



US009502750B2

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

(10) **Patent No.:** **US 9,502,750 B2**
(45) **Date of Patent:** **Nov. 22, 2016**

(54) **ELECTRONIC DEVICE WITH REDUCED
EMITTED RADIATION DURING LOADED
ANTENNA OPERATING CONDITIONS**

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

(72) Inventors: **Salih Yarga**, Sunnyvale, CA (US);
Qingxiang Li, Mountain View, CA
(US); **Robert W. Schlub**, Cupertino,
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 598 days.

(21) Appl. No.: **13/855,568**

(22) Filed: **Apr. 2, 2013**

(65) **Prior Publication Data**

US 2014/0292587 A1 Oct. 2, 2014

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 9/04 (2006.01)

H01Q 1/38 (2006.01)

H01Q 5/378 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/245**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 5/378**
(2015.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,053,841 B2 5/2006 Ponce De Leon et al.
7,345,634 B2 3/2008 Ozkar et al.

8,000,737 B2	8/2011	Caimi et al.	
8,159,399 B2	4/2012	Dorsey et al.	
8,344,956 B2	1/2013	Montgomery et al.	
8,417,296 B2	4/2013	Caballero et al.	
8,432,322 B2	4/2013	Amm et al.	
2011/0012794 A1	1/2011	Schlub et al.	
2012/0214412 A1	8/2012	Schlub et al.	
2013/0057441 A1	3/2013	Brown et al.	
2013/0135157 A1 *	5/2013	Tsou	H01Q 1/2266 343/702
2015/0372371 A1 *	12/2015	Lagnado	H01Q 1/22 343/720

OTHER PUBLICATIONS

Schlub et al., U.S. Appl. No. 13/865,578, filed Apr. 18, 2013.
Caballero et al., U.S. Appl. No. 13/886,157, filed May 2, 2013.

* cited by examiner

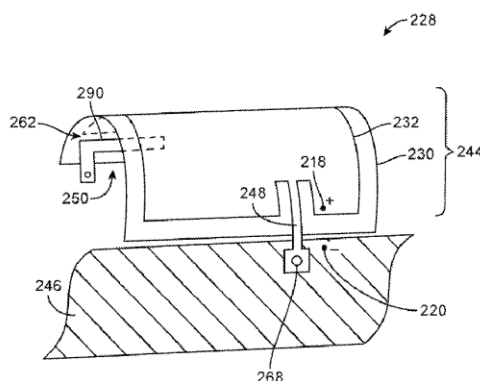
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

An electronic device may have an antenna for providing coverage in wireless communications bands of interest. The wireless communications bands may include a communications band at a first frequency. The antenna may have a parasitic antenna resonating element that supports a low efficiency resonance. In response to operation of the electronic device in free space, the low efficiency resonance will be located at a second frequency that is greater than the first frequency. In response to operation of the electronic device in proximity to a user's body or other external object, the antenna will be loaded and the low efficiency resonance associated with the parasitic antenna resonating element will shift to the communications band at the first frequency. The antenna may include a resonating element formed on a flexible printed circuit or a dielectric carrier such as a plastic support structure.

7 Claims, 13 Drawing Sheets





US009502752B2

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

(10) **Patent No.:** **US 9,502,752 B2**

(45) **Date of Patent:** ***Nov. 22, 2016**

(54) **ANTENNA HAVING FLEXIBLE FEED
STRUCTURE WITH COMPONENTS**

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

(72) Inventors: **Dean F. Darnell**, San Jose, CA (US);
William J. Noellert, Sunnyvale, CA
(US); **Mattia Pascolini**, San Francisco,
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 169 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **14/486,602**

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

(65) **Prior Publication Data**

US 2015/0035706 A1 Feb. 5, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/435,351, filed on
Mar. 30, 2012, now Pat. No. 8,836,587.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/50 (2006.01)
H05K 1/02 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 1/50** (2013.01); **H01Q 9/045**
(2013.01); **H05K 1/028** (2013.01); **H05K**
1/181 (2013.01); **H05K 1/189** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 1/50;
H01Q 9/045

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,173,055 A 12/1992 Grabbe
5,583,523 A 12/1996 Wallace
6,075,713 A 6/2000 Lee et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101682119 3/2010
CN 201533015 7/2010

(Continued)

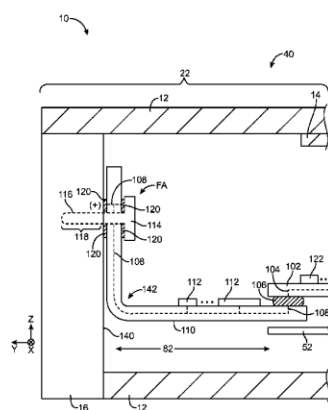
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

Electronic devices may include antenna structures. The antenna structures may form an antenna having first and second feeds at different locations. Transceiver circuitry for transmitting and receiving radio-frequency antenna signals may be mounted on one end of a printed circuit board. Transmission line structures may be used to convey signals between an opposing end of the printed circuit board and the transceiver circuitry. The printed circuit board may be coupled to an antenna feed structure formed from a flexible printed circuit using solder connections. The flexible printed circuit may have a bend and may be screwed to conductive electronic device housing structures using one or more screws at one or more respective antenna feed terminals. Electrical components such as an amplifier circuit and filter circuitry may be mounted on the flexible printed circuit.

19 Claims, 12 Drawing Sheets





US009502757B2

(12) **United States Patent**
Zuniga

(10) **Patent No.:** **US 9,502,757 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **LOW-COST ULTRA WIDEBAND LTE**
ANTENNA

(71) Applicant: **Eleazar Zuniga**, Escondido, CA (US)

(72) Inventor: **Eleazar Zuniga**, Escondido, CA (US)

(73) Assignee: **TAOGLAS GROUP HOLDINGS**
LIMITED, Wexford (IE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 42 days.

(21) Appl. No.: **14/438,611**

(22) PCT Filed: **Oct. 8, 2013**

(86) PCT No.: **PCT/US2013/063947**

§ 371 (c)(1),

(2) Date: **May 1, 2015**

(87) PCT Pub. No.: **WO2014/058926**

PCT Pub. Date: **Apr. 17, 2014**

(65) **Prior Publication Data**

US 2015/0288059 A1 Oct. 8, 2015

Related U.S. Application Data

(60) Provisional application No. 61/711,196, filed on Oct. 8, 2012.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
H01Q 9/42 (2006.01)

H01Q 5/364 (2015.01)

H01Q 5/10 (2015.01)

H01Q 5/371 (2015.01)

H01Q 9/40 (2006.01)

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

CPC **H01Q 1/38** (2013.01); **H01Q 5/10**
(2015.01); **H01Q 5/364** (2015.01); **H01Q**
5/371 (2015.01); **H01Q 9/40** (2013.01); **H01Q**
9/42 (2013.01)

(58) **Field of Classification Search**

CPC **H01Q 1/38**; **H01Q 9/0414**; **H01Q 9/0421**;
H01Q 5/364

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,657,593 B2 * 12/2003 Nagumo **H01Q 1/38**
343/700 MS

7,345,650 B2 * 3/2008 Bae **H01Q 1/36**
343/700 MS

* cited by examiner

Primary Examiner — Dameon E Levi

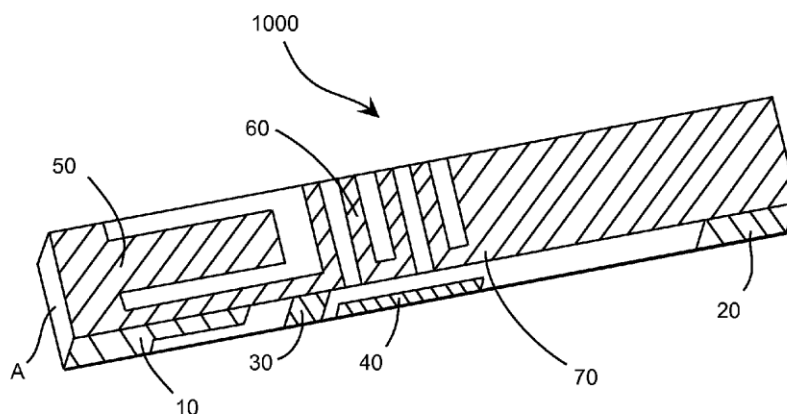
Assistant Examiner — Ricardo Magallanes

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

(57) **ABSTRACT**

An antenna capable of operating among all LTE bands, and also capable of operation among all remote side cellular applications, such as GSM, AMPS, GPRS, CDMA, WCDMA, UMTS, and HSPA among others. The antenna provides a low cost alternative to active-tunable antennas suggested in the prior art for the same multi-platform objective.

14 Claims, 7 Drawing Sheets





US009502769B2

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

(10) **Patent No.:** **US 9,502,769 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **MULTIBAND SWITCHABLE ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)

(72) Inventors: **Chin-Lung Tsai**, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Ying-Cong Deng, Taoyuan (TW);
Chung-Hung Lo, Taoyuan (TW);
Kuan-Hsien Lee, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**,
Guishan Dist., Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 11 days.

(21) Appl. No.: **14/695,817**

(22) Filed: **Apr. 24, 2015**

(65) **Prior Publication Data**

US 2016/0156101 A1 Jun. 2, 2016

(30) **Foreign Application Priority Data**

Nov. 28, 2014 (TW) 103141339 A

(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 5/328 (2015.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/328** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/328
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0278755 A1 * 11/2009 Shoji H01Q 1/24
343/745
2011/0102290 A1 * 5/2011 Milosavljevic H01Q 1/243
343/852
2011/0128200 A1 6/2011 Hossain et al.
2013/0154897 A1 * 6/2013 Sorensen H01Q 7/005
343/861
2013/0194139 A1 * 8/2013 Nickel H01Q 5/328
343/703
2014/0253398 A1 * 9/2014 Hsieh H01Q 5/328
343/745

FOREIGN PATENT DOCUMENTS

TW I 436620 5/2014

OTHER PUBLICATIONS

Chinese language office action dated Dec. 18, 2015, issued in application No. TW 103141339.

* cited by examiner

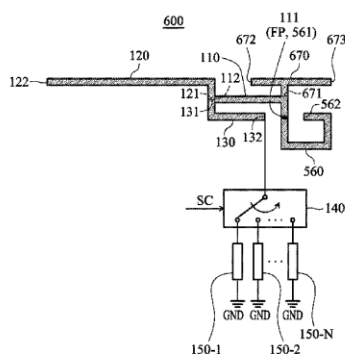
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A multiband switchable antenna structure includes a feeding element, a first radiation element, a second radiation element, circuit branches, and a switch circuit. A first end of the feeding element is a feeding point. A first end of the first radiation element is coupled to a second end of the feeding element. A second end of the first radiation element is open. A first end of the second radiation element is coupled to the second end of the feeding element. The circuit branches have different impedance values. The switch circuit selects one of the circuit branches as a matching branch according to a control signal. A second end of the second radiation element is coupled through the matching branch to a ground voltage.

9 Claims, 7 Drawing Sheets





(12) **United States Patent**
Rao

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

(71) Applicant: **BlackBerry Limited**, Waterloo (CA)

(72) Inventor: **Qinjiang Rao**, Kanata (CA)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 320 days.

OTHER PUBLICATIONS

(21) Appl. No.: 13/948,845

(22) Filed: **Jul. 23, 2013**

(65) **Prior Publication Data**

US 2014/0028511 A1 Jan. 30, 2014

Related U.S. Application Data

(62) Division of application No. 12/615,267, filed on Nov. 10, 2009, now Pat. No. 8,514,132.

(51) **Int. Cl.**
H01Q 5/35 (2015.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/30 (2015.01)

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

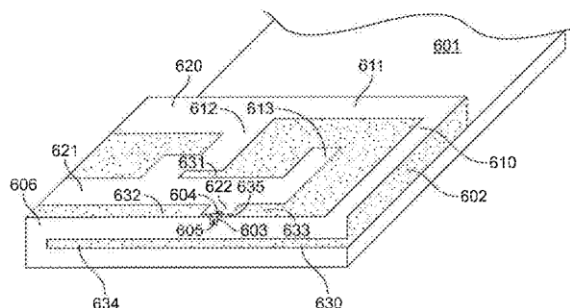
(52) **U.S. Cl.**
CPC **H01Q 5/35** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 5/30** (2015.01); **H01Q**
9/0421 (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0008146	A1	1/2004	Ikegaya et al.	
2004/0263396	A1	12/2004	Sung	
2008/0094290	A1	4/2008	Wen et al.	
2008/0266186	A1*	10/2008	Tai	H01Q 1/2266 343/700 MS





US009502771B2

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

(10) **Patent No.:** **US 9,502,771 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **LOOP ANTENNA FOR MOBILE HANDSET
AND OTHER APPLICATIONS**

(75) Inventors: **Marc Harper**, Cambridge (GB); **Devis
Iellici**, Cambridge (GB); **Christopher
Tomlin**, Cambridge (GB)

(73) Assignee: **Microsoft Technology Licenseing,
LLC**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 297 days.

(21) Appl. No.: **13/878,971**

(22) PCT Filed: **Sep. 28, 2011**

(86) PCT No.: **PCT/GB2011/051837**

§ 371 (c)(1),
(2), (4) Date: **Apr. 11, 2013**

(87) PCT Pub. No.: **WO2012/049473**

PCT Pub. Date: **Apr. 19, 2012**

(65) **Prior Publication Data**

US 2013/0201074 A1 Aug. 8, 2013

(30) **Foreign Application Priority Data**

Oct. 15, 2010 (GB) 1017472

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 5/378 (2015.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 5/321**
(2015.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 7/00; H01Q 7/005
USPC 343/870, 702, 744, 866, 749
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,993,998 A 11/1976 Kimmett
4,940,992 A 7/1990 Nguyen et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0584882 A1 3/1994
EP 1063722 A2 12/2000

(Continued)

OTHER PUBLICATIONS

Di Nallo et al "Multiband internal antenna for mobile phones,"
Electronic Letters, vol. 41, Issue 9, dated Apr. 28, 2005, pp. 514-515
(<http://ieeexplore.org/xpl/articleDetails.jsp?arenumber>).

(Continued)

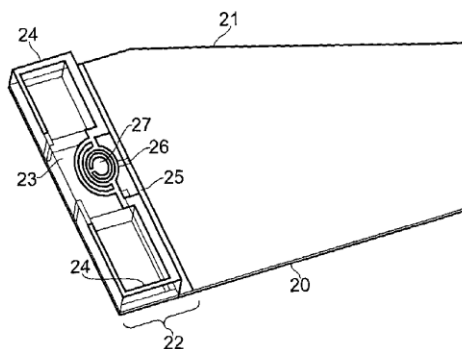
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Brandon Roper; Judy
Yee; Micky Minhas

(57) **ABSTRACT**

There is disclosed a loop antenna for mobile handsets and other devices. The antenna comprises a dielectric substrate (23) having first and second opposed surfaces and a conductive track (24) formed on the substrate (23). A feed point (26) and a grounding point (25) are provided adjacent to each other on the first surface of the substrate (23), with the conductive track (24) extending in generally opposite directions from the feed point (26) and grounding point (25) respectively and winding around the substrate (23) to the second surface and passing along a path generally opposite to the path taken on the first surface of the dielectric substrate (23). The conductive tracks (24) then connect to respective sides of a conductive arrangement (27) that extends into a central part of a loop formed by the conductive track (24) on the second surface of the dielectric substrate (23). The conductive arrangement (27) comprises both inductive and capacitive elements. The antenna can be multi-moded and operate in several frequency bands. Alternatively, the loop antenna is fed parasitically by a monopole or a feeding loop. The parasitic loop antenna may alternatively comprise a conductive loading plate instead of the conductive arrangement.

18 Claims, 8 Drawing Sheets





US009502772B2

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

(10) **Patent No.:** **US 9,502,772 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**

USPC 343/770
See application file for complete search history.

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

(72) Inventors: **Jin-Bo Chen**, New Taipei (TW);
Che-Yen Lin, 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 420 days.

(21) Appl. No.: **14/061,929**

(22) Filed: **Oct. 24, 2013**

(65) **Prior Publication Data**

US 2014/0354497 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**

Jun. 4, 2013 (TW) 102119701 A

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 5/378 (2015.01)
H01Q 9/42 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 9/42

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,764,236 B2 * 7/2010 Hill H01Q 1/243
343/702
8,405,557 B2 * 3/2013 Lu H01Q 9/26
343/700 MS
8,441,399 B2 * 5/2013 Wu H01Q 1/2258
343/700 MS
2003/0189522 A1 * 10/2003 Zeilinger H01Q 9/0421
343/702
2004/0041734 A1 * 3/2004 Shiotsu G06F 1/1616
343/702
2009/0153409 A1 * 6/2009 Chiang H01Q 1/243
343/702
2012/0262342 A1 10/2012 Lee

FOREIGN PATENT DOCUMENTS

TW 201132119 9/2011

* cited by examiner

Primary Examiner — Dameon E Levi

Assistant Examiner — Hasan Islam

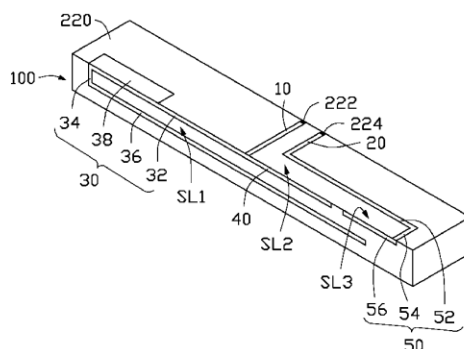
(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57) **ABSTRACT**

An antenna structure includes a feed section, a ground section, a first radiator, a second radiator, and a third radiator. The first radiator and the second radiator are both connected to the feed section. The third radiator is connected to the ground section. The first radiator defines a first slot. A second slot is defined between the second radiator and the third radiator. The third radiator defines a third slot. The third slot communicates with the second slot. Current is coupled from the first radiator and the second radiator to the third radiator via the first slot, the second slot, and the third slot.

20 Claims, 3 Drawing Sheets

200





US009502775B1

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

(10) **Patent No.:** **US 9,502,775 B1**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **SWITCHING A SLOT ANTENNA**

(71) Applicant: **GOOGLE INC.**, Mountain View, CA (US)

(72) Inventors: **Ajay Chandra Venkata Gummalla**, Sunnyvale, CA (US); **Huan Liao**, Mountain View, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 85 days.

(21) Appl. No.: **14/254,546**

(22) Filed: **Apr. 16, 2014**

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H04B 1/401 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H04B 1/401** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,392,139 A * 7/1983 Aoyama H01Q 25/002 343/705
5,754,143 A * 5/1998 Warnagiris H01Q 1/36 343/746

2003/0122721 A1 * 7/2003 Sievenpiper H01Q 9/14 343/767
2006/0044200 A1 * 3/2006 Mori H01Q 19/30 343/770
2006/0079177 A1 * 4/2006 Okubora H01Q 1/24 455/25
2007/0002805 A1 * 1/2007 Laurila H01Q 1/246 370/337
2014/0049432 A1 * 2/2014 Hill H01Q 1/243 343/702

* cited by examiner

Primary Examiner — David Bilodeau

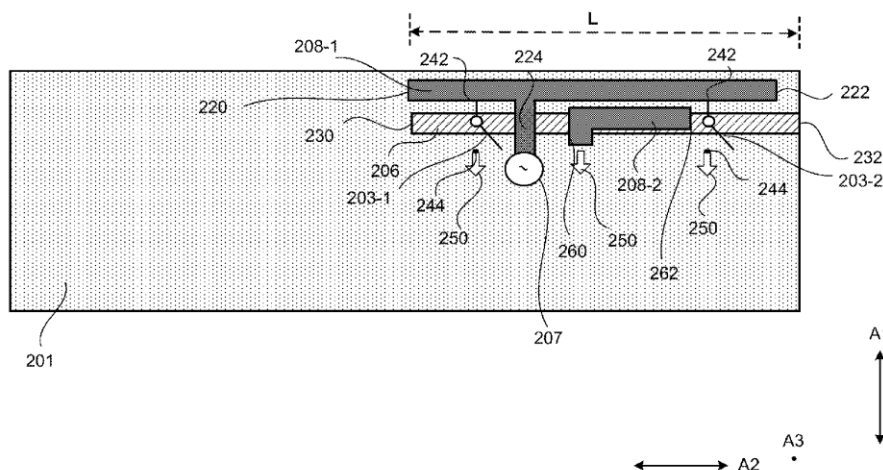
(74) *Attorney, Agent, or Firm* — Brake Hughes
Bellerma LLP

(57) **ABSTRACT**

A computing device may include a conductive member, a slot antenna having a slot defined by the conductive member and an antenna pattern portion disposed proximate to the slot, and/or a slot switch configured to switch a portion of the slot. The slot switch may have a first terminal and a second terminal such that the portion of the slot is disposed between the first terminal and the second terminal. The slot switch may be switchable between a first configuration in which the first and second terminals are electrically connected and a second configuration in which the first and second terminals are not electrically connected. The computing device may also include a switching controller configured to switch the slot switch between the first and second configurations.

14 Claims, 5 Drawing Sheets

200





US009502776B2

(12) **United States Patent**
Di Nallo et al.

(10) **Patent No.:** **US 9,502,776 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **ANTENNA SURROUNDED BY METAL HOUSING**

(71) Applicants: **Carlo Di Nallo**, Plantation, FL (US);
Simone Paulotto, Rockville, MD (US)

(72) Inventors: **Carlo Di Nallo**, Plantation, FL (US);
Simone Paulotto, Rockville, MD (US)

(73) Assignee: **MAXTENA**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 385 days.

(21) Appl. No.: **13/841,744**

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

(65) **Prior Publication Data**

US 2014/0111388 A1 Apr. 24, 2014

Related U.S. Application Data

(60) Provisional application No. 61/621,910, filed on Apr. 9, 2012, provisional application No. 61/767,773, filed on Feb. 21, 2013.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/00 (2015.01)
H01Q 13/10 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/364 (2015.01)
H01Q 5/378 (2015.01)

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

CPC **H01Q 13/106** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/364** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01); **H01Q 13/10** (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 1/44; **H01Q 5/278**; **H01Q 5/385**;
H01Q 5/392; **H01Q 9/0421**; **H01Q 13/10**;
H01Q 13/103; **H01Q 13/106**; **H01Q 13/16**;
H01Q 13/18; **H01Q 5/314**; **H01Q 5/328**;
H01Q 5/378
USPC **343/702**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,100,849 A * 8/2000 Tsubaki et al. **343/702**
6,518,922 B1 * 2/2003 Hoffmeister **H01Q 9/0421**
343/700 MS
6,614,400 B2 * 9/2003 Egorov **H01Q 1/243**
343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1973197 A1 9/2008
EP 2434576 A1 3/2012

Primary Examiner — Sue A Purvis

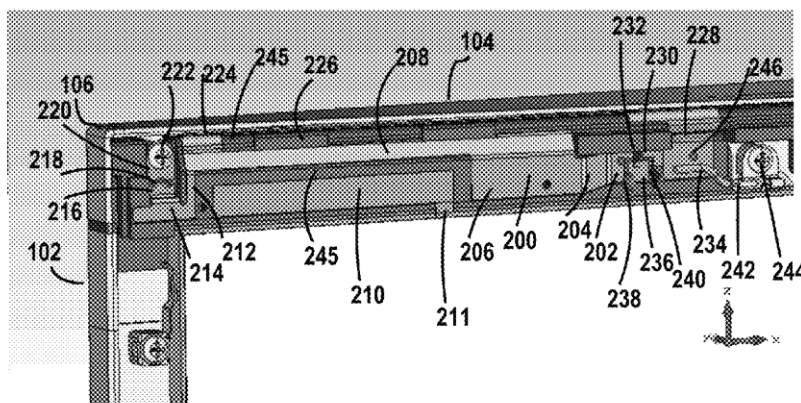
Assistant Examiner — Patrick Holecek

(57) **ABSTRACT**

An antenna system includes a metal housing including a first edge and a second edge that meet at a corner and a slot located proximate the second edge that extends from the first edge parallel to the second edge defining a strip and an antenna located behind and in close proximity to the strip. The antenna is coupled to the strip. A parasitic element is located proximate the antenna and the strip includes a ground coupling that crosses the slot in spaced relation thereto. The parasitic element assists in establishing second and third higher frequency modes of the antenna system.

21 Claims, 9 Drawing Sheets

100





US009502772B2

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

(10) **Patent No.:** **US 9,502,772 B2**

(45) **Date of Patent:** **Nov. 22, 2016**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**

USPC 343/770
See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Jin-Bo Chen**, New Taipei (TW);
Che-Yen Lin, New Taipei (TW);
Cho-Kang Hsu, New Taipei (TW)

7,764,236 B2 * 7/2010 Hill H01Q 1/243
343/702
8,405,557 B2 * 3/2013 Lu H01Q 9/26
343/700 MS
8,441,399 B2 * 5/2013 Wu H01Q 1/2258
343/700 MS
2003/0189522 A1 * 10/2003 Zeilinger H01Q 9/0421
343/702
2004/0041734 A1 * 3/2004 Shiotsu G06F 1/1616
343/702
2009/0153409 A1 * 6/2009 Chiang H01Q 1/243
343/702
2012/0262342 A1 10/2012 Lee

(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 420 days.

(21) Appl. No.: **14/061,929**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Oct. 24, 2013**

TW 201132119 9/2011

(65) **Prior Publication Data**

US 2014/0354497 A1 Dec. 4, 2014

* cited by examiner

(30) **Foreign Application Priority Data**

Jun. 4, 2013 (TW) 102119701 A

Primary Examiner — Dameon E Levi

Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Zhigang Ma

(51) **Int. Cl.**

H01Q 13/10 (2006.01)

H01Q 5/378 (2015.01)

H01Q 9/42 (2006.01)

H01Q 1/24 (2006.01)

H01Q 5/371 (2015.01)

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

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

(58) **Field of Classification Search**

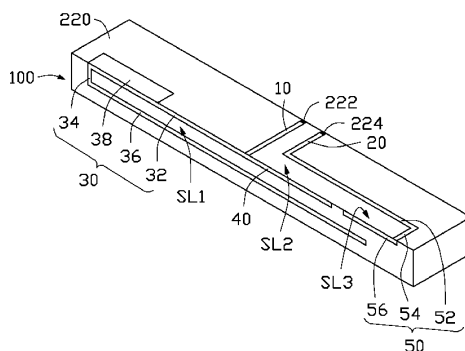
CPC H01Q 13/10; H01Q 9/42

(57) **ABSTRACT**

An antenna structure includes a feed section, a ground section, a first radiator, a second radiator, and a third radiator. The first radiator and the second radiator are both connected to the feed section. The third radiator is connected to the ground section. The first radiator defines a first slot. A second slot is defined between the second radiator and the third radiator. The third radiator defines a third slot. The third slot communicates with the second slot. Current is coupled from the first radiator and the second radiator to the third radiator via the first slot, the second slot, and the third slot.

20 Claims, 3 Drawing Sheets

200





US009509042B1

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

(10) **Patent No.:** **US 9,509,042 B1**

(45) **Date of Patent:** **Nov. 29, 2016**

(54) **SINGLE FEED PASSIVE ANTENNA FOR A METAL BACK COVER**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Amazon Technologies, Inc.**, Seattle, WA (US)

(72) Inventors: **Ming Zheng**, Cupertino, CA (US); **Adrian Napoles**, Cupertino, CA (US); **Jerry Kuo**, San Jose, CA (US); **Khaled Obeidat**, Santa Clara, CA (US)

2011/0001673	A1 *	1/2011	You	H01Q 1/243	343/702
2012/0112969	A1 *	5/2012	Caballero	H01Q 1/243	343/702
2012/0299785	A1 *	11/2012	Bevelacqua	H01Q 9/42	343/702
2013/0169490	A1 *	7/2013	Pascolini	H01Q 5/357	343/702
2014/0266922	A1 *	9/2014	Jin	H01Q 21/28	343/702

(73) Assignee: **Amazon Technologies, Inc.**, Seattle, WA (US)

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.

CN	102394354	A	3/2012
WO	2013107921	A1	7/2013

* cited by examiner

Primary Examiner — Hoanganh Le

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

(21) Appl. No.: **14/819,412**

(57) **ABSTRACT**

(22) Filed: **Aug. 5, 2015**

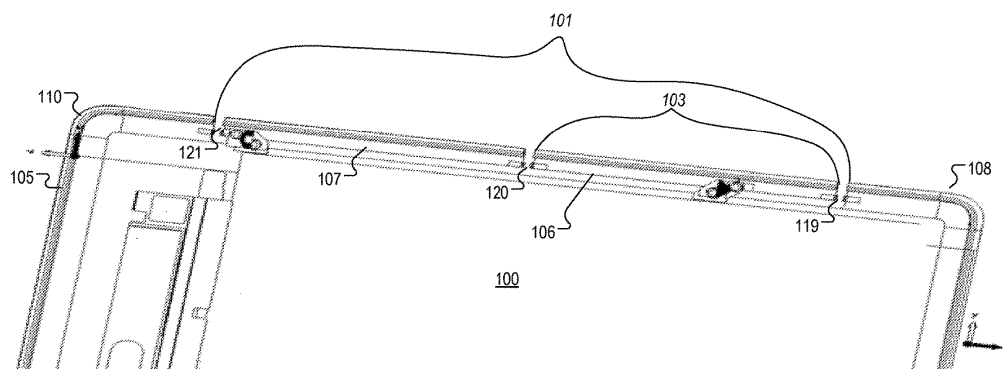
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/307** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/307
USPC 343/702, 872, 846, 848, 700 MS
See application file for complete search history.

Antenna structures and methods of operating the same are described. One apparatus includes a metal cover having a first corner ground element, a second corner ground element, a first strip element, a second strip element, a radio frequency (RF) feed, and a RF circuit. The first strip element is physically separated from the first corner ground element by a first cutout in the metal cover. The first strip element is physically separated from the second strip element by a second cutout in the metal cover. The second strip element is physically separated from the second corner ground element by a third cutout in the metal cover. The RF circuitry is coupled to the RF feed, where the RF circuitry is operable to cause the first corner ground element and the first strip element as well as the second corner ground element and the second strip element to radiate electromagnetic energy.

20 Claims, 9 Drawing Sheets





US009509048B2

(12) **United States Patent**
Kashiwagi

(10) **Patent No.:** **US 9,509,048 B2**

(45) **Date of Patent:** **Nov. 29, 2016**

(54) **ANTENNA APPARATUS AND ELECTRONIC
DEVICE INCLUDING THE ANTENNA
APPARATUS**

(71) Applicant: **KABUSHIKI KAISHA TOSHIBA**,
Minato-ku, Tokyo (JP)

(72) Inventor: **Ippei Kashiwagi**, Tokyo (JP)

(73) Assignee: **KABUSHIKI KAISHA TOSHIBA**,
Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 11 days.

(21) Appl. No.: **14/726,970**

(22) Filed: **Jun. 1, 2015**

(65) **Prior Publication Data**

US 2016/0064818 A1 Mar. 3, 2016

Related U.S. Application Data

(60) Provisional application No. 62/043,280, filed on Aug.
28, 2014.

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 5/378 (2015.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 5/378**
(2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/364; H01Q 5/371
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,136,022	B2	11/2006	Sato et al.
7,477,199	B2	1/2009	Hotta et al.
7,791,546	B2	9/2010	Hotta et al.
8,941,548	B2	1/2015	Kashiwagi et al.
2008/0169981	A1	7/2008	Hotta et al.
2009/0079639	A1	3/2009	Hotta et al.
2012/0249393	A1	10/2012	Hotta et al.
2013/0050036	A1	2/2013	Kashiwagi et al.
2013/0257681	A1	10/2013	Kashiwagi et al.
2013/0285870	A1	10/2013	Hotta et al.
2014/0354484	A1	12/2014	Kashiwagi et al.
2014/0354489	A1	12/2014	Kashiwagi

FOREIGN PATENT DOCUMENTS

JP	3775795	B1	5/2008
JP	2008-177668	A	7/2008
JP	4233100	B2	3/2009
JP	4643624	B2	3/2011
JP	2012-213231	A	11/2012
JP	5127966	B1	1/2013

(Continued)

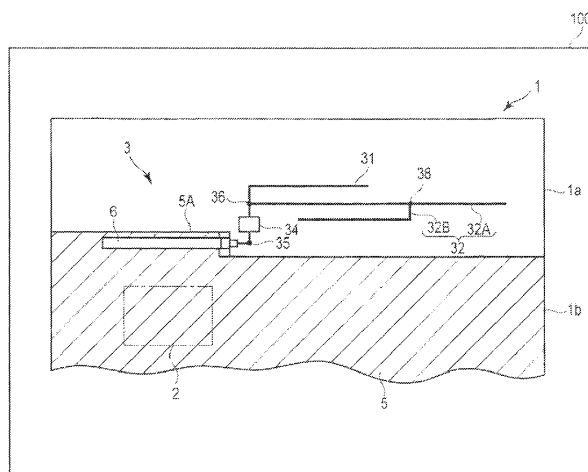
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

According to one embodiment, an antenna includes a second element that has an end connected to a first point of a first element, and first and second ends kept open, and includes a first portion extending from a feed terminal to the first end, and a second portion extending from the feed terminal and bifurcated at a second point between the first point and the first end. The lengths of the first and second portions are set to substantially $\frac{1}{4}$ of a resonance frequency, and substantially $\frac{3}{4}$ of a resonance frequency, severally. The second portion includes a portion extending from the feed terminal to the second point, and a portion extending from the second point to the second end and interposed between the portion and a ground.

10 Claims, 12 Drawing Sheets





US009509814B1

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

(10) **Patent No.:** **US 9,509,814 B1**

(45) **Date of Patent:** **Nov. 29, 2016**

(54) **MOBILE TERMINAL**

(71) Applicants: **Hua Jiang**, Shenzhen (CN); **Li Han**,
Shenzhen (CN)

(72) Inventors: **Hua Jiang**, Shenzhen (CN); **Li Han**,
Shenzhen (CN)

(73) Assignee: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

(*) 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.: **15/061,834**

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

(30) **Foreign Application Priority Data**

Jul. 31, 2015 (CN) 2015 1 0460536

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/0274** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0202; H04M 1/0249; H04M
1/0254; H04M 1/0274
USPC 455/575.1, 575.3, 575.4, 575.5, 90.3
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2013/0207854 A1 * 8/2013 Ryu H01Q 5/35
343/702
2014/0320359 A1 * 10/2014 Wong H01Q 5/35
343/749
2015/0270619 A1 * 9/2015 Zhu G01V 3/00
343/702

* cited by examiner

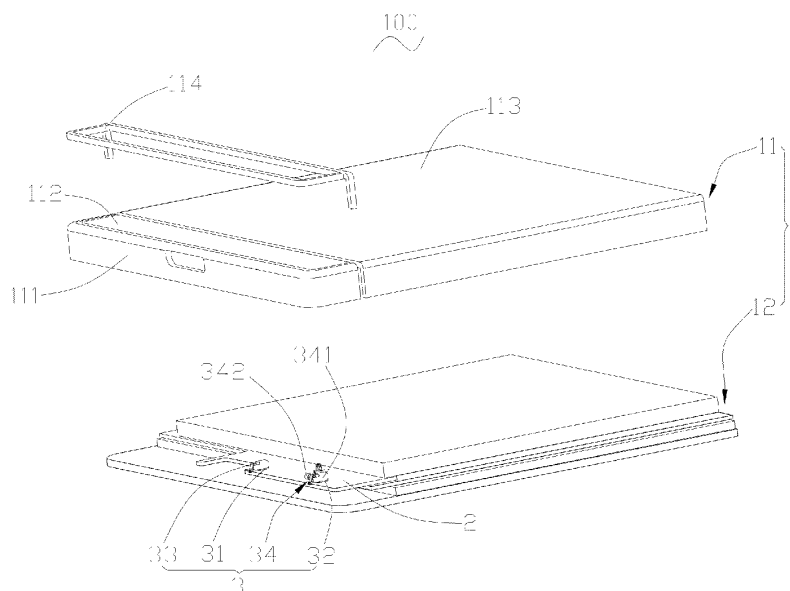
Primary Examiner — Tuan Pham

(74) *Attorney, Agent, or Firm* — Na Xu; IPro, PLLC

(57) **ABSTRACT**

A mobile terminal is disclosed. The mobile terminal includes a housing with an accommodation space, the housing including a metal rear cover serving as a radiator, the metal rear cover including a first metal part, a second metal part and a third metal part insulated to each other; a mainboard received in the accommodation space, the mainboard including a grounding part and a feed part; an antenna module including a grounding dynamic switch unit and a feed dynamic switch unit; wherein the grounding dynamic switch unit is connected between the grounding part and the first metal part, one end of the feed dynamic switch unit connects with the feed part, and the other end connects with the first metal part or the second metal part selectively.

10 Claims, 8 Drawing Sheets





US009515381B2

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

(10) **Patent No.:** **US 9,515,381 B2**

(45) **Date of Patent:** **Dec. 6, 2016**

(54) **ANTENNA**

(71) Applicants: **LG INNOTEK CO., LTD.**, Seoul (KR); **INDUSTRY-UNIVERSITY COOPERATION FOUNDATION HANYANG UNIVERSITY**, Seoul (KR)

(72) Inventors: **Sae Won Oh**, Seoul (KR); **Hyeong Dong Kim**, Seoul (KR); **Sin Hyung Jeon**, Seoul (KR); **Bum Ki Park**, Seoul (KR); **Jin Hyuk Jang**, 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 575 days.

(21) Appl. No.: **13/871,741**

(22) Filed: **Apr. 26, 2013**

(65) **Prior Publication Data**

US 2013/0285872 A1 Oct. 31, 2013

(30) **Foreign Application Priority Data**

Apr. 27, 2012 (KR) 10-2012-0044991

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

(52) **U.S. Cl.**
CPC **H01Q 5/0041** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/357** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/335; H01Q 5/357; H01Q 5/371; H01Q 5/314
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2001/0054979 A1 * 12/2001 Bahr H01Q 1/243 343/700 MS

2004/0087341 A1 5/2004 Edvardsson
(Continued)

FOREIGN PATENT DOCUMENTS

CN 201867863 U 6/2011
CN 102299418 A 12/2011

(Continued)

OTHER PUBLICATIONS

European Search Report dated Aug. 9, 2013 in European Application No. 13157124.2.

(Continued)

Primary Examiner — Sue A Purvis

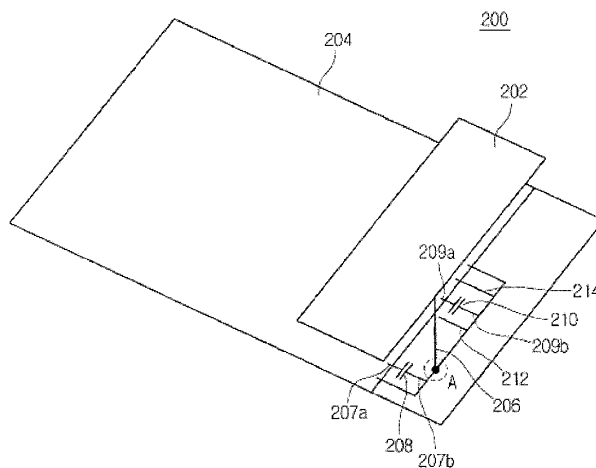
Assistant Examiner — Daniel J Munoz

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

(57) **ABSTRACT**

An antenna according to an embodiment includes a substrate; a radiator; a ground plane spaced apart from the radiator; a feeding pin for feeding an RF signal; a first branch reactance at one side of the feeding pin, the first branch reactance including one end connected to the substrate and an opposite end connected to the ground plane; and a second branch reactance at an opposite end of the feeding pin, the second branch reactance including one end connected to the substrate and an opposite end connected to the ground plane.

11 Claims, 3 Drawing Sheets





US009520641B2

(12) **United States Patent**
Lin

(10) **Patent No.:** **US 9,520,641 B2**

(45) **Date of Patent:** **Dec. 13, 2016**

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

USPC 343/700 MS, 702, 829, 846, 848
See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventor: **Yen-Hui Lin**, New Taipei (TW)

7,034,754 B2 * 4/2006 Hung H01Q 1/242

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

7,091,908 B2 * 8/2006 Fabrega-Sanchez .. H01Q 1/243

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 508 days.

7,339,528 B2 * 3/2008 Wang H01Q 1/243

7,642,967 B2 * 1/2010 Wang H01Q 1/243

8,325,094 B2 * 12/2012 Ayala Vazquez H01Q 1/2258

8,587,486 B2 * 11/2013 Chiu H01Q 9/0421

8,698,673 B2 * 4/2014 Wong H01Q 1/2266

2008/0165063 A1 * 7/2008 Schlub H01Q 1/243

343/702

* cited by examiner

(21) Appl. No.: **14/014,633**

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

(65) **Prior Publication Data**

US 2014/0313098 A1 Oct. 23, 2014

(30) **Foreign Application Priority Data**

Apr. 23, 2013 (TW) 102114467 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/378 (2015.01)

H01Q 5/392 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/378**
(2015.01); **H01Q 5/392** (2015.01); **H01Q 9/42**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/234; H01Q 5/378; H01Q 5/392;
H01Q 9/42

Primary Examiner — Tho G Phan

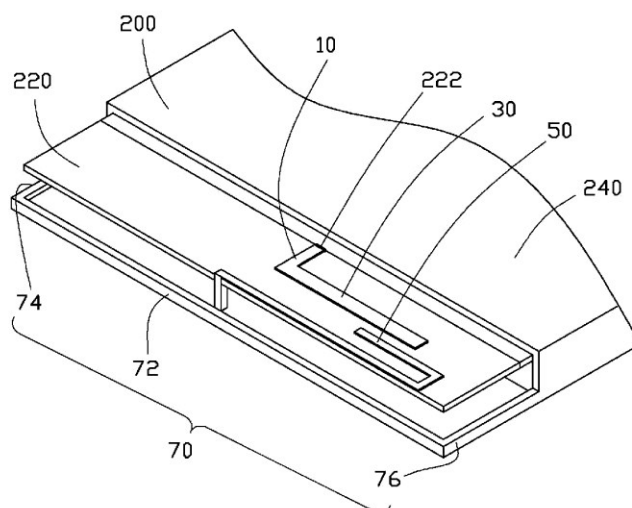
(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57)

ABSTRACT

An antenna assembly which can be adapted for the metal housing of any wireless device includes a feeding terminal, a first radiator connecting to the feeding terminal, a second radiator positioned parallel and adjacent to the first radiator, and a metal element connecting to the second radiator. The wireless signal fed to the first radiator can be coupled to the second radiator, and flows through the metal element to ground, thus utilizing the metal housing itself in the wireless transmission and reception process. An electronic device using the antenna assembly is also described.

13 Claims, 6 Drawing Sheets





US009520650B2

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

(10) **Patent No.:** **US 9,520,650 B2**

(45) **Date of Patent:** **Dec. 13, 2016**

(54) **COMBINATION LTE AND WIGIG ANTENNA**

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

(72) Inventors: **Songnan Yang**, San Jose, CA (US);
Helen K. Pan, Portland, OR (US);
Manish A. Hiranandanl, Santa Clara, CA (US); **Fan (Cherry) Xia**, Shanghai (CN); **Ulun Karacaoglu**, San Diego, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 218 days.

(21) Appl. No.: **14/230,316**

(22) Filed: **Mar. 31, 2014**

(65) **Prior Publication Data**

US 2015/0280318 A1 Oct. 1, 2015

(51) **Int. Cl.**
H01Q 9/40 (2006.01)
H01Q 21/00 (2006.01)
H01Q 5/378 (2015.01)
H01Q 5/40 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 9/40** (2013.01); **H01Q 5/378** (2015.01); **H01Q 5/40** (2015.01); **H01Q 21/00** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/40; H01Q 5/378

USPC 343/700 MS, 725, 729, 893, 702

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,298,339 B1 * 11/2007 Ollikainen H01Q 1/243
343/700 MS
7,446,712 B2 * 11/2008 Itoh H01Q 13/206
343/700 MS
7,973,726 B2 * 7/2011 Tseng H01Q 1/243
343/700 MS
8,242,970 B2 * 8/2012 Fukui H01Q 1/38
343/700 MS
2007/0164920 A1 * 7/2007 Chen H01Q 1/2275
343/795

FOREIGN PATENT DOCUMENTS

CN 101971519 A 2/2011
TW 201251198 A 12/2012
TW M472323 U 11/2013

* cited by examiner

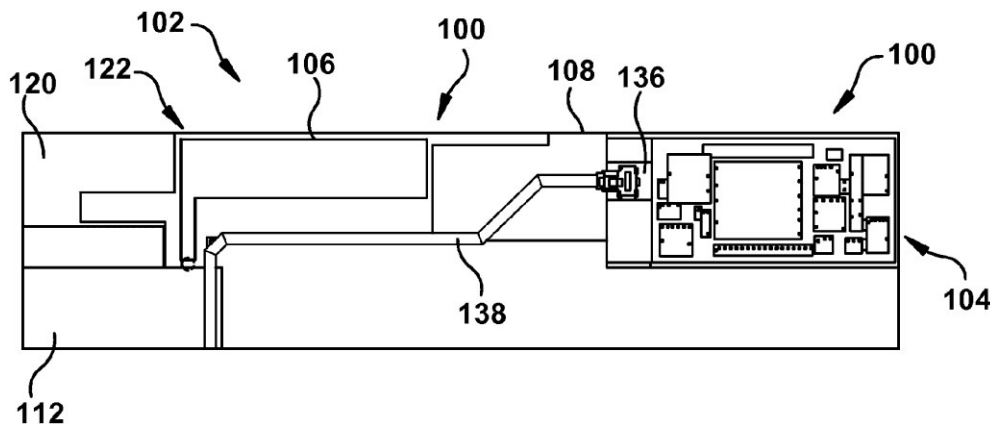
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Eschweiler & Associates, LLC

(57) **ABSTRACT**

A combined antenna device includes a coupled feed antenna including a first grounded coupling element and a millimeter wave phased array antenna having a ground plane structure including a portion of the first grounded coupling element.

16 Claims, 3 Drawing Sheets





US009521222B1

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

(10) **Patent No.:** **US 9,521,222 B1**

(45) **Date of Patent:** **Dec. 13, 2016**

(54) **MOBILE COMMUNICATION DEVICE**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Hsin-Wu Chiang**, New Taipei (TW);
Wan-Chu Wei, New Taipei (TW);
Pei-Chi Ma, New Taipei (TW);
Pei-Yuan Chiu, 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 0 days.

(21) Appl. No.: **15/057,125**

(22) Filed: **Mar. 1, 2016**

(30) **Foreign Application Priority Data**

Nov. 25, 2015 (TW) 104139251 A

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)
H04W 88/02 (2009.01)

(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **H01Q 1/243** (2013.01); **H04W 88/02** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/026; H01Q 1/243; H04W 88/02
USPC 455/575.5, 575.7
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,912,961 B2 * 12/2014 Hallivuori H01Q 1/243
343/702
9,172,142 B2 * 10/2015 Sudo H01Q 1/48
9,268,420 B2 * 2/2016 Liu G06F 3/041

2004/0066337 A1 * 4/2004 Fukuda H01P 1/213
343/700 MS
2007/0141806 A1 * 6/2007 Uemura H01L 33/40
438/458
2010/0117916 A1 * 5/2010 Gustafsson H01Q 1/243
343/839
2012/0229343 A1 * 9/2012 Sudo H01Q 1/38
343/700 MS
2012/0299841 A1 * 11/2012 Tang H01Q 1/1271
345/173

(Continued)

FOREIGN PATENT DOCUMENTS

TW 201417390 5/2014

OTHER PUBLICATIONS

Liu et al., "High-Gain Printed Dipole Antenna", Microwave and Optical Technology Letters, Aug. 5, 2005, pp. 214-218.

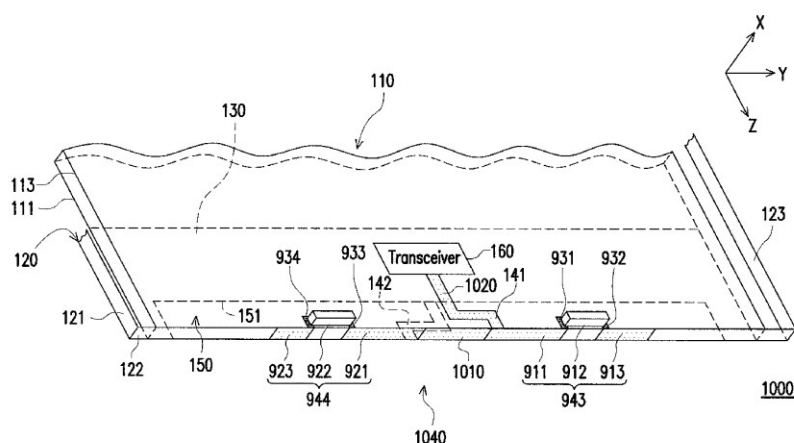
Primary Examiner — Shahriar Behnamian

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

(57) **ABSTRACT**

A mobile communication device includes a substrate, a frame, a ground plane, and an antenna element. The substrate includes a first surface and a side wall. The frame includes a frame portion adjacent to the side wall. The ground plane is arranged on the first surface and includes a notch. An opening of the notch faces the frame portion. The antenna element includes a first radiation portion having a feeding point, a second radiation portion electrically connected to the ground plane, a third radiation portion electrically connected to the first radiation portion, and a fourth radiation portion electrically connected to the second radiation portion. Orthogonal projections of the first and second radiation portions on the first surface are located in the notch of the ground plane, and the third and fourth radiation portions are located on the frame portion or the side wall of the substrate.

10 Claims, 7 Drawing Sheets





US009524602B2

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

(10) **Patent No.:** **US 9,524,602 B2**

(45) **Date of Patent:** **Dec. 20, 2016**

(54) **COMPACT ANTENNA STRUCTURE WITH A COUPLING DEVICE**

(71) Applicant: **CONTINENTAL AUTOMOTIVE GMBH**, Hannover (DE)

(72) Inventors: **Guy-Aymar Chakam**, Regensburg (DE); **Martin Weinberger**, Munich (DE)

(73) Assignee: **CONTINENTAL AUTOMOTIVE GMBH**, Hanover (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 129 days.

(21) Appl. No.: **14/369,950**

(22) PCT Filed: **Dec. 19, 2012**

(86) PCT No.: **PCT/EP2012/076129**

§ 371 (c)(1),

(2) Date: **Sep. 18, 2014**

(87) PCT Pub. No.: **WO2013/098151**

PCT Pub. Date: **Jul. 4, 2013**

(65) **Prior Publication Data**

US 2015/0042452 A1 Feb. 12, 2015

(30) **Foreign Application Priority Data**

Dec. 29, 2011 (DE) 10 2011 090 139

(51) **Int. Cl.**
G08B 21/00 (2006.01)
G07C 9/00 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **G07C 9/00944** (2013.01); **G07C 9/00007** (2013.01); **H01Q 1/3241** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC G07C 2009/00769; G07C 9/00007;
G07C 9/00944; H04B 1/03; H01Q 9/26

USPC 340/5.64
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,764,773 A 8/1988 Larsen et al. 343/713
5,668,565 A * 9/1997 Robinson H01Q 1/085
333/34

(Continued)

FOREIGN PATENT DOCUMENTS

DE 3689376 T2 4/1994 H01Q 1/12
DE 202005015708 U1 12/2005 H01Q 21/26

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion, Application No. PCT/EP2012/076129, 18 pages, Mar. 14, 2013.

(Continued)

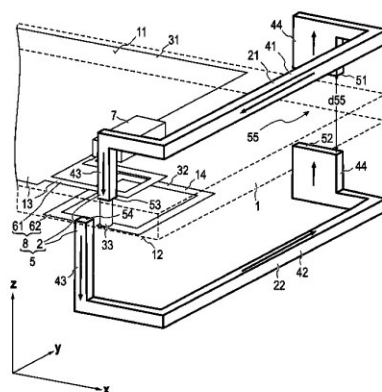
Primary Examiner — Mark Rushing

(74) *Attorney, Agent, or Firm* — Slayden Grubert Beard PLLC

(57) **ABSTRACT**

A transmission arrangement for a radio station of an access system may include a printed circuit board with an upper main surface and a first metallization plane in which conducting paths are formed. A drive circuit for supplying a frequency signal and an antenna structure are also provided. The antenna structure includes a coupling device, a conductor structure and a continuous, electrically conductive path having first and second ends opposite each other. The coupling device is configured to couple a frequency signal supplied by the drive circuit into the conductor structure. The first and/or second ends form end(s) of the conductor

(Continued)





(45) **Date of Patent:** **Dec. 20, 2016**

[illegible]



US009525761B1

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

(10) **Patent No.:** **US 9,525,761 B1**

(45) **Date of Patent:** **Dec. 20, 2016**

(54) **MOBILE COMMUNICATION DEVICE**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ching-Chi Lin, 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 0 days.

(21) Appl. No.: **14/958,912**

(22) Filed: **Dec. 3, 2015**

(30) **Foreign Application Priority Data**

Sep. 4, 2015 (TW) 104129400 A

(51) **Int. Cl.**

H04M 1/00 (2006.01)

H04M 1/02 (2006.01)

H04B 1/3827 (2015.01)

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

CPC **H04M 1/02** (2013.01); **H04B 1/3838**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/242–1/245; H01Q 1/084;

H04B 1/3833; H04B 1/3838

USPC 455/90.1, 90.3, 550.1, 575.1,
575.5, 455/575.7, 333

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0276958 A1* 11/2012 Inami H04M 1/0237
455/566
2015/0075958 A1* 3/2015 Fang H03K 17/9622
200/5 R

FOREIGN PATENT DOCUMENTS

TW 201336165 9/2013
TW 201528605 7/2015

* cited by examiner

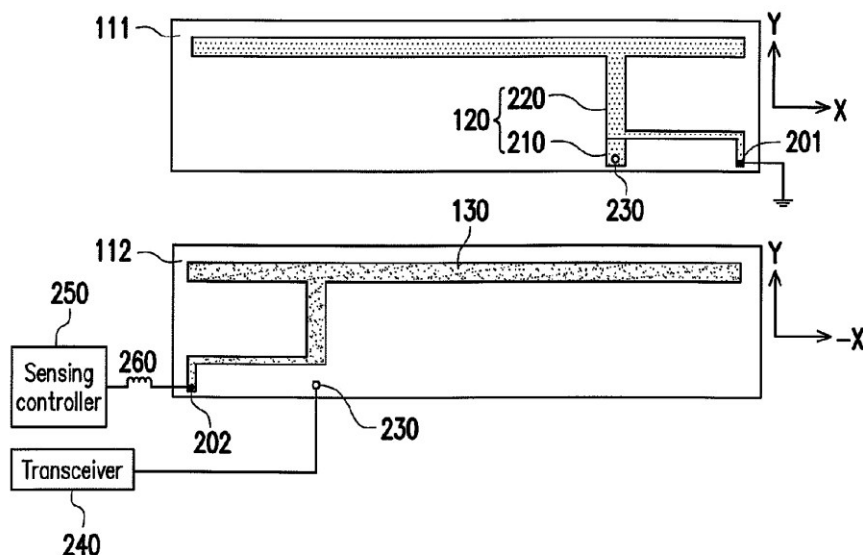
Primary Examiner — Nhan Le

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

(57) **ABSTRACT**

A mobile communication device including a substrate, an antenna element and a sensing element is provided. The substrate includes a first surface and a second surface opposite to each other. The antenna element is disposed on the first surface and converts a feeding signal into an electromagnetic wave. The antenna element includes a first portion receiving the feeding signal and a second portion electrically connected to a ground. The sensing element is disposed on the second surface and generates a sensing signal in response to proximity of an object. An orthogonal projection of the sensing element on the first surface and an orthogonal projection of the second portion on the first surface are overlapped with each other and have the same shape.

10 Claims, 4 Drawing Sheets





US009525762B2

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

(10) **Patent No.:** **US 9,525,762 B2**

(45) **Date of Patent:** **Dec. 20, 2016**

(54) **MOBILE TERMINAL HAVING ANTENNA**

(2013.01); **H01Q 1/48** (2013.01); **H01Q 1/52**

(2013.01); **H01Q 13/16** (2013.01); **H04B**

1/3838 (2013.01)

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

(58) **Field of Classification Search**

CPC G06K 19/077

USPC 455/274

See application file for complete search history.

(72) Inventors: **Oh Yong Kwon**, Hwaseong-si (KR);
Jeon Il Lee, Suwon-si (KR)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,747,294 B2 6/2010 Kwon
2011/0031320 A1 * 2/2011 Kato G06K 19/07749
235/492
2011/0193758 A1 8/2011 Liu et al.

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 56 days.

(21) Appl. No.: **14/511,533**

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

FOREIGN PATENT DOCUMENTS

SE WO 2011076582 A1 * 6/2011 H01Q 1/243

* cited by examiner

(65) **Prior Publication Data**

US 2015/0024810 A1 Jan. 22, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/404,281, filed on
Feb. 24, 2012, now Pat. No. 8,880,132.

Primary Examiner — Vladimir Magloire

Assistant Examiner — Randy Peaches

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

(30) **Foreign Application Priority Data**

Sep. 23, 2011 (KR) 10-2011-0096203

(57) **ABSTRACT**

A mobile terminal that can prevent radiation performance deterioration of an antenna is provided. The mobile terminal includes a circuit board in which an antenna and one or more key buttons are mounted, a housing mounted on the antenna and the circuit board, and a case for enclosing a periphery of the one or more key buttons and having a plurality of openings according to the quantity of the key buttons, wherein an antenna adjacent opening among the plurality of openings is extended through a slot toward an edge of the case to embody a loop antenna. Therefore, radiation deterioration of an antenna due to a case can be prevented. In addition, production costs can be minimized, and a desired external appearance of the mobile terminal is not compromised.

(51) **Int. Cl.**

H04B 7/00 (2006.01)

H04M 1/02 (2006.01)

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)

H01Q 1/52 (2006.01)

H01Q 13/16 (2006.01)

H04B 1/3827 (2015.01)

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

CPC **H04M 1/0202** (2013.01); **H01Q 1/243**

22 Claims, 12 Drawing Sheets

