



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**

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(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,889,147 B2* 2/2011 Tam et al. 343/777
* cited by examiner

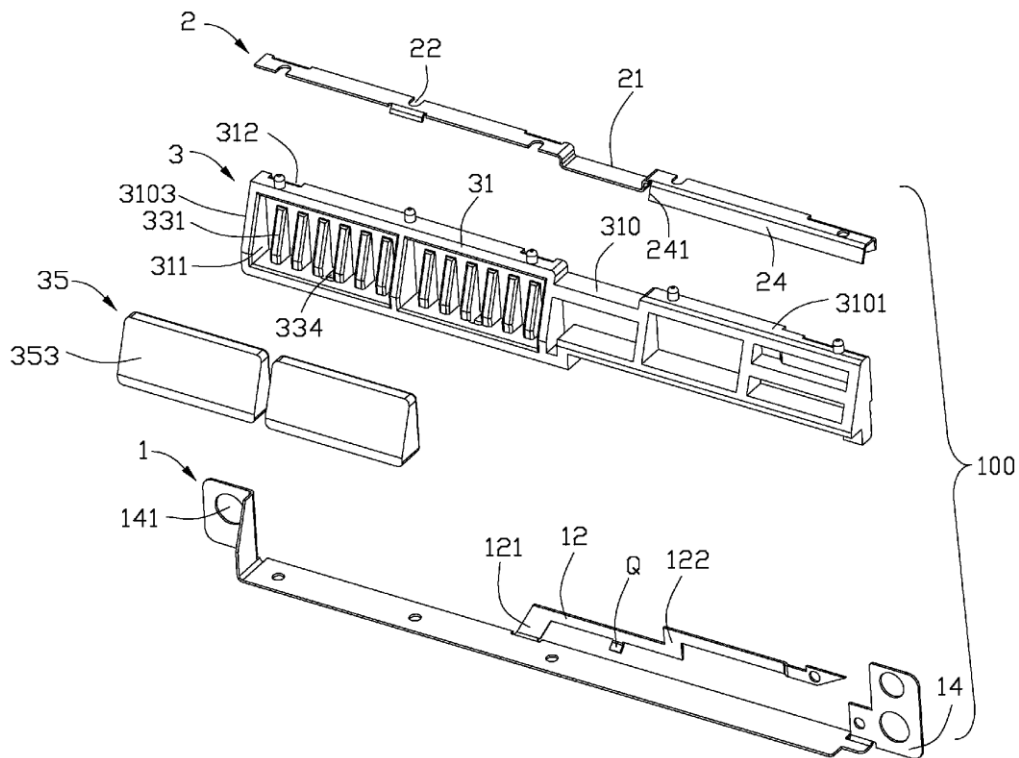
Primary Examiner — Tan Ho

(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**
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- (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**

U.S. PATENT DOCUMENTS

2,745,102 A 5/1956 Norgorden
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1316797 10/2007
DE 10015583 11/2000

(Continued)

OTHER PUBLICATIONS

"An Adaptive Microstrip Patch Antenna For Use In Portable Transceivers", Rostbakken et al., Vehicular Technology Conference, 1996, Mobile Technology for the Human Race, pp. 339-343.

(Continued)

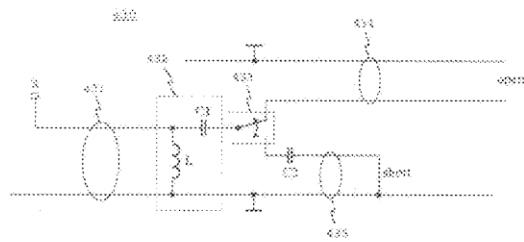
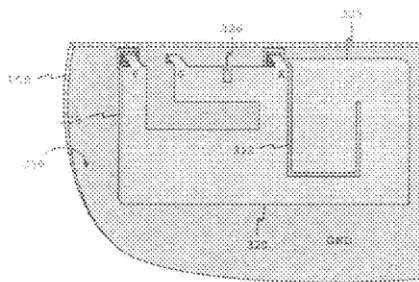
Primary Examiner — Tan Ho

(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**

U.S. PATENT DOCUMENTS

7,798,858 B1 *	9/2010	Zuo	439/630
8,223,502 B2 *	7/2012	Shen et al.	361/748
2001/0043160 A1 *	11/2001	Hirai et al.	343/702

OTHER PUBLICATIONS

RF-Link 5.8GHz Audio/Video Sender, user manual, by RF-Link, offered for sale Sep. 14, 2004.*

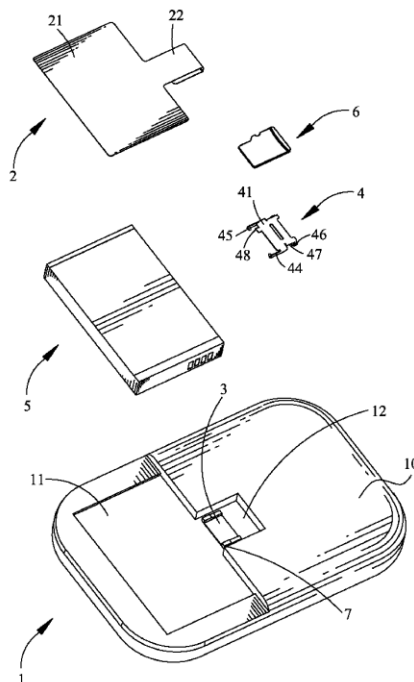
* cited by examiner

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**

6,885,880	B1	4/2005	Ali	455/575.7
6,922,172	B2	7/2005	Oshiyama et al.	343/700
6,930,641	B2	8/2005	Ohara et al.	343/702
6,980,154	B2	12/2005	Vance et al.	373/700
7,015,863	B2	3/2006	Sadler et al.	343/702
7,043,285	B2	5/2006	Boyle	455/575.7
7,053,844	B2	5/2006	Gaucher et al.	343/702
7,088,293	B2	8/2006	Imaizumi et al.	343/702
7,187,338	B2	3/2007	Boyle et al.	343/770
7,265,722	B2	9/2007	Liu et al.	343/702
7,383,067	B2	6/2008	Phillips et al.	455/575.1
7,417,591	B2	8/2008	Iguchi et al.	343/702
7,760,146	B2*	7/2010	Ollikainen	343/702
2005/0041624	A1	2/2005	Hui et al.	370/335
2005/0225484	A1	10/2005	Kuramoto	343/700
2006/0214857	A1	9/2006	Ollikainen	343/702
2010/0195854	A1	8/2010	Qi et al.	381/315
2011/0210894	A1	9/2011	Man et al.	343/702

- (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.

FOREIGN PATENT DOCUMENTS

CN	1511359	7/2004
EP	1291968	3/2003
EP	1503450	2/2005
EP	1440492	1/2006
WO	02/05381	1/2002
WO	03/017425	2/2003
WO	2005/067635	7/2005

* cited by examiner

Primary Examiner — Hoang V Nguyen

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

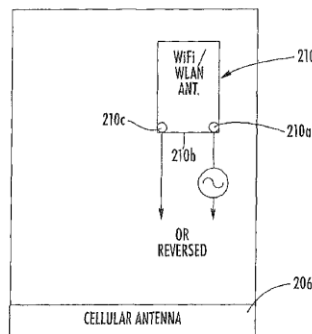
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702; 343/725**
- (58) **Field of Classification Search**
USPC 343/702, 725, 700 MS, 893; 455/575.1, 455/575.3, 575.4, 575.7
See application file for complete search history.

(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.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
6,448,933 B1 9/2002 Hill et al. 343/702
6,670,923 B1 12/2003 Kadambi et al. 343/700

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)

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

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

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

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

(65) **Prior Publication Data**

US 2011/0025572 A1 Feb. 3, 2011

(30) **Foreign Application Priority Data**

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

(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**

U.S. PATENT DOCUMENTS

6,358,432 B1 * 3/2002 Tomono et al. 252/62.63
6,623,879 B2 9/2003 Okano et al.
6,660,179 B2 12/2003 Umeda et al.

6,669,861 B2 * 12/2003 Marusawa 252/62.63
6,858,156 B2 2/2005 Takami et al.
7,169,319 B2 1/2007 Takami et al.
7,425,280 B2 * 9/2008 Nagaoka et al. 252/62.63
7,651,626 B2 * 1/2010 Gonda et al. 252/62.63
7,764,143 B2 * 7/2010 Miyata et al. 333/185
7,910,214 B2 3/2011 Kimura et al.
2003/0148147 A1 8/2003 Okano et al.

FOREIGN PATENT DOCUMENTS

CN 1380663 A 11/2002
CN 1426383 A 6/2003
CN 1530971 A 9/2004
CN 101014548 A 8/2007
CN 101262085 A 9/2008
JP 2002-260912 * 9/2002
KR 10-2002-0079484 A 10/2002
KR 10-2005-0050681 A 5/2005
KR 10-2007-0107654 A 11/2007
KR 10-2008-0082466 A 9/2008

* cited by examiner

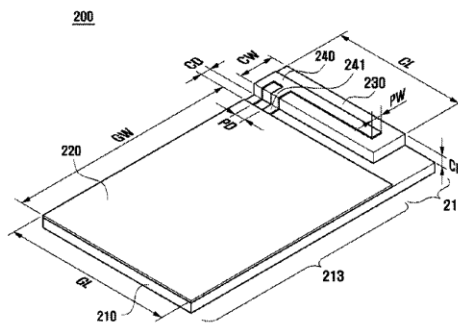
Primary Examiner — Hoang V Nguyen

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

(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.

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**

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(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**

U.S. PATENT DOCUMENTS

7,218,282 B2 * 5/2007 Humpfer et al. 343/700 MS
7,705,788 B2 * 4/2010 Hung et al. 343/702
2009/0262026 A1 * 10/2009 Yu et al. 343/700 MS
2010/0201578 A1 * 8/2010 Parsche 343/700 MS

* cited by examiner

Primary Examiner — Jacob Y Choi

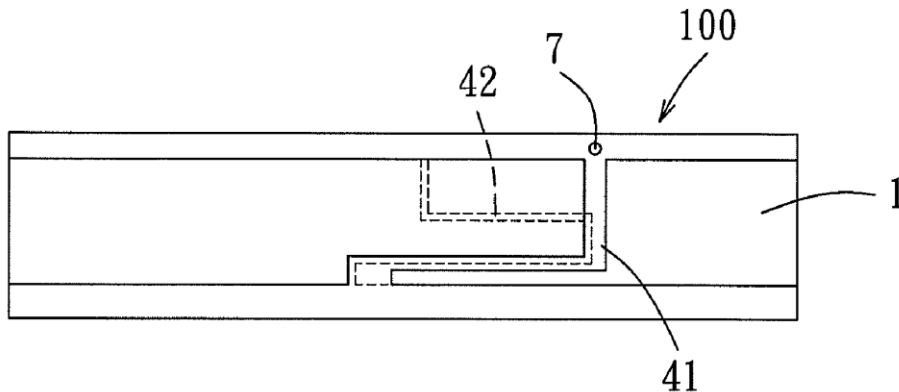
Assistant Examiner — Amal Patel

(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**
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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**
U.S. PATENT DOCUMENTS
- | | | | | |
|--------------|------|---------|------------------|------------|
| 5,801,660 | A | 9/1998 | Masataka | |
| 6,285,342 | B1 * | 9/2001 | Brady et al. | 343/895 |
| 7,202,822 | B2 * | 4/2007 | Baliarda et al. | 343/700 MS |
| 7,761,115 | B2 * | 7/2010 | Castaneda et al. | 455/562.1 |
| 8,188,926 | B2 * | 5/2012 | Ganwani et al. | 343/700 MS |
| 2003/0222821 | A1 | 12/2003 | Mikkonen | |
| 2004/0160368 | A1 | 8/2004 | Huang | |
| 2006/0256018 | A1 | 11/2006 | Jordi | |
| 2010/0177001 | A1 | 7/2010 | Alexopoulos | |

FOREIGN PATENT DOCUMENTS

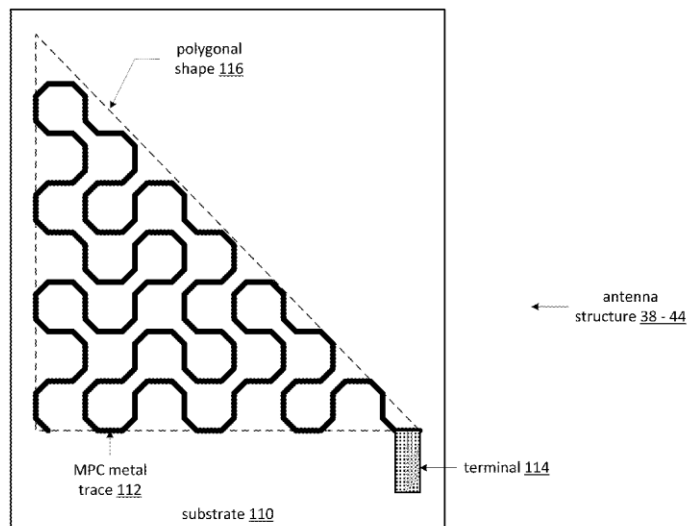
- WO 2004095635 A1 11/2004
- OTHER PUBLICATIONS**

European Search Report; Application No. 10015737.9-2220; Apr. 8, 2011; 4 pages.
 Crnjevic-Bengin V.; "Compact 2D Hilbert Microstrip Resonators"; Microwave and Optical Technology Letters; vol. 48, No. 2; Feb. 2006; pp. 270-273.
 Vesna Crnjevic-Bengin and Djuradj Budimir; Novel 3D Hilbert Microstrip Resonators; 2005 Microwave and Optical Technology Letters; Aug. 5, 2005; pp. 195-197; vol. 46, No. 3; Wiley Periodicals, Inc.

* cited by examiner
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.

Foreign Application Priority Data

- (30) 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**

U.S. PATENT DOCUMENTS

- 6,154,176 A * 11/2000 Fathy et al. 343/700 MS
 - 6,417,807 B1 * 7/2002 Hsu et al. 343/700 MS
- (Continued)

FOREIGN PATENT DOCUMENTS

- EP 1 429 413 A1 6/2004
- EP 1 717 903 A1 11/2006

(Continued)

OTHER PUBLICATIONS

Japanese Examination Report (dated Oct. 24, 2012) for corresponding Japanese Application No. 2010-511732.
Haridas, et al., Adaptive Micro-Antenna on Silicon Substrate., Adaptive Hardware and Systems, XP010920164, pp. 43-50 (2006).

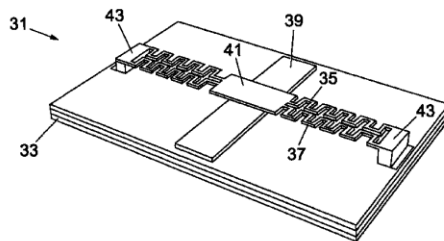
Primary Examiner — Jason M Crawford

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

(57) **ABSTRACT**

A micro electromechanical (MEMS) antenna (36) is positioned on one side of a substrate and is connected to a MEMS switch comprising a capacitor bridge (46) and to a transmission 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 electromagnetic 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-paraxylene (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





US008570224B2

(12) **United States Patent**
Mattis

(10) **Patent No.:** **US 8,570,224 B2**
(45) **Date of Patent:** **Oct. 29, 2013**

(54) **APPARATUS PROVIDING THERMAL MANAGEMENT FOR RADIO FREQUENCY DEVICES**

2001/0048397 A1 12/2001 Smith
2002/0145567 A1* 10/2002 Spiegel et al. 343/700 MS
2003/0096585 A1 5/2003 Danet et al.

(75) Inventor: **Eric Stephen Mattis**, San Diego, CA (US)

FOREIGN PATENT DOCUMENTS

EP 1737065 A1 12/2006
WO WO2008012533 A1 1/2008

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 444 days.

International Search Report and Written Opinion—PCT/US2011/036354—ISA/EPO—Jul. 29, 2011.

* cited by examiner

(21) Appl. No.: **12/778,922**

(22) Filed: **May 12, 2010**

Primary Examiner — Hoanganh Le

(65) **Prior Publication Data**

(74) *Attorney, Agent, or Firm* — Ramin Mobarhan

US 2011/0279331 A1 Nov. 17, 2011

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

(57) **ABSTRACT**

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

Apparatus providing thermal management for radio frequency devices. An antenna is provided that includes an antenna body configured for transmitting electrical signals, and one or more mounting surfaces coupled to the antenna body, the one or more mounting surfaces configured for mounting to a device surface so that a resulting thermal resistance (R_{th}) between the device surface and the antenna body is less than 15 degrees centigrade per watt. The antenna body forms one of a PIFA antenna, whip antenna, patch antenna, or a meandered patch antenna.

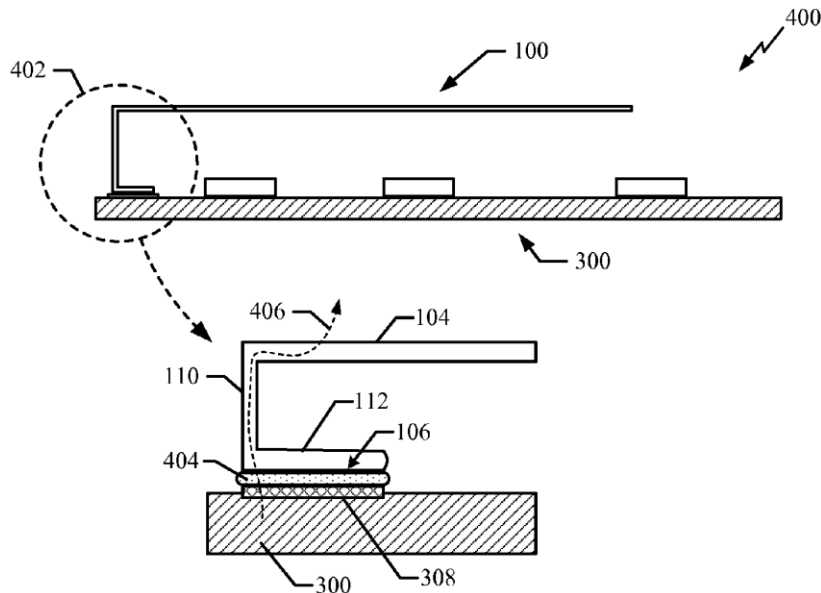
(58) **Field of Classification Search**
USPC 343/702, 700 MS, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,456,249 B1* 9/2002 Johnson et al. 343/702
7,508,347 B2* 3/2009 Sakama et al. 343/700 MS
8,051,550 B2* 11/2011 Cheng et al. 29/600

20 Claims, 5 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**
- (75) Inventors: **Hideaki Shoji**, Tokyo (JP); **Yoshiki Kanayama**, Saitama (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 311 days.

- (21) Appl. No.: **12/955,535**
- (22) Filed: **Nov. 29, 2010**

- (65) **Prior Publication Data**
US 2011/0237309 A1 Sep. 29, 2011

- Related U.S. Application Data**
- (60) Provisional application No. 61/317,307, filed on Mar. 25, 2010.
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702**
- (58) **Field of Classification Search**
USPC 343/721, 893, 897, 705, 700 MS, 846
See application file for complete search history.

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

7,091,907	B2 *	8/2006	Brachat	343/700	MS
7,417,588	B2 *	8/2008	Castany et al.	343/700	MS
7,539,510	B2 *	5/2009	Toyoda et al.	455/550.1	
7,965,249	B1 *	6/2011	Wolf et al.	343/745	
2003/0148784	A1 *	8/2003	Sawamura et al.	455/550	
2004/0239575	A1 *	12/2004	Shoji et al.	343/770	
2010/0225554	A1 *	9/2010	Huang et al.	343/821	

- FOREIGN PATENT DOCUMENTS

JP	09-147639	6/1997
JP	2006-262414	9/2006

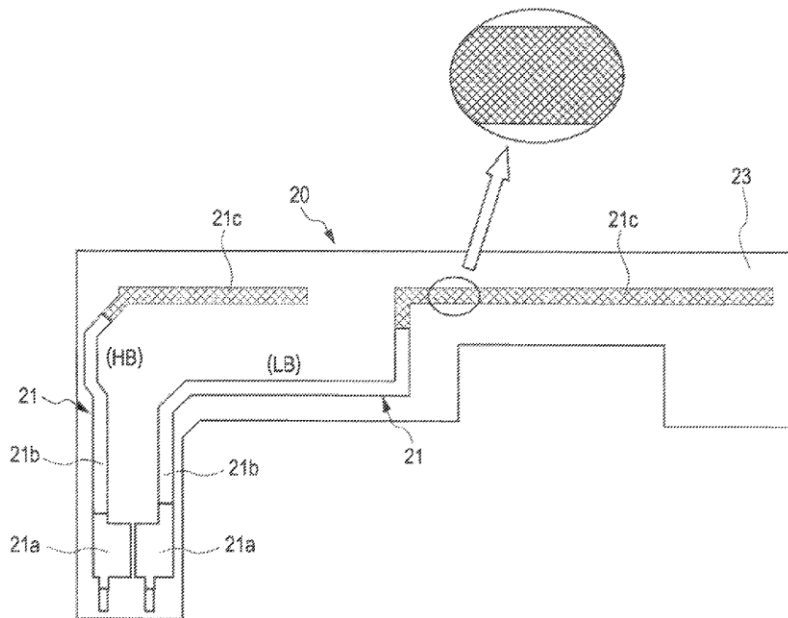
- OTHER PUBLICATIONS
- Chinese Office Action issued Jun. 26, 2013 in Chines Application No. 201110029363.4 with English translation, 24 pages.

* cited by examiner

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

- (57) **ABSTRACT**
- 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.

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**

U.S. PATENT DOCUMENTS

7,443,346	B2 *	10/2008	Shih	343/700	MS
2007/0247370	A1 *	10/2007	Hu et al.	343/700	MS
2009/0046019	A1 *	2/2009	Sato	343/702	
2011/0215972	A1 *	9/2011	Wong et al.	343/702	

* cited by examiner

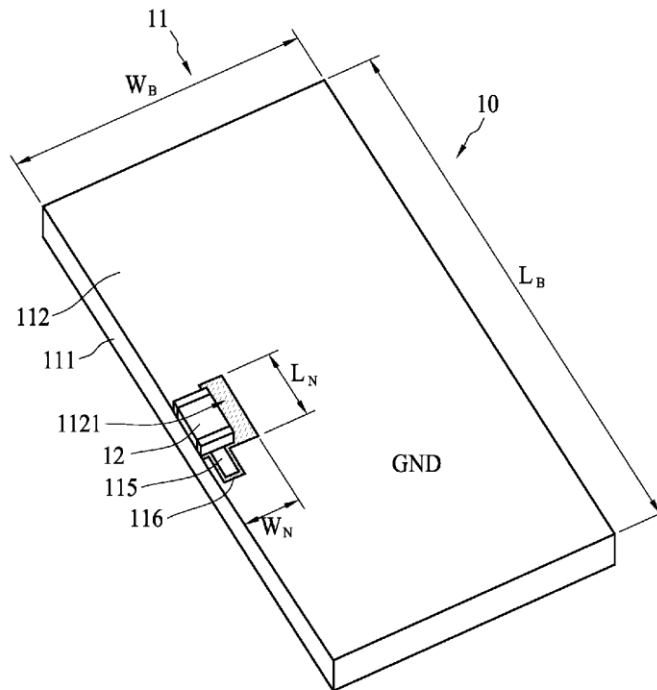
Primary Examiner — Ahshik Kim

(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.

4,131,892 A	12/1978	Munson et al.
4,204,212 A	5/1980	Sindoris et al.
4,233,607 A	11/1980	Sanford et al.
4,358,769 A	11/1982	Tada et al.
4,451,829 A	5/1984	Stuckey, Jr. et al.
4,527,163 A	7/1985	Stanton
4,546,459 A	10/1985	Congdon
4,613,868 A	9/1986	Weiss
4,710,775 A	12/1987	Coe
4,839,663 A	6/1989	Kurtz

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1147150	4/1997
EP	1959518 A2	8/2008

(Continued)

OTHER PUBLICATIONS

Brown, et al., "Circularly-Polarized Omnidirectional Antenna**" RCA Review, pp. 259-269, Jun. 1947.

(Continued)

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

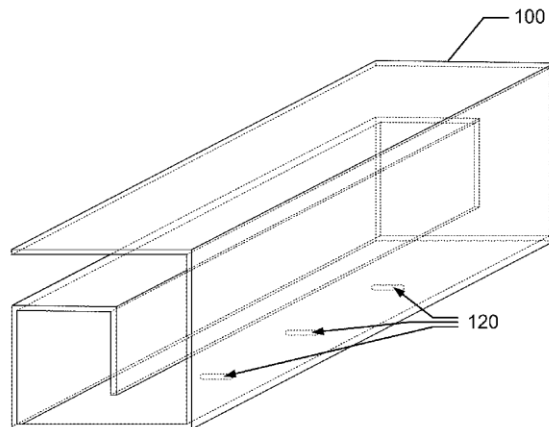
(58) **Field of Classification Search**

USPC 343/872, 895
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,625,654 A	1/1953	Alford
2,812,514 A	11/1957	Smith
3,474,452 A	10/1969	Bogner
3,555,552 A	1/1971	Alford
3,618,114 A	11/1971	Dietrich
3,665,479 A	5/1972	Silliman
3,810,183 A	5/1974	Krutsinger et al.





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.

7,256,750	B1	8/2007	Honda	
7,307,588	B2 *	12/2007	Tseng	343/700 MS
7,358,918	B2 *	4/2008	Itsuji	343/772
2002/0175877	A1	11/2002	Schantz	
2006/0139225	A1	6/2006	Taguchi et al.	
2007/0120741	A1 *	5/2007	Tseng	343/700 MS
2007/0194990	A1 *	8/2007	Ling et al.	343/700 MS
2011/0156981	A1	6/2011	Ridgeway	

FOREIGN PATENT DOCUMENTS

EP	1986270	10/2008
WO	WO-2006002090	A1 1/2006

OTHER PUBLICATIONS

"International Application No. PCT/US2010/054718, International Search Report and Written Opinion mailed Feb. 25, 2011", 10 pgs.
 Yanagi, Masahiro, et al., "A Planar UWB Monopole Antenna Formed on a Printed Circuit Board", 1 pg.
 Yang, H.Y. David, "Printed Straight F Antennas for WLAN and Bluetooth", Dept. of Electrical and Computer Engineering, Univ. of Illinois at Chicago, 4 pgs.

* cited by examiner

Primary Examiner — Hoang V Nguyen

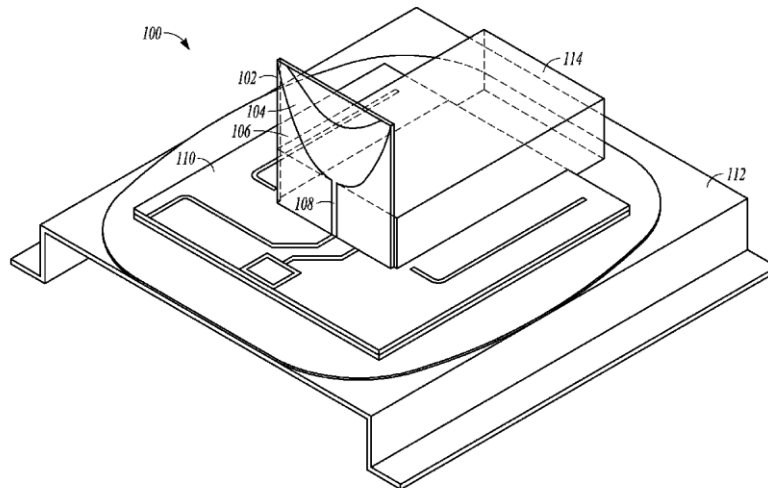
(74) *Attorney, Agent, or Firm* — Fogg & Powers LLC

(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

- (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**
U.S. PATENT DOCUMENTS
6,590,541 B1 7/2003 Schultze
6,759,984 B2 7/2004 Wielsma
6,768,461 B2 * 7/2004 Huebner et al. 343/700 MS
7,034,750 B2 4/2006 Asakura et al.





US008576127B1

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

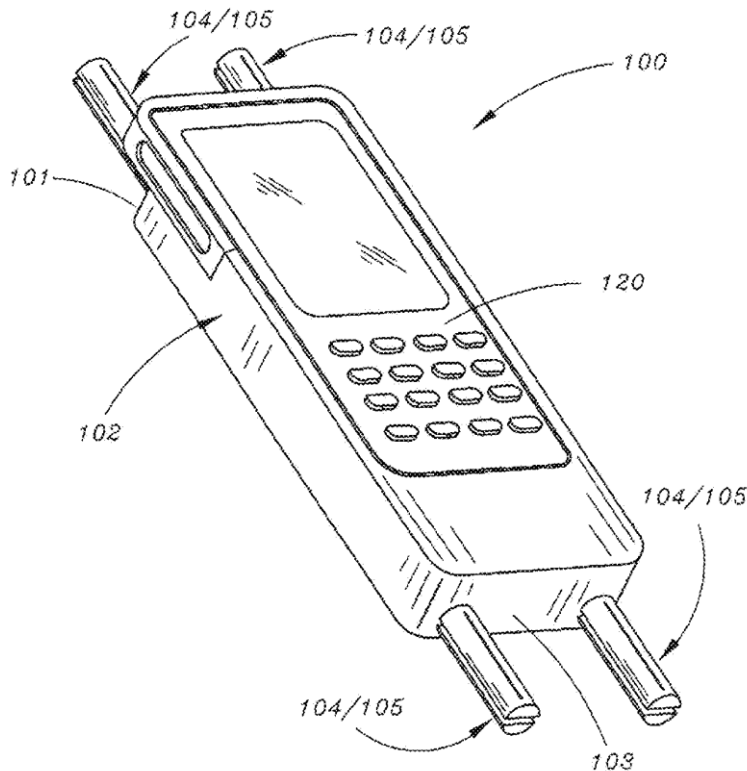
(10) **Patent No.:** **US 8,576,127 B1**
(45) **Date of Patent:** **Nov. 5, 2013**

- (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**
U.S. PATENT DOCUMENTS
6,873,293 B2 * 3/2005 Proctor et al. 343/702
7,190,313 B2 * 3/2007 Chiang et al. 343/702
7,525,493 B2 * 4/2009 Iwai et al. 343/702
* cited by examiner
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**

(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)

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

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

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

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

(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.

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,394,160	A	2/1995	Iwasaki et al.	
5,943,018	A	8/1999	Miller	
7,415,265	B2	8/2008	Noro et al.	
2002/0122007	A1	9/2002	Jansen	
2005/0062671	A1*	3/2005	Berezin et al.	343/846
2005/0237255	A1	10/2005	Zhang et al.	
2005/0254591	A1	11/2005	Weil	
2006/0033666	A1*	2/2006	Su et al.	343/700 MS
2006/0244663	A1	11/2006	Fleck et al.	
2011/0063779	A1	3/2011	Ochi et al.	

* cited by examiner

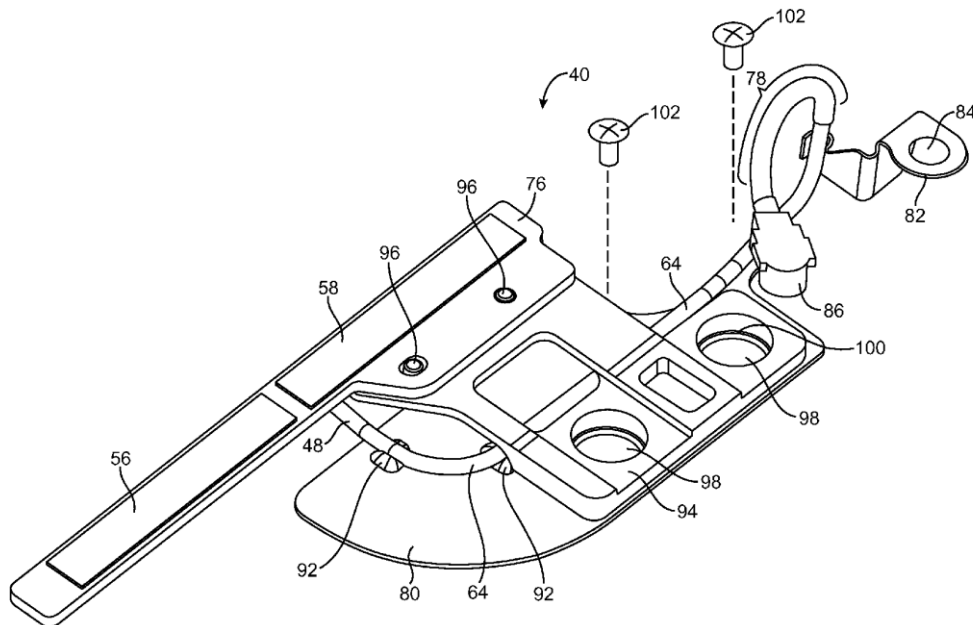
Primary Examiner — Dieu H Duong

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

(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.

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**

U.S. PATENT DOCUMENTS

5,867,370	A *	2/1999	Masuda	361/800
2005/0237443	A1	10/2005	Nakanishi et al.	
2006/0232920	A1	10/2006	Miyamoto et al.	
2008/0284939	A1 *	11/2008	Lee et al.	349/58
2009/0303408	A1 *	12/2009	Huang et al.	349/58

FOREIGN PATENT DOCUMENTS

JP	H08-150629	6/1996
JP	H10-100193	4/1998
JP	H10-215080	8/1998
JP	3059644	3/1999
JP	H11-298158	10/1999
JP	2002-232220	8/2002
JP	2002-268063	9/2002
JP	2002-314262	10/2002
JP	2004-1424	1/2004
JP	2004-280331	10/2004
JP	2005-149463	6/2005
JP	2006-013797	1/2006
JP	2008-3714	1/2008

* cited by examiner

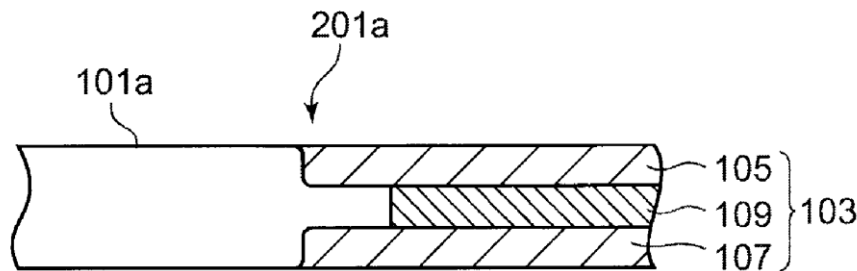
Primary Examiner — Nathanael R Briggs

(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**

5,917,450 A 6/1999 Tsunekawa et al.
5,956,626 A 9/1999 Kashke et al.
6,124,831 A 9/2000 Rutkowski et al.

(Continued)

(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)

FOREIGN PATENT DOCUMENTS

DE 102005035935 2/2007
EP 0564164 10/1993

(Continued)

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

OTHER PUBLICATIONS

(*) 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.

(Continued)

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

(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

(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.

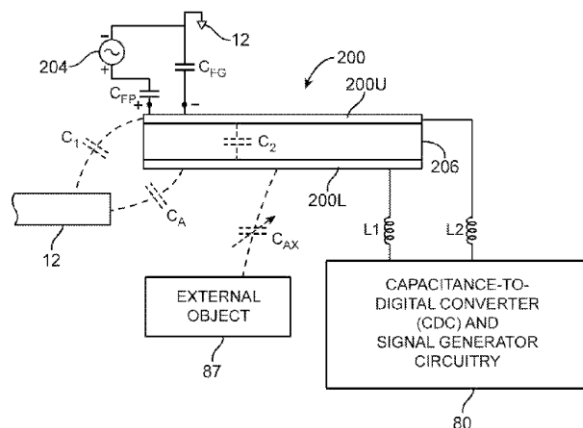
(58) **Field of Classification Search**
USPC 455/41.1, 41.3, 41.7, 550.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,546,357 A 10/1985 Laughon et al.
5,337,353 A * 8/1994 Boie et al. 379/433.01
5,463,406 A 10/1995 Vannatta et al.
5,650,597 A 7/1997 Redmayne
5,826,458 A 10/1998 Little
5,854,972 A 12/1998 Pennock et al.
5,864,316 A 1/1999 Bradley et al.
5,905,467 A 5/1999 Narayanaswamy et al.

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**

2009/0295648 A1 * 12/2009 Dorsey et al. 343/702
2010/0194647 A1 8/2010 Man et al.
2010/0231476 A1 * 9/2010 Chiang et al. 343/780
2011/0065392 A1 3/2011 Chung et al.

(75) Inventors: **Peter C. Cotterill**, Mountain View, CA (US); **Robert W. Schlub**, Cupertino, CA (US)

FOREIGN PATENT DOCUMENTS

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

EP 1098454 5/2001
EP 1215893 6/2002
JP 2006279649 10/2006
WO 2006042399 4/2006

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 39 days.

* cited by examiner

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

Primary Examiner — Ajibola Akinyemi

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

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

(65) **Prior Publication Data**

US 2012/0142296 A1 Jun. 7, 2012

(57) **ABSTRACT**

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

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.

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

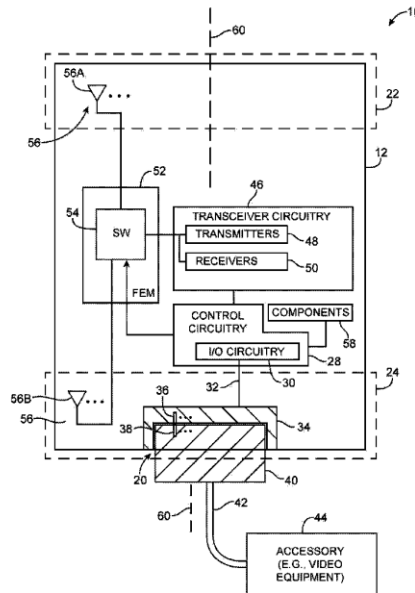
(58) **Field of Classification Search**
USPC 455/277.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0018814 A1 1/2004 Lin et al.
2006/0109067 A1 5/2006 Shtrum
2007/0123207 A1 5/2007 Terlizzi

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**

U.S. PATENT DOCUMENTS

5,913,174 A 6/1999 Casarez et al.
5,983,119 A 11/1999 Martin et al.
6,208,874 B1 3/2001 Rudsill et al.

6,232,924	B1	5/2001	Winstead et al.	
6,259,409	B1	7/2001	Fulton et al.	
6,266,017	B1*	7/2001	Aldous	343/702
6,272,356	B1	8/2001	Dolman et al.	
6,317,085	B1	11/2001	Sandhu et al.	
6,359,591	B1*	3/2002	Mou	343/702
6,377,218	B1*	4/2002	Nelson et al.	343/702
7,050,008	B2	5/2006	Saito et al.	
7,429,956	B2*	9/2008	Park et al.	343/702
7,567,217	B1	7/2009	Chen	
7,579,993	B2*	8/2009	Lev et al.	343/702
8,138,978	B1*	3/2012	Vier et al.	343/702
2002/0021252	A1*	2/2002	Schremmer et al.	343/702
2004/0140937	A1*	7/2004	Yang	343/702
2005/0093762	A1	5/2005	Pick	

* cited by examiner

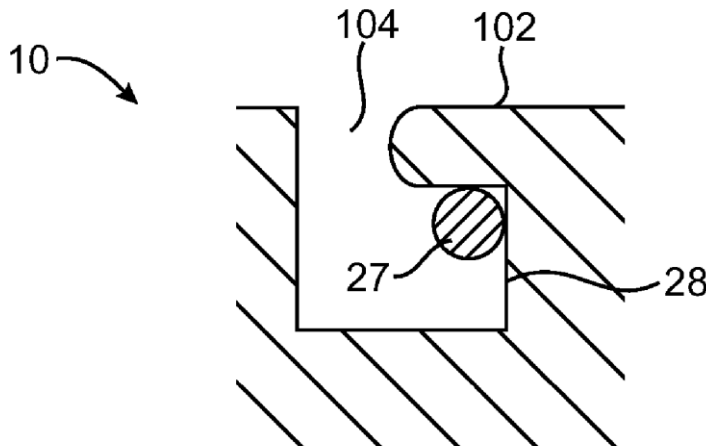
Primary Examiner — Tho G Phan

(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





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**

U.S. PATENT DOCUMENTS

6,239,753 B1 5/2001 Kado et al.
6,295,030 B1 9/2001 Kozakai et al.
6,867,746 B2* 3/2005 Mendolia et al. 343/841

7,209,087 B2 4/2007 Tang et al.
7,471,249 B2* 12/2008 Tang et al. 343/702
7,511,668 B2* 3/2009 Hirabayashi 343/700 MS
2003/0193437 A1 10/2003 Kangasvieri et al.
2004/0051669 A1 3/2004 Rutfors et al.
2005/0200535 A1 9/2005 Elkobi et al.
2006/0208949 A1 9/2006 Hirabayashi
2007/0210968 A1 9/2007 Chung et al.

FOREIGN PATENT DOCUMENTS

DE 197 13 929 A1 11/1997
DE 19713929 A1 11/1997
DE 694 14 853 T2 4/1999
DK 19713929 A1 11/1997
EP 0 720 252 A1 7/1996
KR 1995-0013610 B1 11/1995
KR 10-2001-0040027 A 5/2001
WO WO 95/02284 A1 1/1995
WO WO 03/103361 A1 12/2003

* cited by examiner

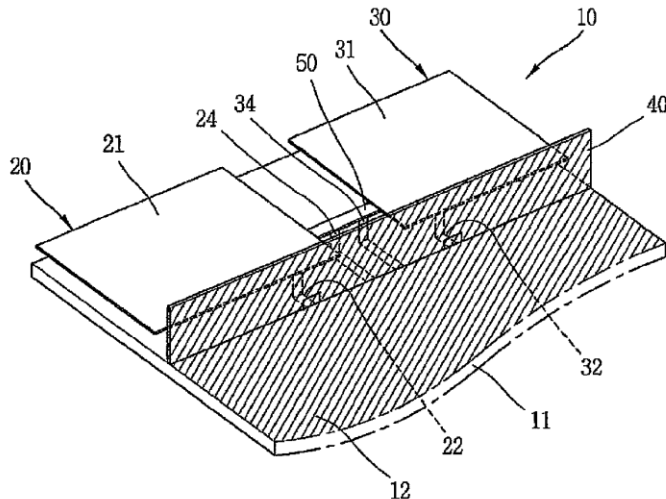
Primary Examiner — Hoang V Nguyen

(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**

U.S. PATENT DOCUMENTS

7,330,155 B2	2/2008	Chan et al.	343/702
7,403,161 B2	7/2008	DiNallo et al.	343/702
7,423,598 B2	9/2008	Bit-Babik et al.	343/702
7,626,551 B2 *	12/2009	Chien et al.	343/700 MS
7,642,964 B2	1/2010	DiNallo et al.	343/700
7,928,915 B2 *	4/2011	Sanz Arronte et al.	343/700 MS
2005/0007283 A1 *	1/2005	Jo et al.	343/702
2008/0055164 A1 *	3/2008	Zhang et al.	343/702
2008/0231530 A1 *	9/2008	Rao et al.	343/767
2009/0146905 A1 *	6/2009	Morita	343/895
2010/0019421 A1 *	1/2010	Kenning et al.	266/45
2012/0019421 A1 *	1/2012	Lai et al.	343/729
2012/0032857 A1 *	2/2012	Lai et al.	343/700 MS

* cited by examiner

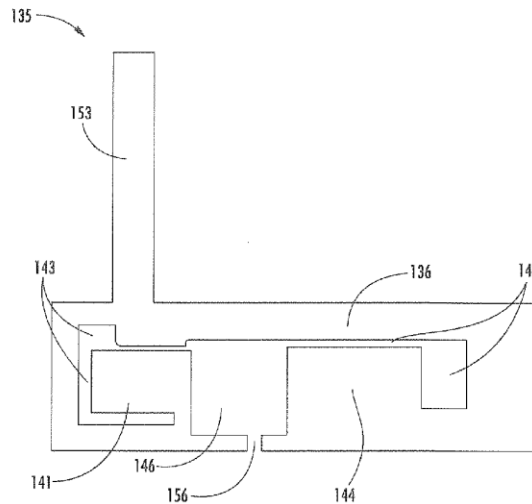
Primary Examiner — Trinh Dinh

(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**

2010/0033393 A1 2/2010 Myszne et al.
2010/0190464 A1 7/2010 Chen et al.
2010/0327068 A1 12/2010 Chen et al.

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

FOREIGN PATENT DOCUMENTS

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

TW 200952251 12/2009
TW 201011984 3/2010
WO 2009/105146 A1 8/2009
WO 2009/128866 A1 10/2009

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

OTHER PUBLICATIONS

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

International Search Report and Written Opinion of the International Search Authority dated Mar. 15, 2012, PCTUS12/20639.

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

H. Uchimura et al., "A Ceramic Planar 77GHz Antenna Array," 1999 IEEE MTT-S International Microwave Symposium Digest, Jun. 1999, pp. 453-456.

(65) **Prior Publication Data**

US 2012/0188138 A1 Jul. 26, 2012

Xin Wang et al., "A 79 Ghz LTCC Differential Microstrip Line to Laminated Waveguide Transition Using High Permittivity Material," Microwave Conference Proceedings (APMC), Dec. 2010, 4 pages.

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

Taras Kushta et al., "High Isolated and High-Performance Vertical Transitions for Multilayer Printed Circuit Boards," Proceedings of International Symposium on Electromagnetic Compatibility, 2004, pp. 57-60, vol. 1.

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

Communication dated Jul. 11, 2013 from German Patent office for counterpart application 11 2012 000 285.7.

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

* cited by examiner

(56) **References Cited**

Primary Examiner — Hoanganh Le

U.S. PATENT DOCUMENTS

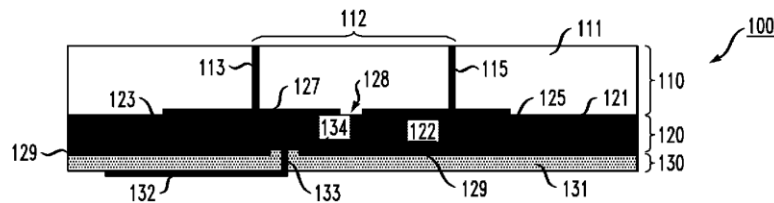
(74) *Attorney, Agent, or Firm* — Anne V. Dougherty; Ryan, Mason & Lewis, LLP

- 5,043,738 A 8/1991 Shapiro et al.
- 6,791,438 B2 9/2004 Takahashi et al.
- 7,391,372 B2 6/2008 Lynch et al.
- 7,675,466 B2 3/2010 Gaucher et al.
- 2003/0067410 A1* 4/2003 Puzella et al. 343/700 MS
- 2007/0132642 A1 6/2007 Iluz et al.
- 2007/0229182 A1 10/2007 Gaucher et al.
- 2008/0129453 A1 6/2008 Shanks et al.
- 2009/0207080 A1 8/2009 Floyd et al.
- 2009/0256752 A1 10/2009 Akkermans et al.
- 2010/0001906 A1 1/2010 Akkermans et al.

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,187,490	A *	2/1993	Ohta et al.	343/770
5,293,171	A *	3/1994	Cherrette	343/700 MS
5,309,164	A *	5/1994	Dienes et al.	343/700 MS
5,444,452	A *	8/1995	Itoh et al.	343/700 MS
5,497,164	A *	3/1996	Croq	343/700 MS
5,646,634	A *	7/1997	Bokhari et al.	343/700 MS
8,228,254	B2 *	7/2012	Foltz et al.	343/795

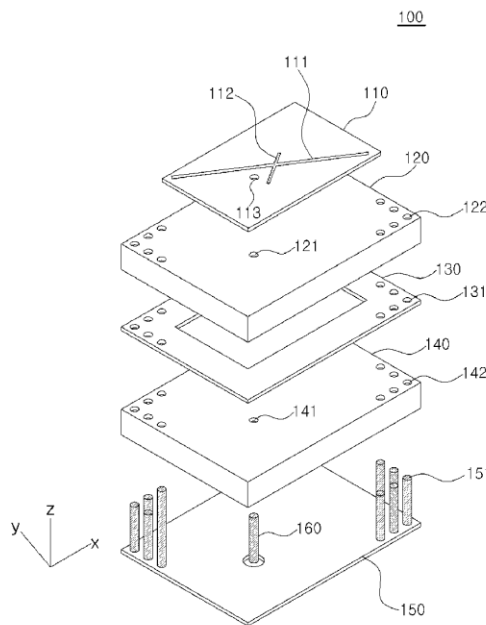
* cited by examiner

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**

U.S. PATENT DOCUMENTS

7,446,717 B2 *	11/2008	Hung et al.	343/702
7,602,341 B2 *	10/2009	Wei-Shan et al.	343/700 MS
8,111,195 B2 *	2/2012	Hung et al.	343/700 MS
2010/0182210 A1 *	7/2010	Ryou et al.	343/722

* cited by examiner

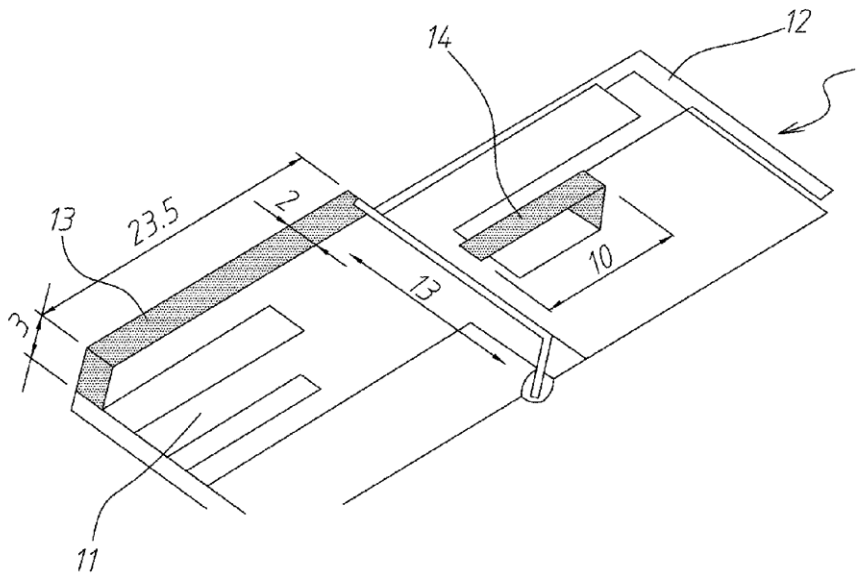
Primary Examiner — Hoanganh Le

(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**

U.S. PATENT DOCUMENTS

6,337,663	B1	1/2002	Chiang	
2005/0017902	A1	1/2005	Oyama et al.	
2006/0132366	A1*	6/2006	Seol et al.	343/702
2006/0139218	A1*	6/2006	Jang	343/702
2006/0290591	A1*	12/2006	Nilsson et al.	343/906
2009/0002244	A1*	1/2009	Woo	343/702
2009/0115671	A1	5/2009	Ishihara	

OTHER PUBLICATIONS

European Search Report dated Nov. 2, 2010 for corresponding European Application Serial No. 10005657.1.

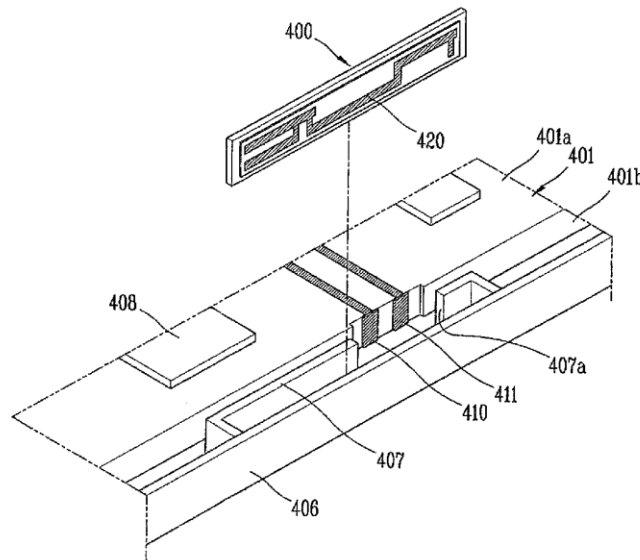
* cited by examiner

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)

CN	2554814	6/2003
CN	101369683	8/2007
CN	101106211	1/2008
CN	101447600	6/2009
TW	I240450	9/2005

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
New Taipei (TW)

* cited by examiner

(*) 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.

(56) **References Cited**

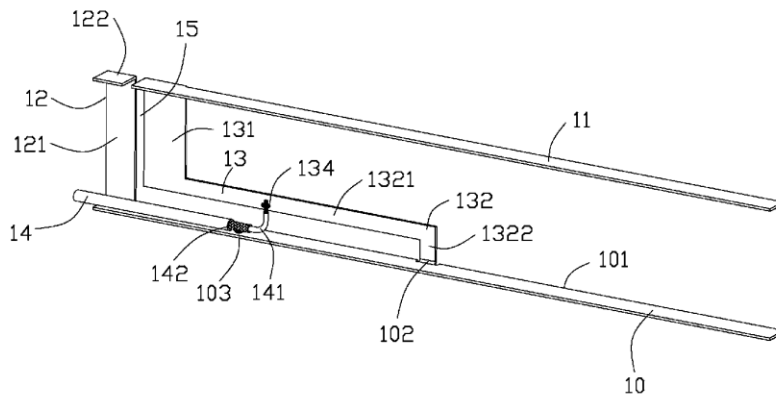
U.S. PATENT DOCUMENTS

6,836,252	B2	12/2004	Tai et al.	
7,050,010	B2 *	5/2006	Wang et al.	343/702
7,639,192	B2 *	12/2009	Tsai et al.	343/702
8,144,062	B2	3/2012	Ke et al.	
2010/0053002	A1 *	3/2010	Wojack et al.	343/702
2010/0238072	A1 *	9/2010	Ayatollahi et al.	343/700 MS

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

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

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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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,309,163 A * 5/1994 Ngan et al. 343/700 MS
6,317,084 B1 * 11/2001 Chen et al. 343/700 MS
6,762,723 B2 7/2004 Nallo

7,023,387 B2 4/2006 Wen
7,119,748 B2 * 10/2006 Autti 343/702
7,443,344 B2 * 10/2008 Boyle 343/700 MS
7,466,271 B2 12/2008 Wen
2002/0126052 A1 * 9/2002 Boyle 343/702
2004/0145521 A1 7/2004 Hebron et al.
2008/0030411 A1 2/2008 Wen et al.
2009/0040110 A1 2/2009 Chien et al.
2009/0085812 A1 4/2009 Qi et al.
2010/0097282 A1 * 4/2010 Chirila 343/770

FOREIGN PATENT DOCUMENTS

DE 10331281 A1 2/2004
EP 1304765 A2 4/2003
EP 1950833 A1 7/2008
WO 2005018045 A1 2/2005

OTHER PUBLICATIONS

Extended European Search Report for EP10169439.6 dated Oct. 28, 2010.

Pentanova, Custom penta-band antenna, v. 7, May 7, 2008.

Combined 4-band GSM and W-CDMA 2100 Antenna; W3530 Datasheet version 1.0; Pulse Finland Oy, Sep. 2007.

* cited by examiner

Primary Examiner — Douglas W Owens

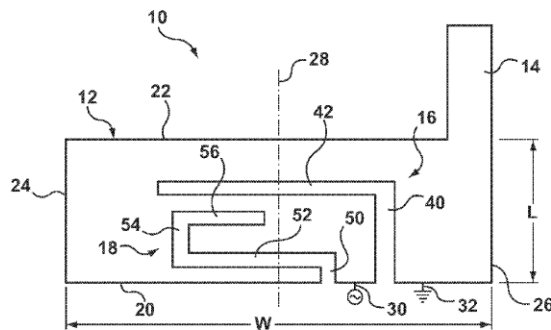
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(57) **ABSTRACT**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,906,680	B2 *	6/2005	Rawnick et al.	.....	343/846
6,992,628	B2 *	1/2006	Rawnick et al.	.....	343/700 MS
7,023,384	B2 *	4/2006	Brown et al.	.....	343/700 MS
7,084,828	B2 *	8/2006	Rawnick et al.	.....	343/846
8,350,770	B1 *	1/2013	Dawson	.....	343/761

OTHER PUBLICATIONS

Chang-Wook Baek, et al., A V-Band Micromachined 2-D Beam-Steering Antenna Driven by Magnetic Force With Polymer-Based Hinges, Journal: IEEE Transactions on Microwave Theory and Techniques, Jan. 2003, vol. 51, No. 1, pp. 325-331, IEEE Xplore, Published on the World Wide Web.

S. Befahy, et al., Stretchable helical gold conductor on silicone rubber microwire, Journal: Applied Physics Letters 91, 141911, Oct. 2007, pp. 1-3, American Institute of Physics, Published on the World Wide Web.

Dominique Brosteaux, et al., Design and Fabrication of Elastic Interconnections for Stretchable Electronic Circuits, Journal: IEEE Electron Device Letters, Jul. 2007, pp. 552-554, vol. 28, No. 7, IEEE Xplore, Published on the World Wide Web.

Shi Cheng, et al., Liquid metal stretchable unbalanced loop antenna, Journal: Applied Physics Letters 94, 144103, Apr. 2009, pp. 1-3, American Institute of Physics, Published on the World Wide Web.

Ryan C. Chiechi, et al., Eutectic Gallium-Indium (EGaln): A Moldable Liquid Metal for Electrical Characterization of Self-Assembled Monolayers, Journal: Angewandte Chemie Int. Ed., 2007, pp. 1-4, vol. 46, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

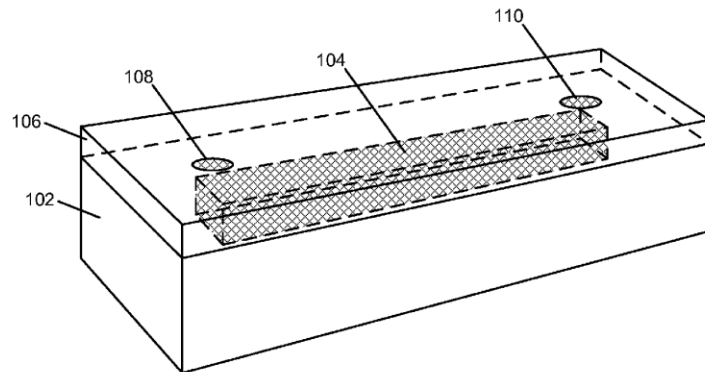
(Continued)

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(74) *Attorney, Agent, or Firm* — Jenkins, Wilson, Taylor & Hunt, P.A.

(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





US008587494B2

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

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

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

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H01Q 1/38 (2006.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,734,825 B1 * 5/2004 Guo et al. 343/700 MS
7,324,050 B2 * 1/2008 Chung et al. 343/700 MS
2007/0008224 A1 * 1/2007 Chung et al. 343/700 MS

FOREIGN PATENT DOCUMENTS

JP 2004172912 A 6/2004
JP 2006197254 A 7/2006
JP 2007123982 A1 5/2007

OTHER PUBLICATIONS

International Search Report issued on Nov. 13, 2009 from International Application No. PCT/KR2009/001608.
Wang, Hanyang et al. 'Input Impedance-Tuning Slots of PIFA Antennas' In: Proceedings of 2nd European Conference on Antennas and Propagation, Nov. 11-16, 2007, Edinburgh, UK, pp. 1-4.

* cited by examiner

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(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

