



US008169373B2

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

(10) **Patent No.:** **US 8,169,373 B2**
(45) **Date of Patent:** **May 1, 2012**

(54) **ANTENNAS WITH TUNING STRUCTURE
FOR HANDHELD DEVICES**

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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 853 days.

(21) Appl. No.: **12/205,829**

(22) Filed: **Sep. 5, 2008**

(65) **Prior Publication Data**

US 2010/0060529 A1 Mar. 11, 2010

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

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

(58) **Field of Classification Search** **343/700,**
343/702, 846

See application file for complete search history.

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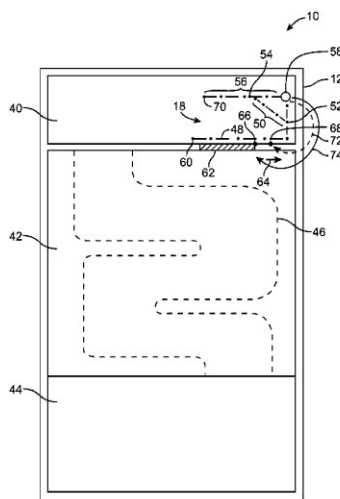
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

Handheld electronic devices are provided that contain wire-
less communications circuitry. The wireless communications
circuitry may include antenna structures. To accommodate
manufacturing variations, the antenna structures and hand-
held electronic devices may be characterized by performing
measurements such as antenna performance measurements.
Appropriate antenna adjustments may be made during manu-
facturing of a handheld electronic device based on the char-
acterizing measurements. An antenna may be formed using
an inverted-F design in which an antenna flex circuit is
mounted to a dielectric antenna support structure. Cavities in
the support may be selectively filled with dielectric material
and dielectric patches may be added to the antenna flex circuit
to adjust the dielectric loading of the antenna. The length of a
ground return path in the antenna may be adjusted by appro-
priate positioning of an electrical connector within the ground
return path.

27 Claims, 19 Drawing Sheets



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US008169374B2

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

(10) **Patent No.:** **US 8,169,374 B2**
(45) **Date of Patent:** **May 1, 2012**

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

(75) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Campbell, CA (US);
Ruben Caballero, San Jose, CA (US)

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

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

(21) Appl. No.: **13/083,487**

(22) Filed: **Apr. 8, 2011**

(65) **Prior Publication Data**
US 2011/0183721 A1 Jul. 28, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/941,006, filed on Nov. 5, 2010, now Pat. No. 7,924,231, which is a continuation of application No. 12/564,803, filed on Sep. 22, 2009, now Pat. No. 7,843,396, which is a continuation of application No. 11/821,192, filed on Jun. 21, 2007, now Pat. No. 7,612,725.

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

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

(58) **Field of Classification Search** 343/700,
343/702, 829, 846
See application file for complete search history.

(56) **References Cited**

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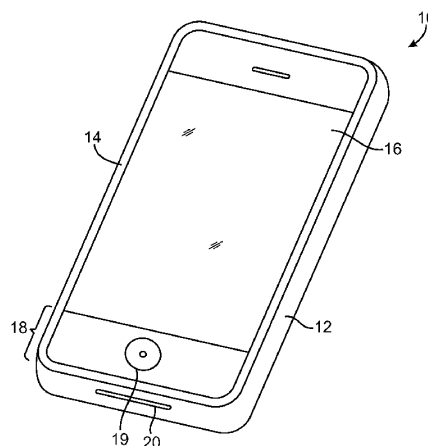
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A handheld electronic device may be provided that contains wireless communications circuitry. The handheld electronic device may have a housing and a display. The display may be attached to the housing using a conductive bezel. The handheld electronic device may have one or more antennas for supporting wireless communications. A ground plane in the handheld electronic device may serve as ground for one or more of the antennas. The ground plane and bezel may define an opening. A rectangular slot antenna or other suitable slot antenna may be formed from or within the opening. One or more antenna resonating elements may be formed above the slot. An electrical switch that bridges the slot may be used to modify the perimeter of the slot so as to tune the communications bands of the handheld electronic device.

20 Claims, 20 Drawing Sheets



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US008174390B2

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

(10) **Patent No.:** **US 8,174,390 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **RADIO FREQUENCY IDENTIFICATION TAG
AND ANTENNA FOR RADIO FREQUENCY
IDENTIFICATION TAG**

(75) Inventors: **Jeong Seok Kim**, Daejeon (KR); **Won
Kyu Choi**, Daejeon (KR); **Gil Young
Choi**, Daejeon (KR); **Cheol Sig Pyo**,
Daejeon (KR); **Jong-Suk Chae**, Daejeon
(KR)

(73) Assignee: **Electronics and Telecommunications
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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 959 days.

(21) Appl. No.: **12/176,757**

(22) Filed: **Jul. 21, 2008**

(65) **Prior Publication Data**
US 2009/0146820 A1 Jun. 11, 2009

(30) **Foreign Application Priority Data**
Dec. 6, 2007 (KR) 10-2007-0126292
Mar. 11, 2008 (KR) 10-2008-0022615

(51) **Int. Cl.**
G08B 13/14 (2006.01)
(52) **U.S. Cl.** **340/572.7; 343/700 MS**
(58) **Field of Classification Search** **340/572.7,**
340/500, 540, 568.1, 572.1; 343/850, 852,
343/857, 860, 862
See application file for complete search history.

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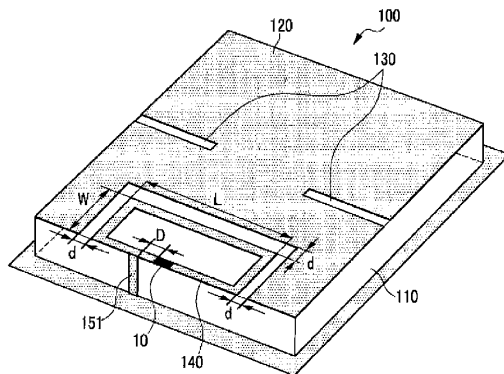
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Primary Examiner — Brian Zimmerman
Assistant Examiner — Sara Samson
(74) *Attorney, Agent, or Firm* — Kile Park Goekjian Reed &
McManus PLLC

(57) **ABSTRACT**

An RFID tag attached to an object and transmitting a signal
that corresponds to identification information includes an
RFID tag chip that modulates the signal according to the
identification information and an RFID tag antenna that trans-
mits the modulated signal. The RFID tag antenna includes a
dielectric material, a radiating patch, and a slit. The dielectric
material has a polyhedral shape and includes a first surface
that contacts the object and a second surface that is parallel
with the first surface, the radiating patch is formed on at least
a part of the second surface and radiates electromagnetic to
waves, and the slit is formed on at least a part of the radiating
patch to expose the dielectric material.

17 Claims, 5 Drawing Sheets



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US008174443B2

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

(10) **Patent No.:** **US 8,174,443 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **TRUE TIME DELAY SYSTEMS WITH ARRAY ANTENNA FOR THE SPATIALLY CHANGEABLE RADIATION PATTERN FOR MAXIMUM POWER ULTRA-WIDEBAND PULSES**

(75) Inventors: **Jung Markus**, Eicklingen (DE); **Jürgen Schmitz**, Gifhorn (DE); **Bernd Schünemann**, Bergen (DE); **Gerd-Walter Wollmann**, Celle (DE)

(73) Assignee: **Rheinmetal Waffe Munition GmbH**, Unterluss (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 204 days.

(21) Appl. No.: **12/677,084**

(22) PCT Filed: **Aug. 12, 2008**

(86) PCT No.: **PCT/EP2008/006639**

§ 371 (c)(1),
(2), (4) Date: **May 14, 2010**

(87) PCT Pub. No.: **WO2009/033541**

PCT Pub. Date: **Mar. 19, 2009**

(65) **Prior Publication Data**

US 2010/0277371 A1 Nov. 4, 2010

(30) **Foreign Application Priority Data**

Sep. 7, 2007 (DE) 10 2007 042 614

(51) **Int. Cl.**
H01Q 3/22 (2006.01)

(52) **U.S. Cl.** 342/375

(58) **Field of Classification Search** 342/375
See application file for complete search history.

(56) **References Cited**

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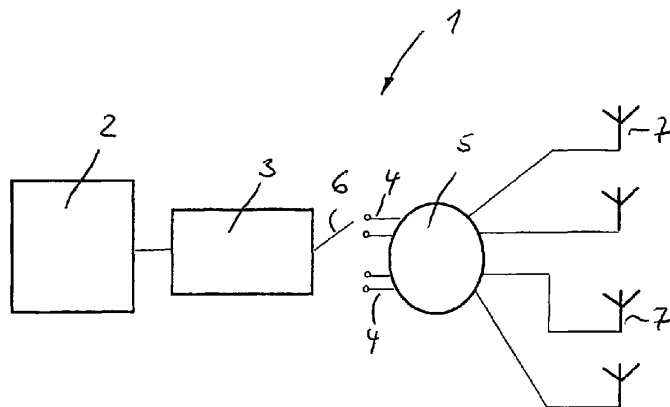
Primary Examiner — Harry Liu

(74) Attorney, Agent, or Firm — Griffin & Szipl, P.C.

(57) **ABSTRACT**

An HPEM module (1,10) is provided, wherein the output pulse or the trigger pulse is transmitted on a single input trigger pulse (Trigger 2, 11) with an intermediate TTD network (5, 14) in a phase-defined and time-defined manner independent of frequency depending on the selected input of the electromagnetic lens via the geometric form of the lens. The trigger signal defines the time point for the generation of an UWB pulse in the pulse generator (3, 16). The main lobe of an antenna array (1*n) of several antennae (7, 15) is thus altered in the same number of positions in a plane accordingly as the number of adjustable phase differences or time differences. For an m*n array the alignment of the antenna lobe is no longer restricted to the plane.

16 Claims, 1 Drawing Sheet



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US008174450B2

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

(10) **Patent No.:** **US 8,174,450 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **BROADBAND MICROPATCH ANTENNA SYSTEM WITH REDUCED SENSITIVITY TO MULTIPATH RECEPTION**

(75) Inventors: **Dmitry Tatarnikov**, Moscow (RU);
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Sergey Emelianov, Moscow (RU);
Anton Stepanenko, Dedovsk (RU)

(73) Assignee: **Topcon GPS, LLC**, Oakland, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 252 days.

(21) Appl. No.: **12/418,656**

(22) Filed: **Apr. 6, 2009**

(65) **Prior Publication Data**

US 2009/0273522 A1 Nov. 5, 2009

Related U.S. Application Data

(60) Provisional application No. 61/125,935, filed on Apr. 30, 2008.

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

(52) **U.S. Cl.** **343/700 MS**; 343/789; 343/846

(58) **Field of Classification Search** 343/700 MS,
343/789, 846
See application file for complete search history.

(56) **References Cited**

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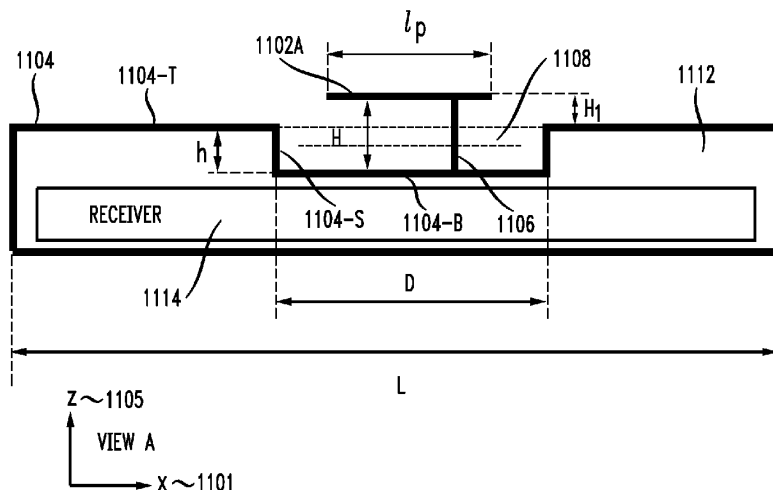
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Wolff & Samson PC

(57) **ABSTRACT**

A micropatch antenna system with simultaneous high bandwidth and low sensitivity to multipath radiation is achieved by positioning a radiating element within a cavity in a ground plane. Bandwidth and sensitivity to multipath radiation may be varied by varying the height of the radiating element above the bottom of the cavity and above the top of the ground plane. The electromagnetic and physical characteristics of the antenna system may be further controlled by introducing dielectric solids or wave-slowing structures between the bottom of the cavity and the radiating element. A dual-band micropatch antenna system with simultaneous high bandwidth and low sensitivity to multipath radiation may be similarly configured by stacking a second radiating element on top of the first radiating element.

24 Claims, 11 Drawing Sheets



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US008174452B2

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

(10) **Patent No.:** **US 8,174,452 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **CAVITY ANTENNA FOR WIRELESS
ELECTRONIC DEVICES**

(75) Inventors: **Enrique Ayala Vazquez**, Watsonville,
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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 391 days.

(21) Appl. No.: **12/238,384**

(22) Filed: **Sep. 25, 2008**

(65) **Prior Publication Data**

US 2010/0073241 A1 Mar. 25, 2010

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

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

(58) **Field of Classification Search** **343/702,**
343/700 MS, 895

See application file for complete search history.

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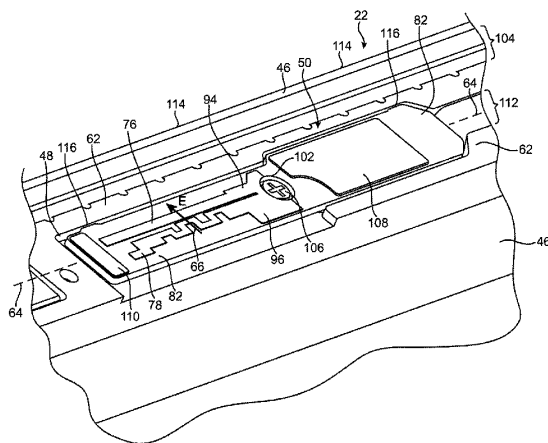
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

Wireless portable electronic devices such as laptop computers are provided with cavity-backed monopole antennas. A wireless device may have a housing. Conductive portions of the housing such as a conductive outer metal layer and internal frame structures may form a cavity having conductive walls. An antenna resonating element structure may be formed from monopole antenna resonating element arms of dissimilar lengths. One of the arms may be straight and another of the arms may be implemented using a meandering path. The antenna resonating element may be mounted over the cavity to form a cavity-backed monopole antenna. A display within the device may be covered by a cover glass. An opaque bezel region around the periphery of the cover glass may cover the antenna and block it from view. The antenna resonating element arms may run parallel to the longitudinal axis of the cavity.

19 Claims, 10 Drawing Sheets



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US008174453B2

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

(10) **Patent No.:** **US 8,174,453 B2**

(45) **Date of Patent:** **May 8, 2012**

(54) **FOLDER-TYPE MOBILE COMMUNICATION DEVICE**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Chao-An Lyu, Taipei Hsien (TW);
Cheng-Tse Lee, Taipei Hsien (TW)

(73) Assignee: **Acer Inc.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 259 days.

(21) Appl. No.: **12/726,388**

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

(65) **Prior Publication Data**

US 2011/0156970 A1 Jun. 30, 2011

(30) **Foreign Application Priority Data**

Dec. 24, 2009 (TW) 98144822 A

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

(52) **U.S. Cl.** 343/722; 343/702; 343/846

(58) **Field of Classification Search** 343/702,
343/722, 846, 700 MS
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

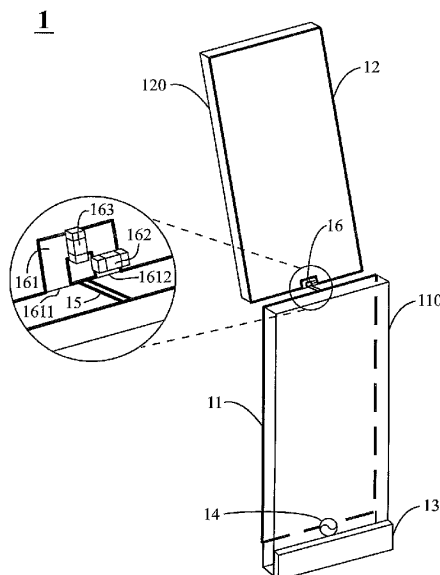
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath IP Lawfirm, PA

(57) **ABSTRACT**

The present invention is related to a folder-type mobile communication device. The device comprises a first dielectric substrate, a first ground plane disposed on the first dielectric substrate, a second dielectric substrate, a second ground plane disposed on the second dielectric substrate, an antenna element, a metal line, and a band-stop circuit. The antenna element is located near the first ground plane and is electrically connected to a source on the first dielectric substrate. The second ground plane is electrically connected to the first ground plane through the metal line. The band-stop circuit is located either on the first ground plane or on the second ground plane. The band-stop circuit includes a slit, a capacitive element, and an inductive element. The slit is near the metal line. The capacitive element is electrically connected to the two sides of the slit, and the inductive element is electrically connected to the two sides of the slit such that the inductive element and the capacitive element form a parallel LC resonant circuit. Therefore, the band-stop circuit generates a parallel resonance at a specified frequency.

10 Claims, 5 Drawing Sheets



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US008174454B2

(12) **United States Patent
Mayer**

(10) **Patent No.:** **US 8,174,454 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **DUAL-BAND ANTENNA**

(75) Inventor: **Lukas W. Mayer**, Vienna (AT)

(73) Assignee: **Infineon Technologies AG** (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1095 days.

(21) Appl. No.: **11/745,385**

(22) Filed: **May 7, 2007**

(65) **Prior Publication Data**

US 2008/0278391 A1 Nov. 13, 2008

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

(52) **U.S. Cl.** **343/725**; 343/728

(58) **Field of Classification Search** 343/767,
343/769, 895; 340/572.1

See application file for complete search history.

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Primary Examiner — Jacob Y Choi

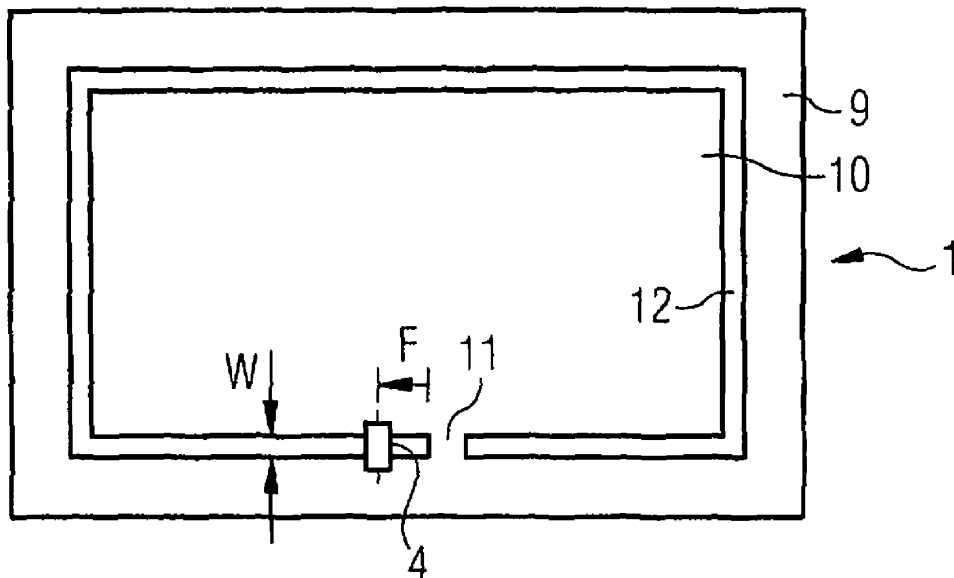
Assistant Examiner — Kyana R McCain

(74) *Attorney, Agent, or Firm* — Dickstein Shapiro LLP

(57) **ABSTRACT**

Dual-band antenna including a shorted loop slot antenna and a spiral antenna.

33 Claims, 3 Drawing Sheets



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US008174455B2

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

(10) **Patent No.:** **US 8,174,455 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **ANTENNA ELEMENT WITH IMPROVED RADIATION CHARACTERISTICS**

(75) Inventors: **Akira Miyoshi**, Tokyo (JP); **Kozo Shimizu**, Akita (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 241 days.

(21) Appl. No.: **12/477,379**

(22) Filed: **Jun. 3, 2009**

(65) **Prior Publication Data**

US 2009/0303143 A1 Dec. 10, 2009

(30) **Foreign Application Priority Data**

Jun. 4, 2008 (JP) P2008-147182

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 21/00 (2006.01)
(52) **U.S. Cl.** **343/728; 343/700 MS; 343/855**
(58) **Field of Classification Search** **343/700 MS, 343/728, 732, 855, 857, 743, 866**
See application file for complete search history.

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Primary Examiner — Jacob Y Choi

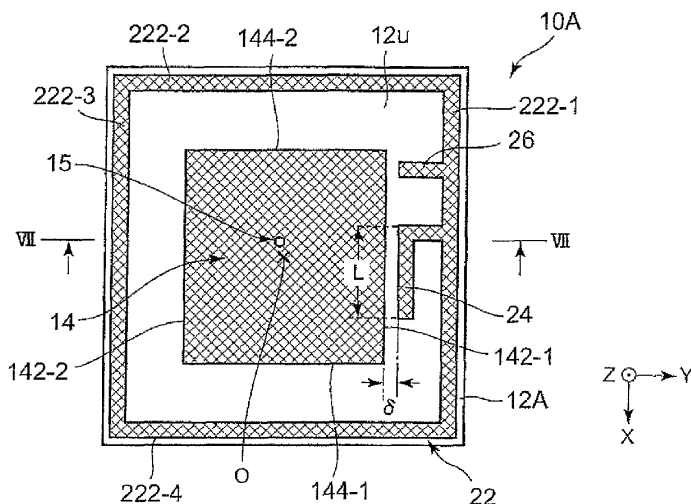
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Whitham Curtis Christofferson & Cook, PC

(57) **ABSTRACT**

An antenna element is disclosed. A substrate is made of dielectric material and has a first face. A first antenna element is made of conductive material and is provided on the first face. A first power feeding portion is made of conductive material and is disposed on the first antenna element. A second antenna element is made of conductive material, is provided on the first face, and forms a loop surrounding the first antenna element with a gap. A second power feeding portion is made of conductive material. The second power feeding portion is extended from the second antenna element toward the first antenna element and is arranged to form an electromagnetic coupling with the first antenna element. A perturbation element is made of conductive material and is extended from the second antenna element. A length of loop is twice a circumferential length of the first antenna element.

11 Claims, 6 Drawing Sheets



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US008174457B1

(12) **United States Patent**
Lam

(10) **Patent No.:** **US 8,174,457 B1**
(45) **Date of Patent:** **May 8, 2012**

(54) **BROADBAND TELEVISION ANTENNA**

(75) Inventor: **Alan M. L. Lam**, Hong Kong (HK)

(73) Assignee: **RadioShack, Corporation**, Fort Worth, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 668 days.

(21) Appl. No.: **12/358,316**

(22) Filed: **Jan. 23, 2009**

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

(52) **U.S. Cl.** **343/828**; 343/829; 343/846

(58) **Field of Classification Search** 343/702, 343/720, 825, 826, 828-830, 845, 846, 847
See application file for complete search history.

(56) **References Cited**

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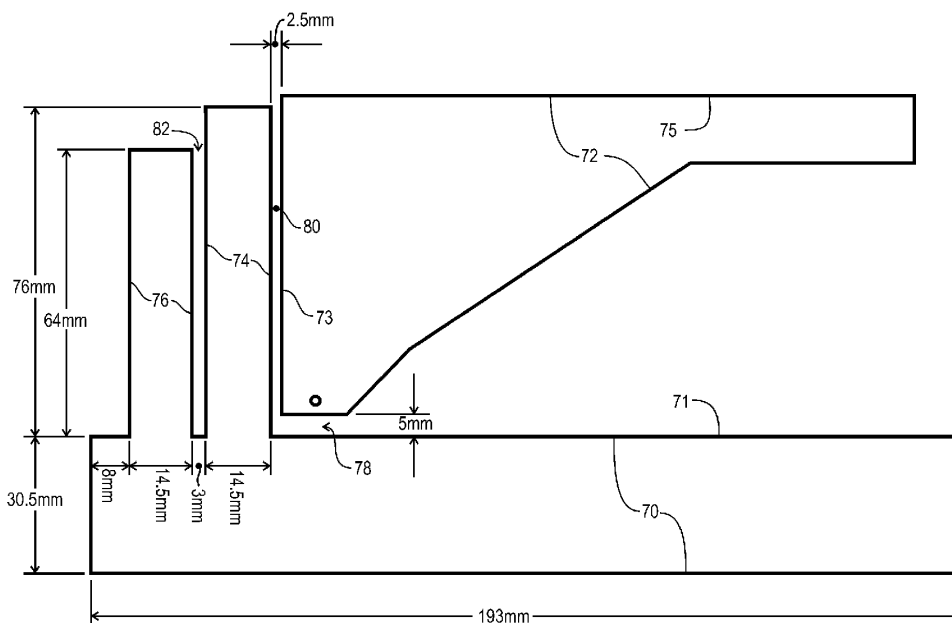
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Dan Brown Law Office; Daniel R. Brown

(57) **ABSTRACT**

A broadband antenna apparatus that is generally disposed along a plane. The antenna apparatus includes a ground plate with an edge and an inverted "L" antenna that has a base leg and an elongated leg, which define an interior corner. The interior corner is filled with a triangulated portion for broadening the bandwidth of the antenna. There is an antenna feed point at a distal end of the base leg. The antenna is oriented so that the distal end of the base leg is adjacent to the edge, forming a first dielectric gap therebetween, and further oriented with the elongated leg parallel to the edge. A first parasitic ground element extends from the edge and is positioned adjacent to the base leg, forming a second dielectric gap therebetween. The antenna apparatus also includes a second parasitic ground element extending from the edge of the ground plate.

28 Claims, 12 Drawing Sheets



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US008174458B2

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

(10) **Patent No.:** **US 8,174,458 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **DUAL-FEED ANTENNA**

(56) **References Cited**

(75) Inventors: **Jui-Hung Chou**, Taichung (TW);
Saou-Wen Su, Taipei (TW)

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(73) Assignees: **Silitek Electronics (Guangzhou) Co., Ltd.**, Guangzhou (CN); **Lite-On Technology Corporation**, 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 451 days.

(21) Appl. No.: **12/574,034**

Primary Examiner — Huedung Mancuso

(22) Filed: **Oct. 6, 2009**

(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(65) **Prior Publication Data**

US 2010/0265151 A1 Oct. 21, 2010

(57) **ABSTRACT**

The invention relates to a dual-feed antenna. The dual-feed antenna includes a substrate, a first antenna unit and a second antenna unit. The second antenna unit includes a second radiating unit and a second grounding unit. The second radiating unit includes a second radiator which has a first groove. The first groove has a first bottom and a pair of first arms. The second grounding unit includes a first sub-grounding-area and a second sub-grounding-area. The second sub-grounding-area has a second groove which includes a second bottom and a pair of second arms. The first sub-grounding-area is cross-wise connected with the second sub-grounding-area at the bottom of the groove, and the second arms symmetrically distribute to both sides of the first sub-grounding-area, and the first groove has an opening direction opposite to the opening direction of the second groove.

(30) **Foreign Application Priority Data**

Apr. 16, 2009 (CN) 2009 1 0038776

(51) **Int. Cl.**

H01Q 5/00 (2006.01)

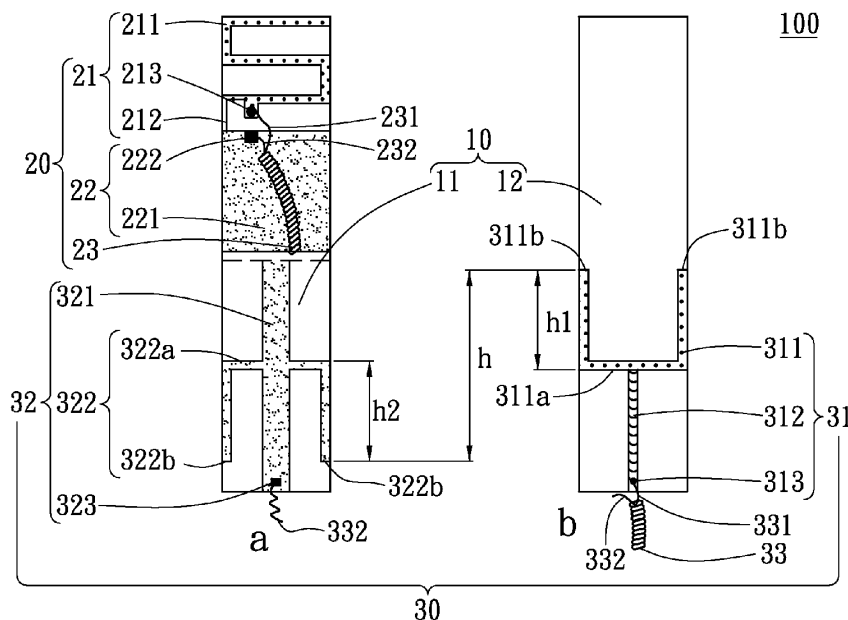
H01Q 21/00 (2006.01)

H01Q 1/48 (2006.01)

(52) **U.S. Cl.** **343/843**; 343/893; 343/846

(58) **Field of Classification Search** 343/843, 343/893, 846, 702, 700 MS, 848, 829
See application file for complete search history.

20 Claims, 9 Drawing Sheets



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US008174459B2

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

(10) **Patent No.:** **US 8,174,459 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **COPLANAR ANTENNA UNIT AND
COPLANAR ANTENNA**

(75) Inventors: **Fu-Chiarng Chen**, Hsinchu (TW);
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(73) Assignee: **National Chiao Tung University**,
Hsinchu (TW)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 440 days.

(21) Appl. No.: **12/603,845**

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

(65) **Prior Publication Data**
US 2011/0037675 A1 Feb. 17, 2011

(30) **Foreign Application Priority Data**
Aug. 14, 2009 (TW) 98127509 A

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)
(52) **U.S. Cl.** **343/848**; 343/700 MS; 343/846;
343/845
(58) **Field of Classification Search** 343/847-9
See application file for complete search history.

(56) **References Cited**

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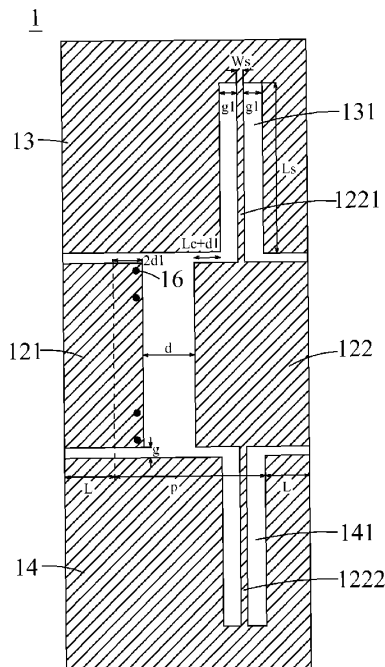
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Primary Examiner — Douglas W Owens
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — WPAT, P.C.; Anthony King

(57) **ABSTRACT**

The present invention is related to a coplanar antenna unit and a coplanar antenna. By utilizing the unique properties of meta-material to design 1-D balanced CRLH leaky-wave antenna. The antenna can be realized with the coplanar antenna unit consisting of MIM capacitor and grounded inductor. In this invention, all proposed elements are implemented by planar print circuit board, so the full-space switched beam scanning antenna has shorter length of leaky-wave antenna and good radiation performance.

22 Claims, 8 Drawing Sheets



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US008174460B2

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

(10) **Patent No.:** **US 8,174,460 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **VARIABLE ANTENNA MATCHING
NETWORK FOR AN IMPLANTABLE
ANTENNA**

(75) Inventors: **Dennis E. Larson**, White Bear Lake,
MN (US); **Prashant Rawat**, Blaine, MN
(US); **Daniel Kollmann**, Andover, MN
(US)

(73) Assignee: **Cardiac Pacemakers, Inc.**, St. Paul,
MN (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 951 days.

(21) Appl. No.: **12/182,964**

(22) Filed: **Jul. 30, 2008**

(65) **Prior Publication Data**
US 2008/0288028 A1 Nov. 20, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/668,622, filed on
Jan. 30, 2007, now Pat. No. 7,409,245.

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

(52) **U.S. Cl.** **343/861**; 343/860; 607/36; 607/60

(58) **Field of Classification Search** 343/850,
343/860, 861; 607/36, 60, 61
See application file for complete search history.

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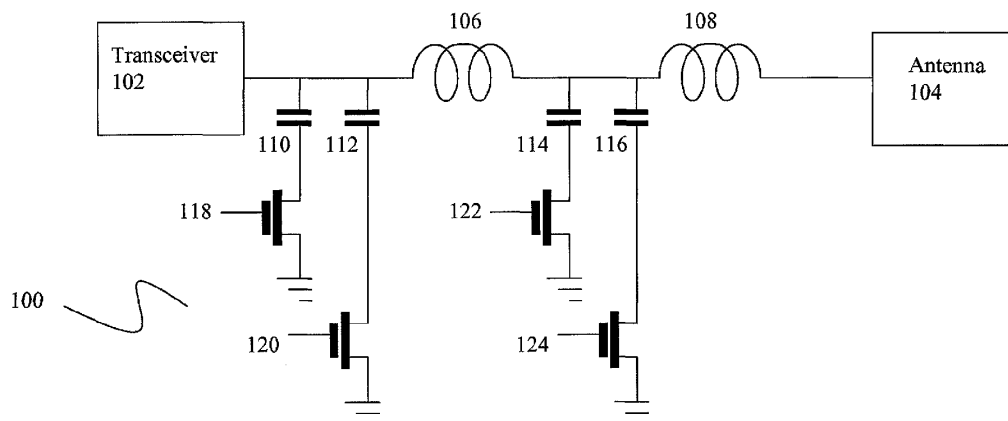
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Schwegman, Lundberg &
Woessner, P.A.

(57) **ABSTRACT**

An implantable medical device can include an implantable antenna for communication with external devices or other internal devices. Changes in the patient's body position, weight, composition or other factors may change the efficiency of the implantable antenna and hinder communication. The disclosed circuit can calculate a value for a matching network for an implantable telemetry circuit to decrease an impedance difference between the implantable telemetry circuit and the implantable antenna or increase or maximize a communication power transfer value associated with the implantable medical device.

21 Claims, 3 Drawing Sheets



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US008175524B2

(12) **United States Patent**
Sathath

(10) **Patent No.:** **US 8,175,524 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **INFORMATION PROCESSING APPARATUS
HAVING A SHARED ANTENNA ELEMENT**

(75) Inventor: **Anwar Sathath, Ome (JP)**

(73) Assignee: **Kabushiki Kaisha Toshiba, Tokyo (JP)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 690 days.

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(21) Appl. No.: **11/787,465**

(22) Filed: **Apr. 16, 2007**

(65) **Prior Publication Data**

US 2007/0275660 A1 Nov. 29, 2007

(30) **Foreign Application Priority Data**

May 29, 2006 (JP) 2006-148472

(51) **Int. Cl.**
H04B 7/14 (2006.01)

(52) **U.S. Cl.** **455/19; 455/82; 455/269; 455/13.4;**
370/297; 370/302

(58) **Field of Classification Search** 455/13.4,
455/19, 82, 83, 269, 280; 370/297, 302;
343/702; 333/126

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Kamran Afshar

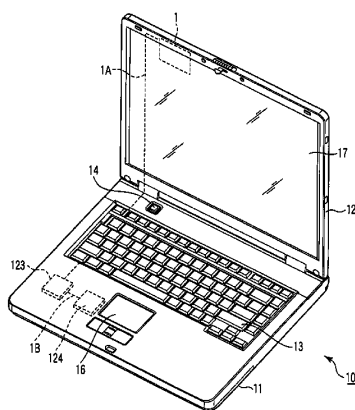
Assistant Examiner — Marisol Fahnert

(74) *Attorney, Agent, or Firm* — Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

According to one embodiment, an information processing apparatus includes an antenna element, a first wireless communication module including a printed circuit board and a wireless communication circuit which is provided on the printed circuit board, and a second wireless communication module. A diplexer is provided on the printed circuit board of the first wireless communication module, and includes a first terminal which is connected to the antenna element via a first antenna connector provided on the printed circuit board and a first cable, a second terminal which is connected to the wireless communication circuit via a wiring pattern on the printed circuit board, and a third terminal which is connected to a second antenna connector provided on the printed circuit board. The second wireless communication module is connected to the second antenna connector via a second cable.

12 Claims, 5 Drawing Sheets



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(12) **United States Patent**
Nissinen

- (54) **DUAL ANTENNA APPARATUS AND METHODS**
- (75) Inventor: **Pertti Nissinen**, Kempele (FI)
- (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 852 days.

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- (21) Appl. No.: 12/009,009
(22) Filed: Jan. 15, 2008

(65) **Prior Publication Data**

US 2008/0204328 A1 Aug. 28, 2008

(30) **Foreign Application Priority Data**

Sep. 28, 2007 (FI) 20075687

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

(52) **U.S. Cl.** 343/700 MS
(58) **Field of Classification Search** 343/700 MS,
343/702, 829, 846
See application file for complete search history.

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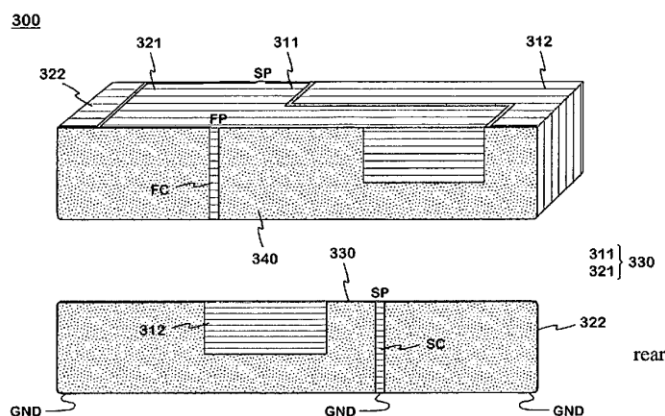
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

A dielectric dual antenna apparatus intended for applications such as small-sized radio frequency devices. The dual antenna comprises a first partial antenna which implements the lower operating band of the antenna and another partial antenna implementing the upper operating band. The partial antennas have a shared substrate, which together with the radiators constitutes an integrated antenna component. The matching of the dual antenna can be improved in either operating band without degrading it in the other operating band at the same time. Methods of operating the aforementioned apparatus are also disclosed.

41 Claims, 6 Drawing Sheets



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US008179323B2

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

(10) **Patent No.:** **US 8,179,323 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **LOW COST INTEGRATED ANTENNA
ASSEMBLY AND METHODS FOR
FABRICATION THEREOF**

(75) Inventors: **Jeffrey Shamblin**, San Marcos, CA
(US); **Laurent Desclos**, San Diego, CA
(US); **Mark Krier**, San Diego, CA (US)

(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 386 days.

(21) Appl. No.: **12/337,639**

(22) Filed: **Dec. 18, 2008**

(65) **Prior Publication Data**

US 2009/0231206 A1 Sep. 17, 2009

Related U.S. Application Data

(60) Provisional application No. 61/037,298, filed on Mar.
17, 2008.

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/824;
343/893; 343/895; 235/462.45

(58) **Field of Classification Search** 343/700 MS,
343/824, 829, 846, 853, 893, 702, 895; 235/462.45
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

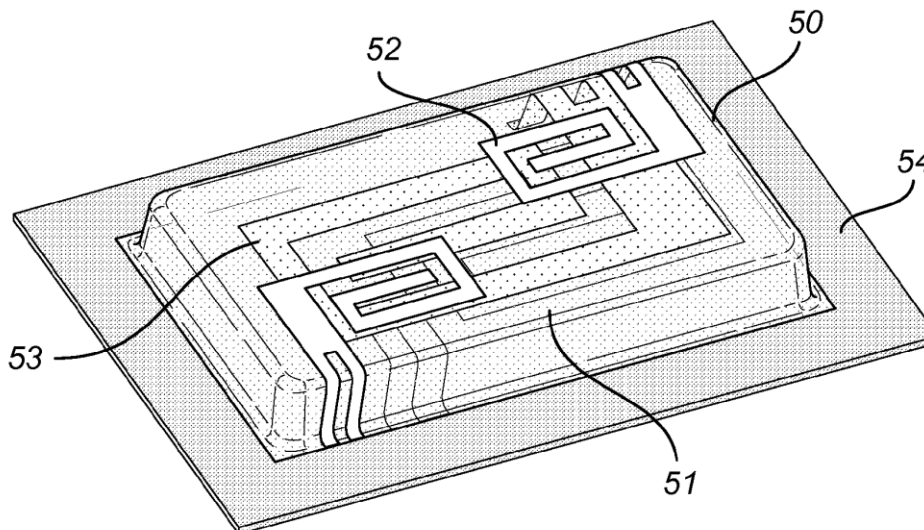
Assistant Examiner — Chuc Tran

(74) *Attorney, Agent, or Firm* — Costal Patent Agency

(57) **ABSTRACT**

A conductive layer is applied to a thermoformed plastic component to form an integrated antenna assembly. The conductive layer is on a flexible layer and adhered or attached to the rigid thermoformed plastic carrier. Features are designed into the thermoformed plastic carrier to provide electrical contacts from the conductive layer to the circuit board of the communication device and to mechanically attach the carrier to the circuit board. Multiple conductive layers can be applied to a multi-layered thermoformed structure to form a multi-antenna assembly.

16 Claims, 9 Drawing Sheets



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US008179324B2

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

(10) **Patent No.:** **US 8,179,324 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **MULTIPLE INPUT, MULTIPLE OUTPUT
ANTENNA FOR HANDHELD
COMMUNICATION DEVICES**

(75) Inventors: **Qinjiang Rao**, Waterloo (CA); **Dong Wang**, Waterloo (CA)

(73) Assignee: **Research In Motion Limited**, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

(21) Appl. No.: **12/364,932**

(22) Filed: **Feb. 3, 2009**

(65) **Prior Publication Data**
US 2010/0194642 A1 Aug. 5, 2010

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/845;
343/846; 343/848; 343/893

(58) **Field of Classification Search** 343/700 MS,
343/702, 845-846, 848, 893, 914
See application file for complete search history.

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Primary Examiner — Jacob Y Choi

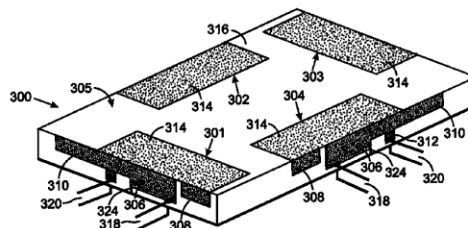
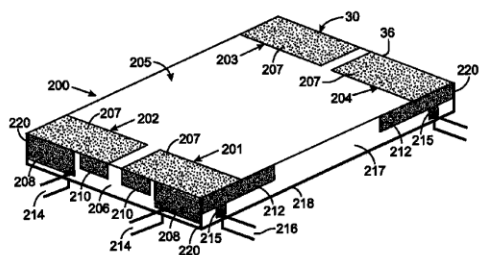
Assistant Examiner — Shawn Buchanan

(74) *Attorney, Agent, or Firm* — Hamilton & Terrile, LLP; Stephen A. Terrile

(57) **ABSTRACT**

An antenna assembly for a mobile wireless communication device has a support with a first surface and a second surface between which a third surface and a fourth surface extend. A conductive ground plane is formed on the second surface. An antenna includes an electrically conductive patch located on the first surface, and first and second electrically conductive legs and an electrically conductive stripe all abutting the patch. In one version the first and second legs and the stripe are all on the third surface. In another version the first and second legs are on the third surface and the strip is on the fourth surface that is orthogonal to the third surface. A first signal port is adapted to apply a first signal to the first leg and a second signal port is adapted to apply a second signal to the third leg.

20 Claims, 4 Drawing Sheets



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US008179325B2

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

(10) **Patent No.:** **US 8,179,325 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **PLANAR TRIPOLAR ANTENNA**

(76) Inventors: **David J. Edwards**, Oxfordshire (GB);
Tong Hao, Oxfordshire (GB); **Wasim Q Malik**, Oxfordshire (GB); **Christopher J. Stevens**, Oxfordshire (GB)

(*) 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.: **12/521,595**

(22) PCT Filed: **Jan. 2, 2008**

(86) PCT No.: **PCT/GB2008/050004**

§ 371 (c)(1),
(2), (4) Date: **Sep. 15, 2010**

(87) PCT Pub. No.: **WO2008/081200**

PCT Pub. Date: **Jul. 10, 2008**

(65) **Prior Publication Data**

US 2011/0006960 A1 Jan. 13, 2011

(30) **Foreign Application Priority Data**

Jan. 6, 2007 (GB) 0700218.1

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

(52) **U.S. Cl.** **343/700 MS**; 343/725; 343/795

(58) **Field of Classification Search** 343/700,
343/725, 727, 795
See application file for complete search history.

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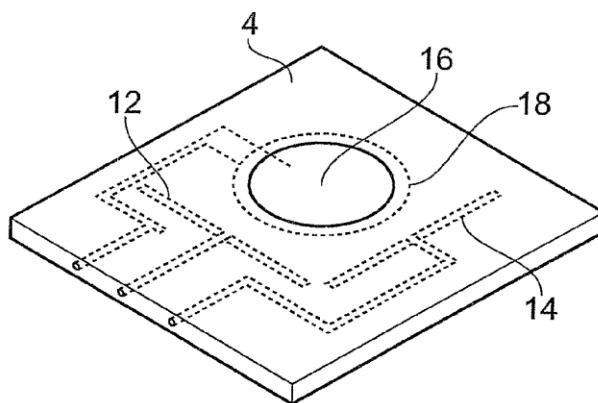
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec, P.A.

(57) **ABSTRACT**

A tripolar antenna is described having at least two electromagnetic signal transmitting/receiving elements arranged such that their axes of signal transmission/reception sensitivity are not parallel, wherein said elements are provided on or at least partially in a substrate of dielectric material so portions of said at least two elements are coplanar and dielectrically isolated from one another. In a preferred arrangement, two dipoles are provided on the substrate in perpendicular orientation and in the plane containing of the surface of said dielectric material. Most preferably a further third element is provided so as to render the antenna tripolar, said third element comprising a first circular disk element secured to an upper surface of the dielectric material, and a second slightly larger circular disk element, concentrically positioned on the corresponding opposite and lower surface of the dielectric.

14 Claims, 3 Drawing Sheets



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US008180412B2

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

(10) **Patent No.:** **US 8,180,412 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE HAVING FREQUENCY SELECTIVE
GROUNDING AND RELATED METHOD**

(75) Inventors: **Joshua Kwan Ho Wong**, Waterloo
(CA); **Adrian M. Cooke**, Kitchener
(CA)

(73) Assignee: **Research In Motion 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 58 days.

(21) Appl. No.: **12/868,763**

(22) Filed: **Aug. 26, 2010**

(65) **Prior Publication Data**

US 2012/0052916 A1 Mar. 1, 2012

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

(52) **U.S. Cl.** **455/575.1**; 455/114.1; 455/347;
455/550.1

(58) **Field of Classification Search** 455/575.1,
455/550.1; 361/56

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Vladimir Magloire

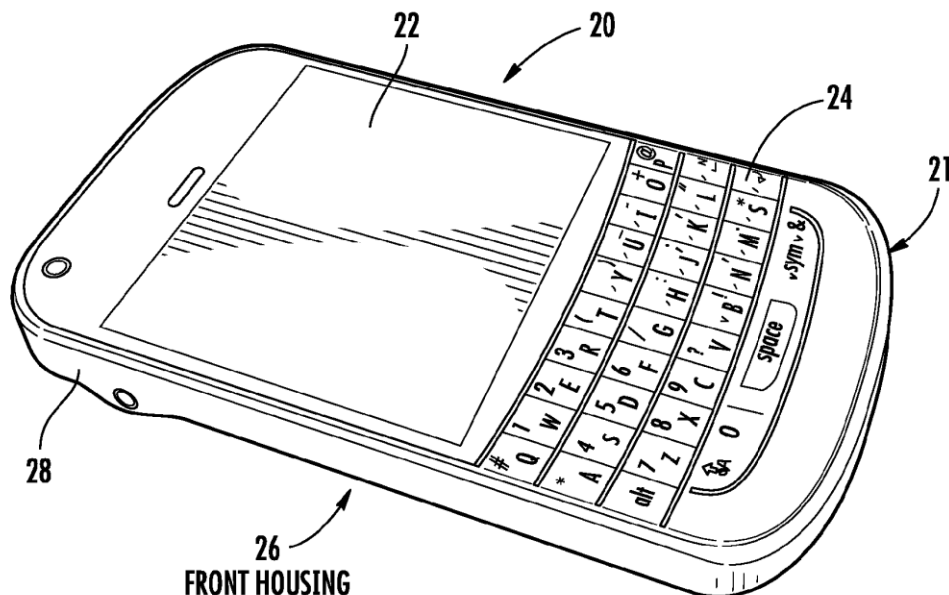
Assistant Examiner — Gerald Johnson

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

(57) **ABSTRACT**

A mobile wireless communications device includes a portable housing having a metallic front housing forming a peripheral sidewall as a metallic ring. A circuit board is carried by the portable housing and forms a chassis ground plane. A wireless communications circuit is carried by a circuit board. An antenna circuit is carried by a circuit board and connected to the wireless communications circuit. A frequency selective grounding circuit is positioned at a selected grounding location at the chassis ground plane and metallic front housing and forms a harmonic trap that responds to a specific range of frequencies.

24 Claims, 13 Drawing Sheets



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US008180414B2

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

(10) **Patent No.:** **US 8,180,414 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **PORTABLE RADIO DEVICE**

(56) **References Cited**

(75) Inventors: **Hiroyuki Uejima**, Sendai (JP); **Shingo Sumi**, Sendai (JP); **Hideki Hayama**, Yokohama (JP); **Haruhiko Kakitsu**, Sendai (JP); **Yukari Yamazaki**, Sendai (JP)

(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 135 days.

(21) Appl. No.: **12/681,370**

(22) PCT Filed: **Sep. 30, 2008**

(86) PCT No.: **PCT/JP2008/002747**

§ 371 (c)(1),

(2), (4) Date: **Apr. 1, 2010**

(87) PCT Pub. No.: **WO2009/057247**

PCT Pub. Date: **May 7, 2009**

(65) **Prior Publication Data**

US 2010/0240424 A1 Sep. 23, 2010

(30) **Foreign Application Priority Data**

Oct. 31, 2007 (JP) 2007-283437
Jun. 10, 2008 (JP) 2008-151977

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

(52) **U.S. Cl.** **455/575.3**; 455/575.1; 455/575.7;
343/702; 343/893

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

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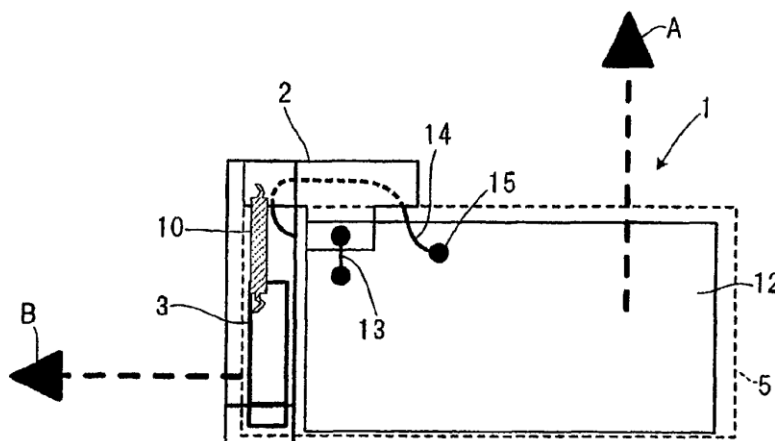
Primary Examiner — Tuan H Nguyen

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

(57) **ABSTRACT**

There is adopted an enclosure dipole antenna structure including antenna elements respectively provided in a lower enclosure and an upper enclosure. There is also adopted a structure in which the lower structure and the upper structure are rotatably joined together along two axes of hinges. The enclosures thereby become openable and closable in two directions including a vertical direction and a horizontal direction. There can be implemented high antenna performance without use of an external antenna even regardless of whether the enclosures are opened in the vertical direction or the horizontal direction. A feeding section and a connection section are separated from each other by a distance of $\frac{1}{20}$ or more of a wavelength corresponding to an operating frequency. Power can well be fed to the antenna elements.

7 Claims, 8 Drawing Sheets



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US008184054B2

(12) **United States Patent**
Tsujimura

(10) **Patent No.:** **US 8,184,054 B2**
(45) **Date of Patent:** **May 22, 2012**

(54) **PORTABLE TERMINAL AND BUILT-IN ANTENNA**

(75) Inventor: **Akihiro Tsujimura**, Kokubunji (JP)

(73) Assignee: **Kabushiki Kaisha Toshiba**, Tokyo (JP)

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

(21) Appl. No.: **12/512,240**

(22) Filed: **Jul. 30, 2009**

(65) **Prior Publication Data**

US 2010/0149047 A1 Jun. 17, 2010

(30) **Foreign Application Priority Data**

Dec. 12, 2008 (JP) 2008-317006

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

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

(58) **Field of Classification Search** **343/700 MS, 343/702**

See application file for complete search history.

(56) **References Cited**

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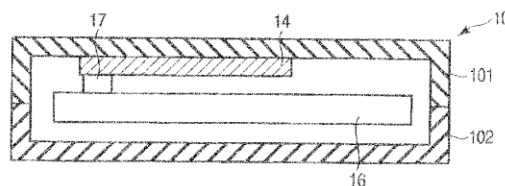
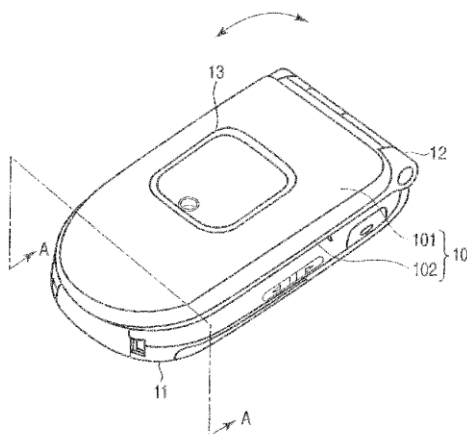
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A portable terminal includes a non-conductive resin chassis that is formed by molding a molding material and internally provided with a printed circuit board on which a wireless circuit is formed, and an antenna pattern that is disposed on a wall surface of the chassis and in a region excluding a eject pin track formed when the chassis electrically connected with the printed circuit board is formed, wherein the antenna pattern is constituted by sequentially laminating a copper layer, a nickel layer and a gold layer by electroless plating, and the nickel layer is rendered amorphous.

18 Claims, 6 Drawing Sheets



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US008184063B2

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

(10) **Patent No.:** **US 8,184,063 B2**

(45) **Date of Patent:** ***May 22, 2012**

(54) **BALANCED DIPOLE ANTENNA**

(75) Inventors: **Yihong Qi**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Paul Dullaert**, Kitchener (CA)

(73) Assignee: **Research In Motion Limited**, Waterloo (CA)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/544,657**

(22) Filed: **Aug. 20, 2009**

(65) **Prior Publication Data**

US 2009/0315800 A1 Dec. 24, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/725,733, filed on Mar. 20, 2007, now Pat. No. 7,586,457, which is a continuation of application No. 10/984,699, filed on Nov. 9, 2004, now Pat. No. 7,193,579.

(51) **Int. Cl.**
H01Q 9/16 (2006.01)

(52) **U.S. Cl.** **343/821**; 343/793; 343/820

(58) **Field of Classification Search** 343/793, 343/795, 820, 821, 822, 823
See application file for complete search history.

(56) **References Cited**

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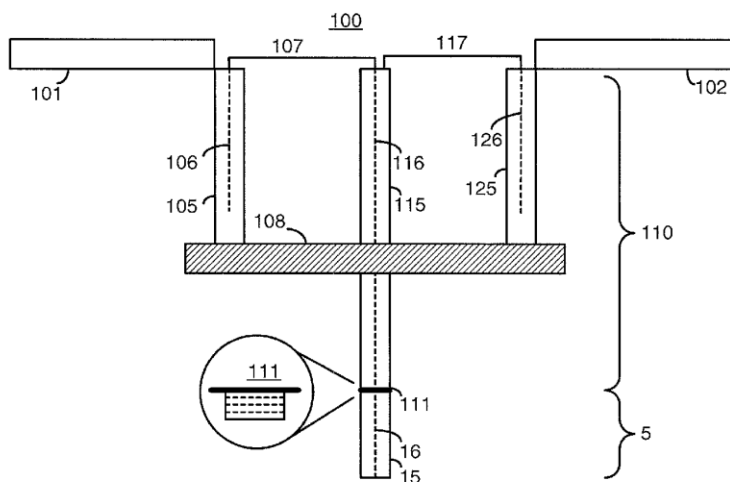
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Ridout & Maybee LLP

(57) **ABSTRACT**

A balanced dipole antenna, comprising: a left dipole arm having a center end, a right dipole arm having a center end, a coaxial cable having an outer conductor and a single inner conductor and a top end electrically located between the center ends of the left and right dipole arms, a left stub coupling the left dipole arm and the coaxial cable, and a right stub coupling the right dipole arm and the coaxial cable, wherein the inner conductor of the coaxial cable is connected to one of the left and right dipole arms, and the outer conductor of the coaxial cable is connected to the other of the left and right dipole arms.

18 Claims, 4 Drawing Sheets



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US008185061B2

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

(10) **Patent No.:** **US 8,185,061 B2**
(45) **Date of Patent:** **May 22, 2012**

(54) **WIRELESS TERMINAL WITH FREQUENCY SWITCHING CIRCUITS FOR CONTROLLING AN OPERATING FREQUENCY**

(75) Inventors: **Koichi Sato**, Tachikawa (JP); **Satoshi Mizoguchi**, Ome (JP); **Isao Ohba**, Hachioji (JP)

(73) Assignee: **Kabushiki Kaisha Toshiba**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 249 days.

(21) Appl. No.: **12/724,669**

(22) Filed: **Mar. 16, 2010**

(65) **Prior Publication Data**

US 2011/0070843 A1 Mar. 24, 2011

(30) **Foreign Application Priority Data**

Sep. 24, 2009 (JP) 2009-218701

(51) **Int. Cl.**

H04B 1/40 (2006.01)

H04B 1/00 (2006.01)

H04B 15/00 (2006.01)

H04B 1/44 (2006.01)

H04B 1/18 (2006.01)

H04M 1/00 (2006.01)

G06F 3/033 (2006.01)

(52) **U.S. Cl.** **455/75**; 455/63.3; 455/78; 455/83; 455/192.1; 455/575.5; 455/130

(58) **Field of Classification Search** 455/78, 455/83, 63.3, 75, 182.1, 192.1, 82, 130, 575.5
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Temesgh Ghebretinsae

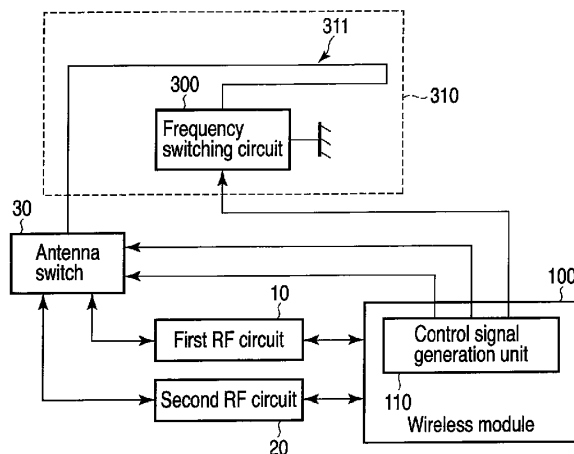
Assistant Examiner — Devan Sandiford

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

(57) **ABSTRACT**

A wireless terminal includes an antenna which comprises an antenna element and at least one frequency switching circuit to control an operating frequency of the antenna element in accordance with a frequency control signal, a plurality of RF circuits to perform an RF signal processing, an antenna switch to connect the antenna to one of the plurality of RF circuits in accordance with a connection control signal, and a generation unit configured to generate the frequency control signal and the connection control signal in accordance with switching between a plurality of wireless communication systems or switching between transmission and reception.

4 Claims, 7 Drawing Sheets



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US008185166B2

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

(10) **Patent No.:** **US 8,185,166 B2**

(45) **Date of Patent:** **May 22, 2012**

(54) **THERMAL SPRAY COATING FOR
SEAMLESS AND RADIO-TRANSPARENT
ELECTRONIC DEVICE HOUSING**

(75) Inventors: **Douglas Weber**, Arcadia, CA (US);
Naoto Matsuyuki, Okazaki (JP); **David**
A. Pakula, San Francisco, CA (US);
Evans Hankey, San Francisco, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 552 days.

(21) Appl. No.: **12/343,335**

(22) Filed: **Dec. 23, 2008**

(65) **Prior Publication Data**

US 2010/0103612 A1 Apr. 29, 2010

Related U.S. Application Data

(60) Provisional application No. 61/108,460, filed on Oct.
24, 2008.

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

(52) **U.S. Cl.** **455/575.1**; 455/575.7; 455/575.8;
361/679.56; 361/705; 361/807; 361/815

(58) **Field of Classification Search** 455/575.1,
455/575.5, 575.7, 575.8
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Kent Chang

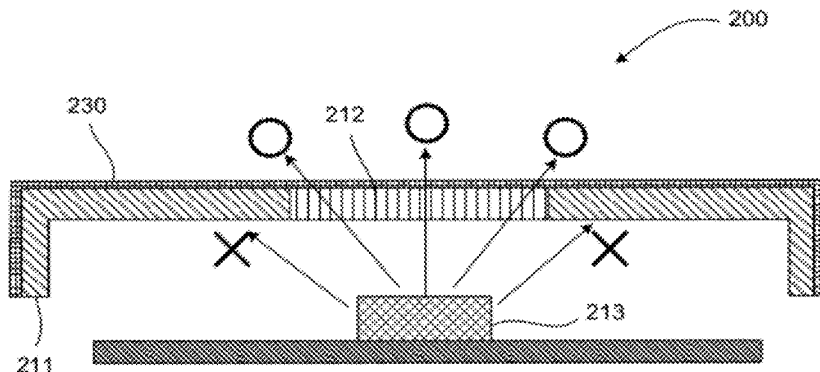
Assistant Examiner — Magdi Elhag

(74) *Attorney, Agent, or Firm* — Beyer Law Group LLP

(57) **ABSTRACT**

Electronic devices and other apparatuses adapted to receive
electromagnetic wave communications are disclosed. An
outer housing encloses various device components, including
at least an internal antenna located fully therewithin and
adapted to receive/send communications from/to an outside
source via RF or other electromagnetic waves. A ceramic
coating can be a thermal spray coating that covers at least a
portion of the outer surface proximate to the internal antenna,
and can be "RF transparent"—adapted to allow communica-
tions to/from the internal antenna via electromagnetic waves.
The outer housing can be plastic, metal or a combination
thereof. For metal or other non-RF transparent housings, an
RF-transparent insert can be fitted into a window in the hous-
ing to permit communications to the internal antenna. The
ceramic coating covers some or all of the metal, plastic and/or
insert that comprise the outer housing and surface for a final
aesthetic finish to the device.

27 Claims, 4 Drawing Sheets



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US008188925B2

(12) **United States Patent**
DeJean

(10) **Patent No.:** **US 8,188,925 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **BENT MONOPOLE ANTENNA WITH SHARED SEGMENTS**

(75) Inventor: **Gerald R. DeJean**, Redmond, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 413 days.

(21) Appl. No.: **12/267,480**

(22) Filed: **Nov. 7, 2008**

(65) **Prior Publication Data**

US 2010/0117909 A1 May 13, 2010

(51) **Int. Cl.**
H01Q 5/00 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/893**

(58) **Field of Classification Search** **343/702, 343/700 MS, 793, 893**

See application file for complete search history.

(56) **References Cited**

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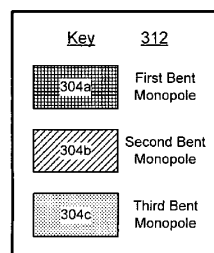
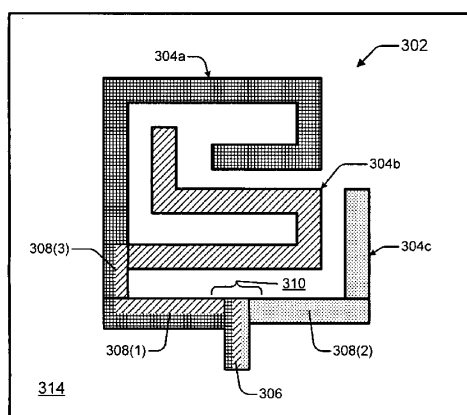
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Joseph R. Kelly; Westman, Champlin & Kelly, P.A.

(57) **ABSTRACT**

A bent monopole antenna with shared segments is capable of tri-band communication. In an example embodiment, an antenna assembly includes a substrate, a first bent monopole, a second bent monopole, and a third bent monopole. The first, second, and third bent monopoles are disposed on the substrate. The first bent monopole includes a feedline segment and a first segment. The second bent monopole includes the feedline segment and the first segment. The third bent monopole includes the feedline segment and a second segment. The first, second, and third bent monopoles share the feedline segment, while the first and second bent monopoles also share the first segment. A T-junction is formed by the feedline segment, the first segment, and the second segment. In an example implementation, the first segment has a first width, and the second segment has a second width, with the first width being greater than the second width.

16 Claims, 8 Drawing Sheets



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US008188926B2

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

(10) **Patent No.:** **US 8,188,926 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **FOLDED ANTENNA STRUCTURES FOR PORTABLE DEVICES**

(75) Inventors: **Nisha Ganwani**, Austin, TX (US);
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Aaron Blank, Elgin, TX (US)

(73) Assignee: **Silicon Laboratories, Inc.**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 666 days.

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(21) Appl. No.: **12/317,031**

Primary Examiner — Dieu H Duong

(22) Filed: **Dec. 18, 2008**

(74) *Attorney, Agent, or Firm* — O'Keefe, Egan, Peterman & Enders, LLP

(65) **Prior Publication Data**

US 2010/0109970 A1 May 6, 2010

Related U.S. Application Data

(60) Provisional application No. 61/198,010, filed on Oct. 31, 2008.

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/895

(58) **Field of Classification Search** 343/700 MS, 343/702, 895, 713

See application file for complete search history.

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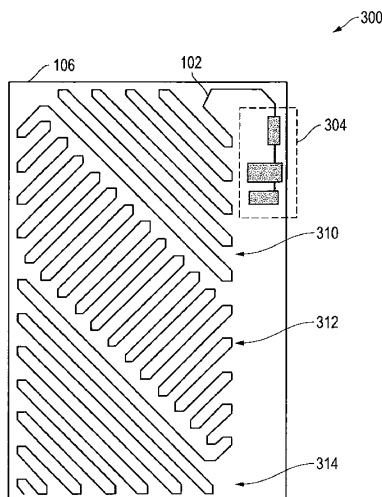
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(57) **ABSTRACT**

Methods and systems are disclosed for folded antenna structures that allow for receive and/or transmit antennas to be used for portable or other devices. The folded antennas described herein can be configured, for example, to fit the design constraints and considerations for portable devices. The folded antenna structures can be implemented using relatively flat flexible printed circuits (e.g., flex circuits) and can be placed in available spaces within the portable device, such as above or behind a battery, while still providing good performance characteristics. Still further, the folded antenna structures can be implemented on a printed circuit board and/or as part of plastic materials and pieces included as part of a portable device.

20 Claims, 6 Drawing Sheets



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US008188929B2

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

(10) **Patent No.:** **US 8,188,929 B2**

(45) **Date of Patent:** **May 29, 2012**

(54) **SELF-RESONATING ANTENNA**

(75) Inventors: **Sung-Hoon Oh**, Plantation, FL (US);
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Mattia Pascolini, Plantation, FL (US)

(73) Assignee: **Motorola Mobility, Inc.**, Libertyville, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 914 days.

(21) Appl. No.: **12/128,681**

(22) Filed: **May 29, 2008**

(65) **Prior Publication Data**

US 2009/0295646 A1 Dec. 3, 2009

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

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

(58) **Field of Classification Search** **343/700, 343/702, 749, 767**
See application file for complete search history.

(56) **References Cited**

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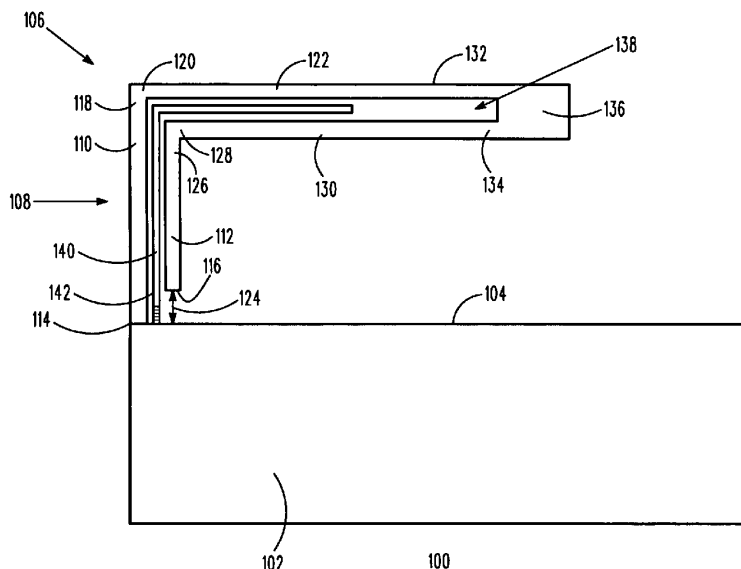
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Mayback & Hoffman, P.A.;
Gregory L. Mayback; Thomas Bethea

(57) **ABSTRACT**

An antenna includes a U-shaped radiator portion having a first extending arm and a second extending arm parallel and adjacent the first extending arm and coupled to the first extending arm by a junction portion, where the first and second extending arms and the junction portion defining a slot. The antenna further includes a ground plane physically coupled only to the first extending arm and a distributed feed element disposed at least partially within the slot and operable to radiate electromagnetic signals within a first frequency range and electrically excite at least portions of the radiator portion at at least a second frequency range having frequencies outside the first frequency range, thereby causing the radiator portion to radiate electromagnetic signals within the second frequency range.

14 Claims, 13 Drawing Sheets



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US008188930B2

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

(10) **Patent No.:** **US 8,188,930 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **ANTENNA DEVICE OF MOBILE TERMINAL**

(56) **References Cited**

(75) Inventors: **Sang Bong Sung**, Gumi-si (KR); **In Jin Hwang**, Gumi-si (KR); **Seung Hwan Kim**, Suwon-si (KR); **Jae Ho Lee**, Yongin-si (KR)

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(73) Assignee: **Samsung Electronics Co., Ltd** (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 526 days.

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(21) Appl. No.: **12/489,044**

Primary Examiner — Hoanganh Le

(22) Filed: **Jun. 22, 2009**

(74) Attorney, Agent, or Firm — The Farrell Law Firm, P.C.

(65) **Prior Publication Data**

US 2009/0315789 A1 Dec. 24, 2009

(30) **Foreign Application Priority Data**

Jun. 20, 2008 (KR) 10-2008-0058619

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

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

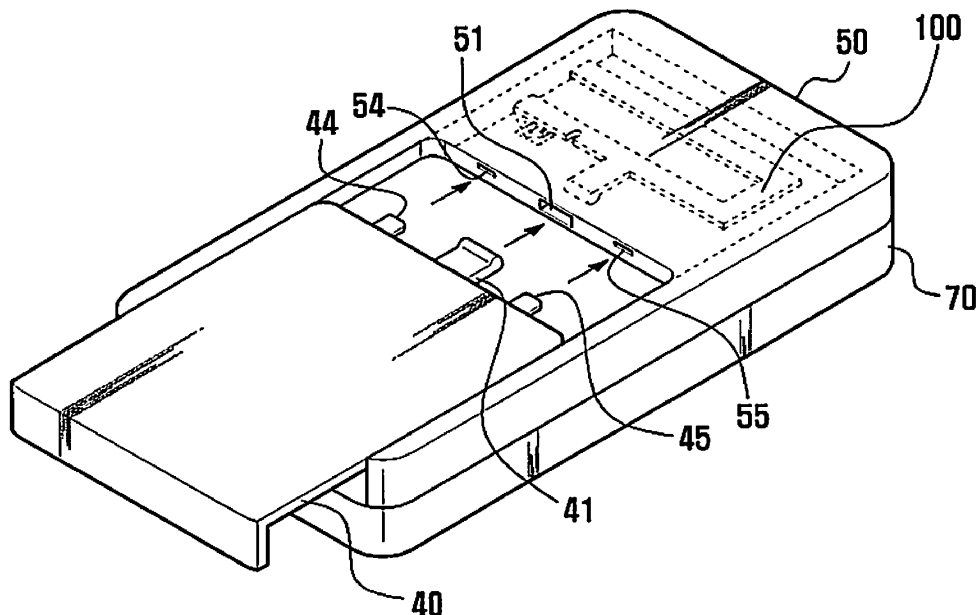
(58) **Field of Classification Search** 343/702,
343/700 MS

See application file for complete search history.

(57) **ABSTRACT**

An antenna device of a mobile terminal that can secure radiation performance is provided. The antenna device having a battery cover composed of a metal material includes a radiation unit for transmitting and receiving a signal, a feeding unit formed at an end portion of a first side of the radiation unit for electrically connecting the radiation unit to a Printed Circuit Board (PCB), and a ground part disposed a predetermined distance from the feeding unit and formed at a second side of the radiation unit. When the battery cover is fastened to the mobile terminal, the ground part contacts a first side of the battery cover.

13 Claims, 7 Drawing Sheets



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US008190104B2

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

(10) **Patent No.:** **US 8,190,104 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **MIMO ANTENNA APPARATUS CHANGING
ANTENNA ELEMENTS BASED ON
TRANSMISSION CAPACITY**

(75) Inventors: **Atsushi Yamamoto**, Kyoto (JP); **Hiroshi Iwai**, Osaka (JP); **Tsutomu Sakata**, Osaka (JP); **Yoshio Koyanagi**, Ishikawa (JP); **Toshiteru Hayashi**, Kanagawa (JP)

(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 792 days.

(21) Appl. No.: **12/361,770**

(22) Filed: **Jan. 29, 2009**

(65) **Prior Publication Data**

US 2009/0196371 A1 Aug. 6, 2009

(30) **Foreign Application Priority Data**

Jan. 29, 2008 (JP) 2008-017538

(51) **Int. Cl.**
H04B 1/44 (2006.01)

(52) **U.S. Cl.** **455/101; 455/562.1; 375/267**

(58) **Field of Classification Search** 455/73,
455/550.1, 562.1, 101, 102, 133, 134, 277.1,
455/277.2; 375/267, 347; 343/702, 750

See application file for complete search history.

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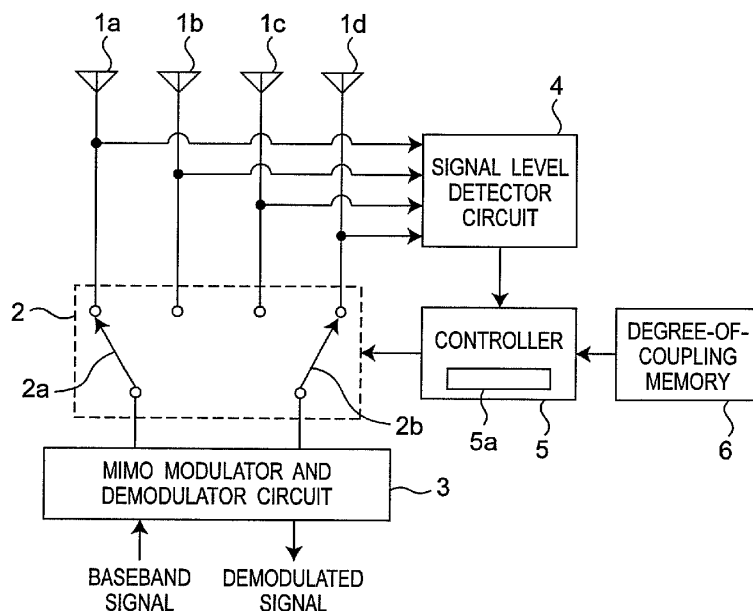
Primary Examiner — Thanh Le

(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**

A controller of a MIMO antenna apparatus calculates a current transmission capacity based on signal levels detected by a signal level detector circuit. The controller calculates an estimated transmission capacity assuming that at least one of antenna elements currently connected to a MIMO modulator and demodulator circuit is changed to a further antenna element not connected to the MIMO modulator and demodulator circuit, based on the detected signal levels and degrees of electromagnetic coupling stored in a degree-of-coupling memory. The controller controls a switch circuit to connect the further antenna element to the MIMO modulator and demodulator circuit when the current transmission capacity becomes lower than the estimated transmission capacity.

19 Claims, 12 Drawing Sheets



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US008190112B2

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

(10) **Patent No.:** **US 8,190,112 B2**
(45) **Date of Patent:** ***May 29, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE WITH REDUCED MICROPHONE
NOISE FROM RADIO FREQUENCY
COMMUNICATIONS CIRCUITRY**

(75) Inventors: **Michael Corrigan**, Waterloo (CA);
George Mankaruse, Kitchener (CA);
Lizhong Zhu, Waterloo (CA)

(73) Assignee: **Research In Motion 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 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/009,314**

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

(65) **Prior Publication Data**

US 2011/0111810 A1 May 12, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/128,710, filed on
May 29, 2008, now Pat. No. 7,899,427, which is a
continuation of application No. 11/064,702, filed on
Feb. 24, 2005, now Pat. No. 7,398,072.

(60) Provisional application No. 60/605,751, filed on Aug.
31, 2004.

(51) **Int. Cl.**
H04B 1/10 (2006.01)

(52) **U.S. Cl.** **455/301; 455/575.8; 455/300**

(58) **Field of Classification Search** **455/575.1,**
455/575.8, 300, 301; 379/433.03

See application file for complete search history.

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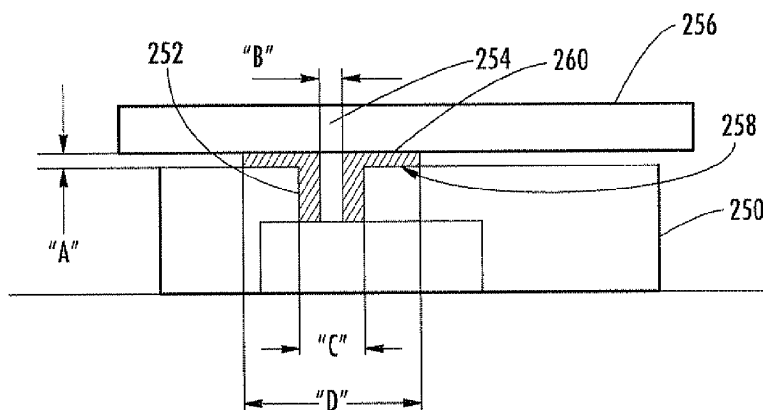
Primary Examiner — Christian Hannon

(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 in the housing and having radio frequency (RF) circuitry and a power amplifier and microphone mounted thereon. An antenna is carried within the housing and operative with the RF circuitry. An RF shield surrounds and isolates the microphone from the RF circuitry, power amplifier and antenna and shields the microphone from radiated energy generated from the RF circuitry, antenna or power amplifier.

19 Claims, 12 Drawing Sheets



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