



US009088067B2

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

(10) **Patent No.:** **US 9,088,067 B2**
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **COMMUNICATION DEVICE AND TUNABLE ANTENNA ELEMENT THEREIN**

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

(72) Inventors: **Kin-Lu Wong**, Kaohsiung (TW);
Shu-Chuan Chen, Kaohsiung (TW)

(73) Assignee: **ACER INCORPORATED**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 317 days.

(21) Appl. No.: **13/716,701**

(22) Filed: **Dec. 17, 2012**

(65) **Prior Publication Data**
US 2014/0097994 A1 Apr. 10, 2014

(30) **Foreign Application Priority Data**
Oct. 4, 2012 (TW) 101136632 A

(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 5/00 (2015.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/0024** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/30** (2013.01); **H01Q 9/04** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/00
USPC 343/750, 702, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,768,466	B2 *	8/2010	Chi et al.	343/741
7,978,141	B2 *	7/2011	Chi et al.	343/741
8,077,116	B2	12/2011	Shamblin et al.	
8,593,348	B2 *	11/2013	Krupa et al.	343/700 MS
8,816,920	B2 *	8/2014	Abe et al.	343/745
2007/0268191	A1	11/2007	Ishizuka et al.	
2009/0128428	A1	5/2009	Ishizuka et al.	
2009/0284433	A1 *	11/2009	Tsutsumi et al.	343/825
2011/0273360	A1 *	11/2011	Campero et al.	343/893
2012/0299781	A1 *	11/2012	Lee	343/700 MS

FOREIGN PATENT DOCUMENTS

EP 2 405 533 1/2012

OTHER PUBLICATIONS

European Search Report dated Nov. 27, 2013.

* cited by examiner

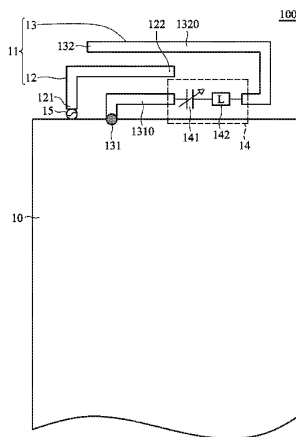
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

A communication device includes a ground element and an antenna element. The antenna element includes a first radiation element, a second radiation element, and a control circuit. One end of the first radiation element is coupled to a signal source, and another end of the first radiation element is an open end. The second radiation element includes at least a first portion and a second portion. A first end of the first portion is a shorted end coupled to the ground element, and a fourth end of the second portion is an open end. The second radiation element surrounds the open end of the first radiation element. The control circuit is coupled between a second end of the first portion and a third end of the second portion of the second radiation element. The control circuit provides at least two different impedances.

10 Claims, 6 Drawing Sheets





US009088069B2

(12) **United States Patent**
Bungo

(10) **Patent No.:** **US 9,088,069 B2**
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **WIRELESS COMMUNICATION APPARATUS**

(75) Inventor: **Akihiro Bungo**, Tokyo (JP)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Mobile Communications Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 269 days.

(21) Appl. No.: **13/541,162**

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

(65) **Prior Publication Data**

US 2013/0069836 A1 Mar. 21, 2013

Related U.S. Application Data

(60) Provisional application No. 61/537,109, filed on Sep. 21, 2011.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/28 (2006.01)
H01Q 25/00 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/28** (2013.01); **H01Q 25/00** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 21/28; H01Q 1/521
USPC 343/702, 767
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,164,898 B2 * 1/2007 Hankui et al. 455/311
8,483,751 B2 * 7/2013 Black et al. 455/552.1
2001/0043159 A1 * 11/2001 Masuda et al. 343/700 MS

2003/0179143 A1 * 9/2003 Iwai et al. 343/702
2006/0181468 A1 8/2006 Iguchi et al.
2007/0194995 A1 * 8/2007 Fang et al. 343/702
2008/0007469 A1 * 1/2008 Hung et al. 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 201289902 Y 8/2009
CN 101730957 A 6/2010

(Continued)

OTHER PUBLICATIONS

Extended European Search Report issued Nov. 7, 2012, in European Patent Application No. 12180513.9.

(Continued)

Primary Examiner — Dieu H Duong

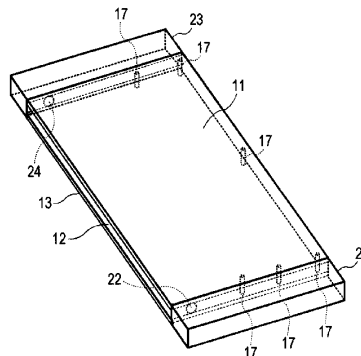
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57)

ABSTRACT

A wireless communication apparatus that includes a first antenna section having a first power feed point; a second antenna section having a second power feed point; a first electrically conductive plate extending between the first antenna section and the second antenna section; a second electrically conductive plate disposed substantially in parallel with the first electrically conductive plate and extending between the first antenna section and the second antenna section; and a short-circuiting member that electrically short-circuits the first electrically conductive plate and the second electrically conductive plate to each other such that a slit is formed by a part of a periphery of the first electrically conductive plate and a part of a periphery of the second electrically conductive plate.

11 Claims, 31 Drawing Sheets





US009088070B2

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

(10) **Patent No.:** **US 9,088,070 B2**
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **WIRELESS DEVICE**
(71) Applicants: **Koichi Sato**, Tachikawa (JP); **Makoto Tabata**, Fuchu (JP)
(72) Inventors: **Koichi Sato**, Tachikawa (JP); **Makoto Tabata**, Fuchu (JP)
(73) Assignee: **KABUSHIKI KAISHA TOSHIBA**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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

(56) **References Cited**
U.S. PATENT DOCUMENTS
6,686,886 B2 2/2004 Flint et al.
7,541,987 B2 6/2009 Kyou et al.
7,961,150 B2 6/2011 Kyou et al.
2002/0061775 A1 5/2002 Iwai et al.
(Continued)

FOREIGN PATENT DOCUMENTS
CN 1770551 A 5/2006
CN 101127414 A 2/2008
(Continued)

OTHER PUBLICATIONS
Japanese Office Action dated May 24, 2011 (and English translation thereof) in counterpart Japanese Application No. 2009-082341.
(Continued)

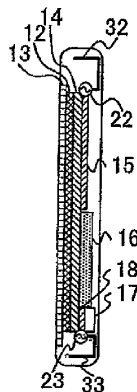
(21) Appl. No.: **13/654,145**
(22) Filed: **Oct. 17, 2012**
(65) **Prior Publication Data**
US 2013/0038560 A1 Feb. 14, 2013
Related U.S. Application Data
(63) Continuation of application No. 12/556,766, filed on Sep. 10, 2009, now abandoned.
(30) **Foreign Application Priority Data**
Mar. 30, 2009 (JP) 2009-082341

Primary Examiner — Christopher R Lamb
(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick PC

(57) **ABSTRACT**
A wireless device includes: a casing having a first face; a display configured to be visible from the first face; a touch sensor formed by a transparent material and mounted in the casing with respect to the display as a part of the first face; a substrate mounted to a side opposite to the first face with respect to the display; and an antenna element including: a first portion built in the casing, connected to a feeding point included in the substrate, and located within a first range occupied by the touch sensor when viewed from a direction perpendicular to the first face; and a second portion located within a second range other than the first range.

9 Claims, 6 Drawing Sheets

(51) **Int. Cl.**
G06F 3/041 (2006.01)
H01Q 1/24 (2006.01)
G06F 1/16 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/30 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1698** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 9/30** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)





US009088072B2

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

(10) **Patent No.:** **US 9,088,072 B2**
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **ANTENNA**
(75) Inventors: **Yasunori Takaki**, Tottori (JP); **Akinori Misawa**, Tottori (JP)
(73) Assignee: **HITACHI METALS, LTD.**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/40; H01Q 1/243; H01Q 9/30; H01Q 9/40; H01Q 9/42
USPC 343/700 MS, 702, 873
See application file for complete search history.

(21) Appl. No.: **13/510,742**
(22) PCT Filed: **Nov. 19, 2010**
(86) PCT No.: **PCT/JP2010/070731**
§ 371 (c)(1),
(2), (4) Date: **May 18, 2012**

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,748,149 A 5/1998 Kawahata
7,061,434 B2 6/2006 Aoyama et al.
(Continued)

(87) PCT Pub. No.: **WO2011/062274**
PCT Pub. Date: **May 26, 2011**
(65) **Prior Publication Data**
US 2012/0229345 A1 Sep. 13, 2012

FOREIGN PATENT DOCUMENTS
JP 09-162633 A 6/1997
JP 2000-278028 * 10/2000 H01Q 1/38
(Continued)

(30) **Foreign Application Priority Data**
Nov. 20, 2009 (JP) 2009-264621
Feb. 10, 2010 (JP) 2010-027127

OTHER PUBLICATIONS
Communication dated Apr. 30, 2014 from the Japanese Patent Office in counterpart Japanese Application No. 2011-541980.

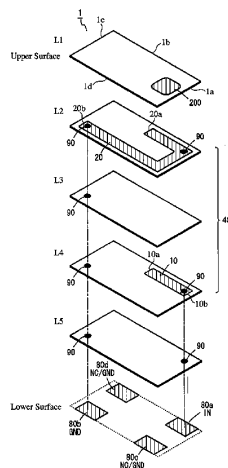
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Suhgrue Mion, PLLC

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

(57) **ABSTRACT**
An antenna comprising a laminate of dielectric ceramic layers each provided with electrode patterns, the laminate comprising a first terminal electrode connected to a feed line and a second terminal electrode for grounding on the lower surface, a radiation electrode on the upper surface or on a layer near the upper surface, and a coupling electrode between the lower surface and the radiation electrode; the coupling electrode being connected to the first terminal electrode through via-holes; the radiation electrode being connected to the second terminal electrode through via-holes; and the coupling electrode being partially opposite to the radiation electrode in a lamination direction to form a capacitance-coupling portion.

(52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/40** (2013.01); **H01Q 5/385** (2013.01); **H01Q 5/40** (2013.01); **H01Q 7/00** (2013.01)

8 Claims, 20 Drawing Sheets





US009088077B2

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

(10) **Patent No.:** **US 9,088,077 B2**
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **ANTENNA SYSTEM FOR WIRELESS COMMUNICATION DEVICE**

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/106; H01Q 21/28
See application file for complete search history.

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(56) **References Cited**

(72) Inventors: **Ming-Feng Chang**, Hsinchu (TW);
Kai-Yang Cheng, Hsinchu (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Wistron NeWeb Corporation**, Hsinchu Science Park, Hsinchu (TW)

2010/0238079 A1 * 9/2010 Ayatollahi et al. 343/729
2010/0321255 A1 * 12/2010 Kough et al. 343/702
2013/0293425 A1 * 11/2013 Zhu et al. 343/702
2013/0314293 A1 * 11/2013 Wong et al. 343/848
2014/0015714 A1 * 1/2014 Hong et al. 343/702

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 298 days.

* cited by examiner

Primary Examiner — Robert Karacsony

(21) Appl. No.: **13/760,072**

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

(22) Filed: **Feb. 6, 2013**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2014/0168025 A1 Jun. 19, 2014

The present invention discloses an antenna system for a wireless communication device, which includes a first metal slice formed with a first slot structure, a second metal slice formed with a second slot structure, a first signal transmission line, and a second signal transmission line, wherein when the first metal slice and the second metal slice are not connected and have a distance between each other, a feeding direction of the first transmission corresponding to the first metal slice is substantially opposite to a feeding direction of the second transmission corresponding to the second metal slice; or when the first metal slice and the second metal slice are partially connected, a feeding direction of the first transmission corresponding to the first metal slice is substantially the same as or different to a feeding direction of the second transmission corresponding to the second metal slice.

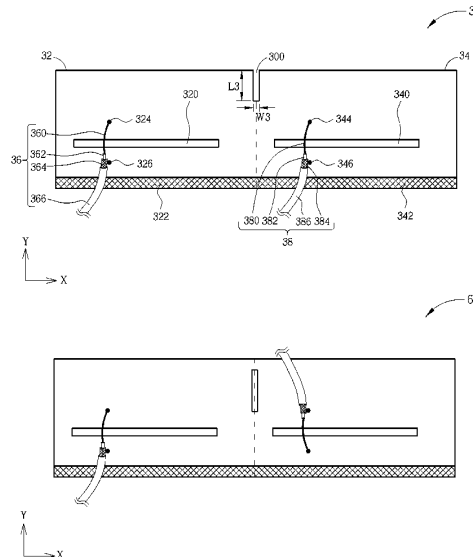
(30) **Foreign Application Priority Data**

Dec. 13, 2012 (TW) 101147251 A

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/52 (2006.01)

12 Claims, 10 Drawing Sheets

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/521** (2013.01); **H01Q 13/10** (2013.01); **H01Q 13/106** (2013.01)





US009093746B2

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

(10) **Patent No.:** **US 9,093,746 B2**
(45) **Date of Patent:** **Jul. 28, 2015**

(54) **WIRELESS COMMUNICATION DEVICE HAVING METAL ASSEMBLY AND CONDUCTIVE ASSEMBLY FOR REDUCING SPECIFIC ABSORPTION RATE (SAR)**

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

(72) Inventors: **Cheng-Hung Ko**, Shindian (TW); **Chao-Wei Ho**, 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 0 days.

(21) Appl. No.: **14/132,488**

(22) Filed: **Dec. 18, 2013**

(65) **Prior Publication Data**

US 2014/0375506 A1 Dec. 25, 2014

(30) **Foreign Application Priority Data**

Jun. 24, 2013 (TW) 102122425 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/245** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/0407; H01Q 1/50
USPC 343/700 MS, 745, 749, 845, 850, 898
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,380,895 B1 * 4/2002 Moren et al. 343/700 MS
7,859,471 B2 * 12/2010 Bungo et al. 343/702
2008/0246674 A1 * 10/2008 Rutfors et al. 343/722
2009/0073048 A1 * 3/2009 Kim 343/700 MS
2009/0079637 A1 * 3/2009 Fukui et al. 343/700 MS

* cited by examiner

Primary Examiner — Sue A Purvis

Assistant Examiner — Jae Kim

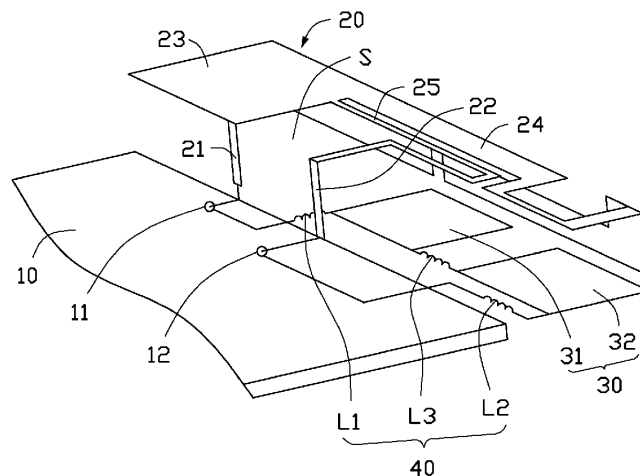
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

A wireless communication device includes a base board, an antenna, a metal assembly, and a conductive assembly. The base board includes a feed portion and a ground portion, and defines a keep-out-zone. The antenna is located above the keep-out-zone, and is electronically connected to the feed portion and the ground portion. The metal assembly is located at the keep-out-zone, and is spaced from the antenna. The metal assembly is electronically connected to the feed portion and the ground portion through the conductive assembly.

9 Claims, 1 Drawing Sheet

100





US009093747B2

(12) **United States Patent**
Ma

(10) **Patent No.:** **US 9,093,747 B2**
(45) **Date of Patent:** ***Jul. 28, 2015**

(54) **INSERT TYPE ANTENNA MODULE FOR PORTABLE TERMINAL AND METHOD FOR MANUFACTURING THE SAME**

2031/3437 (2013.01); B29L 2031/3456 (2013.01); Y10T 29/49016 (2015.01)

(71) Applicant: **Sang-Yong Ma**, Ansan-si (KR)

(58) **Field of Classification Search**

CPC B29C 45/1671; B29K 2995/0005; B29L 2031/3437; B29L 2031/3456; H01Q 1/243; H01Q 1/40; H01Q 21/28; Y10T 29/49016
USPC 343/702, 788, 873, 895, 700 MS
See application file for complete search history.

(72) Inventor: **Sang-Yong Ma**, Ansan-si (KR)

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

This patent is subject to a terminal disclaimer.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,369,777 B1 * 4/2002 Ohara et al. 343/895
2006/0092082 A1 * 5/2006 Komine 343/702
2013/0106662 A1 * 5/2013 Ishida 343/702
2013/0113663 A1 * 5/2013 Zhang et al. 343/702
2014/0132460 A1 * 5/2014 Cho et al. 343/702
2014/0228080 A1 * 8/2014 Choi et al. 455/575.1

* cited by examiner

Primary Examiner — Thien M Le

(74) Attorney, Agent, or Firm — Lexyoume IP Meister, PLLC

(21) Appl. No.: **14/247,337**

(22) Filed: **Apr. 8, 2014**

(65) **Prior Publication Data**

US 2014/0230237 A1 Aug. 21, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/139,031, filed as application No. PCT/KR2009/007454 on Dec. 11, 2009, now Pat. No. 8,760,351.

(30) **Foreign Application Priority Data**

Dec. 11, 2008 (KR) 10-2008-0125877
Mar. 31, 2009 (KR) 10-2009-0027587
Jul. 13, 2009 (KR) 10-2009-0063476
Sep. 2, 2009 (KR) 10-2009-0082243

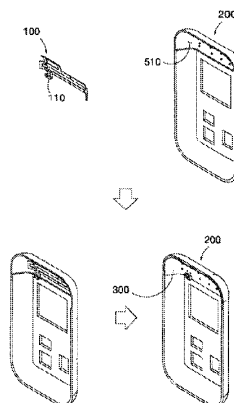
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
B29C 45/16 (2006.01)
H01Q 1/40 (2006.01)
H01Q 21/28 (2006.01)
B29L 31/34 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **B29C 45/1671** (2013.01); **H01Q 1/40** (2013.01); **H01Q 21/28** (2013.01); **B29K 2995/0005** (2013.01); **B29L**

(57) **ABSTRACT**

The present invention relates to an antenna module for an insert type antenna module for a portable terminal and a method for manufacturing the same. More specifically, the method for manufacturing an insert type antenna module for a portable terminal comprises an antenna radiation part manufacture step wherein an antenna core is manufactured, the antenna core being engaged by an insert so that an antenna radiation part configured in a predetermined shape selected between a plane shape and a curved shape with at least one axis by cutting and bending a conductive metal sheet is exposed toward an outer surface of one side, wherein in the antenna radiation part manufacture step, in the core forming mold is disposed an antenna support protrusion maintaining a gap for the sake of a thickness development of the antenna core.

16 Claims, 13 Drawing Sheets





US009093752B2

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

(10) **Patent No.:** **US 9,093,752 B2**
(45) **Date of Patent:** **Jul. 28, 2015**

(54) **ELECTRONIC DEVICE WITH CAPACITIVELY LOADED ANTENNA**

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

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 273 days.

(21) Appl. No.: **13/790,549**

(22) Filed: **Mar. 8, 2013**

(65) **Prior Publication Data**

US 2014/0253392 A1 Sep. 11, 2014

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
H01Q 5/328 (2015.01)
H01Q 5/335 (2015.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/36** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/328** (2015.01); **H01Q 5/335** (2015.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/36; H01Q 1/243; H01Q 5/0058; H01Q 5/0041; H01Q 5/0037
USPC 343/702, 700 MS, 749, 750, 752, 745
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,764,190 A * 6/1998 Murch et al. 343/702
6,639,564 B2 * 10/2003 Johnson 343/702
7,183,994 B2 * 2/2007 Weigand 343/795

7,671,804 B2 3/2010 Zhang et al.
8,432,322 B2 4/2013 Amm et al.
2001/0043159 A1 * 11/2001 Masuda et al. 343/700 MS
2002/0149526 A1 * 10/2002 Tran et al. 343/702
2011/0012794 A1 1/2011 Schlub et al.
2011/0050509 A1 3/2011 Ayala Vazquez et al.
2012/0046002 A1 2/2012 Hill et al.
2012/0169543 A1 7/2012 Sharma et al.
2012/0214412 A1 8/2012 Schlub et al.
2012/0223865 A1 9/2012 Li et al.
2012/0223866 A1 9/2012 Ayala Vazquez et al.
2012/0262343 A1 10/2012 Radojkovic
2013/0038494 A1 2/2013 Kuonanoja
2013/0076573 A1 * 3/2013 Rappoport et al. 343/702

OTHER PUBLICATIONS

Yarga et al., U.S. Appl. No. 13/790,549, filed Mar. 8, 2013.
Jiang et al., U.S. Appl. No. 13/864,968, filed Apr. 17, 2013.
Schlub et al., U.S. Appl. No. 13/420,278, filed Mar. 14, 2012.
Zhu et al., U.S. Appl. No. 13/402,831, filed Feb. 22, 2012.

* cited by examiner

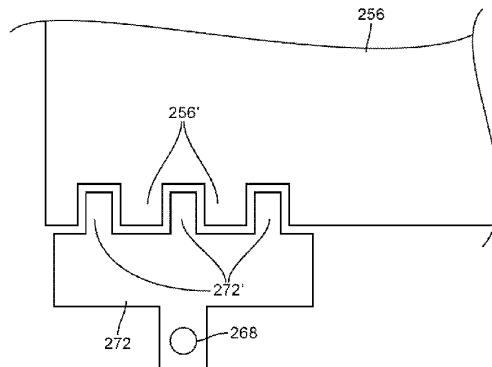
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Joseph F. Guihan

(57) **ABSTRACT**

An electronic device may have an antenna for providing coverage in wireless communications bands of interest such as a low frequency communications band, a middle frequency communications band, and a high frequency communications band. Slot structures in the antenna that might reduce efficiency in the high frequency communications band may be avoided by capacitively loading the antenna and omitting meandering paths in the antenna. A capacitor may be coupled between an antenna ground formed from a metal housing structure and an antenna resonating element having a curved shape that conforms to the shape of the edge of the electronic device. The capacitor may have interdigitated fingers and may be adjustable to tune the antenna. The antenna may transmit and receive radio-frequency signals through a display cover layer in a display and a dielectric antenna window portion of the housing.

14 Claims, 16 Drawing Sheets





US009096029B2

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

(10) **Patent No.:** **US 9,096,029 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **ELECTRONIC DEVICE CASE, METHOD AND MOLD FOR MANUFACTURING THE SAME, AND MOBILE COMMUNICATIONS TERMINAL**

(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**, Suwon, Gyunggi-do (KR)

(72) Inventors: **Jae Suk Sung**, Gyunggi-do (KR); **Sung Eun Cho**, Gyunggi-do (KR); **Ha Ryong Hong**, Gyunggi-do (KR); **Dae Kyu Lee**, Gyunggi-do (KR); **Ki Won Chang**, Gyunggi-do (KR); **Dae Seong Jeon**, Gyunggi-do (KR); **Tae Sung Kim**, Seoul (KR); **Dae Ki Lim**, Gyunggi-do (KR); **Hyun Do Park**, Gyunggi-do (KR); **Nam Il Seo**, Seoul (KR)

(73) Assignee: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, 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 174 days.

(21) Appl. No.: **13/973,103**

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

(65) **Prior Publication Data**

US 2013/0335279 A1 Dec. 19, 2013

Related U.S. Application Data

(62) Division of application No. 12/608,818, filed on Oct. 29, 2009, now Pat. No. 8,618,989.

(30) **Foreign Application Priority Data**

Apr. 23, 2009 (KR) 10-2009-0035635

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
B29D 99/00 (2010.01)

(Continued)

(52) **U.S. Cl.**
CPC **B29D 99/006** (2013.01); **B29C 45/14065** (2013.01); **B29C 45/14639** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC B29C 45/14065; B29C 45/14639; H01Q 1/243; H01Q 1/40; H01Q 1/42; H01Q 9/0421; H04M 1/026; H04W 88/02
USPC 343/702, 872, 873; 29/600
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,285,324 B1 9/2001 Korisch et al.
6,396,444 B1 5/2002 Goward et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE 10 2004 001354 A1 7/2004
DE 10 2004 019510 A1 12/2005

(Continued)

OTHER PUBLICATIONS

United States Office Action issued in U.S. Appl. No. 13/973,936 dated Nov. 20, 2013.

(Continued)

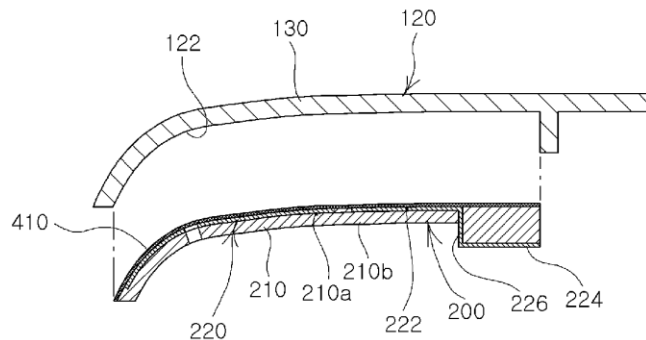
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An electronic device case having an antenna pattern embedded therein includes: a radiator having an antenna pattern portion transmitting and receiving a signal and a connection terminal portion allowing the signal to be transmitted to and received from a circuit board of an electronic device; a connection portion partially forming the radiator and connecting the antenna pattern portion and the connection terminal portion to be arranged in different planes; a radiator frame manufactured by injection molding on the radiator so that the antenna pattern portion of the radiator is provided on one side of the radiator frame and the connection terminal portion is provided on the other side thereof; and a case frame covering the one side of the radiator frame on which the antenna pattern portion is provided so that the antenna pattern portion is embedded between the case frame and the radiator frame.

2 Claims, 19 Drawing Sheets





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

(10) **Patent No.:** **US 9,099,766 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **WIDEBAND ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Kuei Shan
Hsiang, Tao Yuan Shien (TW)

(72) Inventors: **Ming-Che Chan**, Tao Yuan Shien (TW);
Chun-I Lin, Tao Yuan Shien (TW); **Hui Lin**,
Tao Yuan Shien (TW)

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

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

(21) Appl. No.: **14/181,014**

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

(65) **Prior Publication Data**

US 2015/0123874 A1 May 7, 2015

(30) **Foreign Application Priority Data**

Nov. 4, 2013 (TW) 102139900 A

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

(52) **U.S. Cl.**
CPC **H01Q 5/0093** (2013.01); **H01Q 5/0027**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/0093; H01Q 5/0027
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,373,604 B2 2/2013 Wong et al.
8,436,774 B2 5/2013 Wong et al.

2001/0030627	A1 *	10/2001	Andersson	.....	343/702
2005/0275595	A1 *	12/2005	Endo et al.	.....	343/702
2008/0198088	A1 *	8/2008	Lin et al.	.....	343/850
2011/0095949	A1 *	4/2011	Wong et al.	.....	343/702
2011/0122027	A1 *	5/2011	Wong et al.	.....	343/700 MS
2013/0162494	A1	6/2013	Wong et al.		
2013/0307732	A1 *	11/2013	Chiu et al.	.....	343/700 MS

FOREIGN PATENT DOCUMENTS

TW	201115833	5/2011
TW	201119142	6/2011
TW	I366950	6/2012
TW	201328016	7/2013

OTHER PUBLICATIONS

Taiwanese language office action dated Jun. 27, 2014.
English language translation of abstract of TW 201115833 (pub-
lished May 1, 2011).

English language translation of abstract of TW 201119142 (pub-
lished Jun. 1, 2011).

English language translation of abstract of TW I366950 (published
Jun. 21, 2011).

English language translation of abstract of TW 201328016 (pub-
lished Jul. 1, 2013).

* cited by examiner

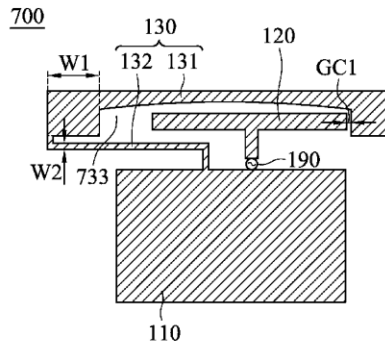
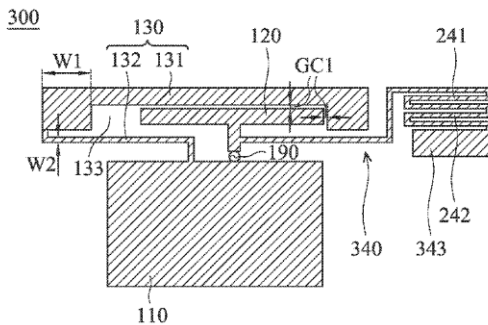
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

An antenna structure includes a ground plane, a feeding ele-
ment, and a coupling radiation element. The feeding element
is coupled to a signal source. The feeding element substan-
tially has a T-shape. The coupling radiation element is sepa-
rate from the feeding element and is adjacent to the feeding
element. The coupling radiation element is further coupled to
the ground plane and at least partially surrounds the feeding
element.

6 Claims, 4 Drawing Sheets





US009099771B2

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

(10) **Patent No.:** **US 9,099,771 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **RESONATING ELEMENT FOR REDUCING RADIO-FREQUENCY INTERFERENCE IN AN ELECTRONIC DEVICE**

(75) Inventors: **Nicholas G. L. Merz**, San Francisco, CA (US); **Scott A. Myers**, San Francisco, CA (US); **Tang Yew Tan**, Palo Alto, CA (US); **Jaydeep V. Ranade**, Cupertino, CA (US); **Mattia Pascolini**, Campbell, 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 311 days.

(21) Appl. No.: **13/017,568**

(22) Filed: **Jan. 31, 2011**

(65) **Prior Publication Data**

US 2012/0178503 A1 Jul. 12, 2012

Related U.S. Application Data

(60) Provisional application No. 61/432,522, filed on Jan. 11, 2011.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H04M 1/02
USPC 343/702; 455/566
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,559,809	B1	5/2003	Mohammadian et al.	
6,724,348	B2 *	4/2004	Fang	343/702
6,937,205	B2 *	8/2005	Chou et al.	343/841
7,230,571	B2	6/2007	Gaucher et al.	
7,231,237	B2	6/2007	Kinezos et al.	
7,595,759	B2 *	9/2009	Schlub et al.	343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN	101627537	1/2010
TW	M286399 U	1/2006

(Continued)

OTHER PUBLICATIONS

Kim, U.S. Appl. No. 12/899,509, filed Oct. 6, 2010.

Primary Examiner — Dameon E Levi

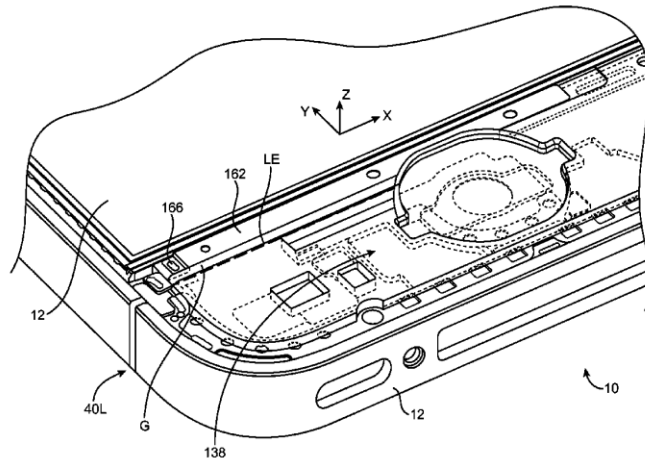
Assistant Examiner — Andrea Lindgren Baltzell

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

(57) **ABSTRACT**

An electronic device may be provided with a display and wireless circuits. The wireless circuits may include antenna structures and radio-frequency transceiver circuitry that transmits and receives radio-frequency signals using the antenna structures. A ground plane for the antenna structures may be located in the center of the electronic device under the display. A resonating element may be used to reduce signal interference that otherwise arises when simultaneously operating the display and the antenna structures. The resonating element may be implemented using an L-shaped structure have an arm that extends parallel to one of the edges of the display.

20 Claims, 5 Drawing Sheets





US009099772B2

(12) **United States Patent**
Kwon

(10) **Patent No.:** **US 9,099,772 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **ANTENNA APPARATUS FOR PORTABLE TERMINAL**

(2013.01); **H01Q 9/0421** (2013.01); **H04M 1/0266** (2013.01); **H04M 2250/22** (2013.01)

(75) Inventor: **Young-Mi Kwon**, Bucheon-si (KR)

(58) **Field of Classification Search**
USPC 343/702, 850; 455/575.7
See application file for complete search history.

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-Si (KR)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 498 days.

U.S. PATENT DOCUMENTS

(21) Appl. No.: **13/298,125**

7,069,043 B2* 6/2006 Sawamura et al. 455/550.1
2002/0126236 A1* 9/2002 Hiratsuka et al. 349/58
2008/0150901 A1* 6/2008 Lowles et al. 345/173
2011/0148718 A1* 6/2011 Wang et al. 343/702

(22) Filed: **Nov. 16, 2011**

* cited by examiner

(65) **Prior Publication Data**
US 2012/0146863 A1 Jun. 14, 2012

Primary Examiner — Dieu H Duong

(30) **Foreign Application Priority Data**
Dec. 8, 2010 (KR) 10-2010-0124717

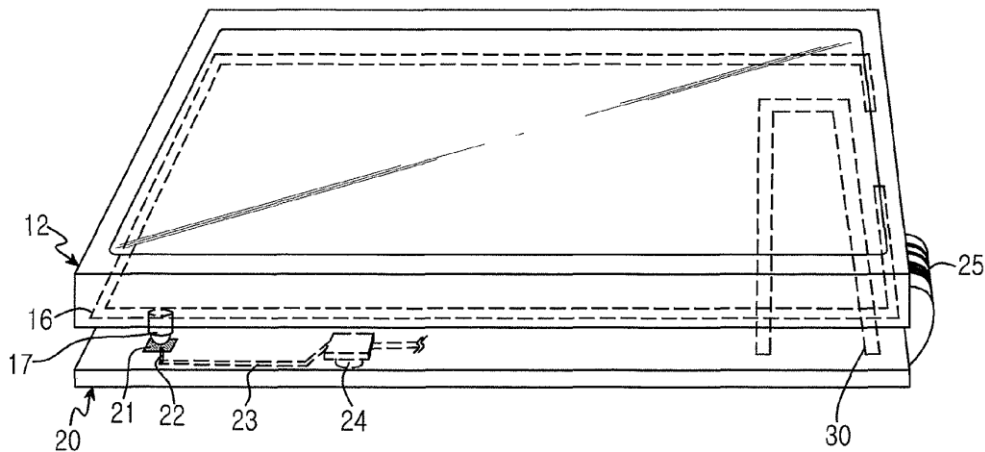
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)
H01Q 9/04 (2006.01)
H04M 1/02 (2006.01)

An antenna apparatus for a portable terminal includes a main board and a display device. The main board has a ground for grounding and a feed terminal for feeding. The display device electrically communicates with the main board by the medium of a Flexible Printed Circuit Board (FPCB) and has an ElectroStatic Charge (ESD) prevention ground. If the display device is mounted above the main board, the ESD prevention ground of the display device comes in electric contact with the feed terminal of the main board, for emission.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44**

17 Claims, 4 Drawing Sheets





US009099774B2

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

(10) **Patent No.:** **US 9,099,774 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **ANTENNA**

(71) Applicant: **Nokia Corporation**, Espoo (FI)

(72) Inventors: **Niels B. Larsen**, Encinitas, CA (US);
Ping Hui, San Diego, CA (US);
Yonghua Wei, San Diego, CA (US);
Francis McGaffigan, Escondido, CA (US);
Nan Xu, San Diego, CA (US);
Kiril Stoyanov, San Diego, CA (US)

(73) Assignee: **Nokia Technologies Oy**, Espoo (FI)

(*) 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.: **14/513,687**

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

(65) **Prior Publication Data**

US 2015/0029061 A1 Jan. 29, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/475,345, filed on May 18, 2012, now Pat. No. 8,896,489.

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/16 (2006.01)
H01Q 9/42 (2006.01)
H01Q 19/00 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/16** (2013.01); **H01Q 9/42** (2013.01); **H01Q 19/005** (2013.01); **Y10T 29/49018** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 19/005; H01Q 1/38; H01Q 1/243
USPC 343/700 MS, 833, 834, 702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,126,539 B2	10/2006	Li et al.	343/700 MS
7,935,265 B2 *	5/2011	Schwanke et al.	216/56
8,125,391 B2 *	2/2012	Knudsen	343/700 MS
2003/0112200 A1	6/2003	Marino	343/824
2006/0055615 A1	3/2006	Zhou	343/790
2009/0135082 A1	5/2009	Hou	343/878
2010/0253579 A1	10/2010	Ryou et al.	343/700 MS

FOREIGN PATENT DOCUMENTS

EP 1298760 A1 4/2003

* cited by examiner

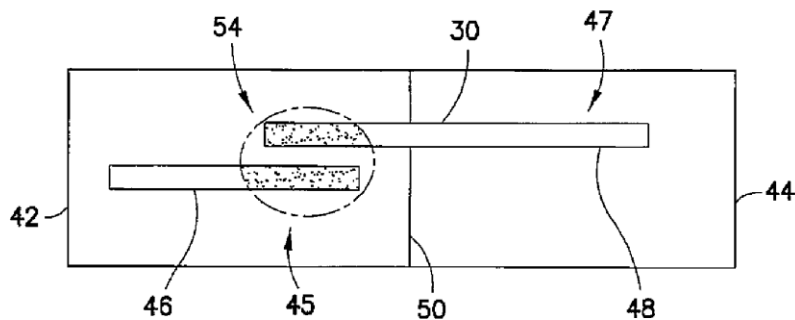
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An apparatus including an antenna having an active element and a parasitic element; and at least one support, where the antenna is at least partially on the at least one support, where the at least one support includes a first section coupled to a second different section, where the active element is at least partially on the first section, and where the first section is at least partially formed with a first manufacturing process and a first material. The parasitic element is at least partially on the second section, and the second section is at least partially formed with a second different manufacturing process and a second different material.

22 Claims, 10 Drawing Sheets





US009099779B2

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

(10) **Patent No.:** **US 9,099,779 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/378; H01Q 9/065
USPC 343/700 MS, 702
See application file for complete search history.

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

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

2006/0197709 A1* 9/2006 Tung 343/702
2006/0232484 A1* 10/2006 Wulff et al. 343/702
2008/0150811 A1* 6/2008 Honda et al. 343/702
2011/0128190 A1* 6/2011 Galeev 343/702
2012/0306709 A1* 12/2012 Wu et al. 343/767

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 220 days.

* cited by examiner

(21) Appl. No.: **13/663,507**

Primary Examiner — Robert Karacsony

(22) Filed: **Oct. 30, 2012**

Assistant Examiner — Daniel J Munoz

(65) **Prior Publication Data**

US 2013/0335277 A1 Dec. 19, 2013

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

(30) **Foreign Application Priority Data**

Jun. 15, 2012 (TW) 101121518 A

(57) **ABSTRACT**

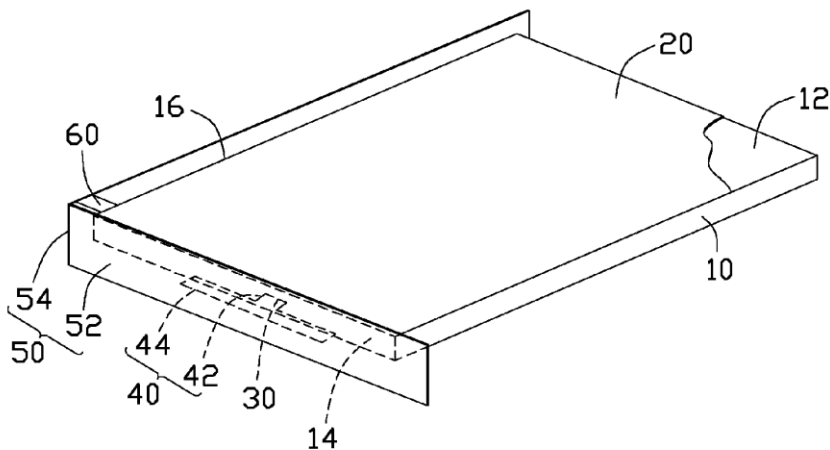
(51) **Int. Cl.**
H01Q 5/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

An antenna assembly employed by a wireless communication device having a housing includes a base board, a grounding member secured on the base board and grounding the antenna assembly, a first radio member electrically connected to the based board to receive and transmit wireless signals having a first central frequency, and a second radio member forming a portion of the housing and electrically connected to the grounding member. The second radio member couples with the first radio member to receive and transmit wireless signals having a second central frequency.

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

13 Claims, 4 Drawing Sheets

100





US009099780B2

(12) **United States Patent
Cheng**

(10) **Patent No.: US 9,099,780 B2**
(45) **Date of Patent: Aug. 4, 2015**

(54) **ANTENNA DEVICE FOR CIRCUIT BOARD**

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

(72) Inventor: **Shih-Chieh Cheng**, Hsinchu (TW)

(73) Assignee: **Arcadyan Technology Corp.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 312 days.

(21) Appl. No.: **13/678,523**

(22) Filed: **Nov. 15, 2012**

(65) **Prior Publication Data**
US 2013/0214977 A1 Aug. 22, 2013

(30) **Foreign Application Priority Data**
Feb. 22, 2012 (TW) 101105912 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 833, 841, 848
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,220,335	A *	6/1993	Huang	343/700 MS
5,844,525	A *	12/1998	Hayes et al.	343/702
6,326,922	B1 *	12/2001	Hegendoerfer	343/700 MS
7,486,237	B2	2/2009	Huang et al.	
7,911,402	B2	3/2011	Rowson	
2001/0021643	A1 *	9/2001	Itoh	455/90
2008/0258979	A1	10/2008	Lin et al.	
2013/0109449	A1 *	5/2013	Desclos et al.	455/575.7

FOREIGN PATENT DOCUMENTS

CN	101154764	4/2008
CN	101501933	8/2009
CN	102017297	4/2011
TW	538561	6/2003
TW	200803038	1/2008

OTHER PUBLICATIONS

Chinese Office Action dated Sep. 28, 2014.
English Abstract, TW 200803038.
English Abstract, CN102017297.
English Abstract, TW538561.
TW Office Action, PD4539.

* cited by examiner

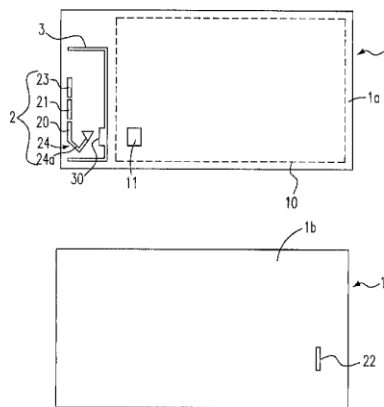
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Law Offices of John Parrish

(57) **ABSTRACT**

An antenna device is provided. The antenna device includes a circuit board including a first side configured with a transmission unit, and a second side opposite to the first side; a main radiator disposed at the first side, electrically connected to the transmission unit, and having a major axis direction; a first parasitical radiator adjacent to the main radiator, and coaxially disposed in the major axis direction at the first side; and a second parasitical radiator coaxially disposed in the major axis direction at the second side.

12 Claims, 3 Drawing Sheets





US009099784B2

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

(10) **Patent No.:** **US 9,099,784 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **ARRAY ANTENNA OF MOBILE TERMINAL AND IMPLEMENTING METHOD THEREOF**

USPC 343/853, 702, 893; 29/600
See application file for complete search history.

(75) Inventors: **Hui Jiang**, Shenzhen (CN); **Hao Ai**, Shenzhen (CN); **Lu Zhang**, Shenzhen (CN); **Ying Liu**, Shenzhen (CN); **Chao Li**, Shenzhen (CN)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0132641 A1* 6/2007 Korva et al. 343/700 MS
2008/0231521 A1* 9/2008 Anguera Pros et al. 343/702
(Continued)

(73) Assignee: **ZTE Corporation** (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 266 days.

FOREIGN PATENT DOCUMENTS

CN 101316008 A 12/2008
CN 101719593 A 1/2010
(Continued)

(21) Appl. No.: **13/976,700**

(22) PCT Filed: **Jun. 13, 2011**

OTHER PUBLICATIONS

International Search Report mailed Oct. 13, 2011 in PCT Application No. PCT/CN2011/075666.
(Continued)

(86) PCT No.: **PCT/CN2011/075666**

§ 371 (c)(1),
(2), (4) Date: **Jul. 30, 2013**

(87) PCT Pub. No.: **WO2012/088837**

PCT Pub. Date: **Jul. 5, 2012**

Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Plumsea Law Group, LLC

(65) **Prior Publication Data**

US 2013/0300629 A1 Nov. 14, 2013

(57) **ABSTRACT**

An antenna array of a mobile terminal and an implementing method thereof are disclosed in this document. The antenna array includes: a mobile terminal floorboard, configured to act as a radiation body to radiate antenna energy coupled by multiple pairs of coupling units, and multiple pairs of coupling units corresponding to multiple antennas, each of which are fixed at two ends of the mobile terminal floorboard and are configured to inspire a waveguide mode of the mobile terminal floorboard to radiate the coupled antenna energy through feed points of feed lines of each coupling unit therein, located at the same side of a dielectric material plate; and a matching circuit located at the other side of the dielectric material plate, connected with the feed points located at the opposite side of the dielectric material plate and configured to implement impedance matching of a micro-strip feed line of each coupling unit.

(30) **Foreign Application Priority Data**

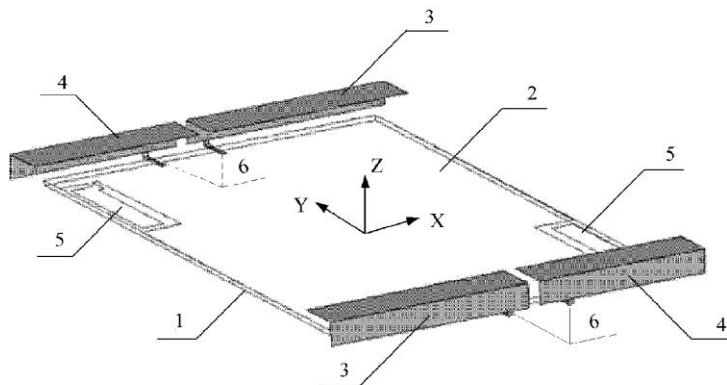
Dec. 27, 2010 (CN) 2010 1 0607713

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 21/29** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/50; H01Q 1/243; H01Q 21/29; H01Q 9/0407; Y10T 29/49016

14 Claims, 4 Drawing Sheets





US009099789B1

(12) **United States Patent**
Modro

(10) **Patent No.:** **US 9,099,789 B1**
(45) **Date of Patent:** **Aug. 4, 2015**

- (54) **DUAL-BAND INVERTED SLOT ANTENNA**
- (71) Applicant: **AMAZON TECHNOLOGIES, INC.**,
Reno, NV (US)
- (72) Inventor: **Joseph Christopher Modro**, Palo Alto,
CA (US)
- (73) Assignee: **Amazon Technologies, Inc.**, Reno, NV
(US)
- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 301 days.
- (21) Appl. No.: **13/712,875**
- (22) Filed: **Dec. 12, 2012**

Related U.S. Application Data

- (60) Provisional application No. 61/697,235, filed on Sep.
5, 2012.
- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 13/00; H01Q 1/38; H01Q 1/24;
H01Q 1/24
USPC 343/767, 702, 700 MS, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,043,785	A *	3/2000	Marino	343/767
7,592,968	B2 *	9/2009	Modro	343/873
7,646,341	B1 *	1/2010	Lin et al.	343/700 MS
2003/0103010	A1 *	6/2003	Boyle	343/702
2005/0248488	A1 *	11/2005	Modro	343/700 MS
2006/0050002	A1 *	3/2006	Wang et al.	343/767

OTHER PUBLICATIONS

Kishan Singh, A novel design of square microstrip antenna for dual band operation, 2011, International journal of electronics engineering, Serials publication, ISSN:0973-7383, pp. 349-352.*

* cited by examiner

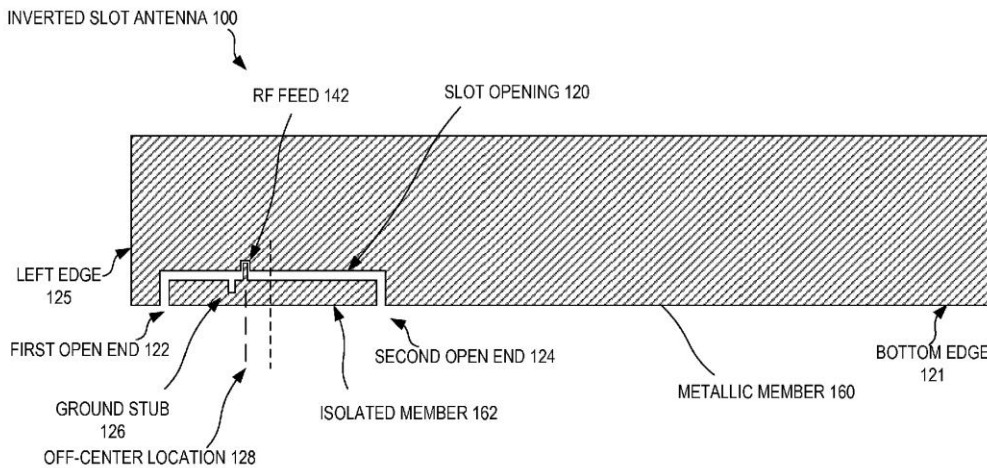
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

Methods and systems for radiating electromagnetic energy with a dual-band inverted slot antenna are described. The dual-band inverted slot antenna may be formed of a metallic member with two open ends at one or more edges of the metallic member. The inverted slot antenna is configured to radiate electromagnetic energy in response to the RF signal at two resonant modes.

25 Claims, 8 Drawing Sheets





US009099790B2

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

(10) **Patent No.:** **US 9,099,790 B2**
(45) **Date of Patent:** **Aug. 4, 2015**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE THEREIN**

USPC 343/702, 767
See application file for complete search history.

(71) Applicant: **HTC Corporation**, Taoyuan, Taoyuan County (TW)

(56) **References Cited**

(72) Inventors: **Ju-Hung Chen**, Taoyuan (TW); **Pei-Ling Teng**, Taoyuan (TW); **Yi-Chun Chen**, Taoyuan (TW); **Tun-Yuan Tsou**, Taoyuan (TW); **Kuo-Cheng Chen**, Taoyuan (TW)

U.S. PATENT DOCUMENTS

(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 286 days.

6,618,020	B2	9/2003	Wang et al.	
6,677,907	B2	1/2004	Shoji et al.	
6,712,983	B2	3/2004	Zhao et al.	
7,327,234	B2	2/2008	Egami et al.	
7,518,564	B2	4/2009	Guthrie	
7,551,142	B1*	6/2009	Zhang et al.	343/702
8,325,094	B2*	12/2012	Ayala Vazquez et al.	343/702
2009/0153412	A1*	6/2009	Chiang et al.	343/702
2009/0256757	A1*	10/2009	Chiang et al.	343/702
2011/0006953	A1*	1/2011	Chiang et al.	343/702
2013/0082884	A1*	4/2013	Gummalla	343/702

* cited by examiner

(21) Appl. No.: **13/728,583**

Primary Examiner — Hoang V Nguyen

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

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

(65) **Prior Publication Data**

US 2014/0184453 A1 Jul. 3, 2014

(57) **ABSTRACT**

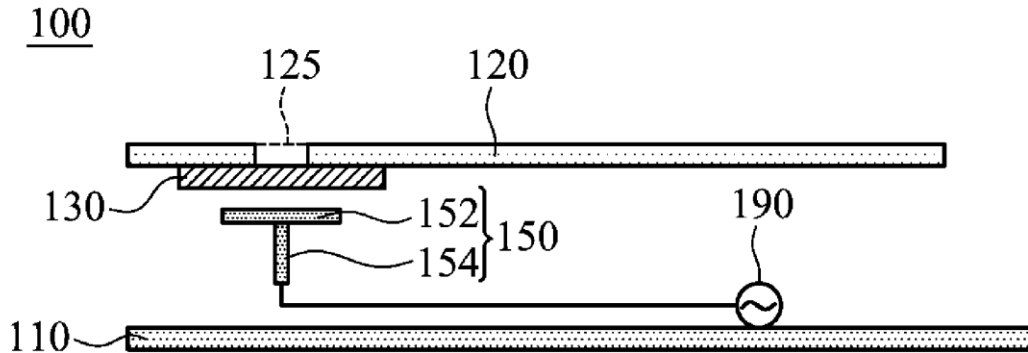
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 13/16 (2006.01)
H01Q 5/371 (2015.01)

A mobile device includes a ground element, a conductive bezel, a nonconductive layer, and a feeding element. The conductive bezel is substantially independent of the ground element. A slot is formed in the conductive bezel. The nonconductive layer is affixed to the conductive bezel and covers the slot of the conductive bezel. The feeding element is close to the slot of the conductive bezel and is coupled to a signal source. An antenna structure is formed by the feeding element and the slot.

(52) **U.S. Cl.**
CPC **H01Q 21/00** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 13/16** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 13/16

24 Claims, 6 Drawing Sheets





US009105966B1

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

(10) **Patent No.:** **US 9,105,966 B1**
(45) **Date of Patent:** **Aug. 11, 2015**

- (54) **ANTENNA WITH AN EXCITER**
- (75) Inventors: **Weiping Dou**, San Jose, CA (US);
James Samuel Bowen, Cupertino, CA (US)
- (73) Assignee: **Amazon Technologies, Inc.**, Reno, NV (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 883 days.
- (21) Appl. No.: **12/858,225**
- (22) Filed: **Aug. 17, 2010**
- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 13/106; H01Q 13/16
USPC 343/702, 872, 767, 770
See application file for complete search history.

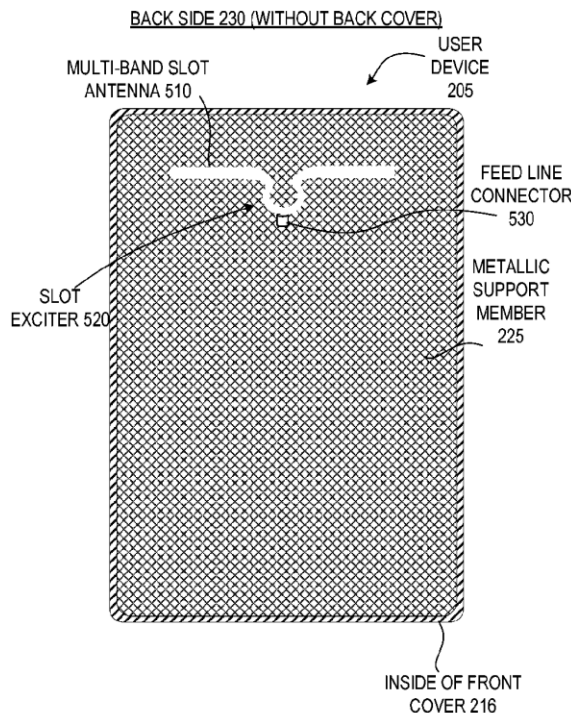
- (56) **References Cited**
U.S. PATENT DOCUMENTS

4,644,343	A *	2/1987	Schneider et al.	343/767
5,748,152	A *	5/1998	Glabe et al.	343/767
6,727,857	B2 *	4/2004	Mikkola et al.	343/702
6,847,329	B2 *	1/2005	Ikegaya et al.	343/702
7,193,576	B2 *	3/2007	Yazdandoost et al.	343/767
7,764,236	B2 *	7/2010	Hill et al.	343/702
7,782,261	B2 *	8/2010	An et al.	343/702
2004/0113849	A1 *	6/2004	Jarmuszewski et al.	343/702
2006/0038724	A1 *	2/2006	Tikhov et al.	343/700 MS
2006/0055612	A1 *	3/2006	Kim et al.	343/767
2007/0085747	A1 *	4/2007	DiNallo et al.	343/702
2009/0153410	A1 *	6/2009	Chiang et al.	343/702
2009/0153412	A1 *	6/2009	Chiang et al.	343/702
2010/0123632	A1 *	5/2010	Hill et al.	343/702
2010/0149048	A1 *	6/2010	Lin	343/702
2010/0238072	A1 *	9/2010	Ayatollahi et al.	343/700 MS
2011/0037656	A1 *	2/2011	Bremner et al.	343/700 MS
2011/0109515	A1 *	5/2011	Rao	343/702

* cited by examiner

Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) Attorney, Agent, or Firm — Lowenstein Sandler LLP

- (57) **ABSTRACT**
A user device having a non-radiating exciter operatively coupled to feed a multi-band aperture antenna is described.
- 16 Claims, 18 Drawing Sheets**





US009105968B2

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

(10) **Patent No.:** **US 9,105,968 B2**
(45) **Date of Patent:** **Aug. 11, 2015**

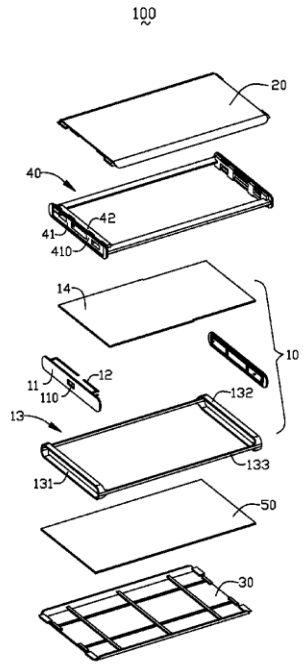
- (54) **ANTENNA ASSEMBLY AND MOBILE TERMINAL USING SAME**
- (71) Applicants: **Ng Guan Hong**, Shenzhen (CN); **Tay Yew Siow**, Shenzhen (CN)
- (72) Inventors: **Ng Guan Hong**, Shenzhen (CN); **Tay Yew Siow**, Shenzhen (CN)
- (73) Assignee: **AAC TECHNOLOGIES PTE. LTD.**, Singapore (SG)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **14/198,990**
- (22) Filed: **Mar. 6, 2014**
- (65) **Prior Publication Data**
US 2014/0306848 A1 Oct. 16, 2014
- (30) **Foreign Application Priority Data**
Mar. 22, 2013 (CN) 2013 1 0094784
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

- (52) **U.S. CL.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01)
- (58) **Field of Classification Search**
USPC 343/702
See application file for complete search history.
- (56) **References Cited**
U.S. PATENT DOCUMENTS
2012/0206302 A1 * 8/2012 Ramachandran et al. 343/702
2012/0262345 A1 * 10/2012 Kim et al. 343/702
* cited by examiner

Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — IPro, Inc.; Na Xu

(57) **ABSTRACT**
An antenna assembly of the present disclosure includes a grounding plate, a metal plate, a metal frame and an antenna body disposed between the grounding plate and the metal plate. The metal frame includes a closed annular portion, and the antenna body includes a feeding portion. One end of the feeding portion is electrically connected to the metal plate and the other end thereof is spaced apart from the grounding plate, and the closed annular portion is spaced apart from the metal plate. The antenna assembly of the present disclosure can improve the performances of the product and make the appearance of the product more aesthetic. Meanwhile, the present disclosure also provides a mobile terminal using the antenna assembly described above.

12 Claims, 6 Drawing Sheets





US009105975B2

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

(10) **Patent No.:** **US 9,105,975 B2**
(45) **Date of Patent:** **Aug. 11, 2015**

(54) **ANTENNA DEVICE AND PORTABLE WIRELESS TERMINAL EQUIPPED WITH THE SAME**

(75) Inventors: **Hiroshi Satou**, Kanagawa (JP); **Takanori Hirobe**, Ishikawa (JP); **Yoshio Koyanagi**, Kanagawa (JP); **Tomoaki Nishikido**, Ishikawa (JP)

(73) Assignee: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 324 days.

(21) Appl. No.: **13/698,181**

(22) PCT Filed: **May 16, 2011**

(86) PCT No.: **PCT/JP2011/002714**
§ 371 (c)(1),
(2), (4) Date: **Nov. 15, 2012**

(87) PCT Pub. No.: **WO2011/145323**
PCT Pub. Date: **Nov. 24, 2011**

(65) **Prior Publication Data**
US 2013/0057448 A1 Mar. 7, 2013

(30) **Foreign Application Priority Data**
May 17, 2010 (JP) 2010-112852

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/52** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/26; H01Q 21/08; H01Q 1/246
USPC 343/853, 893, 702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,526,003 A 6/1996 Ogawa et al.
2008/0258991 A1 10/2008 Montgomery et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP 7-288423 A 10/1995
JP 08-084013 A 3/1996

(Continued)

OTHER PUBLICATIONS

Andersen et al., "Decoupling and Descattering Networks for Antennas," IEEE Transactions on Antennas and Propagation, Nov. 1976, pp. 841-846.

(Continued)

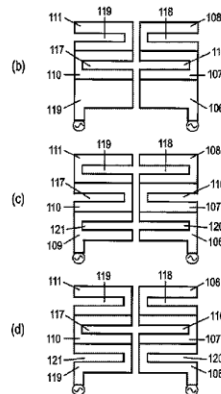
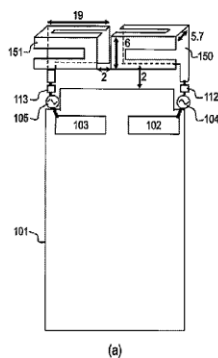
Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Seed IP Law Group PLLC

(57) **ABSTRACT**

A second slit 117 and a fourth slit 119 provided in a first antenna element 150 and a first slit 116 and a third slit 118 provided in a second antenna element 151 are adjusted such that the mutual coupling between the first antenna element 150 and the second antenna element 151 in the desired frequency band is canceled, and reduces degradation in coupling between antenna elements without connecting the antenna elements through components and the like. With such a configuration, it is possible to achieve high-efficiency loosely coupled MIMO array antennas operating in the same frequency band in a portable wireless terminal.

5 Claims, 6 Drawing Sheets





US009105980B2

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

(10) **Patent No.:** **US 9,105,980 B2**
(45) **Date of Patent:** **Aug. 11, 2015**

(54) **RADIO COMMUNICATION APPARATUS**

USPC 343/749, 702
See application file for complete search history.

(75) Inventors: **Masanori Sakurai**, Tokyo (JP); **Naoki Kobayashi**, Tokyo (JP); **Noriaki Ando**, Tokyo (JP); **Hiroshi Toyao**, Tokyo (JP); **Masaharu Imazato**, Tokyo (JP)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,786,979 A * 7/1998 Douglass 361/328
8,405,558 B2 3/2013 Hikino
(Continued)

(73) Assignee: **LENOVO INNOVATIONS LIMITED (HONG KONG)**, Quarry Bay (HK)

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

FOREIGN PATENT DOCUMENTS

CN 101459274 6/2009
JP 2006-197292 A 7/2006
(Continued)

(21) Appl. No.: **13/576,466**

(22) PCT Filed: **Mar. 4, 2011**

OTHER PUBLICATIONS

Ando WO 2010029770 Machine Translation.*
(Continued)

(86) PCT No.: **PCT/JP2011/001281**

§ 371 (c)(1),
(2), (4) Date: **Aug. 1, 2012**

(87) PCT Pub. No.: **WO2011/121893**

PCT Pub. Date: **Oct. 6, 2011**

Primary Examiner — Dameon E Levi
Assistant Examiner — Ricardo Magallanes

(65) **Prior Publication Data**

US 2012/0299787 A1 Nov. 29, 2012

(57) **ABSTRACT**

A radio communication apparatus (100) includes an antenna device (40) that faces at least a part of a conductor plate of a conductor surface (second casing) or a conductor layer of an interconnect substrate (30); and a plurality of conductor components (36) that are located between the antenna device (40) and the conductor surface and are arranged in a repetitive manner so as to intersect in a surface-normal direction of the conductor surface. The radio communication apparatus is, for example, a slide opening and closing type cellular phone and includes a first casing (10), a second casing (20), and a flexible interconnect substrate (30). The first casing (10) and the second casing (20) are slid relatively so that the radio communication apparatus (100) is switched between first and second states. In the first state, the interconnect substrate (30) is folded. The interconnect substrate (30) is extended further in the second state than in the first state.

(30) **Foreign Application Priority Data**

Mar. 31, 2010 (JP) 2010-081456

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

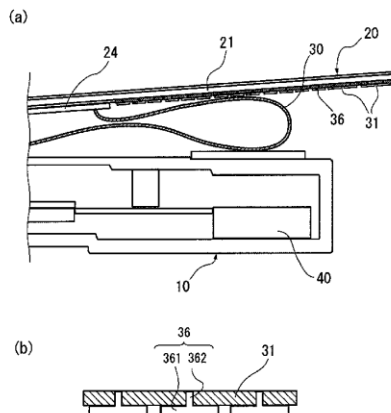
(52) **U.S. Cl.**

CPC **H01Q 15/0086** (2013.01); **H01Q 1/243** (2013.01); **H01Q 15/14** (2013.01); **H04M 1/0237** (2013.01)

(58) **Field of Classification Search**

CPC . H01Q 15/0086; H01Q 1/243; H04M 1/0235; H04M 1/0237; H04M 1/0239; H04B 1/3838; H04B 1/0237

15 Claims, 9 Drawing Sheets





US009105984B2

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

(10) **Patent No.:** **US 9,105,984 B2**
(45) **Date of Patent:** **Aug. 11, 2015**

(54) **WIRELESS COMMUNICATION DEVICE WITH SLOT ANTENNA**

(71) Applicant: **Chiun 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 0 days.

(21) Appl. No.: **14/036,137**

(22) Filed: **Sep. 25, 2013**

(65) **Prior Publication Data**

US 2014/0315509 A1 Oct. 23, 2014

(30) **Foreign Application Priority Data**

Apr. 22, 2013 (TW) 102114172 A

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/321 (2015.01)
H01Q 5/55 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 13/103** (2013.01); **H01Q 5/321** (2015.01); **H01Q 5/55** (2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

USPC 455/575.7, 193.1, 269, 275, 282, 286, 455/288, 290; 343/702, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,129,902 B2 * 10/2006 Bancroft 343/767
8,373,910 B2 * 2/2013 Iwasaki et al. 358/474
2006/0097941 A1 * 5/2006 Bettner et al. 343/767
2008/0316118 A1 * 12/2008 Puente Baliarda et al. ... 343/702
2009/0021439 A1 * 1/2009 Kanno et al. 343/767

* cited by examiner

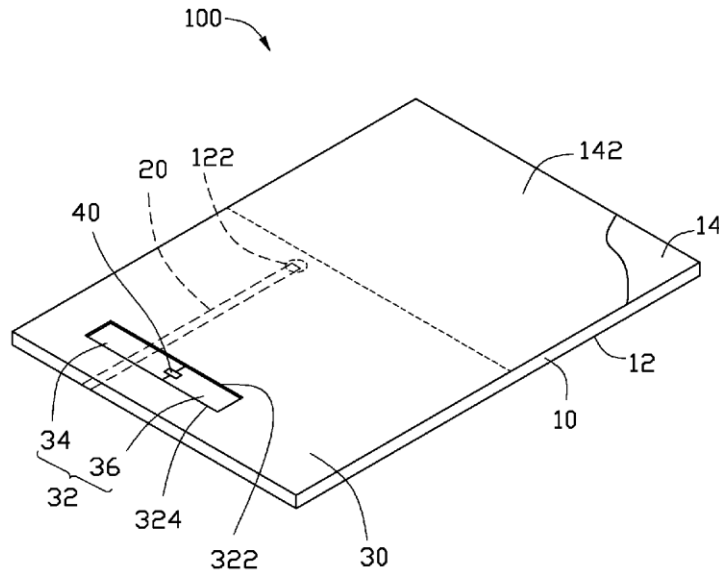
Primary Examiner — Blane J Jackson

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

(57) **ABSTRACT**

A wireless communication device includes a base board, a metal zone, and a filter. The metal zone and the filter are disposed on the base board. The metal zone defines a slot. The filter is connected to the slot to divide the slot into a first slot section and a second slot section. When a current having a first frequency flows through the first slot section and the second slot section, the filter is in an open circuit state, and the first slot section and the second slot section are activated to receive/transmit wireless signals having a first central frequency. When a current having a second frequency only flows through the first slot section, the filter is in a closed circuit state, and the first slot section is activated to receive/transmit wireless signals having a second central frequency.

11 Claims, 4 Drawing Sheets





US009112257B2

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

(10) **Patent No.:** **US 9,112,257 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **COMMUNICATION DEVICE AND METHOD FOR ENHANCING IMPEDANCE BANDWIDTH OF ANTENNA THEREOF**

(75) Inventors: **Wei-Yu Li**, Yilan County (TW);
Hung-Hsuan Lin, Hsinchu County (TW); **Ta-Chun Pu**, Kaohsiung (TW);
Chun-Yih Wu, Taipei (TW)

(73) Assignee: **Industrial Technology Research Institute**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 232 days.

(21) Appl. No.: **13/419,433**

(22) Filed: **Mar. 14, 2012**

(65) **Prior Publication Data**
US 2013/0038491 A1 Feb. 14, 2013

(30) **Foreign Application Priority Data**
Aug. 31, 2011 (TW) 100131333 A
Oct. 26, 2011 (TW) 100138922 A

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

(52) **U.S. Cl.**
CPC **H01Q 5/0041** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/0093** (2013.01); **H01Q 9/0442** (2013.01); **H01Q 9/145** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/48; H01Q 9/40
USPC 343/700 MS, 702, 848
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,218,682 A * 8/1980 Frosch et al. 343/700 MS
4,929,959 A * 5/1990 Sorbello et al. 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1694303 11/2005
CN 101740852 6/2010

(Continued)

OTHER PUBLICATIONS

"Search Report of Europe Counterpart Application", issued on Dec. 20, 2012, p. 1-p. 6.

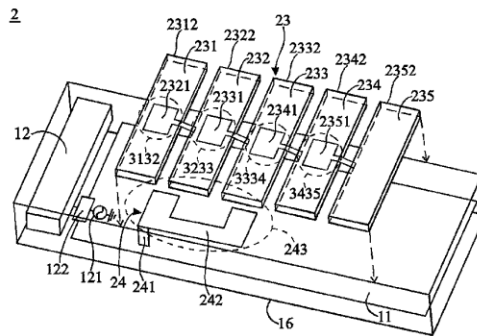
(Continued)

Primary Examiner — Robert Karacsony
Assistant Examiner — Daniel J Munoz
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A communication device and a method for enhancing impedance bandwidth of an antenna are provided. The communication device includes at least one ground, at least one antenna, a current-drawing conductor structure, and at least one coupling conductor structure. The antenna is electrically connected to the ground through a source and generates at least one operating frequency band for transmitting or receiving electromagnetic signals of at least one communication band. The current-drawing conductor structure includes a plurality of conductor elements, where there is at least one mutual coupling portion formed between neighboring conductor elements. The coupling conductor structure has a first conductor portion and a second conductor portion. One end of the first conductor portion is electrically connected to the ground, and another end thereof is electrically connected to the second conductor portion. There is at least one coupling portion formed between the second conductor portion and the current-drawing conductor structure.

19 Claims, 11 Drawing Sheets





US009112259B2

(12) **United States Patent**
Lin

(10) **Patent No.:** **US 9,112,259 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **MULTIBAND ANTENNA AND WIRELESS COMMUNICATION DEVICE USING SAME**

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

(72) Inventor: **Shih-Chieh Lin**, Taoyuan (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 232 days.

(21) Appl. No.: **13/862,852**

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

(65) **Prior Publication Data**
US 2013/0271341 A1 Oct. 17, 2013

(30) **Foreign Application Priority Data**
Apr. 17, 2012 (TW) 101113683 A

(51) **Int. Cl.**
H01Q 5/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/0093** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2013.01); **H01Q 9/0421** (2013.01)

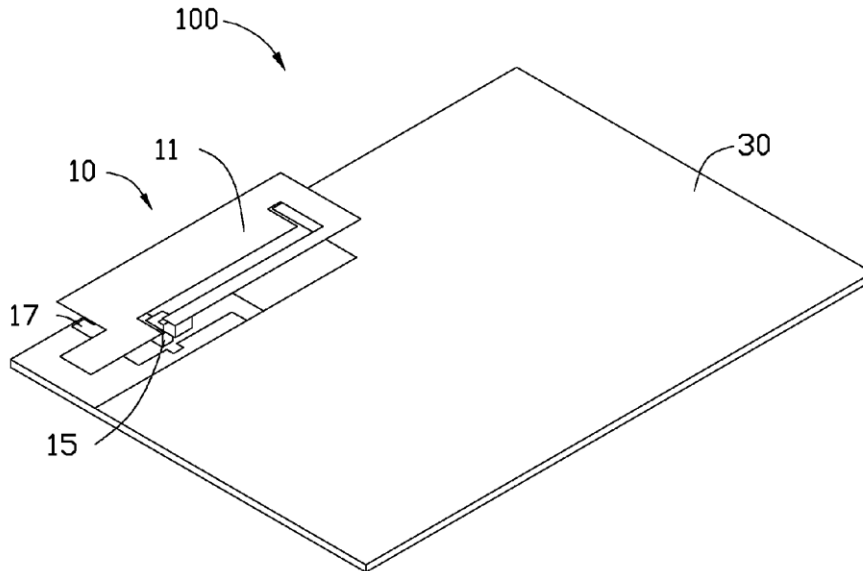
(58) **Field of Classification Search**
CPC H01Q 1/50
USPC 343/860, 700 MS, 893, 859, 702
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
8,472,908 B2 * 6/2013 Anguera et al. 455/272
2008/0062064 A1 * 3/2008 Christie et al. 343/860
2010/0156746 A1 * 6/2010 Yung et al. 343/860
2010/0289705 A1 * 11/2010 Shtrom et al. 343/702
2011/0199272 A1 * 8/2011 He et al. 343/741
* cited by examiner

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

(57) **ABSTRACT**
A multiband antenna, includes a main antenna, a coupling unit, and a matching unit. The main antenna includes a feed portion, a bent portion, a radiation portion, and an extending portion in a same plane. One end of the feed portion is connected to the coupling unit. The bent portion is perpendicularly connected to the other end of the feed portion. The radiation portion is parallel with the feed portion and perpendicularly connected to one end of the bent portion away from the feed portion. The extending portion is connected to one end of the radiation portion away from the bent portion, the coupling unit is parallel with the main antenna and connected to the matching unit, the matching unit feeds signals to and grounds the multiband antenna.

17 Claims, 3 Drawing Sheets





US009112261B2

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

(10) **Patent No.:** **US 9,112,261 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

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

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

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW); **Jin-Bo Chen**, 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 25 days.

(21) Appl. No.: **14/014,616**

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

(65) **Prior Publication Data**

US 2014/0295917 A1 Oct. 2, 2014

(30) **Foreign Application Priority Data**

Apr. 2, 2013 (TW) 102111898 A

(51) **Int. Cl.**

H04B 1/18 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/371 (2015.01)
H04M 1/02 (2006.01)

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

CPC **H01Q 9/0421** (2013.01); **H01Q 5/371** (2015.01); **H04M 1/026** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/00; H01Q 5/0027; H01Q 21/29
USPC 455/73, 19, 562.1, 575.7, 103, 168.1,
455/269; 343/700, 860, 893, 702, 770, 846,
343/700 MS

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0189522 A1 * 10/2003 Zeilinger 343/702

* cited by examiner

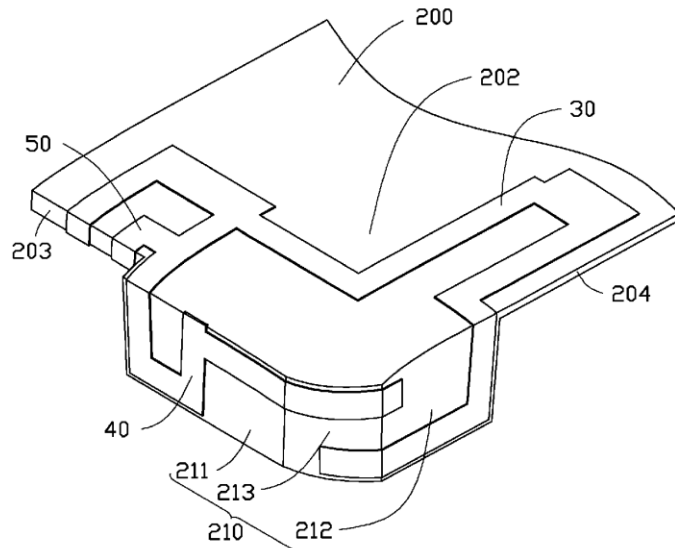
Primary Examiner — Tuan Pham

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

(57) **ABSTRACT**

An antenna structure includes a feed portion, a ground portion, a first radiating body, a second radiating body, and a third radiating body. The feed portion is connected to a first shared portion of the first radiating body. The second radiating body further includes a second shared portion connected to the first shared portion. The first and second shared portions are included in a third radiating body together with a combining portion between the second shared portion and the ground portion. The first radiating body receives and sends wireless signals of a first frequency band, the second radiating body uses a second frequency band, and the third radiating body uses a third frequency band.

20 Claims, 3 Drawing Sheets





US009112265B2

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

(10) **Patent No.:** **US 9,112,265 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **METHOD FOR MANUFACTURING ANTENNA STRUCTURE**

(75) Inventors: **Tzuh-Suan Wang**, Hsinchu (TW);
Yu-Fu Kuo, Hsinchu (TW); **Yuan-Chin Hsu**, Hsinchu (TW); **Chih-Yung Shih**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(*) 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.: **13/609,090**

(22) Filed: **Sep. 10, 2012**

(65) **Prior Publication Data**
US 2013/0318778 A1 Dec. 5, 2013

(30) **Foreign Application Priority Data**
Jun. 1, 2012 (TW) 101119808 A

(51) **Int. Cl.**
H01P 11/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01P 11/00; H01Q 1/243; H01Q 1/38
USPC 29/600, 592.1, 830, 831, 846, 847, 829; 427/555

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,424,315	B1 *	7/2002	Glenn et al.	343/895
7,550,734	B1 *	6/2009	Lee et al.	250/370.12
7,683,785	B2 *	3/2010	Johnson	340/572.1
8,176,621	B2 *	5/2012	Lo et al.	29/600
8,191,231	B2 *	6/2012	Lo et al.	29/600
8,695,207	B2 *	4/2014	Zenz	29/600
2008/0158093	A1 *	7/2008	Hong	343/872
2012/0042505	A1 *	2/2012	Lo et al.	29/600

FOREIGN PATENT DOCUMENTS

CN	102377010	A	3/2012
CN	102377011	A	3/2012
CN	102412437	A	4/2012
TW	201205952	A1	2/2012
TW	201210127	A1	3/2012

* cited by examiner

Primary Examiner — Peter DungBa Vo

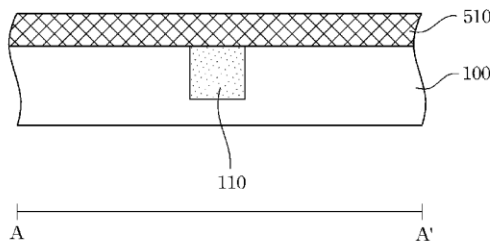
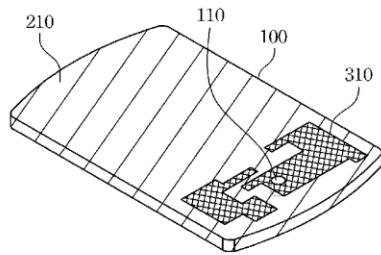
Assistant Examiner — Kaying Kue

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

(57) **ABSTRACT**

A method for manufacturing an antenna structure is disclosed. Employing steps of mixing with a catalyst and embedding a metal insert can simplify steps for manufacturing the antenna structure. Further, a non-conductive frame produced by the process disclosed herein can exhibit waterproof effect. The catalyst mentioned above is mixed with a plastic and then injected into a mold to form the non-conductive frame. The metal insert mentioned above is disposed in the mold before the step of injecting the plastic. Alternatively, the metal insert is embedded in the non-conductive frame after the step of injecting the plastic.

18 Claims, 5 Drawing Sheets





US009112266B2

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

(10) **Patent No.:** **US 9,112,266 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **MULTIBAND MONOPOLE ANTENNA BUILT INTO DECORATIVE TRIM OF A MOBILE DEVICE**

USPC 343/745, 722, 860, 700 MS, 702, 767, 343/770; 455/41.1, 129, 562.1, 475.7, 455/572-574, 550.1, 575.1
See application file for complete search history.

(71) Applicant: **Microsoft Corporation**, Redmond, WA (US)

(56) **References Cited**

(72) Inventors: **Benjamin Shewan**, Redmond, WA (US); **Javier Rodriguez De Luis**, Redmond, WA (US); **Alireza Mahanfar**, Bellevue, WA (US)

U.S. PATENT DOCUMENTS

6,140,966 A 10/2000 Pankinaho
7,050,004 B2 5/2006 Shafai et al.

(Continued)

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

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 2 days.

JP 10190345 7/1998
WO WO 2009/026304 2/2009

(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **13/707,441**

Behdad, et al., "Dual-Band Reconfigurable Antenna with a Very Wide Tunability Range", In *Proceedings of the IEEE transactions on Antennas and Propagation*, vol. 54, No. 2, Feb. 2006, 8 pages.

(22) Filed: **Dec. 6, 2012**

(Continued)

(65) **Prior Publication Data**

US 2014/0162734 A1 Jun. 12, 2014

Primary Examiner — Brandon Miller

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

(74) *Attorney, Agent, or Firm* — Micky Minhas

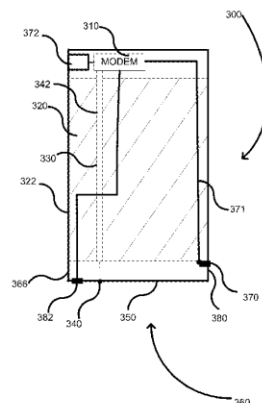
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(57) **ABSTRACT**

A multiband monopole antenna for a mobile device is disclosed that can be dynamically switched between a quarter-wave monopole antenna and a half-wave folded monopole antenna. In one embodiment, a radiator element can be built into at least part of a decorative trim on an outer casing of the mobile device. A circuit element embedded into the radiator element can electrically connect or disconnect a radiator element tip from a grounded portion of the decorative trim. In some embodiments, the circuit element can be a switch or a passive filter element, such as an inductor/capacitive-based filter. In other embodiments, the circuit element can be a tunable filter circuit whose impedance can be dynamically changed.

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/0407; H01Q 9/0421; H01Q 1/243; H01Q 5/00; H01Q 5/0034; H01Q 9/145; H01Q 9/30; H01Q 13/10; H01Q 13/085; H01Q 21/064; H01Q 21/24; H01Q 1/24; H01Q 1/44; H01Q 9/04; H04B 5/02; H04B 1/04; H04B 7/0617; H04B 7/0632; H04W 16/28; G06K 19/0723; G06K 7/0008; H04Q 1/246

19 Claims, 6 Drawing Sheets





US009112269B2

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

(10) **Patent No.:** **US 9,112,269 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **COMMUNICATION DEVICE AND ANTENNA ELEMENT THEREIN**

- (71) Applicant: **Acer Incorporated**, New Taipei (TW)
- (72) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Yi-Ting Hsieh, 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 214 days.

(21) Appl. No.: **13/951,393**

(22) Filed: **Jul. 25, 2013**

(65) **Prior Publication Data**
US 2014/0320358 A1 Oct. 30, 2014

(30) **Foreign Application Priority Data**
Apr. 24, 2013 (TW) 102114536 A

(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 9/30 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/35 (2015.01)

(52) **U.S. Cl.**
 CPC *H01Q 9/30* (2013.01); *H01Q 1/243* (2013.01); *H01Q 5/35* (2015.01); *H01Q 9/42* (2013.01)

(58) **Field of Classification Search**
 CPC *H01Q 5/35*; *H01Q 1/243*; *H01Q 9/30*;
H01Q 9/42
 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,886,499	B2 *	2/2011	Okuda et al.	52/750
7,889,143	B2 *	2/2011	Milosavljevic et al.	343/722
8,581,799	B2 *	11/2013	Choi et al.	343/845
2005/0259010	A1 *	11/2005	Soutome	343/702
2009/0002248	A1 *	1/2009	Zhao et al.	343/722
2011/0207422	A1 *	8/2011	Ban et al.	455/128
2011/0215972	A1 *	9/2011	Wong et al.	343/702
2013/0234903	A1 *	9/2013	Kwak et al.	343/750
2013/0241796	A1 *	9/2013	Nagumo	343/861
2013/0300615	A1 *	11/2013	Wong et al.	343/702

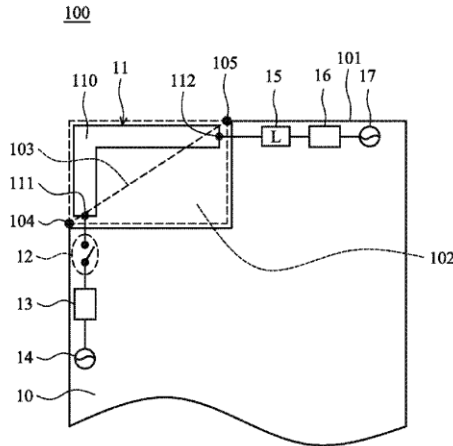
* cited by examiner

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

(57) **ABSTRACT**

A communication device including a ground element and an antenna element is provided. An edge of the ground element has a notch, and the antenna element includes a metal element disposed inside the notch. The metal element of the antenna element has a first end and a second end. The first and second ends are spaced away from each other and are respectively positioned adjacent to two ends of a diagonal line of the notch. The first end is used as a first feeding point of the antenna element, and the second end is used as a second feeding point of the antenna element. The first feeding point is coupled through a switch and a first matching circuit to a first signal source, and the second feeding point is coupled through an inductive element and a second matching circuit to a second signal source.

10 Claims, 5 Drawing Sheets





US009112280B2

(12) **United States Patent**
Bungo

(10) **Patent No.:** **US 9,112,280 B2**
(45) **Date of Patent:** **Aug. 18, 2015**

(54) **ANTENNA APPARATUS AND TERMINAL DEVICE ASSOCIATED WITH ANTENNA APPARATUS**

(75) Inventor: **Akihiro Bungo**, Tokyo (JP)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Mobile Communications Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 425 days.

(21) Appl. No.: **13/545,488**

(22) Filed: **Jul. 10, 2012**

(65) **Prior Publication Data**

US 2014/0015724 A1 Jan. 16, 2014

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
USPC 343/767, 702, 746, 750
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,075,491	A *	6/2000	Dakeya et al.	343/722
2003/0160728	A1 *	8/2003	Fukushima et al.	343/702
2009/0231215	A1	9/2009	Taura	
2010/0316368	A1 *	12/2010	Young et al.	396/310
2012/0091821	A1	4/2012	Kato	

FOREIGN PATENT DOCUMENTS

WO	2007/058230	A1	5/2007
WO	2010/122685	A1	10/2010
WO	2010/122888	A1	10/2010

* cited by examiner

Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Snyder, Clark, Lesch & Chung, LLP

(57) **ABSTRACT**

An antenna apparatus may include a conductor layer having an aperture and a slit that adjoins the aperture; and a resonance tuning component including a first element, a second element, and a third element coupled with the first and second elements. The slit may have an opening at a periphery of the conductor layer. A first gap may be arranged between the first element and the conductor layer. At least a part of the first element may be coupled with the conductor layer. A second gap may be arranged between the second element and the conductor layer. The antenna apparatus may include a capacitor and an inductor. The capacitor may be connected with the inductor in parallel between the first element and the conductor layer. The terminal device may include the antenna apparatus.

19 Claims, 11 Drawing Sheets

