



US007394425B2

(12) **United States Patent**
Luch

(10) **Patent No.:** **US 7,394,425 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **ELECTRICALLY CONDUCTIVE PATTERNS, ANTENNAS AND METHODS OF MANUFACTURE**

(76) Inventor: **Daniel Luch**, 17161 Copper Hill Dr., Morgan Hill, CA (US) 95037

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/223,482**

(22) Filed: **Sep. 8, 2005**

(65) **Prior Publication Data**

US 2006/0017623 A1 Jan. 26, 2006

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/472,875, filed as application No. PCT/US02/09408 on Mar. 25, 2002, now abandoned, application No. 11/223,482, which is a continuation-in-part of application No. 10/988,044, filed on Nov. 12, 2004, which is a continuation-in-part of application No. 10/408,532, filed on Apr. 7, 2003, now abandoned, which is a continuation-in-part of application No. 09/818,128, filed on Mar. 26, 2001, now Pat. No. 6,582,887.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS**

(58) **Field of Classification Search** 343/700 MS, 343/702, 867, 895; 340/572.2-572.8
See application file for complete search history.

(56) **References Cited**

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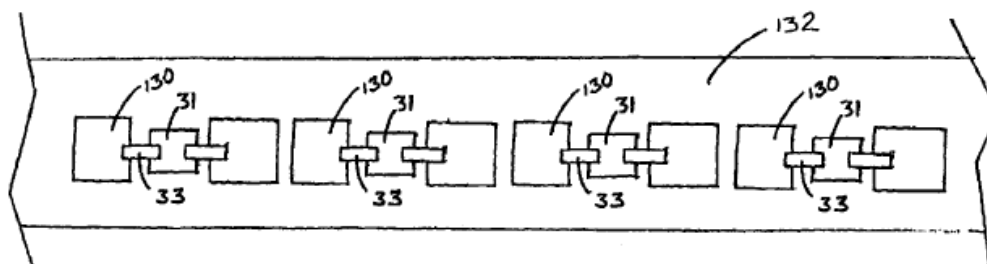
EP 0942441 9/1999

Primary Examiner—Huedung Mancuso

(57) **ABSTRACT**

The invention teaches improved, novel methods and materials for the production of antennas. The invention contemplates the use of Directly Electroplateable Resins for the production of these antennas. The unique suitability of Directly Electroplateable Resins to allow facile manufacture of the antennas desired using a broad range of processing and manufacturing approaches is demonstrated.

11 Claims, 39 Drawing Sheets



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US00D572243S

(12) **United States Design Patent**
Lin et al.

(10) **Patent No.:** **US D572,243 S**
(45) **Date of Patent:** **** Jul. 1, 2008**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Ching-Cui Lin**, Tu-Cheng (TW);
Jia-Hung Su, Tu-Cheng (TW); **Kai Shih**,
Tu-Cheng (TW); **Yu-Yuan Wu**, Tu-Cheng (TW)

(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**,
Taipei Hsien (TW)

(**) Term: **14 Years**

(21) Appl. No.: **29/274,589**

(22) Filed: **May 7, 2007**

(51) **LOC (8) Cl.** **14-03**

(52) **U.S. Cl.** **D14/230**

(58) **Field of Classification Search** D14/138,
D14/230-238, 299, 358; D12/42, 43; 343/700 MS,
343/700 R-705, 711-713, 741, 748, 767,
343/795, 819, 840, 846, 866, 871-908; 455/90.2,
455/90.3, 91, 128, 269, 344, 347, 562.1
See application file for complete search history.

(56) **References Cited**

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2008/0030407 A1 * 2/2008 Hung et al. 343/700 MS

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Primary Examiner—Louis S Zarfas

Assistant Examiner—John Windmuller

(74) *Attorney, Agent, or Firm*—Rosenberg, Klein & Lee

(57) **CLAIM**

The ornamental design for a multi-band antenna, as shown and described.

DESCRIPTION

FIG. 1 is a perspective view of a multi-band antenna showing our new design;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a rear elevational view thereof;

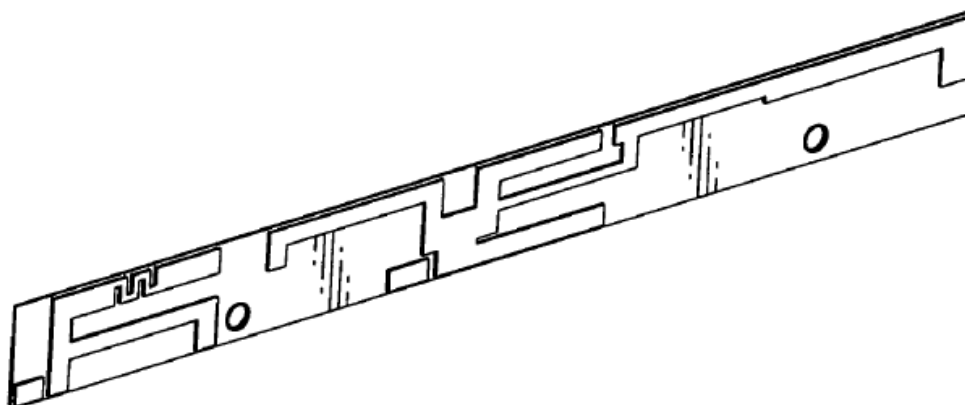
FIG. 4 is a left side elevational view thereof;

FIG. 5 is a right side elevational view thereof;

FIG. 6 is a top plan view thereof; and,

FIG. 7 is a bottom plan view thereof.

1 Claim, 4 Drawing Sheets



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US007394426B2

(12) **United States Patent**
Ogawa et al.

(10) **Patent No.:** **US 7,394,426 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **CIRCULAR POLARIZED ANTENNA,
ANTENNA DESIGN SIMULATOR, AND
WIRELESS MODULE WITH THE ANTENNA**

(75) Inventors: **Tomoyuki Ogawa**, Hitachi (JP); **Ken
Takei**, Hitachi (JP)

(73) Assignee: **Hitachi Cable, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 319 days.

(21) Appl. No.: **11/352,405**

(22) Filed: **Feb. 13, 2006**

(65) **Prior Publication Data**

US 2006/0181460 A1 Aug. 17, 2006

(30) **Foreign Application Priority Data**

Feb. 14, 2005 (JP) 2005-036002

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/895**

(58) **Field of Classification Search** **343/700 MS,
343/702, 845, 895**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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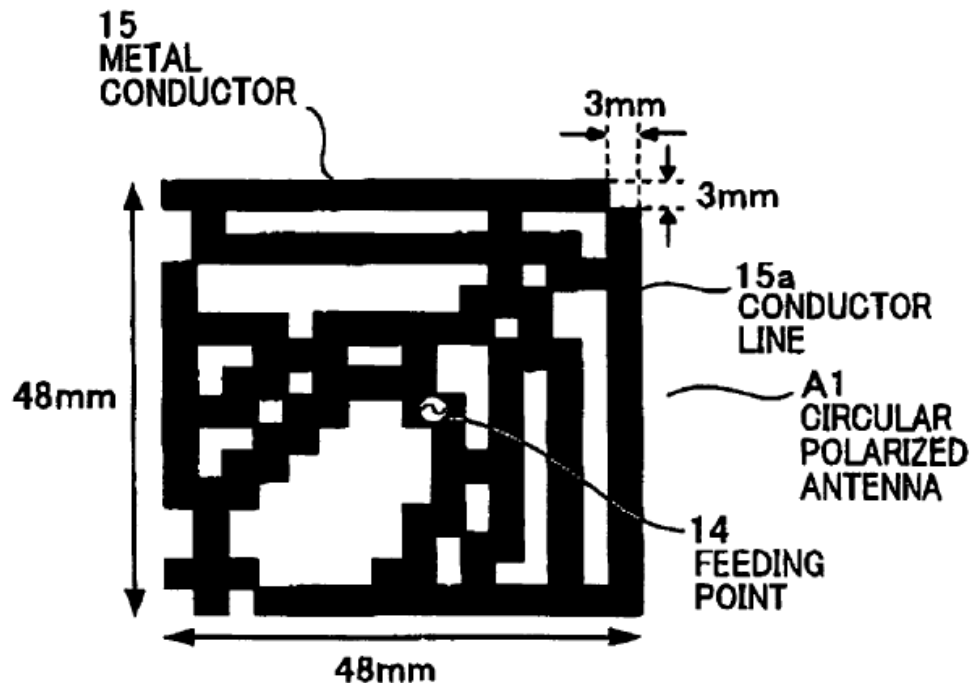
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—McGinn IP Law Group,
PLLC

(57) **ABSTRACT**

A circular polarized antenna has a group of conductor lines that comprise a planar metal conductor, and a feeding point connected to a part of the conductor lines. When a current to be induced on the conductor lines is projected onto two mutually-perpendicular axes to define projections and arguments therebetween, a ratio between absolute values of the projections is 0.7 to 1.3 and an absolute value of a difference between the arguments is 80 to 100 degrees, and a reactance component of an impedance of the feeding point is nearly zero.

10 Claims, 8 Drawing Sheets



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US007394429B2

(12) **United States Patent**
Fang et al.

(10) **Patent No.:** **US 7,394,429 B2**

(45) **Date of Patent:** **Jul. 1, 2008**

(54) **COMMUNICATION DEVICE AND RELATED ANTENNA MODULE**

(75) Inventors: **Chien-Hsing Fang**, Taipei Hsien (TW);
Ho-Chen Chang, Taipei Hsien (TW)

(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 206 days.

(21) Appl. No.: **10/905,191**

(22) Filed: **Dec. 21, 2004**

(65) **Prior Publication Data**

US 2005/0159196 A1 Jul. 21, 2005

(30) **Foreign Application Priority Data**

Jan. 16, 2004 (TW) 93101235 A

(51) **Int. Cl.**

H01Q 1/50 (2006.01)

H01Q 21/24 (2006.01)

H01Q 21/28 (2006.01)

(52) **U.S. Cl.** **343/702; 343/841; 343/853**

(58) **Field of Classification Search** **343/702, 343/841, 853, 756, 799, 834-838**

See application file for complete search history.

(56) **References Cited**

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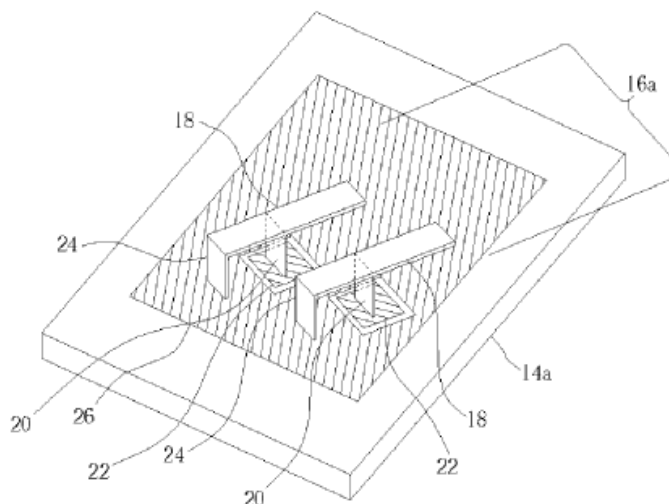
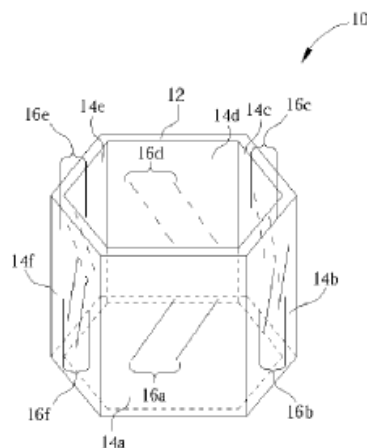
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Winston Hsu

(57) **ABSTRACT**

A wireless communication device includes a shell having a first shielding surface for shielding electromagnetic waves, a data processing module, a wireless communication module connected to the data processing module, and an antenna module disposed on the shell and connected to the wireless communication module. The antenna module has a first antenna unit and a second antenna unit. The first shielding surface shields the first antenna unit from the second antenna unit.

10 Claims, 11 Drawing Sheets



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US007394432B2

(12) **United States Patent**
Baliarda et al.

(10) **Patent No.:** **US 7,394,432 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **MULTILEVEL ANTENNA**

(75) Inventors: **Carles Puente Baliarda**, Barcelona (ES); **Carmen Borja Borau**, Barcelona (ES); **Jaume Anguera Pros**, Barcelona (ES); **Jordi Soler Castany**, Mataro (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **11/550,256**

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(22) Filed: **Oct. 17, 2006**

AU 2438199 A 9/1999

(65) **Prior Publication Data**

US 2007/0279289 A1 Dec. 6, 2007

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Related U.S. Application Data

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(60) Division of application No. 11/179,257, filed on Jul. 12, 2005, which is a continuation of application No. 11/102,390, filed on Apr. 8, 2005, now Pat. No. 7,123,208, which is a continuation of application No. 10/963,080, filed on Oct. 12, 2004, now Pat. No. 7,015,868, which is a continuation of application No. 10/102,568, filed on Mar. 18, 2002, now abandoned, which is a continuation of application No. PCT/ES99/00296, filed on Sep. 20, 1999.

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Primary Examiner—Tho G Phan

(74) Attorney, Agent, or Firm—Howison & Arnott, L.L.P.

(57)

ABSTRACT

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/700 MS;
343/800

(58) **Field of Classification Search** 343/700 MS,
343/702, 798, 800, 829, 846
See application file for complete search history.

(56) **References Cited**

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Antennae in which the corresponding radiative element contains at least one multilevel structure formed by a set of similar geometric elements (polygons or polyhedrons) electromagnetically coupled and grouped such that in the structure of the antenna can be identified each of the basic component elements. The design is such that it provides two important advantages: the antenna may operate simultaneously in several frequencies, and/or its size can be substantially reduced. Thus, a multiband radioelectric behaviour is achieved, that is, a similar behavior for different frequency bands.

6 Claims, 13 Drawing Sheets



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US007394433B2

(12) **United States Patent**
Li et al.

(10) **Patent No.:** **US 7,394,433 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **DUAL BAND WLAN ANTENNA**

(75) Inventors: **James Li**, Santa Clara, CA (US); **Jing Jiang**, San Jose, CA (US)

(73) Assignee: **Marvell World Trade Ltd.**, St. Michael (BB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/581,502**

(22) Filed: **Oct. 16, 2006**

(65) **Prior Publication Data**

US 2007/0182645 A1 Aug. 9, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/519,979, filed on Sep. 12, 2006.

(60) Provisional application No. 60/771,634, filed on Feb. 9, 2006.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/702, 343/700 MS, 795, 846**

See application file for complete search history.

(56) **References Cited**

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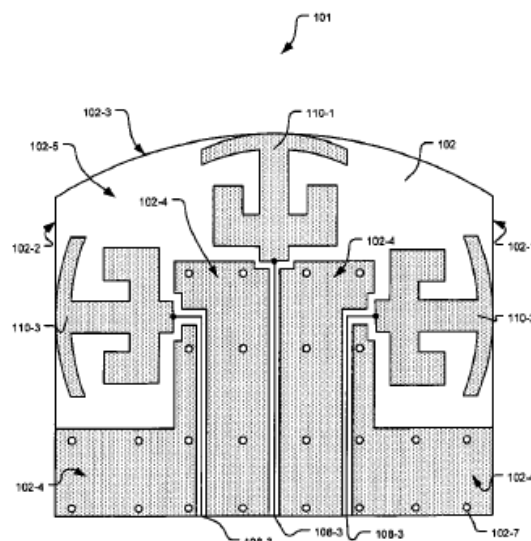
(Continued)

Primary Examiner—Hoang Anh T Le

(57) **ABSTRACT**

An antenna system comprises first, second, and third antennas that are arranged on a printed circuit board (PCB) and that include an arc-shaped element having a concave side and a convex side. A conducting element extends substantially radially from a center of the concave side. A U-shaped element has a base portion with a center that communicates with the conducting element and two side portions that extend from ends of the base portion towards the concave side.

34 Claims, 38 Drawing Sheets



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US007394434B2

(12) **United States Patent**
Chen et al.

(10) **Patent No.:** **US 7,394,434 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **COMBINATION OF TUBE ASSEMBLY AND CLIP FOR WIRELESS ANTENNA GROUNDING**

(75) Inventors: **Chao Chen**, Waterloo (CA); **Timothy H. Kyowski**, Brantford (CA)

(73) Assignee: **Research in Motion Limited**, Waterloo, ON (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **11/676,342**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Feb. 19, 2007**

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(65) **Prior Publication Data**

US 2007/0176837 A1 Aug. 2, 2007

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Related U.S. Application Data

OTHER PUBLICATIONS

(63) Continuation of application No. 11/274,121, filed on Nov. 16, 2005, now Pat. No. 7,196,671, which is a continuation of application No. 10/723,838, filed on Nov. 26, 2003, now Pat. No. 7,053,842.

Patent Abstracts of Japan, vol. 018, No. 364 (E-1575), Jul. 8, 1994 and JP 06 097712 A (Yokowo Co. Ltd) Apr. 8, 1994 abstract.

(60) Provisional application No. 60/430,082, filed on Dec. 2, 2002.

Primary Examiner—Tan Ho

(74) Attorney, Agent, or Firm—Moffat & Co.

(30) **Foreign Application Priority Data**

Nov. 29, 2002 (CA) 2413360

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/846; 343/901**

(58) **Field of Classification Search** **343/702, 343/715, 846, 872, 901, 906**

See application file for complete search history.

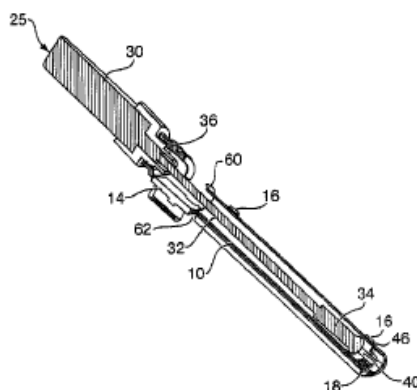
An antenna tube configured to accommodate a grounding clip and an antenna, the antenna tube having a cylindrical tube having an upper end and an inner end opposite the upper end; a circumferentially extending groove in the cylindrical tube located between the upper end and the inner end; and a tapered lip at the inner end of the cylindrical tube, wherein the grounding clip fits between the circumferentially extending groove and the tapered lip, and at least a portion of the antenna slidably fits into the upper end of the cylindrical tube.

(56) **References Cited**

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13 Claims, 6 Drawing Sheets



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US007394437B1

(12) **United States Patent**
Loyet

(10) **Patent No.:** **US 7,394,437 B1**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **MULTI-RESONANT MICROSTRIP DIPOLE ANTENNA**

6,965,353 B2 11/2005 Shirosaka et al.

OTHER PUBLICATIONS

- (75) Inventor: **Lowell Lee Loyet**, Woodinville, WA (US)
(73) Assignee: **AT&T Mobility II LLC**, Atlanta, GA (US)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Nokia. "Transmission Solution for Nokia Mobile Networks"(2000) Product Bulletin, 4 pages, no date avail.
Katherin. "Technical Information and New Products: Cellular Systems" located at www.katherin.de/de/mca/techn-infos/download/9985654.pdf, last viewed Oct. 23, 2006, 16 pages.

(21) Appl. No.: **11/843,673**

Primary Examiner—Hoang V Nguyen

(22) Filed: **Aug. 23, 2007**

(74) *Attorney, Agent, or Firm*—Amin, Turocy & Calvin, LLP

Related U.S. Application Data

- (63) Continuation of application No. 11/424,664, filed on Jun. 16, 2006, now Pat. No. 7,277,062.
(51) **Int. Cl.**
H01Q 9/28 (2006.01)
H01Q 21/00 (2006.01)
(52) **U.S. Cl.** **343/795**; 343/700 MS;
343/810; 343/817; 343/818
(58) **Field of Classification Search** 343/700 MS,
343/795, 846, 810, 817, 818, 872
See application file for complete search history.

(57) **ABSTRACT**

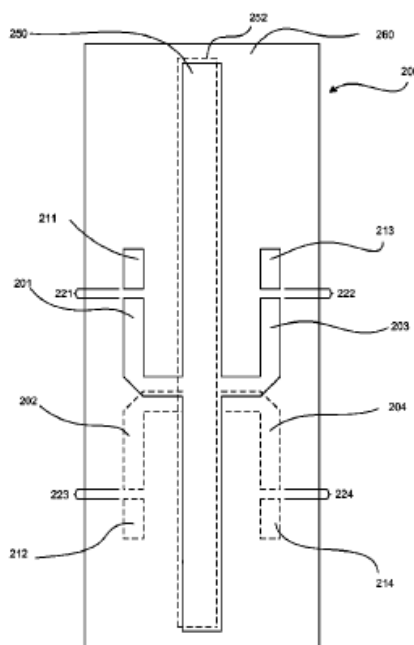
A multi-band antenna for use, for example, in a wireless communications network, employs multi-resonant microstrip dipoles that resonate at multiple frequencies due to microstrip "islands." Gaps in the microstrips create an open RF circuit except for desired frequencies. At a desired frequency, RF energy sees a gap as a short circuit between an island and the rest of a dipole antenna, thus, resonating at the desired frequency. In one instance, the multi-band antenna includes a first, second, third, and fourth dipole elements. Gaps between the first and third dipole elements and the second and fourth dipole elements are sufficiently small that the first, second, third, and fourth dipole elements form a second dipole having a corresponding dipole wavelength longer than that of the first dipole.

(56) **References Cited**

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20 Claims, 7 Drawing Sheets



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US007394440B2

(12) **United States Patent**
Goldberg

(10) **Patent No.:** **US 7,394,440 B2**

(45) **Date of Patent:** **Jul. 1, 2008**

(54) **THREE-DIMENSIONAL ANTENNA
FABRICATION FROM MULTIPLE
TWO-DIMENSIONAL STRUCTURES**

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0015000 A1* 2/2002 Reece et al. 343/795

(75) Inventor: **Steven J. Goldberg**, Downingtown, PA
(US)

(73) Assignee: **InterDigital Technology Corporation**,
Wilmington, DE (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 57 days.

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Primary Examiner—Hoang V Nguyen

Assistant Examiner—Robert Karacsony

(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt,
Milbrath & Gilchrist, P.A.

(21) Appl. No.: **11/343,398**

(57) **ABSTRACT**

(22) Filed: **Jan. 31, 2006**

(65) **Prior Publication Data**

US 2006/0192721 A1 Aug. 31, 2006

Related U.S. Application Data

(60) Provisional application No. 60/651,608, filed on Feb.
10, 2005.

(51) **Int. Cl.**

H01Q 21/00 (2006.01)

H01Q 19/10 (2006.01)

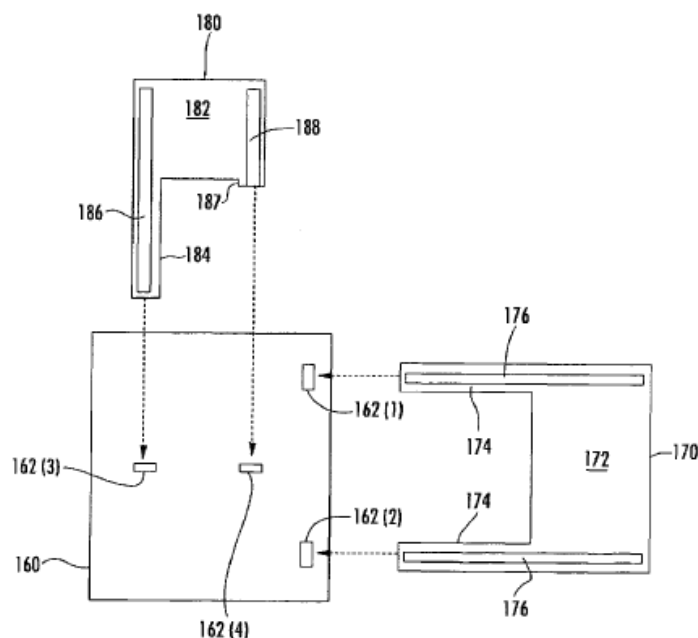
(52) **U.S. Cl.** **343/893**; 343/834; 343/835;
343/836; 343/837

(58) **Field of Classification Search** 343/893,
343/834, 835, 836, 837

See application file for complete search history.

A method for making an antenna array includes forming a ground plane having spaced apart openings extending there-through, and forming a first antenna board having a support section and spaced apart first legs extending outwardly from the support section. An antenna element is formed on each outwardly extending first leg. A second antenna board having a support section and at least one second leg extending outwardly from the support section is formed. An antenna element is formed on the at least one outwardly extending second leg. The outwardly extending first legs are inserted through a corresponding number of openings in the ground plane. Similarly, the at least one outwardly extending second leg is inserted through one of the openings in the ground plane. The first and second legs are inserted so that their respective support sections contact the ground plane.

30 Claims, 6 Drawing Sheets



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US007397430B2

(12) **United States Patent**
Harihara

(10) **Patent No.:** **US 7,397,430 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **SURFACE MOUNTED ANTENNA AND RADIO EQUIPMENT USING THE SAME**

(75) Inventor: **Yasumasa Harihara**, Tokyo (JP)

(73) Assignee: **TDK Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 150 days.

(21) Appl. No.: **11/190,906**

(22) Filed: **Jul. 28, 2005**

(65) **Prior Publication Data**

US 2006/0044191 A1 Mar. 2, 2006

(30) **Foreign Application Priority Data**

Aug. 5, 2004 (JP) 2004-229752

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/846**

(58) **Field of Classification Search** **343/700 MS, 343/702, 846**
See application file for complete search history.

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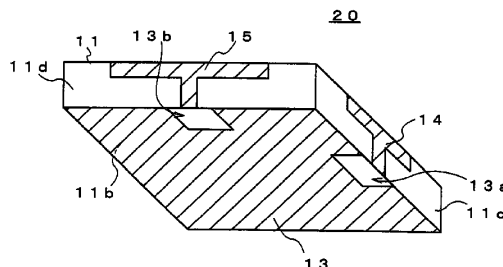
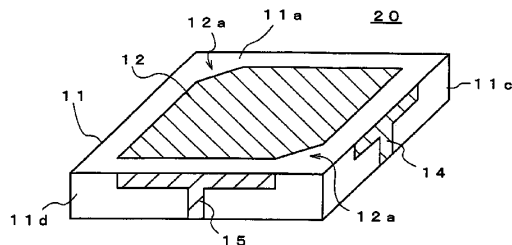
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Wolff Law Offices PLLC;
Kevin Alan Wolff

(57) **ABSTRACT**

A surface mounted antenna according to the present invention includes a dielectric block 11, a radiating electrode 12 formed on one of a main surface 11a of the dielectric block 11, a ground electrode 13 formed on the other main surface 11b of the dielectric block 11, and a feed electrode 14 formed on a side surface 11c of the dielectric block 11 and electromagnetically coupled with the radiating electrode 12. In the present invention, since the feed electrode 14 is formed on the side surface 11c of the dielectric block 11, the size of the main surface 11a of the dielectric block 11 can be made smaller than that of the conventional dielectric block. Accordingly, since further miniaturization can be realized, when the dielectric block 11 is mounted on a printed circuit board or the like, the mounting area can be reduced as compared with the conventional dielectric block.

25 Claims, 11 Drawing Sheets



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US007397432B2

(12) **United States Patent**
Ku et al.

(10) **Patent No.:** **US 7,397,432 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE FOR PORTABLE WIRELESS TERMINAL**

2004/0160367 A1 * 8/2004 Mendolia et al. 343/700 MS
2005/0140554 A1 * 6/2005 Wang et al. 343/702

(75) Inventors: **Do-Il Ku**, Suwon-si (KR); **Chin-Sop Choe**, Sunnam-si (KR)

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(73) Assignee: **Samsung Electronics Co., Ltd.** (KR)

EP 1 209 760 5/2002

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 184 days.

EP 1 286 413 2/2003

EP 1 441 412 7/2004

WO WO 2004/025776 3/2004

(21) Appl. No.: **11/227,885**

(22) Filed: **Sep. 15, 2005**

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(65) **Prior Publication Data**

US 2006/0066490 A1 Mar. 30, 2006

Primary Examiner—HoangAnh T Le

(74) *Attorney, Agent, or Firm*—The Farrell Law Firm, PC

(30) **Foreign Application Priority Data**

Sep. 17, 2004 (KR) 10-2004-0074748

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/846, 848, 702**

See application file for complete search history.

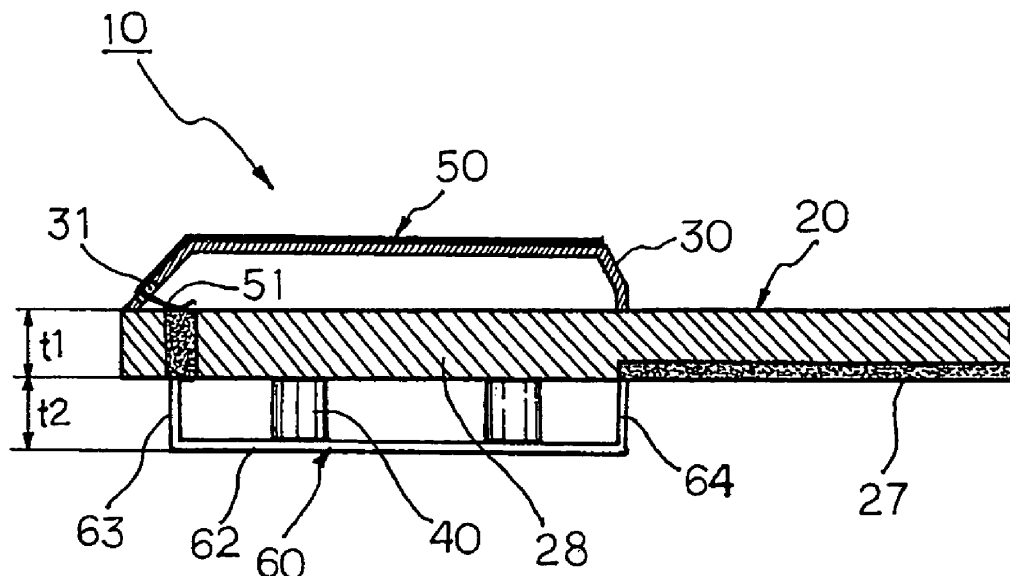
A built-in antenna module for a portable wireless terminal is provided. In the built-in antenna module, a mainboard, which is an RF board, has a feeding unit and a grounding unit. A radiator is disposed on one side of the mainboard and has a feed pin and a ground pin that are electrically connected to the feeding unit and the grounding unit, respectively. A conductive ground plate is disposed on the other side of the mainboard to have a predetermined height. An end of the conductive ground plate is grounded to the grounding unit of the mainboard. The distance between the radiator and the ground plate is maximized to improve antenna performance.

(56) **References Cited**

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2003/0151555 A1 * 8/2003 Holshouser 343/700 MS

7 Claims, 6 Drawing Sheets



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US007397433B2

(12) **United States Patent**
Han et al.

(10) **Patent No.:** **US 7,397,433 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE OF WIRELESS COMMUNICATION TERMINAL**

(75) Inventors: **Sun Kyu Han**, Kyungki-do (KR); **Wook Hee Lee**, Kyungki-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co. Ltd.**, Kyungki-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 100 days.

(21) Appl. No.: **11/430,105**

(22) Filed: **May 9, 2006**

(65) **Prior Publication Data**

US 2006/0256020 A1 Nov. 16, 2006

(30) **Foreign Application Priority Data**

May 10, 2005 (KR) 10-2005-0039044

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/702, 343/700 MS, 840**

See application file for complete search history.

(56) **References Cited**

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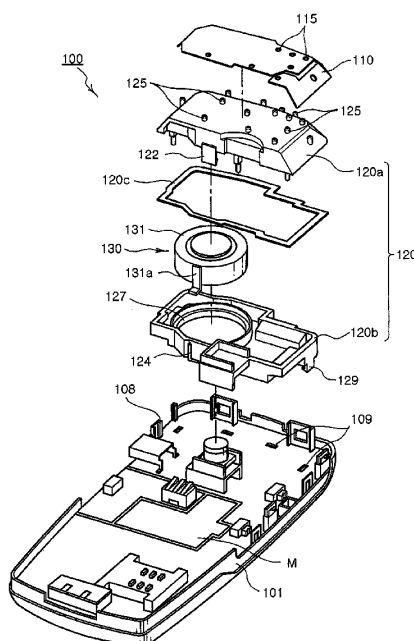
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Lowe Hauptman Ham & Berner

(57) **ABSTRACT**

The invention relates to a built-in antenna module for a wireless communication terminal. The module includes at least one radiator. The module also includes a base having an inner space, disposed on a board of a terminal body, and having the radiator on an outer surface thereof to enable electric connection between an end of the radiator and the board of the terminal body. The module further includes an operator disposed in the inner space of the base for indicating an incoming call when power is supplied. The invention efficiently utilizes a limited space in the terminal body with enhanced capabilities of the antenna.

21 Claims, 8 Drawing Sheets



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US007397434B2

(12) **United States Patent**
Mun et al.

(10) **Patent No.:** **US 7,397,434 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE OF WIRELESS COMMUNICATION TERMINAL**

(75) Inventors: **Ung Han Mun**, Kyungki-do (KR); **Jae Suk Sung**, Kyungki-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Kyungki-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 17 days.

(21) Appl. No.: **11/464,949**

(22) Filed: **Aug. 16, 2006**

(65) **Prior Publication Data**

US 2007/0063903 A1 Mar. 22, 2007

(30) **Foreign Application Priority Data**

Sep. 16, 2005 (KR) 10-2005-0086876

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/702, 343/700 MS, 725**

See application file for complete search history.

(56) **References Cited**

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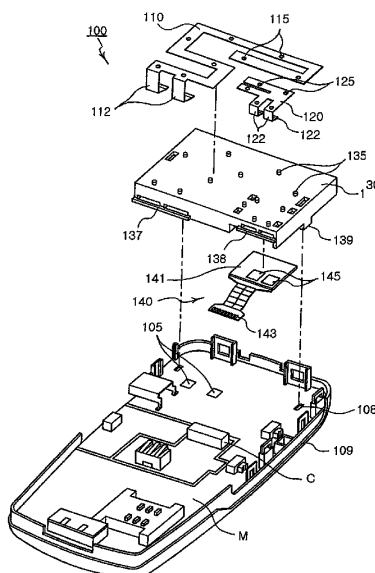
Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Lowe Hauptman Ham & Berner

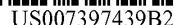
(57) **ABSTRACT**

The invention relates to a built-in antenna for a wireless communication terminal. The built-in antenna includes at least one first radiator for base station and at least one second radiator for Bluetooth. The built-in antenna also includes a base having the first and second radiators mounted on an outer surface thereof. The base is mounted on a board such that each end of the first and second radiators is electrically connected to the board of a terminal body. The built-in antenna further includes a Bluetooth chip set fixed to the base and electrically connected to the second radiator. The invention efficiently utilizes limited space in a terminal body to miniaturize the product, attaining RF capabilities with high reception sensitivity.

13 Claims, 6 Drawing Sheets



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(10) **Patent No.:** US 7,397,439 B2
(45) **Date of Patent:** Jul. 8, 2008

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Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—McDermott Will & Emery LLP

(57) **ABSTRACT**

A slot antenna according to the present invention includes: a ground conductor **12** provided on a rear face side of a dielectric substrate **101**, the ground conductor having a finite area; a slot **14** which recesses into the ground conductor **12**, beginning from an open-end point on a side edge of the ground conductor **12**; and a feed line **261** for supplying a high-frequency signal to the slot **14**, the feed line **261** intersecting the slot **14**. At a first point near the slot, the feed line **261** branches into a group of branch lines including at least two branch lines, such that at least two branch lines in the group of branch lines are connected to each other at a second point near the slot to form at least one loop line **209**. A maximum value of a loop length of each loop line **209** is prescribed to be less than $1 \times$ effective wavelength at an upper limit frequency of an operating band of the slot antenna. In the group of branch lines, any branch line that does not constitute a part of the loop line **209** but terminates with a leading open-end point has a branch length which is less than a $\frac{1}{4}$ effective wavelength at the upper limit frequency of the operating band.

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2006/321541,
filed on Oct. 27, 2006.

(30) **Foreign Application Priority Data**

Nov. 10, 2005 (JP) 2005-325674

(51) **Int. Cl.**
H01Q 13/10 (2006.01)

(52) U.S. Cl. 343/767

(58) **Field of Classification Search** 343/700 MS,
343/767, 770, 771, 862, 864
See application file for complete search history.

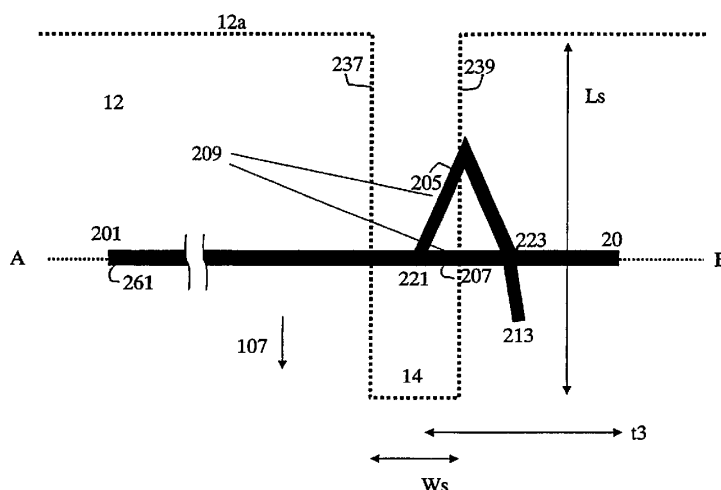
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(Continued)

3 Claims, 26 Drawing Sheets





US007397441B1

(12) **United States Patent**
Zweers

(10) **Patent No.:** **US 7,397,441 B1**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **ANTENNA ELEMENT FOR A PORTABLE COMMUNICATION DEVICE**

(75) Inventor: **Jan-Willem Zweers, Wezep (NL)**

(73) Assignee: **Sony Ericsson Mobile Communications AB, Lund (SE)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/681,347**

(22) Filed: **Mar. 2, 2007**

Related U.S. Application Data

(60) Provisional application No. 60/887,910, filed on Feb. 2, 2007.

(51) **Int. Cl.**
H01Q 7/00 (2006.01)

(52) **U.S. Cl.** **343/866; 343/702; 343/741; 343/895**

(58) **Field of Classification Search** **343/702, 343/741, 742, 866, 867, 846, 718, 895**
See application file for complete search history.

(56) **References Cited**

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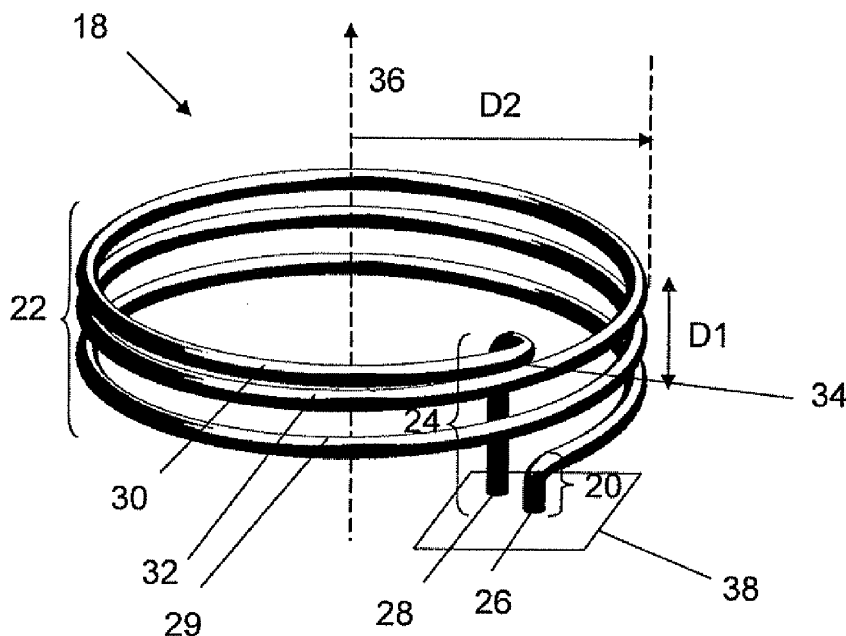
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Harritty Snyder, LLP

(57) **ABSTRACT**

The present invention relates to an antenna element for a portable communication device as well as to a portable communication device including such an antenna element. The antenna element includes a wire of an electrically conducting material having a first and a second feeding end for connection to a radio communication unit and ground. The wire also has a winding section comprising a number of turns around a central axis. The last turn of the winding section, which is provided furthest from the first feeding end is in physical contact with the previous turn and the rest of the turns are separated from each other.

16 Claims, 2 Drawing Sheets



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US007400300B2

(12) **United States Patent**
Qi et al.

(10) **Patent No.:** **US 7,400,300 B2**
(45) **Date of Patent:** ***Jul. 15, 2008**

(54) **MULTIPLE-ELEMENT ANTENNA WITH
FLOATING ANTENNA ELEMENT**

(75) Inventors: **Yihong Qi**, Waterloc (CA); **Ying Tong Man**, Kitchener (CA); **Michael E. Certain**, Kitchener (CA); **Perry Jarmuszewski**, Waterloo (CA)

(73) Assignee: **Research In Motion Limited**, Waterloo (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/590,200**

(22) Filed: **Oct. 31, 2006**

(65) **Prior Publication Data**

US 2007/0176835 A1 Aug. 2, 2007

Related U.S. Application Data

(63) Continuation of application No. 10/864,145, filed on Jun. 9, 2004, now Pat. No. 7,148,846.

(30) **Foreign Application Priority Data**

Jun. 12, 2003 (EP) 03253713

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/24 (2006.01)

H01Q 19/10 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/818**

(58) **Field of Classification Search** **343/700 MS, 343/702, 818**

See application file for complete search history.

(56) **References Cited**

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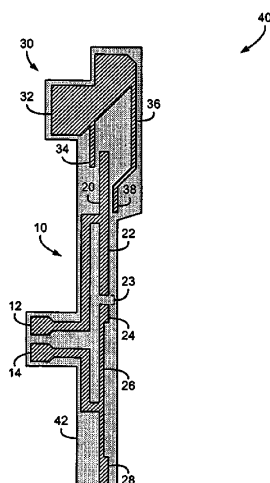
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Jones Day; Krishna K. Pathiyal; Robert C. Liang

(57) **ABSTRACT**

A multiple-element antenna for a wireless communication device is provided. The antenna comprises a first antenna element having a first operating frequency band and a floating antenna element positioned adjacent the first antenna element to electromagnetically couple to the first antenna element. The floating antenna element is configured to operate in conjunction with the first antenna element within a second operating frequency band. A feeding port connected to the first antenna element connects the first antenna element to communications circuitry and exchanges communication signals in both the first operating frequency band and the second operating frequency band between the multiple-element antenna and the communications circuitry. In a wireless mobile communication device having a transceiver and a receiver, the feeding port is connected to both the transceiver and the receiver.

48 Claims, 10 Drawing Sheets



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US007400302B2

(12) **United States Patent**
Winter

(10) **Patent No.:** **US 7,400,302 B2**
(45) **Date of Patent:** **Jul. 15, 2008**

(54) **INTERNAL ANTENNA FOR HANDHELD
MOBILE PHONES AND WIRELESS DEVICES**

(75) Inventor: **James Blake Winter**, Lincoln, NE (US)

(73) Assignee: **Centurion Wireless Technologies, Inc.**,
Lincoln, NE (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 196 days.

(21) Appl. No.: **11/343,167**

(22) Filed: **Jan. 30, 2006**

(65) **Prior Publication Data**

US 2007/0176830 A1 Aug. 2, 2007

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.** **343/702; 343/846**

(58) **Field of Classification Search** 343/846,
343/702, 850, 860, 767; 455/575.5, 575.7
See application file for complete search history.

(56) **References Cited**

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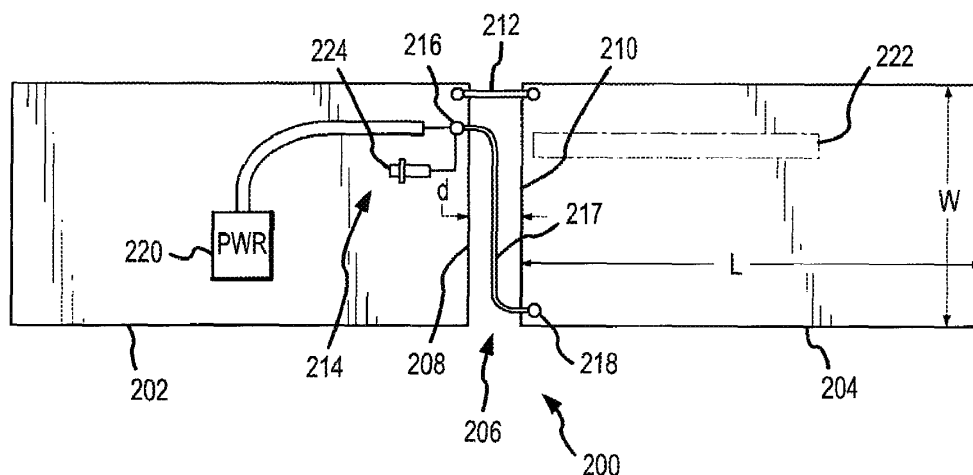
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Holland & Hart LLP

(57) **ABSTRACT**

An antenna for a foldable wireless device is provided. The foldable wireless device and antenna include a first housing and a second housing pivotally connected. A printed circuit board associated with the wireless device comprises a first PCB in the first housing and a second PCB in the second housing. The first and second PCB function as first and second radiating plates respectively. A gap, generally aligned with the pivotal connection separates the first and second PCBs. A short is provided that traverses the gap and connects the first and second PCBs. Radio frequency power is connected to the first and second PCB to supply radio frequency power.

21 Claims, 2 Drawing Sheets



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US007403158B2

(12) **United States Patent**
Kikin

(10) **Patent No.:** **US 7,403,158 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **COMPACT CIRCULAR POLARIZED ANTENNA**

(75) Inventor: **Vadim Kikin**, Spring Valley, NY (US)

(73) Assignee: **Applied Wireless Identification Group, Inc.**, Morgan Hill, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 60 days.

(21) Appl. No.: **11/253,099**

(22) Filed: **Oct. 18, 2005**

(65) **Prior Publication Data**

US 2007/0085742 A1 Apr. 19, 2007

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/846; 340/572.7**

(58) **Field of Classification Search** **343/700 MS, 343/846, 841; 340/505, 572.1, 572.7**
See application file for complete search history.

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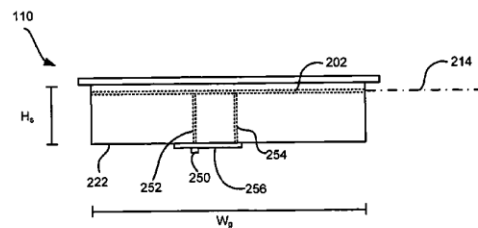
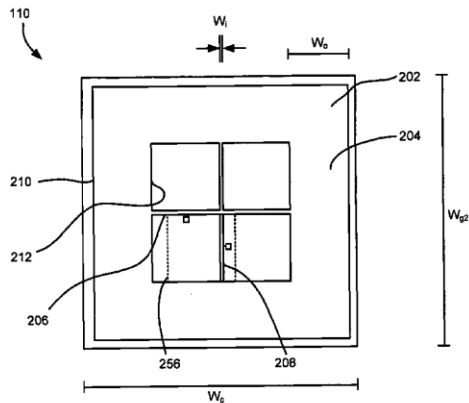
Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Zilka-Kotab, PC

(57) **ABSTRACT**

A circular polarized antenna having an electrically conductive element having a generally annular outer portion and first and second inner members coupled to the outer portion. A ground shield is spaced from the element, the ground shield providing an effective ground plane. A dielectric material is positioned between the element and at least a portion of the ground shield.

30 Claims, 7 Drawing Sheets



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US007403159B2

(12) **United States Patent**
Gooshchin

(10) **Patent No.:** **US 7,403,159 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **MICROSTRIP ANTENNA HAVING A HEXAGONAL PATCH AND A METHOD OF RADIATING ELECTROMAGNETIC ENERGY OVER A WIDE PREDETERMINED FREQUENCY RANGE**

(76) Inventor: **Dmitry Gooshchin**, 39/11 Rubinshtein Street, Jaffo Daled, Tel-Aviv (IL) 68212

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 17 days.

(21) Appl. No.: **11/429,126**

(22) Filed: **May 8, 2006**

(65) **Prior Publication Data**

US 2007/0257843 A1 Nov. 8, 2007

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/700 MS; 343/770**

(58) **Field of Classification Search** **343/700 MS, 343/767, 770**
See application file for complete search history.

(56) **References Cited**

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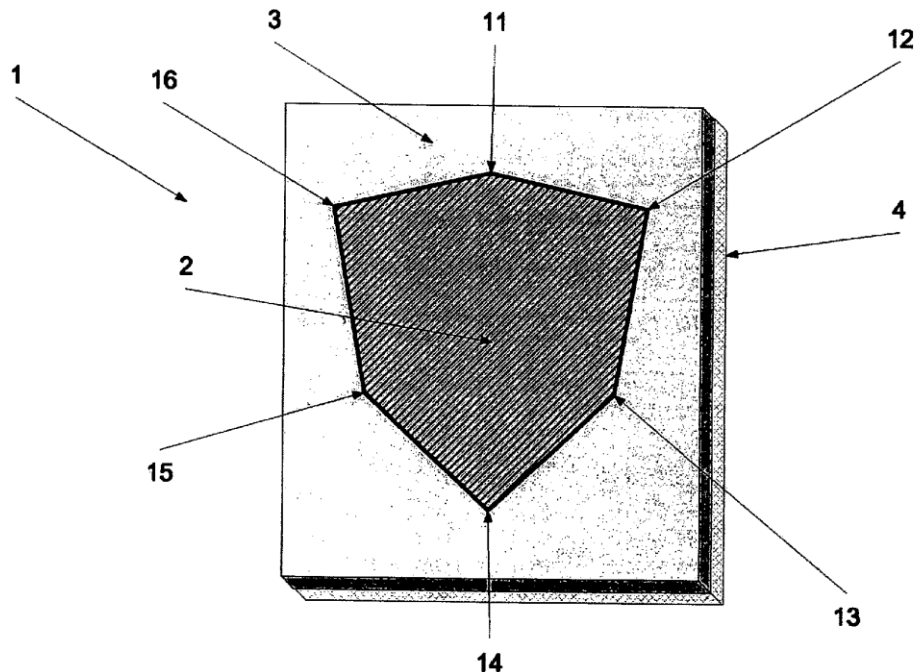
Primary Examiner—Trinh Vo Dinh

Assistant Examiner—Dieu Hien T Duong

(57) **ABSTRACT**

An electrically conductive hexagonal patch element for a patch antenna. The hexagonal patch element comprising a hexagonal shape with a first angle and a second angle opposite the first angle, a third angle and a fourth angle opposite the third angle, a fifth angle and a sixth angle opposite the fifth angle, the first, third, and fifth angles each measuring approximately 150 degrees and the second, forth, and sixth angles each measuring approximately 90 degrees, wherein the first angle is positioned in between the fourth angle and the sixth angle.

24 Claims, 12 Drawing Sheets



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US007403160B2

(12) **United States Patent**
Chiang et al.

(10) **Patent No.:** **US 7,403,160 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **LOW PROFILE SMART ANTENNA FOR WIRELESS APPLICATIONS AND ASSOCIATED METHODS**

(75) Inventors: **Bing A. Chiang**, Melbourne, FL (US); **Michael J. Lynch**, Merritt Island, FL (US); **Douglas H. Wood**, Palm Bay, FL (US); **Thomas Liu**, Melbourne, FL (US); **Govind R. Kadambi**, Melbourne, FL (US); **Mark W. Kishler**, Melbourne, FL (US)

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6,337,668 B1 *	1/2002	Ito et al.	343/833
6,369,770 B1	4/2002	Gothard et al.	343/794
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6,480,157 B1	11/2002	Palmer et al.	343/700 MS
6,753,826 B2	6/2004	Chiang et al.	343/834

(73) Assignee: **Interdigital Technology Corporation**,
Wilmington, DE (US)

(Continued)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

JP 56012102 2/1981

(21) Appl. No.: **11/154,428**

(Continued)

(22) Filed: **Jun. 16, 2005**

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(65) **Prior Publication Data**

US 2005/0280589 A1 Dec. 22, 2005

Ohira et al., Electronically Steerable Passive Array Radiator Antennas for Low-Cost Analog Adaptive Beamforming, 0-7803-6345-0/00, 2000, IEEE.

Related U.S. Application Data

(Continued)

(60) Provisional application No. 60/636,926, filed on Dec. 17, 2004, provisional application No. 60/587,970, filed on Jul. 14, 2004, provisional application No. 60/580,561, filed on Jun. 17, 2004.

Primary Examiner—Michael C Wimer

(74) Attorney, Agent, or Firm—Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 19/02 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/833; 343/834

(58) **Field of Classification Search** 343/702, 343/752, 833, 834, 829, 846, 818; 455/575.7
See application file for complete search history.

(57) **ABSTRACT**

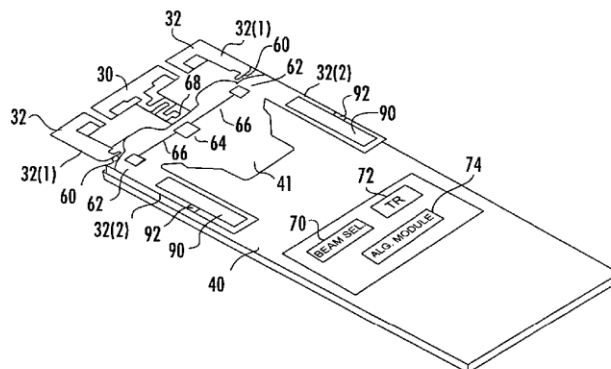
A low profile smart antenna includes an active antenna element carried by a dielectric substrate, and active antenna element has a T-shape. Passive antenna elements are carried by the dielectric substrate, and they have an inverted L-shaped portion laterally adjacent the active antenna element. Impedance elements are selectively connectable to the passive antenna elements for antenna beam steering.

(56) **References Cited**

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3,846,799 A 11/1974 Gueguen 343/833

34 Claims, 9 Drawing Sheets



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US007403161B2

(12) **United States Patent**
DiNallo et al.

(10) **Patent No.:** **US 7,403,161 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **MULTIBAND ANTENNA IN A
COMMUNICATION DEVICE**

(75) Inventors: **Carlo DiNallo**, Plantation, FL (US);
Marco Maddaleno, Turin (IT)

(73) Assignee: **Motorola, Inc.**, Schaumburg, IL (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 201 days.

(21) Appl. No.: **11/250,339**

(22) Filed: **Oct. 14, 2005**

(65) **Prior Publication Data**

US 2007/0085747 A1 Apr. 19, 2007

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/700 MS;
343/767

(58) **Field of Classification Search** 343/700 MS,
343/767, 770, 702, 846

See application file for complete search history.

(56) **References Cited**

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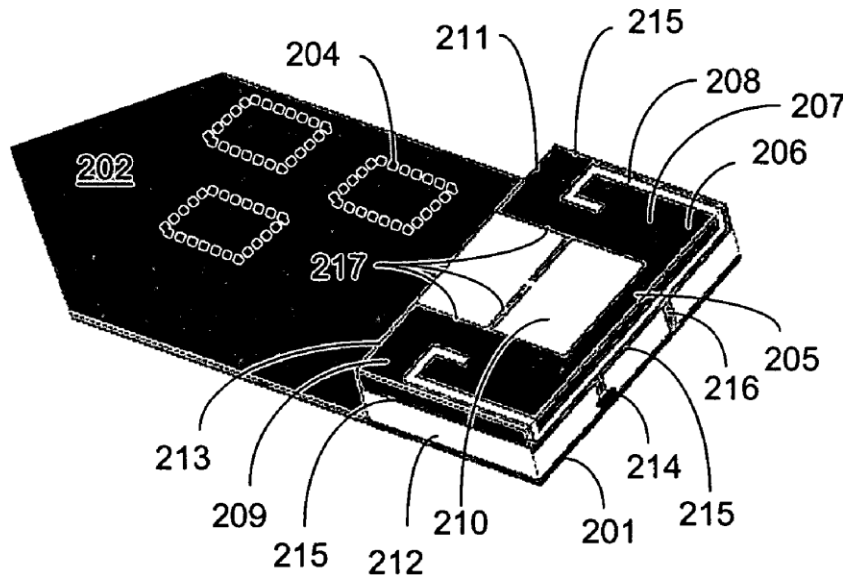
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Pablo Meles

(57) **ABSTRACT**

An apparatus is disclosed for a multiband antenna (102) in a communication device (100). An apparatus that incorporates teachings of the present invention may include, for example, an antenna having a finite ground surface (201, 401), and an elongated conductor (206, 406) that is characterized by a length and is spaced from the finite ground surface. The elongated conductor has a first slot (208, 408) extending through a substantial portion of the length of the elongated conductor, and a second slot (210, 410) having a shorter length than the first slot. The antenna further has a grounding conductor (216, 416) coupling the finite ground surface to the elongated conductor, and a signal feed conductor (214, 414) coupling to the elongated conductor.

18 Claims, 2 Drawing Sheets



102



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US007403162B2

(12) **United States Patent**
Li et al.

(10) **Patent No.:** **US 7,403,162 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **DUAL BAND WLAN ANTENNA** 2005/0062652 A1* 3/2005 Huang 343/700 MS

(75) Inventors: **James Li**, Santa Clara, CA (US); **Jing Jiang**, San Jose, CA (US)

(Continued)

(73) Assignee: **Marvell World Trade Ltd.**, St. Michael (BB)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

EP 0 795 926 A2 9/1997

(21) Appl. No.: **11/581,717**

(Continued)

(22) Filed: **Oct. 16, 2006**

OTHER PUBLICATIONS

(65) **Prior Publication Data**

US 2007/0182647 A1 Aug. 9, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/519,979, filed on Sep. 12, 2006.

(60) Provisional application No. 60/771,634, filed on Feb. 9, 2006.

IEEE Std 802.11a-1999 (Supplement to IEEE Std 802.11-1999) [Adopted by ISO/IEC and redesignated as ISO/IEC 8802-11: 1999/ Amd 1:2000(E)]; Supplement to IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications High-speed Physical Layer in the 5 GHz Band; LAN/MAN Standards Committee of the IEEE Computer Society; 91 pages.

(Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

Primary Examiner—Hoanganh Le

(52) **U.S. Cl.** **343/702**; 343/700 MS

(57) **ABSTRACT**

(58) **Field of Classification Search** 343/702, 343/700 MS, 725, 729, 846

See application file for complete search history.

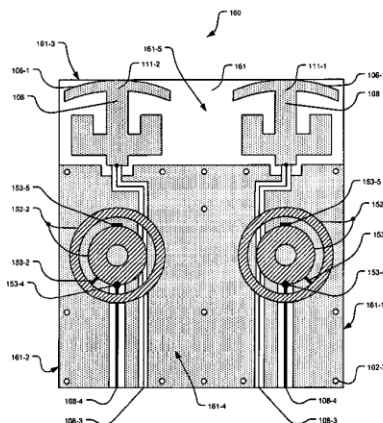
An antenna system comprises first and second antennas that are arranged on a printed circuit board (PCB) and that include an arc-shaped element having a concave side and a convex side. A conducting element extends substantially radially from a center of the concave side. A U-shaped element has a base portion with a center that communicates with the conducting element and two side portions that extend from ends of the base portion towards the concave side. Third and fourth antennas are arranged on the PCB and include an inner ring and an outer ring that is concentric to the inner ring.

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42 Claims, 38 Drawing Sheets



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US007403163B2

(12) **United States Patent**
Kyowski

(10) **Patent No.:** **US 7,403,163 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **LOW PROFILE ANTENNA INSERT NUT**

(75) Inventor: **Timothy H. Kyowski**, Brantford (CA)

(73) Assignee: **Research In Motion Limited**, Waterloo (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/671,211**

(22) Filed: **Feb. 5, 2007**

(65) **Prior Publication Data**

US 2007/0126646 A1 Jun. 7, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/107,974, filed on Apr. 18, 2005, now Pat. No. 7,190,314, which is a continuation of application No. 10/723,839, filed on Nov. 26, 2003, now abandoned.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.** **343/702; 343/906; 439/916**

(58) **Field of Classification Search** **343/702, 343/715, 878, 906; 439/916**
See application file for complete search history.

(56) **References Cited**

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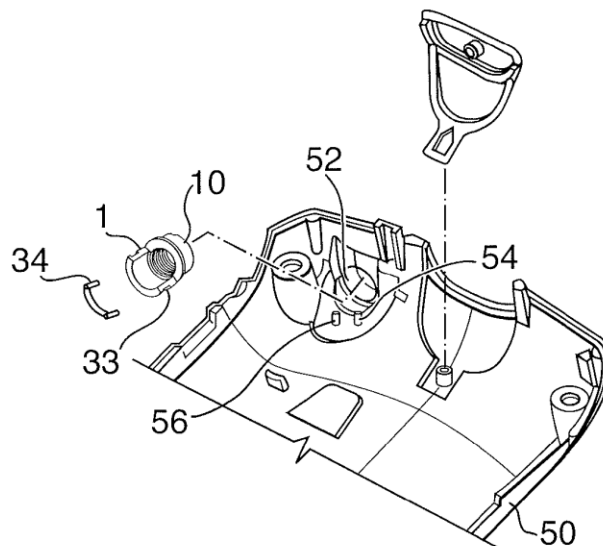
Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Moffat & Co.

(57) **ABSTRACT**

An antenna mount comprising a front cylindrical mount, the front cylindrical mount having a threaded interior for installing an antenna; a flanged central portion; a base mount consisting of a hollow cylinder cut away along a longitudinal axis, leaving a half-circular cross section. The antenna mount can be installed by inserting it into an opening in the casing of a device and rotating the antenna mount until it abuts a stop stud.

9 Claims, 2 Drawing Sheets



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US007403164B2

(12) **United States Patent**
Sanz et al.

(10) **Patent No.:** **US 7,403,164 B2**
(45) **Date of Patent:** ***Jul. 22, 2008**

(54) **MULTI-BAND MONOPOLE ANTENNA FOR A MOBILE COMMUNICATIONS DEVICE**

(75) Inventors: **Alfonso Sanz**, Barcelona (ES); **Carles Puente Baliarda**, Barcelona (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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EP 0 884 796 12/1998

(21) Appl. No.: **11/713,324**

(22) Filed: **Mar. 2, 2007**

(65) **Prior Publication Data**

US 2007/0152894 A1 Jul. 5, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/124,768, filed on May 9, 2005, which is a continuation of application No. PCT/EP02/14706, filed on Dec. 22, 2002.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/702, 895**

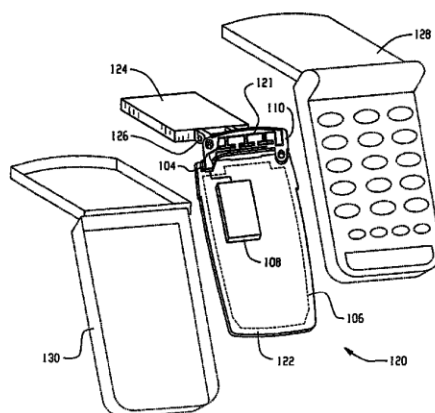
See application file for complete search history.

(56) **References Cited**

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5,457,469	A	10/1995	Diamond

27 Claims, 7 Drawing Sheets



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US007403165B2

(12) **United States Patent**
Qi et al.

(10) **Patent No.:** **US 7,403,165 B2**
(45) **Date of Patent:** ***Jul. 22, 2008**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE COMPRISING NON-PLANAR
INTERNAL ANTENNA WITHOUT GROUND
PLANE OVERLAP**

(75) Inventors: **Yihong Qi**, Waterloo (CA); **Ying Tong
Man**, Kitchener (CA); **Perry
Jarmuszewski**, Waterloo (CA)

(73) Assignee: **Research In Motion Limited**, Ontario
(CA)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **11/769,825**

(22) Filed: **Jun. 28, 2007**

(65) **Prior Publication Data**
US 2007/0247389 A1 Oct. 25, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/422,170, filed on
Jun. 5, 2006, now Pat. No. 7,256,744, which is a con-
tinuation of application No. 11/042,890, filed on Jan.
25, 2005, now Pat. No. 7,091,911.

(60) Provisional application No. 60/576,159, filed on Jun.
2, 2004, provisional application No. 60/576,637, filed
on Jun. 3, 2004.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS;**
343/745

(58) **Field of Classification Search** **343/700 MS,**
343/702, 846, 748, 866, 745

See application file for complete search history.

(56) **References Cited**

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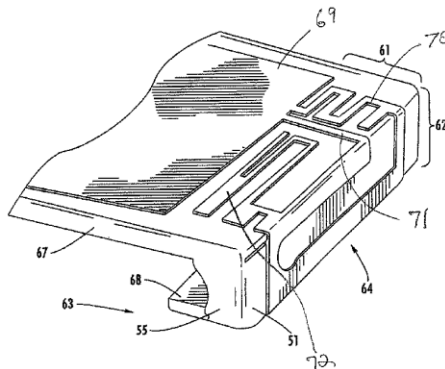
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Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt,
Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a housing, a main dielectric substrate carried by the housing, circuitry carried by the main dielectric substrate, and a ground plane conductor on the main dielectric substrate. The mobile wireless communications device may further include an L-shaped dielectric extension comprising a vertical portion extending outwardly from the main dielectric substrate and an overhang portion extending outwardly from the vertical portion and above an adjacent portion of the main dielectric layer. A main loop antenna conductor comprising at least one conductive trace may be relatively positioned on the overhang portion of the L-shaped dielectric extension so as not to overlap the ground plane conductor.

17 Claims, 11 Drawing Sheets



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US007403168B2

(12) **United States Patent**
Ohara

(10) **Patent No.:** **US 7,403,168 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **ANTENNA DEVICE AND
COMMUNICATIONS SYSTEM USING THE
SAME**

6,522,241 B1 * 2/2003 Baudard 340/5.61
6,621,178 B2 * 9/2003 Morillon 307/10.5
7,271,711 B2 * 9/2007 Daiss et al. 340/447

(75) Inventor: **Masahiro Ohara**, Osaka (JP)

(73) Assignee: **Matsushita Electric Industrial Co.,
Ltd.**, Osaka (JP)

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JP 2001-520337 10/2001
WO WO 99/19585 4/1999

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 50 days.

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(21) Appl. No.: **11/507,591**

Primary Examiner—Tan Ho

(22) Filed: **Aug. 22, 2006**

(74) *Attorney, Agent, or Firm*—McDermott Will & Emery
LLP

(65) **Prior Publication Data**

US 2007/0091003 A1 Apr. 26, 2007

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Oct. 20, 2005 (JP) 2005-305492

(51) **Int. Cl.**

H01Q 1/32 (2006.01)

H01Q 7/08 (2006.01)

(52) **U.S. Cl.** **343/713; 343/788**

(58) **Field of Classification Search** 343/711,
343/713, 787, 788

See application file for complete search history.

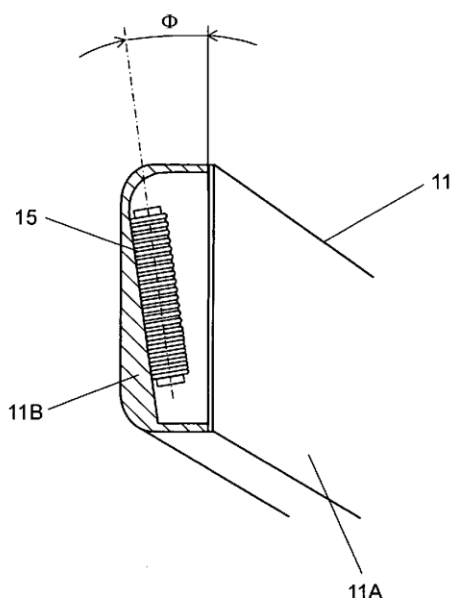
(56) **References Cited**

U.S. PATENT DOCUMENTS

6,400,330 B1 * 6/2002 Maruyama et al. 343/788

An antenna made by winding a coil on the periphery of a rod-like core made of a magnetic material is housed inside a pillar having a relatively small width and disposed in a manner such that its axis line is nearly orthogonal to the vertical axis line of the pillar. With this arrangement, a predetermined communication range is secured as the electromagnetic waves radiated from the antenna are barely absorbed by the vehicle body and radiated to inside the cabin as well as to the outside. Accordingly, an inexpensive antenna device and a communications system using it are provided which enable communication with a portable device inside and outside a vehicle cabin using a single antenna.

4 Claims, 4 Drawing Sheets



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US007403169B2

(12) **United States Patent**
Svensson et al.

(10) **Patent No.:** **US 7,403,169 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **ANTENNA DEVICE AND ARRAY ANTENNA**

(75) Inventors: **Bengt Svensson**, Mölndal (SE); **Anders Höök**, Hindås (SE); **Joakim Johansson**, Töllsjö (SE)

(73) Assignee: **Telefonaktiebolaget LM Ericsson (publ)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 209 days.

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EP 0 455 493 11/1991

(21) Appl. No.: **10/584,907**

(22) PCT Filed: **Dec. 27, 2004**

(Continued)

(86) PCT No.: **PCT/SE2004/002011**

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§ 371 (c)(1),
(2), (4) Date: **Jun. 29, 2006**

(87) PCT Pub. No.: **WO2005/064748**

(Continued)

PCT Pub. Date: **Jul. 14, 2005**

Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye, P.C.

(65) **Prior Publication Data**

US 2007/0126648 A1 Jun. 7, 2007

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Dec. 30, 2003 (WO) PCT/SE03/02102

(51) **Int. Cl.**
H01Q 13/10 (2006.01)

(52) **U.S. Cl.** 343/767; 343/770; 343/771

(58) **Field of Classification Search** 343/767,
343/770, 771, 747, 786, 859, 865

See application file for complete search history.

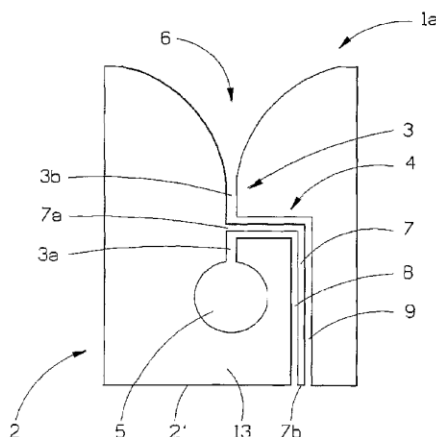
(56) **References Cited**

U.S. PATENT DOCUMENTS

4,853,704 A * 8/1989 Diaz et al. 343/767

The present invention relates to a broadband non-resonant antenna device for wireless transmission of information using electromagnetic signals, comprising a metal sheet layer, forming a plane, with a slotline that comprises a first part and a second part. The side of the second part that is the most distant from the first part transcends into a widening open-ended tapered slot in the metal sheet layer. The device additionally comprises a feeding line in the metal sheet layer. The feeding line comprises a feeding part, with a first end and a second end, and gaps separating the feeding part from the surrounding metal sheet layer by a certain distance, where the slotline is intersected by the feeding line.

23 Claims, 13 Drawing Sheets



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US007403172B2

(12) **United States Patent**
Cheng

(10) **Patent No.:** **US 7,403,172 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **RECONFIGURABLE PATCH ANTENNA
APPARATUS, SYSTEMS, AND METHODS**

(75) Inventor: **Dajun Cheng**, Marlborough, MA (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/379,160**

(22) Filed: **Apr. 18, 2006**

(65) **Prior Publication Data**

US 2007/0241978 A1 Oct. 18, 2007

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/853**; 343/700 MS;
343/824; 343/876

(58) **Field of Classification Search** 343/700 MS,
343/753, 754, 876, 853, 824
See application file for complete search history.

(56) **References Cited**

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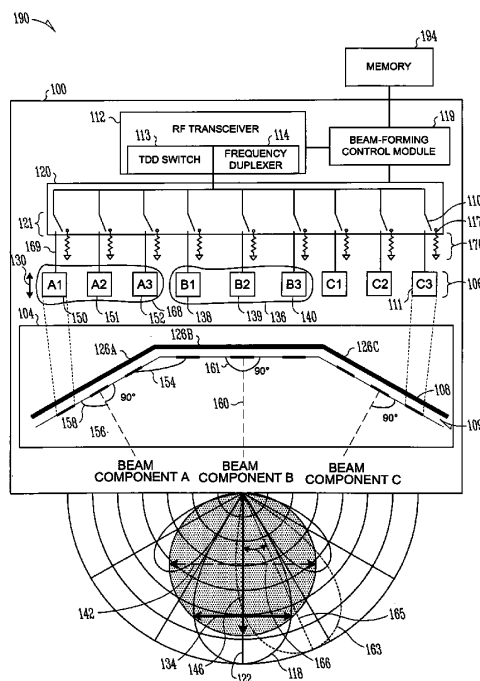
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Schwegman, Lundberg &
Woessner, P.A.

(57) **ABSTRACT**

Embodiments of a beam-reconfigurable patch antenna are
described generally herein. Other embodiments may be
described and claimed.

23 Claims, 6 Drawing Sheets



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US007403173B2

(12) **United States Patent**
Shimamori et al.

(10) **Patent No.:** **US 7,403,173 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **ANTENNA DEVICE**

(75) Inventors: **Takao Shimamori**, Kanagawa-ken (JP);
Minoru Hasegawa, Kanagawa-ken (JP)

(73) Assignee: **Samsung Electronics Co., Ltd.** (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 19 days.

(21) Appl. No.: **11/644,787**

(22) Filed: **Dec. 22, 2006**

(65) **Prior Publication Data**

US 2007/0182648 A1 Aug. 9, 2007

(30) **Foreign Application Priority Data**

Dec. 22, 2005 (JP) 2005-370029
Aug. 21, 2006 (KR) 10-2006-0078761

(51) **Int. Cl.**
H01Q 3/24 (2006.01)

(52) **U.S. Cl.** **343/876**; 343/702; 343/895

(58) **Field of Classification Search** 343/876,
343/895, 702, 850, 860

See application file for complete search history.

(56) **References Cited**

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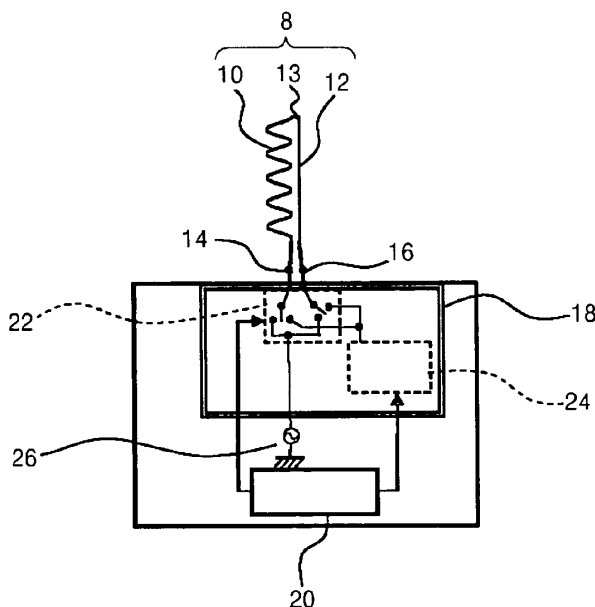
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—McNeely Bodendorf LLP

(57) **ABSTRACT**

Provided is a compact antenna for installment in a portable terminal and adjusting a resonant frequency. The compact antenna device includes an antenna unit including first and second elements, the first element including a first antenna terminal having at least one of meandering and curved patterns wholly or partially, and the second element including an end connected to another end of the first element and another end having a second antenna terminal, a feeding unit exciting the antenna unit through the first and second antenna terminals, a switching circuit connected between the antenna unit and the feeding unit and selectively switching one or both of the first and second elements in order to connect one or both of the first and second elements to the feeding unit. A resonant frequency of the antenna unit varies during feeding by the feeding unit depending on the switching operation of the switching circuit.

15 Claims, 18 Drawing Sheets



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US007405697B2

(12) **United States Patent**
Ying

(10) **Patent No.:** **US 7,405,697 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **COMPACT DIVERSITY ANTENNA**

(76) Inventor: **Zhinong Ying**, Skyttejinnen 50, SE-226
49 Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 15 days.

(21) Appl. No.: **10/549,717**

(22) PCT Filed: **Feb. 18, 2004**

(86) PCT No.: **PCT/EP2004/001503**

§ 371 (c)(1),
(2), (4) Date: **Sep. 16, 2005**

(87) PCT Pub. No.: **WO2004/084344**

PCT Pub. Date: **Sep. 30, 2004**

(65) **Prior Publication Data**

US 2006/0220959 A1 Oct. 5, 2006

Related U.S. Application Data

(60) Provisional application No. 60/458,170, filed on Mar.
27, 2003.

(30) **Foreign Application Priority Data**

Mar. 18, 2003 (EP) 03075785

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/24 (2006.01)

H01Q 3/24 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702;**
343/876

(58) **Field of Classification Search** **343/700 MS;**
343/846, 876, 702

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Hoang V Nguyen

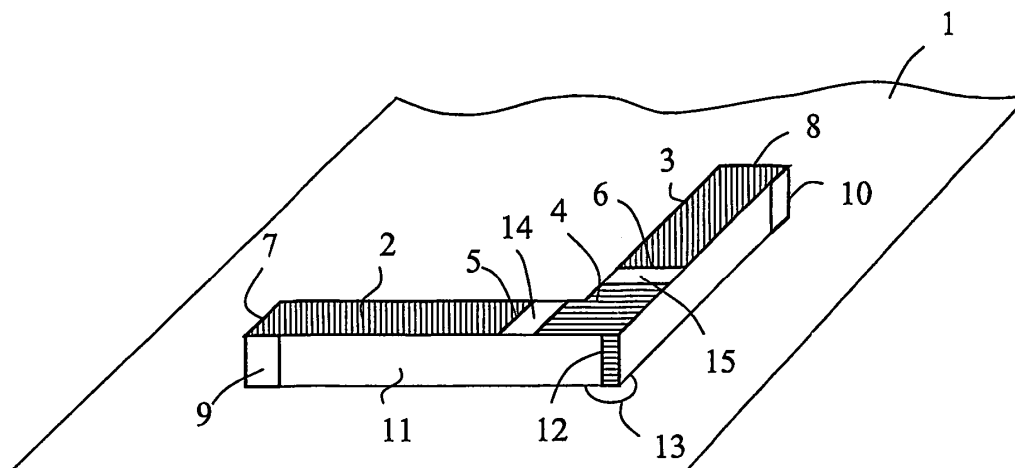
Assistant Examiner—Robert Karacsony

(74) *Attorney, Agent, or Firm*—Myers Bigel Sibley &
Sajovec

(57) **ABSTRACT**

A diversity radio antenna includes a ground substrate and two elongated antenna elements. The antenna elements each extend between respective opposing ends thereof in a plane parallel to and spaced from the ground substrate. An excitation electrode is interposed between the respective ends. A ground connector switch is configured to selectively connect and disconnect the ground substrate to the antenna elements for controlling radiation beam pattern and polarisation diversity of the antenna. The ground connector switch is configured to selectively connect the antenna elements to the ground substrate for adapting the antenna to a circularly-polarised radio wave, or to disconnect one of the antenna elements from the ground substrate for adapting the antenna to a linearly-polarised radio wave.

19 Claims, 4 Drawing Sheets



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US007405699B2

(12) **United States Patent**
Qin

(10) **Patent No.:** **US 7,405,699 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **MULTIPLE INPUT MULTIPLE OUTPUT ANTENNA**

(75) Inventor: **Xiang-Hong Qin**, Shenzhen (CN)

(73) Assignees: **Hong Fu Jin Precision Industry (ShenZhen) Co., Ltd.**, Shenzhen, Guangdong Province (CN); **Hon Hai Precision Industry Co., Ltd.**, Tu-Cheng, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/615,018**

(22) Filed: **Dec. 22, 2006**

(65) **Prior Publication Data**

US 2008/0094282 A1 Apr. 24, 2008

(30) **Foreign Application Priority Data**

Oct. 20, 2006 (TW) 95138886 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/829; 343/846; 343/770; 343/853**

(58) **Field of Classification Search** **343/700 MS**
See application file for complete search history.

(56) **References Cited**

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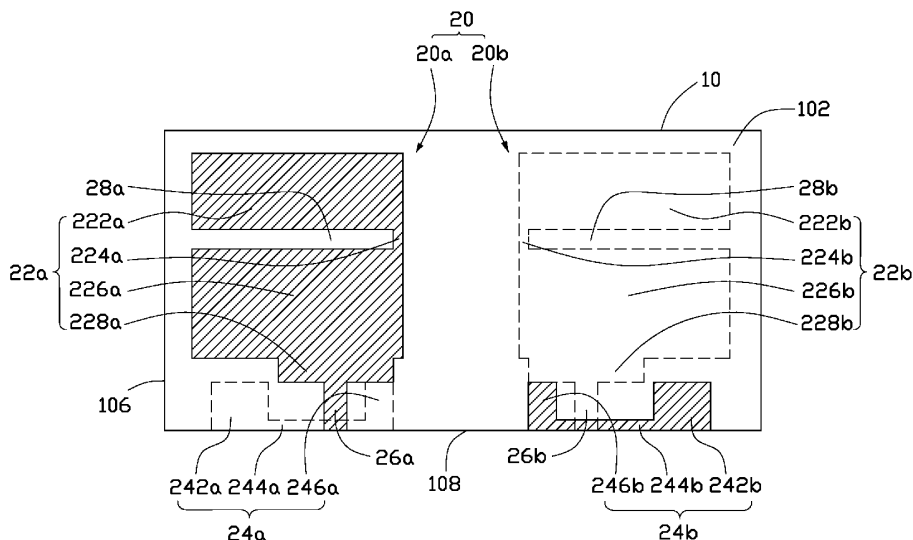
Primary Examiner—Trinh V Dinh

(74) Attorney, Agent, or Firm—Wei Te Chung

(57) **ABSTRACT**

A MIMO antenna (20) disposed on a substrate (10) including a first surface (102) and a second surface (104). The MIMO antenna includes a first antenna (20a) and a second antenna (20b) each including a radiating body (22a), a feeding portion (26a) electrically connected to the radiating body, and a metallic ground plane (24a). The radiating body includes a first radiating portion (222a), a second radiating portion (226a), and a gap (28a) formed between the first radiating portion and the second radiating portion. The radiating body and the feeding portion of the first antenna and the ground plane of the second antenna are laid on the first surface of the substrate, and the radiating body and the feeding portion of the second antenna and the ground plane of the first antenna are laid on the second surface of the substrate.

18 Claims, 6 Drawing Sheets



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US007405700B2

(12) **United States Patent**
Duzdar et al.

(10) **Patent No.:** **US 7,405,700 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **SINGLE-FEED MULTI-FREQUENCY
MULTI-POLARIZATION ANTENNA**

(75) Inventors: **Ayman Duzdar**, Holly, MI (US);
Andreas D. Fuchs, Orion, MI (US)

(73) Assignee: **Laird Technologies, Inc.**, St. Louis, MO
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/633,923**

(22) Filed: **Dec. 5, 2006**

(65) **Prior Publication Data**

US 2007/0222683 A1 Sep. 27, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/145,878, filed on
Jun. 6, 2005, now Pat. No. 7,164,385.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS**

(58) **Field of Classification Search** 343/700 MS,
343/846, 702, 711, 713
See application file for complete search history.

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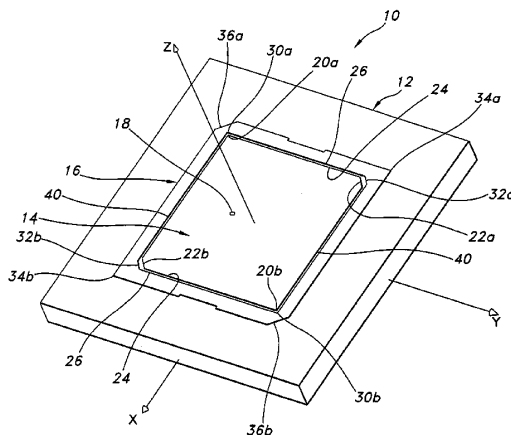
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce,
P.L.C.

(57) **ABSTRACT**

Various embodiments provide antennas capable of receiving
both left-hand circularly polarized (LHCP) signals and right-
hand circularly polarized (RHCP) signals, and outputting
both signals on a single feed. In one exemplary embodiment,
an antenna generally includes two substantially coplanar con-
centric patches. The inner patch is substantially square. The
outer patch has inner and outer edges both of which are
substantially square. The two patches do not physically con-
tact one another. A single feed is connected to the inner patch.
The inner patch receives the LHCP signal, and the two
patches operate collectively together for receiving the RHCP
signal.

26 Claims, 14 Drawing Sheets



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US007405701B2

(12) **United States Patent**
Ozkar

(10) **Patent No.:** **US 7,405,701 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **MULTI-BAND BENT MONOPOLE ANTENNA**

2006/0044187 A1 * 3/2006 Sager et al. 343/700 MS

(75) Inventor: **Mete Ozkar**, Raleigh, NC (US)

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(73) Assignee: **Sony Ericsson Mobile Communications AB** (SE)

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WO	03/096474	11/2003

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 272 days.

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(21) Appl. No.: **11/239,589**

Virga et al., "Low-Profile Enhanced-Bandwidth PIFA Antennas for Wireless Communications Packaging," Oct. 1997, pp. 1879-1888, vol. 45, No. 10, XP11036995.

(22) Filed: **Sep. 29, 2005**

PCT International Search Report, International Application No. PCT/US2006/017711, Mailed Aug. 31, 2006.

(65) **Prior Publication Data**

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US 2007/0069958 A1 Mar. 29, 2007

Primary Examiner—Tho G Phan

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(74) Attorney, Agent, or Firm—Coats & Bennett, P.L.L.C.

(52) **U.S. Cl.** **343/702**; 343/815; 343/846

(58) **Field of Classification Search** 343/700 MS, 343/702, 815, 833, 834, 846
See application file for complete search history.

(57) **ABSTRACT**

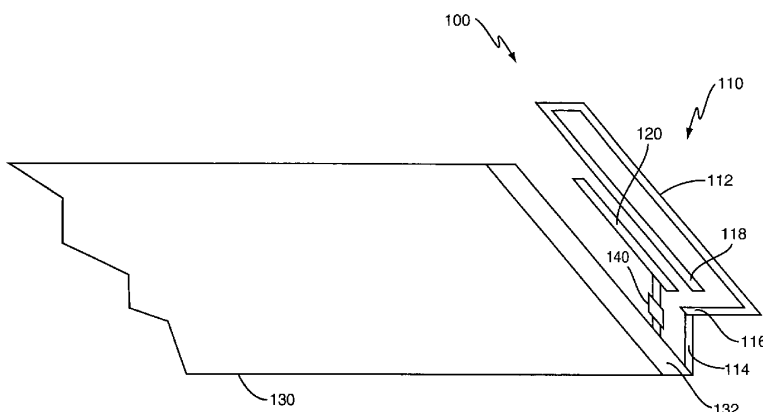
The method and apparatus described herein improves the bandwidth of a selected frequency band of a multi-band antenna. In particular, a selection circuit selectively applies capacitive coupling to the multi-band antenna to improve the bandwidth of a first frequency band without adversely affecting the bandwidth of a second frequency band. To that end, the multi-band antenna of the present invention comprises a main antenna element and a parasitic element disposed proximate the main antenna element. When the multi-band antenna operates in the first frequency band, the main antenna element capacitively couples to the parasitic element. However, when the multi-band antenna operates in the second frequency band, the selection circuit disables the capacitive coupling. By applying the capacitive coupling only when the multi-band antenna operates in the first frequency band, the present invention increases the bandwidth of the first frequency band without adversely affecting the bandwidth of the second frequency band.

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24 Claims, 6 Drawing Sheets





US007405702B2

(12) **United States Patent**
Annamaa et al.

(10) **Patent No.:** **US 7,405,702 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **ANTENNA ARRANGEMENT FOR
CONNECTING AN EXTERNAL DEVICE TO A
RADIO DEVICE**

(75) Inventors: **Petteri Annamaa**, Oulunsalo (FI); **Veli
Torvinen**, Kempele (FI)

(73) Assignee: **Pulse Finland Oy**, Kempele (FI)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 261 days.

(21) Appl. No.: **11/330,714**

(22) Filed: **Jan. 11, 2006**

(65) **Prior Publication Data**
US 2006/0176225 A1 Aug. 10, 2006

Related U.S. Application Data
(63) Continuation of application No. PCT/FI2004/00430,
filed on Jul. 7, 2004.

(30) **Foreign Application Priority Data**
Jul. 24, 2003 (FI) 20031101

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702**; 455/575.2
(58) **Field of Classification Search** 343/700 MS,
343/702, 829, 846, 906; 455/95, 575.2
See application file for complete search history.

(56) **References Cited**
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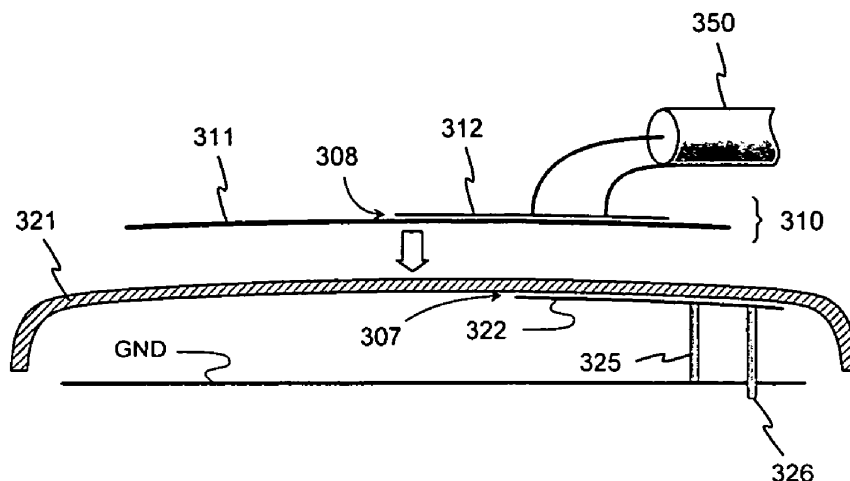
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

An arrangement by which an external device is connected to a radio device via its antenna without modifying the radio device mechanically. The radiating element (311) of the antenna of the radio device is a conductive part of its casing, which is fed electromagnetically by means of a feed element (322). The connecting is implemented by a coupler (310) to be placed at the antenna on top of the casing, from which coupler there is an intermediate cable (350) to the external device. The coupler includes a coupling element (312), from which there is electromagnetic coupling to the radiating element (321) through a thin dielectric membrane, or direct galvanic coupling. From the coupling element to the jumper cable there is electromagnetic coupling through an intermediate element (312), or direct galvanic coupling. Because the radiating plane is located on the outer surface of the radio device, its distance to the coupling element can be made very small. Thus the attenuation caused by the coupler on the transfer path from the antenna port of the radio device to the external device is lower than in the known arrangements.

10 Claims, 4 Drawing Sheets



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US007405704B1

(12) **United States Patent**
Lin et al.

(10) **Patent No.:** **US 7,405,704 B1**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **INTEGRATED MULTI-BAND ANTENNA**

(75) Inventors: **Ching-chi Lin**, Tu-Cheng (TW); **Kai Shih**, Tu-Cheng (TW); **Yu-yuan Wu**, Tu-Cheng (TW); **Jia-hung Su**, Tu-Cheng (TW)

(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 10 days.

(21) Appl. No.: **11/699,465**

(22) Filed: **Jan. 30, 2007**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/702, 846**

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Hoang V Nguyen

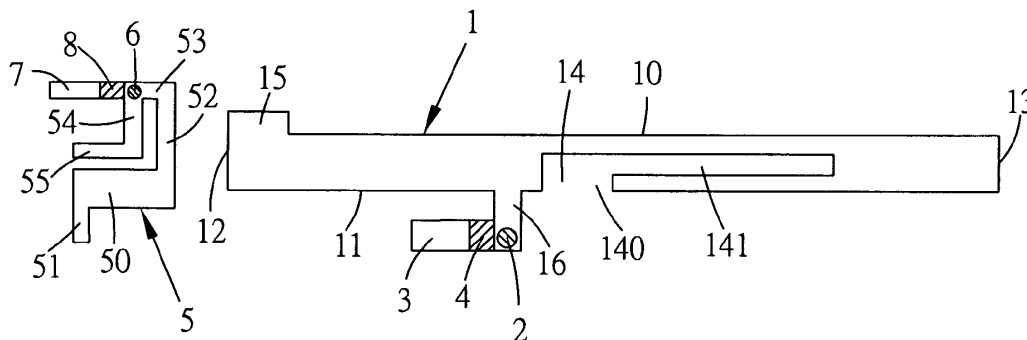
(74) *Attorney, Agent, or Firm*—Rosenberg, Klein & Lee

(57) **ABSTRACT**

An integrated multi-band antenna has a first radiating element and a second radiating element. The first radiating element has a slot and a feeding conductor having a first feeding point. A first ground portion is arranged to close to the feeding conductor. The second radiating element has a first radiating segment, a second radiating segment extending from one end of the first radiating segment, a third, a fourth, a fifth and a sixth radiating segments connecting end to end in sequence wherein one end of the third radiating segment connects to the other end of the first radiating segment, and one end of the sixth radiating segment remains free. A second feeding point is arranged at the corner between the fourth and fifth radiating segments. A second ground portion is arranged to close to the corner. Operation of the integrated multi-band antenna can obtain various wireless communication bands.

20 Claims, 3 Drawing Sheets

100



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US007405705B2

(12) **United States Patent**
Fukuchi

(10) **Patent No.:** **US 7,405,705 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **WIDEBAND ANTENNA**

(75) Inventor: **Keisuke Fukuchi**, Hitachi (JP)

(73) Assignee: **Hitachi Cable, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/812,929**

(22) Filed: **Jun. 22, 2007**

(65) **Prior Publication Data**

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Related U.S. Application Data

(62) Division of application No. 11/444,538, filed on Jun. 1, 2006.

(30) **Foreign Application Priority Data**

Aug. 31, 2005 (JP) 2005-252142

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/767**

(58) **Field of Classification Search** 343/767,
343/768, 700 MS, 795, 702, 770
See application file for complete search history.

(56) **References Cited**

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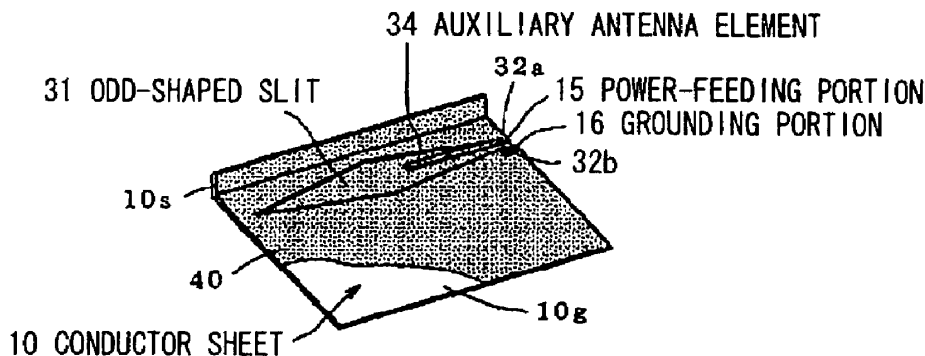
Primary Examiner—Hoang Anh T Le

(74) *Attorney, Agent, or Firm*—Foley & Lardner LLP

(57) **ABSTRACT**

A wideband antenna has: a rectangular conductor sheet; a bow-tie-shaped slit formed in the rectangular conductor sheet, the rectangular conductor sheet having two apex portions defined by the bow-tie-shaped slit, the two apex portions being opposite to each other in the middle of the bow-tie-shaped slit; an auxiliary antenna element formed to extend along the bow-tie-shaped slit on both sides of one of the two apex portions; a power-feeding portion formed at the one of the two apex portions; and a grounding portion formed at an other of the two apex portions.

5 Claims, 5 Drawing Sheets



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US007405707B2

(12) **United States Patent**
Murofushi et al.

(10) **Patent No.:** **US 7,405,707 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **COMPOSITE ANTENNA**

(75) Inventors: **Nobuo Murofushi**, Shizuoka-Ken (JP);
Kouichi Sano, Shizuoka-Ken (JP);
Yasuhito Kiji, Shizuoka-Ken (JP);
Yasuo Matsumoto, Shizuoka-Ken (JP)

(73) Assignee: **Toshiba Tec Kabushiki Kaisha**, Tokyo
(JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 20 days.

(21) Appl. No.: **11/465,293**

(22) Filed: **Aug. 17, 2006**

(65) **Prior Publication Data**
US 2007/0046544 A1 Mar. 1, 2007

(30) **Foreign Application Priority Data**
Aug. 25, 2005 (JP) 2005-244301

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/725**; 343/700 MS;
343/895

(58) **Field of Classification Search** 343/700 MS,
343/725, 895
See application file for complete search history.

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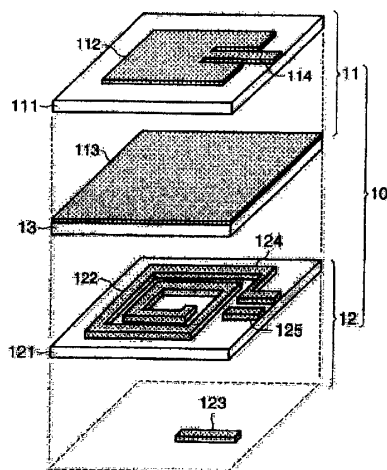
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(57) **ABSTRACT**

A composite antenna includes a first antenna structure and a
second antenna structure integrally combined with the first
antenna structure to operate under different frequency bands
respectively that are used in different radio transmission sys-
tems such that the first antenna structure has a first conductive
layer to operate under a first frequency band and the second
antenna structure has a second conductive layer a thickness of
which is thicker than that of the first conductive layer to
operate under a second frequency band lower than the first
frequency band.

19 Claims, 4 Drawing Sheets



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