



US008253630B2

(12) **United States Patent**  
**Tu**

(10) **Patent No.:** **US 8,253,630 B2**  
(45) **Date of Patent:** **Aug. 28, 2012**

(54) **MICROSTRIP ANTENNA**

(56) **References Cited**

(75) Inventor: **Hsin-Lung Tu**, Taipei Hsien (TW)

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

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

*Primary Examiner* — Hoanganh Le

(21) Appl. No.: **12/699,252**

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(22) Filed: **Feb. 3, 2010**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2010/0302121 A1 Dec. 2, 2010

A microstrip antenna located on a substrate with a first surface and a second surface opposite to the first surface includes a feeding portion, a grounding portion, and a radiating portion. The feeding portion is located on the first surface of the substrate to feed electromagnetic signals. The grounding portion is located on the second surface of the substrate. The radiating portion is located on the first surface and includes a first radiating part, a second radiating part, a third radiating part, and a fourth radiating part. Each of the first radiating part, the second radiating part, and the third radiating part is on a rectangle-shaped strip line. The first radiating part is connected to the feeding portion. The fourth radiating part is perpendicularly connected to a second end of the third radiating part.

(30) **Foreign Application Priority Data**

Jun. 2, 2009 (CN) ..... 2009 1 0302835

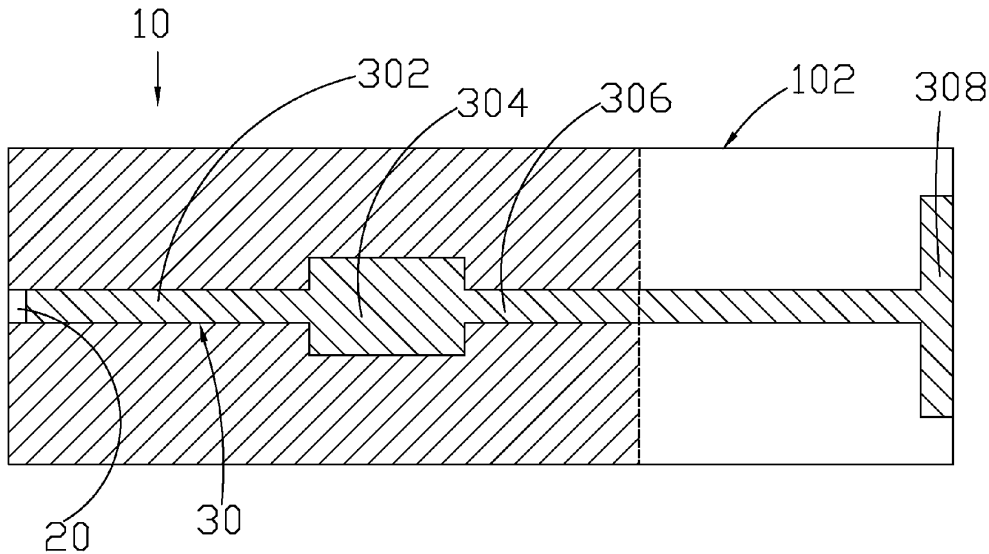
(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)

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

(58) **Field of Classification Search** ..... 343/700 MS,  
343/846, 848

See application file for complete search history.

**19 Claims, 16 Drawing Sheets**





US008253631B2

(12) **United States Patent**  
**Harihara**

(10) **Patent No.:** **US 8,253,631 B2**  
(45) **Date of Patent:** **Aug. 28, 2012**

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

(75) Inventor: **Yasumasa Harihara**, Tokyo (JP)

(73) Assignee: **TDK 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 154 days.

(21) Appl. No.: **12/809,856**

(22) PCT Filed: **Dec. 17, 2008**

(86) PCT No.: **PCT/JP2008/072912**

§ 371 (c)(1),

(2), (4) Date: **Sep. 28, 2010**

(87) PCT Pub. No.: **WO2009/081803**

PCT Pub. Date: **Jul. 2, 2009**

(65) **Prior Publication Data**

US 2011/0001672 A1 Jan. 6, 2011

(30) **Foreign Application Priority Data**

Dec. 21, 2007 (JP) ..... 2007-330581

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

(52) **U.S. Cl.** ..... 343/700 MS; 343/702; 343/787

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

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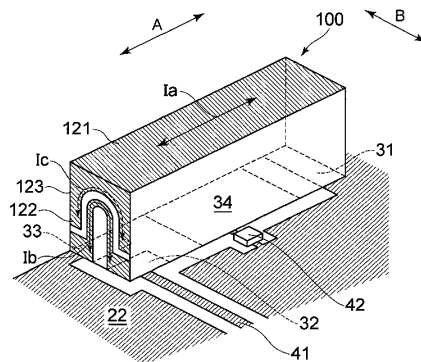
*Primary Examiner* — Trinh Dinh

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

(57) **ABSTRACT**

An object of the present invention is to obtain high radiation efficiency by strengthening electromagnetic coupling in an antenna device that supplies a radiation current by the electromagnetic coupling. An antenna device includes a substrate 110 and a conductor pattern that includes a radiation conductor 121, a feed conductor 122, and a coupling conductor 123 formed on the substrate 110. Both the feed conductor 122 and the coupling conductor 123 are formed on a side surface 115 of the substrate 110. One end 122a of the feed conductor 122 is connected to a feed line, and other end 122b is connected to a ground pattern. A coupling portion 122b of the feed conductor 122 is substantially U-shaped, and the coupling conductor 123 is electromagnetically coupled to the coupling portion 122b of the feed conductor 122. Because the feed conductor 122 is gently curved, an electric field concentration can hardly occur. The length of the feed conductor 122 can be increased, and thus it is possible to obtain a strong electromagnetic coupling with the coupling conductor 123.

**12 Claims, 18 Drawing Sheets**





US008253633B2

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

(10) **Patent No.:** **US 8,253,633 B2**  
(45) **Date of Patent:** **Aug. 28, 2012**

(54) **MULTI-BAND MONOPOLE ANTENNA FOR A MOBILE COMMUNICATIONS DEVICE**

(75) Inventors: **Alfonso Sanz**, Barcelona (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 0 days.

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(21) Appl. No.: **12/652,974**

(22) Filed: **Jan. 6, 2010**

(65) **Prior Publication Data**

US 2010/0123642 A1 May 20, 2010

**Related U.S. Application Data**

(63) Continuation of application No. 12/055,748, filed on Mar. 26, 2008, now Pat. No. 7,675,470, which is a continuation of application No. 11/713,324, filed on Mar. 2, 2007, now Pat. No. 7,403,164, which is a continuation of application No. 11/124,768, filed on May 9, 2005, now Pat. No. 7,411,556, which is a continuation of application No. PCT/EP02/14706, filed on Dec. 22, 2002.

(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, 895**

See application file for complete search history.

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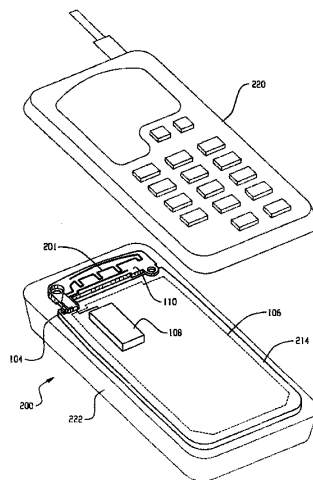
*Primary Examiner* — Tan Ho

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

(57) **ABSTRACT**

A multi-band monopole antenna for a mobile communications device includes a common conductor coupled to both a first radiating arm and a second radiating arm. The common conductor includes a feeding port for coupling the antenna to communications circuitry in a mobile communications device. In one embodiment, the first radiating arm includes a space-filling curve. In another embodiment, the first radiating arm includes a meandering section extending from the common conductor in a first direction and a contiguous extended section extending from the meandering section in a second direction.

**40 Claims, 7 Drawing Sheets**





US008253634B2

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

(10) **Patent No.:** **US 8,253,634 B2**  
(45) **Date of Patent:** **Aug. 28, 2012**

- (54) **RADIO APPARATUS**
- (75) Inventors: **Shuhei Ohguchi**, Osaka (JP); **Hiroyuki Takebe**, Osaka (JP)
- (73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 351 days.

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- (21) Appl. No.: **12/677,493**
- (22) PCT Filed: **Jul. 9, 2009**
- (86) PCT No.: **PCT/JP2009/062510**  
§ 371 (c)(1),  
(2), (4) Date: **Mar. 10, 2010**
- (87) PCT Pub. No.: **WO2010/007931**  
PCT Pub. Date: **Jan. 21, 2010**
- (65) **Prior Publication Data**  
US 2010/0328166 A1 Dec. 30, 2010

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*Primary Examiner* — Hoang V Nguyen

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

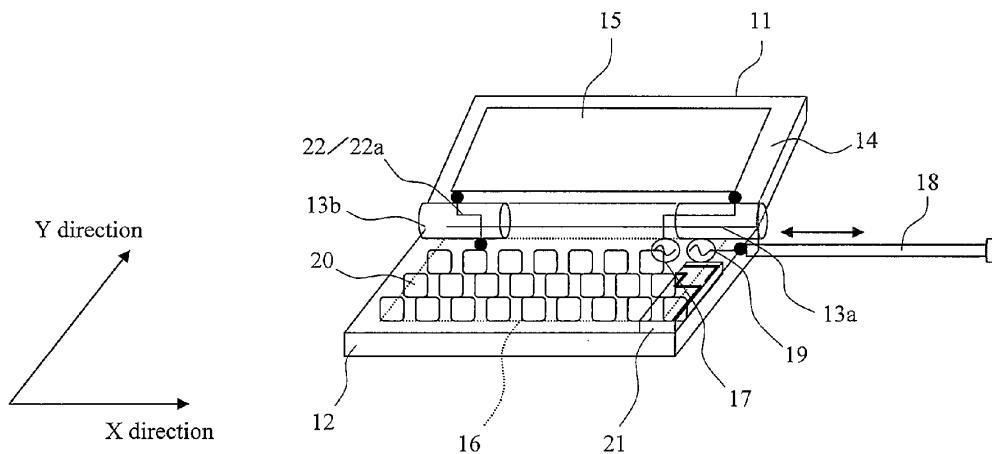
- (30) **Foreign Application Priority Data**  
Jul. 15, 2008 (JP) ..... 2008-183924
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)
- (52) **U.S. Cl.** ..... 343/702; 343/846; 343/876
- (58) **Field of Classification Search** ..... 343/702, 343/846, 876; 455/575.1, 575.3, 575.4, 575.7  
See application file for complete search history.

(57) **ABSTRACT**

In a portable telephone, a first housing and a second housing are connected to each other by hinge sections which makes the first housing and the second housing rotatable about the long-side direction of the housings. A metal frame is provided at a peripheral section of the first housing, and a display section is provided at the central section of the first housing. A metal is used as a frame and can also be operated as an antenna element. In the second housing, a circuit board to which a baseband circuit and a radio circuit are mounted, a first feeding section which supplies electric power to the metal frame, and a draw-out rod antenna which can be drawn out from and housed in the housing are supplied with electric power by the second feeding section. Further, a cellular antenna which performs communication with a base station is also incorporated in the second housing. The rod antenna can be drawn out in the direction substantially in parallel with the rotation axis of the above described hinge.

- (56) **References Cited**  
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**20 Claims, 8 Drawing Sheets**





US008253635B2

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

(10) **Patent No.:** **US 8,253,635 B2**  
(45) **Date of Patent:** **\*Aug. 28, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE INCLUDING A GROUND PATCH PROVIDING SPECIFIC ABSORPTION RATE (SAR) REDUCTION AND RELATED METHODS**

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

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

(56) **References Cited**

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

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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 0 days.  
  
This patent is subject to a terminal disclaimer.

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WO	03/026064	3/2003
WO	2005004277	1/2005

*Primary Examiner* — Hoang V Nguyen

(21) Appl. No.: **13/206,552**

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

(22) Filed: **Aug. 10, 2011**

(65) **Prior Publication Data**

US 2011/0298671 A1 Dec. 8, 2011

(57) **ABSTRACT**

**Related U.S. Application Data**

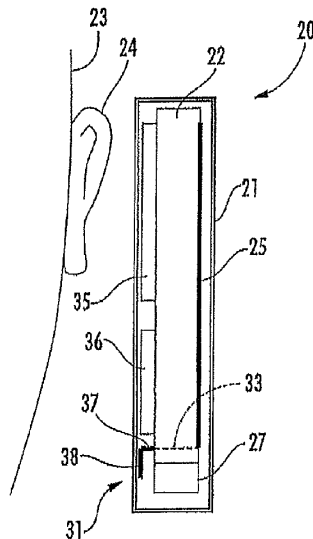
A mobile wireless communications device may include a portable housing, a dielectric substrate carried by the portable housing having a front side facing toward a user and a back side opposite the front side, and a ground plane carried by the dielectric substrate. The device may further include at least one circuit carried by the dielectric substrate, and an antenna carried by the dielectric substrate adjacent an end thereof and electrically connected to the at least one circuit. A ground patch may be adjacent the front side of the dielectric substrate that is electrically connected to the ground plane and spaced apart from and at least partially overlapping the antenna.

(63) Continuation of application No. 12/872,533, filed on Aug. 31, 2010, now Pat. No. 8,013,797, which is a continuation of application No. 12/472,638, filed on May 27, 2009, now Pat. No. 7,791,547, which is a continuation of application No. 11/733,360, filed on Apr. 10, 2007, now Pat. No. 7,554,496.

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

**32 Claims, 3 Drawing Sheets**

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





US008253640B2

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

(10) **Patent No.:** **US 8,253,640 B2**  
(45) **Date of Patent:** **Aug. 28, 2012**

(54) **THIN SLOT ANTENNA HAVING CAVITY, ANTENNA POWER FEEDING METHOD, AND RFID TAG DEVICE USING THE ANTENNA AND THE METHOD**

(75) Inventors: **Hitoshi Kitayoshi**, Miyagi (JP); **Kunio Sawaya**, Miyagi (JP)

(73) Assignee: **Hitoshi Kitayoshi**, Miyagi (JP)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 632 days.

(21) Appl. No.: **12/440,152**

(22) PCT Filed: **Sep. 3, 2007**

(86) PCT No.: **PCT/JP2007/067145**  
§ 371 (c)(1),  
(2), (4) Date: **Apr. 3, 2009**

(87) PCT Pub. No.: **WO2008/029769**  
PCT Pub. Date: **Mar. 13, 2008**

(65) **Prior Publication Data**  
US 2010/0188306 A1 Jul. 29, 2010

(30) **Foreign Application Priority Data**  
Sep. 5, 2006 (JP) ..... 2006-239685

(51) **Int. Cl.**  
**H01Q 13/00** (2006.01)  
**H01Q 13/10** (2006.01)  
(52) **U.S. Cl.** ..... **343/767; 343/746; 343/700 MS**  
(58) **Field of Classification Search** ..... **343/767, 343/700 MS**

See application file for complete search history.

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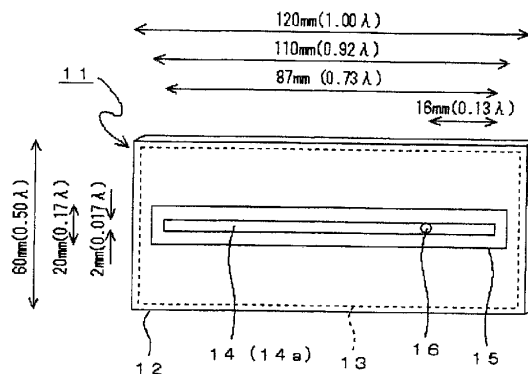
*Primary Examiner* — Douglas W Owens  
*Assistant Examiner* — Jennifer F Hu

(74) *Attorney, Agent, or Firm* — Young & Thompson

(57) **ABSTRACT**

A highly efficient thin slot antenna having a cavity and an RFID tag device are provided, in which such flexible properties can be provided to the antenna that the antenna can be worn on the curved surface of a human body, an object, or the like as well as the antenna can be relatively freely deformed, and changes in the characteristics caused by deformation and changes in the characteristics caused by a product to mount the antenna thereon, are extremely small. Conductive foil such as aluminum or foil vapor deposited with conductive metal such as aluminum is used to form a bag shape for configuring a bag-shaped product having a cavity (12). A relatively soft dielectric sheet (13) is provided inside the cavity (12), and a slot (14) is provided lengthwise on one side of the bag-shaped product at the center position in the width direction.

**3 Claims, 13 Drawing Sheets**





US008259014B2

(12) **United States Patent**  
**Wu**

(10) **Patent No.:** **US 8,259,014 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

(54) **MULTI-LOOP ANTENNA STRUCTURE AND HAND-HELD ELECTRONIC DEVICE USING THE SAME**

2007/0115200 A1 5/2007 Ishimiya  
2008/0169981 A1 7/2008 Hotta et al.  
2009/0289869 A1\* 11/2009 Babakhani et al. .... 343/850

**FOREIGN PATENT DOCUMENTS**

(75) Inventor: **Wei-Yang Wu**, Taoyuan (TW)

EP 1555-715 A1 7/2005  
JP 2007/088975 A 4/2007

(73) Assignee: **HTC Corporation**, Taoyuan County (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 489 days.

*Primary Examiner* — Dieu H Duong  
(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(21) Appl. No.: **12/634,704**

(57) **ABSTRACT**

(22) Filed: **Dec. 10, 2009**

A multi-loop antenna structure and a hand-held electronic device using the same are provided. The multi-loop antenna structure includes a high-frequency radiating body, a low-frequency radiating body, a feeding connecting part and a grounding connecting part. The feeding connecting part electrically connects one terminal of the high-frequency and the low-frequency radiating body to a feeding point. The grounding connecting part grounds the other terminal of the high-frequency and the low-frequency radiating body. The feeding connecting part forms a first folded loop antenna with the high-frequency radiating body and the grounding connecting part for resonating at a first frequency band. The feeding connecting part forms a second folded loop antenna with the low-frequency radiating body and the grounding connecting part for resonating at a second, a third and a fourth frequency band. The first folded loop antenna and the second folded loop antenna are folded for forming a three-dimensional structure.

(65) **Prior Publication Data**

US 2010/0271271 A1 Oct. 28, 2010

(30) **Foreign Application Priority Data**

Apr. 27, 2009 (TW) ..... 98113943 A

(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**

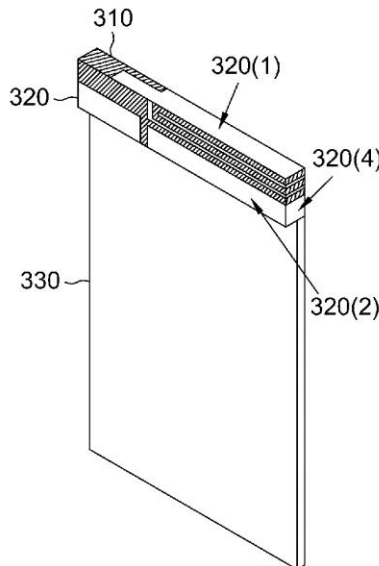
See application file for complete search history.

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**32 Claims, 8 Drawing Sheets**





US008259015B2

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

(10) **Patent No.:** **US 8,259,015 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

(54) **ANTENNA MODULE**

(75) Inventors: **Chao-Hsu Wu**, Luzhu Township, Taoyuan County (TW); **Cheng-Hsiung Wu**, Kaohsiung (TW)  
(73) Assignee: **Quanta Computer Inc.**, Tao Yuan Shien (TW)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 387 days.

(21) Appl. No.: **12/759,758**

(22) Filed: **Apr. 14, 2010**

(65) **Prior Publication Data**  
US 2011/0175775 A1 Jul. 21, 2011

(30) **Foreign Application Priority Data**  
Jan. 18, 2010 (TW) ..... 99101200 A

(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.

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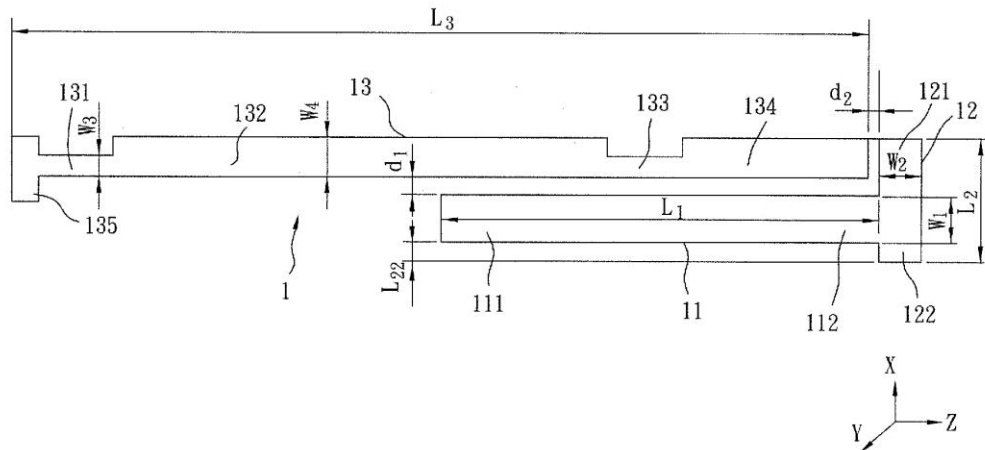
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*Primary Examiner* — Tho G Phan  
(74) *Attorney, Agent, or Firm* — Hammer & Associates, P.C.

(57) **ABSTRACT**

An antenna module includes first, second, and third conductor arms. The second conductor arm has first and second end portions, and is coupled to an end portion of the first conductor arm to form a substantially T-shaped connection. The third conductor arm is spaced apart from the first and second conductor arms by first and second gaps, respectively, and is disposed parallel to the first conductor arm. The first end portion of the second conductor arm and the third conductor arm are electrically coupled to a coaxial cable for receiving two signals therefrom, respectively. The second end portion of the second conductor arm is electrically coupled to a ground cable for grounding.

**7 Claims, 7 Drawing Sheets**







US008259016B2

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

(10) **Patent No.:** **US 8,259,016 B2**  
(45) **Date of Patent:** **\*Sep. 4, 2012**

(54) **MULTI-BAND MONOPOLE ANTENNA FOR A MOBILE COMMUNICATIONS DEVICE**

(75) Inventors: **Alfonso Sanz**, Barcelona (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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/029,382**

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

(65) **Prior Publication Data**

US 2012/0044124 A1 Feb. 23, 2012

**Related U.S. Application Data**

(63) Continuation of application No. 12/652,974, filed on Jan. 6, 2010, which is a continuation of application No. 12/055,748, filed on Mar. 26, 2008, now Pat. No. 7,675,470, which is a continuation of application No. 11/713,324, filed on Mar. 2, 2007, now Pat. No. 7,403,164, which is a continuation of application No. 11/124,768, filed on May 9, 2005, now Pat. No. 7,411,556, which is a continuation of application No. PCT/EP02/14706, filed on Dec. 22, 2002.

(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, 895**

See application file for complete search history.

(56) **References Cited**

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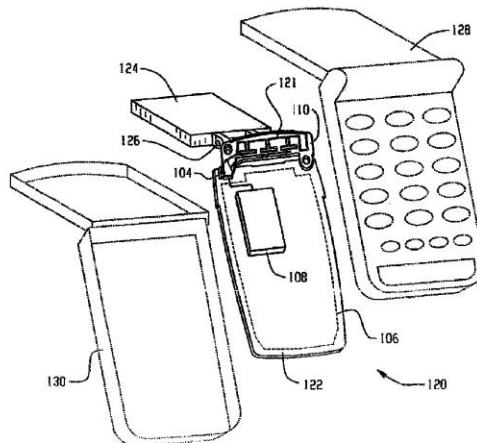
*Primary Examiner* — Tan Ho

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

(57) **ABSTRACT**

A multi-band monopole antenna for a mobile communications device includes a common conductor coupled to both a first radiating arm and a second radiating arm. The common conductor includes a feeding port for coupling the antenna to communications circuitry in a mobile communications device. In one embodiment, the first radiating arm includes a space-filling curve. In another embodiment, the first radiating arm includes a meandering section extending from the common conductor in a first direction and a contiguous extended section extending from the meandering section in a second direction.

**18 Claims, 7 Drawing Sheets**





US008259017B2

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

(10) **Patent No.:** **US 8,259,017 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

- (54) **HYBRID ANTENNAS FOR ELECTRONIC DEVICES**
- (75) Inventors: **Robert W. Schlub**, Campbell, CA (US);  
**Qingxiang Li**, Mountain View, CA (US);  
**Juan Zavala**, Watsonville, CA (US);  
**Robert J. Hill**, Salinas, 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.

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- (21) Appl. No.: **13/335,714**
- (22) Filed: **Dec. 22, 2011**
- (65) **Prior Publication Data**  
US 2012/0092221 A1 Apr. 19, 2012

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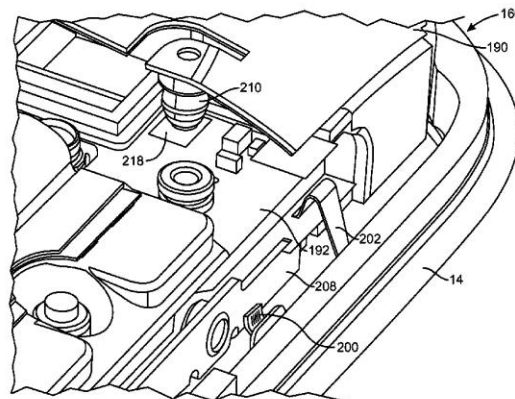
- Related U.S. Application Data**
- (62) Division of application No. 12/120,008, filed on May 13, 2008, now Pat. No. 8,102,319.
- (60) Provisional application No. 61/044,456, filed on Apr. 11, 2008.
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)
- (52) **U.S. Cl.** ..... **343/702; 343/700 MS**
- (58) **Field of Classification Search** ..... **343/700, 343/702, 725, 729, 767, 829, 846**  
See application file for complete search history.

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

- (56) **References Cited**  
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(57) **ABSTRACT**  
A portable electronic device is provided that has a hybrid antenna. The hybrid antenna may include a slot antenna structure and a planar inverted-F antenna structure. The planar inverted-F antenna structure may be formed from traces on a flex circuit substrate. A backside trace may form a series capacitance for the planar inverted-F antenna structure. The antenna slot may have a perimeter that is defined by the location of conductive structures such as flex circuits, metal housing structures, a conductive bezel, printed circuit board ground conductors, and electrical components. Springs may be used in electrically connecting these conductive elements. A spring-loaded pin may be used as part of an antenna feed conductor. The pin may connect a transmission line path on a printed circuit board to the planar inverted-F antenna structure while allowing the planar inverted-F antenna structure to be removed from the device for rework or repair.

**15 Claims, 15 Drawing Sheets**





US008259021B2

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

(10) **Patent No.:** **US 8,259,021 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

(54) **ELECTROMAGNETIC RADIATION APPARATUS AND METHOD FOR FORMING THE SAME**

(75) Inventors: **Ta Chun Pu**, Kaohsiung (TW); **Chun Yih Wu**, Taichung (TW); **Hung Hsuan Lin**, Taipei (TW); **Jui Hung Chen**, Taichung (TW)

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 543 days.

(21) Appl. No.: **12/341,268**

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

(65) **Prior Publication Data**

US 2010/0156738 A1 Jun. 24, 2010

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/702, 846, 767**

See application file for complete search history.

(56) **References Cited**

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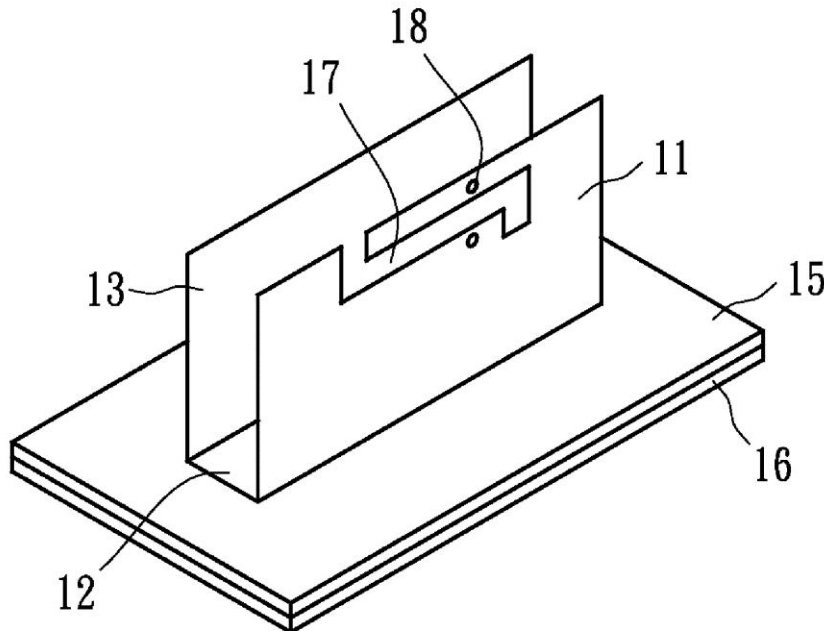
*Primary Examiner* — Hoanganh Le

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

(57) **ABSTRACT**

According to an embodiment of the present invention, an electromagnetic radiation apparatus includes a ground plane and an integrally formed antenna structure. The integrally formed antenna structure may include a radiation plate perpendicular to or with an angle larger than 45 degrees to the ground plane and a shielding structure configured to restrict radiation of the radiation plate.

**20 Claims, 15 Drawing Sheets**





US008259023B2

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

(10) **Patent No.:** **US 8,259,023 B2**  
(45) **Date of Patent:** **\*Sep. 4, 2012**

(54) **ANTENNA COIL AND ANTENNA DEVICE**  
(75) Inventors: **Hiroyuki Kubo**, Kanazawa (JP);  
**Hiromitsu Ito**, Hakusan (JP); **Kuniaki**  
**Yosui**, Kanazawa (JP)  
(73) Assignee: **Murata Manufacturing Co., Ltd.**,  
Kyoto (JP)  
(\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 527 days.  
This patent is subject to a terminal dis-  
claimer.

(21) Appl. No.: **12/357,546**  
(22) Filed: **Jan. 22, 2009**  
(65) **Prior Publication Data**  
US 2009/0121955 A1 May 14, 2009  
**Related U.S. Application Data**  
(63) Continuation of application No. PCT/JP2007/061771,  
filed on Jun. 12, 2007.  
(30) **Foreign Application Priority Data**  
Aug. 9, 2006 (JP) ..... 2006-217198  
(51) **Int. Cl.**  
**H01Q 7/08** (2006.01)  
(52) **U.S. Cl.** ..... **343/788**; 343/787; 343/702  
(58) **Field of Classification Search** ..... 343/787,  
343/788, 702  
See application file for complete search history.

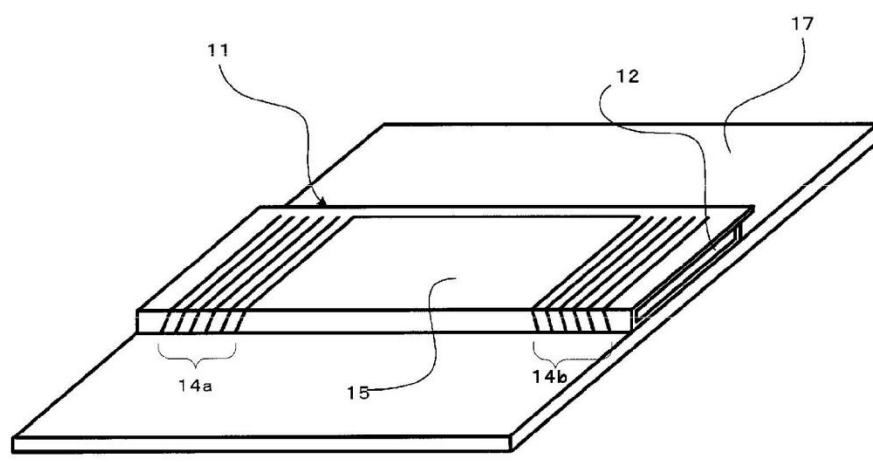
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*Primary Examiner* — Hoang V Nguyen  
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**  
An antenna coil is obtained by winding a flexible substrate  
around a magnetic core. Conductors are provided on the  
flexible substrate, whereby a first coil portion and a second  
coil portion are provided on either side of the magnetic core  
except for in a middle portion. A non-winding portion includ-  
ing no conductors is provided between the first coil portion  
and the second coil portion on a main surface of the magnetic  
core.

**13 Claims, 6 Drawing Sheets**





US008259030B2

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

(10) **Patent No.:** **US 8,259,030 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

(54) **ANTENNA OF THE HELIX TYPE HAVING RADIATING STRANDS WITH A SINUSOIDAL PATTERN AND ASSOCIATED MANUFACTURING PROCESS**

(75) Inventors: **Lamyaa Hanane**, Toulouse (FR); **Sami Hebib**, Toulouse (FR); **Hervé Aubert**, Toulouse (FR); **Nelson Fonseca**, Cugnaux (FR)

(73) Assignee: **Centre National d'Etudes Spatiales** (FR)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 356 days.

(21) Appl. No.: **12/677,597**

(22) PCT Filed: **Sep. 11, 2008**

(86) PCT No.: **PCT/EP2008/062045**

§ 371 (c)(1),  
(2), (4) Date: **Mar. 11, 2010**

(87) PCT Pub. No.: **WO2009/034125**

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

(65) **Prior Publication Data**

US 2010/0194665 A1 Aug. 5, 2010

(30) **Foreign Application Priority Data**

Sep. 11, 2007 (FR) ..... 07 57485

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

(52) **U.S. Cl.** ..... **343/895**

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

See application file for complete search history.

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*Primary Examiner* — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Lerner, David, Littenberg, Krumholz & Mentlik, LLP

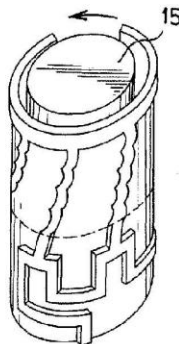
(57) **ABSTRACT**

The invention relates to an antenna of the helix type, comprising a plurality of radiating strands wound in a helix in an axisymmetric form (15), characterized in that each radiating strand is made up of at least one reference pattern (MR1, MR2, MR3) defined by an analytic function defined in a reference frame, the axis of the abscissae of which is the director axis of the radiating strands and is a periodic function of (I) or (II) and  $A_k$  correspond respectively to the frequency and to the amplitude of the sinusoid of index k.

$$y = A_0 \sin\left(2\pi \frac{x}{T}\right) + \sum_{k=1}^{\infty} A_k \sin\left(2\pi \sigma_k \frac{x}{T}\right) \quad (I)$$

$$2\pi \sigma_k \frac{1}{T} \quad (II)$$

**16 Claims, 4 Drawing Sheets**







US008260199B2

(12) **United States Patent**  
**Kowalski**

(10) **Patent No.:** **US 8,260,199 B2**  
(45) **Date of Patent:** **Sep. 4, 2012**

- (54) **NFC MODULE, IN PARTICULAR FOR MOBILE PHONE**
- (76) Inventor: **Jacek Kowalski**, Aix en Provence (FR)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 640 days.

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*Primary Examiner* — Duc Nguyen

*Assistant Examiner* — Charles Chow

(74) *Attorney, Agent, or Firm* — Panitch Schwarze Belisario & Nadel LLP

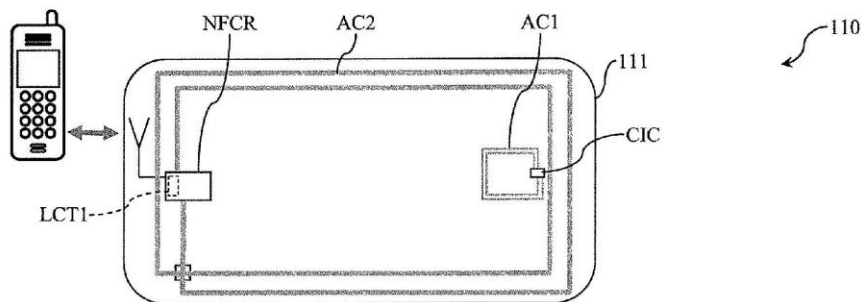
- (21) Appl. No.: **11/750,780**
- (22) Filed: **May 18, 2007**
- (65) **Prior Publication Data**  
US 2008/0245851 A1 Oct. 9, 2008
- (30) **Foreign Application Priority Data**  
Apr. 4, 2007 (FR) ..... 07 02459

- (51) **Int. Cl.**  
**H04B 5/00** (2006.01)
- (52) **U.S. Cl.** . **455/41.1**; 455/41.2; 455/558; 235/462.25; 235/462.45
- (58) **Field of Classification Search** ..... 455/41.1, 455/424, 425, 456.5, 456.6, 561, 550.1, 575.1, 455/415, 412.1, 558, 557, 575.6, 434, 41.2; 340/853.9, 854.8, 854.6, 855.1, 870.15, 870.03, 340/870.11; 325/472, 462, 383; 370/252, 370/338; 235/462.25, 462.45, 462.49, 472.02, 235/472.03  
See application file for complete search history.

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- (57) **ABSTRACT**  
One embodiment of the invention comprises a functional module for storing and exchanging data, comprising a common portable support, at least one passive contactless integrated circuit in the form of a first semi-conductor chip, a contactless integrated circuit reader in the form of a second semi-conductor chip, the contactless integrated circuit and the reader being gathered on or in the common portable support, an antenna coil of the contactless integrated circuit, connected to the contactless integrated circuit, an antenna coil of the reader, connected to the reader, the antenna coil of the contactless integrated circuit being coupled to the antenna coil of the reader.

**34 Claims, 17 Drawing Sheets**





US008264411B2

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

(10) **Patent No.:** **US 8,264,411 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

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

(75) Inventors: **Takuya Murayama**, Ishikawa-gun (JP);  
**Kunihiro Komaki**, Yokohama (JP);  
**Takashi Ishihara**, Ishikawa-gun (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**,  
Kyoto (JP)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

(21) Appl. No.: **12/581,235**

(22) Filed: **Oct. 19, 2009**

(65) **Prior Publication Data**  
US 2010/0026588 A1 Feb. 4, 2010

**Related U.S. Application Data**  
(63) Continuation of application No. PCT/JP2008/057015, filed on Apr. 9, 2008.

(30) **Foreign Application Priority Data**  
May 2, 2007 (JP) ..... 2007-121817

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/846, 767, 895, 702**  
See application file for complete search history.

(56) **References Cited**

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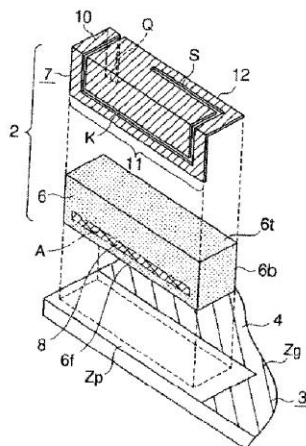
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*Primary Examiner* — Jacob Y Choi  
*Assistant Examiner* — Hasan Islam  
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna element has a dielectric base, at least a portion of which is arranged in a non-ground region of a substrate. A feeding radiation electrode has an intermediate path that is connected to a feeding portion and that is arranged to extend in a perimeter direction of the dielectric base on a side surface of the dielectric base adjacent to the non-ground region and spaced away from a ground region. The feeding radiation electrode has an open end side path that is arranged to extend along a loop path from the termination of the intermediate path and an open end of the extended distal end is arranged parallel or substantially parallel to and spaced apart from the intermediate path. A dielectric material having a high dielectric constant, which increases the capacitance between the intermediate path and the open end, is located in a region including the spaced region between the intermediate path and parallel or substantially parallel open end.

**12 Claims, 9 Drawing Sheets**





US008264412B2

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

(10) **Patent No.:** **US 8,264,412 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

(54) **ANTENNAS AND ANTENNA CARRIER STRUCTURES FOR ELECTRONIC DEVICES**

(75) Inventors: **Enrique Ayala**, Watsonville, CA (US); **Gregory Allen Springer**, Sunnyvale, CA (US); **Douglas B. Kough**, San Jose, CA (US); **Matthew Ian McDonald**, San Jose, CA (US)

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

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 738 days.

(21) Appl. No.: **12/142,744**

(22) Filed: **Jun. 19, 2008**

(65) **Prior Publication Data**

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**Related U.S. Application Data**

(60) Provisional application No. 61/019,218, filed on Jan. 4, 2008.

(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, 742, 767, 844, 846, 867, 873, 793, 343/815, 893, 895, 901**

See application file for complete search history.

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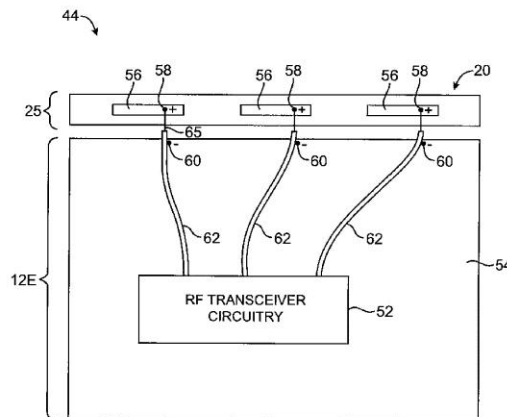
*Primary Examiner* — Hoanganh Le

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

(57) **ABSTRACT**

Antenna support structures and antennas are provided for wireless electronic devices such as portable electronic devices. Antenna resonating elements may be formed from conductive coatings on two-shot molded interconnect device dielectric antenna support structures. The conductive coatings may be formed from wet-plated copper or other conductive materials. The antenna support structure may have tabs that electrically connect antenna resonating elements to the case of a wireless electronic device that serves as an antenna ground plane. The antenna support structure may be curved about its longitudinal axis so that the antenna resonating elements on the support structure protrude upwards to enhance antenna performance. In a portable electronic device such as a portable computer, the antenna support structure may be mounted within a dielectric portion of the computer housing that is located between the display portion of the housing and the base of the housing.

**18 Claims, 11 Drawing Sheets**







US008264413B2

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

(10) **Patent No.:** **US 8,264,413 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

- (54) **SINGLE BAND ANTENNA AND ANTENNA MODULE**
- (75) Inventors: **Chih-Yung Huang**, Taichung County (TW); **Kuo-Chang Lo**, Miaoli County (TW)
- (73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)
- (\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 309 days.
- (21) Appl. No.: **12/649,045**
- (22) Filed: **Dec. 29, 2009**
- (65) **Prior Publication Data**  
US 2010/0164830 A1 Jul. 1, 2010
- (30) **Foreign Application Priority Data**  
Dec. 30, 2008 (TW) ..... 97151468 A
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)
- (52) **U.S. Cl.** ..... **343/702; 343/846**
- (58) **Field of Classification Search** ..... 343/700 MS, 343/702, 846

See application file for complete search history.

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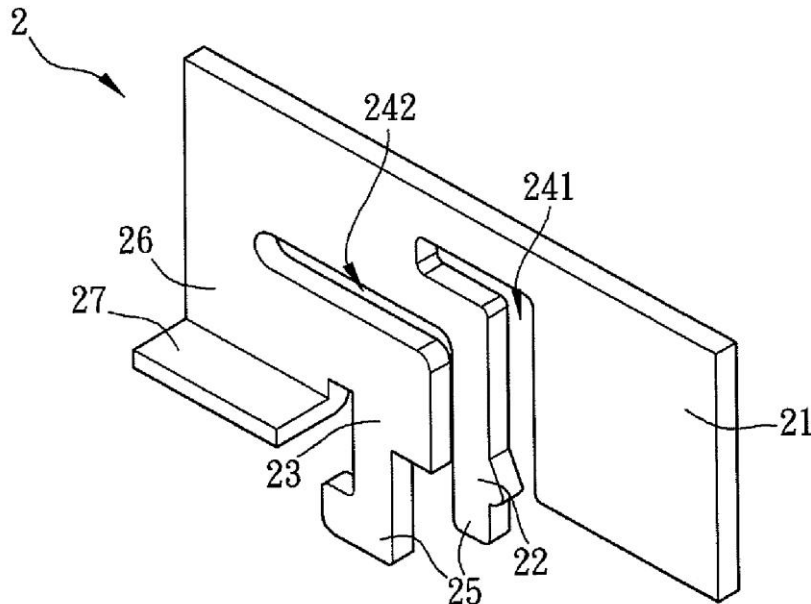
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*Primary Examiner* — Jacob Y Choi  
*Assistant Examiner* — Robert Karacsony  
 (74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, PLLC

(57) **ABSTRACT**

A single band antenna includes a radiating part, a feeding part and a grounding part. The feeding part is connected with the radiating part. A first separating slot exists between the radiating part and the feeding part. The grounding part is connected with the feeding part. A second separating slot exists between the feeding part and the grounding part. Each of the first separating slot and second separating slot has at least one bend.

**19 Claims, 5 Drawing Sheets**





US008264414B2

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

(10) **Patent No.:** **US 8,264,414 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

(54) **ANTENNA APPARATUS INCLUDING MULTIPLE ANTENNA PORTIONS ON ONE ANTENNA ELEMENT**

(75) Inventors: **Tsutomu Sakata**, Osaka (JP); **Atsushi Yamamoto**, Kyoto (JP); **Hiroshi Iwai**, Osaka (JP); **Satoru Amari**, Osaka (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 426 days.

(21) Appl. No.: **12/665,456**

(22) PCT Filed: **Apr. 21, 2009**

(86) PCT No.: **PCT/JP2009/001814**

§ 371 (c)(1),  
(2), (4) Date: **Feb. 12, 2010**

(87) PCT Pub. No.: **WO2009/130887**

PCT Pub. Date: **Oct. 29, 2009**

(65) **Prior Publication Data**

US 2010/0207823 A1 Aug. 19, 2010

(30) **Foreign Application Priority Data**

Apr. 21, 2008 (JP) ..... 2008-110215

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

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

(58) **Field of Classification Search** ..... **343/702,**  
**343/722, 860, 709**

See application file for complete search history.

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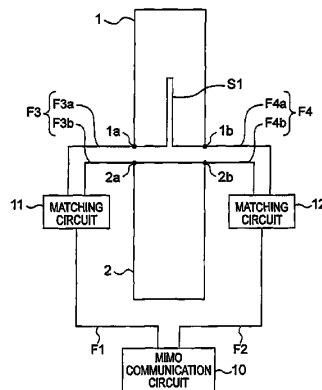
*Primary Examiner* — Huedung Mancuso

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

(57) **ABSTRACT**

An antenna apparatus is provided with two feed ports respectively provided at positions on an antenna element, and the antenna element is simultaneously excited through the two feed ports so as to simultaneously operate as two antenna portions respectively associated with the two feed ports. The antenna apparatus is further provided with a slit provided between the two feed ports, for changing a resonant frequency of the antenna element and producing isolation between the feed ports at a isolation frequency, and provided with matching means for shifting an operating frequency of the antenna element from the changed resonant frequency to the isolation frequency.

**9 Claims, 33 Drawing Sheets**





US008264418B2

(12) **United States Patent**  
**Huang**

(10) **Patent No.:** **US 8,264,418 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

(54) **PLANAR ANTENNA WITH ISOTROPIC RADIATION PATTERN**

FOREIGN PATENT DOCUMENTS

EP 1498982 1/2005  
WO 2008009667 1/2008

(75) Inventor: **Huan-Chu Huang**, Taoyuan County (TW)

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(73) Assignee: **HTC Corporation**, Taoyuan County (TW)

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“Office Action of European Counterpart Application” issued on Mar. 16, 2010, p. 1-p. 3.

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 394 days.

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(21) Appl. No.: **12/619,689**

Primary Examiner — Trinh Dinh

(22) Filed: **Nov. 17, 2009**

(74) Attorney, Agent, or Firm — Jianq Chyun IP Office

(65) **Prior Publication Data**

US 2011/0037673 A1 Feb. 17, 2011

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Aug. 14, 2009 (TW) ..... 98127503 A

A planar antenna with an isotropic radiation pattern is provided. The planar antenna includes a substrate, a dipole antenna, a microstrip line set, and a channel selection module. The dipole antenna is disposed on a first surface of the substrate, and the microstrip line set and the channel selection module are disposed on a second surface of the substrate. A first microstrip line and a second microstrip line of the microstrip line set are spirally extended along two opposite rotation trails on a vertical projection plane to form a high-frequency path with the dipole antenna. The planar antenna controls the on/off state of the channel selection module so that a low-frequency path is formed when the dipole antenna is connected to a first line and a second line. A plurality of channels having different operating frequencies is respectively generated within the high-frequency path and the low-frequency path.

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

(52) **U.S. Cl.** ..... **343/793; 343/895; 343/700 MS**

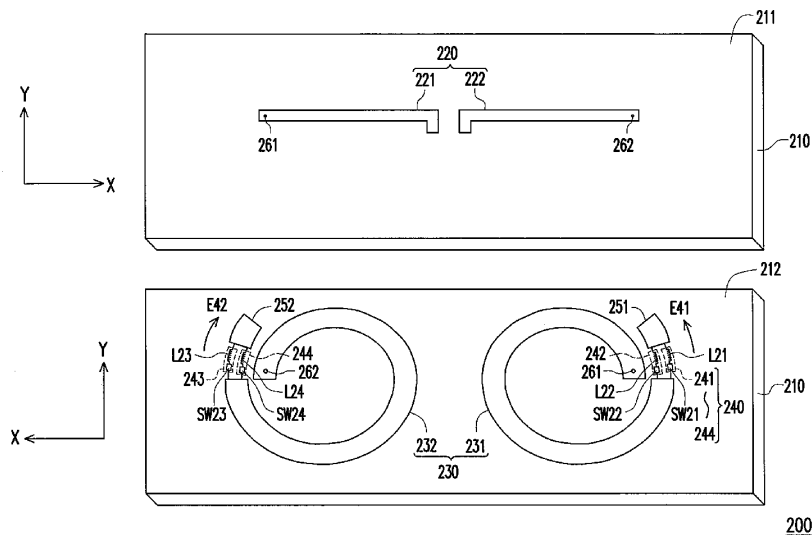
(58) **Field of Classification Search** ..... None  
See application file for complete search history.

(56) **References Cited**

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13 Claims, 6 Drawing Sheets





US008265718B2

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

(10) **Patent No.:** **US 8,265,718 B2**  
(45) **Date of Patent:** **Sep. 11, 2012**

(54) **MOBILE WIRELESS DEVICE**  
(75) Inventors: **Kenshi Horiyata**, Kanagawa (JP);  
**Nobuhiro Iwai**, Kanagawa (JP); **Kenichi Sato**, Miyagi (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 187 days.

(21) Appl. No.: **12/812,421**

(22) PCT Filed: **Dec. 26, 2008**

(86) PCT No.: **PCT/JP2008/003997**  
§ 371 (c)(1),  
(2), (4) Date: **Jul. 9, 2010**

(87) PCT Pub. No.: **WO2009/087739**  
PCT Pub. Date: **Jul. 16, 2009**

(65) **Prior Publication Data**  
US 2010/0285851 A1 Nov. 11, 2010

(30) **Foreign Application Priority Data**  
Jan. 11, 2008 (JP) ..... 2008-004756

(51) **Int. Cl.**  
**H04W 88/02** (2009.01)  
(52) **U.S. Cl.** ..... **455/575.3; 455/575.1; 455/90.3**  
(58) **Field of Classification Search** ..... **455/575.1, 455/575.3, 90.3, 128, 129, 347, 348, 349**  
See application file for complete search history.

(56) **References Cited**

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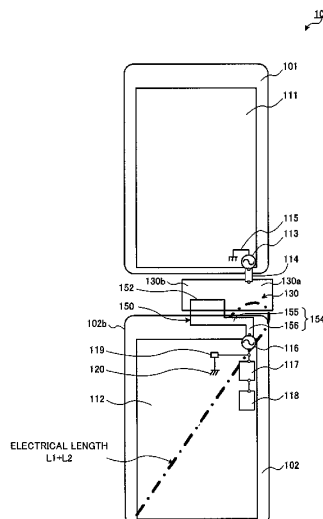
*Primary Examiner* — Cong Tran

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

(57) **ABSTRACT**

Disclosed is a mobile wireless device, which has an antenna structure for feeding a hinge core with an electric power and which can be adapted to wireless communications of low-frequency bands without enlarging a casing itself. In this wireless device, an upper casing (101) equipped with a first circuit substrate (111) and a lower casing (102) equipped with a second circuit substrate (112) having a wireless unit (118) mounted thereon are connected to open and close through a hinge unit having a conductive hinge (130). A feeding unit (113) mounted in the upper casing (101) feeds the conductive hinge (130) with an electric power from the first circuit substrate (111). A cellular antenna (150) mounted in the lower casing (102) is connected with the ground pattern of the second circuit substrate (112) at the position, where an extension (154) is separated along the axial direction of the conductive hinge (130) from a capacity coupling unit (152) arranged to confront a portion of the conductive hinge (130) and coupled capacitively to a portion of the conductive hinge (130), thereby to short-circuit the capacity coupling unit (152) and the ground pattern.

**10 Claims, 6 Drawing Sheets**





US008269672B2

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

(10) **Patent No.:** **US 8,269,672 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

- (54) **OMNI-DIRECTIONAL, MULTI-POLARITY, LOW PROFILE PLANAR ANTENNA**
- (75) Inventors: **Prapan Paul Tinaphong**, Westfield, IN (US); **Hong Yin**, Carmel, IN (US)
- (73) Assignee: **Audiovox Corporation**, Hauppauge, NY (US)
- (\* ) 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.: **12/454,888**  
(22) Filed: **May 26, 2009**

(65) **Prior Publication Data**  
US 2009/0289853 A1 Nov. 26, 2009

- Related U.S. Application Data**
  - (60) Provisional application No. 61/128,801, filed on May 23, 2008.
  - (51) **Int. Cl.**  
**H01Q 1/38** (2006.01)
  - (52) **U.S. Cl.** ..... **343/700 MS; 343/846; 343/893**
  - (58) **Field of Classification Search** ..... **343/700 MS, 343/702, 846, 893**
- See application file for complete search history.

(56) **References Cited**

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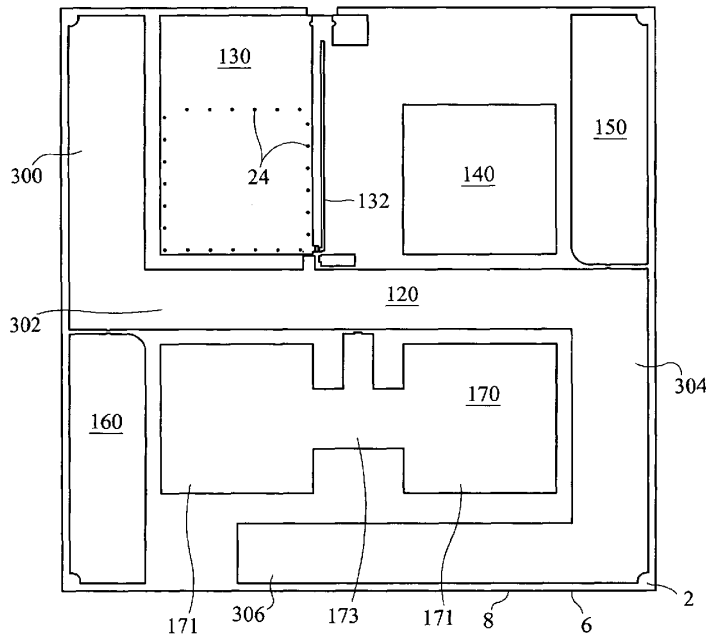
Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration; International Search Report; and the Written Opinion of the International Searching Authority.

*Primary Examiner* — Dieu H Duong  
(74) *Attorney, Agent, or Firm* — Gerald T. Bodner

(57) **ABSTRACT**

An omni-directional, multi-polarity, low profile planar antenna for receiving high definition television signals includes a dielectric substrate having a first side and a second side on which are respectively formed first and second conductive patterns. Each conductive pattern includes segments functioning as antenna elements which are arranged to form a first modified H-shaped pattern on the first side of the dielectric substrate, and a second modified H-shaped pattern on the second side of the dielectric substrate which is disposed substantially ninety degrees with respect to the first modified H-shaped pattern. Each of the H-shaped patterns includes an extended S-shaped segment.

**8 Claims, 9 Drawing Sheets**





US008269673B2

(12) **United States Patent**  
**Chiang**

(10) **Patent No.:** **US 8,269,673 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **BROADBAND ANTENNA AND AN ELECTRONIC DEVICE HAVING THE BROADBAND ANTENNA**

(75) Inventor: **Yuh-Yuh Chiang**, Taipei Hsien (TW)

(73) Assignee: **Wistron Neweb Corp.**, 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 406 days.

(21) Appl. No.: **12/588,707**

(22) Filed: **Oct. 26, 2009**

(65) **Prior Publication Data**  
US 2010/0123634 A1 May 20, 2010

(30) **Foreign Application Priority Data**  
Nov. 14, 2008 (TW) ..... 97144215 A

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

(52) **U.S. Cl.** ..... **343/700 MS; 343/722**

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

(56) **References Cited**

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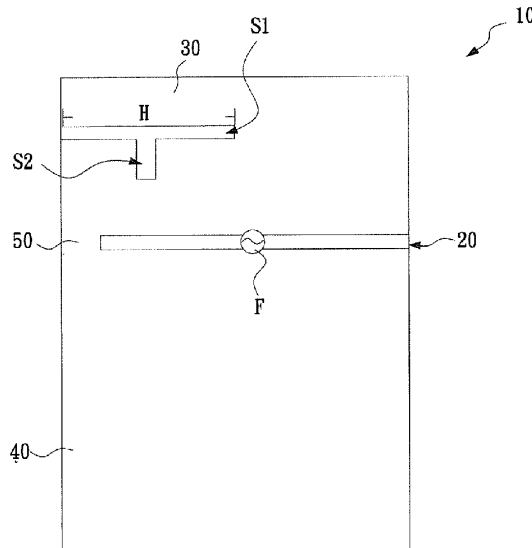
*Primary Examiner* — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Bacon & Thomas, PLLC

(57) **ABSTRACT**

A broadband antenna for wireless signal transmission of an electronic device comprises a base board, a radiating element, a grounding element, a shorting element, and a feeding point. The radiating element, the grounding element, and the shorting element are disposed on the base board. The radiating element comprises a first slot and a second slot. The second slot is connected to the first slot substantially. The first slot and the second slot are used to adjust the operating band of the broadband antenna. The grounding element is used to ground the broadband antenna. The shorting element is used to connect the radiating element and the grounding element. The feeding point is disposed between an edge of the base board and the shorting element, and the horizontal extended range of the first slot does not exceed the position of the feeding point.

**10 Claims, 7 Drawing Sheets**





US008269674B2

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

(10) **Patent No.:** **US 8,269,674 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **ELECTRONIC DEVICE ANTENNA**

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

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 765 days.

(21) Appl. No.: **12/337,499**

(22) Filed: **Dec. 17, 2008**

(65) **Prior Publication Data**  
US 2010/0149751 A1 Jun. 17, 2010

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

(52) **U.S. Cl.** ..... **343/702; 343/872**

(58) **Field of Classification Search** ..... **343/702, 343/793, 795, 872, 873**  
See application file for complete search history.

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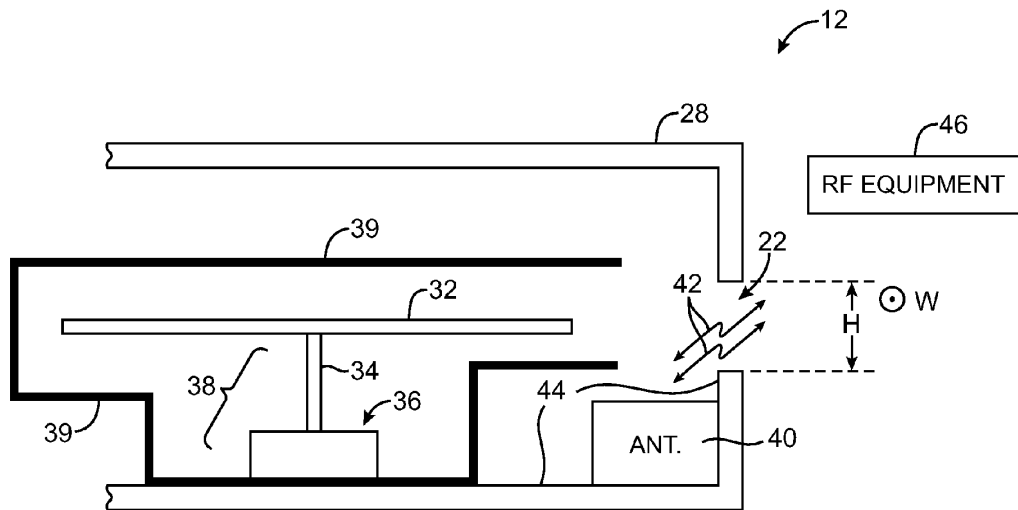
*Primary Examiner* — Dieu H Duong

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

(57) **ABSTRACT**

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

**17 Claims, 6 Drawing Sheets**





US008269675B2

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

(10) **Patent No.:** **US 8,269,675 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **ANTENNAS FOR ELECTRONIC DEVICES WITH CONDUCTIVE HOUSING**

(75) Inventors: **Douglas B. Kough**, San Jose, CA (US); **Gregory A. Springer**, Sunnyvale, CA (US); **Bing Chiang**, Melbourne, FL (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Hao Xu**, Cupertino, CA (US)

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 635 days.

(21) Appl. No.: **12/490,286**

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

(65) **Prior Publication Data**  
US 2010/0321255 A1 Dec. 23, 2010

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
(52) **U.S. Cl.** ..... **343/702**; 343/767  
(58) **Field of Classification Search** ..... 343/702, 343/767, 700 MS, 872  
See application file for complete search history.

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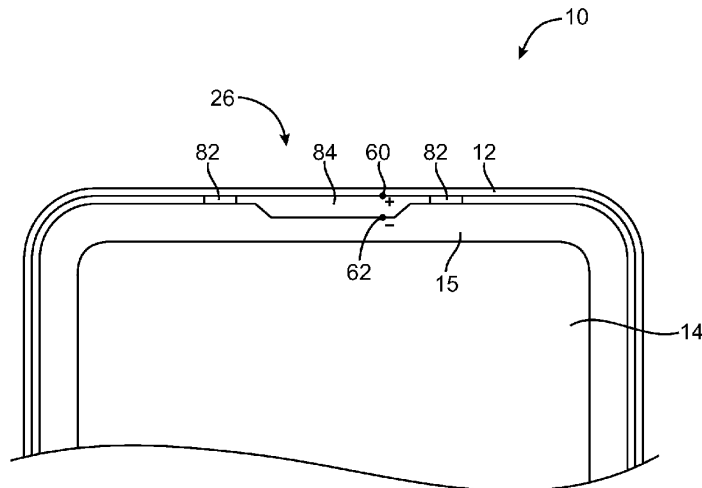
*Primary Examiner* — Hoanganh Le

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

(57) **ABSTRACT**

An electronic device may be provided with a conductive housing. The conductive housing may be formed from a metal. Slots may be formed in the housing. The slots may serve as an antenna and may be fed using an antenna feed structure within the electronic device housing. The electronic device may have a frame to which housing structures are attached and may have a stand or other support structure. The frame may be used to mount a display, to support housing walls, to support clutch barrel structures, etc. The slots may be formed in the frame or in a space between the frame and the housing walls. The slots or other antenna structures may also be formed in the stand. Multiple slots may be used together to support operations in two or more communications bands. There may be multiple dual slot antennas in the electronic device.

**20 Claims, 17 Drawing Sheets**







US008269676B2

(12) **United States Patent**  
**Lin**

(10) **Patent No.:** **US 8,269,676 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **DUAL-BAND ANTENNA AND PORTABLE WIRELESS COMMUNICATION DEVICE EMPLOYING THE SAME**

(75) Inventor: **Hsien-Chang Lin**, Tu-Cheng (TW)

(73) Assignee: **Chi Mei Communication Systems, Inc.**, Tu-Cheng, New Taipei (TW)

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

(21) Appl. No.: **12/536,313**

(22) Filed: **Aug. 5, 2009**

(65) **Prior Publication Data**  
US 2010/0149048 A1 Jun. 17, 2010

(30) **Foreign Application Priority Data**  
Dec. 16, 2008 (CN) ..... 2008 1 0306281

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 13/10** (2006.01)

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

(58) **Field of Classification Search** ..... **343/727, 343/729, 730, 770, 771, 700 MS, 795, 702, 343/767**

See application file for complete search history.

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*Primary Examiner* — Jacob Y Choi

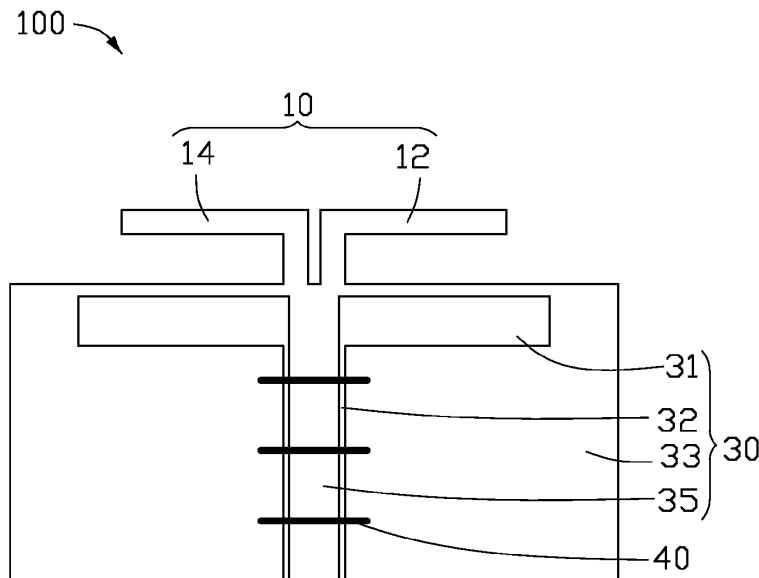
*Assistant Examiner* — Hasan Islam

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An exemplary dual-band antenna includes a first antenna unit and a second antenna unit for receiving /sending radio frequency signals corresponding generating a low resonant frequency and a high resonant frequency. The first antenna unit is perpendicularly connected to the second antenna unit. The second antenna unit includes a feed portion, two slots, two gaps and two grounding sheets. The feed portion is electrically connected to the first antenna unit and is used to receive radio frequency signals. The slots are adjacent to one side of the first antenna unit and are defined at the both sides of the feed portion, and the slots are connected with the feed portion and used to radiate radio frequency signals. The gaps extend away from a position of the first antenna unit and are defined at the both sides of the feed portion, and each gap communicates with corresponding slot. The grounding sheets are symmetrically positioned at both sides of the feed portion.

**15 Claims, 5 Drawing Sheets**





US008269677B2

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

(10) **Patent No.:** **US 8,269,677 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **DUAL-BAND CAVITY-BACKED ANTENNA FOR INTEGRATED DESKTOP COMPUTER**

(75) Inventors: **Jerzy Guterman**, Mountain View, CA (US); **Eduardo Lopez Camacho**, Watsonville, CA (US); **Mattia Pascolini**, Campbell, CA (US); **Enrique Ayala Vazquez**, Watsonville, 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 491 days.

(21) Appl. No.: **12/553,943**

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

(65) **Prior Publication Data**

US 2011/0050508 A1 Mar. 3, 2011

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

(52) **U.S. Cl.** ..... **343/702; 343/789**

(58) **Field of Classification Search** ..... **343/702, 343/789**

See application file for complete search history.

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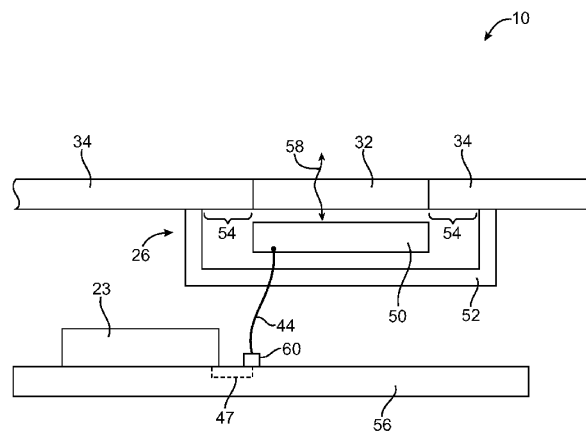
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An electronic device may have a housing with conductive housing walls. A dielectric antenna window may be formed in an opening in one of the conductive housing walls. A dielectric logo may form the dielectric antenna window. A dielectric support structure may have an outline that matches the dielectric logo. An antenna resonating element for an antenna may be formed on the dielectric support structure. An antenna cavity for the antenna may be formed by a conductive cavity structure. A pattern of voids in the dielectric support structure may reduce dielectric loading for the antenna. The conductive cavity structure may be formed from solderable plated metal. The conductive cavity structure may have a planar lip that is attached to the conductive housing walls using conductive adhesive. Rear wall portions of the conductive cavity structure may be oriented at a non-perpendicular non-zero angle with respect to the planar lip.

29 Claims, 14 Drawing Sheets





US008269678B2

(12) **United States Patent**  
**Sun**

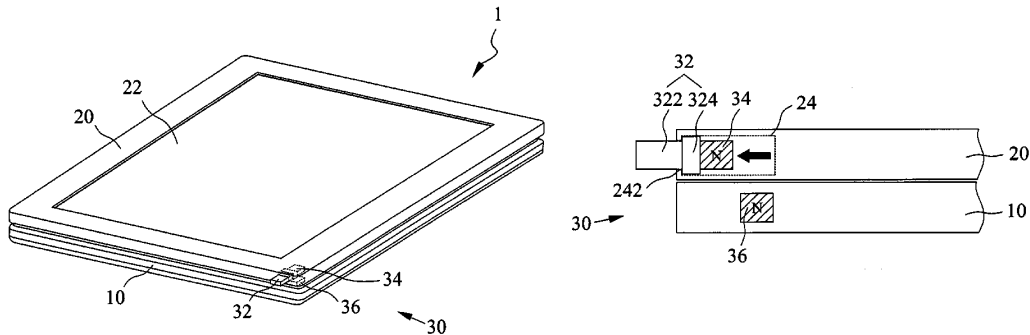
(10) **Patent No.:** **US 8,269,678 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

- (54) **TABLET PERSONAL COMPUTER AND ANTENNA MODULE THEREOF**
- (75) Inventor: **Rong-Cheng Sun**, Taipei Hsien (TW)
- (73) Assignee: **Wistron Corporation**, 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 426 days.
- (21) Appl. No.: **12/588,706**
- (22) Filed: **Oct. 26, 2009**
- (65) **Prior Publication Data**  
US 2010/0171668 A1 Jul. 8, 2010
- (30) **Foreign Application Priority Data**  
Jan. 6, 2009 (TW) ..... 98100229 A
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H04M 1/00** (2006.01)
- (52) **U.S. Cl.** ..... **343/702**; 343/872; 343/787; 455/575.1
- (58) **Field of Classification Search** ..... None  
See application file for complete search history.

- (56) **References Cited**  
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*Primary Examiner* — Trinh Dinh  
(74) *Attorney, Agent, or Firm* — Bacon & Thomas, PLLC

(57) **ABSTRACT**  
An antenna module for a tablet personal computer is disclosed. The tablet personal computer comprises a main body and a housing with a screen, and the housing is pivotally connected to the main body. The tablet personal computer is capable of being switched to a tablet mode. The antenna module comprises an antenna device, a first magnetic element, and a second magnetic element. The antenna device is located concealably in the housing. The first magnetic element is coupled to an end of the antenna device. The second magnetic element is located in the main body. The second magnetic element is positioned corresponding to the first magnetic element in the tablet mode such that an end of the antenna device can be moved outside the housing due to a magnetic force between the first magnetic element and the second magnetic element.

**19 Claims, 7 Drawing Sheets**





US008269681B2

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

(10) **Patent No.:** **US 8,269,681 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **SHEET-LIKE DIPOLE ANTENNA**

(75) Inventors: **Tsai-Yi Yang**, Tainan Hsien (TW);  
**Wei-Hung Hsu**, Tainan Hsien (TW)

(73) Assignee: **Cirocomm Technology Corp.**, Tainan Hsien (TW)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 516 days.

(21) Appl. No.: **12/651,587**

(22) Filed: **Jan. 4, 2010**

(65) **Prior Publication Data**

US 2011/0163929 A1 Jul. 7, 2011

(51) **Int. Cl.**  
**H01Q 13/10** (2006.01)  
**H01Q 9/28** (2006.01)  
**H01Q 21/00** (2006.01)

(52) **U.S. Cl.** ..... **343/725; 343/767; 343/795**

(58) **Field of Classification Search** ..... **343/767, 343/793, 795, 725**

See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Jacob Y Choi

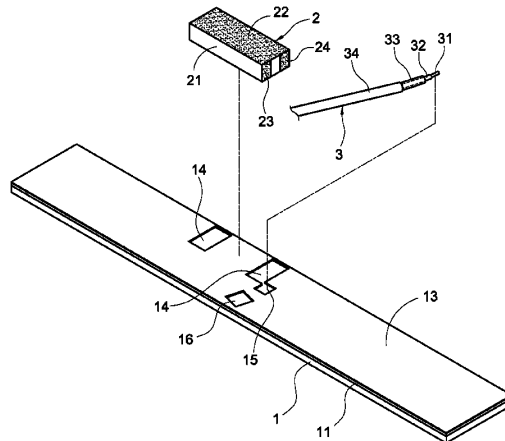
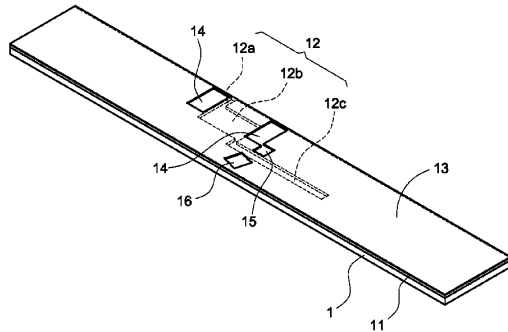
*Assistant Examiner* — Hasan Islam

(74) *Attorney, Agent, or Firm* — Chun-Ming Shih; HDLS IPR Services

(57) **ABSTRACT**

A sheet-like dipole antenna includes a substrate (1), an F-shape antenna (2), and a cable (3). The substrate (1) has a copper clad surface (11) and a slot (12). An insulating film (13) is provided on the copper clad surface (11) and the slot (12). A first soldering region (14), a second soldering region (15), and a third soldering region (16) are positioned adjacent to the slot (12). The cable (3) has a core (31) coated with an insulating layer (32). The insulating layer (32) is coated with a grounding layer (33). The grounding layer (33) is coated with an outer skin (34). One end of the cable (3) is electrically connected to a connector (35). The core (31) is connected to the second soldering region (15). The grounding layer (33) is soldered to the third soldering region (16).

**7 Claims, 15 Drawing Sheets**





US008269682B2

(12) **United States Patent**  
**Su**

(10) **Patent No.:** **US 8,269,682 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **MULTI-LOOP ANTENNA MODULE WITH WIDE BEAMWIDTH**

(75) Inventor: **Saou-Wen Su**, Keelung (TW)

(73) Assignees: **Silitek Electronic (Guangzhou) Co., Ltd.**, Guangzhou (CN); **Lite-On Technology Corporation**, Taipei (TW)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 299 days.

(21) Appl. No.: **12/786,867**

(22) Filed: **May 25, 2010**

(65) **Prior Publication Data**

US 2011/0102281 A1 May 5, 2011

(30) **Foreign Application Priority Data**

Oct. 29, 2009 (CN) ..... 2009 1 0210175

(51) **Int. Cl.**  
**H01Q 11/12** (2006.01)

(52) **U.S. Cl.** ..... 343/742; 343/848; 343/867

(58) **Field of Classification Search** ..... 343/742, 343/848, 867, 893

See application file for complete search history.

(56) **References Cited**

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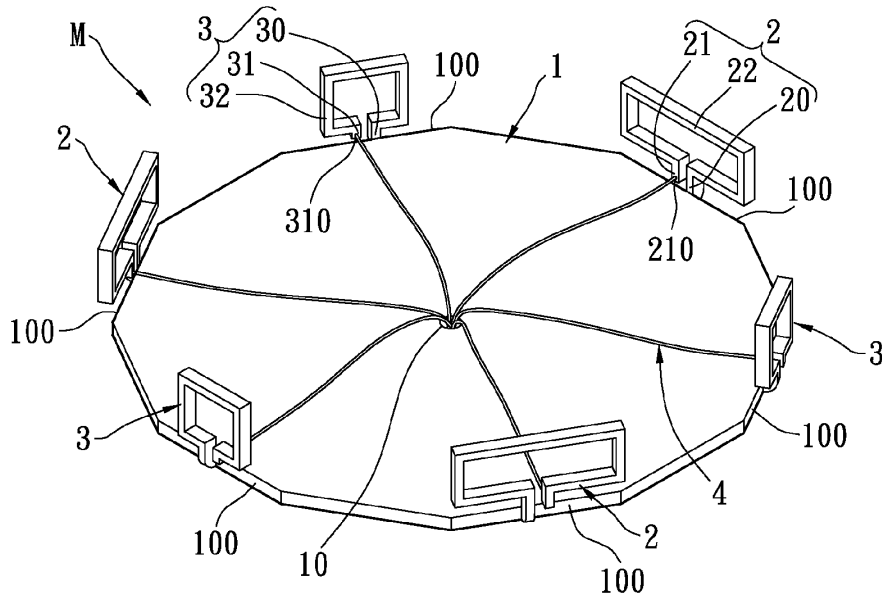
*Primary Examiner* — Tan Ho

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

(57) **ABSTRACT**

A multi-loop antenna module with wide beamwidth includes a grounding unit and a plurality of first loop units and second loop units. The first loop units are vertically disposed on outer peripheral sides of the grounding unit. Each first loop unit has a first shorting pin disposed on the grounding unit, a first feeding pin separated from the first shorting pin and suspended above the grounding unit, and a first loop radiating body connected between the first shorting pin and the first feeding pin. The second loop units are vertically disposed on outer peripheral sides of the grounding unit. Each second loop unit has a second shorting pin disposed on the grounding unit, a second feeding pin separated from the second shorting pin and suspended above the grounding unit, and a second loop radiating body connected between the second shorting pin and the second feeding pin.

**20 Claims, 8 Drawing Sheets**





US008269685B2

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

(10) **Patent No.:** **US 8,269,685 B2**  
(45) **Date of Patent:** **\*Sep. 18, 2012**

(54) **TAPERED SLOT ANTENNA**

(75) Inventors: **Matthew M. McQuaid**, Hudson, NH (US); **Michael J. O'Brien**, Nashua, NH (US); **Nicolas S. Peterson**, Merrimack, NH (US); **Basil W. Thompson**, Hooksett, NH (US); **Duane A. Beaulieu**, Brookline, NH (US); **Kari M. Karwedsky**, Merrimack, NH (US)

(73) Assignee: **BAE Systems Information and Electronic Systems Integration Inc.**, Nashua, NH (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 328 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/776,005**

(22) Filed: **May 7, 2010**

(65) **Prior Publication Data**

US 2011/0273350 A1 Nov. 10, 2011

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

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

(58) **Field of Classification Search** ..... 343/700 MS, 343/767

See application file for complete search history.

(56) **References Cited**

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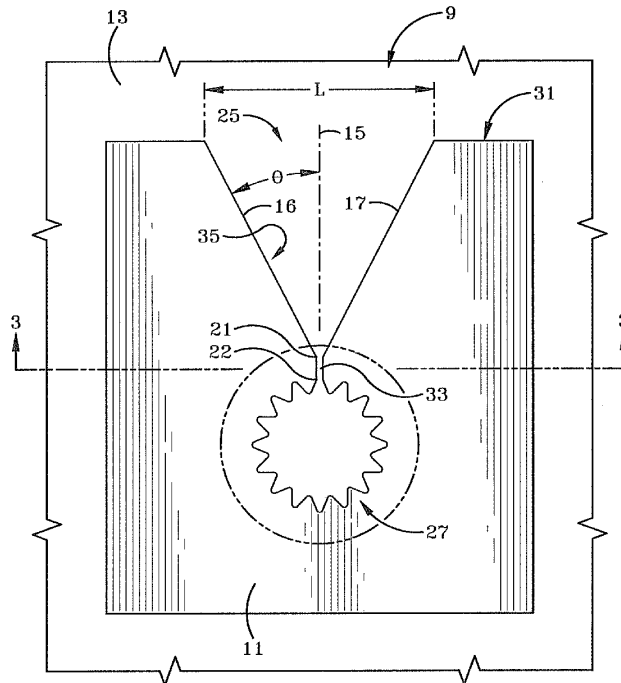
*Primary Examiner* — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Sand & Sebolt; Rodney E. Haven

(57) **ABSTRACT**

Methods, antennas and other embodiments associated with impedance matching an antenna feed slot. A slot antenna includes a planar metal sheet. A feed slot opening is formed in the metal sheet. The feed slot has a first end and a second end. A tapered opening is formed in the metal sheet. Adjacent sides of the tapered opening touch the first end of the feed slot. An impedance matching star shaped opening is formed in the metal. The impedance matching star shaped opening touches the second end of the feed slot.

**21 Claims, 5 Drawing Sheets**





US008269689B2

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

(10) **Patent No.:** **US 8,269,689 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **ANTENNA DEVICE**

(75) Inventors: **Ching-Chi Lin**, Taipei (TW); **Kai Shih**, Taipei (TW); **Yu-Yuan Wu**, Taipei (TW)

(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, New Taipei (TW)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 365 days.

(21) Appl. No.: **12/783,569**

(22) Filed: **May 20, 2010**

(65) **Prior Publication Data**

US 2011/0285600 A1 Nov. 24, 2011

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/702, 846, 848**

See application file for complete search history.

(56) **References Cited**

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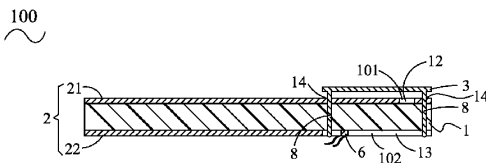
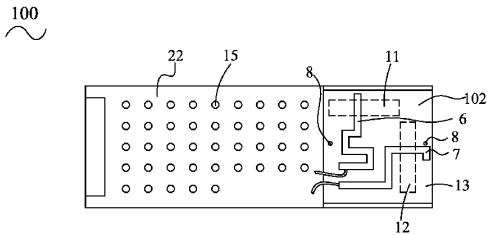
*Primary Examiner* — Tan Ho

(74) *Attorney, Agent, or Firm* — Lin & Associates IP, Inc.

(57) **ABSTRACT**

An antenna device includes an insulating substrate, a ground plane, a radiating element, a horizontal polarized portion and a vertical polarized portion. The insulating substrate has a first surface and a second surface opposite to the first surface, one end of the first surface defines a first isolating area and a second isolating area, one end of the second surface adjacent to the first and second isolating areas defines an insulating area, a horizontal feed circuit and a vertical feed circuit are disposed at the insulating area. The ground plane includes a first ground plane and a second ground plane. The radiating element is positioned opposite to and spaced from the first ground plane. The horizontal and vertical polarized portions are positioned on the radiating element and corresponding to the first and second isolating areas respectively so as to couple with the horizontal and vertical feed circuits, respectively.

**7 Claims, 3 Drawing Sheets**





US008270914B2

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

(10) **Patent No.:** **US 8,270,914 B2**  
(45) **Date of Patent:** **Sep. 18, 2012**

(54) **BEZEL GAP ANTENNAS**

(75) Inventors: **Mattia Pascolini**, Campbell, CA (US); **Robert J. Hill**, Salinas, CA (US); **Juan Zavala**, Watsonville, CA (US); **Nanbo Jin**, Sunnyvale, CA (US); **Qingxiang Li**, Mountain View, 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 315 days.

(21) Appl. No.: **12/630,756**

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

(65) **Prior Publication Data**

US 2011/0136447 A1 Jun. 9, 2011

(51) **Int. Cl.**  
**H04B 1/38** (2006.01)

(52) **U.S. Cl.** ..... **455/90.2**; 455/575.7; 455/90.3;  
455/107; 455/552.1; 455/562.1; 343/702

(58) **Field of Classification Search** ..... 455/90.2,  
455/575.7, 90.3, 107, 552.1, 562.1; 379/90,  
379/428; 343/702

See application file for complete search history.

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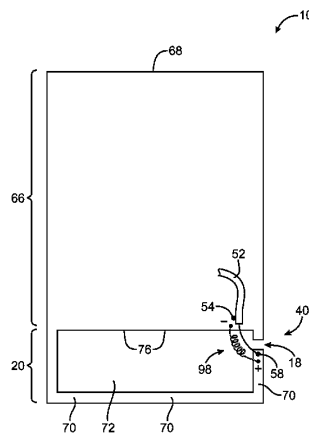
*Primary Examiner* — Sanh Phu

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

(57) **ABSTRACT**

Electronic devices are provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and antenna structures. A parallel-fed loop antenna may be formed from portions of an electronic device bezel and a ground plane. The antenna may operate in multiple communications bands. An impedance matching circuit for the antenna may be formed from a parallel-connected inductive element and a series-connected capacitive element. The bezel may surround a peripheral portion of a display that is mounted to the front of an electronic device. The bezel may contain a gap. Antenna feed terminals for the antenna may be located on opposing sides of the gap. The inductive element may bridge the gap and the antenna feed terminals. The capacitive element may be connected in series between one of the antenna feed terminals and a conductor in a transmission line located between the transceiver circuitry and the antenna.

**23 Claims, 11 Drawing Sheets**







US008274434B2

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

(10) **Patent No.:** **US 8,274,434 B2**  
(45) **Date of Patent:** **Sep. 25, 2012**

(54) **ELECTRONIC APPARATUS WITH A POSITIONING STRUCTURE FOR CABLE ORIENTATION**

(75) Inventors: **Hiroyuki Kusaka**, Mitaka (JP); **Toshiyuki Hirota**, Hino (JP); **Hiroyuki Hotta**, Hamura (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 662 days.

(21) Appl. No.: **12/324,644**

(22) Filed: **Nov. 26, 2008**

(65) **Prior Publication Data**

US 2009/0303137 A1 Dec. 10, 2009

(30) **Foreign Application Priority Data**

Jun. 5, 2008 (JP) ..... 2008-148439

(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.

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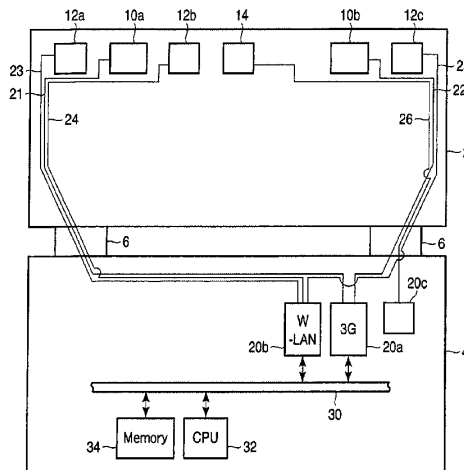
*Primary Examiner* — HoangAnh Le

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

(57) **ABSTRACT**

According to one embodiment, an antenna unit provided on the inner surface of the upper peripheral portion of the display housing of a notebook PC includes a projection that positions a power feeder connected to an electronic component adjacent to the antenna unit such that the power feeder extends at a constant distance from the core member of the antenna unit. The projection projects from the core member at a position at which it does not interfere with an antenna wire, and includes a recess that receives the power feeder.

**19 Claims, 8 Drawing Sheets**





US008274435B2

(12) **United States Patent**  
**Maruyama**

(10) **Patent No.:** **US 8,274,435 B2**  
(45) **Date of Patent:** **Sep. 25, 2012**

(54) **ANTENNA APPARATUS**

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 455 days.

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

(65) **Prior Publication Data**  
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(30) **Foreign Application Priority Data**  
Nov. 25, 2008 (JP) ..... 2008-300046

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
(52) **U.S. Cl.** ..... **343/702**; 343/700 MS; 343/895  
(58) **Field of Classification Search** ..... 343/702,  
343/700 MS, 895, 846, 858  
See application file for complete search history.

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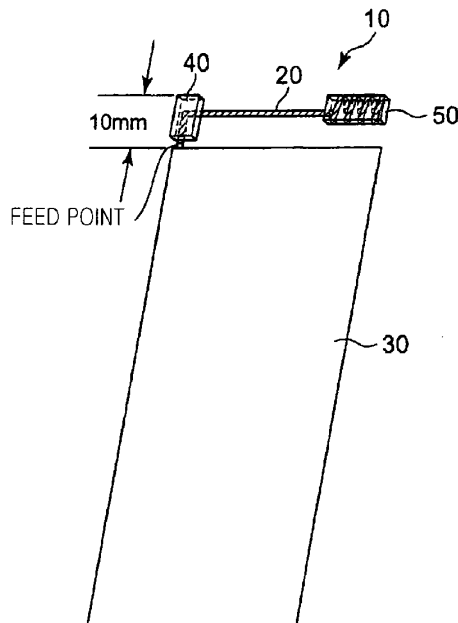
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*Primary Examiner* — Hoanganh Le

(57) **ABSTRACT**

A portable terminal includes a small-sized built-in antenna apparatus having an excellent electric performance. The built-in antenna apparatus includes a ground plate and an antenna unit. The ground plate includes a feed point. The antenna unit is disposed adjacent to an end of the ground plate. The antenna unit includes a reverse L-shaped antenna element. One end of the L-shaped antenna element is connected to the feed point and an opposite end of the L-shaped antenna has a helical shape. A magnetic piece is loaded at a portion where current distribution of the L-shaped antenna element is high, and a dielectric piece is loaded at a portion where current distribution of the L-shaped antenna element is low.

**20 Claims, 12 Drawing Sheets**





US008274436B2

(12) **United States Patent**  
**Huang**

(10) **Patent No.:** **US 8,274,436 B2**  
(45) **Date of Patent:** **Sep. 25, 2012**

(54) **MULTI-BAND ANTENNA**

(75) Inventor: **Chih-Yung Huang**, Taichung County (TW)

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 475 days.

(21) Appl. No.: **12/646,808**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 26, 2008 (TW) ..... 97151132 A

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/702, 846, 848**

See application file for complete search history.

(56) **References Cited**

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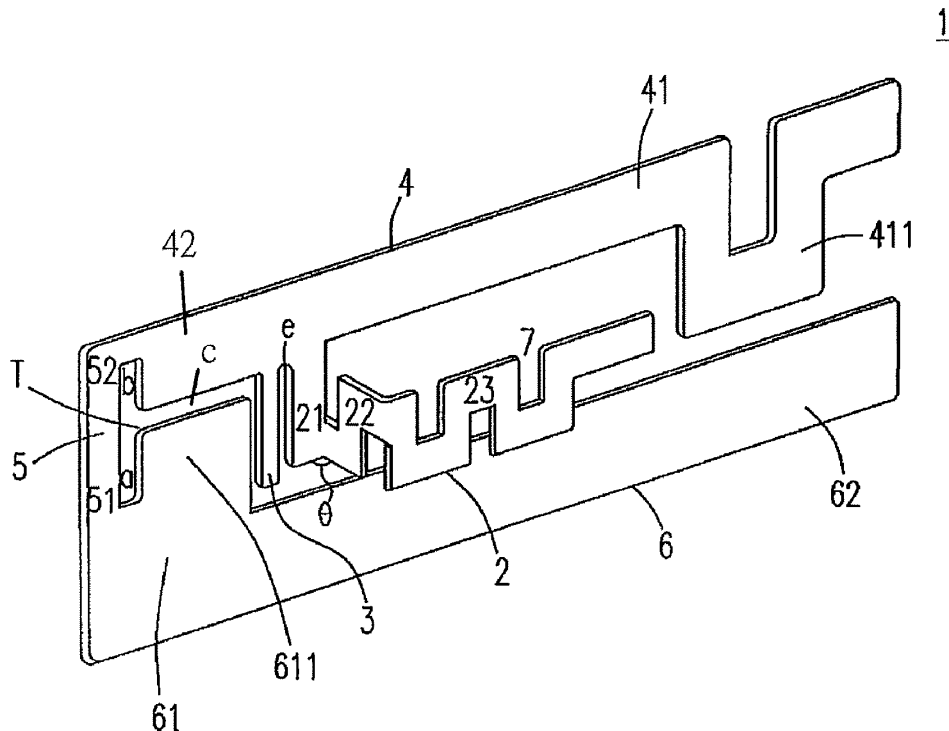
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*Primary Examiner* — Tan Ho

(57) **ABSTRACT**

A multi-band antenna is provided. The multi-band antenna includes a grounding element, a connecting element, a first radiating element and a second radiating element. The connecting element is connected to the grounding element and extends along a second direction. The first radiating element is connected to the connecting element and extends along the first direction, wherein the first radiating element, the grounding element and the connecting element are disposed on a first plane and have a resonating slot thereamong. The second radiating element is connected to the first radiating element and extends along a second plane to reach a specific distance, and then turns to be extended on a third plane parallel to the first plane, wherein the first plane and the third plane have a resonating region therebetween.

**20 Claims, 7 Drawing Sheets**





US008274437B2

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

(10) **Patent No.:** **US 8,274,437 B2**  
(45) **Date of Patent:** **\*Sep. 25, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE COMPRISING MULTI-FREQUENCY BAND ANTENNA AND RELATED METHODS**

(75) Inventors: **Yihong Qi**, Waterloo (CA); **Ying Tong Man**, Kitchener (CA); **Adrian Cooke**, Kitchener (CA); **Perry Jarmuszewski**, 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 disclaimer.

(21) Appl. No.: **13/184,635**

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

(65) **Prior Publication Data**  
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**Related U.S. Application Data**

(63) Continuation of application No. 12/358,054, filed on Jan. 22, 2009, now Pat. No. 7,982,677, which is a continuation of application No. 11/167,506, filed on Jun. 27, 2005, now Pat. No. 7,489,276.

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

(52) **U.S. Cl.** ..... **343/702; 343/828**

(58) **Field of Classification Search** ..... **343/700 MS, 343/702, 826, 828; 455/575.7**

See application file for complete search history.

(56) **References Cited**

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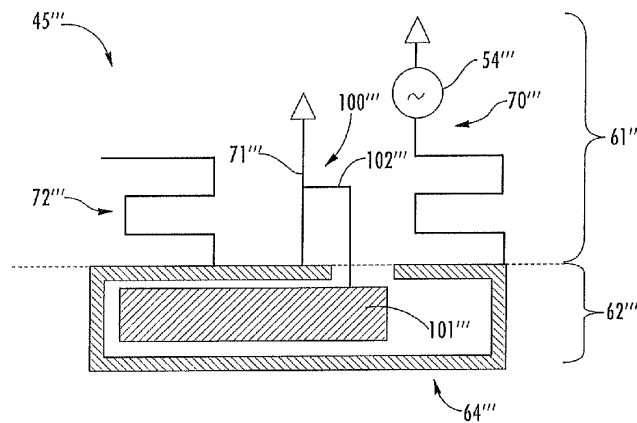
*Primary Examiner* — Michael C Wimer

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

(57) **ABSTRACT**

A mobile wireless communications device may include a housing and a multi-frequency band antenna carried within the housing. The multi-frequency band antenna may include a main loop conductor having a gap therein defining first and second ends of the main loop conductor, a first branch conductor having a first end connected adjacent the first end of the main loop conductor and having a second end defining a first feed point, and a second branch conductor having a first end connected adjacent the second end of the main loop conductor and a second end defining a second feed point. A third branch conductor has a first portion within the main loop conductor, and a second portion connected to the second feed point. A tuning branch conductor may have a first end connected to the main loop conductor between the respective first ends of the first and second branches.

**19 Claims, 14 Drawing Sheets**





US008274438B2

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

(10) **Patent No.:** **US 8,274,438 B2**  
(45) **Date of Patent:** **\*Sep. 25, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE INCLUDING AN ELECTRICALLY CONDUCTIVE, ELECTRICALLY FLOATING ELEMENT AND RELATED METHODS**  
(75) Inventors: **Yihong Qi**, St. Agatha (CA); **Ying Tong Man**, Waterloo (CA); **Krystyna Bandurska**, 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 disclaimer.

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(22) Filed: **Nov. 28, 2011**

(65) **Prior Publication Data**  
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**Related U.S. Application Data**  
(63) Continuation of application No. 12/901,633, filed on Oct. 11, 2010, now Pat. No. 8,068,061, which is a continuation of application No. 11/467,955, filed on Aug. 29, 2006, now Pat. No. 7,812,770.

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 19/00** (2006.01)

(52) **U.S. Cl.** ..... **343/702; 343/833; 343/834; 343/817; 343/700 MS**

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

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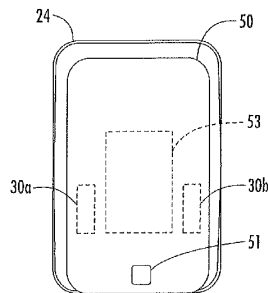
*Primary Examiner* — Trinh Dinh

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

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing having a surface, a printed circuit board (PCB) carried by the portable housing, and wireless transceiver circuitry carried by the PCB. The device may further include an antenna connected to the transceiver, and at least one electrically floating, electrically conductive, antenna beam shaping element secured to the surface of the portable housing for directing a beam pattern of the antenna.

**22 Claims, 4 Drawing Sheets**





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(12) **United States Patent**  
**Suetake**

(10) **Patent No.:** **US 8,275,421 B2**  
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(54) **WIRELESS COMMUNICATION DEVICE**

(75) Inventor: **Hiroyasu Suetake**, Osaka (JP)

(73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)

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

(21) Appl. No.: **12/664,583**

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§ 371 (c)(1),  
(2), (4) Date: **Dec. 14, 2009**

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PCT Pub. Date: **Jan. 15, 2009**

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(30) **Foreign Application Priority Data**

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**H04M 1/00** (2006.01)

(52) **U.S. Cl.** ..... **455/566**; 455/575.7; 455/575.1;  
455/575.4; 455/550.1

(58) **Field of Classification Search** ..... 455/575.7,  
455/575.1, 566, 575.3, 575.4, 550.1  
See application file for complete search history.

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*Primary Examiner* — Kathy Wang-Hurst

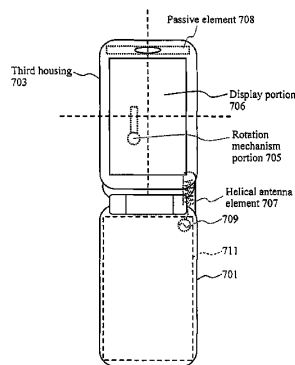
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

With respect to a mobile wireless device in which a first housing **101** and a second housing **102** are foldably connected via a hinge **104**, and in which a third housing **103** comprising a substantially rectangular display portion **106** is connected to the second housing **102** with a rotation mechanism portion **105** that rotates in a plane that is parallel with respect to a surface of the second housing **102**, an antenna **107** is placed at an end portion of the first housing **101** on the side of the hinge, and a passive element **108** is placed at an end portion of the third housing **103**. As a user rotates the third housing **103** by 90° to view visual data in horizontally long display, the antenna **107** and the passive element **108** are electro-magnetically coupled with each other, and the antenna characteristics of the antenna **107** improve. Thus, it becomes possible to provide an antenna that is more efficient when viewing visual data with a mobile wireless device, which is capable of receiving terrestrial digital TV and other visual data, on a screen that displays in a horizontally long manner.

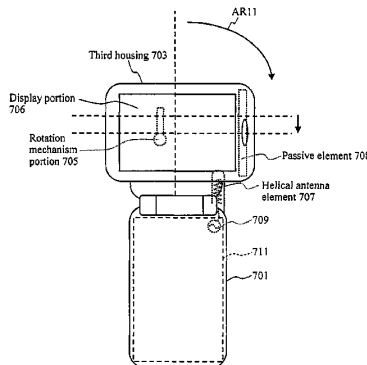
**22 Claims, 14 Drawing Sheets**

(A)



<Vertically long display>

(B)



<Horizontally long display>