



US009350068B2

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

(10) **Patent No.:** **US 9,350,068 B2**
(45) **Date of Patent:** **May 24, 2016**

- (54) **ELECTRONIC DEVICE WITH DUAL CLUTCH BARREL CAVITY ANTENNAS**
- (71) Applicant: **Apple Inc.**, Cupertino, CA (US)
- (72) Inventors: **Jerzy Guterman**, Mountain View, CA (US); **Qingxiang Li**, Mountain View, 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 0 days.
- (21) Appl. No.: **14/733,746**
- (22) Filed: **Jun. 8, 2015**
- (65) **Prior Publication Data**
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Related U.S. Application Data

- (63) Continuation of application No. 14/202,860, filed on Mar. 10, 2014.
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/42 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 9/42** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/24
USPC 343/702, 767, 770, 846, 700 MS
See application file for complete search history.

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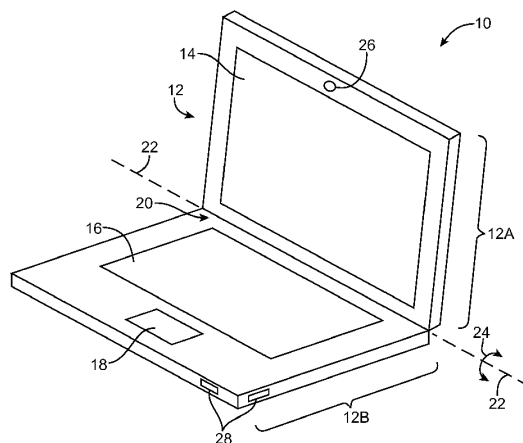
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Primary Examiner — Huedung Mancuso
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(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**

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(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)

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

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

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(Continued)

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

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

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Daniel J Munoz

(65) **Prior Publication Data**

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

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

(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.

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

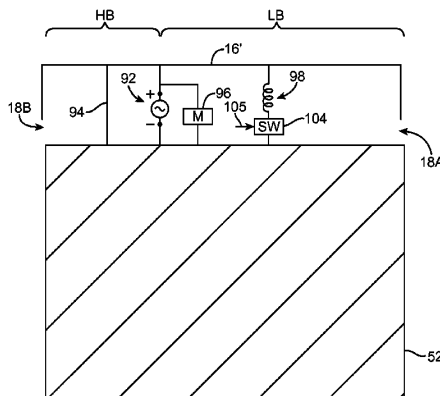
(58) **Field of Classification Search**
CPC H01Q 5/314; H01Q 5/321; H01Q 5/328; H01Q 5/357; H01Q 1/243
USPC 343/702
See application file for complete search history.

(56) **References Cited**

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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**

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

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

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

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(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

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Sep. 24, 2013 (TW) 102134312 A

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.

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/378 (2015.01)

H01Q 5/00 (2015.01)

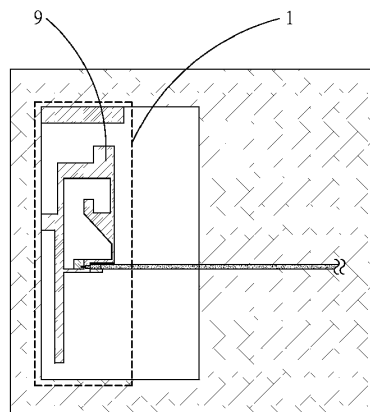
(52) **U.S. Cl.**

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**

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

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

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

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

Primary Examiner — Michael C Wimer

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

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

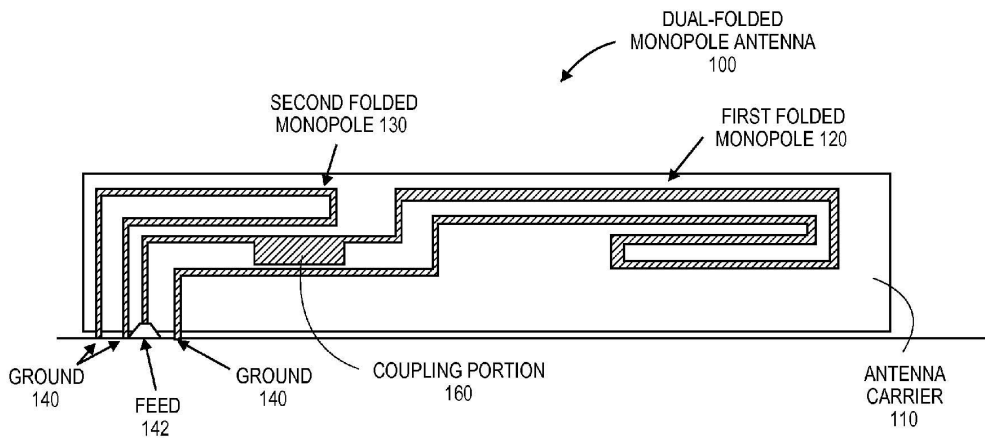
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 9/30** (2013.01)

(57) **ABSTRACT**

(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

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.

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.

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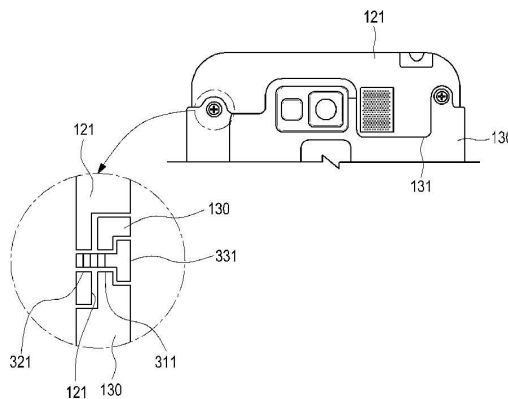
Primary Examiner — Tho G Phan

(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

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(30) **Foreign Application Priority Data**

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

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- (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)

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- (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)

Primary Examiner — Jean B Jeanglaude
(74) *Attorney, Agent, or Firm* — Saliwanchik, Lloyd & Eisenschenk

- (58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 3/005
USPC 343/745, 702, 860
See application file for complete search history.

(57) **ABSTRACT**

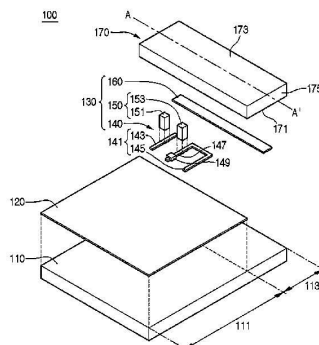
An antenna apparatus includes: a radiator; a feeding structure including a feeding unit to provide a signal to the radiator, a ground unit to ground the radiator, and a resonance applying part between the feeding unit and the ground unit; and a contact part to connect the radiator with the feeding structure.

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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.

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- (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

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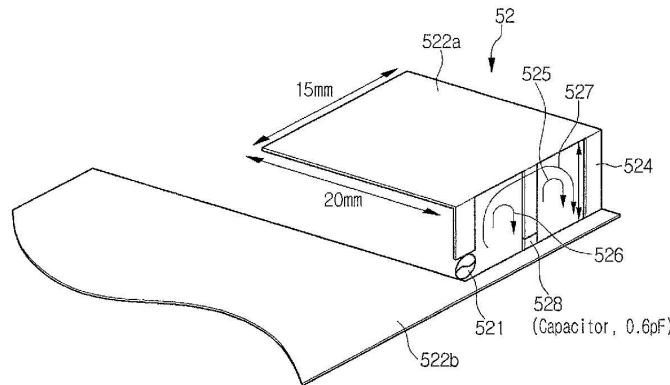
Primary Examiner — Sue A Purvis
Assistant Examiner — Patrick Holecek
 (74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

- (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.

- (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.

- (56) **References Cited**
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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**

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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.

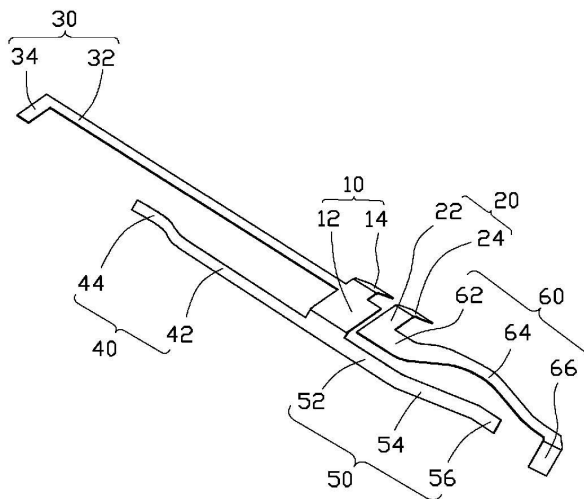
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343/750

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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**
US 2014/0361943 A1 Dec. 11, 2014

(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**

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Primary Examiner — Tan Ho

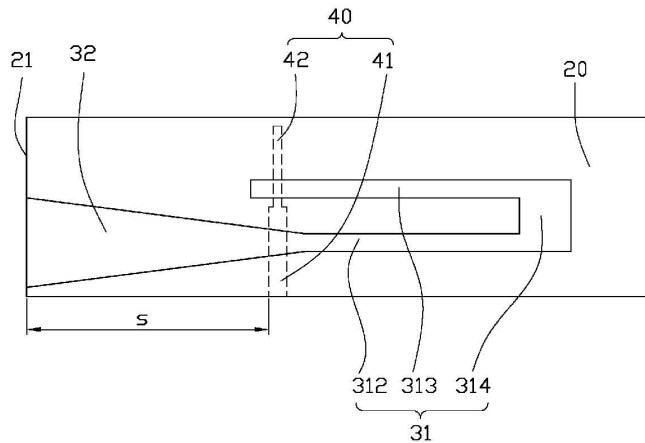
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(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.

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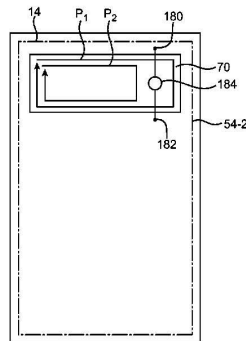
Primary Examiner — Tho G Phan

(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**

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343/770

(65) **Prior Publication Data**
US 2013/0234901 A1 Sep. 12, 2013

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(30) **Foreign Application Priority Data**
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(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)

Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — Edell, Shapiro & Finnan,
LLC

(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.

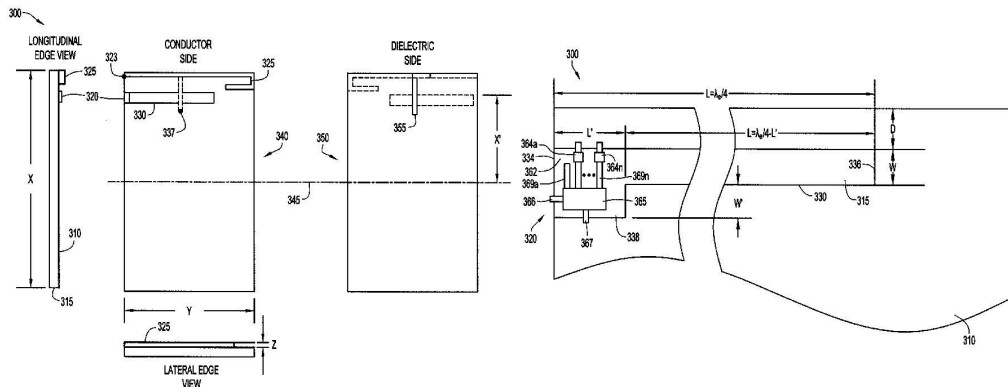
(57) **ABSTRACT**

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.

(56) **References Cited**
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343/767

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**
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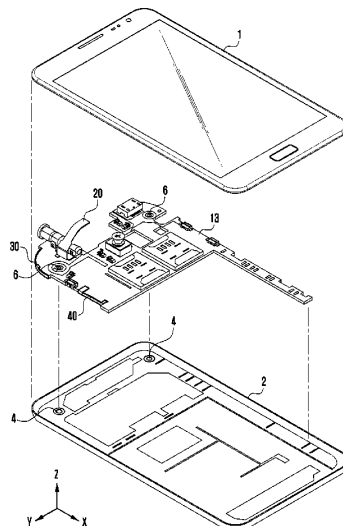
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Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(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**

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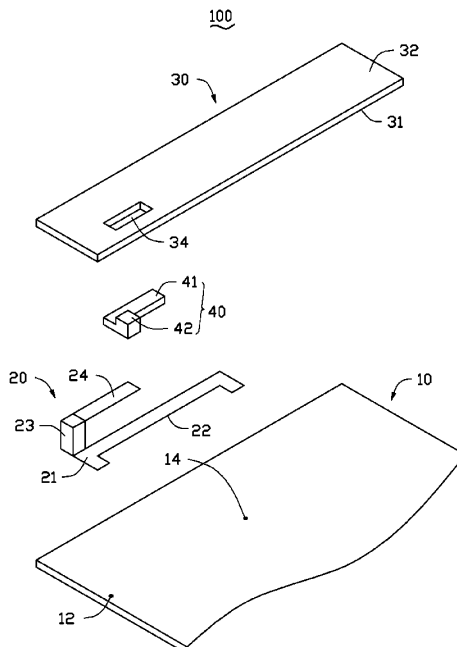
Primary Examiner — Graham Smith

(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 a 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.

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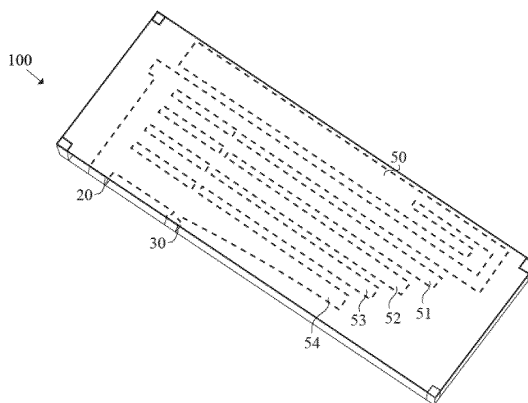
Primary Examiner — Dieu H Duong

(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.**
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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.

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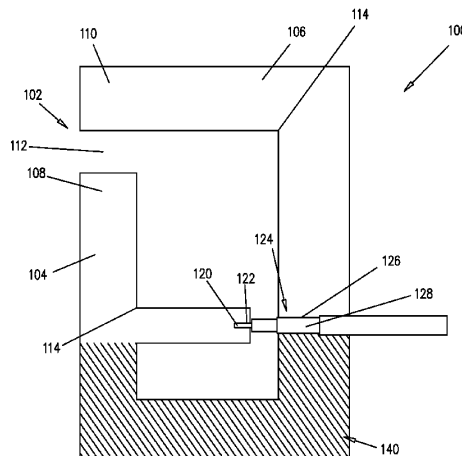
Primary Examiner — Trinh Dinh

(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**

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

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

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

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

(Continued)

(65) **Prior Publication Data**

US 2015/0065204 A1 Mar. 5, 2015

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(30) **Foreign Application Priority Data**

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(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)

Primary Examiner — Pablo Tran

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

(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)

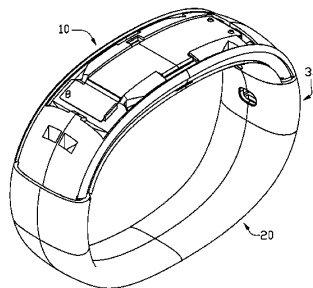
(57) **ABSTRACT**

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.

(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

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 disclaimer.

(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.

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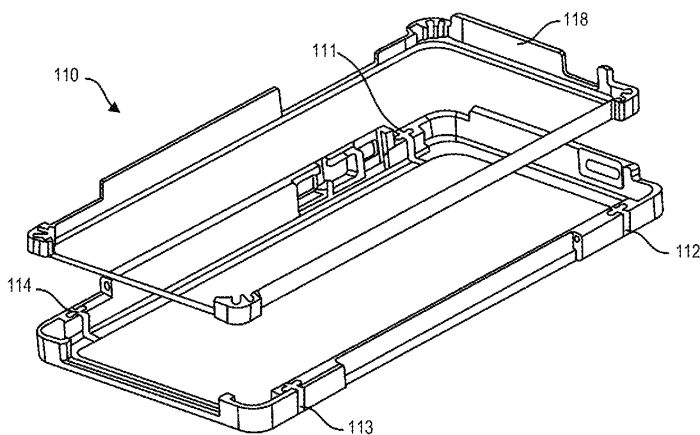
(Continued)

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**

(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)

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

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

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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**

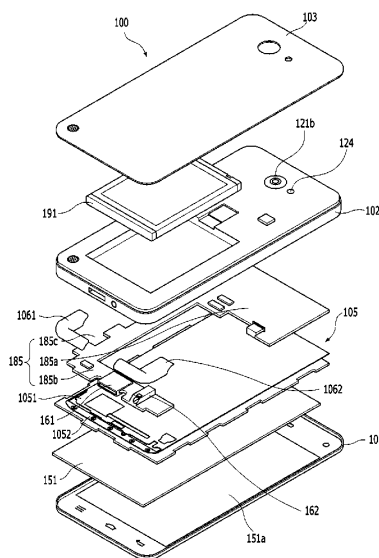
Sep. 19, 2014 (KR) 10-2014-0125062

19 Claims, 18 Drawing Sheets

(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





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)

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345/211

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

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

Primary Examiner — Larry Sternbane

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

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

(65) **Prior Publication Data**

US 2015/0198806 A1 Jul. 16, 2015

(30) **Foreign Application Priority Data**

Jan. 10, 2014 (CN) 2014 1 0012674

(57) **ABSTRACT**

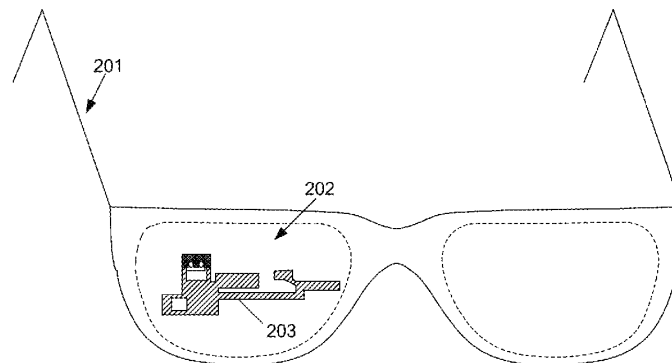
- (51) **Int. Cl.**
- G06F 3/01** (2006.01)
- G02B 27/01** (2006.01)
- H01Q 1/38** (2006.01)
- H01Q 1/44** (2006.01)
- H01Q 9/42** (2006.01)

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.

- (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

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.

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Primary Examiner — Sue A Purvis

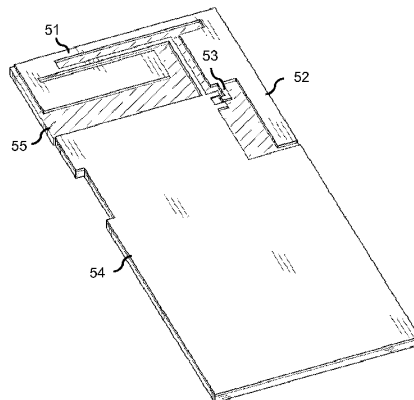
Assistant Examiner — Patrick Holecek

(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**

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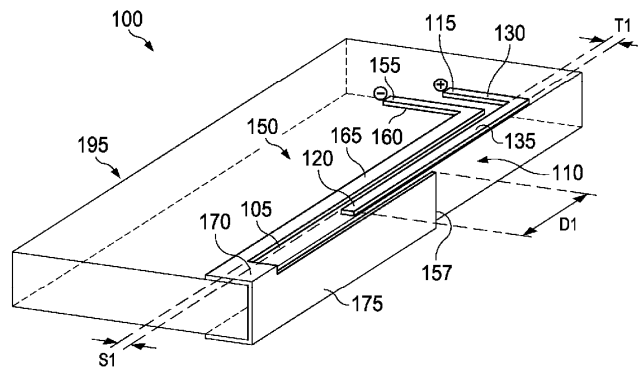
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Primary Examiner — Huedung Mancuso

(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: **Oh Yong 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.

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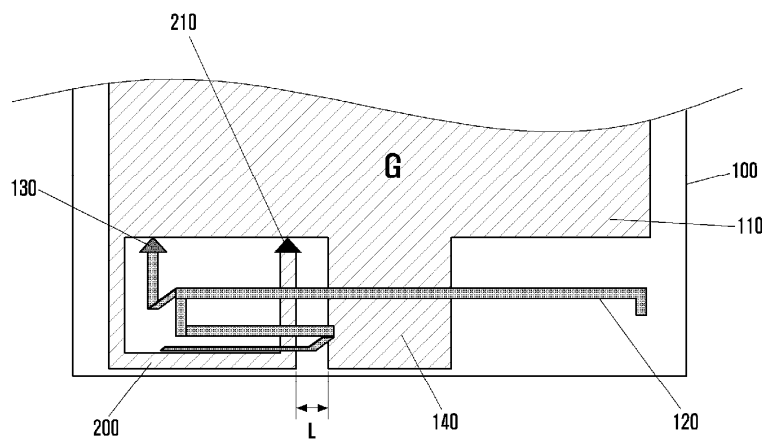
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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(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**

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

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

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343/702
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343/700 MS

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

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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.

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

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(65) **Prior Publication Data**

US 2014/0368399 A1 Dec. 18, 2014

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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)

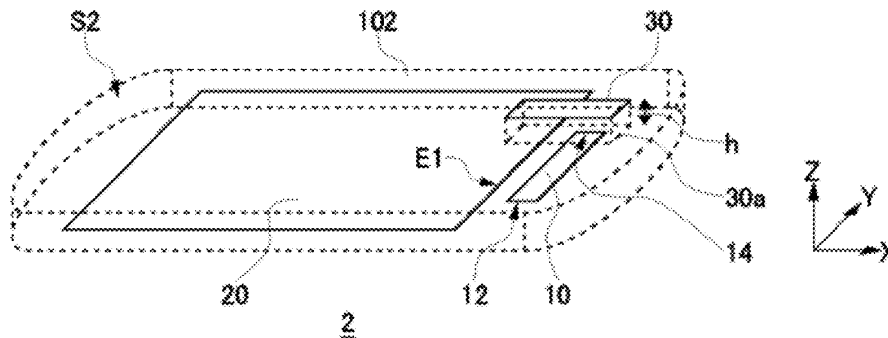
(57) **ABSTRACT**

(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.

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.

- (21) Appl. No.: **14/449,498**
- (22) Filed: **Aug. 1, 2014**
- (65) **Prior Publication Data**
US 2015/0117502 A1 Apr. 30, 2015

- (56) **References Cited**
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- (51) **Int. Cl.**
H04B 1/38 (2015.01)
H01Q 3/24 (2006.01)
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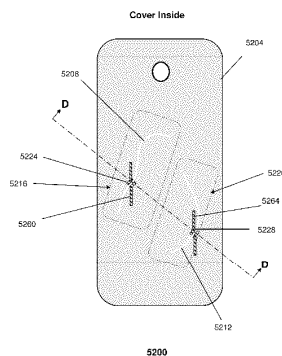
Primary Examiner — Dhaval Patel
(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLLC; Robert Gingher

- (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)

- (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.

- (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;

20 Claims, 100 Drawing Sheets





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(12) **United States Design Patent**
Matsuoka

(10) **Patent No.:** **US D758,999 S**
(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**
- (58) **Field of Classification Search**
USPC D14/230-238, 299, 358; 343/700 R,
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.

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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;
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

