



US008514132B2

(12) **United States Patent**
Rao

(10) **Patent No.:** **US 8,514,132 B2**
(45) **Date of Patent:** **Aug. 20, 2013**

(54) **COMPACT MULTIPLE-BAND ANTENNA FOR WIRELESS DEVICES**

(75) Inventor: **Qinjiang Rao**, Waterloo (CA)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 706 days.

(21) Appl. No.: **12/615,267**

(22) Filed: **Nov. 10, 2009**

(65) **Prior Publication Data**
US 2011/0109515 A1 May 12, 2011

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

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

(58) **Field of Classification Search**
USPC **343/700 MS, 702, 725**
See application file for complete search history.

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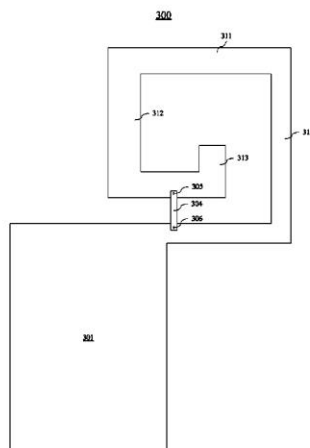
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Moffat & Co.; Timothy Clise; Joseph Ulvr

(57) **ABSTRACT**

A compact multiple-band antenna for wireless devices having a plurality of operating frequency bands is provided. In one embodiment, a multiple-band antenna for a wireless device, comprises a ground area; a first radiating member having a first end, an intermediate portion and a second end and cooperatively receiving and substantially radiating RF signals at a first, second and third resonant frequency, wherein said first end of said first radiating member is electrically connected to said ground area and said intermediate portion is electrically connected to a first feed point; a second radiating member having a first end and a second end and cooperatively receiving and substantially radiating RF signals at a first, second and third resonant frequency, wherein said first end of said second radiating member is electrically connected to said second end of said first radiating member; a third radiating member having a first end and a second end and cooperatively receiving and substantially radiating RF signals at a first, second and third resonant frequency, wherein said first end of said third radiating member is electrically connected to said second end of said second radiating member; and a fourth radiating member having a first end, an intermediate portion and a second end and providing a fourth resonant frequency, wherein said first end of said fourth radiating member is electrically connected to said second end of said third radiating member, said intermediate portion of said fourth radiating member is electrically connected to a second feed point and said second end of said fourth radiating member is unconnected.

13 Claims, 8 Drawing Sheets





US008514134B2

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

(10) **Patent No.:** **US 8,514,134 B2**
(45) **Date of Patent:** **Aug. 20, 2013**

(54) **MIMO ANTENNA HAVING PARASITIC ELEMENTS**

(75) Inventors: **Chan Ho Kim**, Incheon-shi (KR); **Jin Myung Kim**, Seongnam-shi (KR); **Chang-Gyu Choi**, Incheon-shi (KR); **Gyoung Rok Beak**, Siheung-shi (KR); **Young Hun Park**, Cheongju-shi (KR); **Heung Ju Ahn**, Suwon-shi (KR); **Yeon Ho Yang**, Goyang-shi (KR)

(73) Assignee: **Mobitech Corp.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 244 days.

(21) Appl. No.: **13/202,589**

(22) PCT Filed: **Oct. 19, 2009**

(86) PCT No.: **PCT/KR2009/006003**

§ 371 (c)(1),
(2), (4) Date: **Aug. 22, 2011**

(87) PCT Pub. No.: **WO2010/098529**

PCT Pub. Date: **Sep. 2, 2010**

(65) **Prior Publication Data**

US 2011/0298666 A1 Dec. 8, 2011

(30) **Foreign Application Priority Data**

Feb. 27, 2009 (KR) 10-2009-0016593

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

(58) **Field of Classification Search**

USPC 343/700 MS, 829, 846, 815, 833,
343/834

See application file for complete search history.

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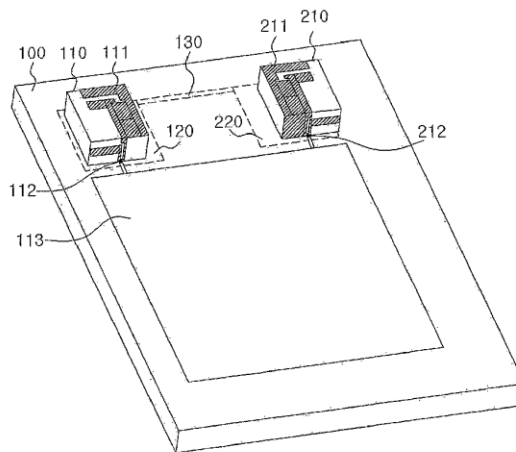
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — LRK Patent Law Firm

(57) **ABSTRACT**

A Multiple-Input Multiple-Output (MIMO) antenna having parasitic elements is provided. The MIMO antenna includes a plurality of antenna elements, a plurality of parasitic elements, and a bridge. The plurality of antenna elements is symmetrically disposed on one side surface of a board while maintaining a predetermined distance therebetween. The plurality of parasitic elements is disposed on the other side surface of the board in a one-to-one correspondence with the plurality of antenna elements. The bridge is formed of a metal pattern line, and is configured to connect the plurality of parasitic elements to each other.

6 Claims, 12 Drawing Sheets





US008514138B2

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

(10) **Patent No.:** **US 8,514,138 B2**
(45) **Date of Patent:** **Aug. 20, 2013**

(54) **MEANDER SLOT ANTENNA STRUCTURE AND ANTENNA MODULE UTILIZING THE SAME**

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(75) Inventors: **Kuo-Fong Hung**, Changhua (TW);
Ming-Hao Yeh, Taipei (TW)

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(73) Assignee: **Mediatek Inc.**, Hsin-Chu (TW)

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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 338 days.

(21) Appl. No.: **13/005,366**

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(22) Filed: **Jan. 12, 2011**

English language translation of abstract of JP 2003-234615 (published Aug. 22, 2003).

(65) **Prior Publication Data**

US 2012/0176292 A1 Jul. 12, 2012

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/48 (2006.01)

(Continued)

(52) **U.S. Cl.**
USPC **343/767**; 343/700 MS; 343/846;
343/770; 343/829

Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(58) **Field of Classification Search**
None
See application file for complete search history.

(57) **ABSTRACT**

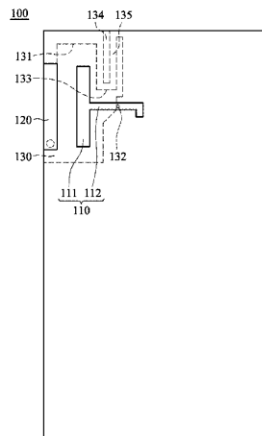
A meander slot antenna structure for transmitting a wireless signal is provided. The meander slot antenna structure includes a substrate, a ground element, a feed conductor and a couple conductor. The substrate includes a first surface and a second surface, wherein the first surface is opposite to the second surface. The ground element is disposed on the second surface, wherein a meander slot is formed in the ground element. The feed conductor is disposed on the first surface, wherein the feed conductor corresponds to the meander slot. The couple conductor is disposed on the first surface and coupled with the feed conductor, wherein a via passes through the substrate and electrically connects the couple conductor to the ground element.

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23 Claims, 12 Drawing Sheets

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US008514146B2

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

(10) **Patent No.:** **US 8,514,146 B2**
(45) **Date of Patent:** **Aug. 20, 2013**

(54) **SINGLE-LAYER METALLIZATION AND VIA-LESS METAMATERIAL STRUCTURES**

(75) Inventors: **Ajay Gummalla**, San Diego, CA (US);
Maha Achour, San Diego, CA (US);
Cheng-Jung Lee, San Diego, CA (US);
Vanceet Pathak, San Diego, CA (US);
Gregory Poilasne, El Cajon, CA (US)

(73) Assignee: **Tyco Electronics Services GmbH** (CH)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 984 days.

(21) Appl. No.: **12/250,477**

(22) Filed: **Oct. 13, 2008**

(65) **Prior Publication Data**

US 2009/0128446 A1 May 21, 2009

Related U.S. Application Data

(60) Provisional application No. 60/979,384, filed on Oct. 11, 2007, provisional application No. 60/987,750, filed on Nov. 13, 2007, provisional application No. 61/024,876, filed on Jan. 30, 2008, provisional application No. 61/091,203, filed on Aug. 22, 2008.

(51) **Int. Cl.**
H01Q 15/02 (2006.01)

(52) **U.S. Cl.**
USPC **343/909**; 343/700 MS

(58) **Field of Classification Search**
USPC 343/909, 911
See application file for complete search history.

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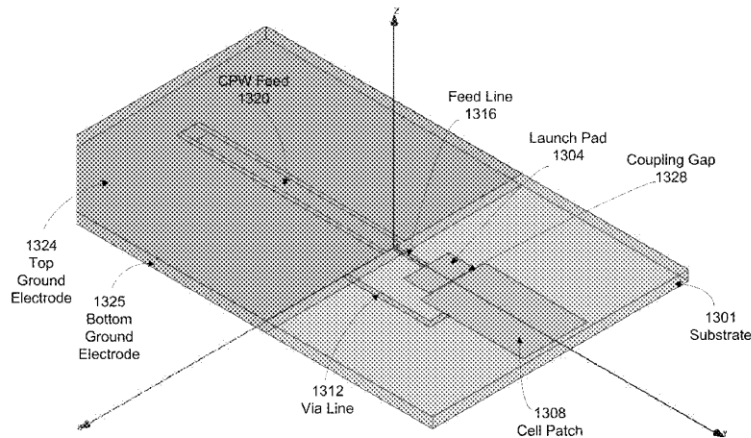
Primary Examiner — Hoang V Nguyen

Assistant Examiner — Kyana R McCain

(57) **ABSTRACT**

Techniques and apparatus based on metamaterial structures provided for antenna and transmission line devices, including single-layer metallization and via-less metamaterial structures.

34 Claims, 49 Drawing Sheets





US008519894B2

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

(10) **Patent No.:** **US 8,519,894 B2**
(45) **Date of Patent:** **Aug. 27, 2013**

(54) **ELECTRONIC APPARATUS AND ANTENNA MODULE THEREOF**

(75) Inventors: **Chun-Fei Yang**, Taipei Hsien (TW);
Hung-Chih Fu, Taipei Hsien (TW)

(73) Assignee: **Wistron Corporation**, 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 376 days.

(21) Appl. No.: **12/461,219**

(22) Filed: **Aug. 5, 2009**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
May 14, 2009 (TW) 98116069 A

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

(52) **U.S. Cl.**
USPC **343/702**

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

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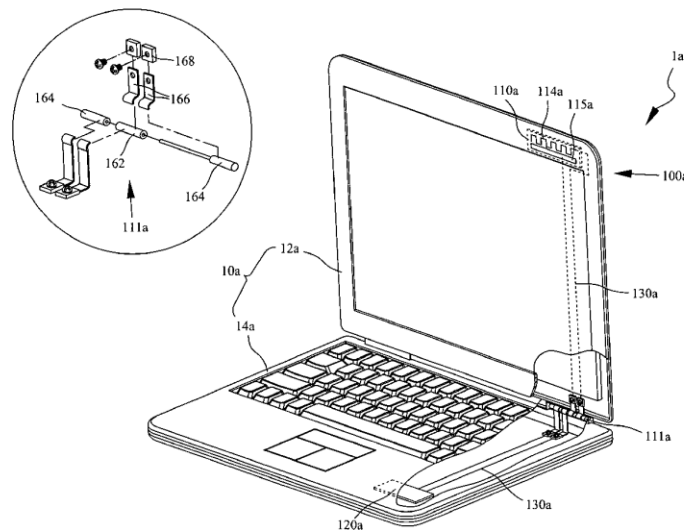
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Primary Examiner — Michael C Wimer
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Bacon & Thomas, PLLC

(57) **ABSTRACT**

An antenna structure for an electronic apparatus is disclosed. The electronic apparatus comprises a case composed of a first case and a second case, and the first case combines correspondingly with the second case. The antenna structure comprises an antenna element and a system antenna module. The antenna element is disposed on the inner side of the first case and comprises a connection portion. The system antenna module disposed in the case comprises a corresponding connection portion, and the position of the corresponding connection portion corresponds to the connection portion. The connection portion can be in contact with the corresponding connection portion to form an electrical connection between them by combining the first case and the second case.

4 Claims, 5 Drawing Sheets





US008519896B2

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

(10) **Patent No.:** **US 8,519,896 B2**
(45) **Date of Patent:** **Aug. 27, 2013**

- (54) **ANTENNA HAVING LINE-SHAPED ELECTRODE ON BOARD END SURFACE**
- (75) Inventors: **Kengo Onaka**, Kanagawa-ken (JP); **Takashi Ishihara**, Tokyo-to (JP)
- (73) Assignee: **Murata Manufacturing Co., Ltd.** (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 444 days.

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Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

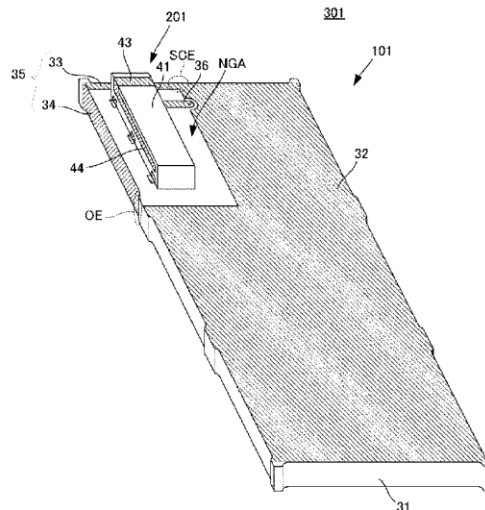
- (21) Appl. No.: **12/911,542**
- (22) Filed: **Oct. 25, 2010**
- (65) **Prior Publication Data**
US 2011/0109510 A1 May 12, 2011
- (30) **Foreign Application Priority Data**
Nov. 6, 2009 (JP) 2009-254970
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702**; 343/700 MS
- (58) **Field of Classification Search**
USPC 343/702, 700 MS, 846
See application file for complete search history.

(57) **ABSTRACT**

An antenna includes a board having a substrate and a ground electrode, electrodes provided on external surfaces of the substrate, a feeding element provided near an end surface of the board. The feeding element includes an electrically insulating base member and a feeding radiation electrode provided on the base member. A non-feeding element including a substantially line-shaped electrode is provided on the board and includes at least one end thereof connected to the ground electrode and electromagnetically coupled with the feeding element. At least part of the substantially line-shaped electrodes is provided on the end surface of the board.

11 Claims, 7 Drawing Sheets

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US008519900B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 8,519,900 B2**
(45) **Date of Patent:** **Aug. 27, 2013**

(54) **GLOBAL POSITIONING SYSTEM ANTENNA**

(56) **References Cited**

(75) Inventor: **Hsi-Chieh Chen**, Tu-Cheng (TW)

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(73) Assignee: **Chi Mei Communication Systems, Inc.**, New Taipei (TW)

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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 435 days.

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(21) Appl. No.: **12/890,697**

Primary Examiner — Jerome Jackson, Jr.

Assistant Examiner — Hai Tran

(22) Filed: **Sep. 26, 2010**

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(65) **Prior Publication Data**

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(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Jun. 30, 2010 (TW) 99121477

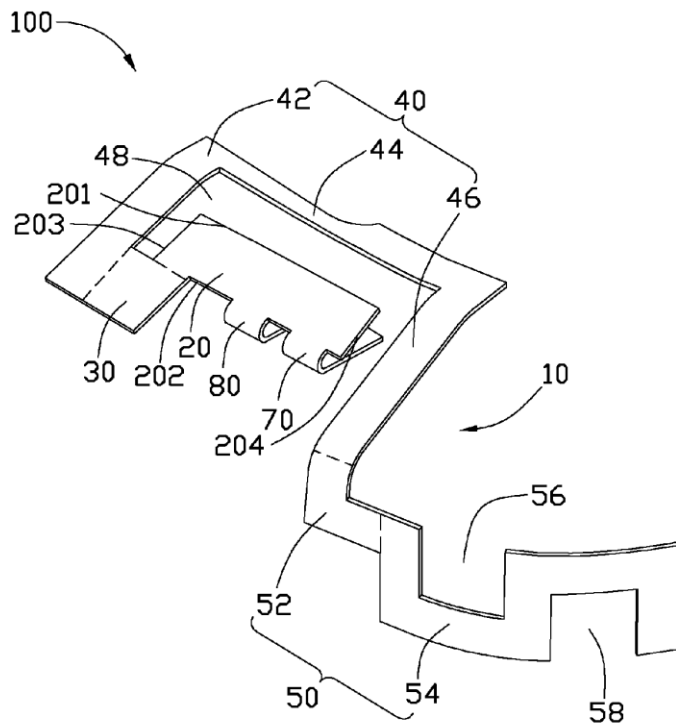
A global positioning system antenna includes a radiator. The radiator includes a base section, an extension section connected to an edge of the base section, a first curved section connected to an edge of the extension section, and a second curved section connected to a distal end of the first curved section. The first curved section and the base section define a slot therebetween. The second curved section defines a first gap and a second gap thereon. The first gap and the second gap face each other.

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

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

(58) **Field of Classification Search**
USPC 343/767
See application file for complete search history.

14 Claims, 2 Drawing Sheets





US008519903B2

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

(10) **Patent No.:** **US 8,519,903 B2**
(45) **Date of Patent:** ***Aug. 27, 2013**

(54) **CONFORMABLE ANTENNA**

(75) Inventors: **Randell Cozzolino**, Phoenix, AZ (US);
Gary Wannagot, Gilbert, AZ (US); **Snir Azulay**, Tiberias, IL (US)

(73) Assignee: **Galtronics Corporation Ltd.**, Tiberias (IL)

(*) 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.: **13/526,737**

(22) Filed: **Jun. 19, 2012**

(65) **Prior Publication Data**

US 2012/0256803 A1 Oct. 11, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/468,579, filed on May 19, 2009, now Pat. No. 8,203,499.

(60) Provisional application No. 61/128,284, filed on May 19, 2008.

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(52) **U.S. Cl.**
USPC **343/821**

(58) **Field of Classification Search**
USPC 343/821, 850, 856; 29/601
See application file for complete search history.

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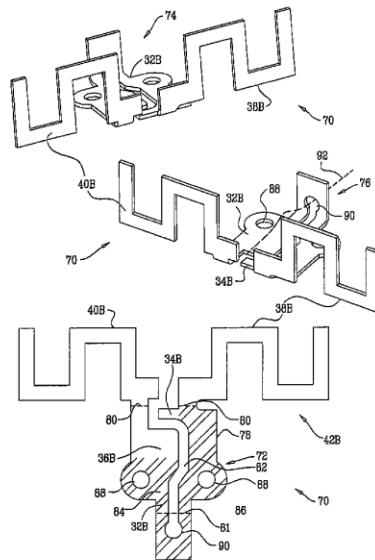
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

A polymorphic antenna, including a metallic template configurable in at least first and second possible different three-dimensional shapes, the antenna, when configured in the at least first and second different three-dimensional shapes, having a common antenna feed point, a common balun coupled to the common antenna feed point; and a common dipole coupled to the common antenna feed point and to the common balun. The antenna operates in a common frequency band when configured in either of the at least first and second different three-dimensional shapes when fed via the common antenna feed point.

20 Claims, 16 Drawing Sheets





US008519904B2

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

(10) **Patent No.:** **US 8,519,904 B2**
(45) **Date of Patent:** **Aug. 27, 2013**

(54) **KEYBOARD STRUCTURE WITH ANTENNA FUNCTION**

(75) Inventors: **Jun-Ting Hsu**, Taoyuan County (TW); **Yih-Ming Yang**, Taipei (TW); **Ming-Fu Yen**, Taipei County (TW); **Hsi-Wang Lee**, Taipei County (TW)

(73) Assignees: **Lite-On Electronics (Guangzhou) Limited**, Guangzhou (CN); **Lite-On Technology Corporation**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 175 days.

(21) Appl. No.: **12/953,620**

(22) Filed: **Nov. 24, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 27, 2010 (CN) 2010 1 0292693

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

(52) **U.S. Cl.**
USPC **343/845; 345/169**

(58) **Field of Classification Search**

USPC 345/168-169
See application file for complete search history.

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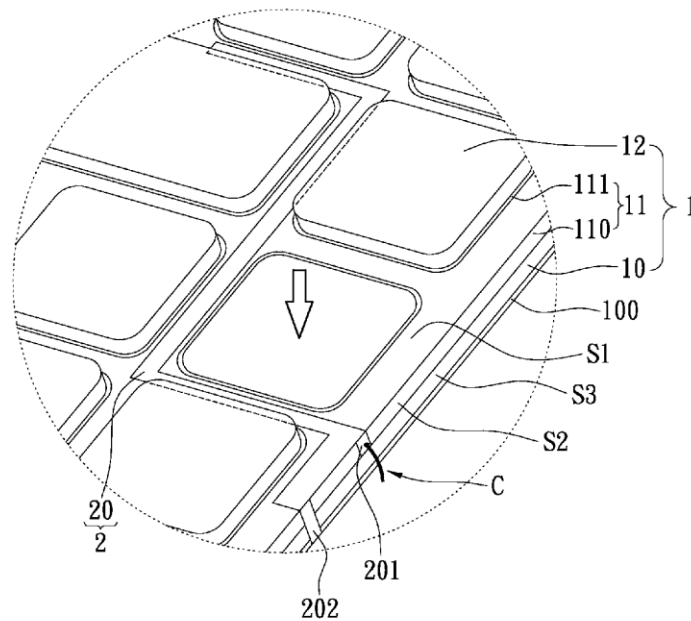
Primary Examiner — Duc Dinh

(74) *Attorney, Agent, or Firm* — Li&Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A keyboard structure with antenna function includes a keyboard unit and an antenna unit. The keyboard unit includes a keyboard signal circuit board, at least one keyboard frame disposed on the keyboard signal circuit board, and a plurality of pressing elements passing through the keyboard frame and movably disposed on the keyboard signal circuit board. The antenna unit includes at least one metal circuit disposed on the keyboard frame. Thus, the length of a signal transmission line between the metal circuit and a wireless antenna module can be substantially reduced. Therefore, not only the insertion loss of the instant disclosure can be reduced to obtain better quality of wireless communication, but also the manufacturing cost and time of the instant disclosure also can be reduced effectively.

8 Claims, 13 Drawing Sheets





US008521240B2

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

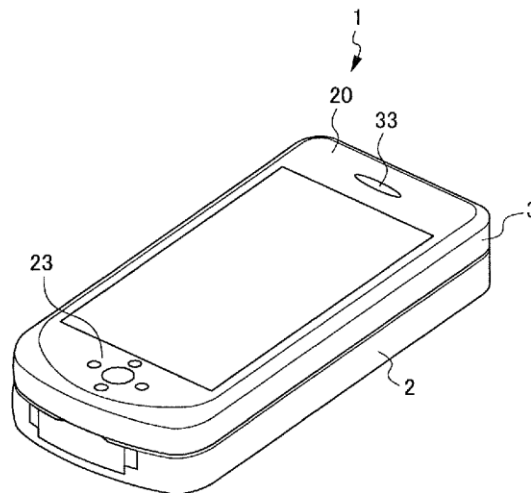
(10) **Patent No.:** **US 8,521,240 B2**
(45) **Date of Patent:** **Aug. 27, 2013**

- (54) **PORTABLE TERMINAL**
- (75) Inventors: **Mitsuhiro Nishizono**, Kanagawa (JP);
Hiroshi Sakai, Kanagawa (JP)
- (73) Assignee: **KYOCERA Corporation**, Kyoto (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 25 days.
- (21) Appl. No.: **13/258,938**
- (22) PCT Filed: **Mar. 26, 2010**
- (86) PCT No.: **PCT/JP2010/055444**
§ 371 (c)(1),
(2), (4) Date: **Sep. 22, 2011**
- (87) PCT Pub. No.: **WO2010/110449**
PCT Pub. Date: **Sep. 30, 2010**
- (65) **Prior Publication Data**
US 2012/0028692 A1 Feb. 2, 2012
- (30) **Foreign Application Priority Data**
Mar. 26, 2009 (JP) 2009-077771
- (51) **Int. Cl.**
H04M 1/00 (2006.01)
- (52) **U.S. Cl.**
USPC **455/575.4; 455/575.1; 455/575.7**
- (58) **Field of Classification Search**
USPC **455/575.4, 575.7, 575.1**
See application file for complete search history.

- (56) **References Cited**
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- Primary Examiner* — Kamran Afshar
- Assistant Examiner* — Omoniyi Obayanju
- (74) *Attorney, Agent, or Firm* — Hoffmann & Baron LLP

- (57) **ABSTRACT**
- Provided is a portable terminal capable of ensuring satisfactory antenna characteristics regardless of a change in state, and of accommodating a plurality of frequency bands. A first circuit unit comprises: a first signal source; a first power feeding unit connected to a first antenna unit; a second power feeding unit connected to a first connection unit; a first switching unit which connects the first power feeding unit or the second power feeding unit to the first signal source by switching; and a first control unit which controls the first switching unit so as to connect the second power feeding unit to the first signal source when the portable terminal is transitioned to a second state. A first disconnection unit is disposed between the first connection unit and the first circuit unit and disconnects a first signal.

8 Claims, 12 Drawing Sheets





US008525731B2

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

(10) **Patent No.:** **US 8,525,731 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **SMALL ANTENNA USING SRR STRUCTURE IN WIRELESS COMMUNICATION SYSTEM AND METHOD FOR MANUFACTURING THE SAME**

(75) Inventors: **Jeongho Ju**, Seoul (KR); **Jae-Ick Choi**, Daejeon (KR); **Wangjoo Lee**, Daejeon (KR); **Dong-Ho Kim**, Daejeon (KR)

(73) Assignee: **Electronics and Telecommunications Research Institute**, Daejeon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 455 days.

(21) Appl. No.: **12/913,985**

(22) Filed: **Oct. 28, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 30, 2009 (KR) 10-2009-0117393

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

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/742; 343/867

(58) **Field of Classification Search**
USPC 343/700 MS, 741, 742, 866, 867
See application file for complete search history.

(56) **References Cited**

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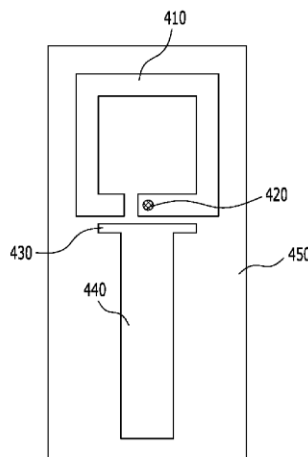
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A small antenna using an SRR structure in a wireless communication system includes: a first radiation unit positioned over a dielectric substrate formed of a predetermined dielectric medium and having a predetermined ring shape; a feed unit positioned over the dielectric substrate and configured to feed a signal to the first radiation unit; a second radiation unit positioned under the dielectric substrate and having a predetermined ring shape; a via formed through the dielectric substrate to connect the first and second radiation units; a ground unit positioned under the dielectric substrate and configured to ground the first and second radiation units; and a metal line unit positioned under the dielectric substrate to connect the second radiation unit and the ground unit. The feed unit includes first and second capacitors which accomplish impedance matching when the signal is fed to the first radiation unit.

16 Claims, 5 Drawing Sheets





US008525732B2

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

(10) **Patent No.:** **US 8,525,732 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **ANTENNA DEVICE**

(75) Inventors: **Naoaki Utawaga**, Tokyo (JP); **Kei Suzuki**, Tokyo (JP); **Yasumasa Harihara**, Tokyo (JP); **Masaki Matsushima**, Tokyo (JP); **Takeshi Ohashi**, 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 231 days.

(21) Appl. No.: **12/963,083**

(22) Filed: **Dec. 8, 2010**

(65) **Prior Publication Data**

US 2011/0133993 A1 Jun. 9, 2011

(30) **Foreign Application Priority Data**

Dec. 9, 2009 (JP) 2009-279272

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

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

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

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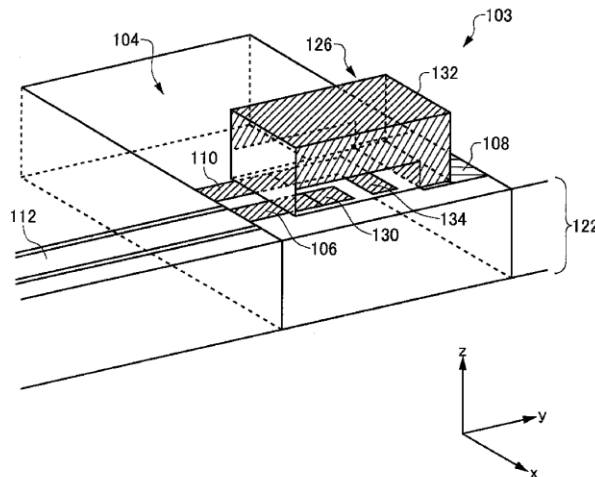
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A radiation electrode **132** is printed on the upper surface of the dielectric body, side surface thereof, and bottom surface thereof in a folded configuration. A feeding electrode **130** and ground electrode **134** are printed on the bottom surface of the antenna elements **124**. The feeding electrode **130** and radiation electrode **132** on the upper surface are opposed to each other as parallel planes. The ground electrode **134** and radiation electrode **132** are also opposite to each other as parallel planes. No electrode is formed on one of the side surfaces of the antenna element **124** that is opposed to the side surface at the side of which the radiation electrode **132** is folded.

4 Claims, 13 Drawing Sheets





US008525733B2

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

(10) **Patent No.:** **US 8,525,733 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

- (54) **LOW-PROFILE WIDE-BANDWIDTH RADIO FREQUENCY ANTENNA**
- (71) Applicant: **Apple Inc.**, Cupertino, CA (US)
- (72) Inventors: **Dean Kitchener**, Essex (GB); **Andrew Urquhart**, Hertfordshire (GB)
- (73) Assignee: **Apple Inc.**, Cupertino, 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.

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- (21) Appl. No.: **13/764,899**
- (22) Filed: **Feb. 12, 2013**
- (65) **Prior Publication Data**
US 2013/0162498 A1 Jun. 27, 2013

Related U.S. Application Data

- (63) Continuation of application No. 13/229,870, filed on Sep. 12, 2011, now Pat. No. 8,416,137, which is a continuation of application No. 12/415,604, filed on Mar. 31, 2009, now Pat. No. 8,040,289.
- (60) Provisional application No. 61/050,028, filed on May 2, 2008.

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)
- (52) **U.S. Cl.**
USPC **343/700 MS**; 343/846; 343/860
- (58) **Field of Classification Search**
USPC 343/700 MS, 846, 860
See application file for complete search history.

- (56) **References Cited**
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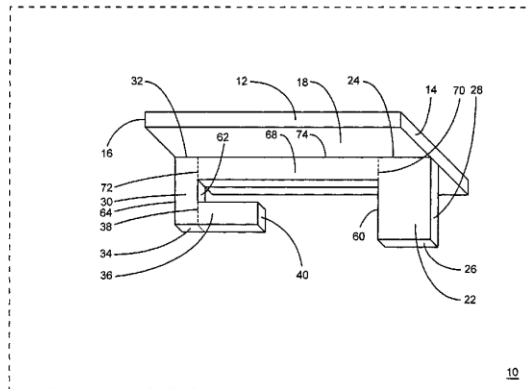
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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Meyertons, Hood, Kivlin, Kowert & Goetzel, P.C.

(57) **ABSTRACT**

The present invention relates to an RE antenna structure that includes a planar structure and a loading plate, such that the planar structure is mounted between a ground plane and the loading plate to form an RF antenna. The loading plate may be about parallel to the ground plane and the planar structure may be about perpendicular to the loading plate and the ground plane. The loading plate may allow the height of the RF antenna structure above the ground plane to be relatively small. For example, the height may be significantly less than one-quarter of a wavelength of RF signals of interest. The planar structure may include two conductive matching elements to help increase the bandwidth of the RF antenna structure.

20 Claims, 29 Drawing Sheets





US008525734B2

(12) **United States Patent**
Krogerus

(10) **Patent No.:** **US 8,525,734 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

- (54) **ANTENNA DEVICE**
- (75) Inventor: **Joonas Veli-Allan Krogerus**, Espoo (FI)
- (73) Assignee: **Nokia Corporation**, Espoo (FI)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 766 days.

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- (21) Appl. No.: **12/520,719**
- (22) PCT Filed: **Dec. 21, 2006**
- (86) PCT No.: **PCT/IB2006/004186**
§ 371 (c)(1),
(2), (4) Date: **Feb. 26, 2010**
- (87) PCT Pub. No.: **WO2008/084273**
PCT Pub. Date: **Jul. 17, 2008**
- (65) **Prior Publication Data**
US 2010/0214180 A1 Aug. 26, 2010

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Primary Examiner — Tho G Phan
 (74) *Attorney, Agent, or Firm* — Nokia Corporation

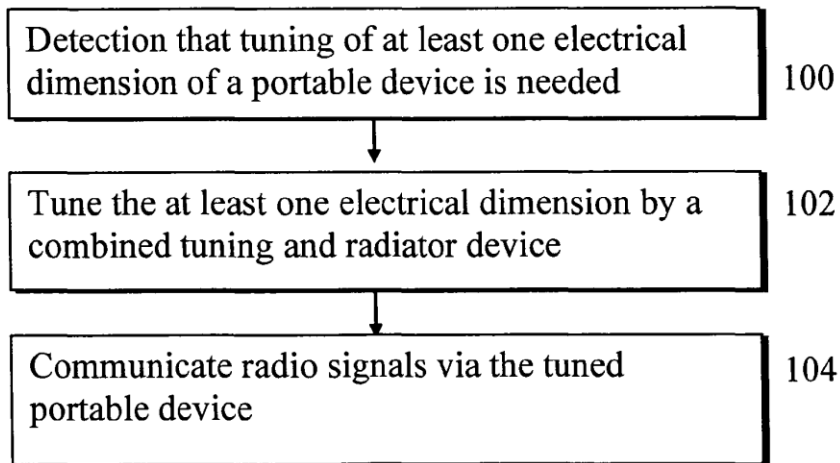
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702; 343/745**
- (58) **Field of Classification Search**
USPC 343/700, 702, 745, 749, 846
See application file for complete search history.

(57) **ABSTRACT**

An antenna device for a portable electronic device and an electronic device provided with such an antenna are disclosed. The antenna device is configured to provide in a combination a tuning element for tuning at least one electrical dimension of the portable electronic device and an antenna radiator element of the portable electronic device.

- (56) **References Cited**
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20 Claims, 13 Drawing Sheets





US008525735B2

(12) **United States Patent**
Kilpi

(10) **Patent No.:** **US 8,525,735 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

- (54) **FOLDABLE/SLIDEABLE APPARATUS FOR RADIO COMMUNICATION WITH BACKSPACE FOR AN ANTENNA**
- (75) Inventor: **Pekka Kilpi**, Helsinki (FI)
- (73) Assignee: **Nokia Corporation**, Espoo (FI)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 968 days.

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- (21) Appl. No.: **12/599,496**
- (22) PCT Filed: **May 7, 2007**
- (86) PCT No.: **PCT/EP2007/004349**
§ 371 (c)(1),
(2), (4) Date: **Nov. 9, 2009**
- (87) PCT Pub. No.: **WO2008/135070**
PCT Pub. Date: **Nov. 13, 2008**

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- (65) **Prior Publication Data**
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Primary Examiner — Douglas W Owens
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — Nokia Corporation

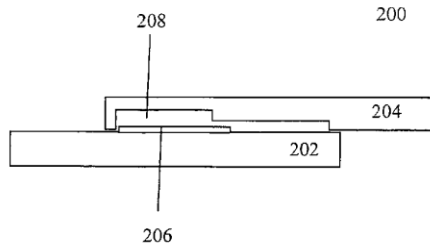
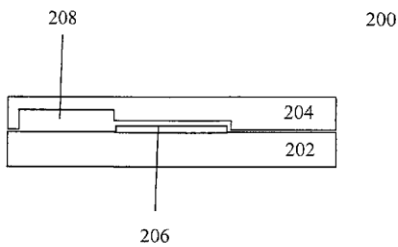
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702**; 455/575.4; 455/575.7
- (58) **Field of Classification Search**
USPC **343/702**; 455/575.3-7
See application file for complete search history.

(57) **ABSTRACT**

An apparatus for radio communication comprising an antenna element and first and second parts, wherein the apparatus is arranged such that the first and second parts are movable with respect to one another between first and second configurations, and wherein movement of the apparatus from the first configuration into the second configuration provides a backspace which can be used as a backspace for the antenna element.

- (56) **References Cited**
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16 Claims, 6 Drawing Sheets





US008525736B2

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

(10) **Patent No.:** **US 8,525,736 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

- (54) **ANTENNA DEVICE**
- (75) Inventors: **Shinsuke Yukimoto**, Tokyo (JP); **Takao Yokoshima**, Tokyo (JP)
- (73) Assignees: **Mitsubishi Cable Industries, Ltd.**, Tokyo (JP); **Mitsubishi Materials 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 833 days.
- (21) Appl. No.: **12/667,614**
- (22) PCT Filed: **Jul. 3, 2008**
- (86) PCT No.: **PCT/JP2008/001755**
§ 371 (c)(1),
(2), (4) Date: **Jan. 4, 2010**
- (87) PCT Pub. No.: **WO2009/004811**
PCT Pub. Date: **Jan. 8, 2009**
- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
Jul. 5, 2007 (JP) 2007-176941
Jul. 5, 2007 (JP) 2007-176942
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702; 343/860**

(58) **Field of Classification Search**
USPC 343/702, 850, 860, 846, 745, 749,
343/866
See application file for complete search history.

(56) **References Cited**
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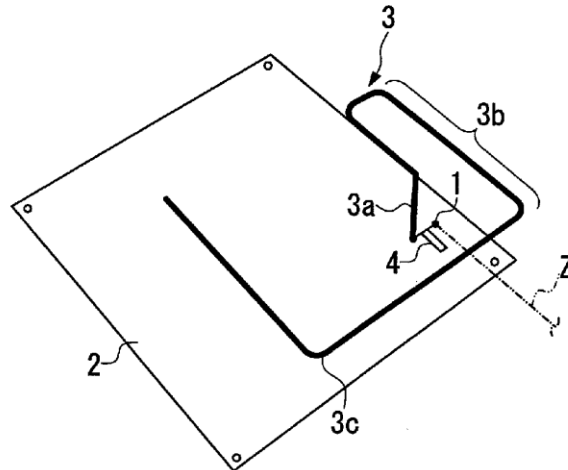
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Primary Examiner — Robert Karacsony
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Carter, DeLuca, Farrell & Schmidt, LLP

(57) **ABSTRACT**
An antenna element has an upstanding section erected from a base member; a tuning section extended from the upper end of the upstanding section into one direction in a parallel plane parallel to the base member, bent in the middle, and then extended in the direction opposite the one direction; and an open element section extended from the front end of the tuning section in the direction in which the open element section spirally turns in the parallel plane about the upstanding section.

10 Claims, 22 Drawing Sheets





US008525737B2

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

(10) **Patent No.:** **US 8,525,737 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **ANTENNA ASSEMBLY AND PORTABLE TERMINAL HAVING THE SAME**

(75) Inventors: **Sungjung Rho**, Seoul (KR); **Jaegon Lee**, Seoul (KR); **Ansun Hyun**, Seoul (KR); **Yochuol Ho**, Seongnam (KR); **Euntaek Jeong**, Anyang (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 384 days.

(21) Appl. No.: **12/875,604**

(22) Filed: **Sep. 3, 2010**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Sep. 4, 2009 (KR) 10-2009-0083659

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

(52) **U.S. Cl.**
USPC **343/702; 343/909**

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 909, 749, 846
See application file for complete search history.

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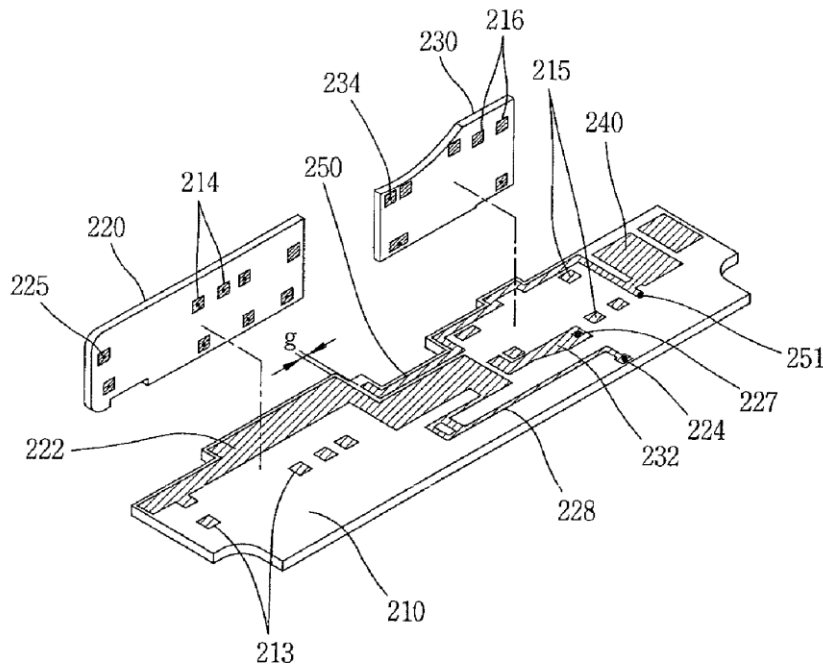
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — KED & Associates, LLP

(57) **ABSTRACT**

An antenna assembly includes a patch coupled to a first board, a conductive pattern coupled to a second board, a first connector electrically coupled to the patch, and a second connector to couple the conductive pattern to a circuit of the first board. The patch has a first section adjacent a first surface and a second section adjacent an opposing second surface of the second board, and the first connector electrically couples the first section to the second section of the patch. The assembly may include a plurality of antennas, and portable terminal may use the assembly to communicate in different frequency bands.

18 Claims, 8 Drawing Sheets





US008525738B2

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

(10) **Patent No.:** **US 8,525,738 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **WIRELESS COMMUNICATION DEVICE AND METHOD THEREOF**

(75) Inventors: **Wei-Yang Wu**, Taoyuan County (TW);
Hsiao-Chuan Lin, Taoyuan County (TW)

(73) Assignee: **HTC Corporation**, Taoyuan County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 434 days.

(21) Appl. No.: **12/879,021**

(22) Filed: **Sep. 10, 2010**

(65) **Prior Publication Data**
US 2011/0194589 A1 Aug. 11, 2011

(30) **Foreign Application Priority Data**
Feb. 11, 2010 (TW) 99104483 A

(51) **Int. Cl.**
H01B 1/24 (2006.01)

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

(58) **Field of Classification Search**
USPC 343/702, 901
See application file for complete search history.

(56) **References Cited**

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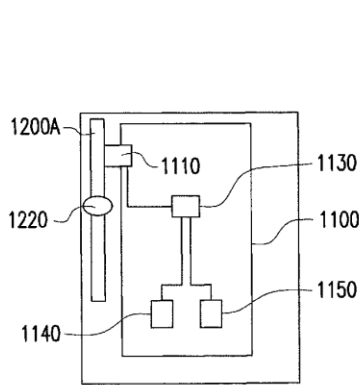
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

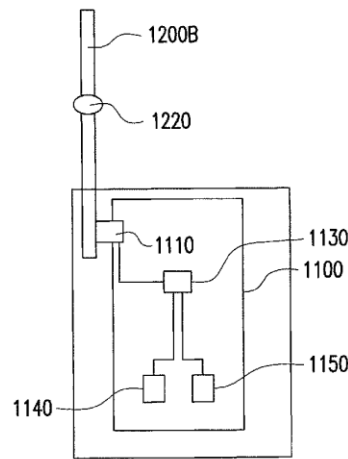
(57) **ABSTRACT**

A wireless communication device including a system ground plane and a retractable antenna is provided. The system ground plane includes a feed point. When the retractable antenna is configured to be a first length, the wireless communication device transceives a first signal of a first bandwidth through the retractable antenna for a first radio frequency system. When the retractable antenna is configured to be a second length, the wireless communication device transceives the first signal and a second signal of a second bandwidth through the retractable antenna respectively for the first radio frequency system and the second radio frequency system. A center frequency of the first bandwidth range is substantially a first odd multiple of a reference frequency, and a center frequency of the second bandwidth range is substantially a second odd multiple of the reference frequency, and the first odd multiple is different to the second odd multiple.

14 Claims, 8 Drawing Sheets



1000



1000



US008525739B2

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

(10) **Patent No.:** **US 8,525,739 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **ANTENNA DEVICE AND PORTABLE TERMINAL HAVING THE SAME**

(75) Inventors: **Jaegon Lee**, Seoul (KR); **Ansun Hyun**, Seoul (KR); **Euntaek Jeoung**, Gyeonggi-Do (KR); **Yochuol Ho**, Gyeonggi-Do (KR); **Viktor Kalinichev**, Moscow (RU)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 366 days.

(21) Appl. No.: **12/908,790**

(22) Filed: **Oct. 20, 2010**

(65) **Prior Publication Data**

US 2011/0128192 A1 Jun. 2, 2011

(30) **Foreign Application Priority Data**

Dec. 2, 2009 (KR) 10-2009-0118688

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

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

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 909
See application file for complete search history.

(56) **References Cited**

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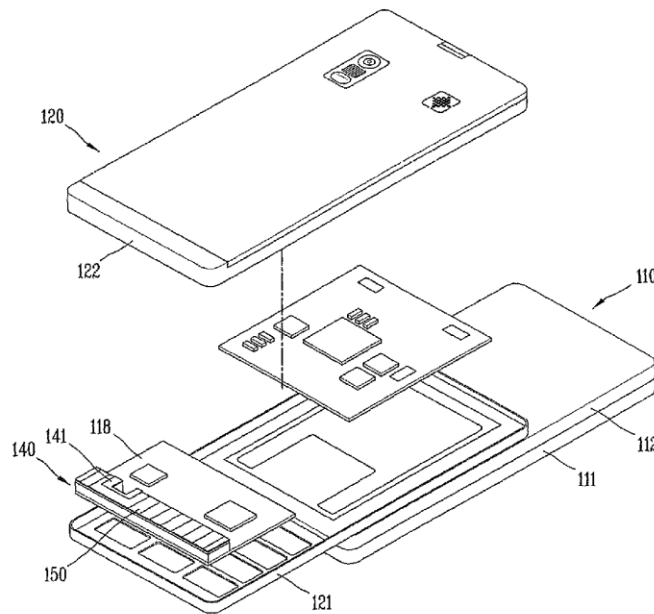
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Disclosed are an antenna device and a portable terminal having the same. The portable terminal includes a terminal body, a radiator including a conductive material, and configured in a preset pattern to transmit or receive wireless signals, a circuit board mounted to the terminal body, and configured to process the wireless signal by being electrically connected to the radiator, and an artificial magnetic conductor module disposed near the radiator, and configured to reflect the wireless signal.

15 Claims, 12 Drawing Sheets





US008525740B2

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

(10) **Patent No.:** **US 8,525,740 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **MOBILE TERMINAL**

(75) Inventors: **Yoonsuk Jeong**, Gyeonggi-Do (KR);
Wooyoung Choi, Gyeonggi-Do (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 350 days.

(21) Appl. No.: **12/939,907**

(22) Filed: **Nov. 4, 2010**

(65) **Prior Publication Data**

US 2011/0156962 A1 Jun. 30, 2011

(30) **Foreign Application Priority Data**

Dec. 30, 2009 (KR) 10-2009-0134762

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

(52) **U.S. Cl.**
USPC **343/702**; 343/846; 343/848

(58) **Field of Classification Search**
USPC 343/702, 846, 848
See application file for complete search history.

(56) **References Cited**

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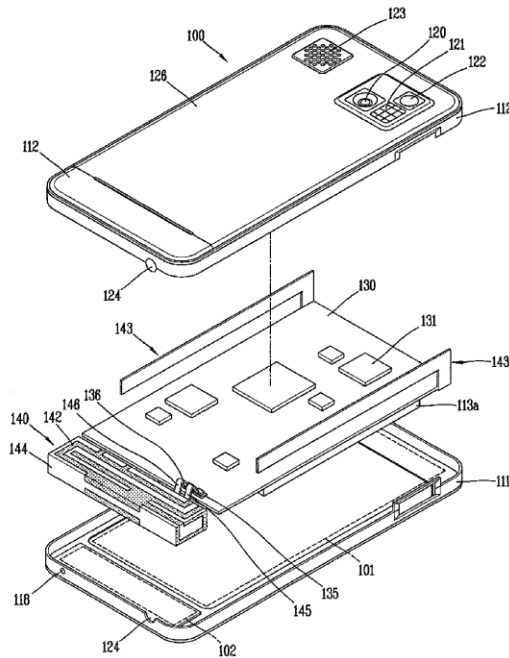
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

According to an embodiment of the present invention, the mobile terminal includes, a terminal body, a printed circuit board (PCB) mounted in the interior of the terminal body, and an internal antenna connected to the PCB, and configured to transmit and receive signals, wherein the internal antenna includes a ground formed on the PCB, a radiator connected to the ground and configured to be operable at a first band, and to feed the signals to the PCB, and a ground extension part extending in at least one direction from the ground, and configured to expand a ground surface of the ground in order for the internal antenna to include a second band, which is lower than a first band, as an operation band.

18 Claims, 13 Drawing Sheets





US008525742B2

(12) **United States Patent**
Yang

(10) **Patent No.:** **US 8,525,742 B2**
(45) **Date of Patent:** ***Sep. 3, 2013**

(54) **COMPACT MULTI-ELEMENT ANTENNA WITH PHASE SHIFT**

(71) Applicant: **Airgain, Inc.**, Carlsbad, CA (US)

(72) Inventor: **Xiao Ping Yang**, Carlsbad, CA (US)

(73) Assignee: **Airgain, Inc.**, Carlsbad, 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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/674,928**

(22) Filed: **Nov. 12, 2012**

(65) **Prior Publication Data**

US 2013/0063306 A1 Mar. 14, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/329,895, filed on Dec. 19, 2011, now Pat. No. 8,310,402, which is a continuation of application No. 11/866,354, filed on Oct. 2, 2007, now Pat. No. 8,081,123.

(60) Provisional application No. 60/827,846, filed on Oct. 2, 2006.

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

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

(58) **Field of Classification Search**
USPC **343/702, 700 MS, 893, 876**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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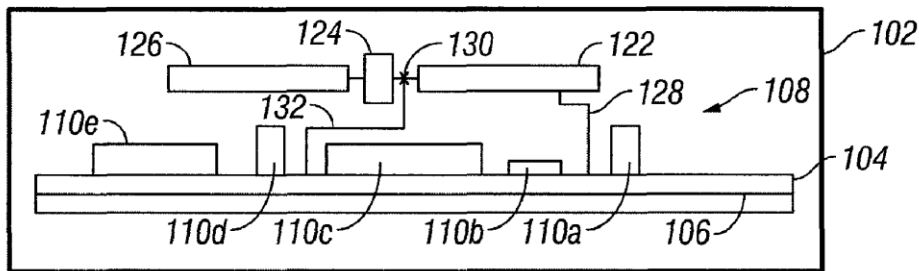
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Clause Eight IPS; Michael Catania

(57) **ABSTRACT**

A phased array antenna system includes a first radiation element that is made of a material and has a length selected to resonate at a desired frequency. A phase-shift element is coupled to one end of the first radiation element. A second radiation element is coupled to the end of the phase-shift element opposite the first radiation element, so that a radio signal passes through the first radiation element through the phase-shift element and through the second radiation element, the second radiation element is made of a material and has a length selected to resonate such that the first and second radiation elements cooperate to form a desired beam pattern from the antenna system.

11 Claims, 10 Drawing Sheets





US008525743B2

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

(10) **Patent No.:** **US 8,525,743 B2**
(45) **Date of Patent:** ***Sep. 3, 2013**

(54) **ANTENNA WITH NEAR-FIELD RADIATION CONTROL**

(71) Applicant: **Research In Motion Limited**, Waterloo (CA)

(72) Inventors: **Yihong Qi**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Adam D. Stevenson**, Waterloo (CA)

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario

(*) 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.: **13/686,518**

(22) Filed: **Nov. 27, 2012**

(65) **Prior Publication Data**
US 2013/0082892 A1 Apr. 4, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/529,531, filed on Jun. 21, 2012, now Pat. No. 8,339,323, which is a continuation of application No. 13/358,126, filed on Jan. 25, 2012, now Pat. No. 8,223,078, which is a continuation of application No. 13/156,728, filed on Jun. 9, 2011, now Pat. No. 8,125,397, which is a continuation of application No. 12/474,075, filed on May 28, 2009, now Pat. No. 7,961,154, which is a continuation of application No. 11/774,383, filed on Jul. 6, 2007, now Pat. No. 7,541,991, which is a continuation of application No. 10/940,869, filed on Sep. 14, 2004, now Pat. No. 7,253,775, which is a continuation of application No. 10/317,659, filed on Dec. 12, 2002, now Pat. No. 6,791,500.

(51) **Int. Cl.**
H01Q 1/12 (2006.01)

(52) **U.S. Cl.**
USPC **343/702**; 343/795; 343/803; 343/818; 343/833

(58) **Field of Classification Search**
USPC 343/702, 795, 803, 818, 833
See application file for complete search history.

(56) **References Cited**

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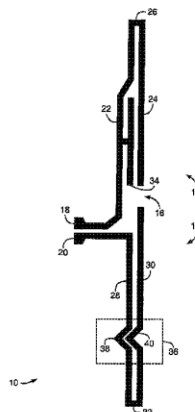
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Jones Day

(57) **ABSTRACT**

An antenna and a wireless mobile communication device incorporating the antenna are provided. The antenna includes a first conductor section electrically coupled to a first feeding point, a second conductor section electrically coupled to a second feeding point, and a near-field radiation control structure adapted to control characteristics of near-field radiation generated by the antenna. Near-field radiation control structures include a parasitic element positioned adjacent the first conductor section and configured to control characteristics of near-field radiation generated by the first conductor section, and a diffuser in the second conductor section configured to diffuse near-field radiation generated by the second conductor section into a plurality of directions.

32 Claims, 4 Drawing Sheets





US008525749B2

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

(10) **Patent No.:** **US 8,525,749 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **GROUND STRUCTURE OF ANTENNA OF MOBILE TERMINAL**

(75) Inventors: **Han Min Cho**, Yongin-si (KR); **Sang Moo Cha**, Suwon-si (KR); **Yong Tae Kim**, Hwaseong-si (KR); **Ung Ryeol Lee**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 356 days.

(21) Appl. No.: **12/860,983**

(22) Filed: **Aug. 23, 2010**

(65) **Prior Publication Data**
US 2011/0050533 A1 Mar. 3, 2011

(30) **Foreign Application Priority Data**
Aug. 28, 2009 (KR) 10-2009-0080754

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

(52) **U.S. Cl.**
USPC **343/848**; 343/702; 343/846

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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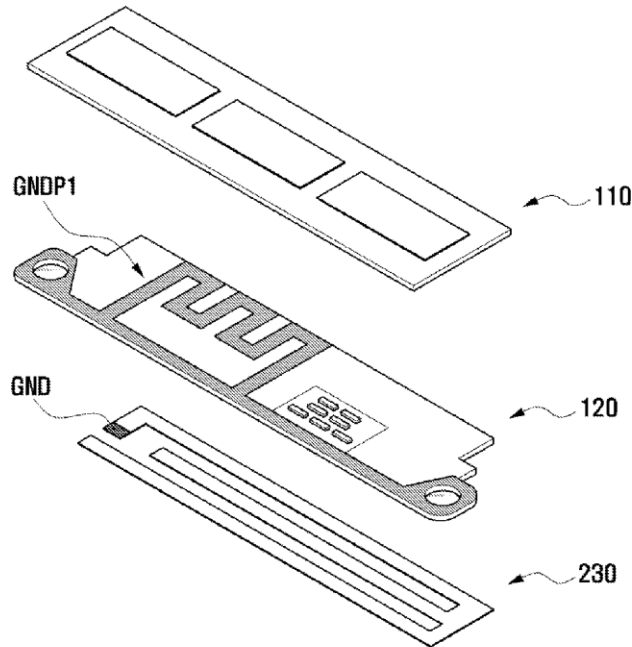
Primary Examiner — Anh Tran

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An antenna ground structure of a mobile terminal is disclosed. The antenna ground structure of a mobile terminal is arranged to provide the ground pattern on a Printed Circuit Board (PCB) adjacent to the antenna and to electrically connect the ground pattern to the ground unit of the antenna, so that the area of the ground of the antenna may be expanded to improve Specific Absorption Rate (SAR) and communication performance.

11 Claims, 5 Drawing Sheets





US008525750B2

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

(10) **Patent No.:** **US 8,525,750 B2**
(45) **Date of Patent:** **Sep. 3, 2013**

(54) **VARYING ANGLE ANTENNA FOR ELECTROMAGNETIC RADIATION DISSIPATION DEVICE**

(75) Inventors: **Kevin B. Tucek**, McKinney, TX (US);
Steven C. Shanks, McKinney, TX (US)

(73) Assignee: **Erchonia Corporation**, McKinney, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 349 days.

(21) Appl. No.: **13/094,166**

(22) Filed: **Apr. 26, 2011**

(65) **Prior Publication Data**

US 2011/0193767 A1 Aug. 11, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/868,287, filed on Aug. 25, 2010, now Pat. No. 7,973,736, which is a continuation of application No. 12/215,231, filed on Jun. 26, 2008, now Pat. No. 7,800,554.

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

(52) **U.S. Cl.**
USPC **343/895**; 343/700 MS; 343/702

(58) **Field of Classification Search**
USPC 343/895, 700 MS, 702
See application file for complete search history.

(56) **References Cited**

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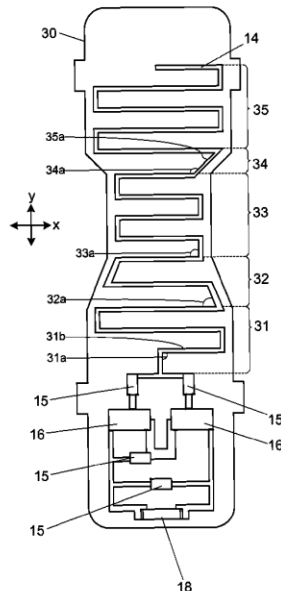
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Etherton Law Group, LLC

(57) **ABSTRACT**

A varying angle antenna design can be used with an electromagnetic radiation dissipation device to reduce exposure to electromagnetic radiation. The antenna captures radiation from an active emission source, such as a cellular telephone as it transmits. The device converts the captured radiation into an electric current and dissipates the collected current by spending it to operate a thermal, mechanical, or electrical device. The varying angle antenna is a printed circuit board trace antenna comprising a microstrip having several serially connected meandering segments. One or more meandering segments include 90-degree bends in the microstrip, and one or more meandering segments include bends of more and less than 90 degrees. Portions of the microstrip that are horizontally oriented are all parallel, while portions of the microstrip that are vertically oriented can be parallel or angled, depending on the bend angle. Near the center of the antenna, the microstrip segments are narrower.

20 Claims, 4 Drawing Sheets





US008531252B2

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

(10) **Patent No.:** **US 8,531,252 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

- (54) **ANTENNA DUPLEXER AND COMMUNICATION APPARATUS EMPLOYING THE SAME**
- (75) Inventors: **Hiroyuki Nakamura**, Osaka (JP); **Tetsuya Tsurunari**, Osaka (JP); **Joji Fujiwara**, Osaka (JP)
- (73) Assignee: **Panasonic Corporation**, Osaka (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 719 days.
- (21) Appl. No.: **12/668,699**
- (22) PCT Filed: **Jul. 8, 2008**
- (86) PCT No.: **PCT/JP2008/001815**
§ 371 (c)(1),
(2), (4) Date: **Jan. 12, 2010**
- (87) PCT Pub. No.: **WO2009/011101**
PCT Pub. Date: **Jan. 22, 2009**
- (65) **Prior Publication Data**
US 2010/0188165 A1 Jul. 29, 2010
- (30) **Foreign Application Priority Data**
Jul. 13, 2007 (JP) 2007-183962
- (51) **Int. Cl.**
H03H 9/70 (2006.01)
H04B 1/48 (2006.01)
- (52) **U.S. Cl.**
USPC **333/133; 333/129; 333/132; 455/82; 455/83; 455/552.1**

(58) **Field of Classification Search**
USPC 333/126, 129, 132, 133; 455/78, 455/82, 83, 552.1
See application file for complete search history.

- (56) **References Cited**
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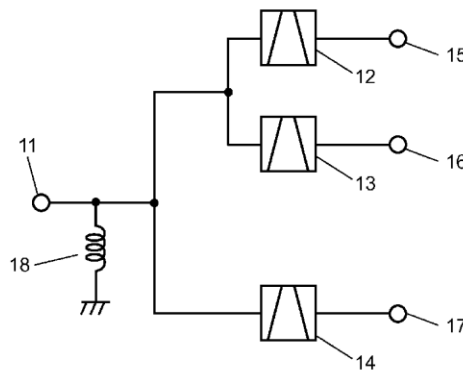
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Primary Examiner — Barbara Summons
(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**
A small antenna duplexer that includes antenna terminal, first filter electrically connected to this antenna terminal and passing a first frequency band, second filter electrically connected to antenna terminal and passing a second frequency band, and third filter electrically connected to antenna terminal and passing a third frequency band. First filter and third filter are used for one band, and second filter and third filter are used for another band.

15 Claims, 9 Drawing Sheets





US008531337B2

(12) **United States Patent**
Soler Castany et al.

(10) **Patent No.:** **US 8,531,337 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

- (54) **ANTENNA DIVERSITY SYSTEM AND SLOT ANTENNA COMPONENT**
- (75) Inventors: **Jordi Soler Castany**, Mataró (ES); **José Mumburu Forn**, 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 1008 days.
- (21) Appl. No.: **11/914,178**
- (22) PCT Filed: **May 12, 2006**
- (86) PCT No.: **PCT/EP2006/062285**
§ 371 (c)(1),
(2), (4) Date: **Nov. 12, 2007**
- (87) PCT Pub. No.: **WO2006/120250**
PCT Pub. Date: **Nov. 16, 2006**
- (65) **Prior Publication Data**
US 2008/0198082 A1 Aug. 21, 2008

Related U.S. Application Data

- (60) Provisional application No. 60/680,693, filed on May 13, 2005, provisional application No. 60/778,323, filed on Mar. 2, 2006.

Foreign Application Priority Data

- (30) May 13, 2005 (EP) 05104026
Feb. 27, 2006 (EP) 06110437

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702; 343/767**

- (58) **Field of Classification Search**
USPC 343/700 MS, 767, 770, 893, 702, 343/846
See application file for complete search history.

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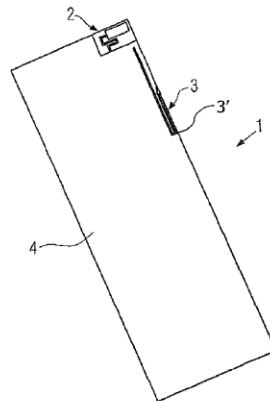
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Primary Examiner — Michael C Wimer
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Kenyon & Kenyon LLP

(57) **ABSTRACT**

The present invention refers to an antenna diversity system comprising at least a first antenna and a second antenna wherein the first antenna substantially behaves as an electric current source or as a magnetic current source, and the second antenna substantially behaves as an electric current source or as a magnetic current source and a corresponding wireless device. Further the invention relates to an SMT-type slot-antenna component comprising at least one conductive surface or sheet of metal in which the pattern of a slot is created, at least one contact terminal accessible from the exterior of said component to electrically connect the conductive surface included in the slot-antenna component with the ground plane of a circuit board such as a printed circuit board and a corresponding wireless device.

110 Claims, 26 Drawing Sheets





US008531338B2

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

(10) **Patent No.:** **US 8,531,338 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

(54) **WIRELESS COMMUNICATION DEVICE**

(75) Inventors: **Chin-Hung Ma**, Taoyuan (TW);
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(73) Assignee: **FIH (Hong Kong) Limited**, Kowloon
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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 576 days.

(21) Appl. No.: **12/819,291**

(22) Filed: **Jun. 21, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 25, 2009 (TW) 98144871 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 3/24 (2006.01)

H01Q 1/50 (2006.01)

(52) **U.S. Cl.**

USPC **343/702**; 343/876; 343/906

(58) **Field of Classification Search**

USPC 343/702, 872, 876, 906; 455/572.1,
455/572.3, 572.4, 572.7

See application file for complete search history.

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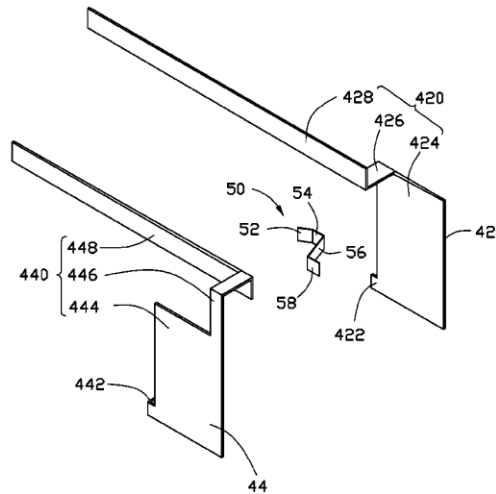
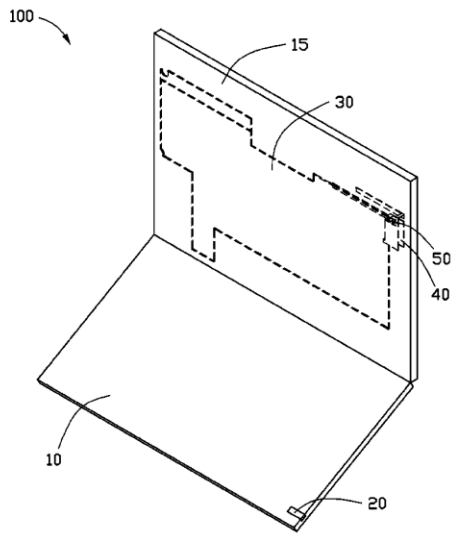
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

A wireless communication device includes a main body, a cover, a base board, an elastic member, and an antenna module. The cover is attached to the main body. The base board includes a feeding point and a grounding point. The elastic member is connected to one of the feeding point and the grounding point. The antenna module includes a first antenna and a second antenna connected to the other feeding point and the grounding point of the base board. The base board, the elastic and the antenna module are mounted in the cover. The elastic member selectively causes the first antenna or the second antenna to contact to the one of the feeding points and the grounding point of the base board when in an open or closed state.

20 Claims, 7 Drawing Sheets





US008531339B2

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

(10) **Patent No.:** **US 8,531,339 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

(54) **HAND-HELD ELECTRONIC DEVICE**

(75) Inventors: **Lin-Chin Huang**, Taoyuan County (TW); **Chia-Yan Hsu**, Taoyuan County (TW); **Kuo-Chuan Liao**, Taoyuan County (TW); **Ming-Chun Huang**, Taoyuan County (TW)

(73) Assignee: **HTC Corporation**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 246 days.

(21) Appl. No.: **13/015,881**

(22) Filed: **Jan. 28, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 1, 2010 (TW) 99117548 A

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

(52) **U.S. Cl.**
USPC **343/702**; 343/904

(58) **Field of Classification Search**
USPC 343/702, 904; 455/575.1, 575.8; 379/433.01, 433.08

See application file for complete search history.

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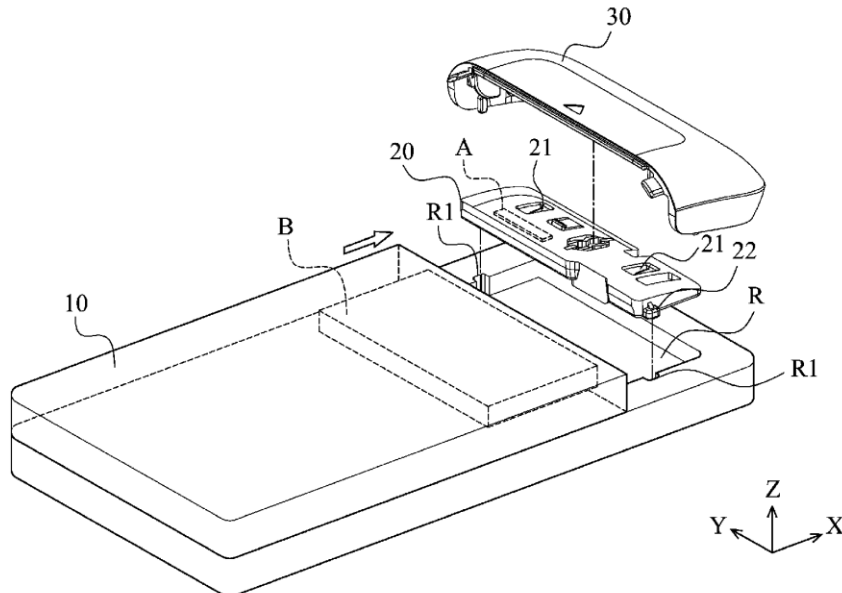
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An electronic device is provided, including a main body, a battery detachably received in the main body, a stopper disposed in a predetermined position to restrict the battery in the main body, an antenna disposed on the stopper, and a cover connected with the stopper and movable relative to the stopper between a first position and a second position. When the cover is in the first position, the cover is engaged with the main body and restricts the stopper in the predetermined position. When the cover is moved from the first position along a first direction to the second position, the cover is disengaged from the main body, and the stopper is releasable from the predetermined position along a second direction.

10 Claims, 4 Drawing Sheets





US008531340B2

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

(10) **Patent No.:** **US 8,531,340 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

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

(75) Inventors: **Tiao-Hsing Tsai**, New Taipei (TW);
Chao-Hsu Wu, Luzhu Township,
Taoyuan County (TW); **Yuan-Chang**
Chao, Dayuan Township, Taoyuan
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(TW)

(73) Assignee: **Quanta Computer, Inc.**, Tao Yuan Hsien
(TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 230 days.

(21) Appl. No.: **13/099,992**

(22) Filed: **May 3, 2011**

(65) **Prior Publication Data**
US 2012/0146858 A1 Jun. 14, 2012

(30) **Foreign Application Priority Data**
Dec. 13, 2010 (TW) 99143470 A

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

(52) **U.S. Cl.**
USPC **343/702**

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 129, 810, 793
See application file for complete search history.

(56) **References Cited**

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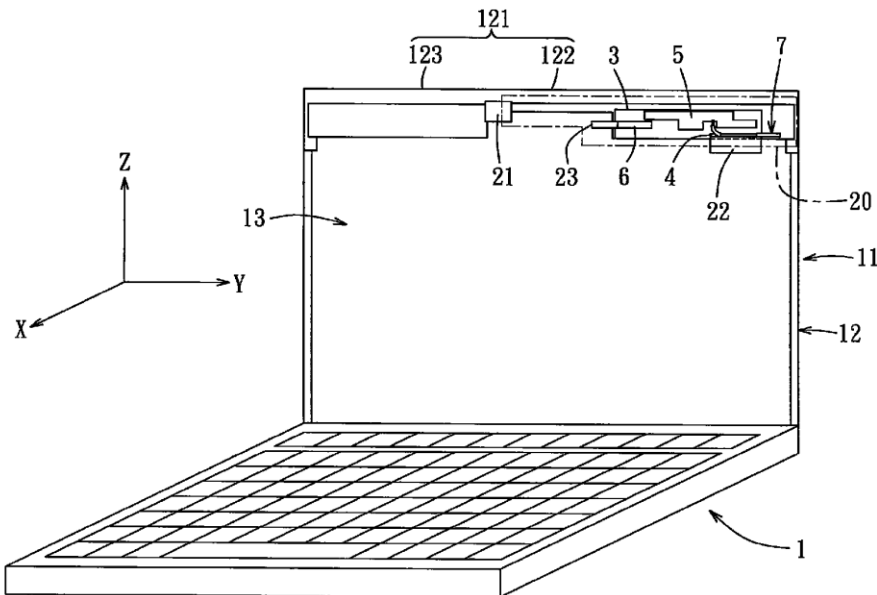
Primary Examiner — Thien M Le

(74) *Attorney, Agent, or Firm* — Brinks Hofer Gilson &
Lione

(57) **ABSTRACT**

A multi-band antenna module is disposed in a housing of an electronic device. The housing has a grounding plane disposed therein and includes a metal frame part having two ends electrically connected to opposite side edges of the grounding plane. The multi-band antenna module includes a conductor, a substrate, a grounding section, and a first radiator section. The conductor is to be coupled across the metal frame part and the grounding plane so as to cooperate with the grounding plane and a portion of the metal frame part to form a closed loop thereamong, in which the substrate is disposed. The first radiator section and the grounding section are disposed on the substrate, with the grounding section to be coupled electrically to the grounding plane. A portion of the first radiator section is disposed to cooperate with the closed loop to resonate in a first frequency band. Another portion of the first radiator section is disposed to cooperate with the grounding section to resonate in a second frequency band.

9 Claims, 8 Drawing Sheets





US008531341B2

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

(10) **Patent No.:** **US 8,531,341 B2**
(45) **Date of Patent:** ***Sep. 10, 2013**

(54) **ANTENNA ISOLATION FOR PORTABLE ELECTRONIC DEVICES**

(75) Inventors: **Robert W. Schlub**, Santa Clara, CA (US); **Robert J. Hill**, Salinas, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, 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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/418,655**

(22) Filed: **Mar. 13, 2012**

(65) **Prior Publication Data**

US 2012/0169550 A1 Jul. 5, 2012

Related U.S. Application Data

(63) Continuation of application No. 13/073,872, filed on Mar. 28, 2011, now Pat. No. 8,144,063, which is a continuation of application No. 11/969,684, filed on Jan. 4, 2008, now Pat. No. 7,916,089.

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

(52) **U.S. Cl.**
USPC **343/702**

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 833-835
See application file for complete search history.

(56) **References Cited**

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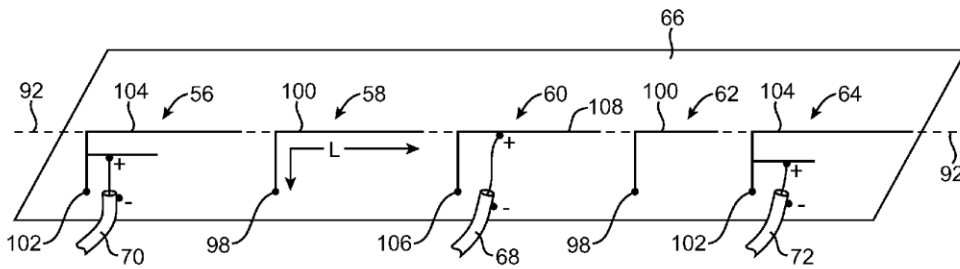
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

Portable electronic devices are provided with wireless circuitry that includes antennas and antenna isolation elements. The antennas may include antennas that have multiple arms and that are configured to handle communications in multiple frequency bands. The antennas may also include one or more antennas that are configured to handle communications in a single frequency band. The antennas may be coupled to different radio-frequency transceivers. For example, there may be first, second, and third antennas and first and second transceivers. The first and third antennas may be coupled to the first transceiver and the second antenna may be coupled to the second transceiver. The antenna isolation elements may be interposed between the antennas and may serve to reduce radio-frequency interference between the antennas. There may be a first antenna isolation element between the first and second antennas and a second antenna isolation element between the second and third antennas.

19 Claims, 16 Drawing Sheets





US008531342B2

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

(10) **Patent No.:** **US 8,531,342 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

(54) **ANTENNA DEVICE OF MOBILE TERMINAL**

(75) Inventors: **Sang Bong Sung**, Gyeongsangbuk-do (KR); **In Jin Hwang**, Gyeongsangbuk-do (KR); **Seung Hwan Kim**, Gyeonggi-do (KR); **Jae Ho Lee**, Gyeonggi-do (KR)

(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 0 days.

(21) Appl. No.: **13/458,453**

(22) Filed: **Apr. 27, 2012**

(65) **Prior Publication Data**

US 2012/0212378 A1 Aug. 23, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/489,044, filed on Jun. 22, 2009, now Pat. No. 8,188,930.

(30) **Foreign Application Priority Data**

Jun. 20, 2008 (KR) 10-2008-0058619

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

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

(58) **Field of Classification Search**

USPC 343/702, 700 MS
See application file for complete search history.

(56) **References Cited**

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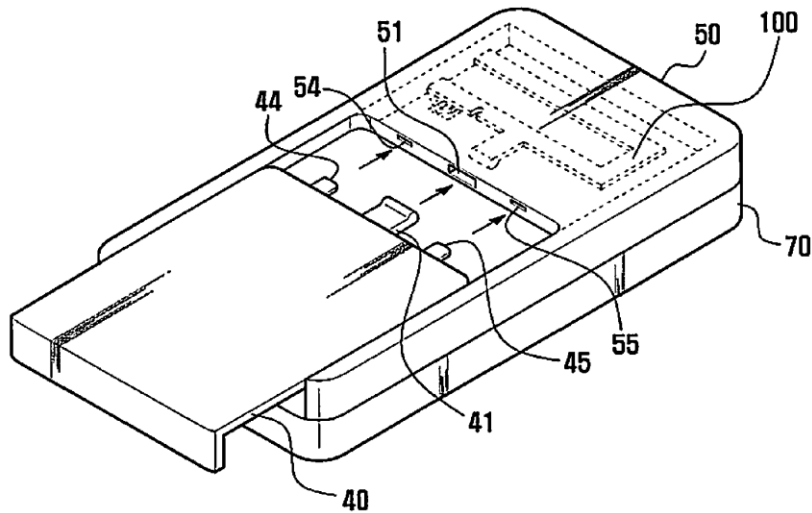
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An antenna device of a mobile terminal that can secure radiation performance is provided. The antenna device having a battery cover composed of a metal material includes a radiation unit for transmitting and receiving a signal, a feeding unit formed at an end portion of a first side of the radiation unit for electrically connecting the radiation unit to a Printed Circuit Board (PCB), and a ground part disposed a predetermined distance from the feeding unit and formed at a second side of the radiation unit. When the battery cover is fastened to the mobile terminal, the ground part contacts a first side of the battery cover.

12 Claims, 7 Drawing Sheets





US008531348B2

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

(10) **Patent No.:** **US 8,531,348 B2**
(45) **Date of Patent:** **Sep. 10, 2013**

- (54) **ELECTRONIC DEVICE WITH EMBEDDED ANTENNA**
- (75) Inventors: **Min-Chung Wu**, Taoyuan County (TW); **Shao-Chin Lo**, Miaoli (TW)
- (73) Assignee: **Ralink Technology Corp.**, Jhubei, Hsinchu County (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 378 days.

(21) Appl. No.: **12/894,191**

(22) Filed: **Sep. 30, 2010**

(65) **Prior Publication Data**
US 2011/0080333 A1 Apr. 7, 2011

(30) **Foreign Application Priority Data**
Oct. 6, 2009 (TW) 98133844 A
Nov. 26, 2009 (TW) 98140322 A

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
(52) **U.S. Cl.**
USPC **343/906**; 343/873; 343/700 MS;
343/702; 343/846; 439/916

(58) **Field of Classification Search**
None
See application file for complete search history.

- (56) **References Cited**
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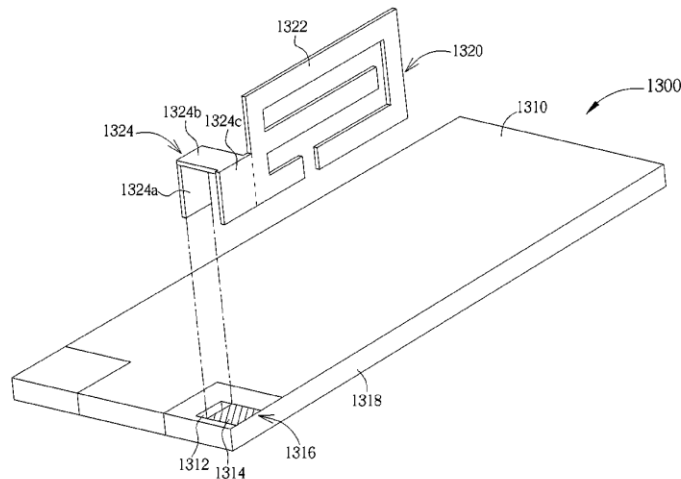
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Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(57) **ABSTRACT**
An electronic device with an embedded three-dimensional antenna is disclosed. The electronic device includes a printed circuit board (PCB) and an embedded three-dimensional antenna. The embedded three-dimensional antenna includes a radiation element and a connection element. The connection element includes a first connection part and a second connection part. The first and second connection parts are coupled to the PCB, and utilized for transferring signals of the embedded three-dimensional antenna to the PCB. The first and second connection parts further clamp the PCB to attach the embedded three-dimensional antenna on the PCB.

11 Claims, 17 Drawing Sheets





US008537052B2

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

(10) **Patent No.:** **US 8,537,052 B2**
(45) **Date of Patent:** **Sep. 17, 2013**

(54) **ANTENNA AND ELECTRONIC DEVICE
EQUIPPED WITH THE SAME**

(75) Inventors: **Nagahisa Furutani**, Kawasaki (JP);
Manabu Kai, Kawasaki (JP); **Satoru
Nogami**, Inagi (JP)

(73) Assignees: **Fujitsu Limited**, Kawasaki (JP); **Fujitsu
Frontech Limited**, Inagi (JP)

(*) Notice: Subject to any disclaimer, the term of this
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(21) Appl. No.: **12/696,527**

(22) Filed: **Jan. 29, 2010**

(65) **Prior Publication Data**
US 2010/0214188 A1 Aug. 26, 2010

(30) **Foreign Application Priority Data**
Feb. 24, 2009 (JP) 2009-041470

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

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

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

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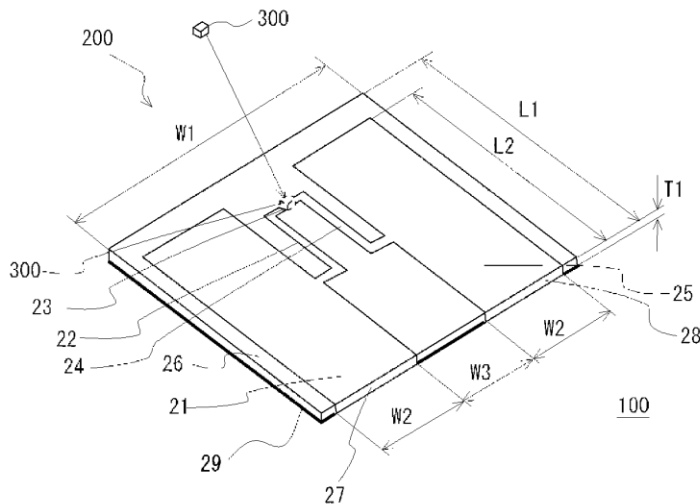
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Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Westerman, Hattori,
Daniels & Adrian, LLP

(57) **ABSTRACT**

An antenna includes a dielectric substrate, a ground electrode
provided on a first surface of the dielectric substrate, a first
antenna element and a second antenna elements provided to a
second surface of the dielectric substrate, the first and second
antenna elements having an identical resonance frequency
and an identical Q value, a transmission line connecting the
first and second antenna elements, and a feed part provided in
the transmission line.

2 Claims, 20 Drawing Sheets





US008537054B2

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

(10) **Patent No.:** **US 8,537,054 B2**
(45) **Date of Patent:** **Sep. 17, 2013**

(54) **ANTENNA WITH MULTIPLE RESONATING CONDITIONS**

(75) Inventors: **Li-Jean Yen**, Hsinchu (TW); **Chia-Tien Li**, Hsinchu (TW)

(73) Assignee: **Wistron NeWeb Corporation**, Hsinchu Science Park, Hsinchu (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.: **13/196,878**

(22) Filed: **Aug. 2, 2011**

(65) **Prior Publication Data**
US 2012/0299779 A1 Nov. 29, 2012

(30) **Foreign Application Priority Data**
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(51) **Int. Cl.**
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(52) **U.S. Cl.**
USPC **343/700 MS; 343/846**

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

(56) **References Cited**

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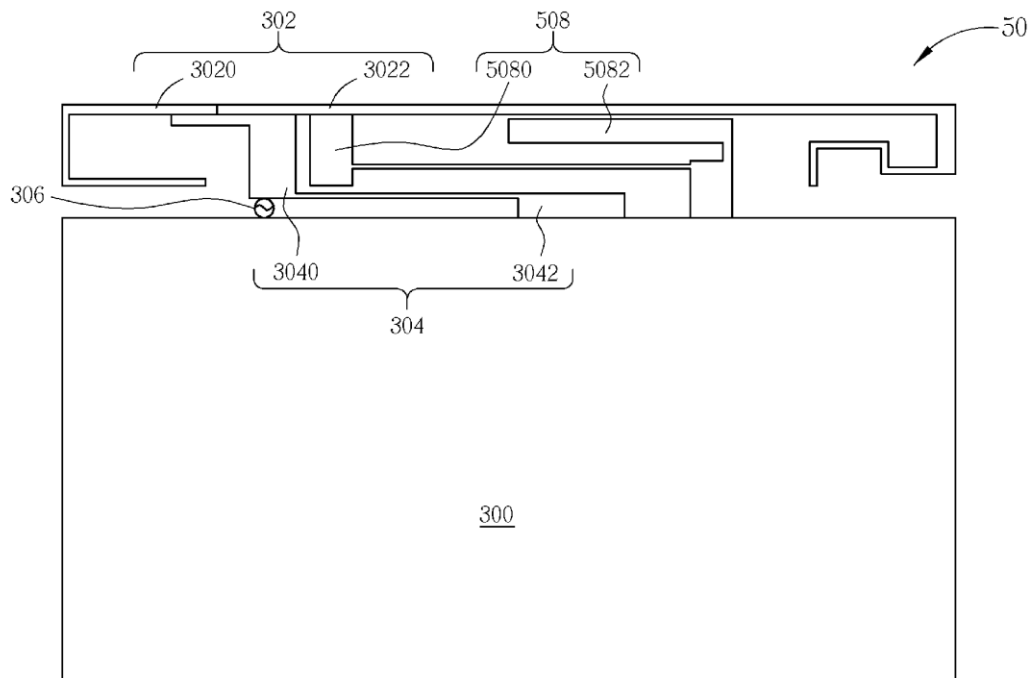
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna with multiple resonating conditions includes a grounding element electrically connected to a ground, a radiating element, a connection element electrically connected between the grounding element and the radiating element, a feed-in element electrically connected between the connection element and the grounding element for receiving feed-in signals, and a radiating-condition generating element electrically connected to the grounding element and extending from the grounding element to the radiating element.

12 Claims, 10 Drawing Sheets





US008537055B2

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

(10) **Patent No.:** **US 8,537,055 B2**
(45) **Date of Patent:** **Sep. 17, 2013**

(54) **PORTABLE ELECTRONIC DEVICE AND
MAGNETIC ANTENNA CIRCUIT**

(75) Inventors: **Kenji Waku**, Kanagawa (JP); **Tadashi Koyama**, Kanagawa (JP); **Masayuki Saito**, Kanagawa (JP); **Yasuhiro Katayama**, Kanagawa (JP); **Katsuji Morishita**, Kanagawa (JP); **Shinobu Kato**, Kanagawa (JP)

(73) Assignee: **Kyocera Corporation**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 994 days.

(21) Appl. No.: **12/528,970**

(22) PCT Filed: **Feb. 27, 2008**

(86) PCT No.: **PCT/JP2008/053449**

§ 371 (c)(1),

(2), (4) Date: **Oct. 28, 2009**

(87) PCT Pub. No.: **WO2008/105477**

PCT Pub. Date: **Sep. 4, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 27, 2007 (JP) 2007-047727

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

(52) **U.S. Cl.**
USPC **343/702; 343/850; 343/895**

(58) **Field of Classification Search**

USPC 343/702, 850, 860, 895
See application file for complete search history.

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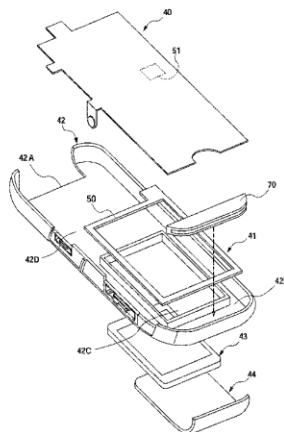
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Procopio, Cory, Hargreaves & Savitch LLP

(57) **ABSTRACT**

A portable electronic device and a magnetic field antenna circuit are provided for making it possible to keep an antenna resonance frequency in a fixed range even if temperature changes. A mobile telephone device (1) is provided with a second communication unit driven by a chargeable battery (43) to execute a predetermined function and an RFID unit (41) accompanied with magnetic communication. The RFID unit (41) includes a magnetic antenna unit (50), which can transmit or receive a wireless signal by a magnetic field, and a capacitor (52), one terminal of which is connected with the magnetic antenna unit (50) to generate a predetermined resonance frequency. The capacitor (52) is characterized in having a temperature-reactance characteristic reverse to an amount of an inductance value that fluctuates as the magnetic antenna unit (50) changes in accordance with temperatures.

16 Claims, 25 Drawing Sheets





US008537056B2

(12) **United States Patent**
Ho

(10) **Patent No.:** **US 8,537,056 B2**
(45) **Date of Patent:** **Sep. 17, 2013**

(54) **ANTENNA AND PORTABLE DEVICE EMPLOYING THE SAME**

(75) Inventor: **Chin-Lung Ho**, Taipei Hsien (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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(58) **Field of Classification Search**
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See application file for complete search history.

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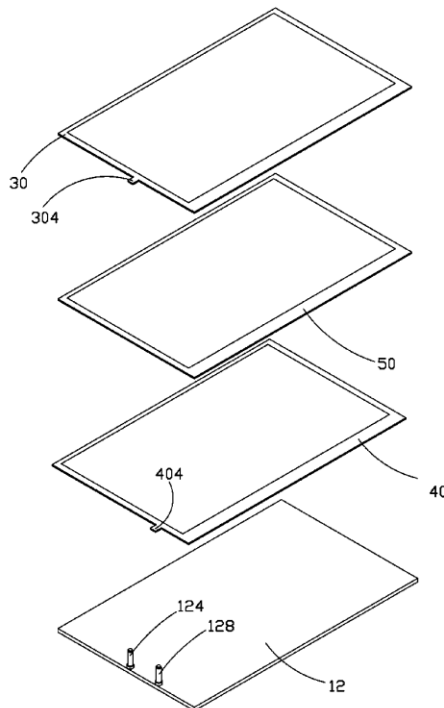
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(57) **ABSTRACT**

A portable device includes a main body and an antenna mounted on the main body. The main body includes a printed circuit board (PCB). A first guide pole and a second guide pole are configured on the PCB. The antenna includes a first conductor portion, a second conductor portion and an insulated portion. The first conductor portion includes a first connecting end electrically connected to the PCB via the first guide pole. The first connecting end acts as a feed portion of the antenna. The second conductor portion is disposed between the first conductor portion and the PCB and includes a second connecting end electrically connected to the PCB via the second guide pole. The insulated portion is sandwiched between the first conductor portion and the second conductor portion to insulate the first conductor portion from the second conductor portion.

9 Claims, 4 Drawing Sheets





US008537057B2

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

(10) **Patent No.:** **US 8,537,057 B2**
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(54) **MOBILE TERMINAL WITH TWO ANTENNAS FOR REDUCING THE RF RADIATION EXPOSURE OF THE USER**

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(Under 37 CFR 1.47)

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H01Q 1/50 (2006.01)
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(58) **Field of Classification Search**
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See application file for complete search history.

(56) **References Cited**

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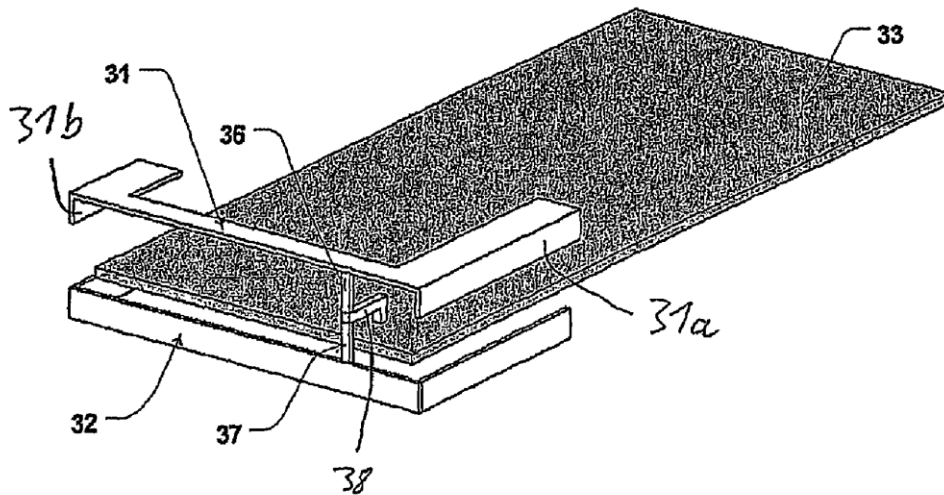
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Assistant Examiner — Graham Smith

(57) **ABSTRACT**

For a mobile terminal for receiving wireless transmissions from a transmitter and transmitting wireless transmissions to a receiver it proposed to provide an antenna arrangement having a plurality of antenna elements each provided on or within a common body or a respective body of the terminal in a defined spatial relation to a conducting chassis part, wherein at least one first antenna element is located on a first side and at least one second antenna element is located on a second side of the same conductive chassis part or of the respective conducting chassis part, wherein high frequency circuitry, for transmitting a respective wireless transmission, is adapted to simultaneously drive said first antenna element and said second antenna element by feeding the same or corresponding high frequency signals to said first antenna element and to said second antenna element.

13 Claims, 6 Drawing Sheets





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Kao

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(54) **ANTENNA ASSEMBLY AND ELECTRONIC DEVICE USING THE SAME**

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(58) **Field of Classification Search**

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See application file for complete search history.

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Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An antenna assembly includes a slide mechanism, a chassis, and an antenna. The slide mechanism includes a fixed plate and a slide plate slidably mounted on the fixed plate. The chassis is mounted on the slide plate. The antenna is mounted on the chassis. The antenna is contained between the fixed plate and the slide plate when the slide mechanism is retracted, and exposed when the slide mechanism is extended.

9 Claims, 4 Drawing Sheets

