



US008896486B2

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

(10) **Patent No.:** **US 8,896,486 B2**
(45) **Date of Patent:** **Nov. 25, 2014**

(54) **MULTIBAND ANTENNA**

(71) Applicant: **Advanced-Connectek Inc.**, New Taipei (TW)

(72) Inventors: **Tsung-Wen Chiu**, 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 0 days.

(21) Appl. No.: **13/940,281**

(22) Filed: **Jul. 12, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 12/825,080, filed on Jun. 28, 2010, now abandoned.

(30) **Foreign Application Priority Data**

Mar. 12, 2010 (TW) 99107222 A

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

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

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/0407; H01Q 9/0421;
H01Q 1/243; H01Q 5/0003
USPC 343/700 MS, 702, 745, 795, 850
See application file for complete search history.

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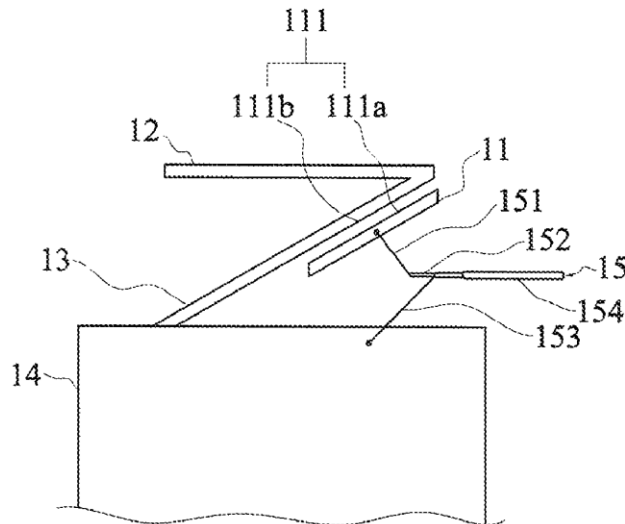
Primary Examiner — Hueund Mancuso

(74) *Attorney, Agent, or Firm* — Tracy M. Heims; Apex Juris, pllc

(57) **ABSTRACT**

A multiband antenna comprises a feeder member, a radiation conductor, a short-circuit member, a grounding plane and a feeder cable. The feeder member has a first coupling side. Two end of the short-circuit member are respectively connected with the radiation conductor and the grounding plane. The short-circuit member has a second coupling side parallel to and conformable to the first coupling side with a gap existing therebetween. The feeder cable has a central wire and an outer wire respectively connected with the feeder member and the grounding plane. The feeder member transmits a high-frequency fed-in signal to the short-circuit member in a capacitive coupling way. The multiband antenna of the present invention has a simplified antenna structure, a miniaturized size and wide frequency bands.

6 Claims, 3 Drawing Sheets





US008896487B2

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

(10) **Patent No.:** **US 8,896,487 B2**
(45) **Date of Patent:** **Nov. 25, 2014**

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

(75) Inventors: **Bing Chiang**, Melbourne, FL (US); **Douglas B. Kough**, San Jose, CA (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Gregory A. Springer**, Sunnyvale, CA (US); **Hao Xu**, Cupertino, CA (US); **Robert W. Schlub**, Cupertino, CA (US); **Eduardo Lopez Camacho**, Watsonville, CA (US); **Mattia Pascolini**, Campbell, CA (US); **Jerzy Guterman**, Mountain View, CA (US); **Yi Jiang**, Cupertino, CA (US); **Rodney Andres Gomez Angulo**, Sunnyvale, CA (US); **Ruben Caballero**, San Jose, CA (US)

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

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(22) Filed: **Jul. 9, 2009**

(65) **Prior Publication Data**
US 2011/0006953 A1 Jan. 13, 2011

(51) **Int. Cl.**
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H01Q 1/38 (2006.01)
G06F 1/16 (2006.01)
H01Q 1/22 (2006.01)
H01Q 13/18 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/18** (2013.01); **G06F 1/1616** (2013.01); **G06F 1/1626** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/2266** (2013.01); **G06F 1/1698** (2013.01)
USPC **343/702**; 343/700 MS

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

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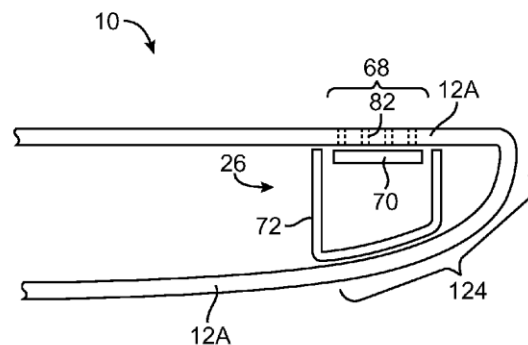
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Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**
Antennas are provided for electronic devices such as portable computers. An electronic device may have a housing in which an antenna is mounted. The housing may have an antenna window for the antenna. The antenna window may be formed from dielectric or from antenna window slots in a conductive member such as a conductive wall of the electronic device housing. An antenna may have an antenna resonating element that is backed by a conductive antenna cavity. The antenna resonating element may have antenna resonating element slots or may be formed using other antenna configurations such as inverted-F configurations. The antenna cavity may have conductive vertical sidewalls and a conductive rear wall. The antenna cavity walls may be formed from conductive layers on a dielectric antenna support structure.

21 Claims, 17 Drawing Sheets





US008896488B2

(12) **United States Patent**
Ayala Vazquez et al.

(10) **Patent No.:** **US 8,896,488 B2**
(45) **Date of Patent:** **Nov. 25, 2014**

(54) **MULTI-ELEMENT ANTENNA STRUCTURE WITH WRAPPED SUBSTRATE**

(75) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Erik A. Uttermann**, San Francisco, CA (US); **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 0 days.

(21) Appl. No.: **13/038,300**

(22) Filed: **Mar. 1, 2011**

(65) **Prior Publication Data**
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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/0062** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)
USPC **343/702**

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

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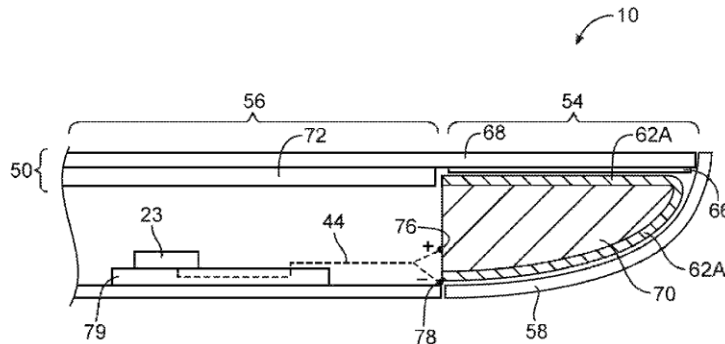
Primary Examiner — Graham Smith

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

(57) **ABSTRACT**

Antennas are provided for electronic devices such as portable computers. Multiple resonating elements may be formed on a flexible antenna resonating element substrate. The flexible antenna resonating element substrate may have a first antenna resonating element at one end and a second antenna resonating element at an opposing end. The flexible antenna resonating substrate may be wrapped around a dielectric carrier and mounted within an electronic device under an inactive display region and above a dielectric housing window. Conductive structures such as conductive housing structures may form antenna ground. The resonating elements and antenna ground may form first and second antennas. A parasitic antenna resonating element may form part of the first antenna.

20 Claims, 8 Drawing Sheets





US008896489B2

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

(10) **Patent No.:** **US 8,896,489 B2**

(45) **Date of Patent:** **Nov. 25, 2014**

(54) **ANTENNA**

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(US); **Nan Xu**, San Diego, CA (US);
Kiril Stoyanov, San Diego, CA (US)

(73) Assignee: **Nokia Corporation**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 153 days.

(21) Appl. No.: **13/475,345**

(22) Filed: **May 18, 2012**

(65) **Prior Publication Data**

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

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

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

(56) **References Cited**

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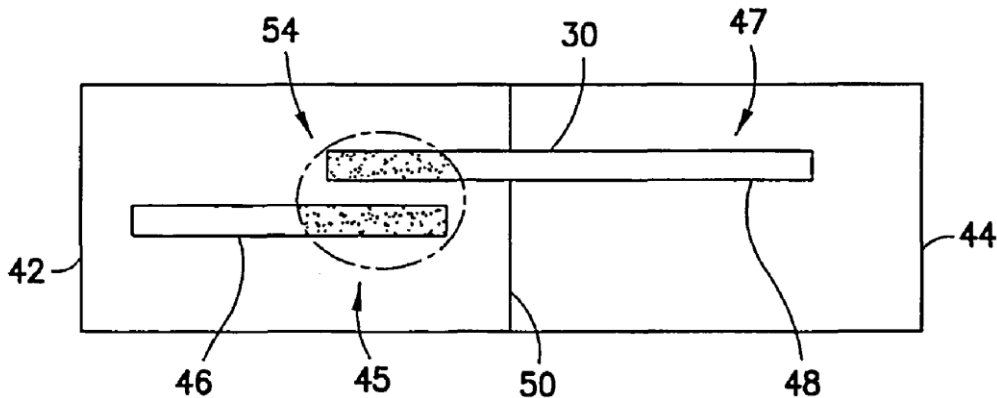
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Harrington & Smith

(57) **ABSTRACT**

An apparatus including an antenna; a first antenna carrier forming a first support substrate for a first portion of the antenna; and a different second antenna carrier forming a second support substrate for a second portion of the antenna. The first and second antenna carriers are coupled to each other. The antenna extends across a joint between the first and second antenna carriers.

25 Claims, 10 Drawing Sheets





US008897843B2

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

(10) **Patent No.:** **US 8,897,843 B2**
(45) **Date of Patent:** ***Nov. 25, 2014**

(54) **RF RADIATION REDIRECTION AWAY FROM PORTABLE COMMUNICATION DEVICE USER**

(75) Inventors: **Alfred Y. Wong**, Los Angeles, CA (US); **Robert Moreno**, Acton, CA (US); **Karl Richard Shields**, North Hills, CA (US); **Rong Wang**, Sherman Oaks, CA (US)

(73) Assignee: **Pong Reseach Corporation**, Encinitas, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 194 days.
This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/492,518**

(22) Filed: **Jun. 8, 2012**

(65) **Prior Publication Data**
US 2012/0242549 A1 Sep. 27, 2012

Related U.S. Application Data
(63) Continuation of application No. 12/724,290, filed on Mar. 15, 2010, now Pat. No. 8,214,003, which is a continuation-in-part of application No. 12/614,132, filed on Nov. 6, 2009, now Pat. No. 8,208,980.
(60) Provisional application No. 61/160,282, filed on Mar. 13, 2009, provisional application No. 61/112,141, filed on Nov. 6, 2008, provisional application No. 61/158,551, filed on Mar. 9, 2009.

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 19/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 19/28** (2013.01); **H01Q 19/005** (2013.01); **H01Q 1/245** (2013.01)

USPC **455/575.7**; 455/575.5; 455/575.1; 455/575.6; 455/575.8; 455/90.3; 343/702

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 19/005; H01Q 19/28
USPC 455/757.5, 575.1, 550.1, 67.11, 90.3, 455/557, 552.1, 553.1, 422.1, 403, 445, 455/426.2, 41.2, 41.1, 575.5, 575.7, 575.8, 455/575.6; 343/702, 718, 720, 782
See application file for complete search history.

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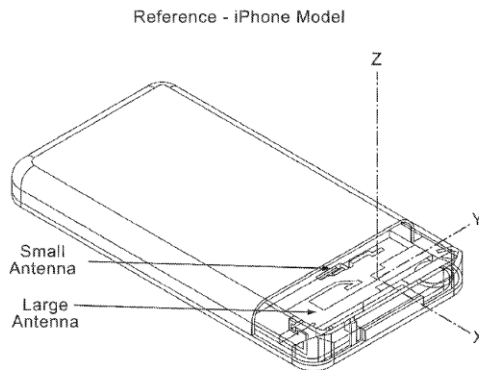
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Primary Examiner — Tan Trinh
(74) *Attorney, Agent, or Firm* — Cooley LLP

(57) **ABSTRACT**
A case for a wireless device includes a number of RF coupling elements mounted in the case and configured such that RF radiation is coupled from an internal antenna of the wireless device out of the device to a first RF coupling element, and from the first RF coupling element to a RF redirector coupling element that redirects the RF radiation in a direction outward from said wireless device that is opposite to a user side of the wireless device. A corrugated metallic shield is optionally provided on an opposite side of the case, facing a user of the device.

20 Claims, 11 Drawing Sheets





US008902107B2

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

(10) **Patent No.:** **US 8,902,107 B2**
(45) **Date of Patent:** **Dec. 2, 2014**

(54) **MOBILE COMMUNICATION DEVICE**

(75) Inventors: **Hok-Sum Horace Luke**, Taoyuan County (TW); **Chih-Ling Chien**, Taoyuan County (TW); **Hung-Yi Huang**, Taoyuan County (TW); **Chung-Ting Hung**, Taoyuan County (TW); **Chien-Chun Cheng**, Taoyuan County (TW); **Chih-Hsien Wu**, Taoyuan County (TW); **Kuo-Cheng Chen**, Taoyuan County (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 535 days.

(21) Appl. No.: **12/689,218**

(22) Filed: **Jan. 18, 2010**

(65) **Prior Publication Data**
US 2010/0302108 A1 Dec. 2, 2010

(30) **Foreign Application Priority Data**
May 26, 2009 (TW) 98117456 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04B 1/38 (2006.01)
H04M 1/02 (2006.01)
G06F 1/16 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/0202** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1698** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H04M 1/0279** (2013.01)
USPC **343/702**; 455/575.7

(58) **Field of Classification Search**
USPC 343/702, 846; 455/575.1, 575.7
See application file for complete search history.

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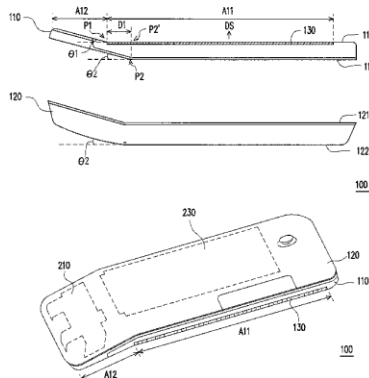
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

A mobile communication device including a first appearance and an antenna is provided. An upper surface of the first appearance is bent a first angle from a border between a display area and a non-display area toward a display direction, and a lower surface of the first appearance is bent a second angle from a bending point toward the display direction, wherein the bending point of the lower surface is corresponding to the display area of the upper surface. The antenna is disposed in the mobile communication device and corresponding to the non-display area of the first appearance. The antenna transmits and receives signals processed by the mobile communication device.

10 Claims, 7 Drawing Sheets





US008902109B2

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

(10) **Patent No.:** **US 8,902,109 B2**
(45) **Date of Patent:** **Dec. 2, 2014**

(54) **COMMUNICATION DEVICE**
(75) Inventors: **Chi-Ming Chiang**, Taoyuan County (TW); **Chun-Chuan Chang**, Keelung (TW)
(73) Assignee: **Auden Techno Corp.**, Taoyuan County (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 161 days.

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Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(65) **Prior Publication Data**
US 2013/0201061 A1 Aug. 8, 2013

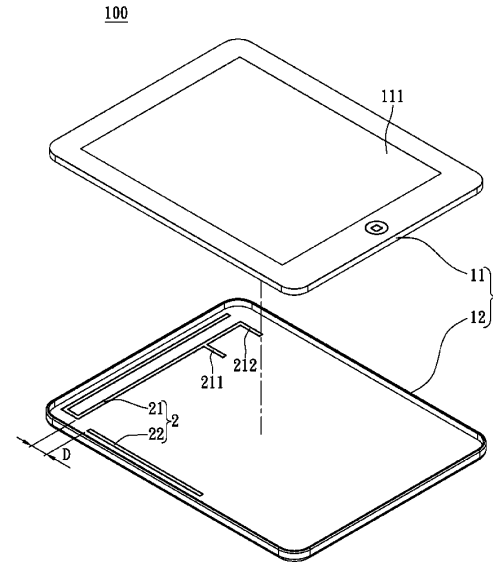
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
(52) **U.S. Cl.**
USPC **343/702; 343/893**
(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 9/40;
H01Q 5/0051; H01Q 5/0027; H01Q 5/0062
USPC 343/702, 893
See application file for complete search history.

A communication device includes a assembly and an antenna structure formed on the assembly. The antenna structure has a feeding antenna and a stub antenna spaced apart from the feeding antenna. The feeding antenna has a feeding portion. The stub antenna is suitable for being excited and coupled by the feeding antenna, resonating at a resonance frequency of the feeding antenna, and causing the antenna structure to form two hotspots in an operated frequency band. The shortest distance between the feeding antenna and the stub antenna is defined as a coupling distance. The coupling distance is larger than zero and smaller than or equal to the length of the stub antenna. Thus, electric field value generated from the feeding antenna can be reduced by the stub antenna being excited and coupled by the feeding antenna and resonating at the resonance frequency of the feeding antenna.

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10 Claims, 10 Drawing Sheets





US008902110B2

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

(10) **Patent No.:** **US 8,902,110 B2**
(45) **Date of Patent:** **Dec. 2, 2014**

(54) **ALL-METAL CASING STRUCTURE AND ANTENNA STRUCTURE**
(75) Inventors: **Yan-Ming Hong**, Hsinchu (TW); **Chih-Wei Chen**, Miaoli County (TW); **Chih-Ming Su**, Taipei (TW); **Sheng-Chi Chen**, Miaoli County (TW)
(73) Assignee: **Inpaq Technology Co., Ltd.**, Miaoli County (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 327 days.

(21) Appl. No.: **13/547,121**

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

(65) **Prior Publication Data**
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H01Q 1/22 (2006.01)

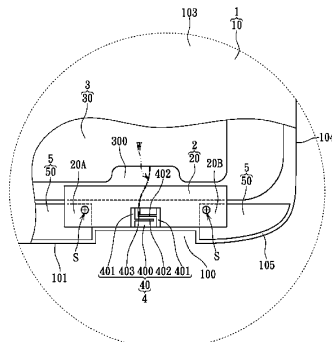
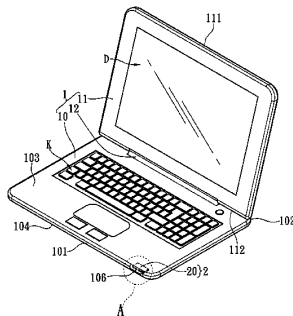
(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01)
USPC **343/702; 343/872**

(58) **Field of Classification Search**
CPC H01Q 1/2266
USPC 343/702, 872
See application file for complete search history.

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

(57) **ABSTRACT**
An all-metal casing structure includes a casing unit, a first substrate unit, a second substrate unit, an antenna unit and a conductive unit. The casing unit includes at least one metal casing having at least one through opening. The first substrate unit includes at least one first substrate body disposed in the metal casing and neighboring to the through opening. The second substrate unit includes at least one second substrate body disposed in the metal casing and neighboring to the first substrate body. The antenna unit includes at least one antenna module disposed on the first substrate body and corresponding to the through opening, and the antenna module is electrically connected to the second substrate body. The conductive unit includes at least two conductive elements separated from each other by a predetermined distance and electrically connected between the metal casing and the first substrate body.

19 Claims, 4 Drawing Sheets





US008907850B2

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

(10) **Patent No.:** **US 8,907,850 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

- (54) **HANDHELD ELECTRONIC DEVICES WITH ISOLATED ANTENNAS**
- (75) Inventors: **Robert W. Schlub**, Campbell, CA (US); **Robert J. Hill**, Salinas, CA (US); **Juan Zavala**, Watsonville, 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 478 days.

- (58) **Field of Classification Search**
CPC H04B 1/40
USPC 343/700 MS, 702, 767, 829, 846
See application file for complete search history.

- (21) Appl. No.: **13/092,875**
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- (65) **Prior Publication Data**
US 2011/0193754 A1 Aug. 11, 2011

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Related U.S. Application Data

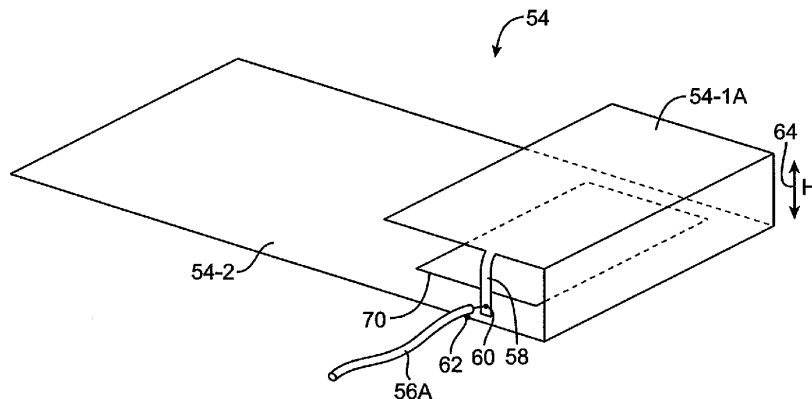
- (63) Continuation of application No. 12/541,874, filed on Aug. 14, 2009, now Pat. No. 8,094,079, which is a continuation of application No. 11/650,071, filed on Jan. 4, 2007, now Pat. No. 7,595,759.

Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Michael H. Lyons

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/29 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/28 (2006.01)
H01Q 21/30 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 21/29** (2013.01); **H01Q 13/10** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/28** (2013.01); **H01Q 21/30** (2013.01)
USPC **343/702**; 343/700 MS; 343/767; 343/846

- (57) **ABSTRACT**
Handheld electronic devices are provided that contain wireless communications circuitry having at least first and second antennas. An antenna isolation element reduces signal interference between the antennas, so that the antennas may be used in close proximity to each other. A planar ground element may be used as a ground by the first and second antennas. The first antenna may be formed using a hybrid planar-inverted-F and slot arrangement in which a planar resonating element is located above a rectangular slot in the planar ground element. The second antenna may be formed from an L-shaped strip. The planar resonating element of the first antenna may have first and second arms. The first arm may resonate at a common frequency with the second antenna and may serve as the isolation element. The second arm may resonate at approximately the same frequency as the slot portion of the hybrid antenna.

12 Claims, 12 Drawing Sheets





US008907851B2

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

(10) **Patent No.:** **US 8,907,851 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

(54) **HANDHELD DEVICE AND PLANAR ANTENNA THEREOF**

(75) Inventors: **Yen-Liang Kuo**, Taoyuan (TW);
Chun-Wei Tseng, Taoyuan (TW);
Wan-Ming Chen, Taoyuan (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 803 days.

(21) Appl. No.: **13/114,437**

(22) Filed: **May 24, 2011**

(65) **Prior Publication Data**
US 2012/0154224 A1 Jun. 21, 2012

(30) **Foreign Application Priority Data**
Dec. 17, 2010 (TW) 99144452 A

(51) **Int. Cl.**
H01Q 1/26 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 9/0442** (2013.01)
USPC **343/702**; 343/701; 343/703; 343/704; 343/705

(58) **Field of Classification Search**
USPC 343/701-705
See application file for complete search history.

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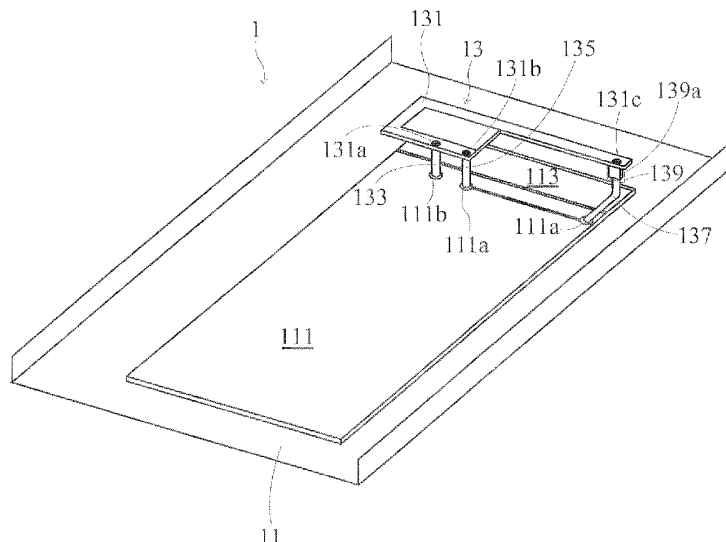
Primary Examiner — Matthew Mikels

(74) *Attorney, Agent, or Firm* — Grossman, Tucker, Perreault & Pfeleger, PLLC

(57) **ABSTRACT**

A handheld device and a planar antenna thereof are provided. The planar antenna comprises a radiator having a feeding point, a first short point and a second short point. The feeding point is coupled to a circuit board of the handheld device so that the handheld device transmits and receives a RF (radio frequency) signal through the radiator. The first short point is coupled to a ground of the circuit board so as to be grounded. A control element is disposed on the handheld device or the planar antenna in order to control the second short point to be selectively electrically coupled to the ground so that the planar antenna can operate at two different central frequencies. Furthermore, the planar antenna can operate at multiple central frequencies by changing a position of the second short point contacted to the radiator.

8 Claims, 6 Drawing Sheets





US008907852B2

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

(10) **Patent No.:** **US 8,907,852 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

(54) **ANTENNAS FOR HANDHELD ELECTRONIC DEVICES WITH CONDUCTIVE BEZELS**

(75) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Campbell, 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 0 days.

(21) Appl. No.: **13/286,612**

(22) Filed: **Nov. 1, 2011**

(65) **Prior Publication Data**

US 2012/0046002 A1 Feb. 23, 2012

Related U.S. Application Data

(60) Division of application No. 13/083,487, filed on Apr. 8, 2011, now Pat. No. 8,169,374, which is a continuation of application No. 12/941,006, filed on Nov. 5, 2010, now Pat. No. 7,924,231, which is a continuation of application No. 12/564,803, filed on Sep. 22, 2009, now Pat. No. 7,843,396, which is a continuation of application No. 11/821,192, filed on Jun. 21, 2007, now Pat. No. 7,612,725.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/30 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/00 (2006.01)
H01Q 23/00 (2006.01)
H01Q 13/10 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 21/30** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 1/52** (2013.01); **H01Q 5/0072** (2013.01); **H01Q**

1/521 (2013.01); **H01Q 23/00** (2013.01); **H01Q 13/103** (2013.01); **H01Q 21/28** (2013.01); **H01Q 5/0058** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
USPC **343/702**; 343/767; 343/846
CPC **H01Q 13/10**; **H01Q 13/103**; **H01Q 9/0421**
USPC **343/700 MS**, **702**, **767**, **829**, **846**
See application file for complete search history.

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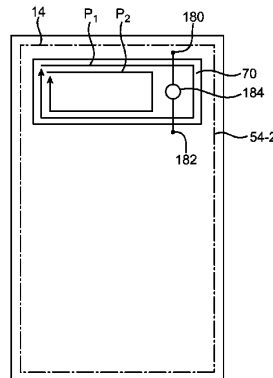
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Treyz Law Group; 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 using 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.

11 Claims, 20 Drawing Sheets





US008907854B2

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

(10) **Patent No.:** **US 8,907,854 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

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

USPC **343/702**; 343/876; 343/872
(58) **Field of Classification Search**
None
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Chih-Yang Tsai**, New Taipei (TW);
Chuan-Chou Chi, New Taipei (TW);
Chi-Sheng Liu, New Taipei (TW);
Hao-Ying Chang, New Taipei (TW)

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

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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 128 days.

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Primary Examiner — Trinh Dinh

(21) Appl. No.: **13/688,251**

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

(22) Filed: **Nov. 29, 2012**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2013/0214978 A1 Aug. 22, 2013

An antenna structure includes a first circuit board having a first antenna unit and a second antenna unit, a second circuit board having a first radio member and a second radio member, and a sliding mechanism. The first antenna unit and the second antenna unit are configured for receiving and transmitting different wireless signals. The sliding mechanism slides the second circuit board relative to the first circuit board, to separate or connect the first antenna unit with the first radio member and the second antenna unit with the second radio member, thus enabling the first antenna unit or a combination of the second antenna unit and the second radio member to receive and transmit a first wireless signal; the second antenna unit or a combination of the first antenna unit and the first radio member receive to transmit a second wireless signal.

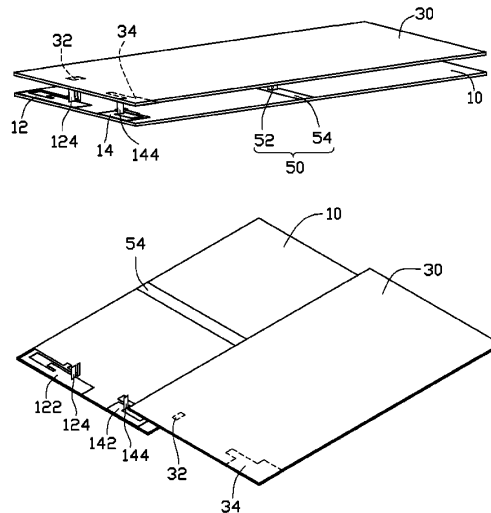
(30) **Foreign Application Priority Data**

Feb. 16, 2012 (TW) 101105095

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/42 (2006.01)
H01Q 1/12 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/1264** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/28** (2013.01)

10 Claims, 5 Drawing Sheets





US008907855B2

(12) **United States Patent**
Chang

(10) **Patent No.:** **US 8,907,855 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

(54) **METAL FRAME ANTENNA FOR A DISPLAY**
(71) Applicant: **Auden Techno.Corp.**, Taoyuan Hsien (TW)
(72) Inventor: **Ching-Wei Chang**, Taoyuan Hsien (TW)
(73) Assignee: **Auden Techno Corp.**, Taoyuan, Hsien (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 187 days.

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 846, 848
See application file for complete search history.

(56) **References Cited**
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(21) Appl. No.: **13/751,659**
(22) Filed: **Jan. 28, 2013**
(65) **Prior Publication Data**
US 2014/0097997 A1 Apr. 10, 2014

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Primary Examiner — Tan Ho
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

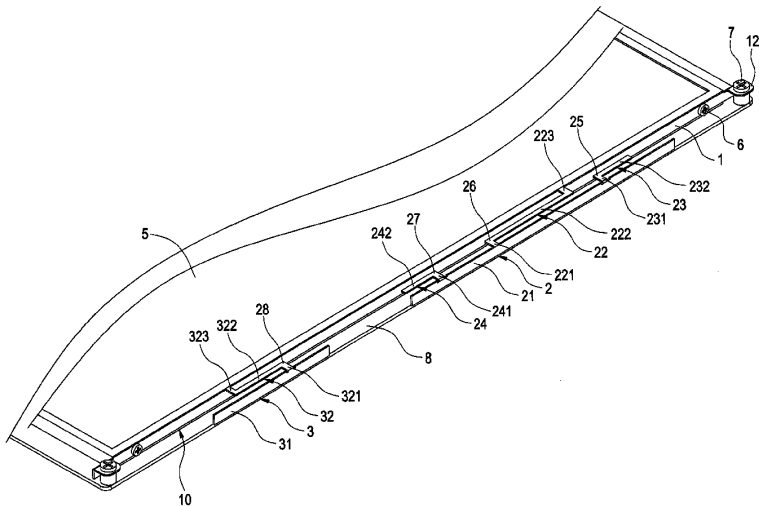
(30) **Foreign Application Priority Data**
Oct. 8, 2012 (TW) 101219453 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(57) **ABSTRACT**
A metal frame antenna includes a grounding part, a first antenna, and a second antenna. The metal frame antenna is assembled in a side of a display panel. The display panel is assembled with a metal backplane through the metal frame antenna. The assembly of a display having the metal frame antenna is easier. The volume of the display having the metal frame antenna is reduced. Moreover, the metal frame antenna having the first antenna and the second antenna is used as a multi-frequency antenna. The metal backplane is used for grounding. Therefore, the transmission efficiency of the metal frame antenna is better.

(52) **U.S. Cl.**
CPC . **H01Q 1/22** (2013.01); **H01Q 1/48** (2013.01);
H01Q 5/0058 (2013.01); **H01Q 9/42** (2013.01);
H01Q 1/2266 (2013.01); **H01Q 21/28** (2013.01)
USPC **343/702**; 343/700 MS; 343/846

16 Claims, 7 Drawing Sheets





US008907860B2

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

(10) **Patent No.:** **US 8,907,860 B2**
(45) **Date of Patent:** **Dec. 9, 2014**

(54) **STAND-ALONE MULTI-BAND ANTENNA**
(75) Inventors: **Cheng-Tse Lee**, Jiaoxi Township, Yilan County (TW); **Saou-Wen Su**, Keelung (TW)
(73) Assignees: **Lite-On Electronics (Guangzhou) Limited**, Guangzhou (CN); **Lite-On Technology Corporation**, Taipei (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 409 days.

USPC 343/700 MS, 702, 841
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen
Assistant Examiner — Patrick Holecek

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

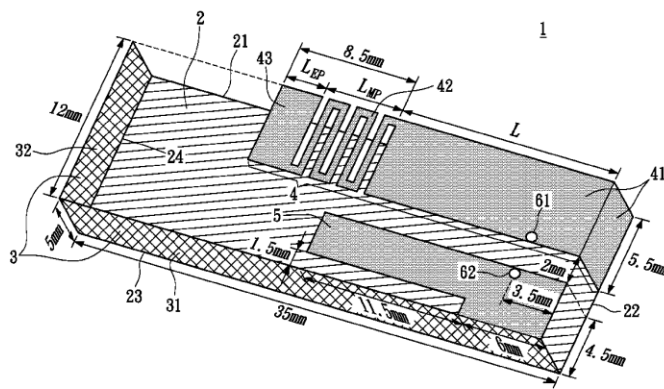
(21) Appl. No.: **13/049,284**
(22) Filed: **Mar. 16, 2011**
(65) **Prior Publication Data**
US 2012/0146874 A1 Jun. 14, 2012
(30) **Foreign Application Priority Data**
Dec. 31, 2010 (CN) 2010 1 0623325

(57) **ABSTRACT**

A stand-alone multi-band antenna includes an antenna ground plate, a shielding metal wall, a first radiating unit, and a signal feed-in source. The first radiating unit connected to at least one side of the antenna ground plate and located above the antenna ground plate is an antenna structure generating the fringing-field. The first radiating unit provides a first operating band and a second operating band. The shielding metal wall is connected to a plurality of the adjacent sides of the antenna ground plate, and the height thereof is larger than or equal to that of the first radiating unit, therefore limiting the fringing-field of the first radiating unit within the stand-alone multi-band antenna. The signal feed-in source has a signal feed-in point and a ground point. The signal feed-in point is electrically connected to the first radiating unit, and the ground point is electrically connected to the shielding metal wall.

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/52** (2013.01); **H01Q 5/0027** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 5/0062** (2013.01)
USPC **343/841**
(58) **Field of Classification Search**
CPC H01Q 5/00; H01Q 5/0003; H01Q 5/001; H01Q 5/0024; H01Q 5/0027; H01Q 5/0051; H01Q 5/0055; H01Q 5/0058; H01Q 5/0062; H01Q 9/0421; H01Q 9/04; H01Q 9/0407; H01Q 1/22; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 1/245; H01Q 1/2258; H01Q 1/2266; H01Q 1/2275; H01Q 1/2291

19 Claims, 13 Drawing Sheets





US008912959B2

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

(10) **Patent No.:** **US 8,912,959 B2**
(45) **Date of Patent:** **Dec. 16, 2014**

(54) **PACKAGING STRUCTURE AND METHOD OF FABRICATING THE SAME**

(75) Inventors: **Chih-Hsien Chiu**, Taichung (TW);
Tsung-Hsien Tsai, Taichung (TW);
Chao-Ya Yang, Taichung (TW)

(73) Assignee: **Siliconware Precision Industries Co., Ltd.**, Taichung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 203 days.

(21) Appl. No.: **13/566,296**

(22) Filed: **Aug. 3, 2012**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 17, 2011 (TW) 100137484 A

(51) **Int. Cl.**
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H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01L 23/552 (2006.01)
H01Q 1/36 (2006.01)
H01L 23/66 (2006.01)
H01L 23/31 (2006.01)

(52) **U.S. Cl.**
CPC **H01L 23/552** (2013.01); **H01L 2223/6677** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01L 23/3121** (2013.01); **H01Q**

I/521 (2013.01); **H01L 2224/32225** (2013.01);
H01Q 1/52 (2013.01); **H01L 2224/73265** (2013.01); **H01L 2224/48227** (2013.01); **H01Q 1/36** (2013.01); **H01L 23/66** (2013.01); **H01L 2224/16225** (2013.01)

USPC **343/700 MS**; 343/702; 343/841
(58) **Field of Classification Search**
USPC 343/700 MS, 841, 702; 257/659, 687, 257/690
See application file for complete search history.

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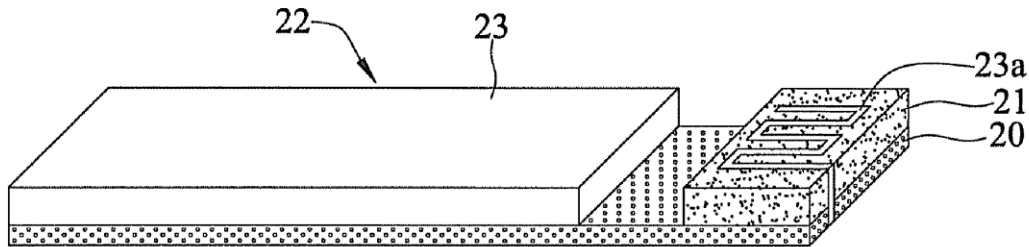
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Edwards Wildman Palmer LLP; Peter F. Corless; Steven M. Jensen

(57) **ABSTRACT**

A packaging structure and a method of fabricating the same are provided. The packaging structure includes a substrate, first packaging element disposed on the substrate, a second packaging element disposed on the substrate and spaced apart from the first packaging element, a first antenna disposed on the first packaging element, and a metal layer formed on the second packaging element. The installation of the metal layer and the antenna enhances the electromagnetic shielding effect.

22 Claims, 4 Drawing Sheets





US008912961B2

(12) **United States Patent**
Hallivuori

(10) **Patent No.:** **US 8,912,961 B2**
(45) **Date of Patent:** **Dec. 16, 2014**

(54) **APPARATUS FOR WIRELESS COMMUNICATION**
(75) Inventor: **Juha Samuel Hallivuori**, Tampere (FI)
(73) Assignee: **Nokia Corporation**, Espoo (FI)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 686 days.

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(21) Appl. No.: **12/584,664**
(22) Filed: **Sep. 9, 2009**
(65) **Prior Publication Data**
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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 7/00 (2006.01)

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(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 5/0048** (2013.01); **H01Q 9/42** (2013.01); **H01Q 7/00** (2013.01)
USPC **343/702**

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Harrington & Smith

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/243; H01Q 9/42
USPC 343/700 MS, 702
See application file for complete search history.

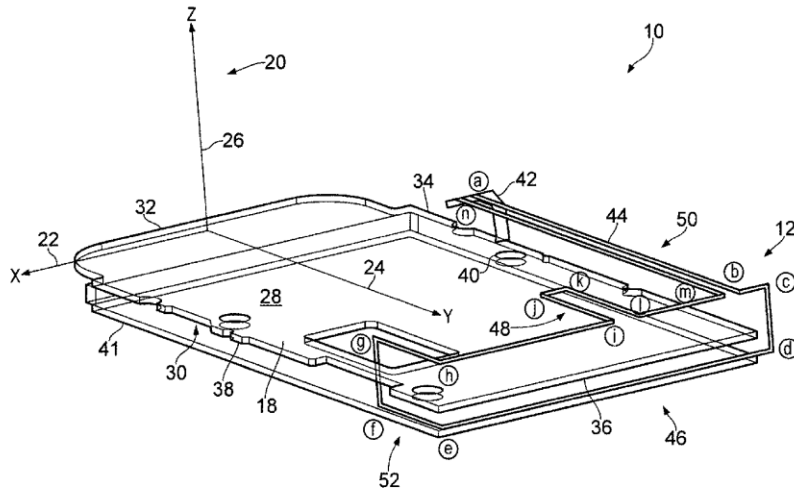
(57) **ABSTRACT**

Apparatus including a ground member oriented in a first orientation; and an antenna including a first portion having a non-overlying arrangement with the ground member, the first portion being oriented in a second orientation, different to the first orientation.

(56) **References Cited**
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18 Claims, 7 Drawing Sheets





US008912965B2

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

(10) **Patent No.:** **US 8,912,965 B2**
(45) **Date of Patent:** ***Dec. 16, 2014**

(54) **SUBSTRATE ANTENNA**

(75) Inventors: **Tutomu Kaneko**, Tokyo (JP); **Takahisa Karakama**, Nakano (JP)

(73) Assignees: **NISSEI Limited**, Tokyo (JP); **Faverights, Inc.**, Nakano-shi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 92 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/483,557**

(22) Filed: **May 30, 2012**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 31, 2011 (JP) 2011-122344

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H01Q 19/06 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/00 (2006.01)

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

CPC **H01Q 9/42** (2013.01); **H01Q 5/0065** (2013.01)
USPC **343/753**; 343/700 MS

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/243; H01Q 9/42; H01Q 7/00; H01Q 5/0058
USPC 343/700 MS, 788, 866
See application file for complete search history.

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Primary Examiner — Dameon E Levi

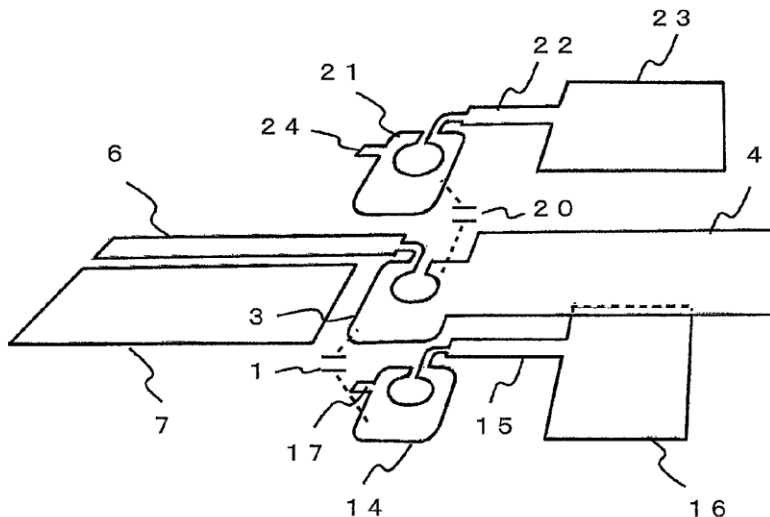
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Crowell & Moring LLP

(57) **ABSTRACT**

The simply configured substrate antenna has a plurality of antennas. A loop-like first joint pattern one spot of which is divided is formed in one-side substrate surface of a substrate composed of a dielectric material. Antenna elements that configure a first antenna are respectively connected to both ends of the first joint pattern at the divided position. A loop-like second joint pattern one spot of which is divided is formed in the other-side substrate surface at a position opposite to the first joint pattern. Antenna elements that configure a second antenna are respectively connected to both ends of the second joint pattern at the divided position. The first and second antennas are set to approximately the same or different resonance frequency bands. Feeding and ground points connected to and formed in the first joint pattern are held in common to transmit or receive a transmission/reception signal.

4 Claims, 3 Drawing Sheets





US008912972B2

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

(10) **Patent No.:** **US 8,912,972 B2**
(45) **Date of Patent:** **Dec. 16, 2014**

(54) **COUPLING DEGREE ADJUSTMENT CIRCUIT, ANTENNA DEVICE, AND WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventors: **Noriyuki Ueki**, Nagaokakyo (JP); **Noboru Kato**, Nagaokakyo (JP); **Kenichi Ishizuka**, Nagaokakyo (JP); **Hiroshi Nishida**, Nagaokakyo (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

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

(21) Appl. No.: **14/071,682**

(22) Filed: **Nov. 5, 2013**

(65) **Prior Publication Data**

US 2014/0049440 A1 Feb. 20, 2014

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2012/061591, filed on May 2, 2012.

(30) **Foreign Application Priority Data**

May 9, 2011 (JP) 2011-103969

(51) **Int. Cl.**

H01Q 21/06 (2006.01)

H01Q 21/00 (2006.01)

H01Q 1/36 (2006.01)

H01Q 1/40 (2006.01)

H01Q 5/00 (2006.01)

H01Q 21/30 (2006.01)

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

CPC **H01Q 21/0006** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/405** (2013.01); **H01Q 5/0051** (2013.01); **H01Q 5/0062** (2013.01); **H01Q 5/0065** (2013.01); **H01Q 21/30** (2013.01)

USPC **343/852**; 343/742; 343/853; 343/867

(58) **Field of Classification Search**

USPC 343/700 MS, 745, 741, 742, 788, 852, 343/853, 866, 867

See application file for complete search history.

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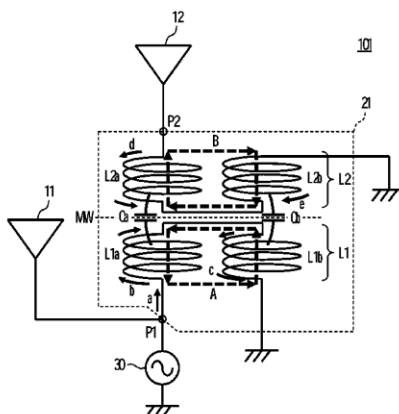
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A dielectric body includes a first radiating element on a first side and a second radiating element on a second side. The first radiating element and the second radiating element are linear conductors that each extend from a first end to a second end (an open end), and are parallel or substantially parallel to each other in a direction from the first end to the second end. The first end of the first radiating element is connected to a first port of a coupling degree adjustment circuit, and the first end of the second radiating element is connected to a second port of the coupling degree adjustment circuit. The first radiating element and the second radiating element are mainly coupled to each other in the coupling degree adjustment circuit.

20 Claims, 20 Drawing Sheets





US008918066B2

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

(10) **Patent No.:** **US 8,918,066 B2**
(45) **Date of Patent:** **Dec. 23, 2014**

(54) **FACILITATING SWITCHING BETWEEN TRANSMITTING ANTENNAS IN PORTABLE ELECTRONIC DEVICES**

(75) Inventors: **Ming Hu**, Sunnyvale, CA (US); **Haining Zhang**, San Jose, CA (US); **Xueting Liu**, 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 176 days.

(21) Appl. No.: **13/597,771**

(22) Filed: **Aug. 29, 2012**

(65) **Prior Publication Data**
US 2013/0331044 A1 Dec. 12, 2013

Related U.S. Application Data
(60) Provisional application No. 61/657,528, filed on Jun. 8, 2012.

(51) **Int. Cl.**
H03C 7/02 (2006.01)
H04B 7/00 (2006.01)

(52) **U.S. Cl.**
USPC **455/101; 375/299**

(58) **Field of Classification Search**
USPC 455/101; 375/299
See application file for complete search history.

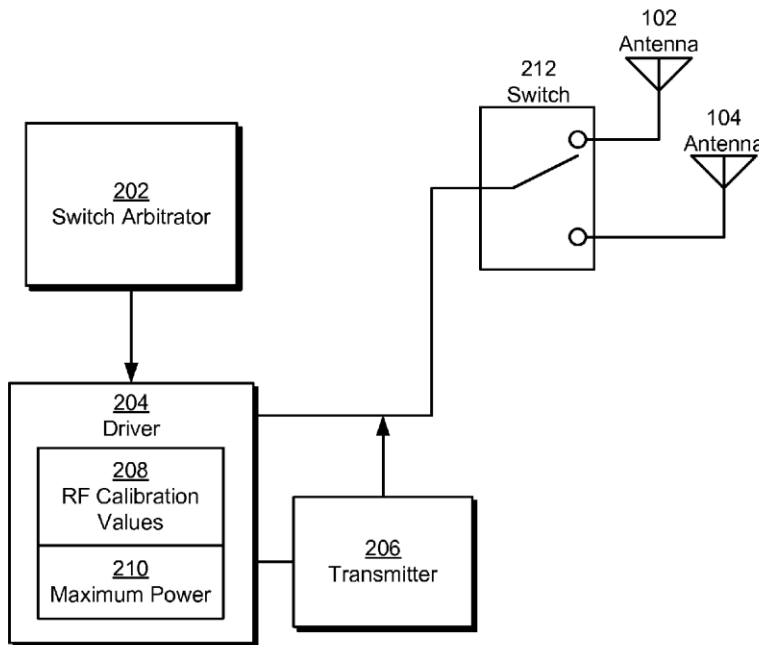
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Primary Examiner — Lee Nguyen
(74) *Attorney, Agent, or Firm* — Park, Vaughan, Fleming & Dowler LLP; Chia-Hsin Suen

(57) **ABSTRACT**
The disclosed embodiments provide a system that uses a first antenna and a second antenna in a portable electronic device. During operation, the system receives a request to switch from the first antenna to the second antenna to transmit a signal to a cellular receiver. Next, the system loads a set of radio-frequency (RF) calibration values for the second antenna. Finally, the system performs the switch from the first antenna to the second antenna to transmit the signal, wherein the second antenna is operated using the RF calibration values after the switch.

25 Claims, 4 Drawing Sheets





US008917216B2

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

(10) **Patent No.:** **US 8,917,216 B2**
(45) **Date of Patent:** **Dec. 23, 2014**

(54) **ANTENNA DEVICE WITH U-SHAPED SLIT**

(56) **References Cited**

(71) Applicants: **Akira Miyoshi**, Tokyo (JP); **Akihiro Oshima**, Tokyo (JP); **Yoshiaki Imano**, Tokyo (JP)

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(72) Inventors: **Akira Miyoshi**, Tokyo (JP); **Akihiro Oshima**, Tokyo (JP); **Yoshiaki Imano**, Tokyo (JP)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Mitsumi Electric Co., Ltd.**, Tokyo (JP)

JP	2003-152429	A	5/2003
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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 208 days.

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(21) Appl. No.: **13/719,455**

Primary Examiner — Hoang V Nguyen

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

(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick PC

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 28, 2011 (JP) 2011-287556

(57) **ABSTRACT**

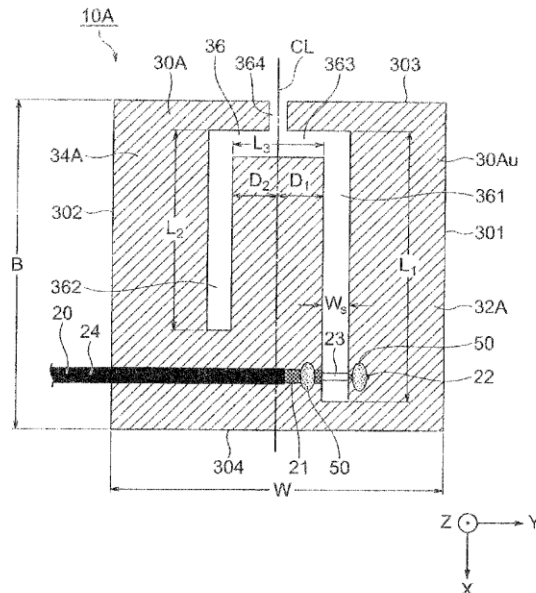
An antenna device includes a feeding line having a first conductor and a second conductor and an antenna element having a conductive flat plate in which a slit is formed. The conductive flat plate has first and second sides opposite to each other and a third side. The antenna element is divided into an antenna pattern portion and a ground pattern portion via the slit. The slit is configured with a first slit portion apart from a center line towards the first side, a second slit portion apart from the center line towards the second side, a third slit portion coupling the first slit portion with the second slit portion, and a cutting portion coupling the third slit portion with the third side.

(51) **Int. Cl.**
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/16** (2013.01)
USPC **343/767**

(58) **Field of Classification Search**
CPC H01Q 13/16; H01Q 13/10
USPC 343/767
See application file for complete search history.

7 Claims, 4 Drawing Sheets





US008917162B2

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

(10) **Patent No.:** **US 8,917,162 B2**
(45) **Date of Patent:** **Dec. 23, 2014**

(54) **WIRELESS COMMUNICATION APPARATUS AND ANTENNA DEVICE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventors: **Makoto Takeoka**, Nagaokakyo (JP);
Noboru Kato, Nagaokakyo (JP);
Makoto Yasutake, Nagaokakyo (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)

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

(21) Appl. No.: **14/308,896**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/JP2013/080453, filed on Nov. 11, 2013.

(30) **Foreign Application Priority Data**

Nov. 16, 2012 (JP) 2012-252570

(51) **Int. Cl.**
H04Q 5/22 (2006.01)
G06K 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **G06K 7/0008** (2013.01)
USPC **340/10.1**

(58) **Field of Classification Search**
USPC 340/10.1, 572.5, 572.2, 12.51, 13.26;
455/130; 343/702, 850, 853
See application file for complete search history.

(56) **References Cited**

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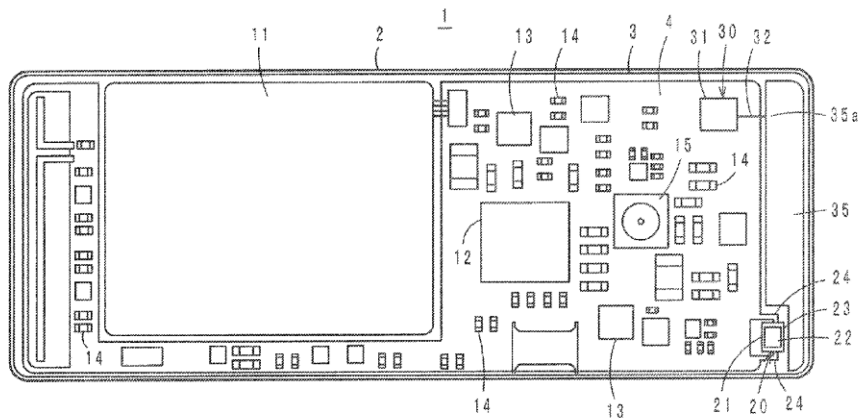
Primary Examiner — Phung Nguyen

(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A wireless communication apparatus includes a first communication system, and a second communication system configured to transmit a transmission signal in a communication frequency band which is the same or substantially the same as that of the first communication system and at an electric power which is stronger than that of a reception signal of the first communication system. The first communication system includes a feeder circuit having a resonant frequency, the resonant frequency being within the communication frequency band if a reception signal of the first communication system is input, and the resonant frequency being out of the communication frequency band if a transmission signal of the second communication system is input.

20 Claims, 14 Drawing Sheets





US008914060B2

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

(10) **Patent No.:** **US 8,914,060 B2**
(45) **Date of Patent:** **Dec. 16, 2014**

(54) **PORTABLE TERMINAL**

(75) Inventors: **Sang-Hun Kim**, Seoul (KR); **Hyun-Su Lim**, Gyeonggi-do (KR); **Jea-Moon Jung**, Gyeonggi-do (KR); **Geun-A Lee**, Seoul (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 319 days.

(21) Appl. No.: **13/050,227**

(22) Filed: **Mar. 17, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 5, 2010 (KR) 10-2010-0075417

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/08 (2006.01)
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/0262** (2013.01); **H01Q 1/084** (2013.01); **H01Q 1/243** (2013.01)
USPC **455/550.1**; 455/572; 455/575.1

(58) **Field of Classification Search**

USPC 455/550.1, 571, 575.1
See application file for complete search history.

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Primary Examiner — Justin Lee

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

(57) **ABSTRACT**

Provided is a portable terminal including a battery opening extending in a longitudinal direction or a widthwise direction of the portable terminal on a rear surface of the portable terminal, a battery pack inserted into the battery opening in the longitudinal direction or the widthwise direction of the portable terminal, and an antenna module pivotably coupled to the rear surface of the portable terminal to open or close the battery opening. The built-in antenna module can pivot, such that the battery pack can be inserted or ejected in the longitudinal direction or the widthwise direction of the portable terminal.

24 Claims, 22 Drawing Sheets

