



US008564483B2

(12) **United States Patent**
Kuo

(10) **Patent No.:** **US 8,564,483 B2**

(45) **Date of Patent:** **Oct. 22, 2013**

(54) **ANTENNA ASSEMBLY WITH IMPROVED SUPPORTING DEVICE**

(75) Inventor: **Peter Kuo**, Tu-Cheng (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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 405 days.

(21) Appl. No.: **12/965,939**

(22) Filed: **Dec. 13, 2010**

(65) **Prior Publication Data**

US 2011/0140986 A1 Jun. 16, 2011

(30) **Foreign Application Priority Data**

Dec. 11, 2009 (TW) 98223197

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

(52) **U.S. Cl.**
USPC 343/700 MS; 343/848

(58) **Field of Classification Search**

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

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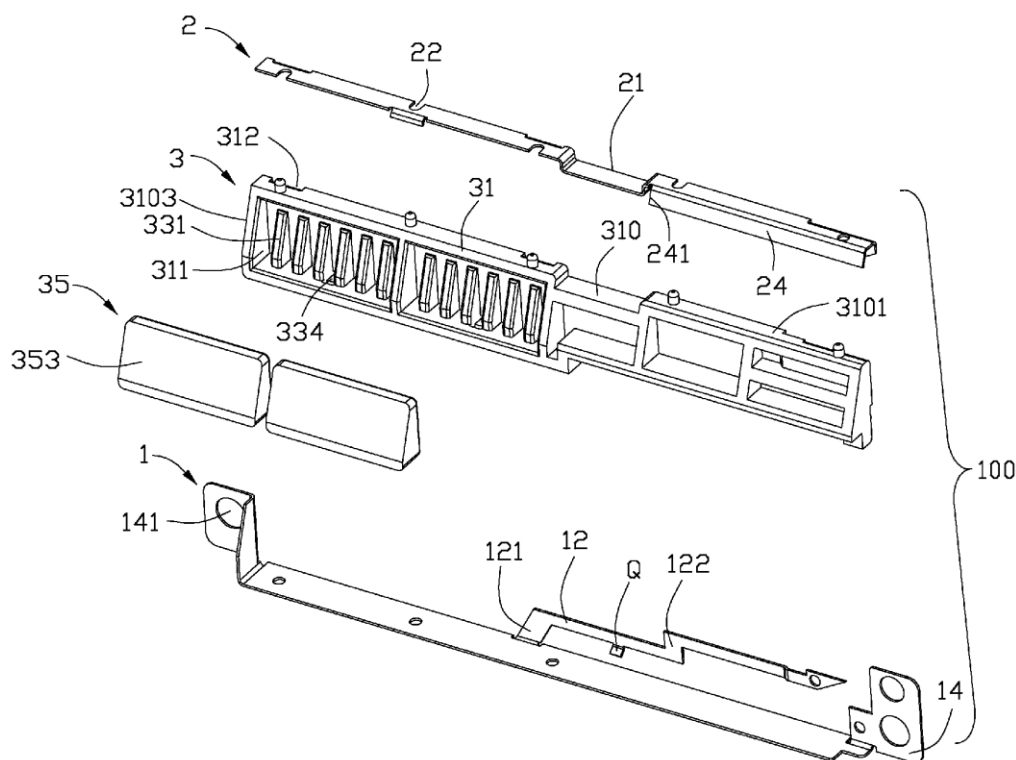
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Wei Te Chung; Ming Chieh Chang

(57) **ABSTRACT**

An antenna assembly includes an antenna and a supporting portion. The antenna includes a radiating element, a grounding element and a connecting element connecting the radiating element and the grounding element. The supporting portion is located between the radiating element and the grounding element, and includes a base portion and a complementary portion assembled on the base portion. The complementary portion has an outer surface being flush with one of the surfaces of the base portion.

20 Claims, 4 Drawing Sheets





US008564485B2

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

(10) **Patent No.:** **US 8,564,485 B2**

(45) **Date of Patent:** **Oct. 22, 2013**

(54) **ADJUSTABLE MULTIBAND ANTENNA AND METHODS**

(75) Inventors: **Zlatoljub Milosavljevic**, Kempele (FI);
Antti Leskelä, Oulu (FI); **Christian Braun**, Stockholm (SE)

(73) Assignee: **Pulse Finland Oy**, Kempele (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 870 days.

(21) Appl. No.: **11/989,451**

(22) PCT Filed: **Jul. 13, 2006**
(Under 37 CFR 1.47)

(86) PCT No.: **PCT/FI2006/050341**
§ 371 (c)(1),
(2), (4) Date: **Jul. 27, 2009**

(87) PCT Pub. No.: **WO2007/012697**
PCT Pub. Date: **Jan. 2, 2007**

(65) **Prior Publication Data**
US 2010/0295737 A1 Nov. 25, 2010

(30) **Foreign Application Priority Data**
Jul. 25, 2005 (FI) 20055420

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

(52) **U.S. Cl.**
USPC **343/702**; 343/700 MS; 343/745;
343/749

(58) **Field of Classification Search**
USPC 343/722, 745, 749, 702, 700 MS
See application file for complete search history.

(56) **References Cited**

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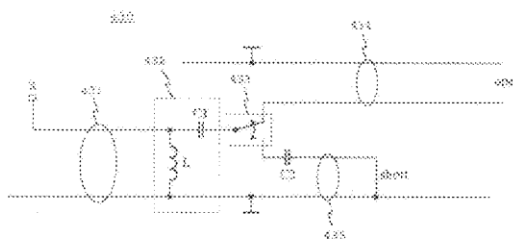
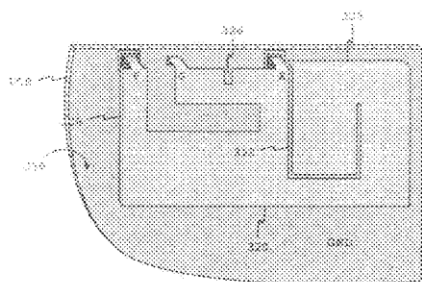
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Gazdzinski & Associates, PC

(57) **ABSTRACT**

An adjustable multi-band planar antenna especially applicable in mobile terminals and a radio device. The adjusting circuit (430) of the antenna is galvanically connected to a point (X) of the radiator, where the circuit can affect the places of at least two operating bands. The adjusting circuit comprises a multi-pole switch (433), by which said radiator point can be connected to one of alternative transmission lines. For example, one of two transmission lines (434, 435) is open and another shorted. A discrete capacitor (C2) can be located between the separate conductor of the transmission line and an output pole of the switch as an additive-tuning element. The adjusting circuit further comprises a LC circuit (432) between the radiator (320) and the switch. Among other things, the lengths of the transmission lines, the values of the discrete components and the distance between the antenna short-circuit point (G) and the adjusting circuit connecting point (X) are then variables from the point of view of the antenna adjusting. Such values are calculated for these variables that each of the antenna operation bands separately shifts to a desired other place when the switch state is changed. The space required for the adjusting circuit is relatively small, and a relatively high efficiency is achieved for the antenna despite of the use of a switch.

39 Claims, 5 Drawing Sheets





US008564486B2

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

(10) **Patent No.:** **US 8,564,486 B2**
(45) **Date of Patent:** **Oct. 22, 2013**

(54) **HOLDING DEVICE WITH AN ANTENNA AND METHOD FOR ASSEMBLING THE SAME**

(75) Inventors: **Tun-Ping Wang**, Taipei (TW); **Ho-Hsin Chou**, Taipei (TW); **Jeng-Hsiang Lee**, Taipei (TW); **Jun-Long Wu**, Taipei (TW)

(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, 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 817 days.

(21) Appl. No.: **12/752,103**

(22) Filed: **Mar. 31, 2010**

(65) **Prior Publication Data**

US 2011/0241970 A1 Oct. 6, 2011

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

(52) **U.S. Cl.**
USPC **343/702**; 439/630

(58) **Field of Classification Search**
USPC 343/882, 702; 29/600; 439/630
See application file for complete search history.

(56) **References Cited**

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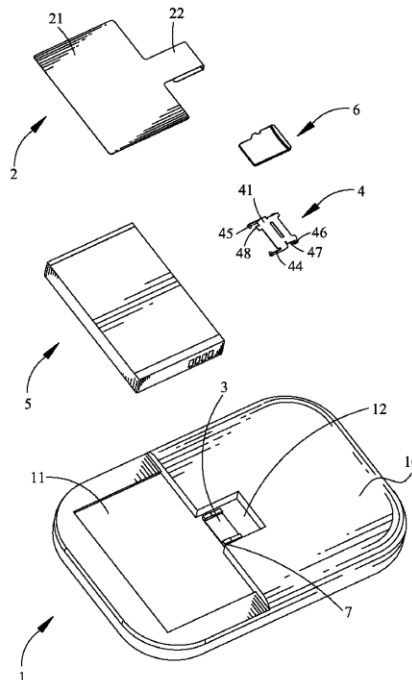
Primary Examiner — Hoang V Nguyen

Assistant Examiner — Kyana R McCain

(57) **ABSTRACT**

A holding device having a printed circuit board includes a base having a securing recess at a top surface thereof, a securing connector fixed in the securing recess and connected with the printed circuit board, a holding shell rotatably covered to the securing connector, and a flexible antenna of flat plate shape. The antenna has a rectangular radiating body, and a strip-shaped connecting portion extended outwards from a side of the radiating body. A free end of the connecting portion is held by the holding shell and rotated to connect with the securing connector electrically and detachably. An exposed portion of the connecting portion is bent so that the radiating body is attached to the top surface of the base.

15 Claims, 5 Drawing Sheets





US008564487B2

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

(10) **Patent No.:** **US 8,564,487 B2**

(45) **Date of Patent:** **Oct. 22, 2013**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE HAVING DUAL ANTENNA SYSTEM
FOR CELLULAR AND WIFI**

(75) Inventors: **Ying Tong Man**, Waterloo (CA); **Yihong Qi**, St. Agatha (CA)

(73) Assignee: **Blackberry Limited**, Waterloo, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 240 days.

(21) Appl. No.: **13/103,144**

(22) Filed: **May 9, 2011**

(65) **Prior Publication Data**

US 2011/0210894 A1 Sep. 1, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/392,321, filed on Feb. 25, 2009, now Pat. No. 7,940,222, which is a continuation of application No. 12/100,613, filed on Apr. 10, 2008, now Pat. No. 7,511,673, which is a continuation of application No. 11/468,803, filed on Aug. 31, 2006, now Pat. No. 7,369,091.

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

(52) **U.S. Cl.**
USPC **343/702**; 343/725

(58) **Field of Classification Search**
USPC 343/702, 725, 700 MS, 893; 455/575.1, 455/575.3, 575.4, 575.7
See application file for complete search history.

(56) **References Cited**

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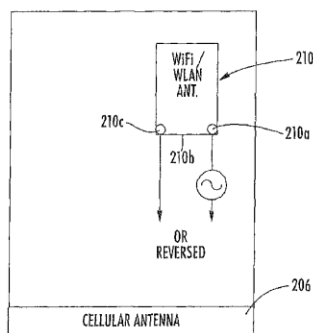
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device includes a housing and circuit board carried by the housing. Radio Frequency (RF) circuitry is mounted on the circuit board. A first antenna is supported by the circuit board within the housing and operatively connected to the RF circuitry and configured for cellular phone communications. A second antenna is supported by the circuit board within the housing and operatively connected to the RF circuitry and configured for WiFi communications. The second antenna comprises an inverted-F or monopole antenna having an opening gap that is pointed away from the first antenna.

22 Claims, 5 Drawing Sheets





US008564493B2

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

(10) **Patent No.:** **US 8,564,493 B2**

(45) **Date of Patent:** **Oct. 22, 2013**

(54) **Y-TYPE HEXAGONAL FERRITE, FABRICATION METHOD THEREOF, AND ANTENNA APPARATUS USING THE SAME**

(75) Inventors: **Joong Hee Lee**, Seongnam-si (KR);
Young Ho Han, Suwon-si (KR); **Il Jeong Park**, Suwon-si (KR)

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(73) Assignees: **Samsung Electronics Co., Ltd.**,
 Suwon-si (KR); **SUNGKYUNKWAN UNIVERSITY Foundation for Corporate Collaboration**, Suwon-si (KR)

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

(21) Appl. No.: **12/844,059**

* cited by examiner

(22) Filed: **Jul. 27, 2010**

Primary Examiner — Hoang V Nguyen

(65) **Prior Publication Data**

US 2011/0025572 A1 Feb. 3, 2011

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

(30) **Foreign Application Priority Data**

Jul. 28, 2009 (KR) 10-2009-0068981

(57) **ABSTRACT**

A method of making Y-type hexagonal ferrite and an antenna using the same are provided. Y-type hexagonal ferrite includes a base ferrite composed of iron oxide, barium carbonate and cobalt oxide, and silicate glass ranging from 0.5 to 5 weight percent added to 100 weight percent of base ferrite. An antenna apparatus includes a magnetic carrier and an antenna pattern formed thereon. The magnetic carrier is formed of such Y-type hexagonal ferrite, and the antenna pattern resonates in a specific frequency band when electric power is supplied. To fabricate the Y-type hexagonal ferrite, a calcination process is performed in which iron oxide, barium carbonate and cobalt oxide are combined into base ferrite at a given calcination temperature after being mixed. A sintering process is performed to sinter the base ferrite and the silicate glass at a given sintering temperature which is lower than the calcination temperature after adding the silicate glass to the base ferrite.

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01F 1/34 (2006.01)

(52) **U.S. Cl.**
 USPC **343/787**; 252/62.63

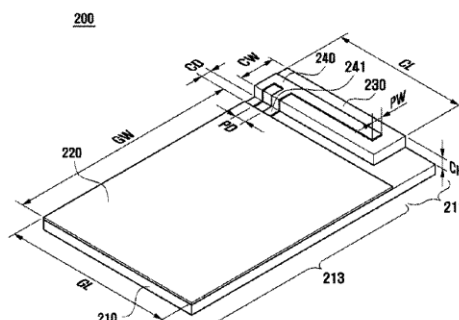
(58) **Field of Classification Search**
 USPC 343/787, 788; 252/62.63, 62.64, 62.62
 See application file for complete search history.

(56) **References Cited**

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8 Claims, 10 Drawing Sheets





US008564496B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 8,564,496 B2**
(45) **Date of Patent:** **Oct. 22, 2013**

(54) **BROADBAND ANTENNA**

(75) Inventor: **Yen-Cheng Chen**, Hsinchu County
(TW)

(73) Assignee: **Wistron NeWeb Corp.**, Hsinchu County
(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.

(21) Appl. No.: **12/985,141**

(22) Filed: **Jan. 5, 2011**

(65) **Prior Publication Data**

US 2012/0032866 A1 Feb. 9, 2012

(30) **Foreign Application Priority Data**

Aug. 4, 2010 (TW) 99214904 U

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
USPC **343/846**; 343/906; 343/700 MS

(58) **Field of Classification Search**
USPC 343/846, 906, 700 MS, 702
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

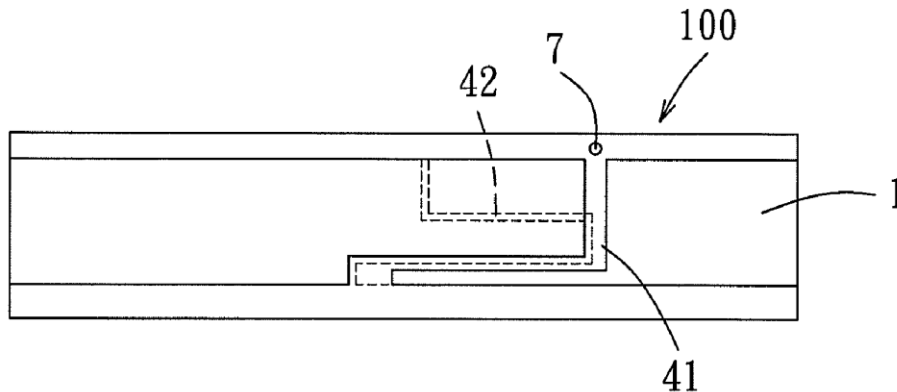
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Merchant & Gould P.C.

(57) **ABSTRACT**

A broadband antenna includes a substrate having a first surface on which a first radiator arm, a second radiator arm, a first connecting conductor and a first grounding section are disposed, and a second surface on which a second connecting conductor and a second grounding section are disposed. The first connecting conductor has one end connected to a junction at which the first and second radiator arms are interconnected, and has another end connected to the first grounding section. The first connecting conductor has a feed-in point disposed thereon. The second connecting conductor has one end connected to the second grounding section. Moreover, at least a portion of the first connecting conductor overlaps with a projection of the second connecting conductor onto the first surface so that transmission directions of signals in the first and second connecting conductors are the same.

5 Claims, 12 Drawing Sheets





US008570222B2

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

(10) **Patent No.:** **US 8,570,222 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

(54) **ANTENNA STRUCTURES AND APPLICATIONS THEREOF**

(75) Inventors: **Nicolaos G. Alexopoulos**, Irvine, CA (US); **Yunhong Liu**, San Juan Capistrano, CA (US); **Seunghwan Yoon**, Costa Mesa, CA (US)

(73) Assignee: **Broadcom Corporation**, Irvine, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 984 days.

(21) Appl. No.: **12/642,360**

(22) Filed: **Dec. 18, 2009**

(65) **Prior Publication Data**
US 2010/0177001 A1 Jul. 15, 2010

Related U.S. Application Data

(60) Provisional application No. 61/145,049, filed on Jan. 15, 2009.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
USPC **343/700 MS; 343/795**

(58) **Field of Classification Search**
USPC **343/700 MS, 793, 795**
See application file for complete search history.

(56) **References Cited**

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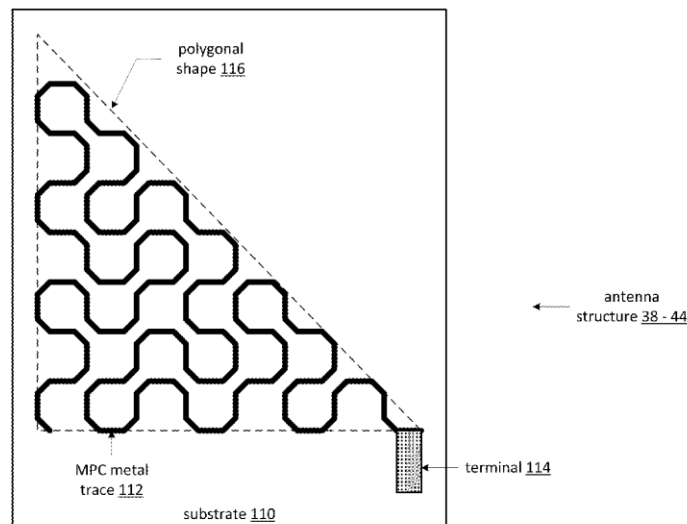
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Garlick & Markison; Bruce E. Garlick

(57) **ABSTRACT**

An antenna apparatus includes a substrate and an antenna structure. The antenna structure includes a metal trace and a terminal. The metal trace has a modified Polya curve shape that is confined in a polygonal shape. The terminal is coupled to the metal trace.

20 Claims, 12 Drawing Sheets





US008570223B2

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

(10) **Patent No.:** **US 8,570,223 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

(54) **RECONFIGURABLE ANTENNA**

(75) Inventors: **Tughrul Arslan**, Edinburgh (GB);
Anthony John Walton, Edinburgh (GB);
Nakul R. Haridas, Edinburgh (GB);
Ahmed Osman El-Rayis, Edinburgh
(GB)

(73) Assignee: **The University Court of the University
of Edinburgh**, Edinburgh (GB)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 644 days.

(21) Appl. No.: **12/663,803**

(22) PCT Filed: **Jun. 13, 2008**

(86) PCT No.: **PCT/GB2008/050448**
§ 371 (c)(1),
(2), (4) Date: **Jul. 7, 2010**

(87) PCT Pub. No.: **WO2008/152428**
PCT Pub. Date: **Dec. 18, 2008**

(65) **Prior Publication Data**
US 2010/0289717 A1 Nov. 18, 2010

Related U.S. Application Data

(60) Provisional application No. 60/934,401, filed on Jun.
13, 2007.

(30) **Foreign Application Priority Data**
Jun. 13, 2007 (GB) 0711382.2

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

(52) **U.S. Cl.**
USPC 343/700 MS; 343/876

(58) **Field of Classification Search**

USPC 343/876, 700 MS
See application file for complete search history.

(56) **References Cited**

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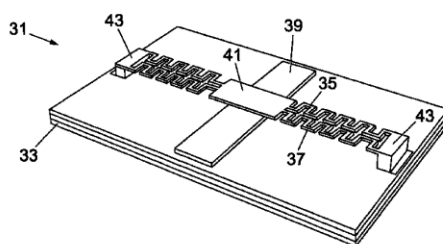
Primary Examiner — Jason M Crawford

(74) *Attorney, Agent, or Firm* — Edwards Wildman Palmer
LLP; Scott D. Wofsy; George N. Chacclas

(57) **ABSTRACT**

A micro electromechanical (MEMS) antenna (36) is posi-
tioned on one side of a substrate and is connected to a MEMS
switch comprising a capacitor bridge (46) and to a transmis-
sion line (42) by means of a thru hole or via (48) which forms
an electrically conducting path through the substrate. This
arrangement provides a common ground plane for the
antenna and switch and shields the switch from the electro-
magnetic radiation received or transmitted from the antenna.
The switch may comprise a topmost metal layer which
extends across a bridge structure formed by a polymer layer
(19). The polymer layer comprises poly-monochloro-para-
xylylene (parylene-C). Homogeneous or heterogeneous
antenna array structures are implemented. The antenna arrays
may include one or more different type of antennas with for
example different shapes, rotations and reflections.

46 Claims, 15 Drawing Sheets





US008570225B2

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

(10) **Patent No.:** **US 8,570,225 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

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

(56) **References Cited**

(75) Inventors: **Hideaki Shoji**, Tokyo (JP); **Yoshiki Kanayama**, Saitama (JP)

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

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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 311 days.

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(21) Appl. No.: **12/955,535**

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(22) Filed: **Nov. 29, 2010**

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(65) **Prior Publication Data**

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Related U.S. Application Data

Primary Examiner — Huedung Mancuso

(60) Provisional application No. 61/317,307, filed on Mar. 25, 2010.

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

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

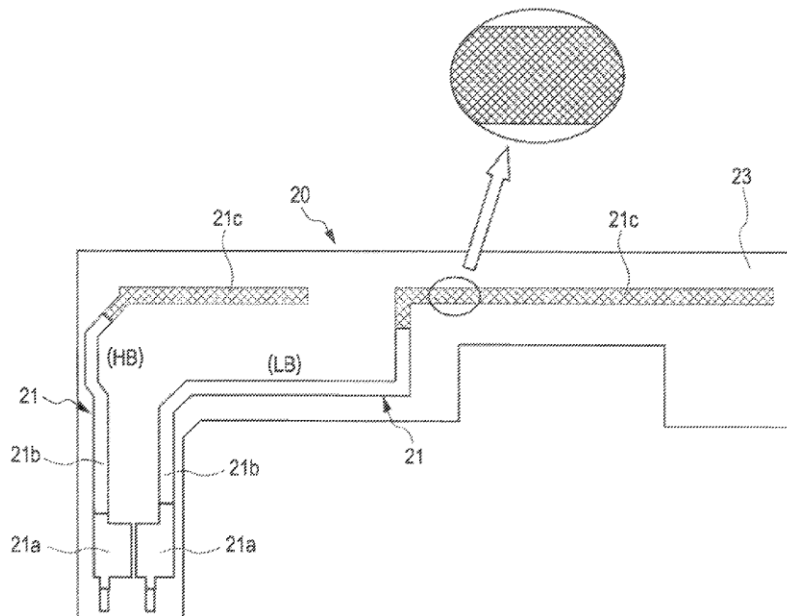
(57) **ABSTRACT**

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

An antenna element including a feeding part and a mesh part including at least a part of an area formed in a mesh state. The feeding part and an area of the antenna element in close proximity to the mesh part are formed of a finer mesh than the mesh part or formed of a solid.

(58) **Field of Classification Search**
USPC 343/721, 893, 897, 705, 700 MS, 846
See application file for complete search history.

11 Claims, 12 Drawing Sheets





US008570234B2

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

(10) **Patent No.:** **US 8,570,234 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

(54) **ASSEMBLY OF CHIP ANTENNA AND
CIRCUIT BOARD**

(75) Inventors: **Meng Hsueh Tsai**, New Taipei (TW);
Chih Ming Su, Taipei (TW); **Lee Ting
Hsieh**, Pingtung County (TW)

(73) Assignee: **Inpaq Technology Co., Ltd.**, Miaoli
(TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 288 days.

(21) Appl. No.: **13/077,014**

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

(65) **Prior Publication Data**

US 2011/0291910 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**

May 31, 2010 (TW) 99210231 U

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

(52) **U.S. Cl.**
USPC **343/848; 343/702**

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

(56) **References Cited**

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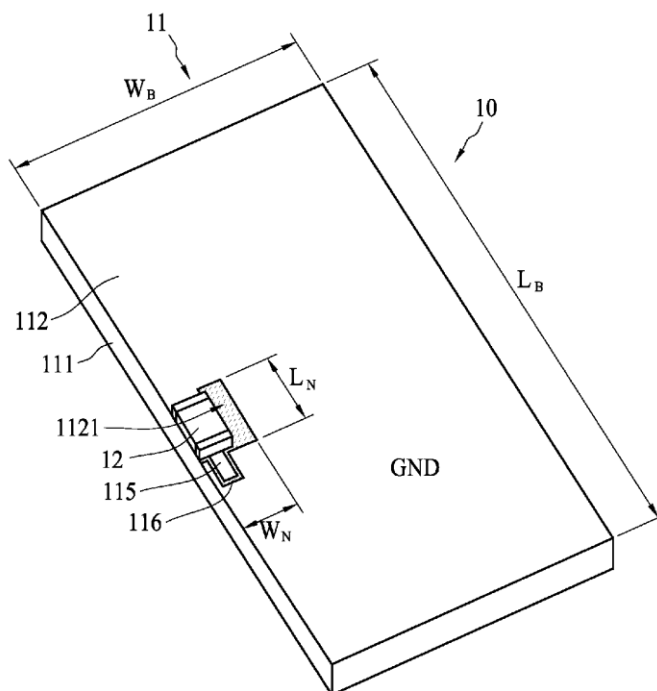
Primary Examiner — Ahshik Kim

(74) *Attorney, Agent, or Firm* — WPAT, P.C.; Anthony King

(57) **ABSTRACT**

An assembly of a chip antenna and a circuit board includes a chip antenna and a circuit board. The circuit board includes a ground layer. The ground layer includes a hollow region formed adjacent to a periphery of the ground layer. The hollow region of the ground layer can be used for configuring an input impedance of the circuit board. The chip antenna is disposed in the hollow region of the ground layer, electrically connecting to the ground layer. The chip antenna includes input impedance. The input impedance of the chip antenna is adjustable to achieve a conjugate impedance match between the chip antenna and the circuit board such that the circuit board and the chip antenna can simultaneously radiate electromagnetic energy.

7 Claims, 6 Drawing Sheets





US008570239B2

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

(10) **Patent No.:** **US 8,570,239 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

(54) **SPIRALING SURFACE ANTENNA**

(75) Inventors: **Royden M. Honda**, Post Falls, ID (US);
Robert J. Conley, Liberty Lake, WA
(US)

(73) Assignee: **LHC2 Inc.**, Liberty Lake, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 823 days.

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RCA Review, pp. 259-269, Jun. 1947.

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Primary Examiner — Jacob Y Choi

Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Lee & Hayes, PLLC

(57) **ABSTRACT**

Antennas that can transceive signals in a horizontally-polarized, omni-directional manner are described. In an example embodiment, an antenna comprises a spiraling surface having a spiral cross-section, the surface forming an internal cavity, an internal channel to the external surface, and an internal wall common to the cavity and the channel. Further, an example embodiment comprises a longitudinal opening allowing access to the cavity and the channel by a transmission feed line. Alternate embodiments comprise various cross-sectional configurations, and may also comprise a radome at least partially surrounding the antenna spiraling surface and supporting structure.

20 Claims, 16 Drawing Sheets

(21) Appl. No.: **12/576,207**

(22) Filed: **Oct. 8, 2009**

(65) **Prior Publication Data**

US 2010/0090924 A1 Apr. 15, 2010

Related U.S. Application Data

(60) Provisional application No. 61/104,633, filed on Oct. 10, 2008.

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

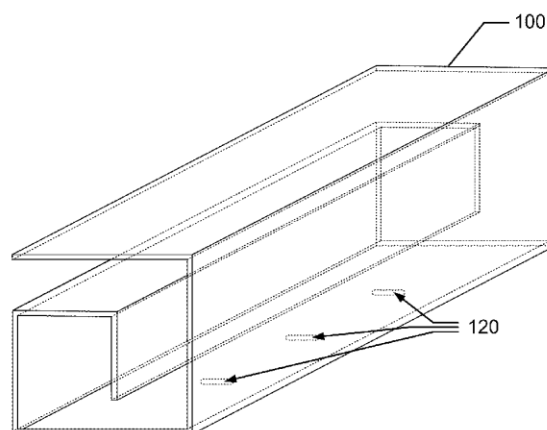
(52) **U.S. Cl.**
USPC **343/895; 343/872**

(58) **Field of Classification Search**
USPC 343/872, 895
See application file for complete search history.

(56) **References Cited**

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US008576125B2

(12) **United States Patent**
Ridgeway

(10) **Patent No.:** **US 8,576,125 B2**

(45) **Date of Patent:** **Nov. 5, 2013**

(54) **PLANAR WIDEBAND ANTENNA**

(75) Inventor: **Robert Wayne Ridgeway**, Saratoga Springs, UT (US)

(73) Assignee: **Digi International Inc.**, Minnetonka, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 476 days.

(21) Appl. No.: **12/915,763**

(22) Filed: **Oct. 29, 2010**

(65) **Prior Publication Data**

US 2011/0156981 A1 Jun. 30, 2011

Related U.S. Application Data

(60) Provisional application No. 61/256,767, filed on Oct. 30, 2009.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
USPC **343/700 MS; 343/862**

(58) **Field of Classification Search**
USPC 343/700 MS, 850, 860, 862
See application file for complete search history.

(56) **References Cited**

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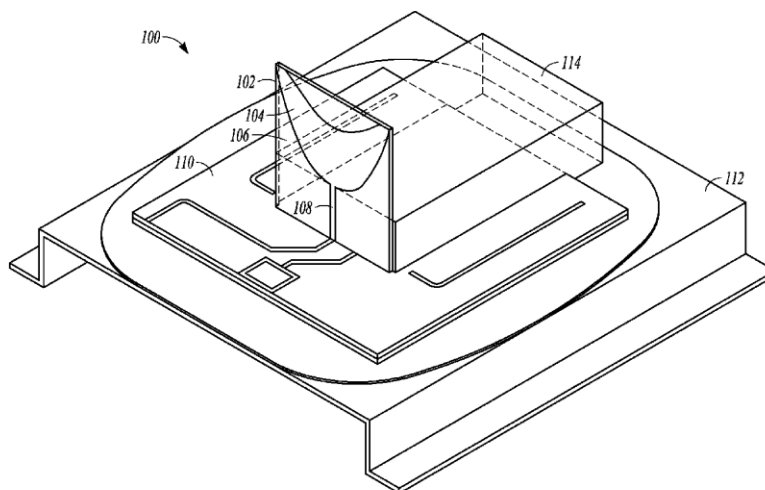
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Fogg & Powers LLC

(57) **ABSTRACT**

An approximately planar wideband antenna can include a first conductive portion coupled to a dielectric portion and mechanically supported by the dielectric portion, the first conductive portion including at least one edge corresponding to a planar conic section, such as including one or more of an elliptic, a parabolic, or a hyperbolic shape. Such an antenna can be electrically coupled to a matching circuit, the matching circuit configured provide a specified input impedance corresponding to a specified range of frequencies. Such a range of frequencies can span at least an octave, or more.

19 Claims, 9 Drawing Sheets





US008576127B1

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

(10) **Patent No.:** **US 8,576,127 B1**
(45) **Date of Patent:** **Nov. 5, 2013**

(54) **UWB MIMO BROADBAND ANTENNA
SYSTEM FOR HANDHELD RADIO**

(75) Inventors: **Jeremiah D Wolf**, Marion, IA (US); **Lee
M Paulsen**, Cedar Rapids, IA (US);
Mark A Willi, Marion, IA (US); **James
B West**, Cedar Rapids, IA (US)

(73) Assignee: **Rockwell Collins, Inc.**, Cedar Rapids,
IA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 291 days.

(21) Appl. No.: **13/193,842**

(22) Filed: **Jul. 29, 2011**

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

(52) **U.S. Cl.**
USPC **343/702; 343/876**

(58) **Field of Classification Search**
USPC **343/702, 876, 893**
See application file for complete search history.

(56) **References Cited**

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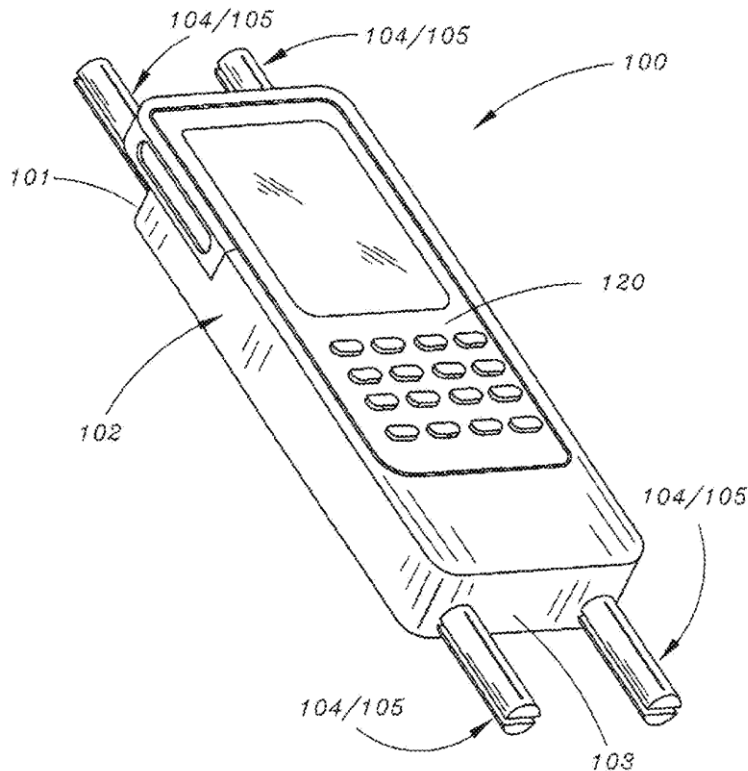
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Donna P. Suchy; Daniel M.
Barbieri

(57) **ABSTRACT**

The present invention is directed to antenna system embodiments which allow for hand-held, ultra-wideband (UWB) multi-antenna operation to be realized within the severe size constraints necessary for Department of Defense (DOD) hand-held missions. Further, the antenna system embodiments disclosed herein provide a miniature UWB multiple antenna solution for multiple-input and multiple-output (MIMO) and radiation pattern null steering suitable for hand-held soldier radios.

20 Claims, 3 Drawing Sheets





US008576136B2

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

(10) **Patent No.:** **US 8,576,136 B2**
(45) **Date of Patent:** **Nov. 5, 2013**

(54) **ELECTRONIC DEVICE ANTENNA**

(56) **References Cited**

(75) Inventors: **Eduardo Lopez Camacho**, Watsonville, CA (US); **Bing Chiang**, Cupertino, CA (US); **Douglas B. Kough**, San Jose, CA (US); **Hao Xu**, Cupertino, CA (US)

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(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.

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(21) Appl. No.: **13/616,765**

Primary Examiner — Dieu H Duong

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

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(65) **Prior Publication Data**

US 2013/0002519 A1 Jan. 3, 2013

Related U.S. Application Data

(62) Division of application No. 12/337,499, filed on Dec. 17, 2008, now Pat. No. 8,269,674.

(57) **ABSTRACT**

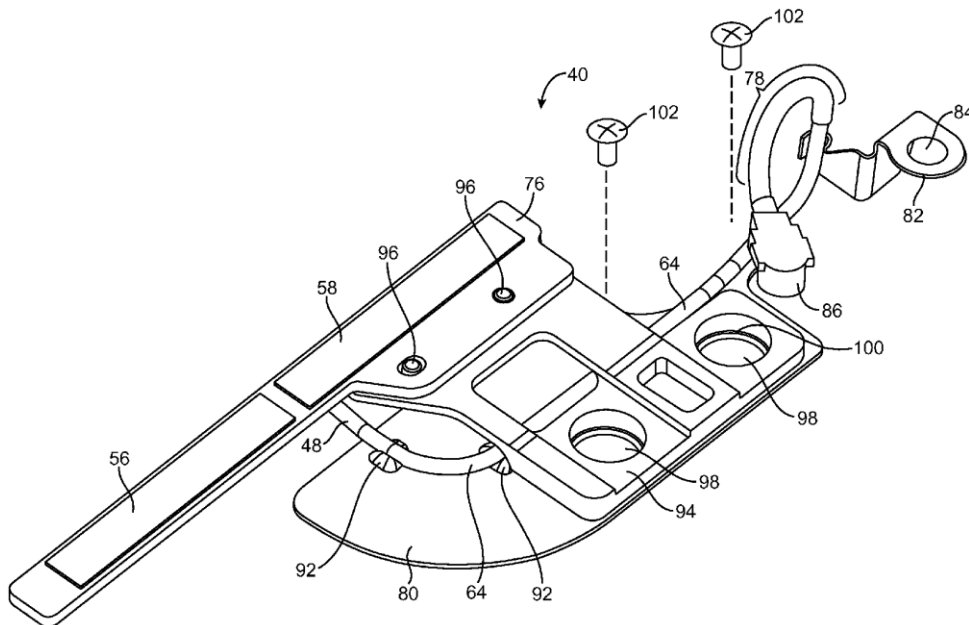
Antennas for electronic devices such as portable computers are provided. An antenna may have a dipole structure in which one antenna element serves as a matching element and another antenna element serves as a radiating element. The antenna elements may be mounted on a substrate. The substrate may be mounted on a support structure that is attached to a grounding plate. The grounding plate may be grounded to a conductive housing portion of a portable computer. The antenna may be mounted within the conductive housing in the vicinity of an opening in the housing. The opening may be a slot opening that is used to accommodate optical disks or other storage media. Radio-frequency signals for the antenna may pass through the opening.

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

(52) **U.S. Cl.**
USPC **343/793**; 343/702; 343/906

(58) **Field of Classification Search**
USPC 343/702, 792, 906, 793
See application file for complete search history.

24 Claims, 6 Drawing Sheets





US008576372B2

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

(10) **Patent No.:** **US 8,576,372 B2**
(45) **Date of Patent:** **Nov. 5, 2013**

(54) **CASING STRUCTURE FOR ELECTRONIC DEVICES**

(71) Applicant: **Lenovo (Singapore) Pte. Ltd.**,
Singapore (SG)

(72) Inventors: **Gang Ji**, Kanagawa-ken (JP); **Tetsuya Ohtani**, Kanagawa-ken (JP); **Takayuki Morino**, Kanagawa-ken (JP); **Akinori Uchino**, Kanagawa-ken (JP)

(73) Assignee: **Lenovo (Singapore) 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.: **13/765,337**

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

(65) **Prior Publication Data**

US 2013/0147079 A1 Jun. 13, 2013

Related U.S. Application Data

(62) Division of application No. 12/351,586, filed on Jan. 9, 2009, now Pat. No. 8,379,164.

(51) **Int. Cl.**
G02F 1/13 (2006.01)
G02F 1/1333 (2006.01)

(52) **U.S. Cl.**
USPC **349/187**; 349/58; 361/679.21; 361/800;
348/794; 348/836

(58) **Field of Classification Search**
USPC 349/58, 187; 348/794, 836; 361/679.21,
361/800

See application file for complete search history.

(56) **References Cited**

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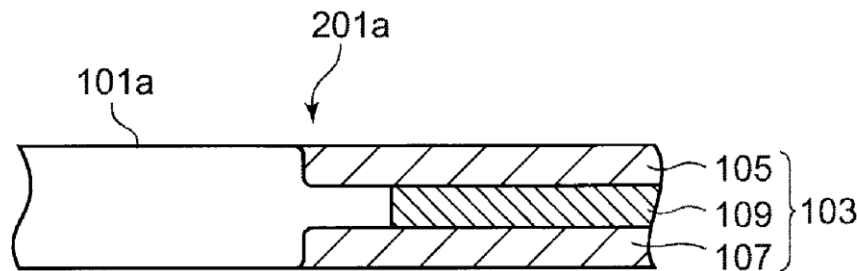
Primary Examiner — Nathanael R Briggs

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

(57) **ABSTRACT**

An aspect provides a method, including: fixing a laminated panel, which has been cut into a predetermined shape, to a mold, said laminated panel having an expanded layer disposed between layers made of a conductive resin; injection of molding non-conducting resin into the mold in which the laminated panel has been fixed; wherein a non-conductive region and a conductive region are joined to form a bottom surface of a display casing, said display casing having an inner and outer surface; and wherein an antenna mounting space is formed in the non-conductive region. Other aspects are described and claimed.

10 Claims, 6 Drawing Sheets





US008577289B2

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

(10) **Patent No.:** **US 8,577,289 B2**

(45) **Date of Patent:** **Nov. 5, 2013**

(54) **ANTENNA WITH INTEGRATED PROXIMITY
SENSOR FOR PROXIMITY-BASED
RADIO-FREQUENCY POWER CONTROL**

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(75) Inventors: **Robert W. Schlub**, Cupertino, CA (US);
Yi Jiang, Sunnyvale, CA (US);
Qingxiang Li, Mountain View, CA (US);
Jiang Zhu, Sunnyvale, CA (US); **Ruben
Caballero**, San Jose, CA (US)

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

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 316 days.

Myllymaki S et al. "Capacitive recognition of the user's hand grip
position in mobile handsets", Progress in Electromagnetics Research
B, vol. 22, 2010, pp. 203-220.

(21) Appl. No.: **13/029,581**

(Continued)

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

Primary Examiner — Edward Urban

Assistant Examiner — Max Mathew

(65) **Prior Publication Data**

US 2012/0214412 A1 Aug. 23, 2012

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

(51) **Int. Cl.**
H04B 5/00 (2006.01)

(52) **U.S. Cl.**
USPC **455/41.1**; 343/702; 343/872; 379/44;
379/388

(58) **Field of Classification Search**
USPC 455/41.1, 41.3, 41.7, 550.1
See application file for complete search history.

(57) **ABSTRACT**

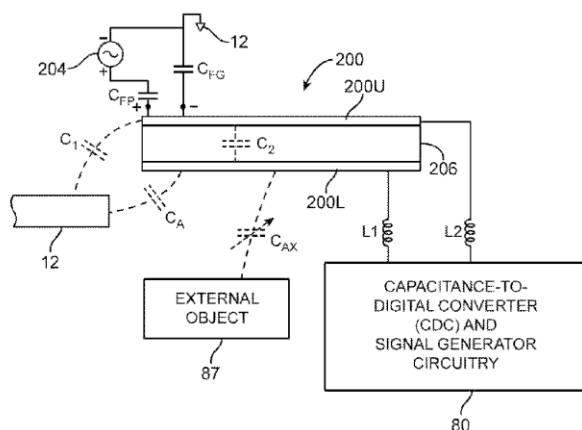
An electronic device may have a housing in which an antenna is mounted. An antenna window may be mounted in the housing to allow radio-frequency signals to be transmitted from the antenna and to allow the antenna to receive radio-frequency signals. Near-field radiation limits may be satisfied by reducing transmit power when an external object is detected in the vicinity of the dielectric antenna window and the antenna. A capacitive proximity sensor may be used in detecting external objects in the vicinity of the antenna. The proximity sensor and the antenna may be formed using integral antenna resonating element and proximity sensor capacitor electrode structures. These structures may be formed from identical first and second patterned conductive layers on opposing sides of a dielectric substrate. A transceiver and proximity sensor may be coupled to the structures through respective high-pass and low-pass circuits.

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21 Claims, 10 Drawing Sheets





US008577321B2

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

(10) **Patent No.:** **US 8,577,321 B2**
(45) **Date of Patent:** **Nov. 5, 2013**

(54) **METHODS FOR SELECTING ANTENNAS TO AVOID SIGNAL BUS INTERFERENCE**

(75) Inventors: **Peter C. Cotterill**, 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 39 days.

(21) Appl. No.: **12/959,258**

(22) Filed: **Dec. 2, 2010**

(65) **Prior Publication Data**

US 2012/0142296 A1 Jun. 7, 2012

(51) **Int. Cl.**
H04B 1/06 (2006.01)

(52) **U.S. Cl.**
USPC **455/277.1**; 455/403; 455/401.1;
455/557; 343/702

(58) **Field of Classification Search**
USPC 455/277.1
See application file for complete search history.

(56) **References Cited**

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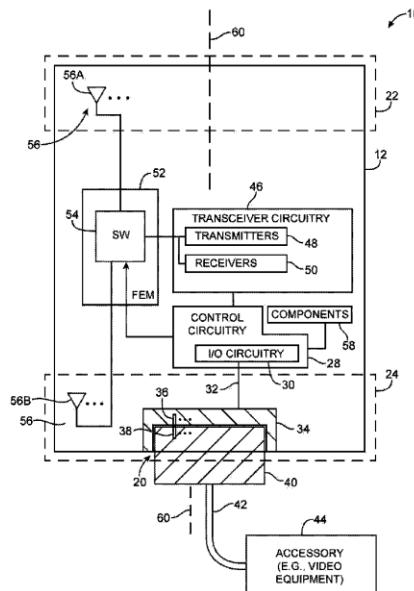
Primary Examiner — Ajibola Akinyemi

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Jason Tsai

(57) **ABSTRACT**

Electronic devices may have multiple antennas. A first antenna may be located at one end of a device and a second antenna may be located at another end of the device. An input-output port in a device may have a connector that receives a mating connector associated with external equipment. The input-output port and the second antenna may be located at one of the ends of the electronic device. When equipment such as an external video accessory is in use, input-output circuitry in an electronic device may transmit high speed data signals through the input-output port. The presence of activity on the input-output port such as video data or other data transmissions may be monitored by control circuitry in the electronic device. When input-output port activity is detected, use of the second antenna in receiving radio-frequency signals can be inhibited.

19 Claims, 3 Drawing Sheets





US008581788B2

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

(10) **Patent No.:** **US 8,581,788 B2**
(45) **Date of Patent:** **Nov. 12, 2013**

(54) **ANTENNAS FOR ELECTRONIC DEVICES**

(75) Inventors: **Brett William Degner**, Menlo Park, CA (US); **Matthew Ian McDonald**, 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 84 days.

(21) Appl. No.: **13/051,905**

(22) Filed: **Mar. 18, 2011**

(65) **Prior Publication Data**

US 2011/0169700 A1 Jul. 14, 2011

Related U.S. Application Data

(62) Division of application No. 12/061,194, filed on Apr. 2, 2008, now Pat. No. 7,911,397.

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

(52) **U.S. Cl.**
USPC **343/702; 343/882; 343/906**

(58) **Field of Classification Search**
USPC **343/702, 882, 906**
See application file for complete search history.

(56) **References Cited**

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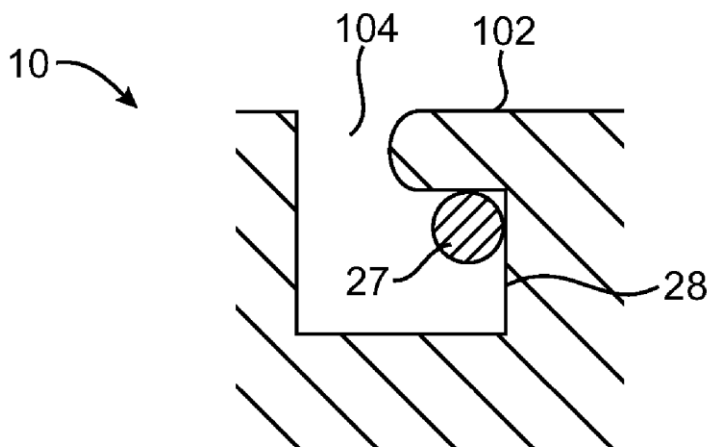
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Treyz Law Group; David C. Kellogg

(57) **ABSTRACT**

A removable antenna and a resilient antenna are provided for an electronic device such as a laptop computer. An antenna resonating element is mounted within the antenna. Flexible coupling structures are used to physically and removably attach the antenna to the electronic device. The flexible coupling structures couple the antenna resonating element to circuitry in the electronic device. The coupling structures may allow the antenna to break away from the electronic device without causing damage. A user may extend the antenna by rotating the removable antenna to its extended position. The electronic device may have an antenna receptacle that holds the resilient antenna in a stowed position and that allows the resilient antenna to flex to an extended position. A user may extend the resilient antenna by removing the resilient antenna from the antenna receptacle and flexing the antenna into its extended position.

11 Claims, 17 Drawing Sheets





US008581799B2

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

(10) **Patent No.:** **US 8,581,799 B2**

(45) **Date of Patent:** ***Nov. 12, 2013**

(54) **GROUND RADIATION ANTENNA**

(75) Inventors: **Hyeng-cheul Choi**, Seoul (KR); **Jaeseok Lee**, Seoul (KR); **Oul Cho**, Suwon-si (KR); **Xinxin Lu**, Seoul (KR); **Jin-hyuk Jang**, Cheonan-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 295 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/081,063**

(22) Filed: **Apr. 6, 2011**

(65) **Prior Publication Data**

US 2011/0210898 A1 Sep. 1, 2011

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2010/009339, filed on Dec. 24, 2010.

(30) **Foreign Application Priority Data**

Feb. 11, 2010	(KR)	10-2010-0012775
Apr. 9, 2010	(KR)	10-2010-0032922
May 7, 2010	(KR)	10-2010-0043186
May 7, 2010	(KR)	10-2010-0043189
May 7, 2010	(KR)	10-2010-0043190
Jun. 14, 2010	(KR)	10-2010-0056207
Dec. 23, 2010	(KR)	10-2010-0133920

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

(52) **U.S. Cl.**
USPC **343/845; 343/846; 343/847**

(58) **Field of Classification Search**

USPC 343/845-847
See application file for complete search history.

(56) **References Cited**

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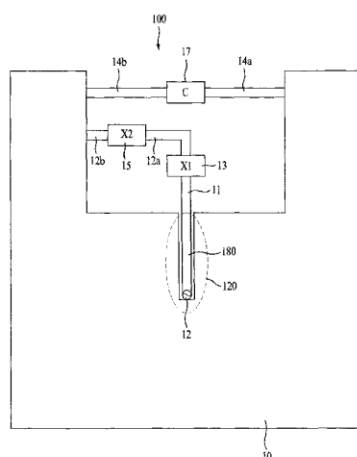
Primary Examiner — Kristy A Haupt

(74) *Attorney, Agent, or Firm* — Park, Kim & Suh, LLC

(57) **ABSTRACT**

A ground radiation antenna is disclosed. Herein, the ground radiation antenna provides a radiator-forming circuit, which is formed to have a simple structure using a capacitive element, as well as a feeding circuit suitable for the provided radiator-forming circuit. Thus, the structure of the antenna becomes simpler and the size of the antenna becomes smaller. Accordingly, the fabrication process of the antenna is simplified, thereby largely reducing the fabrication cost.

16 Claims, 9 Drawing Sheets





US00RE44588E

(19) **United States**
(12) **Reissued Patent**
Chung et al.

(10) **Patent Number:** **US RE44,588 E**
(45) **Date of Reissued Patent:** **Nov. 12, 2013**

(54) **ANTENNA ASSEMBLY AND PORTABLE
TERMINAL HAVING THE SAME**

(75) Inventors: **Kyung-Ho Chung**, Seoul (KR);
Jung-Ho Yoon, Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(21) Appl. No.: **13/278,440**

(22) Filed: **Oct. 21, 2011**
(Under 37 CFR 1.47)

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **7,609,221**
Issued: **Oct. 27, 2009**
Appl. No.: **11/855,716**
Filed: **Sep. 14, 2007**

(30) **Foreign Application Priority Data**

Sep. 27, 2006 (KR) 10-2006-0094121

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

(52) **U.S. Cl.**
USPC **343/841**; 343/700 MS; 343/702

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 841, 846
See application file for complete search history.

(56) **References Cited**

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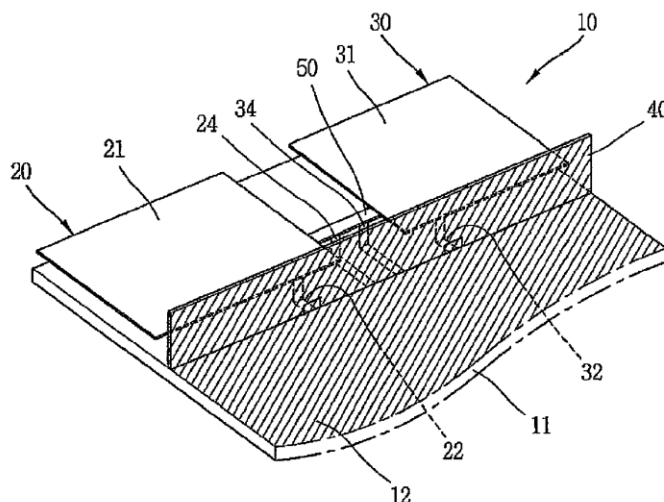
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna assembly, and a portable terminal having the same. The antenna assembly according to an embodiment comprises: a circuit board having a ground plane at a predetermined region; first and second antenna conductors spaced from each other at one side of the ground plane; and a shielding wall disposed between the ground plane and the antenna conductors, for reducing a coupling between the first and second antenna conductors. Since a plurality of antennas are mounted at a small space inside the portable terminal with maintaining their functions, an isolation characteristic between the antennas is enhanced, and a mutual coupling between the antennas is minimized.

42 Claims, 7 Drawing Sheets





US008587481B2

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

(10) **Patent No.:** **US 8,587,481 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **MOBILE WIRELESS DEVICE WITH
ENLARGED WIDTH PORTION MULTI-BAND
LOOP ANTENNA AND RELATED METHODS**

(75) Inventors: **Chun Kit Lai**, Sunrise, FL (US); **Milan
Velimir Lukic**, Sunrise, FL (US); **Soo
Liam Ooi**, Sunrise, FL (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 391 days.

(21) Appl. No.: **13/009,214**

(22) Filed: **Jan. 19, 2011**

(65) **Prior Publication Data**
US 2012/0032863 A1 Feb. 9, 2012

Related U.S. Application Data

(60) Provisional application No. 61/371,989, filed on Aug.
9, 2010.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/866; 343/702;
343/767

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

(56) **References Cited**

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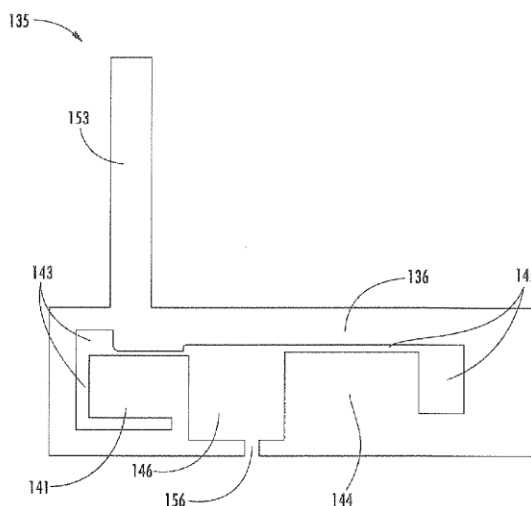
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt,
Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, a printed circuit board (PCB) carried by the portable housing, and wireless transceiver circuitry carried by the PCB. The mobile wireless communications device also may include an antenna coupled to the wireless transceiver circuitry. The antenna may include a loop conductor, a first conductor body coupled to the loop conductor and extending into the interior thereof to define a first slotted opening with adjacent portions of the loop conductor, and a second conductor body coupled to the loop conductor and extending into the interior thereof to define a second slotted opening with adjacent portions of the loop conductor. The first and second conductor bodies may be spaced apart to define a third slotted opening therebetween. The first slotted opening may have an enlarged width portion adjacent the first conductive body.

19 Claims, 19 Drawing Sheets





US008587482B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 8,587,482 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **LAMINATED ANTENNA STRUCTURES FOR PACKAGE APPLICATIONS**

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2010/0327068 A1 12/2010 Chen et al.

(75) Inventor: **Duixian Liu**, Scarsdale, NY (US)

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(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

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(21) Appl. No.: **13/011,441**

(22) Filed: **Jan. 21, 2011**

(65) **Prior Publication Data**

US 2012/0188138 A1 Jul. 26, 2012

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

(52) **U.S. Cl.**
USPC **343/700 MS; 343/776**

(58) **Field of Classification Search**
USPC **343/700 MS, 772, 776, 777**
See application file for complete search history.

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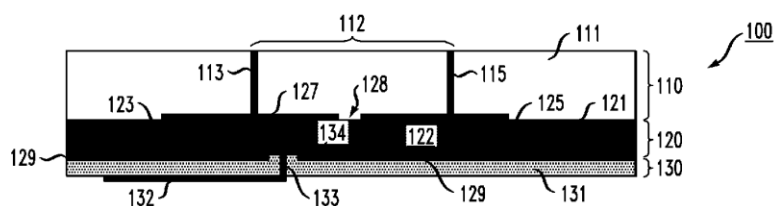
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Anne V. Dougherty; Ryan, Mason & Lewis, LLP

(57) **ABSTRACT**

Apparatus and methods for packaging IC chips and laminated antenna structures with laminated waveguide structures that are integrally constructed as part of an antenna package to form compact integrated radio/wireless communications systems for millimeter wave applications.

25 Claims, 7 Drawing Sheets





US008587483B2

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

(10) **Patent No.:** **US 8,587,483 B2**

(45) **Date of Patent:** **Nov. 19, 2013**

(54) **PATCH ANTENNA**

(75) Inventors: **Tae-Hwan Yoo**, Seoul (KR);
Byoung-Nam Kim, Kyeonggi-Do (KR)

(73) Assignee: **Ace Technologies Corporation**, Incheon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 195 days.

(21) Appl. No.: **13/198,243**

(22) Filed: **Aug. 4, 2011**

(65) **Prior Publication Data**
US 2012/0038529 A1 Feb. 16, 2012

(30) **Foreign Application Priority Data**
Aug. 12, 2010 (KR) 10-2010-0077729

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

(52) **U.S. Cl.**
USPC **343/700 MS; 343/767**

(58) **Field of Classification Search**
USPC 343/700, 767, 846
See application file for complete search history.

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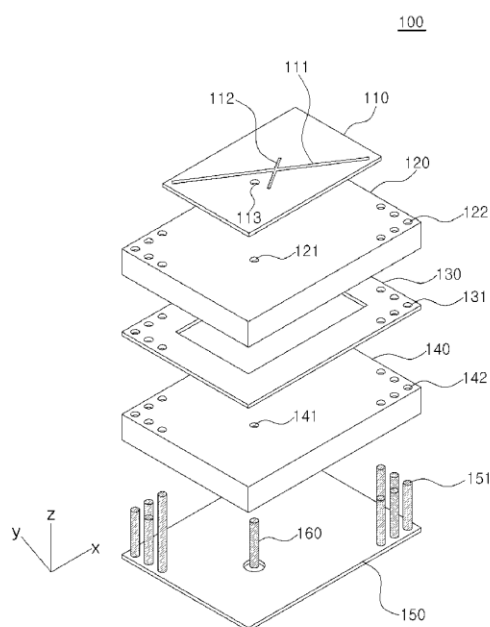
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Edwards Wildman Palmer LLP

(57) **ABSTRACT**

A patch antenna is disclosed. The disclosed patch antenna may include: a first radiator configured to generate a circular polarized wave; a first dielectric substrate equipped under the first radiator; a second radiator, placed under the first radiator at a designated distance from the first radiator, and configured to generate a linear polarized wave; a second dielectric substrate equipped under the second radiator; and a reflecting plate equipped under the second radiator at a designated distance from the second radiator; where the first dielectric substrate, the second radiator, the second dielectric substrate, and the reflecting plate are connected through at least one via. A patch antenna according to the present invention has the advantages of being able to generate linear polarized waves and circular polarized waves simultaneously, and of having a small size while still having a high design frequency band.

9 Claims, 6 Drawing Sheets





US008587484B2

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

(10) **Patent No.:** **US 8,587,484 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **QUASI-BALANCED FED ANTENNA
STRUCTURE FOR REDUCING SAR AND HAC**

(75) Inventors: **Chia-Mei Peng**, Taoyuan County (TW);
I-Fong Chen, Taoyuan County (TW)

(73) Assignee: **I-Fong Chen**, Taoyuan (TW)

(*) 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.: **13/235,690**

(22) Filed: **Sep. 19, 2011**

(65) **Prior Publication Data**
US 2013/0069830 A1 Mar. 21, 2013

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

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

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

(56) **References Cited**

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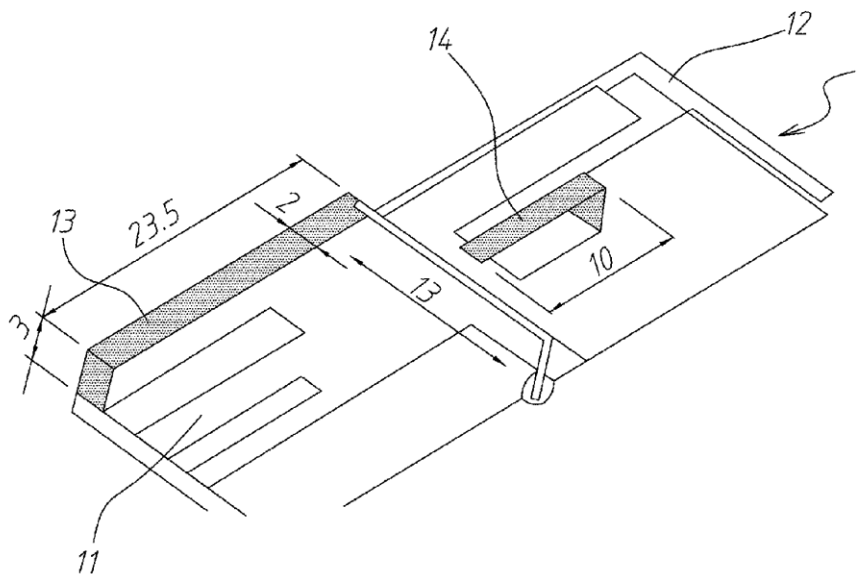
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Guice Patents PLLC

(57) **ABSTRACT**

The proposed antenna structure has first and second asymmetric radiated-strip structures developed by modifying the structure of a printed T-type monopole. Specifically, by combining the radiated-strip and the shorting-line, the proposed antenna structure is similar to modified Type III balun and dipole fed by microstrip-line structure. Hence, the proposed antenna structure can also be regarded as a “quasi-balanced” antenna structure.

5 Claims, 19 Drawing Sheets





US008587485B2

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

(10) **Patent No.:** **US 8,587,485 B2**

(45) **Date of Patent:** **Nov. 19, 2013**

(54) **PORTABLE TERMINAL**

(75) Inventors: **Ui-Soo Tahk**, Goyang (KR);
Kyoung-Hwa Kim, Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 421 days.

(21) Appl. No.: **12/797,421**

(22) Filed: **Jun. 9, 2010**

(65) **Prior Publication Data**
US 2010/0331050 A1 Dec. 30, 2010

(30) **Foreign Application Priority Data**
Jun. 25, 2009 (KR) 10-2009-0057253

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

(52) **U.S. Cl.**
USPC **343/702**; 343/906; 455/566; 455/575.1

(58) **Field of Classification Search**
USPC 343/702, 906, 700 MS; 455/566, 575.1
See application file for complete search history.

(56) **References Cited**

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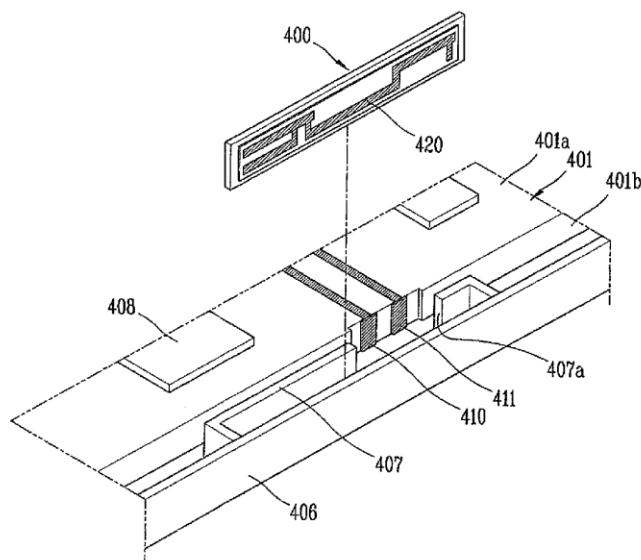
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — KED & Associates LLP

(57) **ABSTRACT**

A portable terminal includes a circuit board having edge and component mounting surfaces. The edge surface includes a first contact terminal and an antenna includes a second contact terminal. The component mounting surface is at least substantially parallel with a display screen of the terminal and the edge surface is at least substantially perpendicular to the display screen. The first and second contact terminals are coupled together to establish an electrical connection between the circuit board and antenna when the antenna and edge surface are mounted in parallel to one another within a housing of the terminal.

21 Claims, 10 Drawing Sheets





US008587486B2

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

(10) **Patent No.:** **US 8,587,486 B2**

(45) **Date of Patent:** **Nov. 19, 2013**

(54) **MULTI-BAND ANTENNA**

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Chun-Ming Chiu**, Tu-Cheng (TW);
Po-Kang Ku, Tu-Cheng (TW);
Wen-Fong Su, Tu-Cheng (TW);
Hsien-Sheng Tseng, Tu-Cheng (TW)

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(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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 584 days.

Primary Examiner — Michael C Wimer

Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Wei Te Chung; Ming Chieh
Chang

(21) Appl. No.: **12/857,769**

(22) Filed: **Aug. 17, 2010**

(65) **Prior Publication Data**

US 2011/0037680 A1 Feb. 17, 2011

(30) **Foreign Application Priority Data**

Aug. 17, 2009 (TW) 98127535

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

(52) **U.S. Cl.**
USPC 343/702; 343/846; 343/848

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

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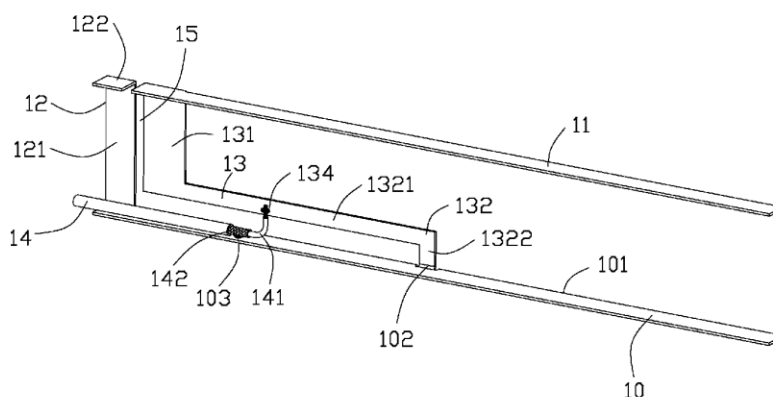
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(57) **ABSTRACT**

A multi-band antenna (1) includes a grounding element (10) extending along a horizontal direction and including a side edge (101) with a connecting point (102) and a grounding point (103) distanced from the connecting point by a length, a first radiating element (11) disposed above and parallel to the grounding element (10), a second radiating element (12) apart from the first radiating element and extending upwardly from the side edge of the grounding portion, a connecting element (13) located between the first radiating element and the grounding element, a feeding point (134) disposed on the connecting element (13), and a feeding line (14) including an inner conductor (141) connected to the feeding point and an outer conductor (142) connected to the grounding point. The first radiating element operates in a first frequency band. The second radiating element defines a L-shaped configuration in a side view and operates in a second frequency band. The connecting element (13) includes a first end linked to an end of said first radiating element and a second end connecting to said connecting point of the grounding element. Said first radiating element extends from said first end of the connecting element along a direction away from the second radiating element, and forms a slot (15) together with said second radiating element and said connecting element.

20 Claims, 5 Drawing Sheets





US008587491B2

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

(10) **Patent No.:** **US 8,587,491 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **ANTENNA WITH A C-SHAPED SLOT
NESTED WITHIN AN L-SHAPED SLOT AND
MOBILE DEVICE EMPLOYING THE
ANTENNA**

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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 273 days.

(21) Appl. No.: **12/835,601**

(22) Filed: **Jul. 13, 2010**

(65) **Prior Publication Data**

US 2011/0012790 A1 Jan. 20, 2011

Related U.S. Application Data

(60) Provisional application No. 61/226,500, filed on Jul.
17, 2009.

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

(52) **U.S. Cl.**
USPC **343/767**; 343/702; 343/770

(58) **Field of Classification Search**
USPC 343/700 MS, 767, 770
See application file for complete search history.

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Primary Examiner — Douglas W Owens

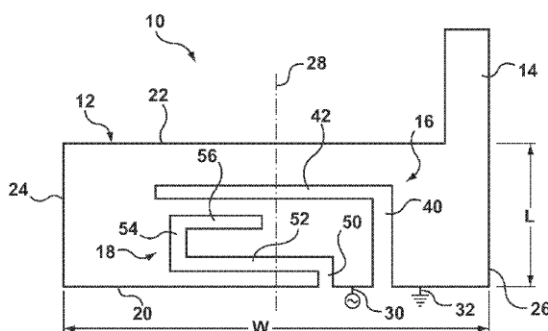
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(57) **ABSTRACT**

A mobile communications device is disclosed as having a
patch antenna, which has defined therein at least two slots
each having two or more parts. The at least two slots may
include an L-shaped slot and a C-shaped slot, wherein the
slots can be open or closed. The L-shaped slot may be an
open-slot projecting into the patch antenna from the edge.
Ground and signal connections may be at the edge of the
patch on either side of the L-shaped slot. The C-shaped slot
may be nested within the L-shaped slot.

12 Claims, 9 Drawing Sheets





US008587493B2

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

(10) **Patent No.:** **US 8,587,493 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **REVERSIBLY DEFORMABLE AND
MECHANICALLY TUNABLE FLUIDIC
ANTENNAS**

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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 491 days.

(21) Appl. No.: **12/889,257**

(22) Filed: **Sep. 23, 2010**

(65) **Prior Publication Data**

US 2012/0075069 A1 Mar. 29, 2012

(51) **Int. Cl.**
H01Q 1/40 (2006.01)

(52) **U.S. Cl.**
USPC **343/789**; 343/700 MS

(58) **Field of Classification Search**
USPC 343/700 MS, 719, 789, 873, 909
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Tho G Phan

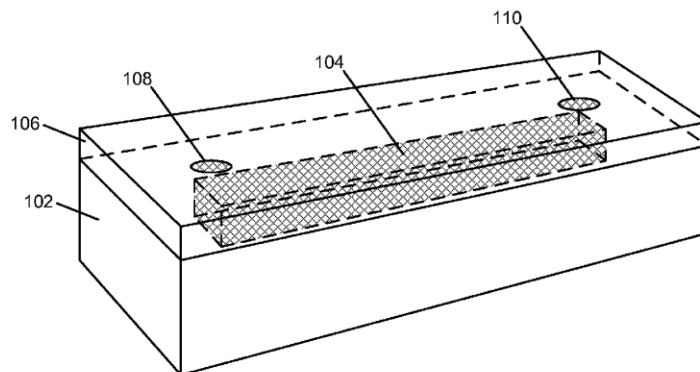
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(57) **ABSTRACT**

A method of manufacturing a fluidic structure is disclosed. A cavity that defines a shape of an element of the fluidic structure within a material is formed. The cavity is filled with liquid metal. The cavity is sealed. The fluidic structure behaves as an antenna. A fluidic antenna includes a material that defines a shape of the fluidic antenna by a cavity filled with liquid metal formed within the material, where the material further defines at least one mechanical property of the fluidic antenna.

6 Claims, 11 Drawing Sheets

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US008587494B2

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

(10) **Patent No.:** **US 8,587,494 B2**
(45) **Date of Patent:** **Nov. 19, 2013**

(54) **INTERNAL ANTENNA PROVIDING
IMPEDANCE MATCHING FOR MULTIBAND**

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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 563 days.

(21) Appl. No.: **12/935,195**

(22) PCT Filed: **Mar. 30, 2009**

(86) PCT No.: **PCT/KR2009/001608**

§ 371 (c)(1),
(2), (4) Date: **Nov. 9, 2010**

(87) PCT Pub. No.: **WO2009/145437**

PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication Data**

US 2011/0043427 A1 Feb. 24, 2011

(30) **Foreign Application Priority Data**

Mar. 31, 2008 (KR) 10-2008-0029714

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **343/850; 343/700 MS**

(58) **Field of Classification Search**
USPC **343/850, 700 MS**
See application file for complete search history.

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(74) Attorney, Agent, or Firm — Duane Morris LLP

(57) **ABSTRACT**

Disclosed is an internal antenna that provides impedance matching for multiple bands. The antenna includes an impedance matching part, which in turn includes a first conductive element electrically coupled to a feeding point and a second conductive element electrically coupled to a ground, and at least one radiator electrically coupled to the first conductive element, where the first conductive element and the second conductive element of the impedance matching part are separated by a particular distance to perform coupling matching and are electrically coupled at a pre-designated position. Certain aspects of the present invention can be utilized to provide wide band characteristics in designing for multi-band applications, even for high-frequency bands.

6 Claims, 6 Drawing Sheets

