

(45) **Date of Patent:** **May 24, 2016**

(Continued)

(Continued)

- “AirPort Product-Specific Details”, AirPort Developer Note, [Online], Updated: Apr. 28, 2008, Retrieved: Sep. 25, 2008, <http://developer.apple.com/documentation/HardwareDrivers/Conceptual/Hwrech_AirportArticles/EIAirP_implementation.html>.

- (Continued)

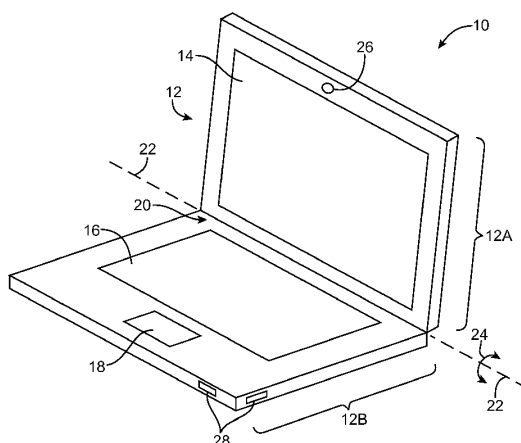
Primary Examiner — Huedung Mancuso

- (74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

- (57)
- ABSTRACT**

- An electronic device has antennas formed from cavity antenna structures. The electronic device may have a metal housing. The metal housing may have an upper housing in which a component such as a display is mounted and a lower housing in which a component such as a keyboard is mounted. Hinges may be used to mount the upper housing to the lower housing for rotation about a rotational axis. Cavity antennas may be formed in a clutch barrel region located between the hinges and running along the rotational axis. A flexible printed circuit may be formed between the cavity antennas. Each cavity antenna may have a first end that is adjacent to one of the hinges and a second end that is adjacent to the flexible printed circuit. Cavity walls for the cavity antennas may be formed from metal housing structures such as metal portions of the lower housing.

- 20 Claims, 11 Drawing Sheets**





US009350069B2

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

(10) **Patent No.:** **US 9,350,069 B2**
(45) **Date of Patent:** **May 24, 2016**

(54) **ANTENNA WITH SWITCHABLE INDUCTOR
LOW-BAND TUNING**

3,736,591 A 5/1973 Rennels et al.
4,123,756 A 10/1978 Nagata et al.
4,349,840 A 9/1982 Henderson

(Continued)

(75) Inventors: **Mattia Pascolini**, Campbell, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Nanbo Jin, Sunnyvale, CA (US);
Matthew A. Mow, Los Altos, CA (US);
Hongfei Hu, Santa Clara, CA (US);
Joshua G. Nickel, San Jose, CA (US)

FOREIGN PATENT DOCUMENTS

CN 1745500 3/2006
CN 1764077 4/2006

(Continued)

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

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 470 days.

"The ARRL Antenna Book", The American Radio Relay League, 1988, pp. 2-24 to 2-25.*

(Continued)

(21) Appl. No.: **13/343,657**

(22) Filed: **Jan. 4, 2012**

(65) **Prior Publication Data**

US 2013/0169490 A1 Jul. 4, 2013

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/00 (2015.01)
H01Q 5/357 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/357** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/314; H01Q 5/321; H01Q 5/328;
H01Q 5/357; H01Q 1/243
USPC 343/702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,324,462 A 7/1943 Leeds et al.
2,942,263 A 6/1960 Baldwin
3,394,373 A 7/1968 Makrancy

Primary Examiner — Hoang V Nguyen

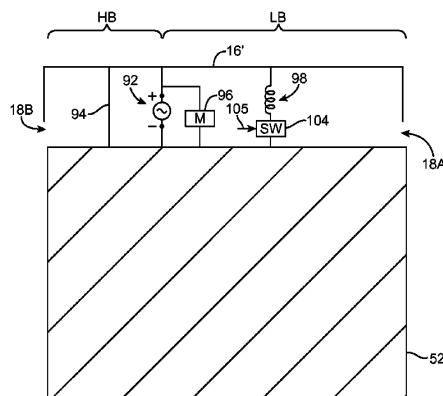
Assistant Examiner — Daniel J Munoz

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and antennas. An antenna may be formed from an antenna resonating element arm and an antenna ground. The antenna resonating element arm may have a shorter portion that resonates at higher communications band frequencies and a longer portion that resonates at lower communications band frequencies. A short circuit branch may be coupled between the shorter portion of the antenna resonating element arm and the antenna ground. A series-connected inductor and switch may be coupled between the longer portion of the antenna resonating element arm and the antenna ground. An antenna feed branch may be coupled between the antenna resonating element arm and the antenna ground at a location that is between the short circuit branch and the series-connected inductor and switch.

26 Claims, 9 Drawing Sheets





US009350082B2

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

(10) **Patent No.:** **US 9,350,082 B2**

(45) **Date of Patent:** **May 24, 2016**

(54) **DUAL-BAND MONOPOLE COUPLING ANTENNA**

USPC 343/700 MS, 745, 793
See application file for complete search history.

(71) Applicant: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Chih-Yung Huang**, Taichung County (TW); **Kuo-Chang Lo**, Miaoli County (TW)

2009/0135087 A1 * 5/2009 Gummalla H01P 3/02 343/909
2012/0127050 A1 * 5/2012 Song H01Q 1/1271 343/756

(73) Assignee: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 267 days.

ARRL, The ARRL Antenna Book, ARRL, p. 2-24.*

* cited by examiner

(21) Appl. No.: **14/186,229**

Primary Examiner — Sue A Purvis

Assistant Examiner — Jae Kim

(22) Filed: **Feb. 21, 2014**

(74) *Attorney, Agent, or Firm* — WPAT, PC; Justin King; Jonathan Chiang

(65) **Prior Publication Data**

US 2015/0084815 A1 Mar. 26, 2015

(30) **Foreign Application Priority Data**

Sep. 24, 2013 (TW) 102134312 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)
H01Q 5/00 (2015.01)

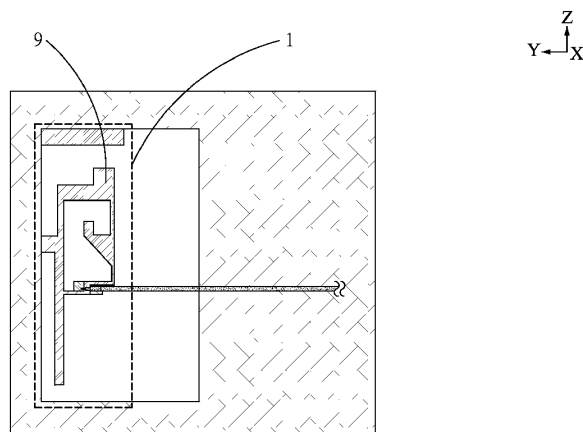
(57) **ABSTRACT**

A dual-band monopole coupling antenna is disclosed, which comprises: a first radiation part, configured with a frame and an extension section while being disposed on a surface of a substrate; a second radiation part, disposed on the surface of the substrate at a position neighboring to the first radiation part for enabling a coupling effect between the two, allowing the second radiation part to be used as an extension of the first radiation part, and thus adjusting the operation frequency, impedance and impedance matching accordingly; a signal ground section, disposed coupling to the second radiation part; a signal feed-in section, disposed on the surface at a position neighboring to the signal ground section while coupling to the first radiation part; a ground, disposed coupling to the second radiation part; and a dielectric layer, disposed at a non-conductive area arranged between the first radiation part and the second radiation part.

(52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 5/0027** (2013.01); **H01Q 5/378** (2015.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/42; H01Q 5/378; H01Q 5/0027; H01Q 1/38

5 Claims, 11 Drawing Sheets





US009356336B1

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

(10) **Patent No.:** **US 9,356,336 B1**

(45) **Date of Patent:** **May 31, 2016**

(54) **DUAL-FOLDED MONOPOLE ANTENNA (DFMA)**

USPC 343/702, 828, 829, 846, 848, 833, 834
See application file for complete search history.

(75) Inventors: **Ming Zheng**, Cupertino, CA (US);
Joseph C. Modro, Palo Alto, CA (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(73) Assignee: **Amazon Technologies Inc.**, Reno, NV (US)

7,026,999	B2 *	4/2006	Umehara et al.	343/702
7,136,022	B2 *	11/2006	Sato et al.	343/702
7,345,637	B2 *	3/2008	Mizoguchi et al.	343/702
7,791,546	B2 *	9/2010	Hotta et al.	343/702
7,825,863	B2 *	11/2010	Martiskainen et al.	343/702
8,779,987	B2 *	7/2014	Endo et al.	343/700 MS
8,836,588	B2 *	9/2014	Hayashi et al.	343/702
8,988,292	B2 *	3/2015	Hotta et al.	343/702

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 865 days.

* cited by examiner

(21) Appl. No.: **13/495,189**

Primary Examiner — Michael C Wimer

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

(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/30 (2006.01)
H01Q 5/378 (2015.01)

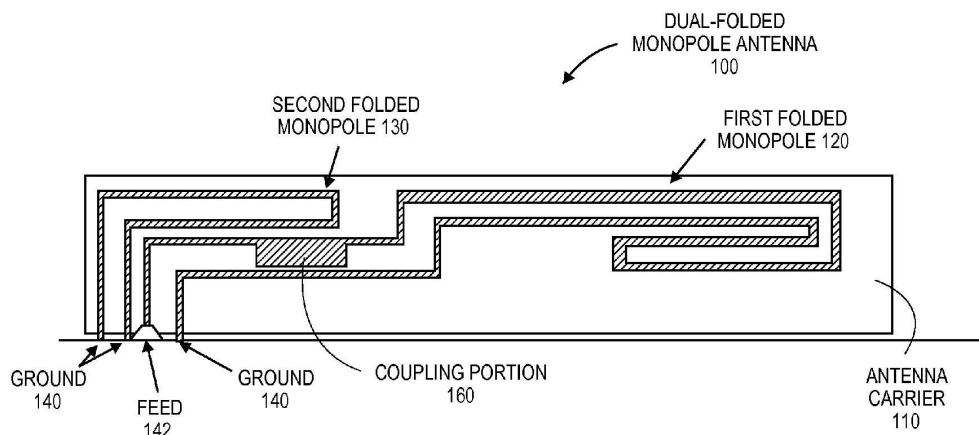
(57) **ABSTRACT**

Methods and systems for extending a bandwidth of a dual-folded monopole antenna of a user device are described. A dual-folded monopole antenna includes a first folded monopole structure coupled to a single radio frequency (RF) input and a parasitic folded monopole structure coupled to a ground plane. The first folded monopole structure is configured to operate as a feeding structure to a parasitic folded monopole structure that is not conductively connected to the RF input.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 9/30** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/378; H01Q 5/385; H01Q 9/0421; H01Q 9/42; H01Q 1/38; H01Q 9/30

21 Claims, 19 Drawing Sheets





US009356337B2

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

(10) **Patent No.:** **US 9,356,337 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **PORTABLE TERMINAL**

(71) Applicant: **Samsung Electronics Co. Ltd.**,
Suwon-si, Gyeonggi-do (KR)

(72) Inventors: **Jae-II Seo**, Suwon-si (KR);
Young-Gyun Kim, Yongin-si (KR);
Seung-Hoon Lee, Seongnam-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 389 days.

(21) Appl. No.: **13/768,682**

(22) Filed: **Feb. 15, 2013**

(65) **Prior Publication Data**

US 2013/0222192 A1 Aug. 29, 2013

(30) **Foreign Application Priority Data**

Feb. 23, 2012 (KR) 10-2012-0018512
Feb. 23, 2012 (KR) 10-2012-0018585

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
H04R 1/02 (2006.01)
H04M 1/03 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H04M 1/026**
(2013.01); **H04M 1/0262** (2013.01); **H04R 1/02**
(2013.01); **H04M 1/035** (2013.01); **H04M**
2250/12 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H04M 1/026; H04M 1/0262
USPC 343/702; 455/575.1, 575.5, 575.7
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,581,654 A * 4/1986 Kobayashi H04N 3/127
348/790
6,501,429 B2 * 12/2002 Nakamura G01S 19/34
343/700 MS
8,260,385 B2 9/2012 Kim et al.
2005/0049014 A1 * 3/2005 Nelson H01Q 1/007
455/575.1
2005/0248492 A1 * 11/2005 Ryu H01Q 9/0407
343/702
2009/0305755 A1 * 12/2009 Lee H01Q 1/243
455/575.4

FOREIGN PATENT DOCUMENTS

EP 2280490 A2 2/2011
EP 23930263 A1 12/2011
KR 10-2011-0080945 A 7/2011
WO 2004/028120 A2 4/2004
WO 2008/014102 A2 1/2008
WO 2008/136238 A1 11/2008

* cited by examiner

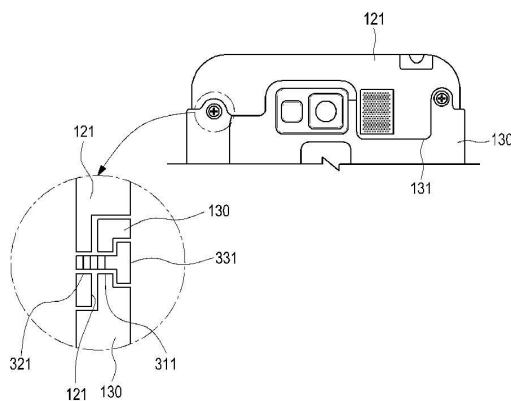
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A portable terminal which can be made light, slim, short, and small is provided. The portable terminal includes an antenna mounted to an inner side surface of a body of the portable terminal, and a rear case covering at least a portion of an inner side of the body and having a battery mounting space. The antenna and the rear case are separably coupled to a rear surface of the body to be exposed to outside the rear surface of the body. The portable terminal may include a speaker module provided at an upper end of a body of the portable terminal within the body, a mounting plate mounted to one side of the speaker module within the body, and a microphone holder fixed to one surface of the mounting plate. The portable terminal can be miniaturized by reducing installation widths of parts disposed parallel to a speaker module.

11 Claims, 6 Drawing Sheets





US009356338B2

(12) **United States Patent
Park**

(10) **Patent No.:** **US 9,356,338 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **ANTENNA APPARATUS AND FEEDING
STRUCTURE THEREOF**

(71) Applicant: **Bum Ki Park**, Seoul (KR)

(72) Inventor: **Bum Ki Park**, Seoul (KR)

(73) Assignee: **LG INNOTEK CO., LTD.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 173 days.

(21) Appl. No.: **14/165,258**

(22) Filed: **Jan. 27, 2014**

(65) **Prior Publication Data**

US 2014/0210679 A1 Jul. 31, 2014

(30) **Foreign Application Priority Data**

Jan. 25, 2013 (KR) 10-2013-0008749

(51) **Int. Cl.**

H01Q 9/00 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/328 (2015.01)

H01Q 5/335 (2015.01)

H01Q 5/357 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/328** (2015.01); **H01Q 5/335** (2015.01); **H01Q 5/357** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/246; H01Q 3/005

USPC 343/745, 702, 860

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,297,776 B1 * 10/2001 Pankinaho H01Q 1/243
343/700 MS

6,819,290 B2 * 11/2004 Hani H01Q 1/243
343/700 MS

7,705,786 B2 * 4/2010 Iellici H01Q 1/243
343/700 MS

8,022,888 B2 * 9/2011 Kim H01P 1/18
343/860

8,111,194 B2 * 2/2012 Chang H01Q 1/2283
343/700 MS

8,164,524 B2 * 4/2012 Tang H01Q 5/364
343/700 MS

2003/0142022 A1 7/2003 Ollikainen et al.
2009/0224996 A1 * 9/2009 Kim H01P 1/18
343/860

2011/0133994 A1 * 6/2011 Korva H01Q 1/243
343/702

2011/0148723 A1 6/2011 Bengtsson et al.
2011/0163934 A1 * 7/2011 Tseng H01Q 9/42
343/846

2012/0050121 A1 3/2012 Kim et al.
2012/0062434 A1 * 3/2012 Kim H01Q 9/42
343/749

2012/0262342 A1 * 10/2012 Lee H01Q 5/35
343/700 MS

2013/0088399 A1 4/2013 Jeon et al.

FOREIGN PATENT DOCUMENTS

JP 2006-054639 A 2/2006
JP 2007-060349 A 3/2007

(Continued)

OTHER PUBLICATIONS

European Search Report dated May 8, 2014 in European Application No. 14152617.8.

(Continued)

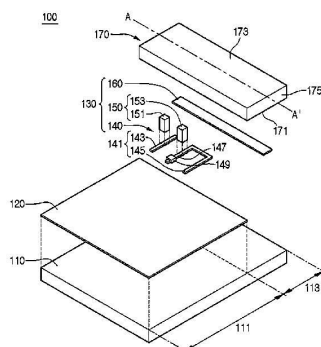
Primary Examiner — Jean B Jeanglaude

(74) *Attorney, Agent, or Firm* — Saliwanchik, Lloyd & Eisenschenk

(57) **ABSTRACT**

An antenna apparatus includes: a radiator; a feeding structure including a feeding unit to provide a signal to the radiator, a ground unit to ground the radiator, and a resonance applying part between the feeding unit and the ground unit; and a contact part to connect the radiator with the feeding structure.

14 Claims, 6 Drawing Sheets





US009356344B2

(12) **United States Patent**
Lim

(10) **Patent No.:** **US 9,356,344 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **ANTENNA APPARATUS AND FEEDING STRUCTURE THEREOF**

(71) Applicant: **LG INNOTEK CO., LTD.**, Seoul (KR)

(72) Inventor: **Dong Uk Lim**, Seoul (KR)

(73) Assignee: **LG Innotek Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 225 days.

(21) Appl. No.: **13/937,973**

(22) Filed: **Jul. 9, 2013**

(65) **Prior Publication Data**

US 2014/0015722 A1 Jan. 16, 2014

(30) **Foreign Application Priority Data**

Jul. 12, 2012 (KR) 10-2012-0076313

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/50 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/364 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 5/364** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243; H01Q 5/30; H01Q 5/314; H01Q 5/328; H01Q 9/0407; H01Q 9/0421
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,693,594 B2 * 2/2004 Pankinaho et al. 343/700 MS
6,836,248 B2 * 12/2004 Fukushima et al. 343/700 MS

7,142,162 B2 * 11/2006 Taromaru H01Q 3/44 343/702

2001/0035843 A1 11/2001 Boyle
2003/0006936 A1 1/2003 Aoyama et al.
2004/0233109 A1 11/2004 Ying et al.
2007/0069956 A1 * 3/2007 Ozkar H01Q 5/00 343/700 MS
2008/0079642 A1 4/2008 Ishizuka et al.
2010/0060530 A1 3/2010 Shoji
2010/0141536 A1 6/2010 Zhang et al.
2011/0128200 A1 6/2011 Hossain et al.
2012/0009983 A1 1/2012 Mow et al.
2013/0194144 A1 8/2013 Lee

FOREIGN PATENT DOCUMENTS

CN 1381079 A 11/2002
CN 101273493 A 9/2008
CN 101308950 A 11/2008
CN 101714698 A 5/2010
JP 2003-069330 A 3/2003
JP 2007-088975 A 4/2007
JP 2009-510901 A 3/2009
JP 2009-182793 A 8/2009
JP 2012-182632 A 9/2012
KR 10-2003-0066779 A 8/2003
KR 2003-0085000 A 11/2003
KR 10-2011-0019666 A 2/2011
KR 10-2011-0068246 A 6/2011
WO WO 2010/137061 A1 12/2010

* cited by examiner

Primary Examiner — Sue A Purvis

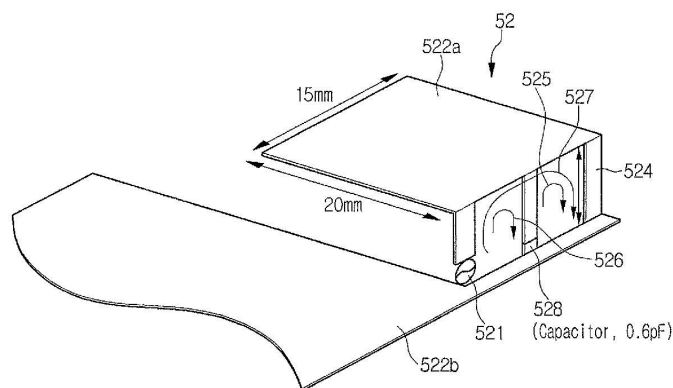
Assistant Examiner — Patrick Holecek

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

(57) **ABSTRACT**

Embodiments provide connecting various circuits to which capacitive elements are connected to obtain an optimal capacitive reactance value needed in a resonance. Embodiments provide a capacitance value of an optimal capacitive reactance needed in a resonance by connecting a plurality of capacitive elements to a conductive line connecting an emitter and a ground in series or connecting one or more capacitive elements in parallel/series.

3 Claims, 14 Drawing Sheets





US009356348B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 9,356,348 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Chi Mei Communication Systems, Inc.**, New Taipei (TW)

(72) Inventor: **Hsi-Chieh Chen**, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 329 days.

(21) Appl. No.: **13/947,645**

(22) Filed: **Jul. 22, 2013**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 25, 2012 (TW) 101135033 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 5/00 (2015.01)

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

H01Q 5/378 (2015.01)

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

CPC **H01Q 5/0027** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24

USPC 343/700 MS, 702, 750, 846

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,602,343 B2 * 10/2009 Takada H01Q 1/243

7,911,387 B2 * 3/2011 Hill 343/700 MS

2007/0030204 A1 * 2/2007 Heng H01Q 1/243

2008/0316116 A1 * 12/2008 Hobson 343/700 MS

2009/0273531 A1 * 11/2009 Ishizuka H01Q 1/22

343/702

2008/0316116 A1 * 12/2008 Hobson H01Q 1/243

343/702

2009/0273531 A1 * 11/2009 Ishizuka H01Q 1/243

343/750

* cited by examiner

Primary Examiner — Huedung Mancuso

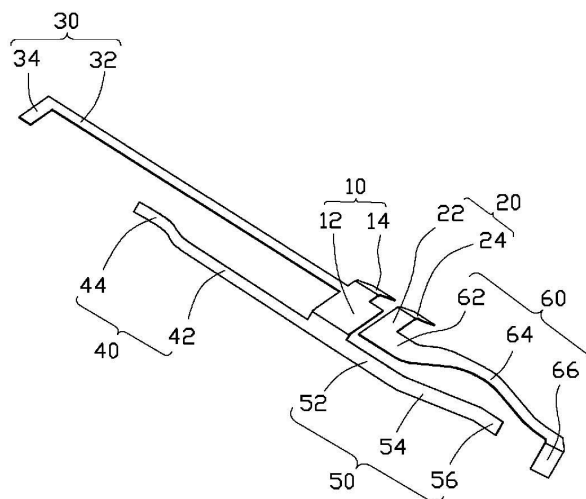
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

An antenna structure includes a feed end, a grounding end, at least one main radiator, and at least one coupling radiator. The grounding end is separated from the feed end. The at least one main radiator is connected to the feed end. The at least one coupling radiator is connected to the grounding end. Current on the feed end is coupled to the grounding end, and current on the least one main radiator is coupled to the at least one coupling radiator.

15 Claims, 2 Drawing Sheets

100





US009356350B2

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

(10) **Patent No.:** **US 9,356,350 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**

(71) Applicant: **CHUIN MAI COMMUNICATION SYSTEMS, INC.**, New Taipei (TW)

(72) Inventors: **Tze-Hsuan Chang**, New Taipei (TW);
Cho-Kang Hsu, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 43 days.

(21) Appl. No.: **14/300,560**

(22) Filed: **Jun. 10, 2014**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 10, 2013 (TW) 102120474 A

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 5/342 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/342** (2015.01); **H01Q 13/10** (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,246,377 B1 * 6/2001 Aiello H01Q 1/36 343/767
2005/0088354 A1 * 4/2005 Chang H01Q 1/38 343/767
2007/0182653 A1 * 8/2007 Yoon H01Q 1/38 343/767
2009/0060088 A1 3/2009 Callard et al.
2009/0073065 A1 * 3/2009 Jordan H01Q 13/106 343/767
2012/0313832 A1 * 12/2012 Pazin H01Q 13/106 343/767

OTHER PUBLICATIONS

A dual band feed structure for slot and notch antennas, 2009 IEEE ISAP, Proceedings.

* cited by examiner

Primary Examiner — Tan Ho

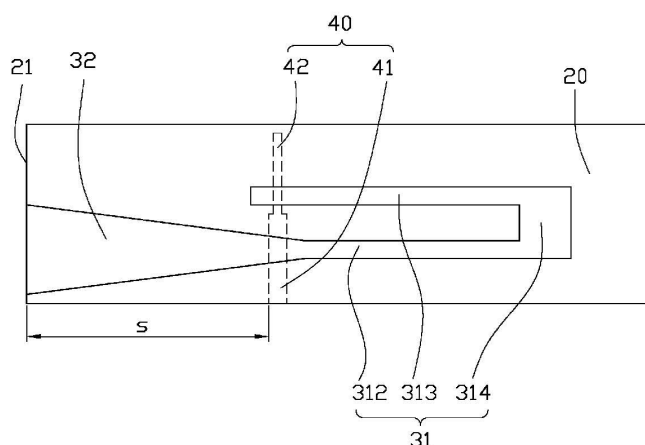
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

An antenna structure includes a dielectric substrate, a slot antenna, and a feeding strip. The dielectric substrate has a first surface and a second surface opposite to the first surface. The slot antenna includes a ground plane positioned on the first surface of the dielectric substrate, and a slot defined in the ground plane where the conductive material is missing. The slot opens at an edge of the ground plane. The feeding strip is positioned on the second surface of the dielectric substrate and extends across the slot, the feeding strip resonates with the slot antenna.

18 Claims, 11 Drawing Sheets

200





US009356355B2

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

(10) **Patent No.:** **US 9,356,355 B2**

(45) **Date of Patent:** ***May 31, 2016**

(54) **ANTENNAS FOR HANDHELD ELECTRONIC DEVICES**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Ruben Caballero, San Jose, 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 264 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/064,589**

(22) Filed: **Oct. 28, 2013**

(65) **Prior Publication Data**

US 2014/0049432 A1 Feb. 20, 2014

Related U.S. Application Data

(60) Continuation of application No. 13/286,612, filed on Nov. 1, 2011, now Pat. No. 8,907,852, which is a division of application No. 13/083,487, filed on Apr. 8, 2011, now Pat. No. 8,169,374, which is a

(Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/521** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/243; H01Q 13/103;
H01Q 23/00; H01Q 5/371; H01Q 9/0421
USPC 343/700 MS, 702, 829, 846, 718
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,942,263 A 6/1960 Baldwin
3,394,373 A 7/1968 Makrancy

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1377102 10/2002
CN 1407653 4/2003

(Continued)

OTHER PUBLICATIONS

Hobson et al. U.S. Appl. No. 60/833,587, filed Jan. 5, 2007.

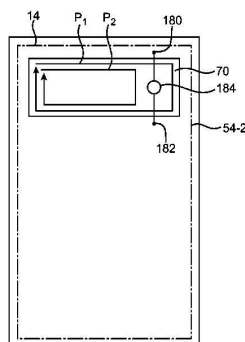
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

A handheld electronic device may be provided that contains wireless communications circuitry. The handheld electronic device may have a housing and a display. The display may be attached to the housing a conductive bezel. The handheld electronic device may have one or more antennas for supporting wireless communications. A ground plane in the handheld electronic device may serve as ground for one or more of the antennas. The ground plane and bezel may define an opening. A rectangular slot antenna or other suitable slot antenna may be formed from or within the opening. One or more antenna resonating elements may be formed above the slot. An electrical switch that bridges the slot may be used to modify the perimeter of the slot so as to tune the communications bands of the handheld electronic device.

20 Claims, 20 Drawing Sheets





US009356356B2

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

(10) **Patent No.:** **US 9,356,356 B2**

(45) **Date of Patent:** **May 31, 2016**

(54) **TUNABLE SLOT ANTENNA**

(75) Inventors: **Chih-Hua Chang**, New Taipei (TW);
Yu-Kai Hung, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 427 days.

(21) Appl. No.: **13/557,310**

(22) Filed: **Jul. 25, 2012**

(65) **Prior Publication Data**

US 2013/0234901 A1 Sep. 12, 2013

(30) **Foreign Application Priority Data**

Mar. 8, 2012 (TW) 101107827 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/103** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 13/106**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/00; H01Q 13/10; H01Q 13/103;
H01Q 13/106; H01Q 1/243; H01Q 1/48
USPC 343/745, 767, 768, 770, 746
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,893,131 A 1/1990 Smith et al.
6,043,786 A * 3/2000 Vannatta H01Q 1/38
343/700 MS
6,864,848 B2 * 3/2005 Sievenpiper H01Q 9/14
343/767

7,176,842 B2 2/2007 Bettner et al.
7,372,406 B2 * 5/2008 Shiotsu G06F 1/1616
343/700 MS
8,884,835 B2 * 11/2014 Pelosi H01Q 1/243
343/702
2003/0122721 A1 7/2003 Sievenpiper
2003/0160728 A1 * 8/2003 Fukushima H01Q 1/242
343/702
2004/0021605 A1 * 2/2004 Kouam H01Q 1/38
343/700 MS
2005/0174294 A1 8/2005 Peroulis et al.
2008/0316118 A1 * 12/2008 Puente Baliarda ... H01Q 9/0421
343/702
2010/0060530 A1 * 3/2010 Shoji H01Q 9/145
343/702
2015/0029068 A1 * 1/2015 Toyao H01Q 1/2266
343/770

FOREIGN PATENT DOCUMENTS

CN 101243583 A 8/2008
DE 3246365 A1 6/1984

(Continued)

OTHER PUBLICATIONS

European Search Report, EP12192247, Jun. 21, 2013, 11 pages.

(Continued)

Primary Examiner — Dameon E Levi

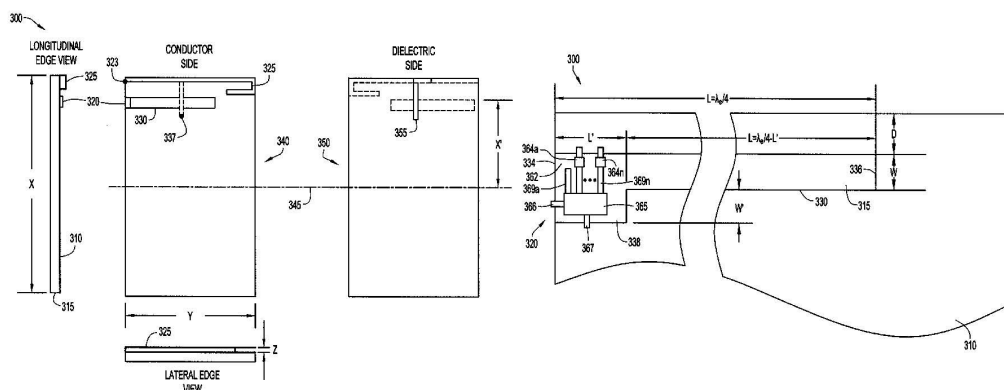
Assistant Examiner — Jennifer F Hu

(74) Attorney, Agent, or Firm — Edell, Shapiro & Finnan, LLC

(57) **ABSTRACT**

An open slot antenna is formed in a planar conductor on a dielectric substrate. A tuning circuit is disposed toward an open end of the slot antenna and is used to select a resonant frequency of the antenna by electrically connecting one of multiple tuning elements across opposing sides of the slot. The tunable antenna so constructed may be incorporated into a handheld mobile communication device that can be operated in different geographic regions, each having different regional communication standards under which mobile communications are conducted.

18 Claims, 8 Drawing Sheets





US009362611B2

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

(10) **Patent No.:** **US 9,362,611 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

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

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(72) Inventors: **Jeongwan Park**, Gyeongsangbuk-do
(KR); **Byungchan Jang**,
Gyeongsangbuk-do (KR); **Sukho Kim**,
Gyeonggi-do (KR); **Seunghwan Kim**,
Seoul (KR); **Joonho Byun**, Gyeonggi-do
(KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 328 days.

(21) Appl. No.: **13/954,256**

(22) Filed: **Jul. 30, 2013**

(65) **Prior Publication Data**

US 2014/0043192 A1 Feb. 13, 2014

(30) **Foreign Application Priority Data**

Aug. 13, 2012 (KR) 10-2012-0088376

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/08 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/088**
(2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/088; H01Q 1/38
USPC 343/702, 893
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,219,230 B1 * 4/2001 Cho G06F 1/1616
16/342
2009/0213029 A1 8/2009 Baliarda et al.
2011/0215971 A1 * 9/2011 Rao H01Q 1/243
343/702
2012/0046002 A1 * 2/2012 Hill H01Q 1/243
455/73

FOREIGN PATENT DOCUMENTS

EP 2 182 579 A1 5/2010
WO 02/31921 A2 4/2002
WO 2011/105381 A1 9/2011

* cited by examiner

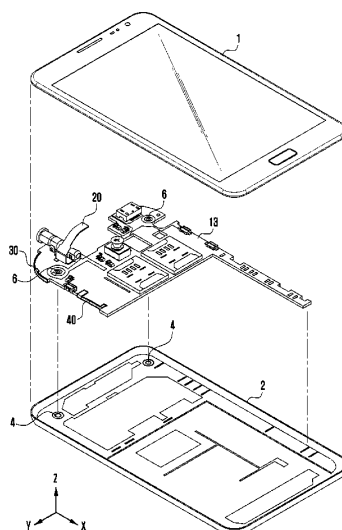
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

An antenna of a mobile includes at least two internal antennas and a printed circuit board disposed between a front cover and a rear cover. The printed circuit board includes at least one first antenna mounted on an upper surface and the printed circuit board having at least one fastening opening therein. A second antenna is mounted in an upper portion of a side surface of the printed circuit board and included a protruded portion of one end protruded from a body and in which the protruded portion is fastened to the fastening opening to be fastened to a side surface of the printed circuit board and the mobile terminal can be produced having a reduced thickness.

18 Claims, 6 Drawing Sheets





US009362612B2

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

(10) **Patent No.:** **US 9,362,612 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

(54) **WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **FIH (Hong Kong) Limited**, Kowloon (HK)

(72) Inventors: **Chi-Sheng Liu**, New Taipei (TW);
Chuan-Chou Chi, New Taipei (TW);
Chih-Yang Tsai, New Taipei (TW);
Pai-Cheng Huang, New Taipei (TW)

(73) Assignee: **FIH (Hong Kong) Limited**, Kowloon (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 128 days.

(21) Appl. No.: **14/084,725**

(22) Filed: **Nov. 20, 2013**

(65) **Prior Publication Data**

US 2014/0340270 A1 Nov. 20, 2014

(30) **Foreign Application Priority Data**

May 17, 2013 (TW) 102117672 A

(51) **Int. Cl.**
H01Q 11/12 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/14 (2006.01)
H01Q 9/42 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 9/14** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/14
USPC 343/723
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0085745 A1 * 4/2007 Su et al. 343/700 MS
* cited by examiner

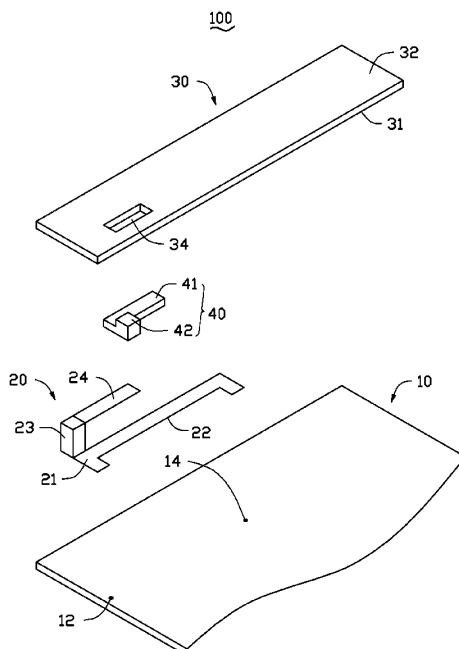
Primary Examiner — Graham Smith

(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

A wireless communication device includes a cover, an antenna, and an adjusting member. The adjusting member is slidably mounted to the cover and is made of non-conductive materials. The antenna includes an extending portion, the extending portion is sandwiched between the cover and the adjusting member. The adjusting member contacts and partially overlaps with the extending portion, the adjusting member slides relative to the cover to change contact positions of the extending portion and the adjusting member.

2 Claims, 4 Drawing Sheets





US009362621B1

(12) **United States Patent**
He

(10) **Patent No.:** **US 9,362,621 B1**
(45) **Date of Patent:** **Jun. 7, 2016**

- (54) **MULTI-BAND LTE ANTENNA**
(71) Applicant: **Ziming He**, Irvine, CA (US)
(72) Inventor: **Ziming He**, Irvine, 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 52 days.

(21) Appl. No.: **14/071,571**

(22) Filed: **Nov. 4, 2013**

Related U.S. Application Data

- (63) Continuation-in-part of application No. 29/457,103, filed on Jun. 6, 2013, now Pat. No. Des. 692,870.
(60) Provisional application No. 61/826,981, filed on May 23, 2013.
(51) **Int. Cl.**
H01Q 5/00 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 5/001** (2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/38; H01Q 5/001; H01Q 1/243
USPC 343/702, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 6,408,190 B1 * 6/2002 Ying H01Q 1/243 343/700 MS
7,061,437 B2 6/2006 Lin et al.
7,148,849 B2 12/2006 Lin
7,215,296 B2 5/2007 Abramov et al.

- D546,821 S 7/2007 Oliver
D549,696 S 8/2007 Oshima et al.
7,333,067 B2 2/2008 Hung et al.
7,336,959 B2 2/2008 Khitrik et al.
D573,589 S 7/2008 Montgomery et al.
7,405,704 B1 7/2008 Lin et al.
7,477,195 B2 1/2009 Vance
D592,195 S 5/2009 Wu et al.
7,570,215 B2 8/2009 Abramov et al.
D599,334 S 9/2009 Chiang
D606,053 S 12/2009 Wu et al.
D607,442 S 1/2010 Su et al.
D608,769 S 1/2010 Bufe
D612,368 S 3/2010 Yang et al.
7,705,783 B2 4/2010 Rao et al.
7,729,662 B2 6/2010 Abramov et al.
D621,819 S 8/2010 Tsai et al.
7,843,390 B2 11/2010 Liu
D633,483 S 3/2011 Su et al.
D635,127 S 3/2011 Tsai et al.
7,907,971 B2 3/2011 Salo et al.
D635,560 S 4/2011 Tsai et al.
D635,963 S 4/2011 Podduturi
D635,964 S 4/2011 Podduturi
D635,965 S 4/2011 Mi et al.
D636,382 S 4/2011 Podduturi
7,965,242 B2 6/2011 Abramov et al.

(Continued)

Primary Examiner — Dieu H Duong

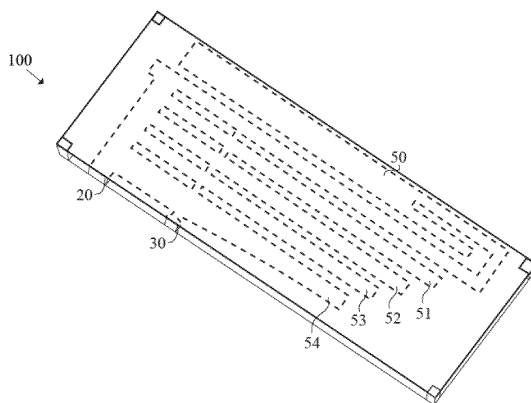
(74) *Attorney, Agent, or Firm* — Clause Eight IPS; Michael Catania

(57)

ABSTRACT

A surface-mounted multi-band LTE antenna that covers the frequency band of 698-960 MHz (LTE 700/800/900 bands) and 2400-2500 GHz (WLAN 2.4G band) is disclosed herein. The antenna preferably has high gain and high radiation efficiency, and is used for a variety of wireless communication devices applications. The surface-mounted multi-band LTE antenna has compact size, wide bandwidth, good return loss, high gain and high radiation efficiency, and no matching circuit is needed.

12 Claims, 8 Drawing Sheets





US009362624B2

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

(10) **Patent No.:** **US 9,362,624 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

(54) **COMPACT ANTENNA WITH DUAL TUNING MECHANISM**

(71) Applicant: **GALTRONICS CORPORATION LTD.**, Tiberias (IL)
(72) Inventors: **Marin Stoytchev**, Chandler, AZ (US);
Randell Cozzolino, Phoenix, AZ (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 59 days.

(21) Appl. No.: **14/514,977**

(22) Filed: **Oct. 15, 2014**

(65) **Prior Publication Data**
US 2015/0102974 A1 Apr. 16, 2015

Related U.S. Application Data

(60) Provisional application No. 61/891,449, filed on Oct. 16, 2013.

(51) **Int. Cl.**
H01Q 11/00 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/371 (2015.01)
H01Q 9/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 9/045; H01Q 9/0421; H01Q 5/0027

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,203,499 B2 * 6/2012 Cozzolino H01Q 1/36 29/601
8,519,903 B2 * 8/2013 Cozzolino H01Q 1/36 343/821
2011/0063172 A1 * 3/2011 Podduturi H01Q 1/2233 343/700 MS
2013/0342415 A1 * 12/2013 Cozzolino H01Q 1/36 343/821
2014/0132469 A1 * 5/2014 Wang H01Q 1/2266 343/821

* cited by examiner

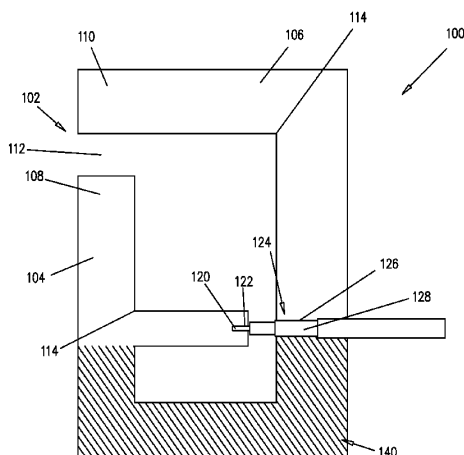
Primary Examiner — Trinh Dinh

(74) Attorney, Agent, or Firm — Ingrassia Fisher & Lorenz, P.C.

(57) **ABSTRACT**

An antenna, including at least one set of conductive arms radiative at a resonant frequency, the at least one set of conductive arms including a first conductive arm having a first terminus and a second conductive arm having a second terminus, the first and second termini being closely spaced so as to form a capacitive gap therebetween, the capacitive gap having a width, a feed connection located on the first conductive arm, a first electrical length being defined along the first conductive arm between the feed connection and the first terminus, a ground connection located on the second conductive arm, a second electrical length being defined along the second conductive arm between the ground connection and the second terminus, the resonant frequency depending at least on the width of the capacitive gap and on the first and second electrical lengths, a total electrical length along the set of conductive arms between the first and second termini being less than or equal to half of a wavelength corresponding to the resonant frequency, and a balun coupled to the first and second conductive arms.

20 Claims, 7 Drawing Sheets





US009362767B2

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

(10) **Patent No.:** **US 9,362,767 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

(54) **PORTABLE WIRELESS COMMUNICATION DEVICE**

1/273; H01Q 1/00; H01Q 11/20; A61B 5/681;
A63B 24/0062; A63B 71/0622; G04G 17/045;
G04G 17/08; G04G 21/025

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

See application file for complete search history.

(72) Inventors: **Kun-Lin Sung**, New Taipei (TW);
Ting-Chih Tseng, New Taipei (TW);
Yen-Hui Lin, New Taipei (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 109 days.

8,442,588	B2 *	5/2013	Sims		H01R 11/00 359/196.1
8,562,489	B2 *	10/2013	Burton		G04F 10/00 482/1
8,964,364	B2 *	2/2015	Abdelsamie		G06F 1/1628 361/679.03
9,122,250	B2 *	9/2015	Hoffman		G04F 10/00
9,142,874	B2 *	9/2015	Wu		H01Q 1/2275
2011/0059769	A1 *	3/2011	Brunolli		G08C 17/02 455/556.1
2011/0244728	A1 *	10/2011	Chang		H01R 31/06 439/628
2013/0106603	A1 *	5/2013	Weast		G06F 1/163 340/539.11

(21) Appl. No.: **14/467,924**

(22) Filed: **Aug. 25, 2014**

(65) **Prior Publication Data**

US 2015/0065204 A1 Mar. 5, 2015

(Continued)

(30) **Foreign Application Priority Data**

Aug. 27, 2013 (CN) 2013 1 03768403

FOREIGN PATENT DOCUMENTS

JP	2010-286	A	1/2010
JP	2011-259193	A	12/2011

(Continued)

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H02J 7/00 (2006.01)
H04Q 1/44 (2006.01)
H04B 1/3827 (2015.01)
H01Q 1/27 (2006.01)
H01Q 1/44 (2006.01)

(52) **U.S. Cl.**
CPC **H02J 7/0045** (2013.01); **H01Q 1/273**
(2013.01); **H01Q 1/44** (2013.01); **H04B 1/385**
(2013.01); **H04B 2001/3855** (2013.01); **H04B**
2001/3861 (2013.01)

(58) **Field of Classification Search**
CPC H02J 7/0045; H02J 7/00; H02J 7/36;
H04B 1/385; H04B 2001/3861; H04B
2001/3855; H04B 1/38; H01Q 1/44; H01Q

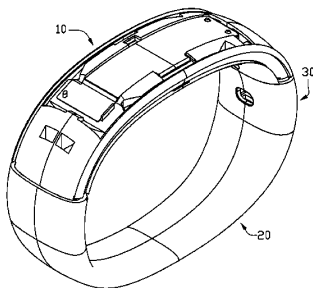
Primary Examiner — Pablo Tran

(74) *Attorney, Agent, or Firm* — Novak Druce Connolly
Bove + Quigg LLP

(57) **ABSTRACT**

A portable wireless communication device includes a connector configured to charge the portable wireless communication device by electronically connecting a power source to the portable wireless communication device. The connector includes a plurality of pins, one of the pins configured to serve as a radiation portion of an antenna to receive/send wireless signals when the connector electronically is uncoupled to the power source.

18 Claims, 5 Drawing Sheets





US009362972B2

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

(10) **Patent No.:** **US 9,362,972 B2**
(45) **Date of Patent:** ***Jun. 7, 2016**

(54) **METALLIC PROTECTIVE CASE FOR
ELECTRONIC DEVICE**

(71) Applicant: **Otter Products, LLC**, Fort Collins, CO
(US)

(72) Inventors: **Jamie L. Johnson**, Fort Collins, CO
(US); **Aaron M. Gaylord**, Fort Collins,
CO (US); **Julie T. Pettit**, Fort Collins,
CO (US); **John P. Fitzgerald**, Fort
Collins, CO (US)

(73) Assignee: **OTTER PRODUCTS, LLC**, Fort
Collins, CO (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 dis-
claimer.

(21) Appl. No.: **14/987,213**

(22) Filed: **Jan. 4, 2016**

(65) **Prior Publication Data**

US 2016/0119014 A1 Apr. 28, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/590,948, filed on
Jan. 6, 2015, now Pat. No. 9,264,090.

(60) Provisional application No. 61/924,699, filed on Jan.
7, 2014.

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H04B 1/3888 (2015.01)
H04M 1/02 (2006.01)
A45C 11/00 (2006.01)

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

CPC **H04B 1/3888** (2013.01); **A45C 11/00**
(2013.01); **H04M 1/0206** (2013.01); **A45C**
2011/002 (2013.01)

(58) **Field of Classification Search**

CPC H04B 1/3888; H04B 2001/3894;
H04M 1/185
USPC 455/63.1, 501, 575.1, 575.3, 575.4,
455/575.8, 90.3
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,249,256	B1	6/2001	Luxon et al.
7,876,272	B2	1/2011	Dou et al.
8,054,231	B2	11/2011	Ahn et al.
8,204,559	B2	6/2012	Honma
8,208,980	B2	6/2012	Wong et al.
8,214,003	B2	7/2012	Wong et al.
8,442,602	B2	5/2013	Wong et al.
8,750,948	B2	6/2014	Wong et al.
9,264,090	B2 *	2/2016	Johnson H04B 1/3888
2003/0045246	A1	3/2003	Lee et al.
2006/0022889	A1	2/2006	Chiang et al.

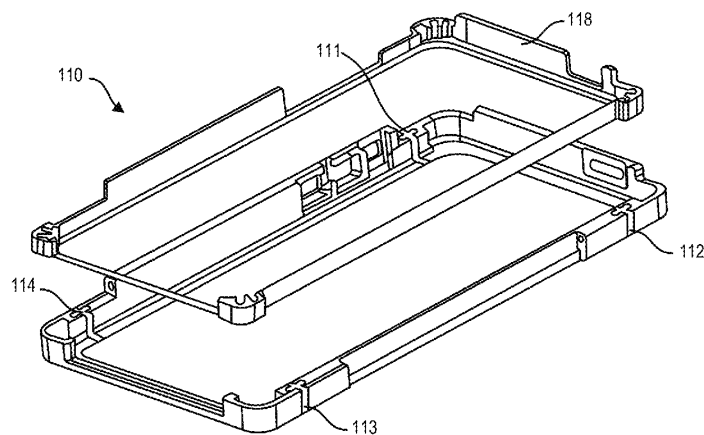
(Continued)

Primary Examiner — Tuan Pham

(57) **ABSTRACT**

A protective case for an electronic device having an antenna includes a first case member and a second case member. The first case member includes at least two metallic case portions joined to each other by at least one electrical insulator segment that electrically isolates the at least two metallic case portions from each other to reduce electromagnetic interference between the first case member and the antenna of the electronic device. The second case member that attaches to the first case member to form an enclosure that at least partially encloses the electronic device when the electronic device is installed in the protective case.

20 Claims, 22 Drawing Sheets





US009363341B2

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

(10) **Patent No.:** **US 9,363,341 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

(54) **MOBILE TERMINAL EQUIPPED WITH AN ANTENNA TRANSMITTING AND RECEIVING WIRELESS COMMUNICATION**

USPC 455/550.1, 575.1, 575.7, 90.3
See application file for complete search history.

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Byungwoon Jung**, Seoul (KR); **Jaewoo Lee**, Seoul (KR); **Sungjung Rho**, Seoul (KR); **Changwon Yun**, Seoul (KR); **Daeyong Kwak**, Seoul (KR); **Sungjoon Hong**, Seoul (KR)

2005/0195119	A1	9/2005	Gaucher et al.
2008/0150815	A1	6/2008	Nakahata et al.
2008/0165067	A1	7/2008	Kim
2012/0274532	A1	11/2012	Kurashima et al.
2013/0069842	A1	3/2013	Lee et al.
2013/0234911	A1	9/2013	Lee

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

FOREIGN PATENT DOCUMENTS

(*) 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	1 437 794	A1	7/2004
JP	2012-85262	A	4/2012

Primary Examiner — Sam Bhattacharya

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

(21) Appl. No.: **14/693,539**

(22) Filed: **Apr. 22, 2015**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2016/0088130 A1 Mar. 24, 2016

According to the present invention, a mobile terminal includes a main body including a front side with which a display unit is combined, a first antenna mounted on the main body, extended in a first direction and including a first slot of which one end is closed and another end is opened, a second antenna mounted on the main body, extended in a second direction corresponding to a direction opposite to the direction to which the first slot is extended and including a second slot of which one end is closed and another end is opened, a power supply unit mounted in the inside of the main body, a first feeder configured to supply power to the first antenna from the power supply unit and a second feeder configured to supply power to the second antenna from the power supply unit.

(30) **Foreign Application Priority Data**

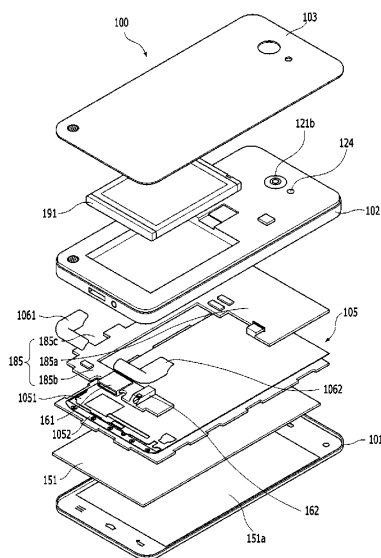
Sep. 19, 2014 (KR) 10-2014-0125062

(51) **Int. Cl.**
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0214; H04M 1/23; H04M 1/03; H04M 1/3833

19 Claims, 18 Drawing Sheets





US009366865B2

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

(10) **Patent No.:** **US 9,366,865 B2**
(45) **Date of Patent:** **Jun. 14, 2016**

(54) **WEARABLE ELECTRONIC DEVICE WITH INTEGRATED ANTENNA**

USPC 345/8
See application file for complete search history.

(71) Applicant: **LENOVO (BEIJING) CO., LTD.**,
Beijing (CN)

(56) **References Cited**

(72) Inventors: **Liefeng Jin**, Beijing (CN); **Jin Liu**,
Beijing (CN); **Jinqiang Lin**, Beijing
(CN)

U.S. PATENT DOCUMENTS

(73) Assignee: **LENOVO (BEIJING) CO., LTD.**,
Beijing (CN)

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

5,821,904 A * 10/1998 Kakizawa H01Q 1/1278
343/704
8,096,654 B2 * 1/2012 Amirparviz B29D 11/00826
345/8
2010/0110368 A1 * 5/2010 Chaum G02B 27/017
351/158
2013/0070198 A1 * 3/2013 Willey G02C 7/083
351/158
2013/0077175 A1 * 3/2013 Hotta G02B 3/08
359/630
2013/0250233 A1 * 9/2013 Blum G02C 11/10
351/158
2014/0267208 A1 * 9/2014 Yajima G02B 27/017
345/211

(21) Appl. No.: **14/459,683**

(22) Filed: **Aug. 14, 2014**

* cited by examiner

(65) **Prior Publication Data**

US 2015/0198806 A1 Jul. 16, 2015

Primary Examiner — Larry Sternbane

(30) **Foreign Application Priority Data**

Jan. 10, 2014 (CN) 2014 1 0012674

(74) *Attorney, Agent, or Firm* — Peter Su; Dentons US LLP

(51) **Int. Cl.**
G06F 3/01 (2006.01)
G02B 27/01 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/44 (2006.01)
H01Q 9/42 (2006.01)

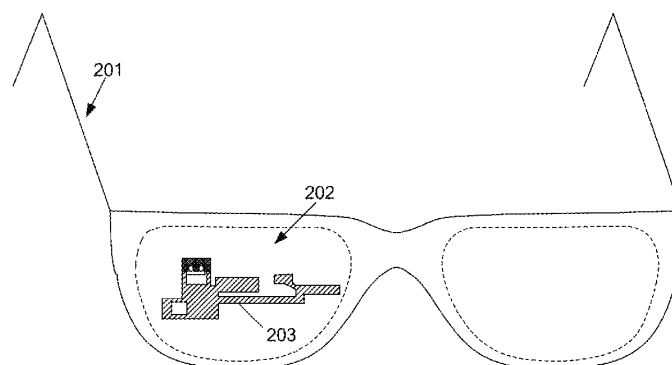
(52) **U.S. Cl.**
CPC **G02B 27/017** (2013.01); **G06F 3/012**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 1/44**
(2013.01); **H01Q 9/42** (2013.01); **G02B**
2027/0178 (2013.01)

(58) **Field of Classification Search**
CPC G02B 27/017; G02B 2027/0178;
H01Q 1/00; H01Q 1/38; H01Q 1/44; H01Q
9/42; G06F 3/012; G06F 3/013

(57) **ABSTRACT**

The invention discloses a wearable electronic device, comprising a fixing component, at least one display component fixedly provided on the fixing component and a signal transceiver component provided on the display component; when a user wears the wearable electronic device, the fixing component maintains a relative positional relationship between the wearable electronic device and the user's head; the display component includes a transparent module whose light transmittance is greater than a first light transmittance; the signal transceiver component is for receiving and transmitting a signal, is of a slice shape, and has a hollow geometric pattern constituted by two or more lines.

10 Claims, 4 Drawing Sheets





US009368858B2

(12) **United States Patent**
Lin

(10) **Patent No.:** **US 9,368,858 B2**
(45) **Date of Patent:** **Jun. 14, 2016**

(54) **INTERNAL LC ANTENNA FOR WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

(72) Inventor: **Weichun Lin**, San Diego, CA (US)

(73) Assignee: **ETHERTRONICS, INC.**, San Diego, 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.: **14/595,155**

(22) Filed: **Jan. 12, 2015**

(65) **Prior Publication Data**

US 2015/0194725 A1 Jul. 9, 2015

Related U.S. Application Data

(63) Continuation of application No. 12/883,610, filed on Sep. 16, 2010, now abandoned, which is a continuation of application No. 12/776,333, filed on May 7, 2010, now abandoned.

(60) Provisional application No. 61/176,438, filed on May 7, 2009.

(51) **Int. Cl.**
H01Q 5/00 (2015.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/357 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/357** (2015.01); **H01Q 9/0407** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2258; H01Q 1/2266; H01Q 1/24;

H01Q 1/241; H01Q 1/242; H01Q 1/243;
H01Q 1/38; H01Q 5/00; H01Q 5/0003;
H01Q 5/02; H01Q 5/001; H01Q 5/0024;
H01Q 5/0027; H01Q 9/065; H01Q 9/16;
H01Q 9/26; H01Q 9/285; H01Q 5/30; H01Q
5/307; H01Q 5/342; H01Q 5/357; H01Q
5/364; H01Q 5/371
USPC 343/702, 700 MS, 729, 730, 795, 810,
343/893

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,019,832	A *	5/1991	Ekdahl	343/774
6,239,765	B1 *	5/2001	Johnson et al.	343/795
6,882,317	B2 *	4/2005	Koskineni et al.	343/700 MS
7,068,230	B2 *	6/2006	Qi et al.	343/702
7,113,135	B2 *	9/2006	Jo et al.	343/702
8,188,926	B2 *	5/2012	Ganwani et al.	343/700 MS

* cited by examiner

Primary Examiner — Sue A Purvis

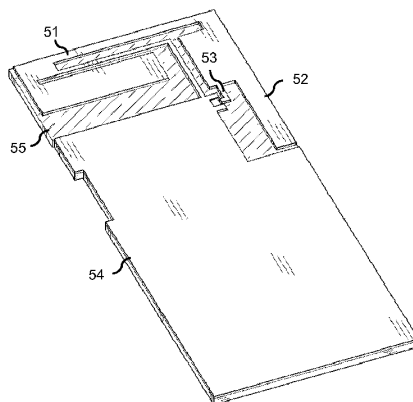
Assistant Examiner — Patrick Holecek

(74) *Attorney, Agent, or Firm* — Coastal Patent Law Group, P.C.

(57) **ABSTRACT**

An L-shape Corner (LC) Antenna uses an L shaped antenna on the corner of a circuit board of a wireless device. A low band element is positioned and designed to resonate along the long dimension of the adjacent ground plane while a high band element is positioned and designed to resonate along the short dimension of the adjacent ground plane. The single antenna element provides two separate radiating sections that allow for optimization of low and high band resonances that are often required to service the cellular and other wireless frequency bands. The two radiating sections of the antenna provide different polarizations for the two resonances that assist in de-coupling the two resonances from each other.

9 Claims, 5 Drawing Sheets





US009368862B2

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

(10) **Patent No.:** **US 9,368,862 B2**
(45) **Date of Patent:** **Jun. 14, 2016**

(54) **WIDEBAND ANTENNA AND AN ELECTRONIC DEVICE INCLUDING THE SAME**

(71) Applicant: **Nvidia Corporation**, Santa Clara, CA (US)

(72) Inventors: **Sung Hoon Oh**, Santa Clara, CA (US);
Joselito Gavilan, Santa Clara, CA (US);
Warren Lee, Santa Clara, CA (US)

(73) Assignee: **NVIDIA 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 160 days.

(21) Appl. No.: **14/159,880**

(22) Filed: **Jan. 21, 2014**

(65) **Prior Publication Data**

US 2015/0207219 A1 Jul. 23, 2015

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/50 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/50** (2013.01); **H01Q 13/106** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 13/10
USPC 343/702, 722, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,125,810 A 11/1978 Pavio
5,861,854 A 1/1999 Kawahata et al.

6,229,487 B1 5/2001 Sadler et al.
6,476,769 B1 11/2002 Lehtola
6,911,940 B2 6/2005 Poilasne et al.
7,091,908 B2 8/2006 Fabrega-Sanchez
7,362,286 B2 4/2008 Fang
7,551,142 B1 6/2009 Zhang et al.
7,696,928 B2 4/2010 Rowell
8,421,682 B2 4/2013 Nielsen et al.
8,648,752 B2 2/2014 Ramachandran et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101106211 A 1/2008
CN 101442151 A 5/2009

(Continued)

OTHER PUBLICATIONS

Oh, Sung Hoon, et al., U.S. Appl. No. 14/159,880, filed Jan. 21, 2014, entitled "Wideband Antenna and an Electronic Device Including the Same".

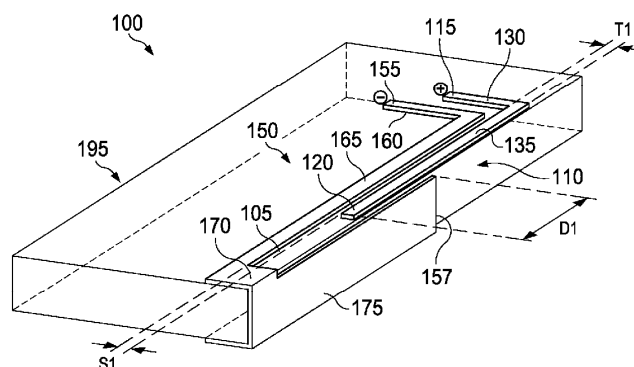
(Continued)

Primary Examiner — Huedung Mancuso

(57) **ABSTRACT**

Provided is an antenna. The antenna, in one embodiment, includes a feed element having a first feed element end and a second feed element end, the first feed element end configured to electrically connect to a positive terminal of a transmission line. The antenna, in this embodiment, further includes a ground element having a first ground element end and a second ground element end, the first ground element end configured to electrically connect to a negative terminal of the transmission line. In this particular embodiment, the first ground element end is located proximate and inside the first feed element end, and the second ground element end is located proximate and outside the second feed element end.

20 Claims, 2 Drawing Sheets





US009368863B2

(12) **United States Patent**
Kwon

(10) **Patent No.:** **US 9,368,863 B2**
(45) **Date of Patent:** **Jun. 14, 2016**

(54) **ANTENNA DEVICE AND ELECTRONIC
DEVICE HAVING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si, Gyeonggi-do (KR)

(72) Inventor: **Ohjong Kwon**, Hwaseong-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 202 days.

(21) Appl. No.: **14/290,228**

(22) Filed: **May 29, 2014**

(65) **Prior Publication Data**
US 2014/0354505 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**
May 29, 2013 (KR) 10-2013-0061326

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 9/0407** (2013.01); **H01Q**
9/0442 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/46; H01Q 1/48; H01Q 1/243;
H01Q 9/0407; H01Q 9/0442
USPC 343/846, 848, 702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,450,072 B2 *	11/2008	Kim		H01Q 1/243
				343/700 MS
2008/0079635 A1	4/2008	Rowell		
2012/0062434 A1	3/2012	Kim et al.		
2012/0218163 A1	8/2012	Wong et al.		
2012/0274532 A1	11/2012	Kurashima et al.		

FOREIGN PATENT DOCUMENTS

JP	2004228861 A	8/2004
KR	1020070063958 A	6/2007
KR	100813313 B1	3/2008
KR	1020090081162 A	7/2009
KR	1020100095910 A	9/2010
KR	1020100098197 A	9/2010
KR	1020100106164 A	10/2010
KR	1020100123307 A	11/2010
KR	1020110019666 A	2/2011
KR	1020110073403 A	6/2011
KR	1020110096021 A	8/2011

* cited by examiner

Primary Examiner — Hoang V Nguyen

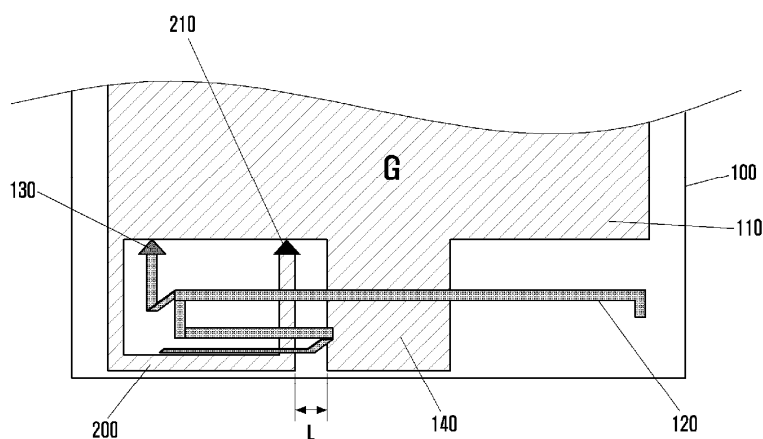
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57)

ABSTRACT

An electronic device with an antenna device is provided. The electronic device include a radiator configured to transmit/receive an electromagnetic wave, a ground portion connected to one end of the radiator, the ground portion configured to conduct current such that a current corresponding to an opposite polarity of a current, which flows in the radiator, flowing in the ground portion, an expanded ground extending from a part of the ground portion, and a ground path extending from the ground portion to a region adjacent to the expanded ground so as to cause current to flow from the ground portion through a current path corresponding to the length of the radiator.

13 Claims, 7 Drawing Sheets





US009368864B2

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

(10) **Patent No.:** **US 9,368,864 B2**

(45) **Date of Patent:** **Jun. 14, 2016**

(54) **ANTENNA DEVICE AND ELECTRONIC APPARATUS USING IT**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Sony Computer Entertainment Inc.**,
Tokyo (JP)

6,469,670	B2	10/2002	Ito	
7,002,521	B2	2/2006	Egawa	
7,468,708	B2	12/2008	Park et al.	
7,554,496	B2 *	6/2009	Qi	H01Q 1/245 343/702

(72) Inventors: **Minoru Wakabayashi**, Tokyo (JP);
Yoshio Miyazaki, Kanagawa (JP)

8,305,274	B2 *	11/2012	Shim	H01Q 1/243 343/702
8,502,741	B2 *	8/2013	Lin	H01Q 1/243 343/700 MS

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Interactive Entertainment Inc.**, Tokyo (JP)

2002/0014994	A1	2/2002	Ito	
2004/0130492	A1	7/2004	Egawa	
2008/0001831	A1	1/2008	Park	
2010/0245178	A1	9/2010	Hsieh	

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 140 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/289,882**

EP	2099093	A1	9/2009
JP	2002026627	A	1/2002
JP	2003258523	A	9/2003
JP	2007067512		3/2007
JP	2008017485	A	1/2008
JP	2010233218	A	10/2010
JP	2013516833	T	5/2013
WO	2011081630	A1	7/2011

(22) Filed: **May 29, 2014**

* cited by examiner

(65) **Prior Publication Data**

US 2014/0368399 A1 Dec. 18, 2014

OTHER PUBLICATIONS

(30) **Foreign Application Priority Data**

Jun. 13, 2013 (JP) 2013-124974

Office Action for corresponding JP Application No. 2013124974, dated Mar. 24, 2015.

Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Matthew B. Dernier, Esq.

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/24 (2006.01)

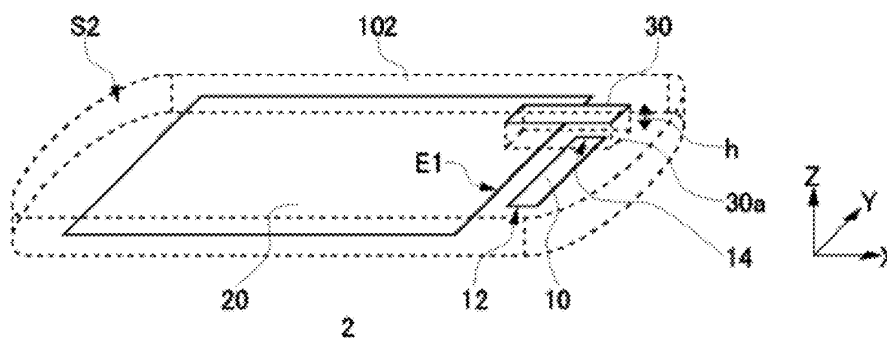
(57) **ABSTRACT**

(52) **U.S. Cl.**
CPC **H01Q 1/52** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/245** (2013.01); **H01Q 1/526** (2013.01)

An antenna device includes a ground conductor, a radiation conductor having a feed point, and a guard conductor that is insulated from the ground conductor and is disposed at a position that is closer to a specific site of a user than the radiation conductor in one use form and is such a position that at least part of the guard conductor overlaps with a place where the intensity of an electric field radiated from the radiation conductor is high.

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/526; H01Q 1/245; H01Q 1/242; H01Q 1/243
USPC 343/841, 702
See application file for complete search history.

14 Claims, 14 Drawing Sheets





US009368869B2

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

(10) **Patent No.:** **US 9,368,869 B2**

(45) **Date of Patent:** **Jun. 14, 2016**

(54) **ANTENNA STRUCTURES AND METHODS**

(71) Applicant: **Skycross, Inc.**, San Jose, CA (US)

(72) Inventors: **Li Chen**, Melbourne, FL (US); **Frank M. Caimi**, Vero Beach, FL (US); **Mark T. Montgomery**, Melbourne Beach, FL (US); **Mark W. Kishler**, Rockledge, FL (US)

(73) Assignee: **SKYXCROSS, INC.**, San Jose, 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.: **14/449,498**

(22) Filed: **Aug. 1, 2014**

(65) **Prior Publication Data**

US 2015/0117502 A1 Apr. 30, 2015

Related U.S. Application Data

(60) Provisional application No. 61/896,233, filed on Oct. 28, 2013, provisional application No. 61/932,831, filed on Jan. 29, 2014, provisional application No. 61/941,888, filed on Feb. 19, 2014.

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H01Q 3/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 3/24** (2013.01); **G01C 21/20** (2013.01); **G01R 23/02** (2013.01); **G01R 25/00** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 13/10; H01Q 3/24; H01Q 5/48; H01Q 21/12; H01Q 1/38; H01Q 5/371; H01Q 9/42; H01Q 9/16; H01Q 21/29; H01Q 1/2291; H01Q 21/0006; H01Q 9/30; H01Q 9/40; H01Q 9/28; H01Q 5/40; H01Q 9/04; H01Q 5/0024; H01Q 9/0442; H01Q 13/103; H01Q 9/145; H01Q 1/50; H01Q 21/00; H01Q 21/28; H01Q 5/00; H01Q 3/34; H04B 7/0404; H04B 1/38; H04B 7/024; H04B 7/0632; H04B 1/401; H04B 7/0413;

H04B 7/0417; H04B 1/0053; H04B 7/0628; H03J 5/244; H03J 5/0245; H03J 5/242; H03J 2200/15; H04W 36/18; H04W 72/085; H04W 40/12; H04W 72/0486; H04W 28/12; H04W 24/08; H04W 64/003; H04W 36/08; H04W 4/026; H04W 36/32; H04W 24/10; H04W 72/0453; H04W 88/06; G01R 25/00; G01R 29/10; G01R 23/02; G01R 29/0807; G01C 21/20

USPC 375/219, 304, 315; 343/702, 893, 843, 343/745, 703, 770
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,947,987 A 8/1960 Dodington
3,646,559 A 2/1972 Wiley

(Continued)

OTHER PUBLICATIONS

"PCT International Search Report and Written Opinion for International Application No. PCT/US07/76667", Date of Mailing: Aug. 20, 2008.

(Continued)

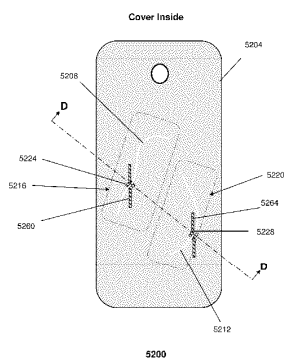
Primary Examiner — Dhaval Patel

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLLC; Robert Gingher

(57) **ABSTRACT**

A communication device that incorporates the subject disclosure may include, for example, a conductive cover, an antenna structure, and a circuit. The antenna structure can comprise a first portion of the conductive cover having a first slot formed therein. The first portion can form a first antenna element for converting between first electromagnetic signals and first electrical signals. The first slot can define a shape of a trade dress design in the conductive cover. The circuit can be communicatively coupled to first edges of the first slot to define a first port. The circuit can perform operations comprising transmitting the first electronic signals into the first antenna element. Other embodiments are disclosed.

20 Claims, 100 Drawing Sheets





US00D758999S

(12) **United States Design Patent** (10) **Patent No.:** **US D758,999 S**
Matsuoka (45) **Date of Patent:** **** Jun. 14, 2016**

(54) **ANTENNA**

(71) Applicant: **Google Inc.**, Mountain View, CA (US)

(72) Inventor: **Yoshimichi Matsuoka**, Sunnyvale, CA (US)

(73) Assignee: **Google Inc.**, Mountain View, CA (US)

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

(21) Appl. No.: **29/494,344**

(22) Filed: **Jun. 19, 2014**

(51) **LOC (10) Cl.** **14-03**

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

USPC **D14/230**

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343/733, 747-748, 753, 779, 781 CA,
343/793-794, 801, 803, 806, 811, 841-842,
343/846, 878-882

CPC H01Q 7/00; H01Q 13/10; H01Q 9/285;
H01Q 19/30; H01Q 19/12; H01Q 1/38;
H04B 1/0475; H04B 1/034; H05K 11/00

See application file for complete search history.

(56)

References Cited

U.S. PATENT DOCUMENTS

2,821,710 A * 1/1958 Hale H01Q 9/26
343/720
3,590,383 A * 6/1971 Nakahara H01Q 13/20
246/30

(Continued)

FOREIGN PATENT DOCUMENTS

CN 301048825 * 10/2009
CN 301171164 * 4/2010

(Continued)

OTHER PUBLICATIONS

One For All SV9215 Indoor Digital TV HD Aerial FM FreeView Aerial Antenna, website copyright 2015, online, <http://www.zeppy.io/product/gb/2/221898960605/one-for-all-sv9215-indoor-digital-tv-hd-aerial-fm-freeview-aerial-antenna-new>, site visited [Oct. 29, 2015 2:35:43 PM].*

(Continued)

Primary Examiner — John Windmuller

Assistant Examiner — John R Yeh

(74) *Attorney, Agent, or Firm* — Honigman Miller Schwartz and Cohn LLP

(57)

CLAIM

The ornamental design for an antenna, as shown and described.

DESCRIPTION

FIG. 1 is a top perspective view of an antenna, showing my new design;

FIG. 2 is a bottom perspective view thereof;

FIG. 3 is a front view thereof; and

FIG. 4 is a rear view thereof.

FIG. 5 is a top view thereof;

FIG. 6 is a bottom view thereof;

FIG. 7 is a left side view thereof;

FIG. 8 is a right side view thereof.

FIG. 9 is a top perspective view of another embodiment of the antenna;

FIG. 10 is a bottom perspective view thereof;

FIG. 11 is a front view thereof; and

FIG. 12 is a rear view thereof.

FIG. 13 is a top view thereof;

FIG. 14 is a bottom view thereof;

FIG. 15 is a left side view thereof; and,

FIG. 16 is a right side view thereof.

The dashed lines in the drawing views depict portions of the design that form no part of the claim. Any dashed, unclaimed portion may be removed from the drawings without affecting the scope of the claim.

1 Claim, 16 Drawing Sheets

