201
5
113
103
112
100
102
Wd

FIG.2

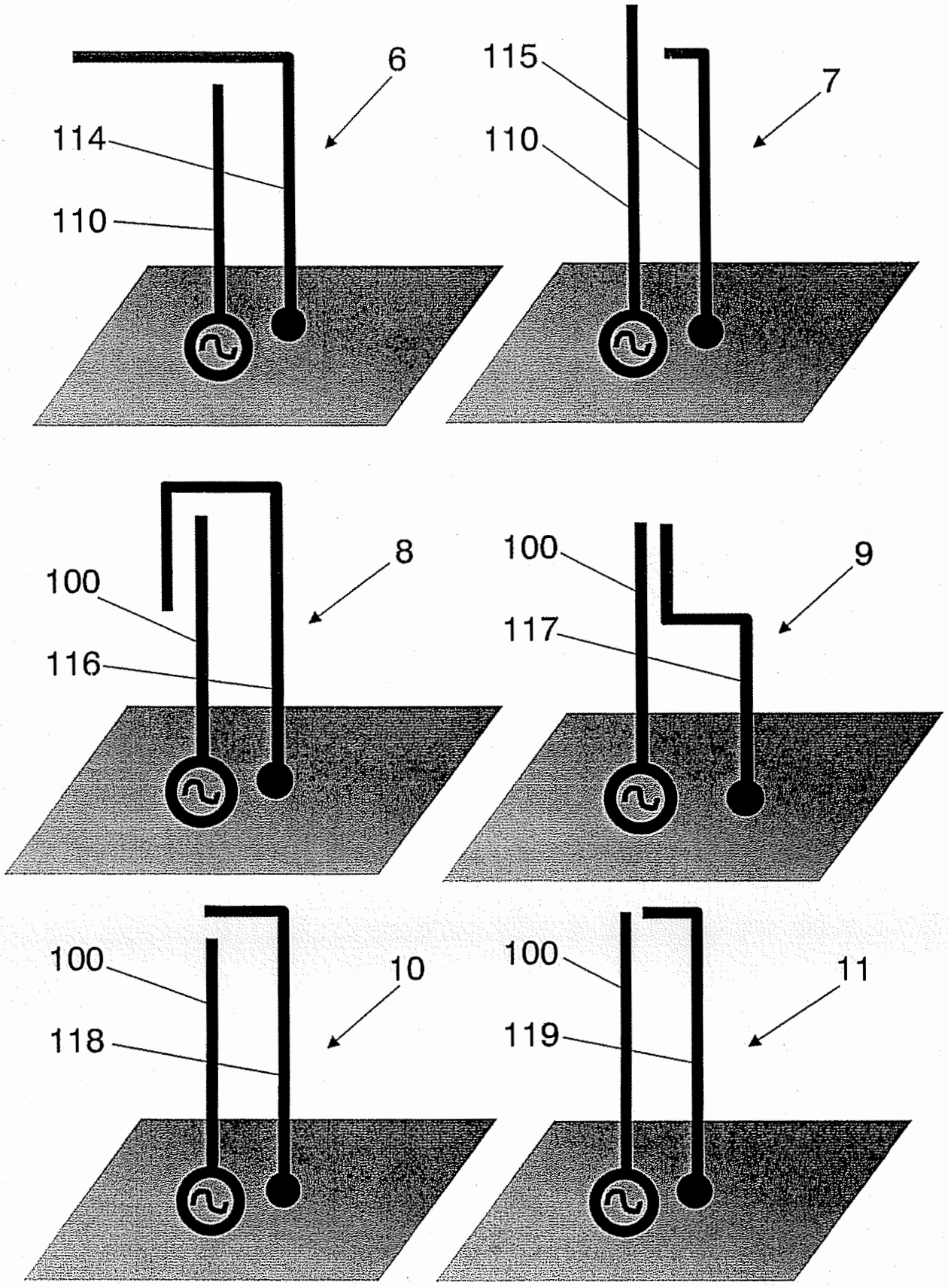


FIG.3

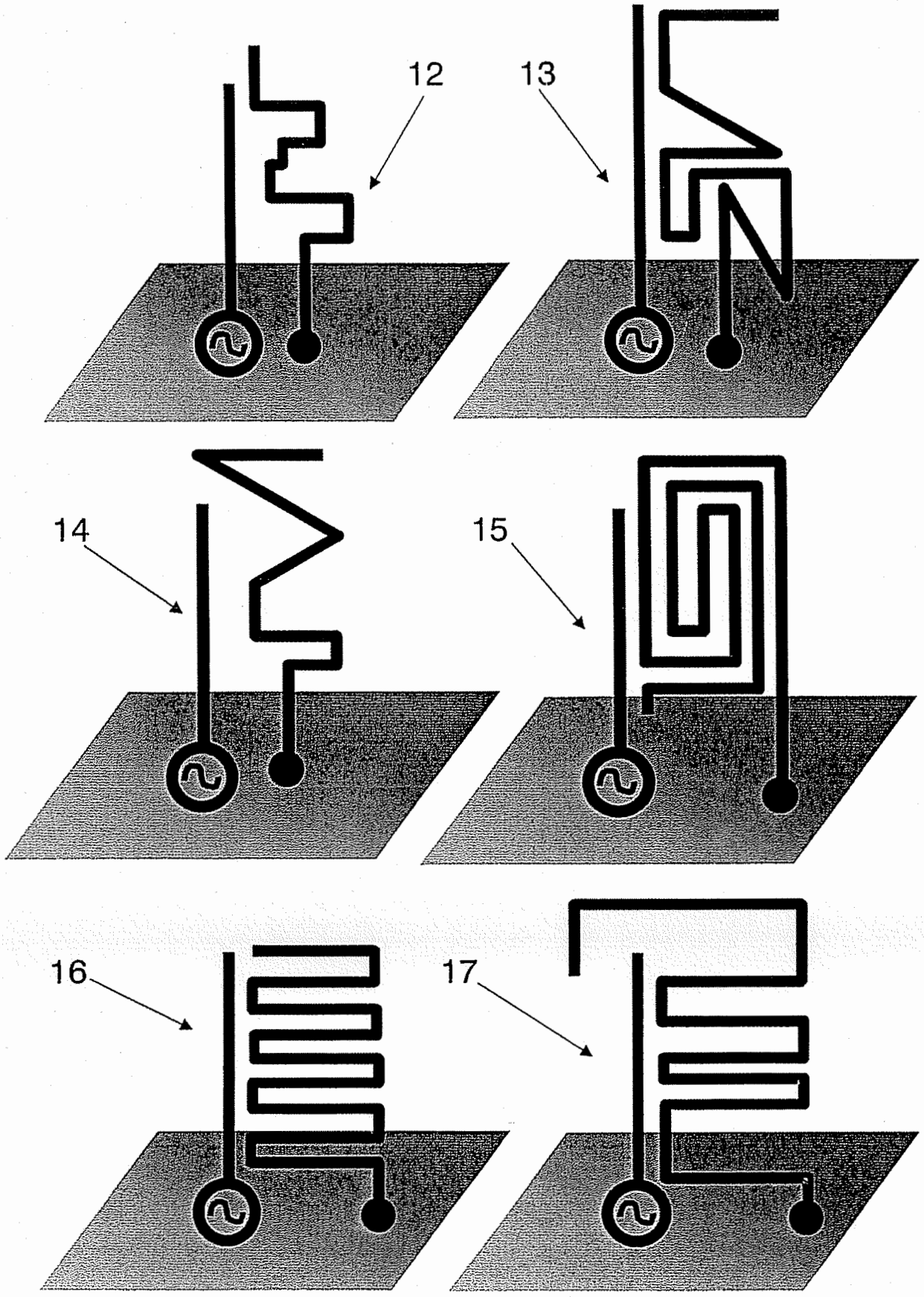


FIG.4

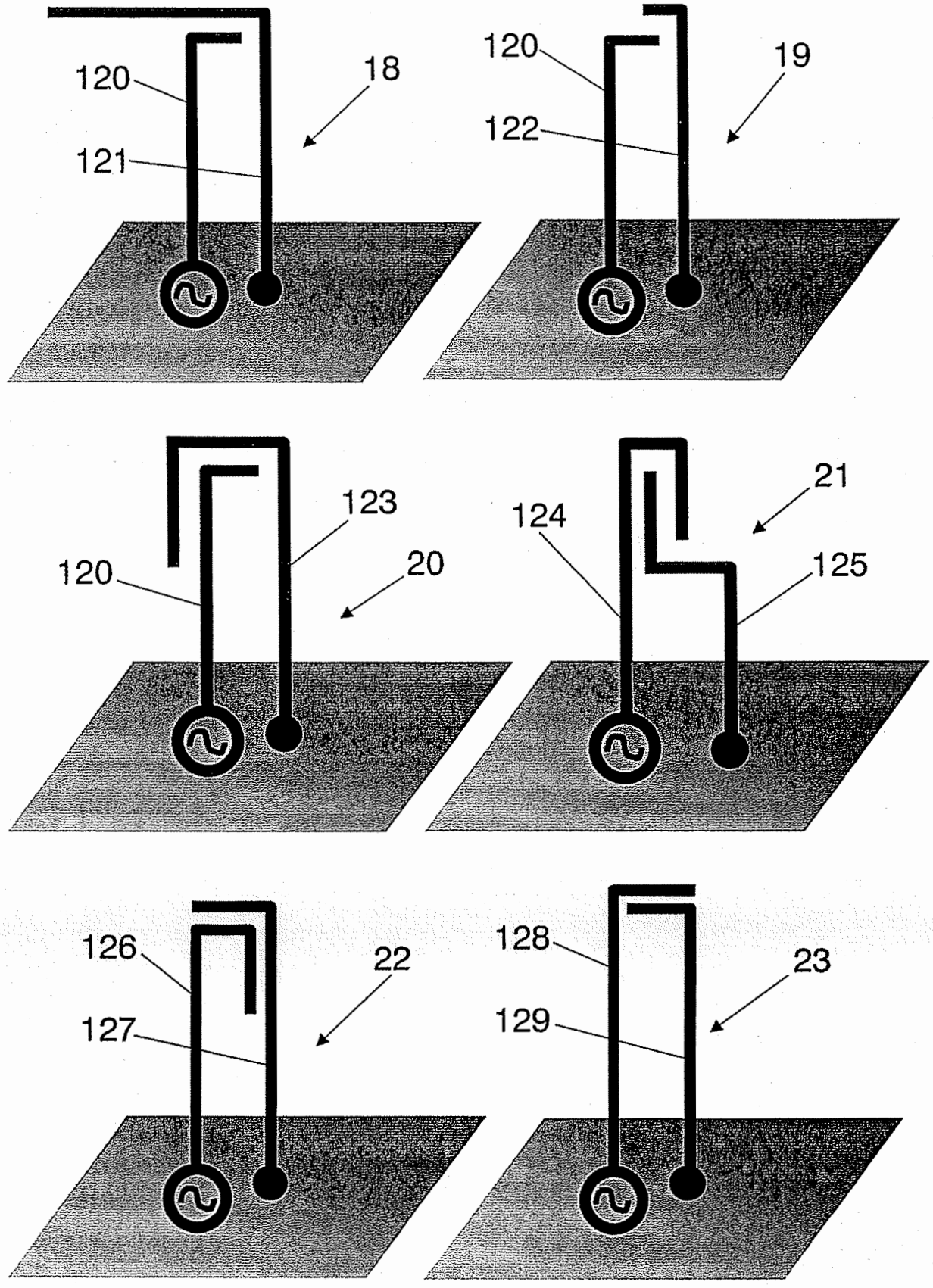


FIG.5

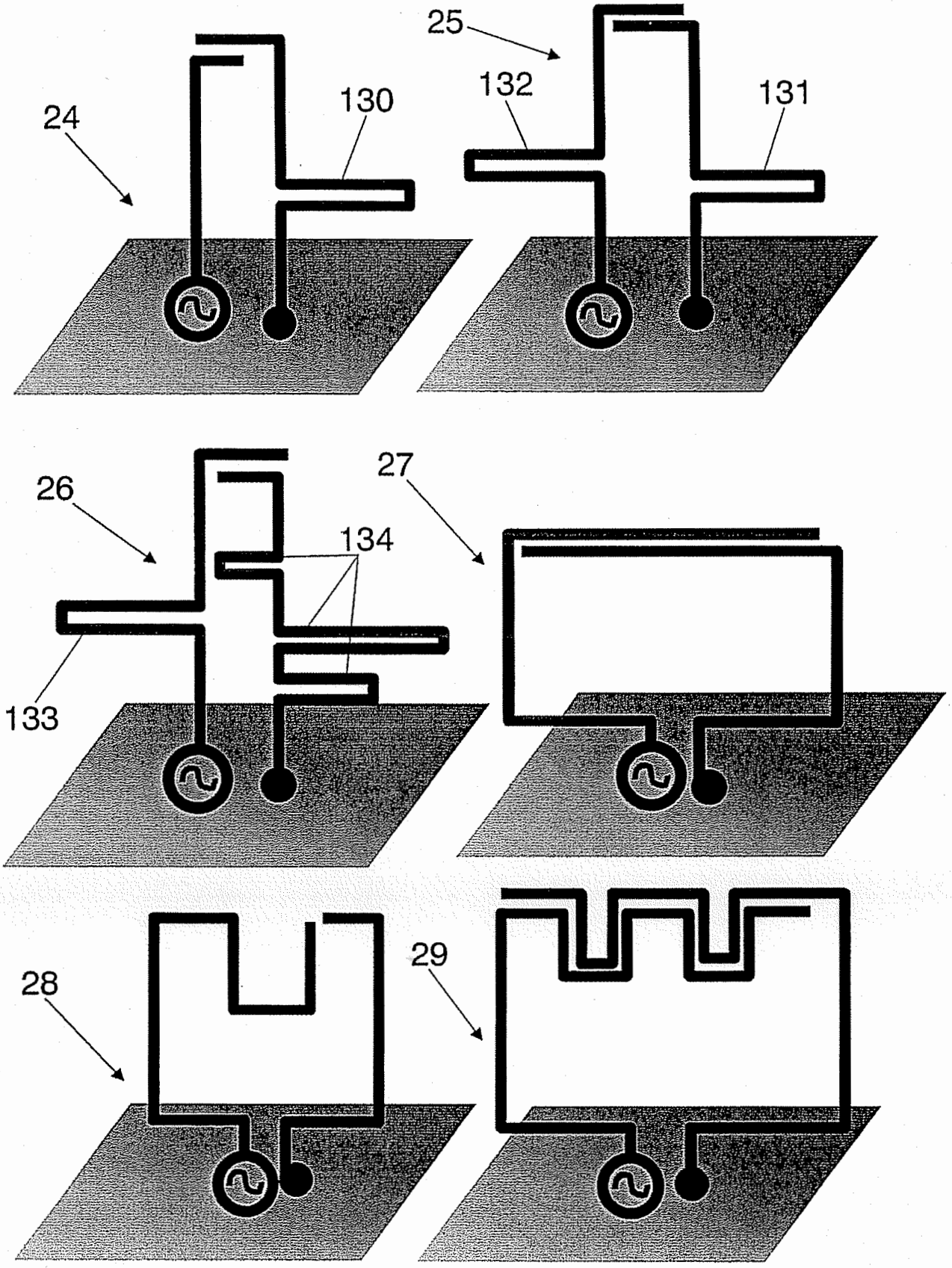


FIG.6

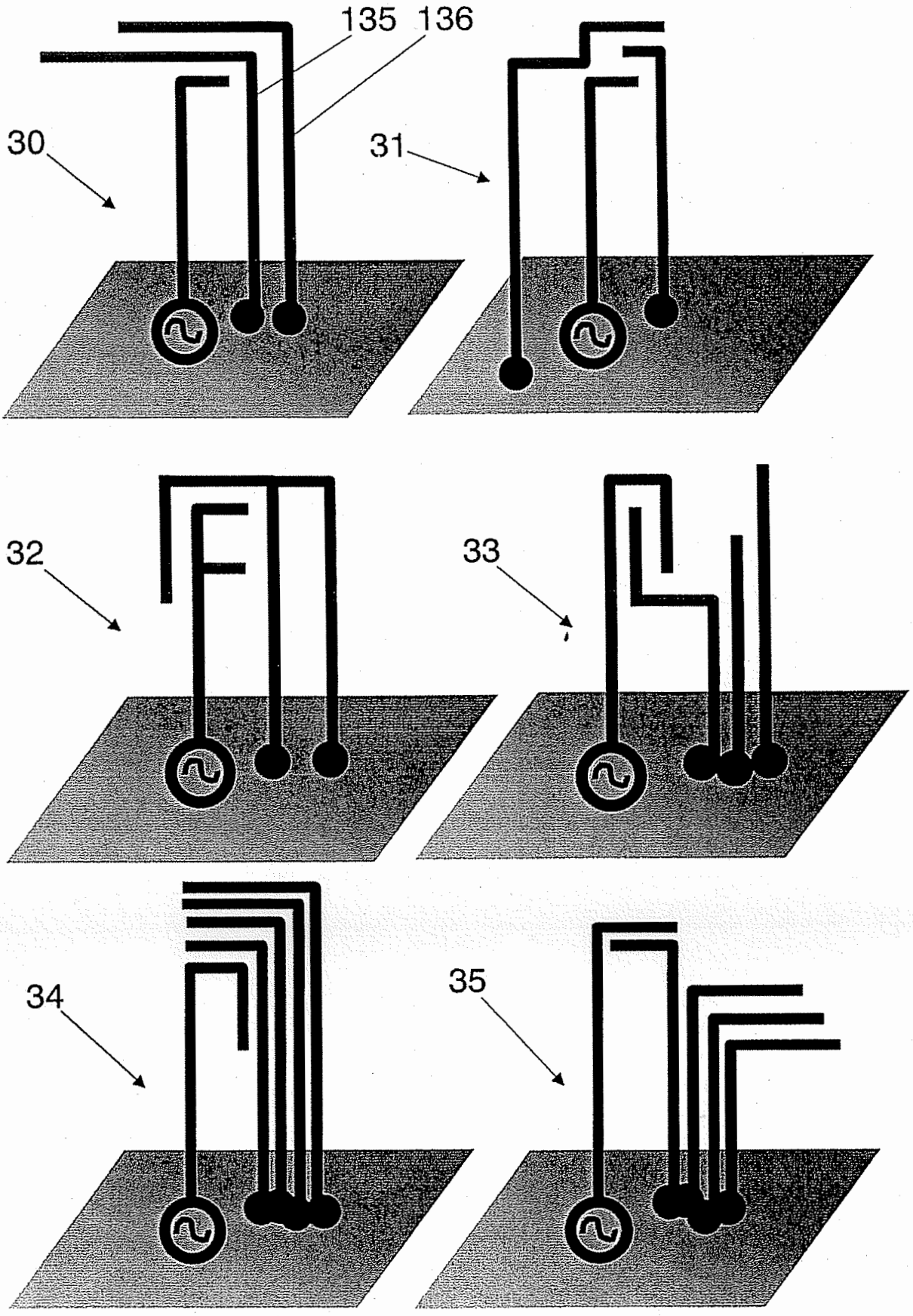


FIG.7

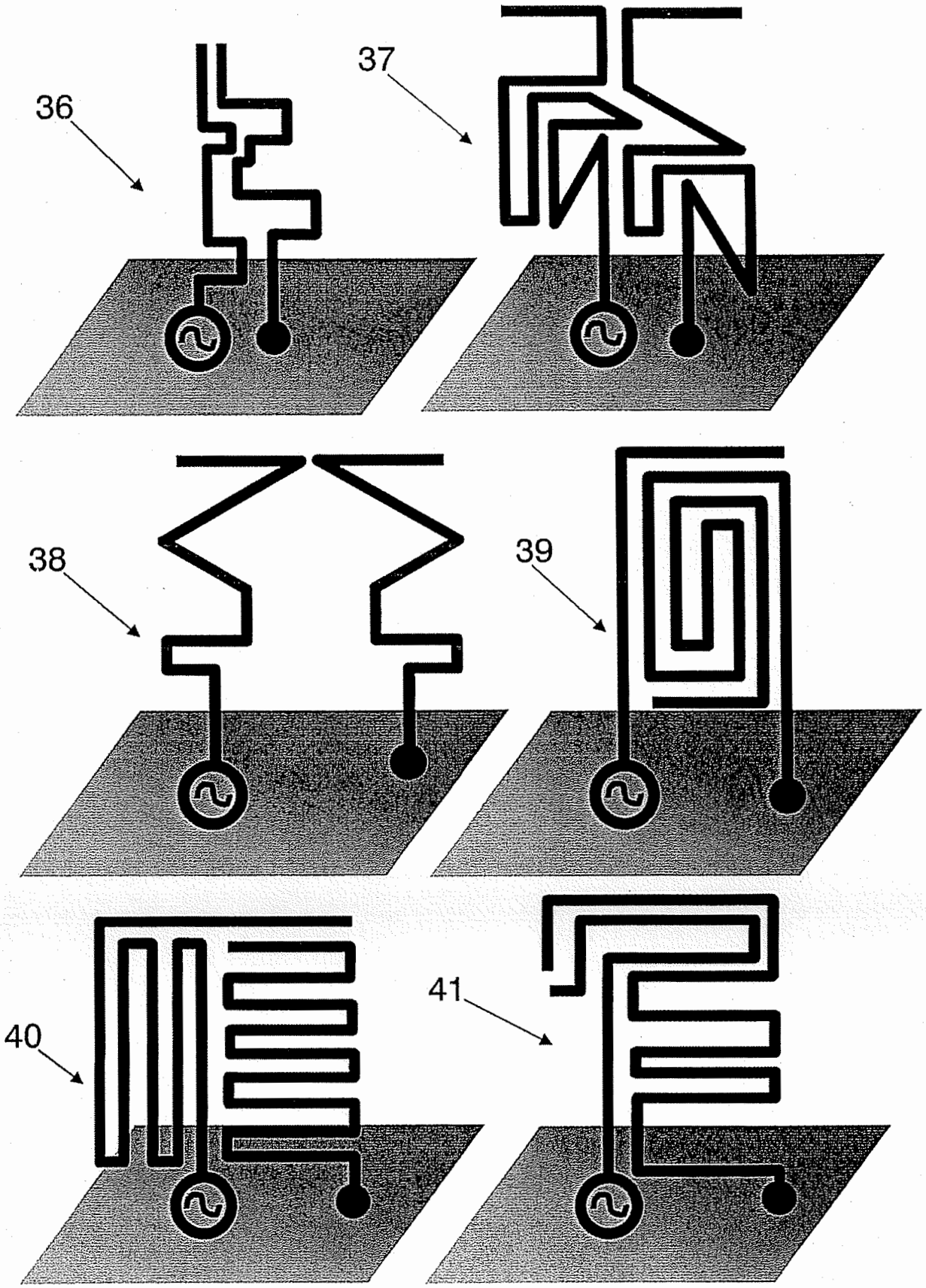


FIG.8

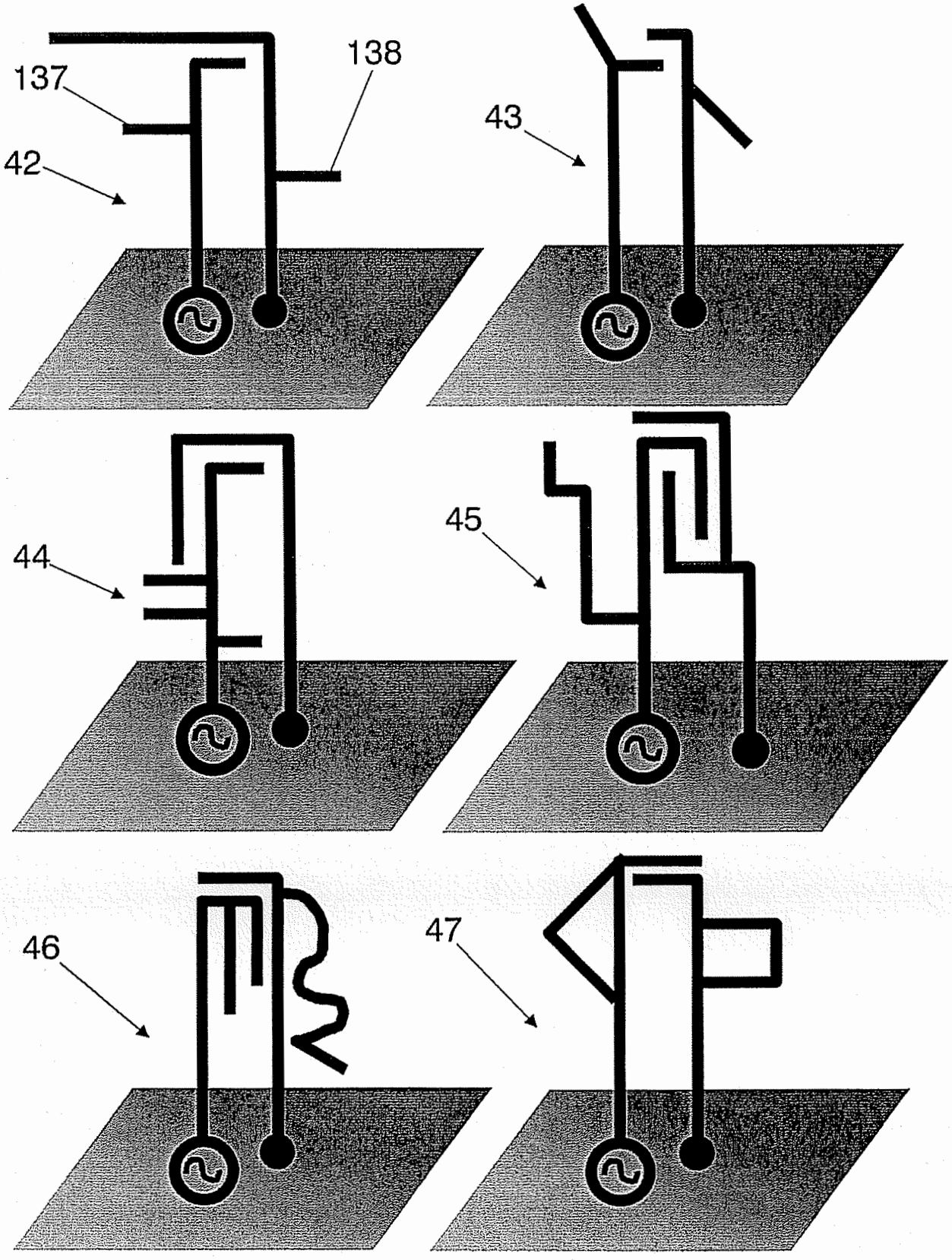


FIG.9

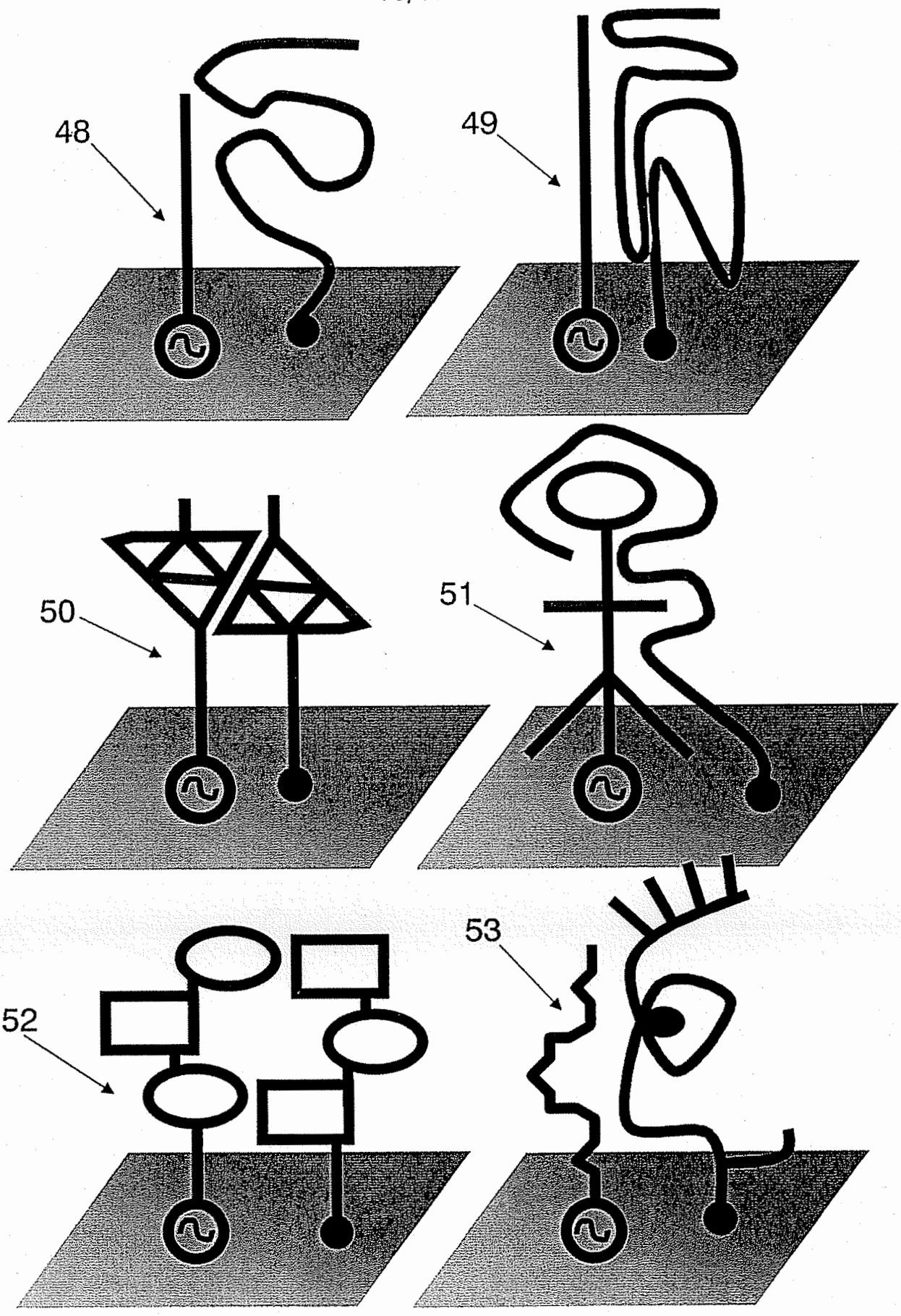


FIG.10

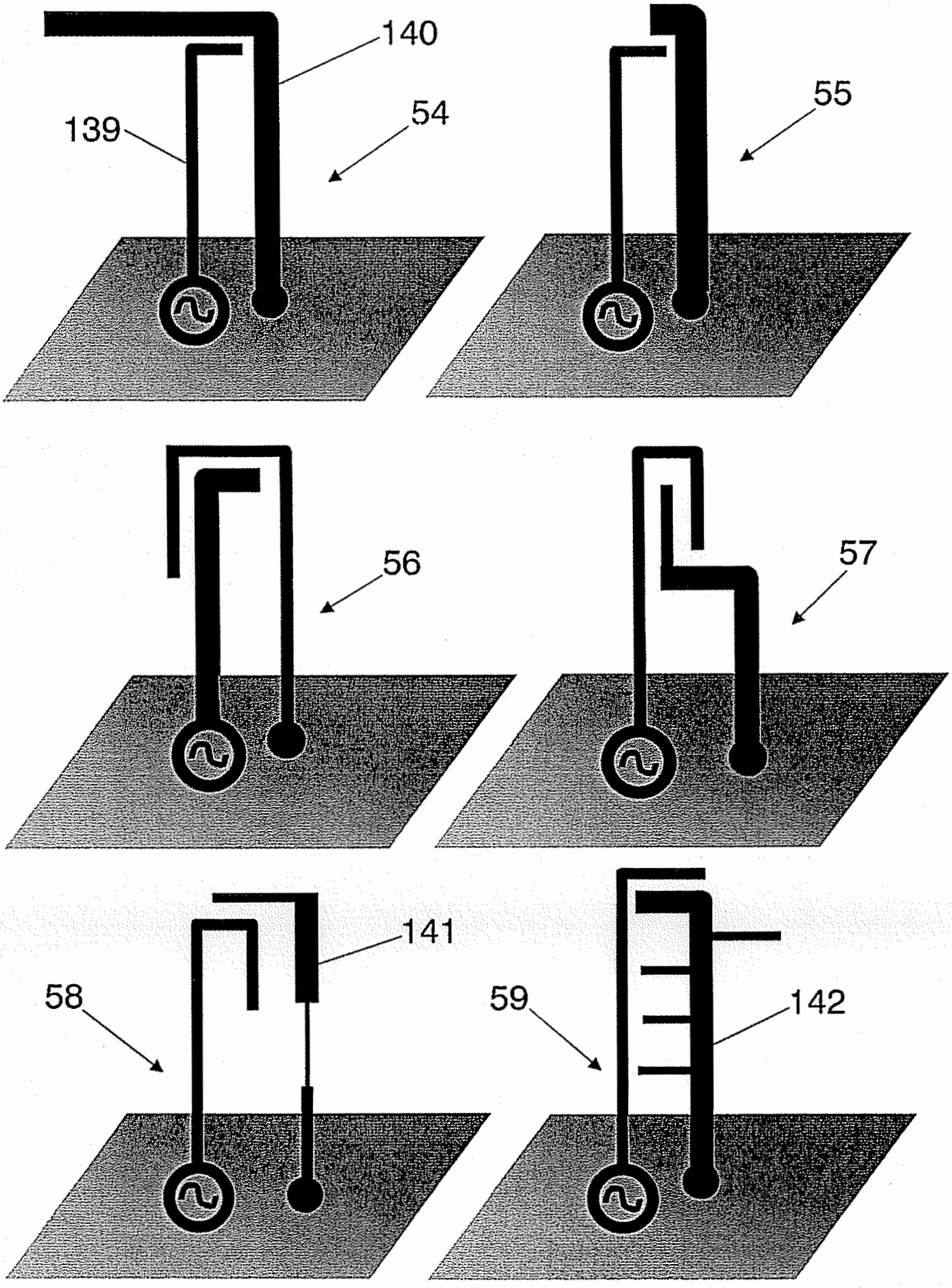


FIG.11

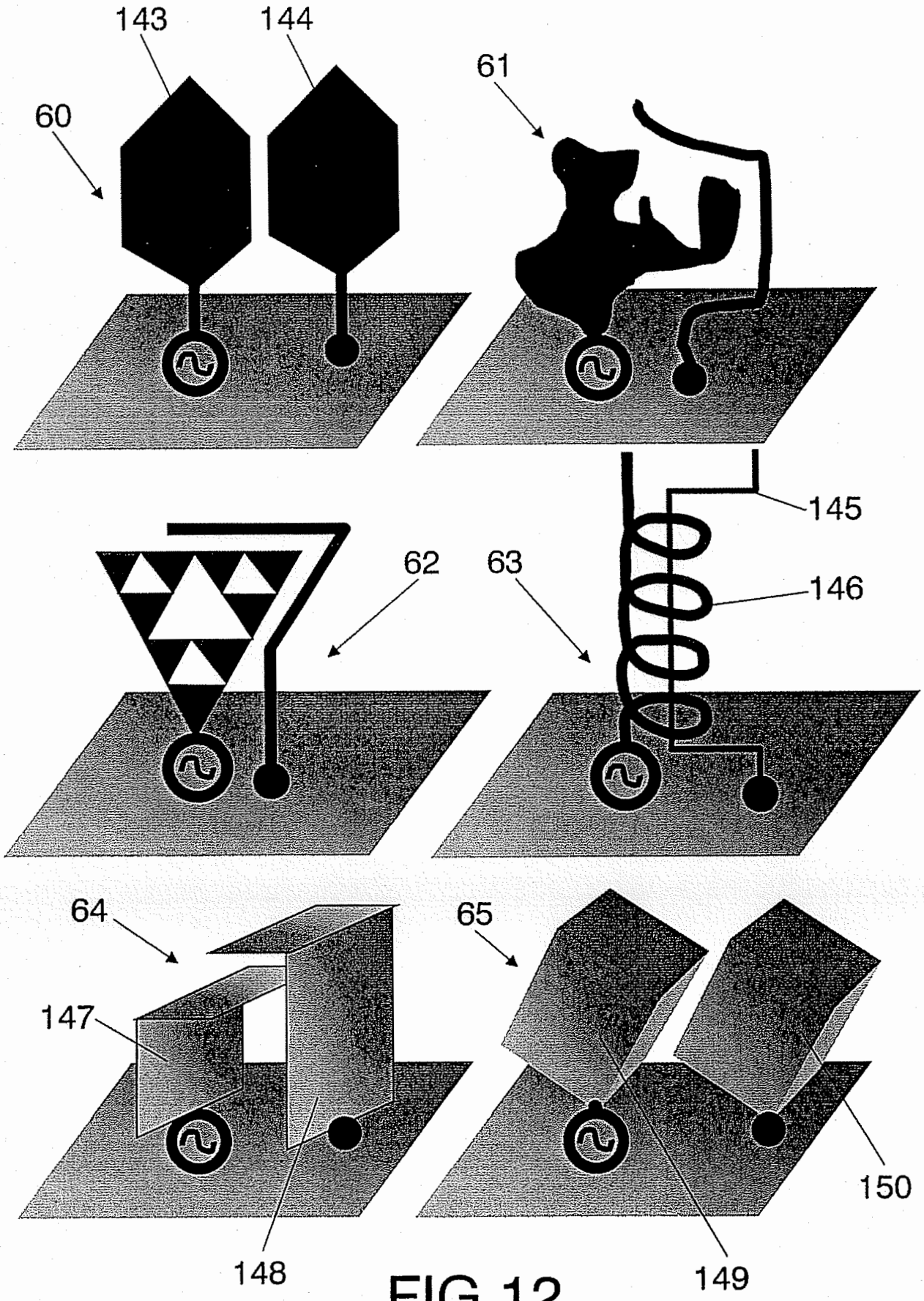
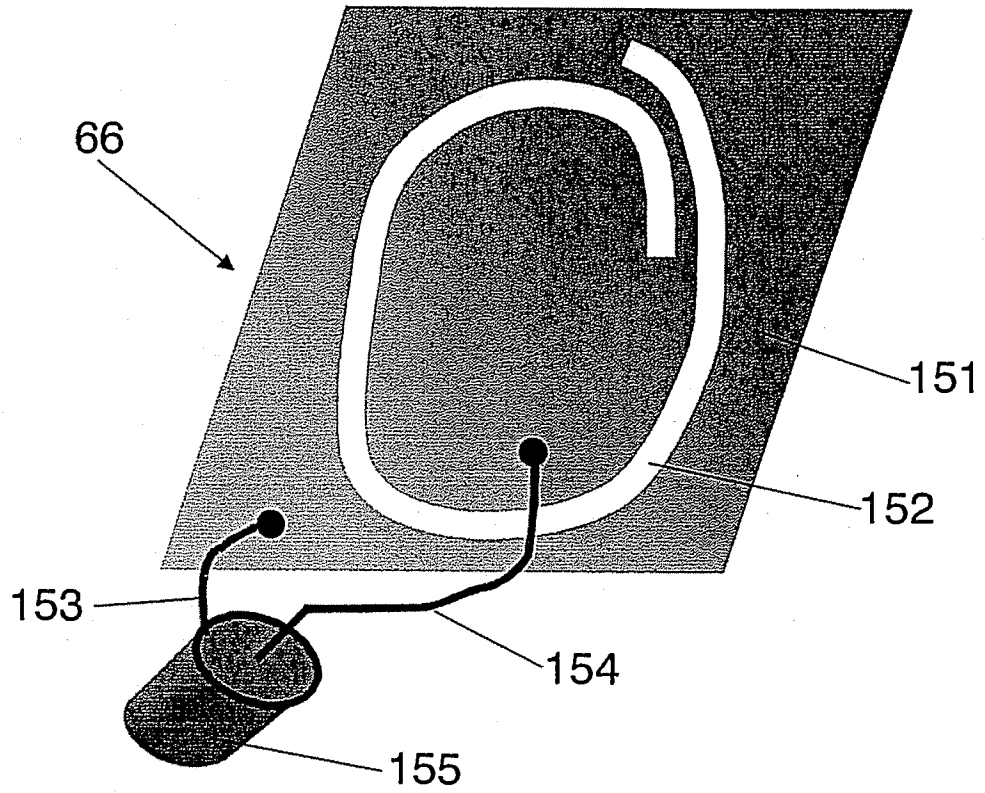


FIG.12



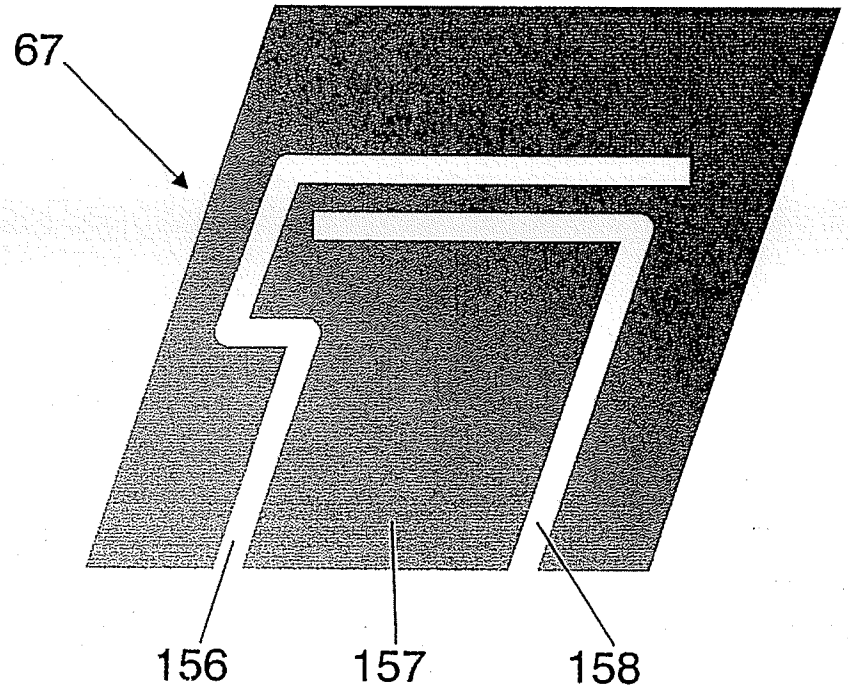


FIG.13

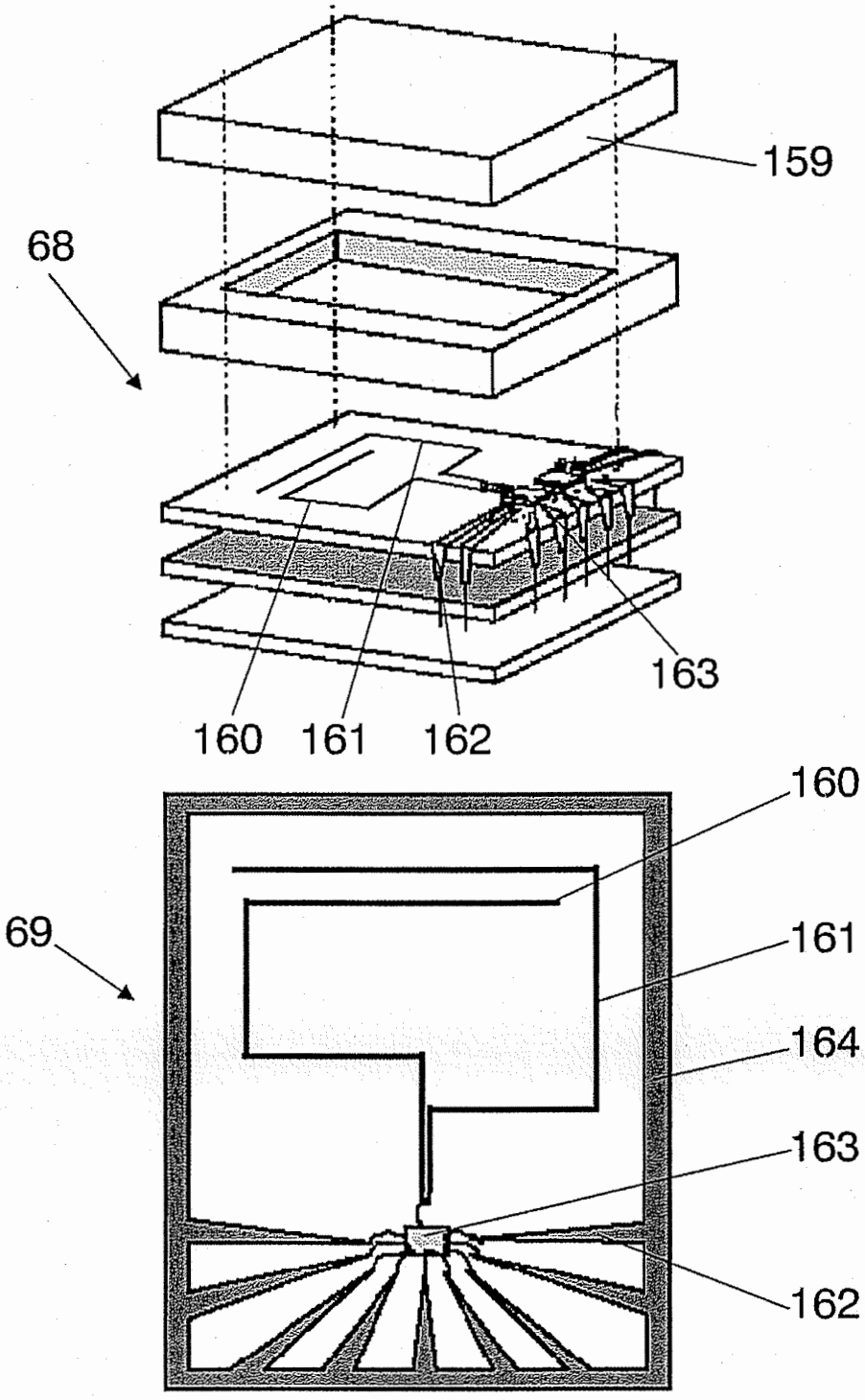
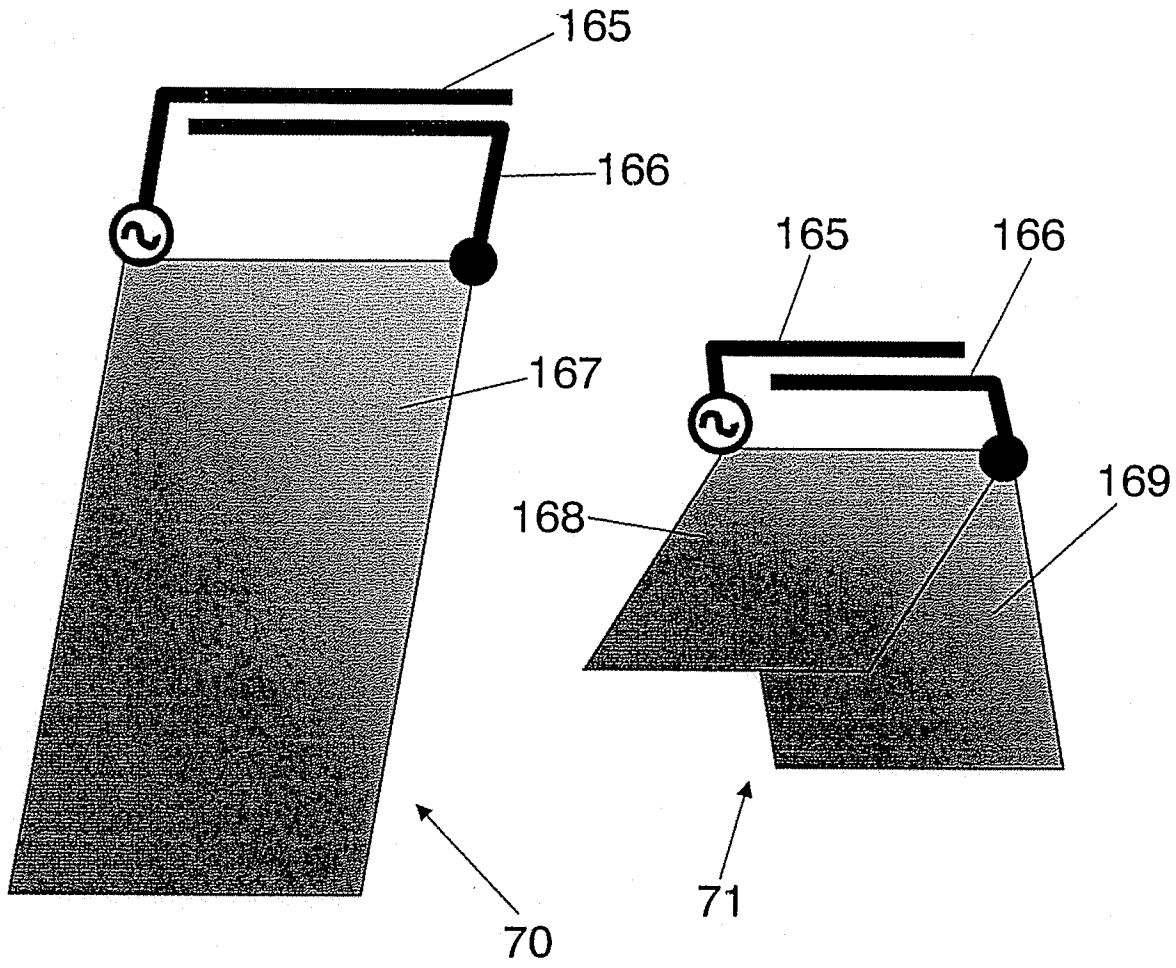


FIG.14



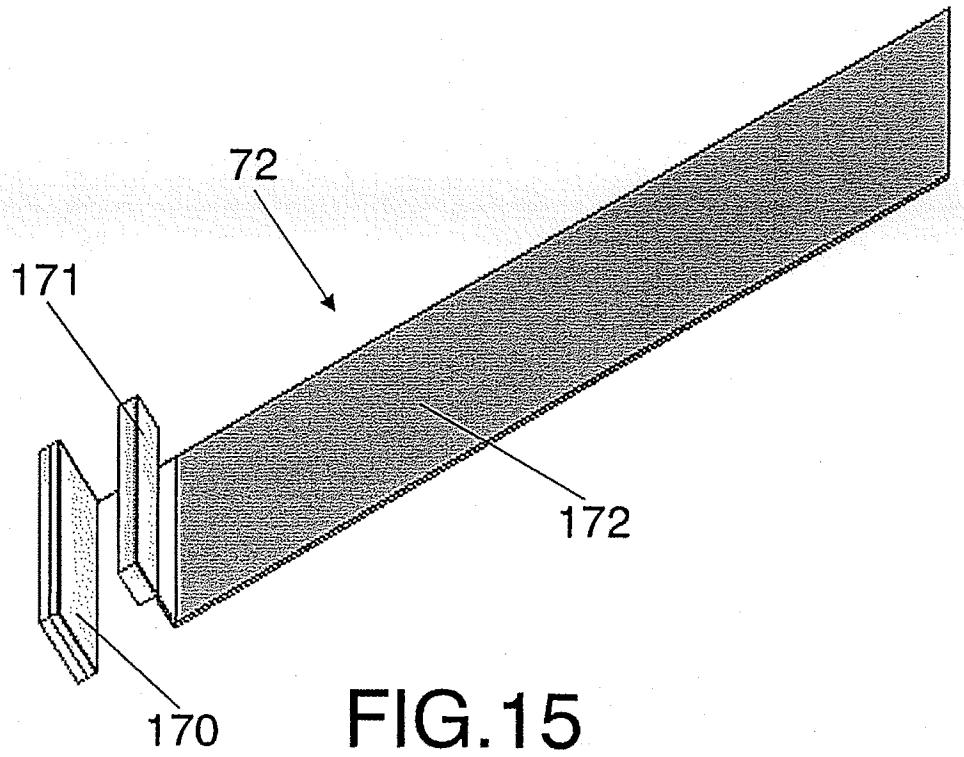


FIG.15

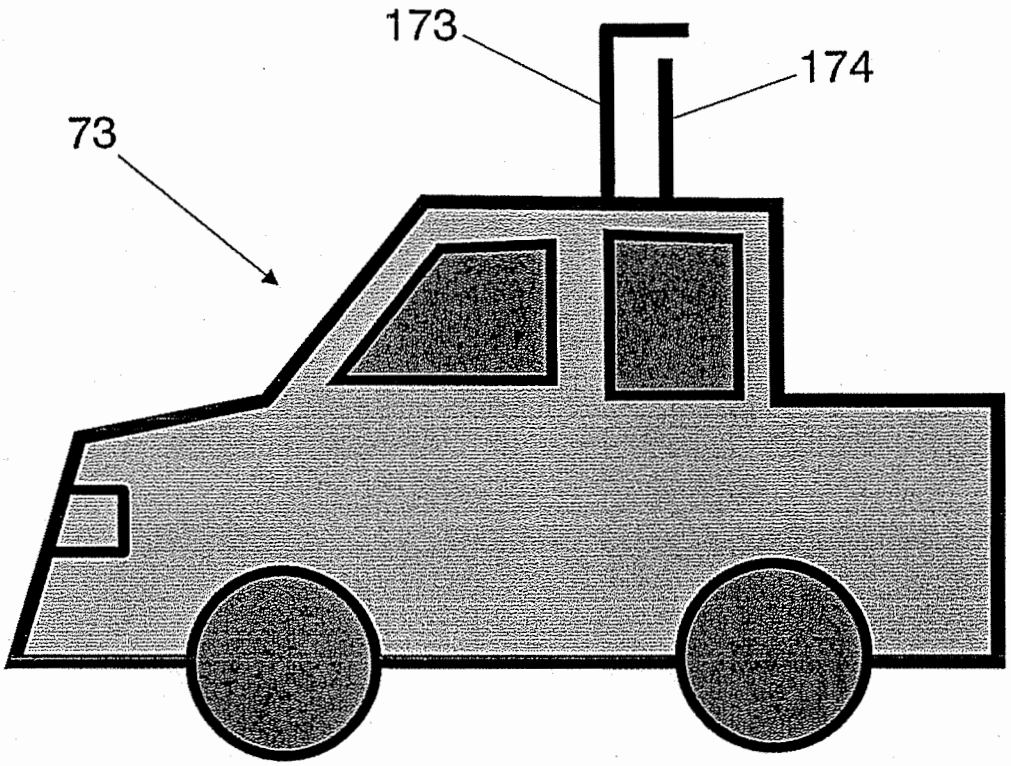


FIG.16

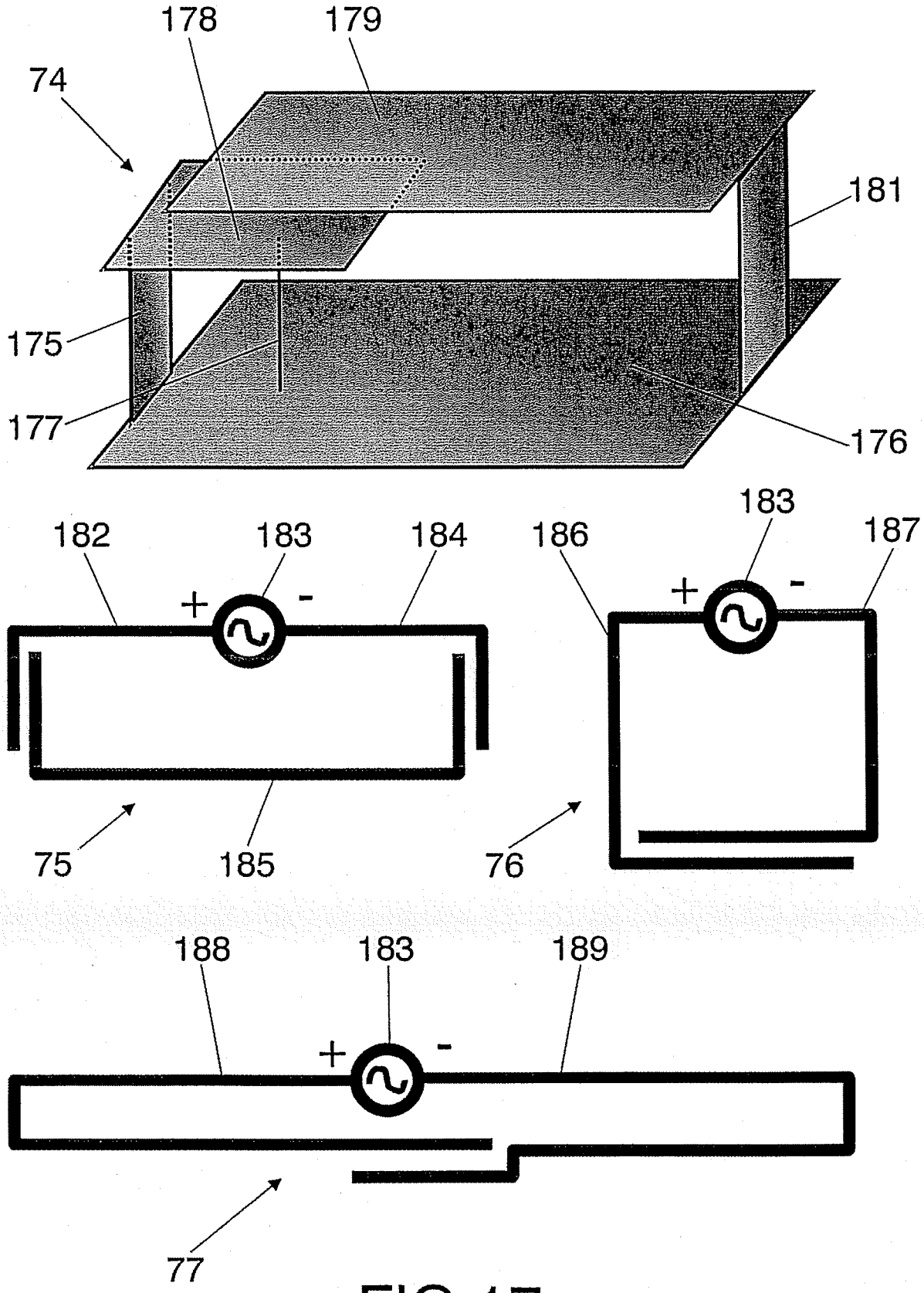

178
179
74
181
175
177
176
182
183
184
186
183
187
75
185
76
188
183
189
77

FIG.17

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Filer:	Ross Robinson
Attorney Docket Number:	47005-P015WUSC1

Filed as Large Entity

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	310	310
Utility Search Fee	1111	1	510	510
Utility Examination Fee	1311	1	210	210
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1030**

Electronic Acknowledgement Receipt

EFS ID:	2550045
Application Number:	11950835
International Application Number:	
Confirmation Number:	7241
Title of Invention:	COUPLED MULTIBAND ANTENNAS
First Named Inventor/Applicant Name:	Carles Puente Baliarda
Customer Number:	61060
Filer:	Ross Robinson
Filer Authorized By:	
Attorney Docket Number:	47005-P015WUSC1
Receipt Date:	05-DEC-2007
Filing Date:	
Time Stamp:	15:14:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1030
RAM confirmation Number	542
Deposit Account	232426
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	declaration.pdf	173310 04d7d4060195c91f80099bb8e46892fc0fe90cef	no	3
Warnings:					
Information:					
2		application.pdf	4735280 225b9785c43c1d20dcaf5863579d0038df92a822	yes	42

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	20
Claims	21	24
Abstract	25	25
Drawings-only black and white line drawings	26	42

Warnings:					
Information:					
3	Fee Worksheet (PTO-06)	fee-info.pdf	8350 858b5529a49ba4f460ddac7bdfb10735ad934c4f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	4916940		

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

New Applications Under 35 U.S.C. 111

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

National Stage of an International Application under 35 U.S.C. 371

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

New International Application Filed with the USPTO as a Receiving Office

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

Filing Date: 12/05/07

Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 11/950,835

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	255		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	105		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	0	X$ 25	0	OR	X$50	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1	* 0	X$105			X$210	
APPLICATION SIZE FEE (37 CFR 1.16(s))	420If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			185			370	
			TOTAL	435		TOTAL	0

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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

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

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