



US008451176B2

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

(10) **Patent No.:** **US 8,451,176 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **METHOD FOR ACHIEVING INTRINSIC SAFETY COMPLIANCE IN WIRELESS DEVICES USING ISOLATED OVERLAPPING GROUNDS AND RELATED APPARATUS**

(75) Inventors: **Gourango Biswas**, Bangalore (IN);
Cyril A. A. Emmanuel, Bangalore (IN)

(73) Assignee: **Honeywell International Inc.**,
Morristown, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 652 days.

(21) Appl. No.: **12/637,379**

(22) Filed: **Dec. 14, 2009**

(65) **Prior Publication Data**

US 2010/0315298 A1 Dec. 16, 2010

Related U.S. Application Data

(60) Provisional application No. 61/186,253, filed on Jun. 11, 2009.

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

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/702; 343/846;
29/600

(58) **Field of Classification Search**
USPC . 343/700 MS, 702, 846; 333/33, 238; 29/600
See application file for complete search history.

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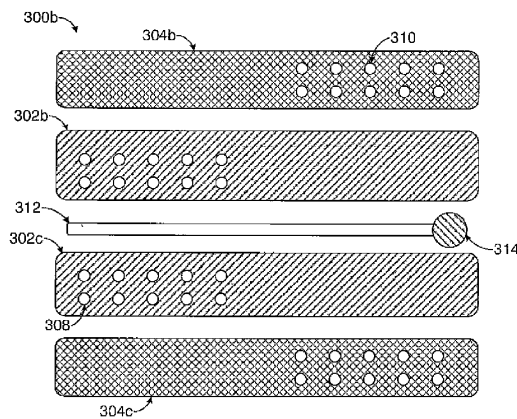
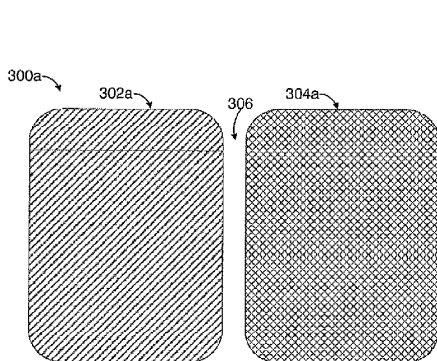
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Primary Examiner — Dieu H Duong

(57) **ABSTRACT**

A system includes a wireless radio board, an antenna, and a ground pattern having a radio board ground and an antenna ground. At least a portion of the radio board ground and at least a portion of the antenna ground overlap. The radio board ground could include a first portion in a first layer of the ground pattern and a second portion in a second layer of the ground pattern, and the antenna ground could include a first portion in the first layer of the ground pattern. The antenna ground could further include a second portion in the second layer of the ground pattern. The radio board and antenna grounds could be separated by a minimum distance, such as 0.5 mm or 3.0 mm.

20 Claims, 4 Drawing Sheets





US008451177B2

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

(10) **Patent No.:** **US 8,451,177 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **WIDEBAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Jen-Min Shau**, Hsinchu (TW); **Hsiao-Yi Lin**, Hsinchu (TW); **Wei-Shan Chang**, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 281 days.

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Primary Examiner — Dieu H Duong

(21) Appl. No.: **12/878,038**

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

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

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2012/0001803 A1 Jan. 5, 2012

A wideband antenna for a radio transceiver device includes a first radiating element for transmitting and receiving wireless signals of a first frequency band, a second radiating element for transmitting and receiving wireless signals of a second frequency band, a grounding unit, a connection strip having one end coupled to the first radiating element and the second radiating element, and another end coupled to the grounding unit, and a feeding terminal coupled to the connection strip for transmitting wireless signals of the first frequency band and the second frequency band. The second frequency band is lower than the second frequency band, and the connection strip includes a structure extending toward the first radiating element.

(30) **Foreign Application Priority Data**

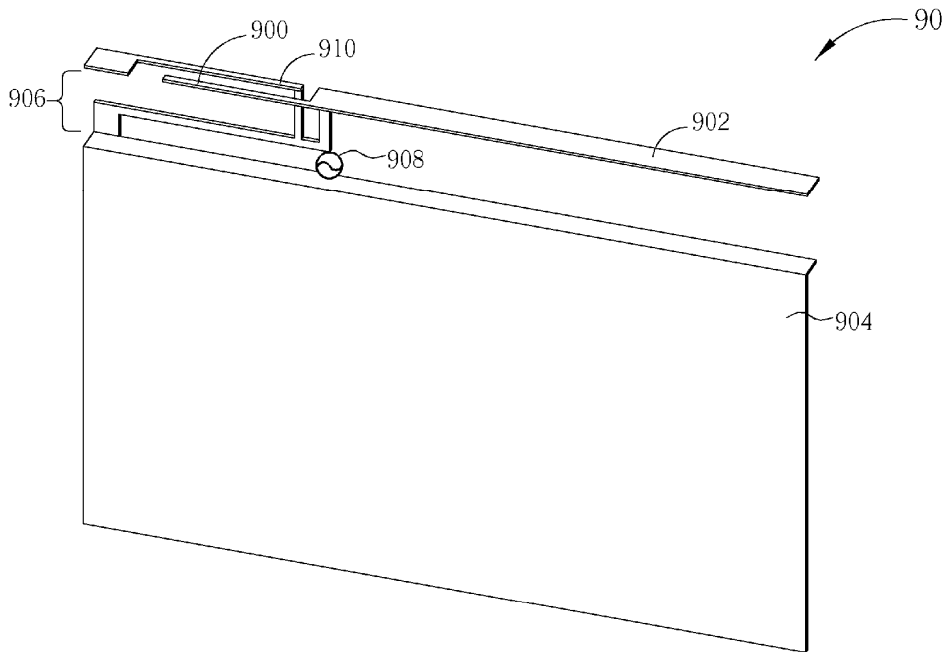
Jul. 2, 2010 (TW) 99212632 U

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

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

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

7 Claims, 25 Drawing Sheets





US008451178B2

(12) **United States Patent**
Sakai

(10) **Patent No.:** **US 8,451,178 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **ANTENNA**

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(75) Inventor: **Hiroto Sakai**, Niiza (JP)

JP 07-288415 A 10/1995

(73) Assignee: **Honda Access Corp.**, Niiza-shi, Saitama (JP)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 427 days.

Professor Yamada et al.; "Small sized antenna and system application"; Publisher : K-Laboratory publishing, pp. 40-41.

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(21) Appl. No.: **12/949,895**

Primary Examiner — Hoang V Nguyen

(22) Filed: **Nov. 19, 2010**

(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(65) **Prior Publication Data**

US 2011/0128188 A1 Jun. 2, 2011

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Nov. 30, 2009 (JP) 2009-272064

There is provided an antenna small in its size but capable of achieving sufficient gain. The antenna comprises antenna elements connected to a power source. The antenna elements comprise upstanding vertical sections connected to the power source and horizontal sections substantially parallel with a ground pattern and having one end thereof connected to an end portion of the vertical sections. The antenna elements further comprise short stubs provided away from the vertical sections toward the other end of the horizontal sections and connected to the ground pattern, and open-ended open stubs provided away from the short stubs toward the other end of the horizontal sections and extending from the horizontal sections toward the ground pattern. The antenna elements are made of a metal foil and are provided on an antenna board.

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

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

USPC **343/700 MS; 343/702**

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 846, 848

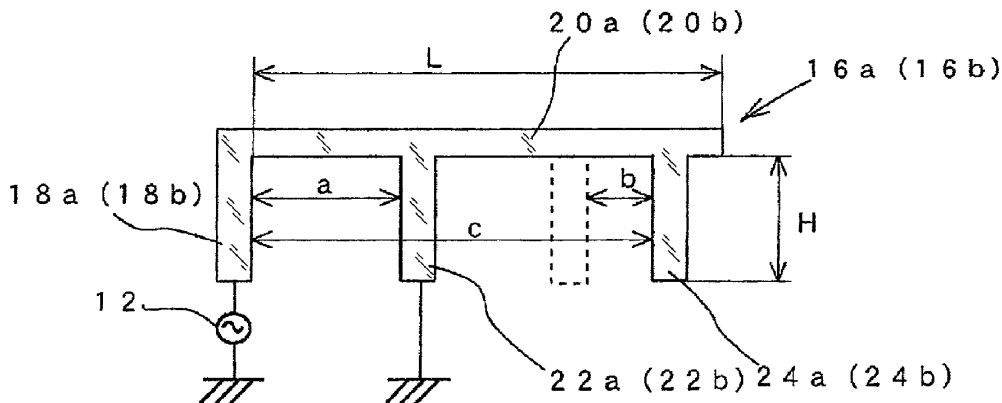
See application file for complete search history.

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7 Claims, 3 Drawing Sheets





US008451179B2

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

(10) **Patent No.:** **US 8,451,179 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **SLIDING ANTENNA APPARATUS**

(75) Inventors: **Guining Shi**, San Diego, CA (US);
Jerome Tu, Saratoga, CA (US)

(73) Assignee: **Hewlett-Packard Development**
Company, L.P., Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 766 days.

(21) Appl. No.: **12/260,444**

(22) Filed: **Oct. 29, 2008**

(65) **Prior Publication Data**

US 2010/0103054 A1 Apr. 29, 2010

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

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

(58) **Field of Classification Search**
USPC 343/702, 846; 455/575.1, 575.3,
455/575.4, 575.7, 575.8
See application file for complete search history.

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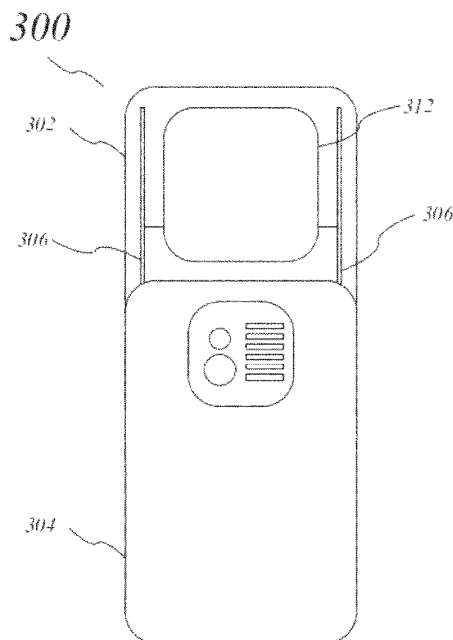
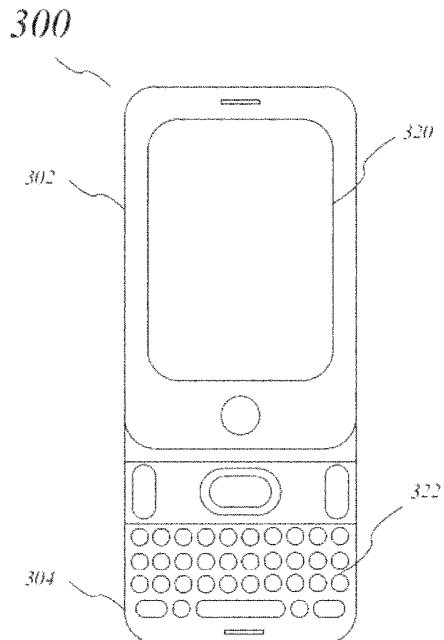
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Primary Examiner — Hoanganh Le

(57) **ABSTRACT**

Various embodiments of a mobile computing device are described. In one embodiment, the mobile computing device comprises an internal antenna system and a first housing coupled to a second housing by one or more electrically conductive sliding portions, the one or more electrically conductive sliding portions to operate as radiating arms for the internal antenna system. Other embodiments are described and claimed.

17 Claims, 4 Drawing Sheets





US008451180B2

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

(10) **Patent No.:** **US 8,451,180 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **INTEGRATED ANTENNA AND DISPLAY SHADE**
(75) Inventors: **Holden Bonwit**, Simi Valley, CA (US);
Abraham Hartenstein, Chatsworth, CA (US)
(73) Assignee: **AeroVironment, Inc.**, Monrovia, CA (US)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 621 days.

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(21) Appl. No.: **12/624,163**
(22) Filed: **Nov. 23, 2009**

(65) **Prior Publication Data**
US 2011/0122029 A1 May 26, 2011

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 19/10 (2006.01)
(52) **U.S. Cl.**
USPC **343/702**; 343/872; 343/834; 343/818
(58) **Field of Classification Search**
None
See application file for complete search history.

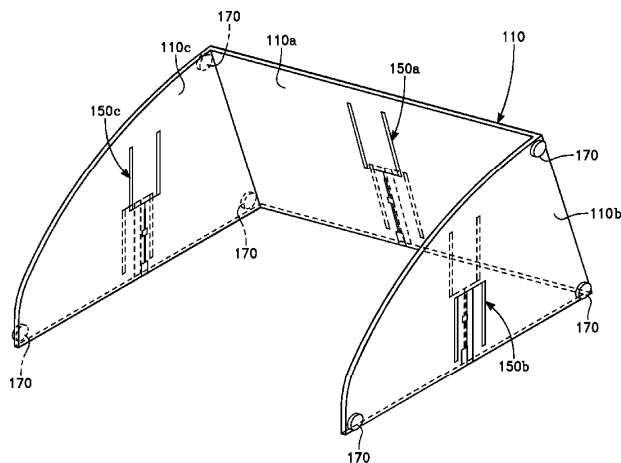
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Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — Christopher R Ralzan; Eric J. Aagaard

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(57) **ABSTRACT**
In one embodiment, an integrated antenna and display shade for a wireless portable control unit is provided which includes a stowable display shade having two side panels and a front panel between the two side panels. Each of the two side panels are foldably connected to opposing edges of the front panel so as to be capable of folding into planes generally parallel with a plane of the front panel when stowed and into planes generally orthogonal to the plane of the front panel when deployed to shade a visual display. The front panel includes an active antenna and each of the side panels include a parasitic antenna.

30 Claims, 6 Drawing Sheets





US008451183B2

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

(10) **Patent No.:** **US 8,451,183 B2**
(45) **Date of Patent:** **May 28, 2013**

(54) **FREQUENCY-TUNABLE METAMATERIAL ANTENNA APPARATUS**

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(75) Inventors: **Vladimir Penev**, San Diego, CA (US);
Vaneet Pathak, San Diego, CA (US)

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(73) Assignee: **Tyco Electronics Services GmbH** (CH)

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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 781 days.

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(21) Appl. No.: **12/546,571**

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(22) Filed: **Aug. 24, 2009**

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(65) **Prior Publication Data**

US 2010/0060544 A1 Mar. 11, 2010

Related U.S. Application Data

(60) Provisional application No. 61/094,839, filed on Sep. 5, 2008.

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(51) **Int. Cl.**
H01Q 9/00 (2006.01)

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(52) **U.S. Cl.**
USPC 343/745; 343/700 MS; 343/961

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(58) **Field of Classification Search**
USPC 343/745, 861, 700 MS
See application file for complete search history.

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Primary Examiner — Hoang V Nguyen
Assistant Examiner — Kyana R McCain

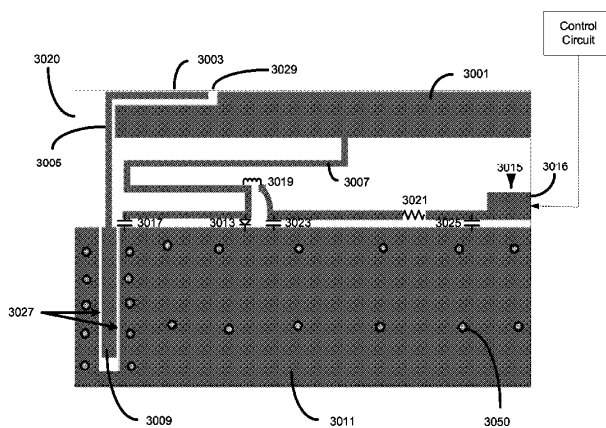
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(57) **ABSTRACT**

Techniques and apparatus based on metamaterial structures to achieve tunable operations of an antenna at different antenna frequencies.

29 Claims, 25 Drawing Sheets





US008451185B2

(12) **United States Patent**
Webb

(10) **Patent No.:** **US 8,451,185 B2**
(45) **Date of Patent:** ***May 28, 2013**

(54) **MULTI-FEED DIPOLE ANTENNA AND METHOD**

(75) Inventor: **Spencer L. Webb**, Pelham, NH (US)

(73) Assignee: **Antennasys, Inc.**, Pelham, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 608 days.

This patent is subject to a terminal disclaimer.

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Primary Examiner — Jacob Y Choi

Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — ARC IP Law, PC; Joseph J. Mayo

(57) **ABSTRACT**

A multi-feed dipole antenna and method. Provides a volumetrically efficient antenna with wide radiation pattern bandwidth and wide impedance bandwidth that are relatively independent. Driving the antenna at multiple locations provides for a half wavelength dipole antenna with a wider frequency range than any other known fat dipole of similar volume. The apparatus is constructed from brass or any other suitable metal without requiring dielectric loading and without requiring direct coupling on the outside of the tubes. The apparatus utilizes a parasitic center tube with two end tubes that are driven by a collinearly mounted metal rod that is driven from the midpoint. Insulators hold the parasitic tube to the end tubes. The parasitic tube allows for induced currents to flow on the surface of the tube which allow for operation of the dipole over a wide frequency range.

16 Claims, 87 Drawing Sheets

(21) Appl. No.: **12/728,009**

(22) Filed: **Mar. 19, 2010**

(65) **Prior Publication Data**

US 2011/0227776 A1 Sep. 22, 2011

Related U.S. Application Data

(66) Continuation of application No. 12/034,838, filed on Feb. 21, 2008, now Pat. No. 7,692,597, Substitute for application No. 60/890,840, filed on Feb. 21, 2007.

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 9/16 (2006.01)

(52) **U.S. Cl.**
USPC **343/790; 343/792; 343/793**

(58) **Field of Classification Search**
USPC **343/790, 792, 793**
See application file for complete search history.

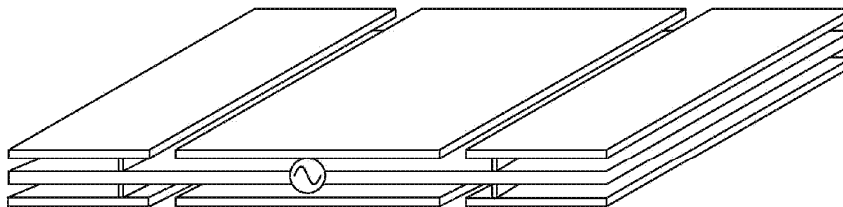
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4,087,823 A	5/1978	Faigen et al.

Planar Implementation

(to optimize use of a rectangular space v. cylindrical)





US008456365B2

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

(10) **Patent No.:** **US 8,456,365 B2**
(45) **Date of Patent:** **Jun. 4, 2013**

(54) **MULTI-BAND MONOPOLE ANTENNAS FOR MOBILE COMMUNICATIONS DEVICES**

(75) Inventors: **Jaume Anguera Pros**, Vinaros (ES);
Carles Puente Baliarda, Barcelona (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 664 days.

(21) Appl. No.: **12/228,487**

(22) Filed: **Aug. 13, 2008**

(65) **Prior Publication Data**
US 2009/0033561 A1 Feb. 5, 2009

Related U.S. Application Data

(63) Continuation of application No. 10/584,442, filed as application No. PCT/EP2005/000880 on Jan. 28, 2005, now Pat. No. 7,423,592, and a continuation-in-part of application No. PCT/EP02/14706, filed on Dec. 22, 2002.

(60) Provisional application No. 60/540,450, filed on Jan. 30, 2004.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)

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

(58) **Field of Classification Search**
USPC **343/700 MS, 702, 895, 833, 834**
See application file for complete search history.

(56) **References Cited**

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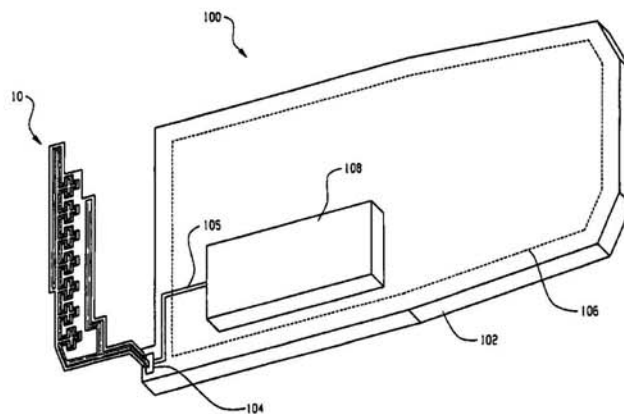
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Winstead PC

(57) **ABSTRACT**

Antennas for use in mobile communication devices are disclosed. The antennas disclosed can include a substrate with a base, a top, a front side and a back side; a first conductor can be located on the first side of the antenna substrate; and a second conductor can be located on the second side of the antenna substrate. The conductors can have single or multiple branches. If a conductor is a single branch it can, for example, be a spiral conductor or a conducting plate. If a conductor has multiple branches, each branch can be set up to receive a different frequency band. A conductor with multiple branches can have a linear branch and a space-filling or grid dimension branch. A conducting plate can act as a parasitic reflector plane to tune or partially tune the resonant frequency of another conductor. The first and second conductors can be electrically connected.

45 Claims, 17 Drawing Sheets





US008456366B2

(12) **United States Patent**
Vance

(10) **Patent No.:** **US 8,456,366 B2**
(45) **Date of Patent:** **Jun. 4, 2013**

(54) **COMMUNICATIONS STRUCTURES INCLUDING ANTENNAS WITH SEPARATE ANTENNA BRANCHES COUPLED TO FEED AND GROUND CONDUCTORS**

(75) Inventor: **Scott LaDell Vance**, Staffanstorp (SE)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Mobile Communications AB**, Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 482 days.

(21) Appl. No.: **12/767,162**

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

(65) **Prior Publication Data**

US 2011/0263289 A1 Oct. 27, 2011

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

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

(58) **Field of Classification Search**
USPC **343/860, 905, 700 MS, 702, 846, 343/848; 455/550.1**
See application file for complete search history.

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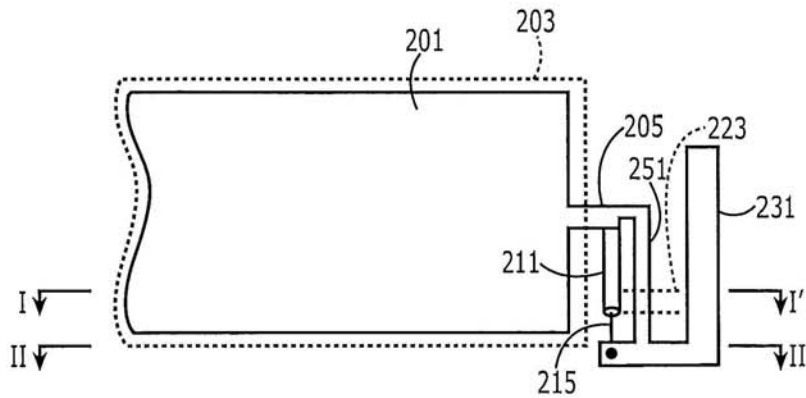
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Primary Examiner — Jacob Y Choi
Assistant Examiner — Scott Petersen
(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec

(57) **ABSTRACT**

A communications structure may include a ground plane, a ground conductor electrically coupled to the ground plane and extending from the ground plane, and a feed conductor. A first antenna branch may be electrically coupled to the ground conductor, with an electrical coupling between the first antenna branch and the ground conductor being spaced apart from an electrical coupling between the ground plane and the ground conductor. A second antenna branch may be electrically coupled to the feed conductor, with the first and second antenna branches being spaced apart. In addition, a radio frequency (RF) transmitter and/or receiver may be provided with the ground plane and the feed conductor being electrically coupled to the RF transmitter and/or receiver.

19 Claims, 6 Drawing Sheets





US008456371B2

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

(10) **Patent No.:** **US 8,456,371 B2**
(45) **Date of Patent:** **Jun. 4, 2013**

(54) **SHIELDING ANTENNAS IN WIRELESS APPLICATION DEVICES**

(75) Inventors: **Jia-woei Chen**, Taipei (TW); **Po-chih Chen**, Taipei (TW)

(73) Assignee: **Laird Technologies Taiwan Inc.**, Taipei County (TW)

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

(21) Appl. No.: **13/420,714**

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

(65) **Prior Publication Data**

US 2012/0176280 A1 Jul. 12, 2012

Related U.S. Application Data

(63) Continuation of application No. PCT/IB2009/006971, filed on Sep. 16, 2009.

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

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

(58) **Field of Classification Search**
USPC 343/702, 841, 882, 872, 873; 455/575.7
See application file for complete search history.

(56) **References Cited**

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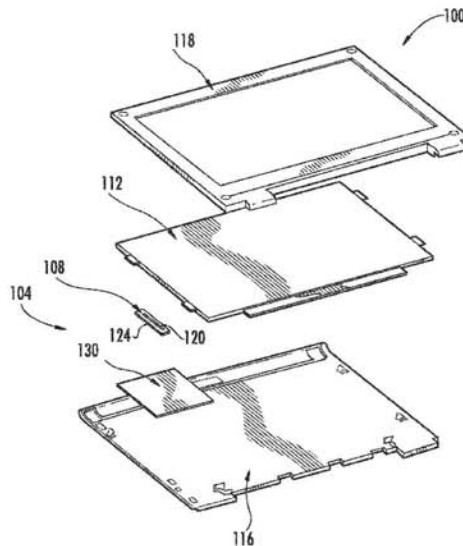
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

An antenna assembly that includes an antenna module fitting between a display panel of an electronic device and a metallic cover of the device. The antenna module includes an antenna and a support for the antenna. A shielding layer fits between the antenna module and the cover. The shielding layer has a grounding area configured for electrical connection with the antenna and for electrical isolation from the cover.

20 Claims, 12 Drawing Sheets





US008456372B2

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

(10) **Patent No.:** **US 8,456,372 B2**
(45) **Date of Patent:** **Jun. 4, 2013**

- (54) **MOBILE WIRELESS COMMUNICATIONS DEVICE WITH HUMAN INTERFACE DIVERSITY ANTENNA AND RELATED METHODS**
- (75) Inventors: **Vytas Robertas Kezys**, Ancaster (CA);
Yihong Qi, 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.
- (21) Appl. No.: **13/611,439**
- (22) Filed: **Sep. 12, 2012**
- (65) **Prior Publication Data**
US 2013/0005321 A1 Jan. 3, 2013

Related U.S. Application Data

- (63) Continuation of application No. 13/357,230, filed on Jan. 24, 2012, now Pat. No. 8,299,973, which is a continuation of application No. 12/112,955, filed on Apr. 30, 2008, now Pat. No. 8,115,687, which is a continuation of application No. 11/616,405, filed on Dec. 27, 2006, now Pat. No. 7,379,027, which is a continuation of application No. 11/067,935, filed on Feb. 28, 2005, now Pat. No. 7,187,332.

- (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**
See application file for complete search history.

(56) **References Cited**

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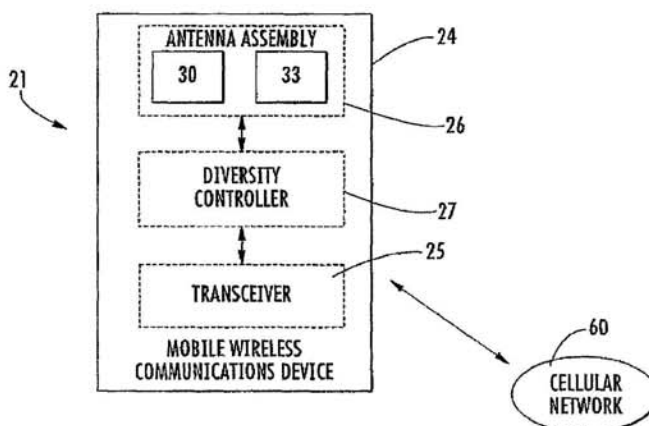
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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**
A mobile wireless communications device may include a portable handheld housing, and a wireless transceiver carried by the housing. A pair of antennas are positioned in side-by-side relation preferably in the upper portion of the portable handheld housing. A human interface diversity controller is connected to the wireless transceiver to preferentially operate with the plurality of antennas based upon a relative position of the portable handheld housing with respect to a hand of a human user. The device can select or weight the antennas based upon the position of the device when being held by a user.

26 Claims, 4 Drawing Sheets





US008456959B2

(12) **United States Patent**
Fujisawa

(10) **Patent No.:** **US 8,456,959 B2**
(45) **Date of Patent:** **Jun. 4, 2013**

(54) **TIMEPIECE WITH WIRELESS COMMUNICATION FUNCTION**
(75) Inventor: **Teruhiko Fujisawa**, Nagano-ken (JP)
(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 246 days.

(21) Appl. No.: **12/828,600**
(22) Filed: **Jul. 1, 2010**

(65) **Prior Publication Data**
US 2011/0013491 A1 Jan. 20, 2011

(30) **Foreign Application Priority Data**
Jul. 14, 2009 (JP) 2009-165503

(51) **Int. Cl.**
G04C 11/02 (2006.01)
(52) **U.S. Cl.**
USPC **368/47**
(58) **Field of Classification Search**
USPC 368/47, 296
See application file for complete search history.

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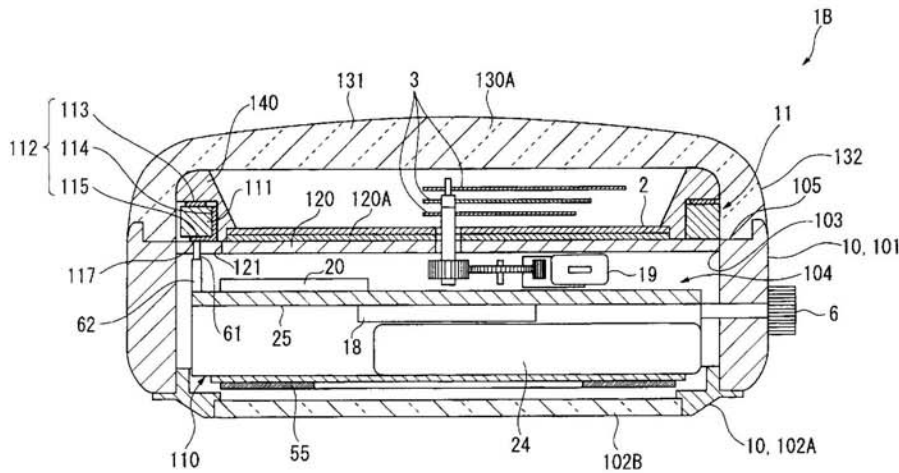
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Primary Examiner — R S Luebke
Assistant Examiner — Jason Collins

(57) **ABSTRACT**

A timepiece with a wireless function, including a movement for displaying time; a conductive case that holds the movement; a crystal that is disposed on the face side of the case and covers the face side of the movement; a conductive plate that is electrically conductive, disposed between the movement and the crystal, and reflects radio waves; and an antenna that has a substantially annular, conductive antenna electrode, and is disposed along the outside edge of the conductive plate between the conductive plate and the crystal.

10 Claims, 12 Drawing Sheets





US008462051B2

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

(10) **Patent No.:** **US 8,462,051 B2**
(45) **Date of Patent:** **Jun. 11, 2013**

- (54) **CHIP ANTENNA AND ANTENNA APPARATUS**
- (75) Inventors: **Hiroya Tanaka**, Kyoto-fu (JP); **Ryo Komura**, Kyoto-fu (JP); **Kazuhisa Yamaki**, Kyoto-fu (JP); **Yuichi Kushihi**, Kyoto-fu (JP)
- (73) Assignee: **Murata Manufacturing Co., Ltd.** (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 216 days.

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- (21) Appl. No.: **13/193,291**
- (22) Filed: **Jul. 28, 2011**
- (65) **Prior Publication Data**
US 2011/0279349 A1 Nov. 17, 2011

Related U.S. Application Data

- (63) Continuation of application No. PCT/JP2009/063658, filed on Jul. 31, 2009.

Foreign Application Priority Data

Jan. 29, 2009 (JP) 2009-017854

- (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 343/700 MS, 702, 906
See application file for complete search history.

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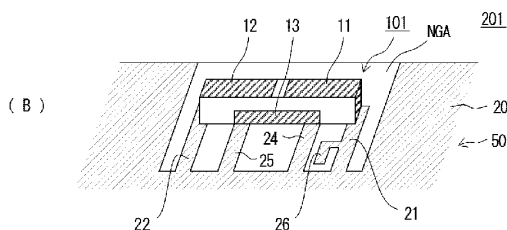
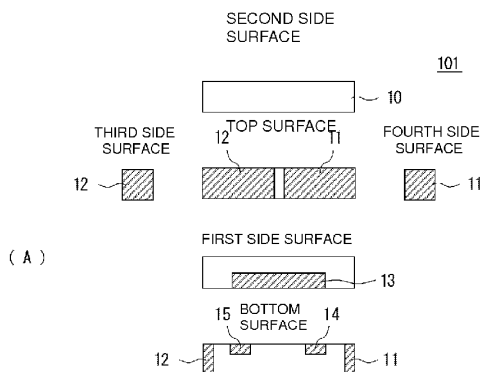
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Primary Examiner — Tan Ho
(74) Attorney, Agent, or Firm — Studebaker & Brackett PC

(57) **ABSTRACT**

A chip antenna and an antenna apparatus, which allow the resonance frequency of the antenna to be set with a high degree of freedom, include a feeding electrode formed on the bottom surface, fourth side surface, and top surface of a dielectric substrate, a non-feeding electrode formed on the bottom surface, third side surface, and top surface of the dielectric substrate, wherein the leading ends of the feeding electrode and the non-feeding electrode are facing each other with a predetermined distance therebetween on the top surface of the dielectric substrate. The chip antenna and antenna apparatus further include a frequency adjusting electrode formed on the first side surface of the dielectric substrate, and ground electrodes connected to ground electrodes of a circuit substrate on which the chip antenna is mounted, wherein the ground electrodes are electrically connected to the frequency adjusting electrode and are formed on the bottom surface of the dielectric substrate.

18 Claims, 7 Drawing Sheets





US008462061B2

(12) **United States Patent**
Brown

(10) **Patent No.:** **US 8,462,061 B2**
(45) **Date of Patent:** ***Jun. 11, 2013**

- (54) **PRINTED COMPOUND LOOP ANTENNA**
- (75) Inventor: **Forrest James Brown**, Carson City, NV (US)
- (73) Assignee: **Dockon AG**, Zurich (CH)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 40 days.
This patent is subject to a terminal disclaimer.

- (21) Appl. No.: **12/878,018**
- (22) Filed: **Sep. 8, 2010**
- (65) **Prior Publication Data**
US 2011/0018776 A1 Jan. 27, 2011

- Related U.S. Application Data**
- (63) Continuation-in-part of application No. 12/921,124, filed as application No. PCT/GB2009/050296 on Mar. 26, 2009.
- (60) Provisional application No. 61/303,594, filed on Feb. 11, 2010.

- (30) **Foreign Application Priority Data**
Mar. 26, 2008 (GB) 0805393.6

- (51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/00 (2006.01)
- (52) **U.S. Cl.**
USPC **343/725; 343/729; 343/844; 343/867**
- (58) **Field of Classification Search**
USPC **343/867**
See application file for complete search history.

- (56) **References Cited**
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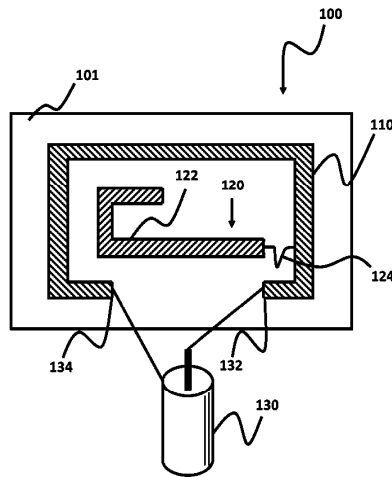
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Primary Examiner — Jacob Y Choi
Assistant Examiner — Graham Smith
 (74) *Attorney, Agent, or Firm* — Woodcock Washburn LLP

(57) **ABSTRACT**

The present invention relates to printed or single-sided compound field antennas. The single-sided compound loop antennas have coplanar electric field radiators and magnetic loops with electric fields orthogonal to magnetic fields that achieve performance benefits in higher bandwidth (lower Q), greater radiation intensity/power/gain, and greater efficiency.

28 Claims, 11 Drawing Sheets





US008462072B2

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

(10) **Patent No.:** **US 8,462,072 B2**
(45) **Date of Patent:** **Jun. 11, 2013**

(54) **ANTENNA DEVICE, PRINTED CIRCUIT BOARD INCLUDING ANTENNA DEVICE, AND WIRELESS COMMUNICATION DEVICE INCLUDING ANTENNA DEVICE**

(75) Inventors: **Andrey Andrenko**, Kawasaki (JP);
Takashi Yamagajo, Kawasaki (JP)

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 708 days.

(21) Appl. No.: **12/645,551**

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

(65) **Prior Publication Data**

US 2010/0156745 A1 Jun. 24, 2010

(30) **Foreign Application Priority Data**

Dec. 24, 2008 (JP) 2008-327040

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

(52) **U.S. Cl.**
USPC **343/848**; 343/700 MS; 343/702

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

(56) **References Cited**

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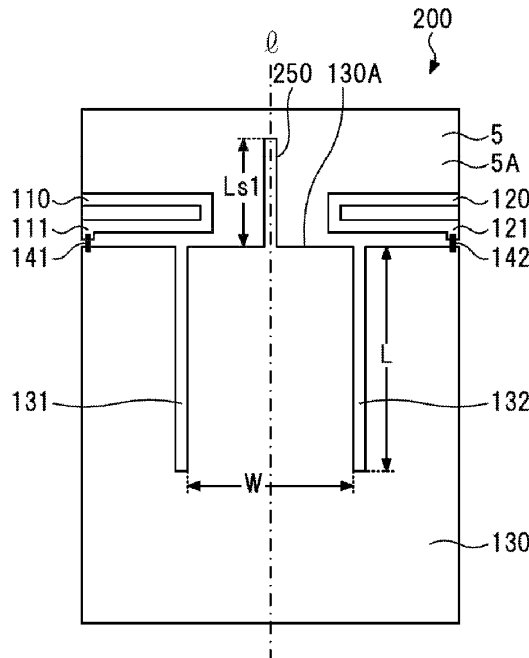
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Fujitsu Patent Center

(57) **ABSTRACT**

An antenna device includes a substrate, a pair of antenna elements formed on a face of the substrate and which is arranged so as to be axisymmetrical with respect to a symmetrical axis, and a ground section formed on the face of the substrate on which the pair of antenna elements is formed and which is arranged proximal to the pair of antenna elements, wherein the ground section is arranged so as to be axisymmetrical with respect to the symmetrical axis, and the ground section includes a first pair of slit sections notched from an end section and extending in one direction of the symmetrical axis.

23 Claims, 38 Drawing Sheets





US008463222B2

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

(10) **Patent No.:** **US 8,463,222 B2**
(45) **Date of Patent:** **Jun. 11, 2013**

(54) **MULTIPLE-INPUT-MULTIPLE-OUTPUT ANTENNA DEVICE**

(75) Inventors: **Saou-Wen Su**, Taipei (TW); **Lin-Han Tsai**, Taipei (TW); **Chuan-Hsing Chen**, Taipei (TW)

(73) Assignee: **Lite-On Technology Corporation**, Neihu Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 418 days.

(21) Appl. No.: **12/791,176**

(22) Filed: **Jun. 1, 2010**

(65) **Prior Publication Data**

US 2011/0151810 A1 Jun. 23, 2011

(30) **Foreign Application Priority Data**

Dec. 22, 2009 (CN) 2009 1 0261357

(51) **Int. Cl.**
H04B 1/18 (2006.01)

(52) **U.S. Cl.**
USPC **455/289**; 455/272; 455/13.3

(58) **Field of Classification Search**
USPC 455/562.1, 13.3, 103, 575.7, 129, 455/272-274, 280, 289; 343/777, 876

See application file for complete search history.

(56) **References Cited**

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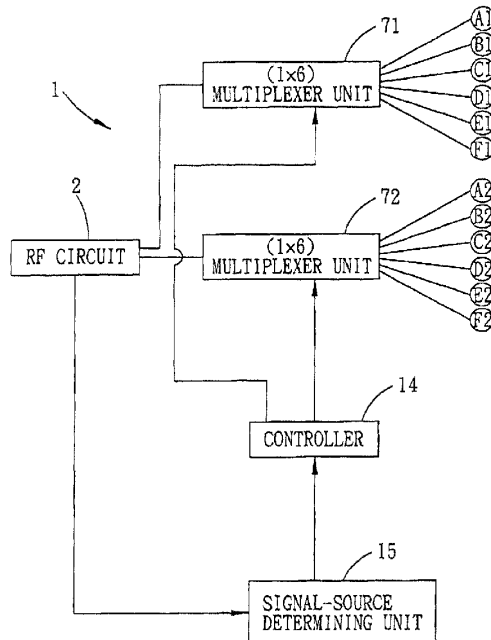
Primary Examiner — Christian Hannon

(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A Multiple-Input-Multiple-Output (MIMO) antenna device is adapted for connecting electrically to a radio frequency (RF) circuit for transmitting and receiving RF signals. The MIMO antenna device includes a circuit board, a plurality of antenna units, and a plurality of multiplexer units. The antenna units are disposed on the circuit board proximate to a peripheral edge thereof, are arranged in a loop formation, and are divided into a plurality of groups of the antenna units. Each of the multiplexer units is connected electrically to a respective one of the groups of the antenna units for selecting one of the corresponding antenna units and for connecting electrically the selected one of the corresponding antenna units to the RF circuit, thereby achieving the MIMO technique with the independently and simultaneously operating antenna units.

18 Claims, 10 Drawing Sheets





US008463339B2

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

(10) **Patent No.:** **US 8,463,339 B2**
(45) **Date of Patent:** **Jun. 11, 2013**

(54) **PORTABLE TERMINAL**

- (75) Inventors: **Michiaki Hiraoka**, Kanagawa (JP);
Hiroshi Tsukiji, Kanagawa (JP)
- (73) Assignee: **Kyocera Corporation**, Kyoto (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/495,911**

(22) Filed: **Jun. 13, 2012**

(65) **Prior Publication Data**

US 2012/0252542 A1 Oct. 4, 2012

Related U.S. Application Data

- (63) Continuation of application No. 12/088,675, filed as application No. PCT/JP2006/319521 on Sep. 29, 2006, now Pat. No. 8,219,161.

(30) **Foreign Application Priority Data**

Sep. 29, 2005 (JP) 2005-285663

- (51) **Int. Cl.**
H04M 1/00 (2006.01)
- (52) **U.S. Cl.**
USPC **455/575.4**; 455/575.5; 455/575.3;
455/556.1; 455/550.1; 343/702
- (58) **Field of Classification Search**
USPC 455/575.4
See application file for complete search history.

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Primary Examiner — Meless N Zewdu

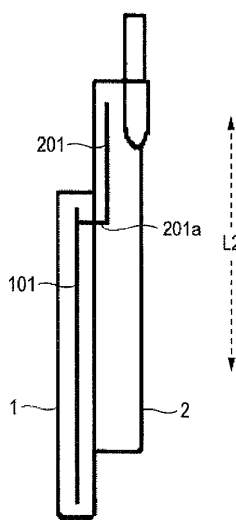
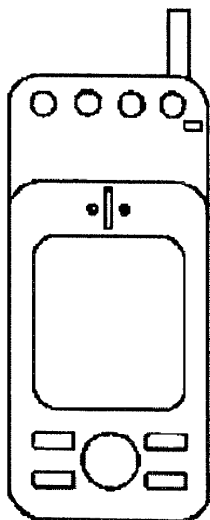
Assistant Examiner — Jean Chang

(74) *Attorney, Agent, or Firm* — DLA Piper LLP (US)

(57) **ABSTRACT**

A portable terminal, which is small sized, excellent in portability, and having high operability for various functions other than a call function, is provided. Two housings are connected such that they can be extended in directions different from each other. The housings have a retraction state, a first extension state, a second extension state, and a third extension state that is a state achieved by further sliding the housings from the second extension into another state. Broadcast receiving conditions are improved by changing the length of an antenna for receiving digital broadcast reception in the second extension state and the third extension state.

3 Claims, 28 Drawing Sheets





US008463340B2

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

(10) **Patent No.:** **US 8,463,340 B2**
(45) **Date of Patent:** **Jun. 11, 2013**

(54) **COMMUNICATION TERMINAL HAVING MULTIPLE ANTENNAS AND METHOD FOR PERFORMING ACCESS TO COMMUNICATION SYSTEM THEREOF**

(75) Inventors: **Jong In Lee**, Gyeonggi-do (KR); **Kun Hui Yi**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 197 days.

(21) Appl. No.: **12/748,557**

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

(65) **Prior Publication Data**

US 2010/0291922 A1 Nov. 18, 2010

(30) **Foreign Application Priority Data**

May 18, 2009 (KR) 10-2009-0042916

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

(52) **U.S. Cl.**
USPC **455/575.7**; 455/432.1; 455/552.1; 455/193.2; 343/876

(58) **Field of Classification Search**
USPC 455/432.1, 575.7, 550.1, 552.1, 553.1, 455/193.2, 193.1, 432.2; 343/876, 893; 370/310-350

See application file for complete search history.

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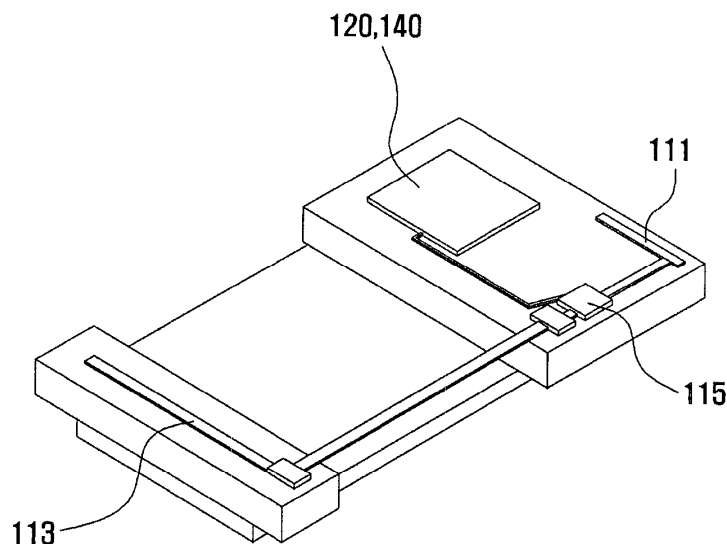
Primary Examiner — Allahyar Kasraian

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

(57) **ABSTRACT**

Provided is a method of accessing to a communication system in a terminal comprising a plurality of antennas, which includes determining a home system which is previously set to preferentially access from a preferred roaming list of a plurality of communications systems, when power is turned on; connecting a system switch to a home antenna for communicating with the home system in a specific frequency band; and accessing the home system to use the home service through the home antenna.

17 Claims, 5 Drawing Sheets





US008466837B2

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

(10) **Patent No.:** **US 8,466,837 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

- (54) **HOOKED TURNSTILE ANTENNA FOR NAVIGATION AND COMMUNICATION**
- (75) Inventors: **Mark L. Rentz**, Torrance, CA (US);
Liza C. Ma, Redondo Beach, CA (US)
- (73) Assignee: **Navcom Technology Inc.**, Torrance, CA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 332 days.
- (21) Appl. No.: **12/392,037**
- (22) Filed: **Feb. 24, 2009**

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Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

An antenna includes a first antenna element and a second antenna element, wherein the first antenna element and the second antenna element are both configured in a hook shape. The antenna also includes a first impedance matching circuit coupled to the first antenna element, wherein the first impedance matching circuit includes a first plurality of filters and a second impedance matching circuit coupled to the second antenna element, wherein the second impedance matching circuit includes a second plurality of filters.

20 Claims, 18 Drawing Sheets

(65) **Prior Publication Data**

US 2010/0164831 A1 Jul. 1, 2010

Related U.S. Application Data

(60) Provisional application No. 61/142,058, filed on Dec. 31, 2008.

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

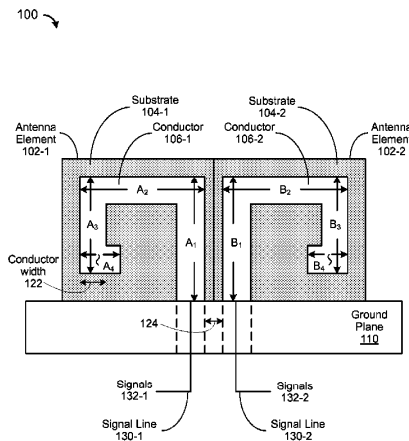
(52) **U.S. Cl.**
USPC **343/700 MS; 343/795; 343/797**

(58) **Field of Classification Search**
USPC 343/795, 797, 850, 852, 725, 727, 343/803–804, 809, 821, 853, 741, 806, 700, 343/829, 846
See application file for complete search history.

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US008466839B2

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

(10) **Patent No.:** **US 8,466,839 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

(54) **ELECTRONIC DEVICES WITH PARASITIC ANTENNA RESONATING ELEMENTS THAT REDUCE NEAR FIELD RADIATION**
(75) Inventors: **Robert W. Schlub**, Campbell, CA (US); **David T. Amm**, Sunnyvale, CA (US); **Omar S. Leung**, Palo Alto, CA (US); **Brian M. King**, Santa Cruz, CA (US); **Qingxiang Li**, Mountain View, CA (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Rodney Andres Gomez Angulo**, Sunnyvale, CA (US); **Yi Jiang**, Sunnyvale, 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 481 days.

(21) Appl. No.: **12/632,697**
(22) Filed: **Dec. 7, 2009**
(65) **Prior Publication Data**
US 2011/0012794 A1 Jan. 20, 2011

Related U.S. Application Data

(60) Provisional application No. 61/226,684, filed on Jul. 17, 2009.
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
USPC **343/702**; 343/872; 343/873
(58) **Field of Classification Search**
USPC 343/702, 872, 873
See application file for complete search history.

(56) **References Cited**

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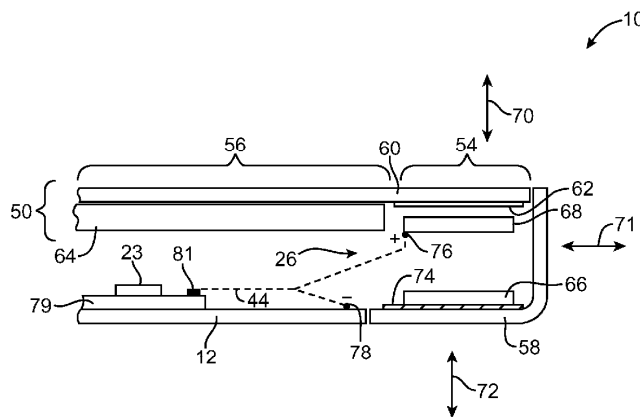
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Primary Examiner — Dieu H Duong
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Chih-Yun Wu

(57) **ABSTRACT**
Antennas are provided for electronic devices such as portable computers. An electronic device may have a housing in which an antenna is mounted. The housing may be formed of conductive materials. A dielectric 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 proximity sensor may be used in detecting external objects. A parasitic antenna resonating element may be interposed between the antenna resonating element and the dielectric antenna window to minimize near-field radiation hotspots. The parasitic antenna resonating element may be formed using a capacitor electrode for the proximity sensor. A ferrite layer may be interposed between the parasitic element and the antenna window.

4 Claims, 13 Drawing Sheets





US008466840B2

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

(10) **Patent No.:** **US 8,466,840 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

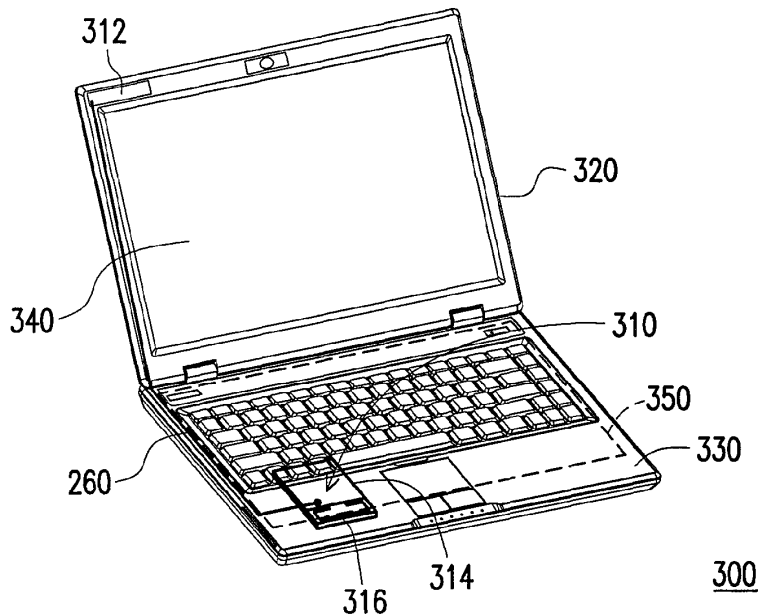
- (54) **WIRELESS TRANSMISSION DEVICE AND COMPUTER SYSTEM USING THE SAME**
- (75) Inventors: **Guo-Ying Hung**, Taipei (TW); **Kei-Zan Chen**, Taipei (TW)
- (73) Assignee: **ASUSTeK Computer Inc.**, Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 321 days.
- (21) Appl. No.: **12/938,382**
- (22) Filed: **Nov. 3, 2010**
- (65) **Prior Publication Data**
US 2011/0102271 A1 May 5, 2011
- Related U.S. Application Data**
- (60) Provisional application No. 61/257,824, filed on Nov. 3, 2009.
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
USPC **343/702**
- (58) **Field of Classification Search**
USPC 343/702
See application file for complete search history.

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- Primary Examiner* — Hoang V Nguyen
- (74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A wireless transmission device and a computer system using the same are provided. The wireless transmission device is adapted to a computer system having a first housing and a second housing, a display is disposed in the first housing, and a motherboard is disposed in the second housing. The wireless transmission device includes a first antenna and a signal processing module. The first antenna is disposed in the side edge of the first housing opposite to the second housing and the signal processing module is disposed in the second housing. The signal processing module is connected with the first antenna via a cable, and it also has a second antenna, so as to process a wireless signal transmitted by the first antenna and the second antenna.

12 Claims, 6 Drawing Sheets





US008466841B1

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

(10) **Patent No.:** **US 8,466,841 B1**
(45) **Date of Patent:** **Jun. 18, 2013**

(54) **DIPOLE ANTENNA WITH GAMMA MATCHING**

(75) Inventors: **Douglas Blake Kough**, San Jose, CA (US); **Joe Freeman Britt, Jr.**, Los Altos, CA (US)

(73) Assignee: **Google Inc.**, Mountain View, 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.: **13/541,859**

(22) Filed: **Jul. 5, 2012**

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

(52) **U.S. Cl.**
USPC **343/702; 343/720; 343/795; 343/803**

(58) **Field of Classification Search**
USPC **343/702, 720, 795, 802, 803, 820, 343/821**

See application file for complete search history.

(56) **References Cited**

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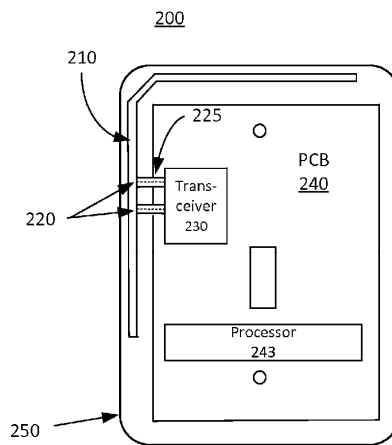
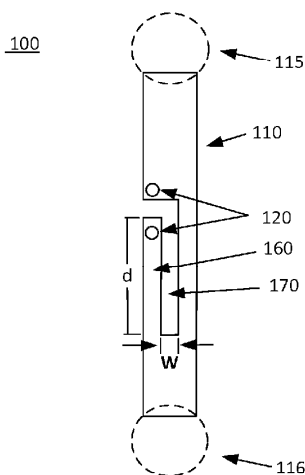
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Morris & Kamlay LLP

(57) **ABSTRACT**

Disclosed are a system and a device including a dipole antenna, signal conductors and a transceiver. The dipole antenna may be enclosed in a housing, and have offset signal connections for transmitting and receiving signals. The signal conductors may be communicatively connected to the offset signal connections. The transceiver may be connected to the signal conductors through a balanced communication signal path. The impedance of the dipole antenna may be substantially gamma matched to the impedance of the balanced communication signal path and an input impedance of the transceiver according to an amount of offset of the signal connections.

26 Claims, 4 Drawing Sheets





US008466844B2

(12) **United States Patent**
Ying

(10) **Patent No.:** **US 8,466,844 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

(54) **MULTI-BAND ANTENNAS USING MULTIPLE PARASITIC COUPLING ELEMENTS AND WIRELESS DEVICES USING THE SAME**

FOREIGN PATENT DOCUMENTS

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(75) Inventor: **Zhinong Ying**, Lund (SE)

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(73) Assignee: **Sony Ericsson Mobile Communications AB**, Lund (SE)

Annex to Form PCT/ISA/206 Communication Relating to the Results of the Partial International Search of International Application No. PCT/IB2011/001109 mailed Aug. 24, 2011.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 354 days.

PCT Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration of International Application No. PCT/IB2011/001109 mailed Oct. 11, 2011.

(21) Appl. No.: **12/816,661**

International Preliminary Report on Patentability Corresponding to International Application No. PCT/IB2011/001109; Mailing Date: Jan. 3, 2013; 12 Pages.

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

(65) **Prior Publication Data**

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US 2011/0309986 A1 Dec. 22, 2011

(51) **Int. Cl.**
H01Q 9/00 (2006.01)

Primary Examiner — James H Cho

(52) **U.S. Cl.**
USPC 343/752; 343/700 MS; 343/702

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

(58) **Field of Classification Search**
USPC 343/752, 700 MS, 702
See application file for complete search history.

(57) **ABSTRACT**

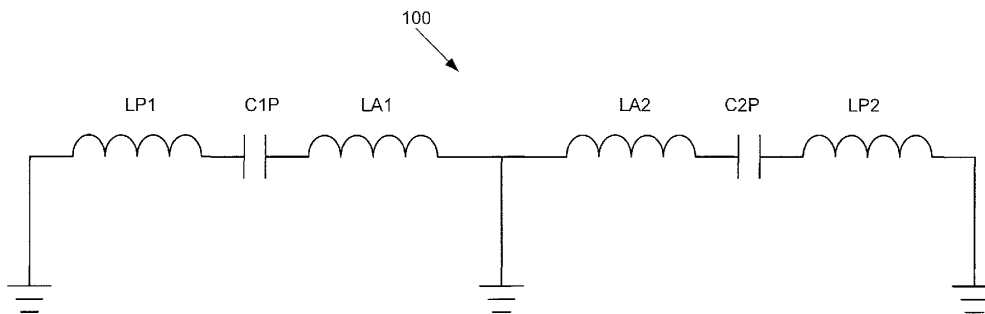
A multi-band antenna includes a ground plane, a branch active element connected to the ground plane, and a plurality of parasitic coupling elements connected to the ground plane. Respective ones of the parasitic coupling elements are electrically coupled to the branch active element such that the multi-band antenna resonates at a plurality of frequency bands.

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18 Claims, 4 Drawing Sheets





US008466849B2

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

(10) **Patent No.:** **US 8,466,849 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

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

(75) Inventors: **Jun Yoon**, Gumi-si (KR); **Yeong-Moo Ryu**, Daegu (KR); **Kwon-Sik Min**, Gumi-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 746 days.

(21) Appl. No.: **12/248,433**

(22) Filed: **Oct. 9, 2008**

(65) **Prior Publication Data**
US 2009/0096708 A1 Apr. 16, 2009

(30) **Foreign Application Priority Data**
Oct. 12, 2007 (KR) 10-2007-0103087

(51) **Int. Cl.**
H01Q 3/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/876; 343/900**

(58) **Field of Classification Search**
USPC 343/702, 876; 455/572
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

Assistant Examiner — Kyana R McCain

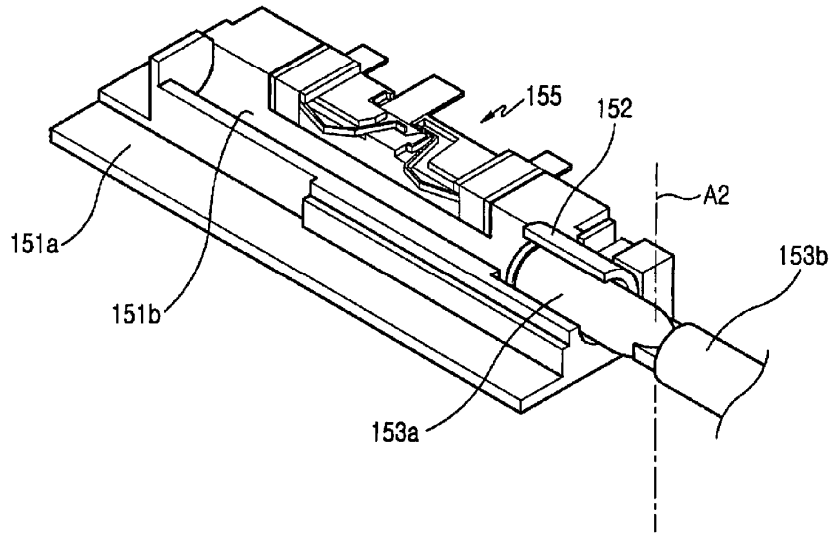
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An antenna device for a portable terminal, in which a first radiator is installed within the portable terminal, a second radiator is elongated lengthwise and installed to be retractable into and extendable from the portable terminal, and a switch portion has at least one plate spring and connects a communication circuit portion of the portable terminal selectively to the first radiator or the second radiator. When the second radiator is retracted into the portable terminal, the communication circuit portion is connected to the first radiator through the at least one plate spring, and when the second radiator is extended from the portable terminal, the communication circuit portion is connected to the second radiator through the at least one plate spring.

12 Claims, 5 Drawing Sheets

105





US008467272B2

(12) **United States Patent**
Fujisawa

(10) **Patent No.:** **US 8,467,272 B2**
(45) **Date of Patent:** **Jun. 18, 2013**

(54) **TIMEPIECE WITH INTERNAL ANTENNA**

(75) Inventor: **Teruhiko Fujisawa**, Nagano-ken (JP)

(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 267 days.

(21) Appl. No.: **12/871,483**

(22) Filed: **Aug. 30, 2010**

(65) **Prior Publication Data**

US 2011/0051561 A1 Mar. 3, 2011

(30) **Foreign Application Priority Data**

Sep. 1, 2009 (JP) 2009-201557
Jun. 24, 2010 (JP) 2010-143886

(51) **Int. Cl.**
G04C 11/02 (2006.01)

(52) **U.S. Cl.**
USPC **368/47**

(58) **Field of Classification Search**
USPC 200/46, 47, 64, 76, 14, 10, 13, 185,
200/55, 276, 278; 343/718, 702, 846, 848,
343/720
See application file for complete search history.

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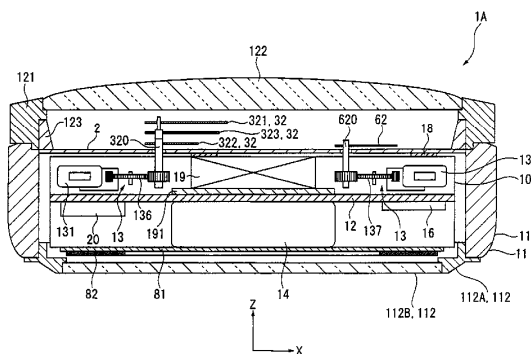
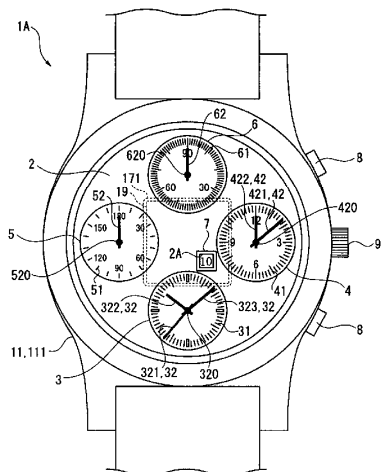
(Continued)

Primary Examiner — Edwin A. Leon

(57) **ABSTRACT**

A timepiece with an internal antenna, including: a case that is made from a conductive material; a movement that is housed in the case and has a plurality of motors that drive staffs disposed at a plurality of locations; a dial that is made from a nonconductive material; and a patch antenna that is disposed inside the case on the back side of the dial, receives radio signals transmitted from an external source, and includes a dielectric and an electrode formed in the dielectric; wherein the patch antenna is disposed separated at least a specific distance from the inside surface of the case, and the staffs are disposed between the case and the patch antenna.

29 Claims, 17 Drawing Sheets





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(54) **RADIO-FREQUENCY DEVICE AND WIRELESS COMMUNICATION DEVICE**

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(52) **U.S. Cl.**
USPC ... **455/575.7**; 455/90.1; 455/90.3; 455/550.1;
455/575.1; 455/575.5

(58) **Field of Classification Search**
USPC 455/575.7, 550.1, 575.1, 575.5, 90.1,
455/90.3, 522, 552.1, 575.8, 90.2
See application file for complete search history.

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(57) **ABSTRACT**
A radio-frequency (RF) device and a wireless communication device include a capacitive sensing unit capable of using a radiating element of an antenna to sensing an environment capacitance within a specified range, such that an RF signal processing device is capable of adjusting power of an RF signal accordingly, to prevent affecting a user. When the radiating element of the antenna includes a direct-current signal route to a ground terminal, the RF device and the wireless communication device further includes at least a capacitor for cutting off the direct-current signal route.

22 Claims, 16 Drawing Sheets

