



US007920094B2

(12) **United States Patent**
Hansen

(10) **Patent No.:** **US 7,920,094 B2**
(45) **Date of Patent:** **Apr. 5, 2011**

(54) **ANTENNA STRUCTURE HAVING PATCH ELEMENTS**

(75) Inventor: **Thomas Hansen**, Hildesheim (DE)

(73) Assignee: **Robert Bosch GmbH**, Stuttgart (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 74 days.

(21) Appl. No.: **11/660,424**

(22) PCT Filed: **Jun. 17, 2005**

(86) PCT No.: **PCT/EP2005/052822**

§ 371 (c)(1),

(2), (4) Date: **Sep. 26, 2007**

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PCT Pub. Date: **Feb. 23, 2006**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 17, 2004 (DE) 10 2004 039 743

(51) **Int. Cl.**

H01Q 1/38

(2006.01)

H01Q 21/08

(2006.01)

(52) **U.S. CL.** **343/700 MS; 343/853; 343/810; 343/824; 343/825; 343/826**

(58) **Field of Classification Search** **343/700 MS, 343/846, 737, 770, 824, 853**
See application file for complete search history.

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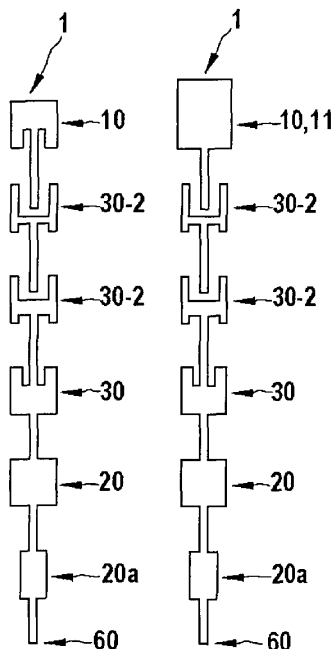
Primary Examiner — Trinh V Dinh

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

(57) **ABSTRACT**

In an antenna structure having a plurality of serially fed patch elements, at least one of the patch elements has a slot coupling to the continuation of the feed line for influencing the radiation of this patch element.

17 Claims, 6 Drawing Sheets



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US007920095B2

(12) **United States Patent**
Wei

(10) **Patent No.:** **US 7,920,095 B2**
(45) **Date of Patent:** **Apr. 5, 2011**

(54) **THREE-DIMENSIONAL MULTI-FREQUENCY ANTENNA**

(75) Inventor: **Shen-Pin Wei**, Taipei Hsien (TW)

(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, 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 697 days.

(21) Appl. No.: **11/845,089**

(22) Filed: **Aug. 26, 2007**

(65) **Prior Publication Data**
US 2009/0033557 A1 Feb. 5, 2009

(30) **Foreign Application Priority Data**
Jul. 31, 2007 (TW) 96128114 A

(51) **Int. Cl.**
H01Q 5/00 (2006.01)
(52) **U.S. Cl.** **343/700 MS**; 343/703; 343/749
(58) **Field of Classification Search** 343/700 MS,
343/702, 781 CA, 754, 781 P, 840, 781 R,
343/785, 175, 802, 725, 790, 752, 742, 780,
343/749, 708, 727, 703, 729; 342/379, 352;
340/572.2; 333/139

See application file for complete search history.

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Primary Examiner — Douglas W Owens

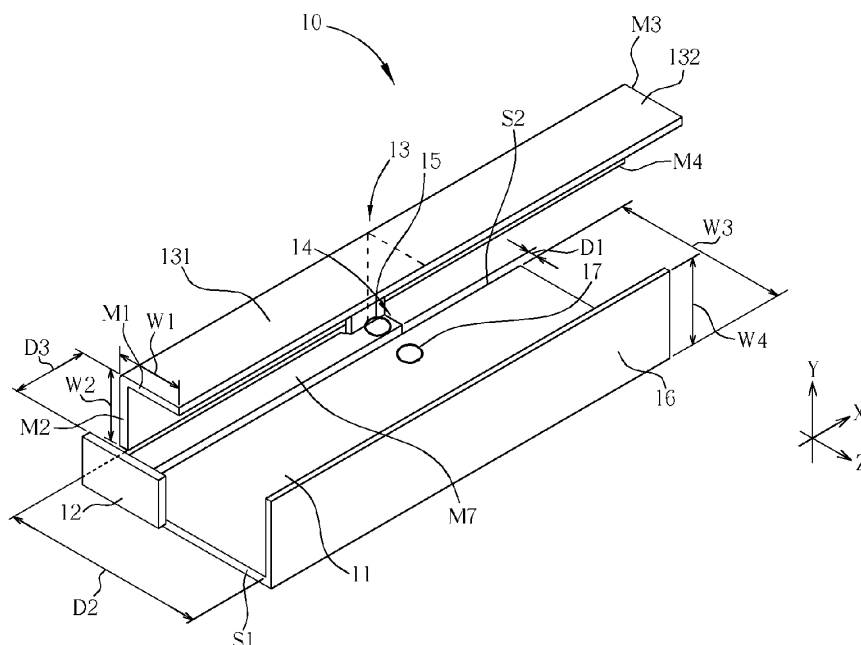
Assistant Examiner — Jae K Kim

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

(57) **ABSTRACT**

A three-dimensional multi-frequency antenna includes a substrate; a shorting wall vertically formed on a first edge of the substrate; a radiation element including a first radiator corresponding to a first resonance frequency band, and a second radiator corresponding to a second resonance frequency band, the first radiator and the second radiator capable of generating a frequency-multiplying third resonance frequency extending toward opposite directions; and a connection element, for connecting the shorting wall and the radiation element, separated from a second edge of the substrate by a gap; wherein the width of the radiation element and the gap conforms to a specific ratio.

20 Claims, 12 Drawing Sheets



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US007920097B2

(12) **United States Patent**
Quintero Illera et al.

(10) **Patent No.:** **US 7,920,097 B2**
(45) **Date of Patent:** **Apr. 5, 2011**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Ramiro Quintero Illera**, 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 95 days.

(21) Appl. No.: **12/229,483**

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

(65) **Prior Publication Data**

US 2009/0066582 A1 Mar. 12, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/702,791, filed on Feb. 6, 2007, now Pat. No. 7,439,923, which is a continuation of application No. 10/823,257, filed on Apr. 13, 2004, now Pat. No. 7,215,287, which is a continuation of application No. PCT/EP01/11912, filed on Oct. 16, 2001.

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

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

(58) **Field of Classification Search** 343/700 MS, 343/702, 800, 846, 895

See application file for complete search history.

(56) **References Cited**

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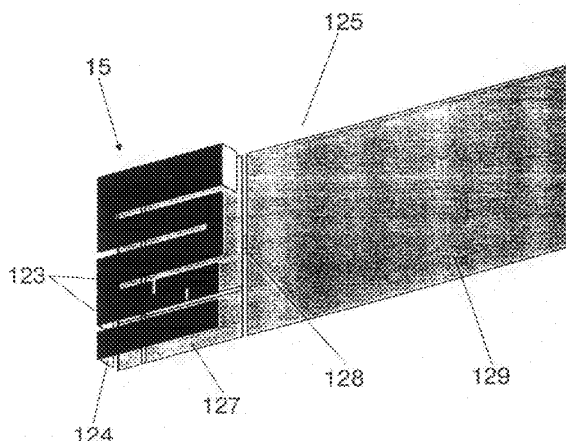
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A multiband antenna includes at least two polygons. The at least two polygons are spaced by means of a non-straight gap shaped as a space-filling curve, in such a way that the whole gap length is increased yet keeping its size and the same overall antenna size allowing for an effective tuning of frequency bands of the antenna.

50 Claims, 7 Drawing Sheets



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US007924226B2

(12) **United States Patent**
Soler Castany et al.

(10) **Patent No.:** **US 7,924,226 B2**
(45) **Date of Patent:** **Apr. 12, 2011**

(54) **TUNABLE ANTENNA**

(56) **References Cited**

(75) Inventors: **Jordi Soler Castany**, Mataró (ES);
Carles Puente Baliarda, Barcelona
(ES); **José Mumbro Forn**, 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 871 days.

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Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Kenyon & Kenyon LLP

(65) **Prior Publication Data**

US 2008/0062049 A1 Mar. 13, 2008

Related U.S. Application Data

(60) Provisional application No. 60/613,394, filed on Sep. 27, 2004, provisional application No. 60/640,380, filed on Dec. 30, 2004.

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

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

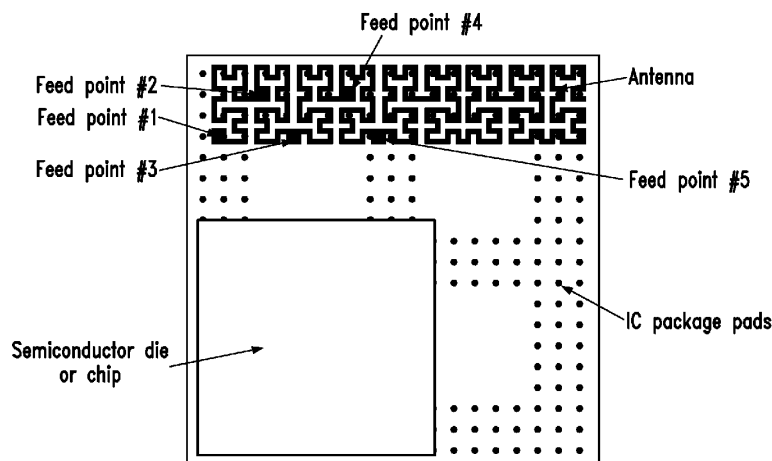
(58) **Field of Classification Search** 343/700 MS,
343/702, 895

See application file for complete search history.

(57) **ABSTRACT**

The invention refers to an antenna comprising: a conducting trace (15, 20), said conducting trace (15, 20) defining a curve (1, 4, 5, 6, 6', 6'', 8), said curve (1, 4, 5, 6, 6', 6'', 8) including two or more feeding points (16a, 16b, 16c, 17, 18, 19), a portion of said curve (1, 4, 5, 6, 6', 6'', 8) being shaped according a geometry selected from a group of geometries including a space-filling curve, a grid-dimension curve, a box-counting curve and a contour curve or the curve (1, 4, 5, 6, 6', 6'', 8) or a portion of said curve having a shape of a multilevel structure. Further the invention refers to a related SMD component, an IC-package, a wireless device and a method for contacting an antenna.

104 Claims, 31 Drawing Sheets



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US007924229B2

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

(10) **Patent No.:** **US 7,924,229 B2**
(45) **Date of Patent:** **Apr. 12, 2011**

(54) **ANTENNA APPARATUS AND METHOD FOR ADJUSTING CHARACTERISTICS THEREOF**

(75) Inventors: **Tetsuya Shibata**, Tokyo (JP); **Yasumasa Harihara**, Tokyo (JP); **Hideaki Shimoda**, 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 379 days.

(21) Appl. No.: **12/236,619**

(22) Filed: **Sep. 24, 2008**

(65) **Prior Publication Data**

US 2009/0079651 A1 Mar. 26, 2009

(30) **Foreign Application Priority Data**

Sep. 26, 2007 (JP) 2007-249846

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/860**

(58) **Field of Classification Search** **343/700 MS; 343/702, 860**

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

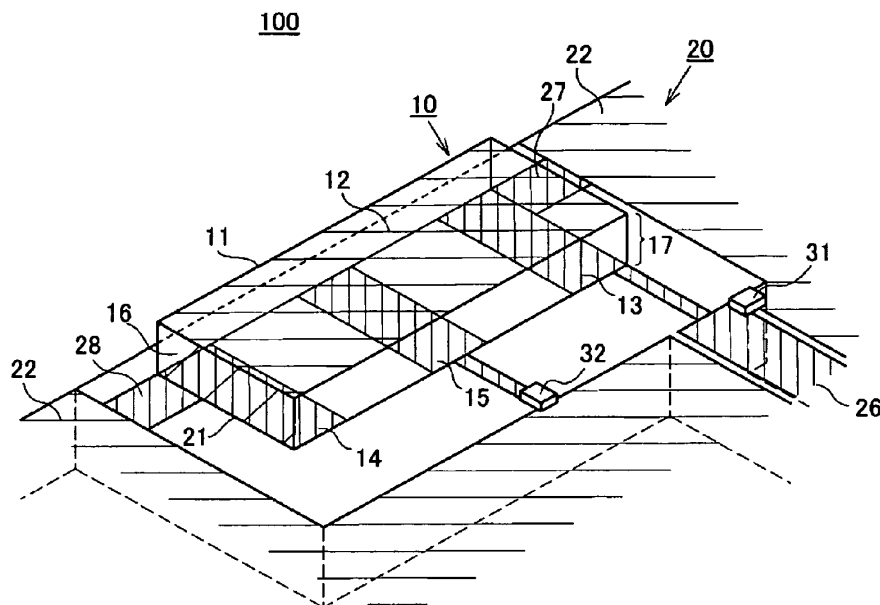
Assistant Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

An antenna apparatus includes an antenna block and a substrate. The antenna block has a base that is made of a substantially cuboid dielectric body, an upper-surface conductor formed on an upper surface of the base, first and second pad electrodes that are formed on both ends of a bottom surface of the base in a longitudinal direction of the base, respectively, and a lateral-surface conductor connecting the upper-surface conductor and the second pad electrode. The substrate has a region mounting the antenna block, a ground pattern provided around the mounting region, first and second lands that are provided within the mounting region so as to correspond to the positions of the first and second pad electrodes, a feed line that is connected to the first land, an impedance-adjusting pattern connecting the first land and the ground pattern, and a frequency-adjusting pattern connecting the second land and the ground pattern.

12 Claims, 11 Drawing Sheets



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US007924230B2

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

(10) **Patent No.:** **US 7,924,230 B2**
(45) **Date of Patent:** **Apr. 12, 2011**

(54) **MULTI-FREQUENCY ANTENNA SUITABLY WORKING IN DIFFERENT WIRELESS NETWORKS**

(75) Inventors: **Chen-Ta Hung**, Tu-Cheng (TW);
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Lung-Sheng Tai, Tu-Cheng (TW);
Shu-Yean Wang, Tu-Cheng (TW)

(73) Assignee: **Hon Hai Precision Ind. 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 174 days.

(21) Appl. No.: **12/378,644**

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

(65) **Prior Publication Data**

US 2009/0153430 A1 Jun. 18, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/906,691, filed on Oct. 2, 2007, now Pat. No. 7,498,992, which is a continuation of application No. 11/201,463, filed on Aug. 11, 2005, now Pat. No. 7,289,071.

(30) **Foreign Application Priority Data**

May 23, 2005 (TW) 94116677 A

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

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

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

(56) **References Cited**

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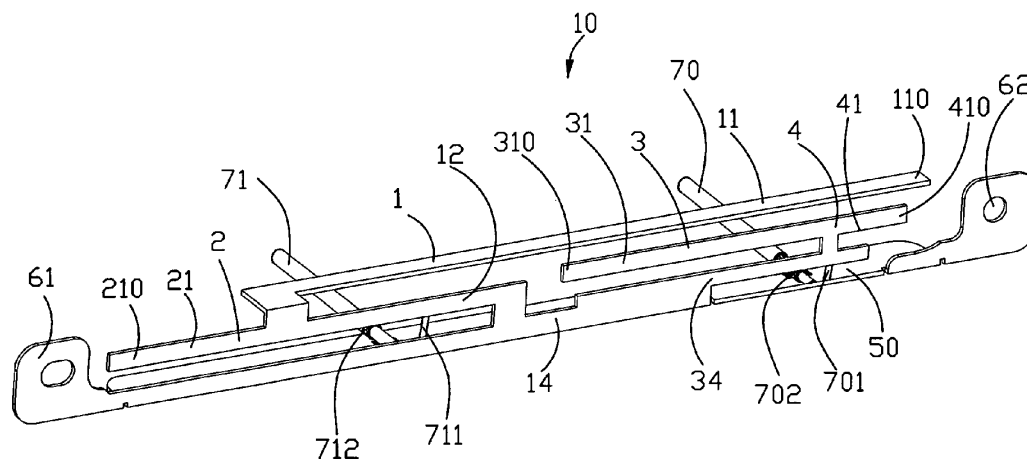
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A multi-frequency antenna includes a first antenna (1) and a second antenna (2) both operating at wireless wide area network, a third antenna (3) and a fourth antenna (4) both operating at wireless local area network. The first antenna, the second antenna, the third antenna and the fourth antenna are integrally made from a metal sheet and have a common grounding portion (50). The first and the second antennas have a first connecting portion (12) on which a feeding point (120) is located, and the third and the fourth antenna have a second connecting portion (34) on which another feeding point (340) is located.

20 Claims, 5 Drawing Sheets



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US007924231B2

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

(10) **Patent No.:** **US 7,924,231 B2**
(45) **Date of Patent:** **Apr. 12, 2011**

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

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

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

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

(21) Appl. No.: **12/941,006**

(22) Filed: **Nov. 5, 2010**

(65) **Prior Publication Data**

US 2011/0050513 A1 Mar. 3, 2011

Related U.S. Application Data

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

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/767;
343/846

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

(56) **References Cited**

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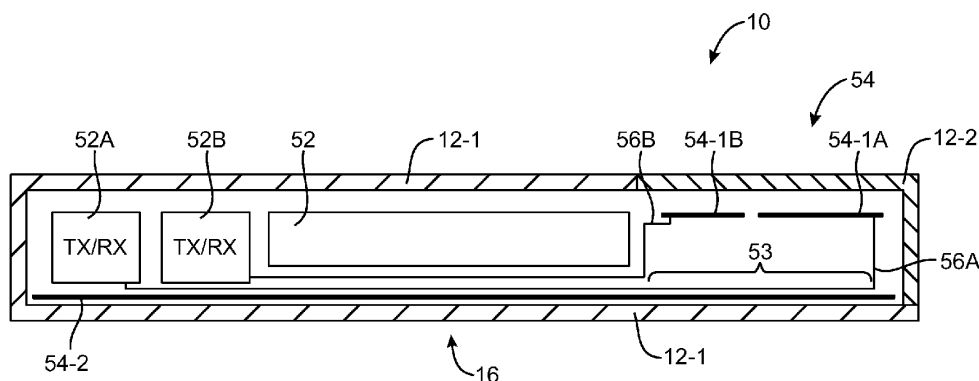
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

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

15 Claims, 20 Drawing Sheets



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US007924233B2

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

(10) **Patent No.:** **US 7,924,233 B2**
(45) **Date of Patent:** **Apr. 12, 2011**

(54) **THREE-DIMENSIONAL ANTENNA AND
RELATED WIRELESS COMMUNICATION
DEVICE**

(58) **Field of Classification Search** 343/736,
343/700 MS, 702
See application file for complete search history.

(75) Inventors: **Chih-Ming Wang**, Taipei Hsien (TW);
Feng-Chi Eddie Tsai, Taipei Hsien
(TW); **Yi-Chih Wang**, Taipei Hsien
(TW)

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(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, 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 369 days.

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Primary Examiner — Hoang V Nguyen

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

(21) Appl. No.: **12/332,348**

(22) Filed: **Dec. 11, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 11/737,146,
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(30) **Foreign Application Priority Data**

Dec. 22, 2006 (TW) 95148343 A

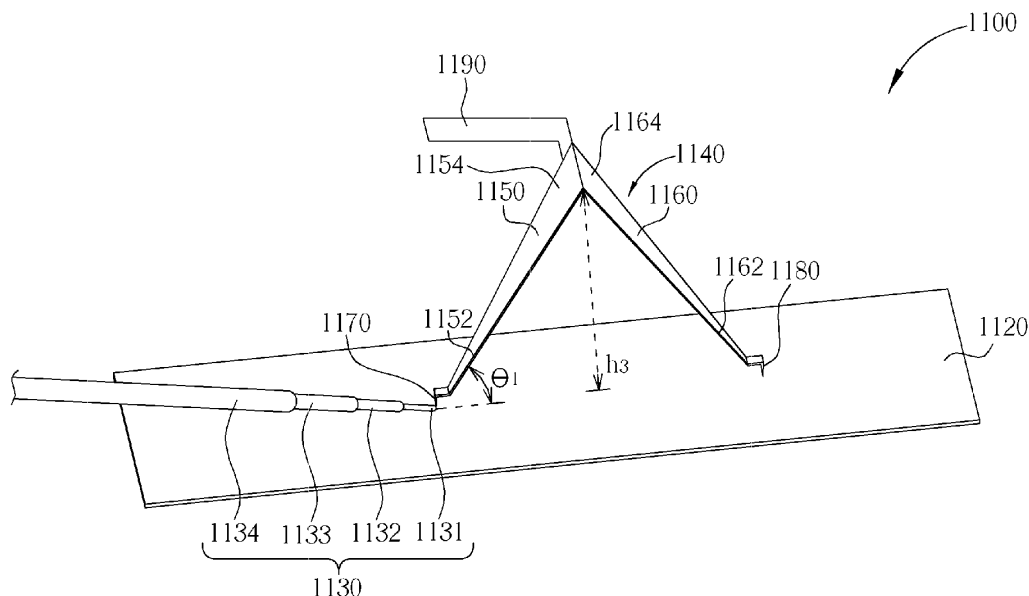
(51) **Int. Cl.**
H01Q 11/06 (2006.01)

(52) **U.S. Cl.** 343/736; 343/700 MS; 343/702

(57) **ABSTRACT**

A three-dimensional antenna includes a substrate, a radiator, a second radiator, a signal feeding element, and a grounding element. The radiator is installed on the substrate. The radiator includes a first child radiator and a second child radiator. The first child radiator has a first end and a second end. The second child radiator has a first end and a second end, wherein the second end of the second child radiator is coupled to the second end of the first child radiator. The second radiator is coupled to the radiator. The signal feeding element is coupled to the first end of the first child radiator. The grounding element is coupled between the substrate and the first end of the second child radiator. The first child radiator and the second child radiator form an inverted V-shape installed on the substrate.

22 Claims, 46 Drawing Sheets



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US007928911B2

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

(10) **Patent No.:** **US 7,928,911 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **DIGITAL TELEVISION (DTV) ANTENNA APPARATUS**

(75) Inventors: **Yen-Yu Chen**, Chung Ho (TW);
Kuo-Ying Su, Chung Ho (TW);
Yung-Da Lin, Chung Ho (TW)

(73) Assignee: **Avermedia Technologies, Inc.**, Chung Ho, 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 380 days.

(21) Appl. No.: **12/146,886**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

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

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

See application file for complete search history.

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Primary Examiner — Jacob Y Choi

Assistant Examiner — Darleen J Stockley

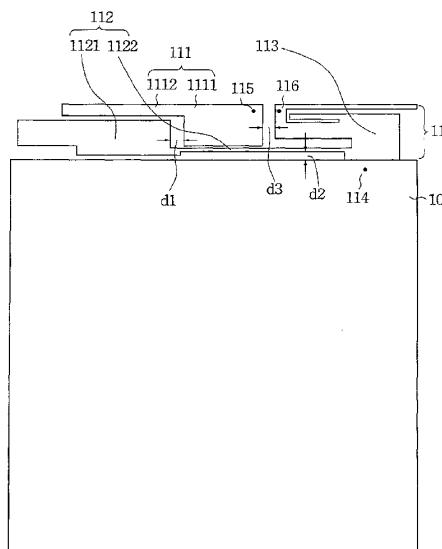
(74) *Attorney, Agent, or Firm* — Thomas, Kayden, Horstemeyer & Risley, LLP

(57) **ABSTRACT**

The present invention discloses a DTV antenna apparatus build in a portable device. The portable device includes a system ground. The DTV antenna includes a ground plane with a short circuit point, an extending metal arm with a grounding point and a radiation element. The ground plane is the system ground. The radiation element and the ground plane are arranged in parallel to each other. The extending metal arm connects with the short circuit point. The antenna receives signals with frequencies in the range from 470 MHz to 870 MHz. The radiation element includes a radiation arm and a parasitic arm. The radiation arm has a feeding terminal. The parasitic arm connects with the short circuit point.

16 Claims, 4 Drawing Sheets

100



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US007928912B2

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

(10) **Patent No.:** **US 7,928,912 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Wen-Hua Chen**, Beijing (CN); **Xin Wang**, Beijing (CN); **Zheng-He Feng**, Beijing (CN)

(73) Assignees: **Tsinghua University**, Beijing (CN); **Hon Hai Precision Industry Co., Ltd.**, 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 381 days.

(21) Appl. No.: **12/171,428**

(22) Filed: **Jul. 11, 2008**

(65) **Prior Publication Data**

US 2009/0015487 A1 Jan. 15, 2009

(30) **Foreign Application Priority Data**

Jul. 13, 2007 (CN) 2007 1 0076042

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/826; 343/828; 343/846

(58) **Field of Classification Search** 343/700 MS, 343/702, 826, 828, 829, 830, 833, 834, 846
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

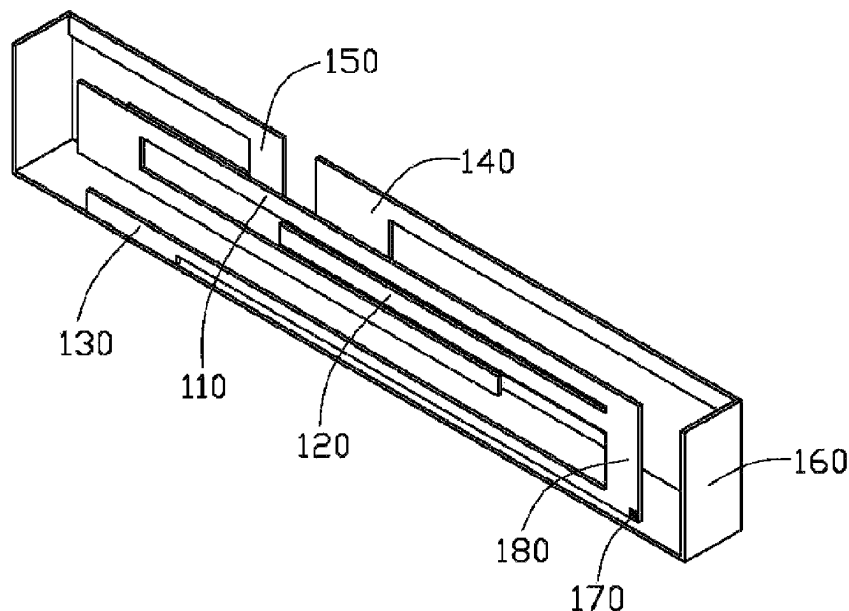
Assistant Examiner — Darleen J Stockley

(74) *Attorney, Agent, or Firm* — D. Austin Bonderer

(57) **ABSTRACT**

A multiband antenna includes a long radiating branch, a short radiating branch, a short strip, a feed point, a grounding portion, a connecting portion, a long parasitic strip, and a short parasitic strip. The feed point, the long radiating branch, the short radiating branch, and the short strip are in a first plane. The grounding portion connects to the short strip. The connecting portion connects the long radiating branch, the short radiating branch, and the short strip. The long radiating branch, the short strip, and the connecting portion form a first inverted-L shaped antenna structure. The short radiating branch, the short strip, and the connecting portion form a second inverted-L shaped antenna structure. The long parasitic strip and the short parasitic strip are in a second plane and respectively connected to the grounding portion. The first plane is parallel to the second plane.

7 Claims, 6 Drawing Sheets



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US007928913B2

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

(10) **Patent No.:** **US 7,928,913 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **METHOD AND APPARATUS FOR A TUNABLE CHANNELIZING PATCH ANTENNA**

(75) Inventors: **Noriaki Kaneda**, Westfield, NJ (US);
Carsten Metz, München (DE)

(73) Assignee: **Alcatel-Lucent USA Inc.**, Murray Hill,
NJ (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 163 days.

(21) Appl. No.: **12/194,565**

(22) Filed: **Aug. 20, 2008**

(65) **Prior Publication Data**

US 2010/0045550 A1 Feb. 25, 2010

(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,**
343/702, 848, 846

See application file for complete search history.

(56) **References Cited**

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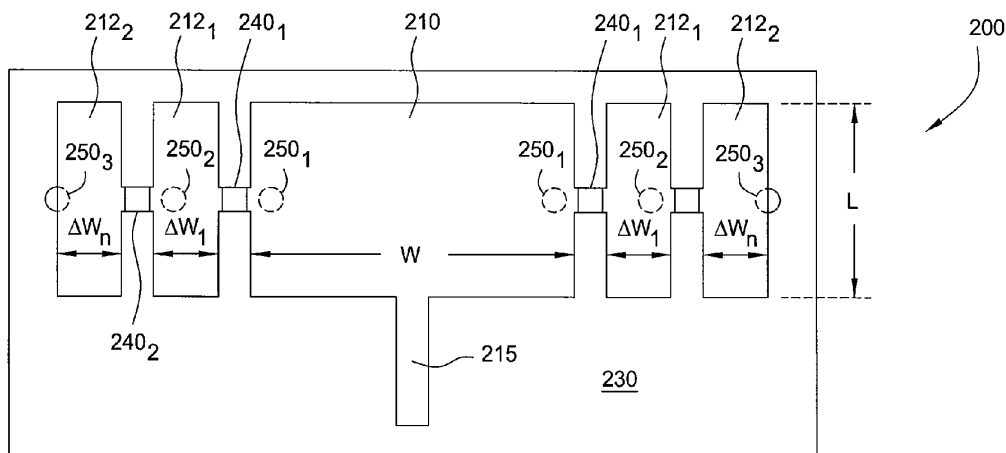
Primary Examiner — Hoang Anh T Le

(74) *Attorney, Agent, or Firm* — Wall & Tong LLP

(57) **ABSTRACT**

A method and apparatus providing a tunable channelized patch antenna by selectively adjoining one or more radiating element extensions successively to a radiating element of the patch antenna, and adjusting fringe capacitance at active outer edges of the patch antenna.

22 Claims, 7 Drawing Sheets



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US007928914B2

(12) **United States Patent**
Bit-Babik et al.

(10) **Patent No.:** **US 7,928,914 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **MULTI-FREQUENCY CONDUCTIVE-STRIP ANTENNA SYSTEM**

(75) Inventors: **Giorgi G. Bit-Babik**, Sunrise, FL (US);
Carlo Di Nallo, Plantation, FL (US);
Antonio Faraone, Plantation, FL (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1432 days.

(21) Appl. No.: **10/945,234**

(22) Filed: **Sep. 20, 2004**

(65) **Prior Publication Data**
US 2005/0280586 A1 Dec. 22, 2005

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

(56) **References Cited**

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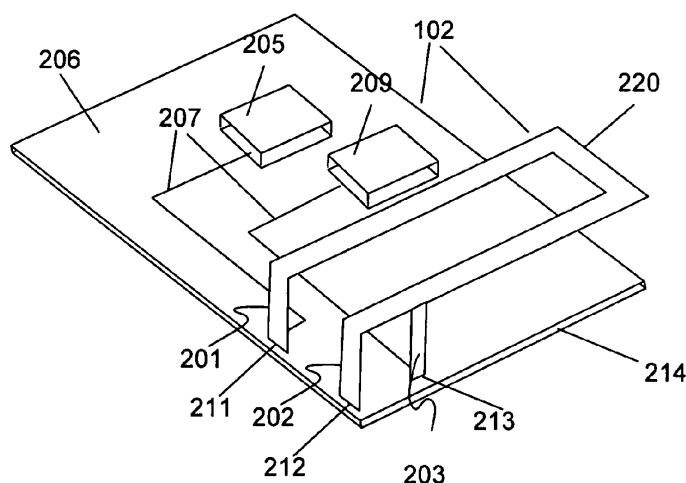
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Primary Examiner — Hung T Vy
Assistant Examiner — Binh V Ho

(57) **ABSTRACT**

To address the above-mentioned need an antenna (100) is provided having a conductive-strip radiating element (102) supported above a substrate (206) via three legs (201-203). The point where the substrate contacts the three legs form two antenna ports and a ground utilized for feeding the RF signal, tuning the antenna, and grounding. More particularly, a first leg (201) of the radiating element is used solely as a tuning port, while a second leg (202) is grounded, and a third leg (203) is utilized solely as a feed port. The tuning port is substantially maximally distal to the feed port on the substrate. Reactive loads are provided at the tuning port to effectively tune the central operating frequency of the antenna.

19 Claims, 3 Drawing Sheets



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US007928915B2

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

(10) **Patent No.:** **US 7,928,915 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **MULTILEVEL GROUND-PLANE FOR A
MOBILE DEVICE**

(75) Inventors: **Alfonso Sanz Arronte**, Barcelona (ES);
David Gala Gala, Barcelona (ES);
Antonio Condes Martinez, 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 867 days.

(21) Appl. No.: **11/662,044**

(22) PCT Filed: **Sep. 20, 2005**

(86) PCT No.: **PCT/EP2005/010131**

§ 371 (c)(1),
(2), (4) Date: **Sep. 11, 2007**

(87) PCT Pub. No.: **WO2006/032455**

PCT Pub. Date: **Mar. 30, 2006**

(65) **Prior Publication Data**

US 2008/0074332 A1 Mar. 27, 2008

Related U.S. Application Data

(60) Provisional application No. 60/611,889, filed on Sep.
21, 2004.

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/846;
343/849

(58) **Field of Classification Search** 343/700 MS,
343/702, 846, 849

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

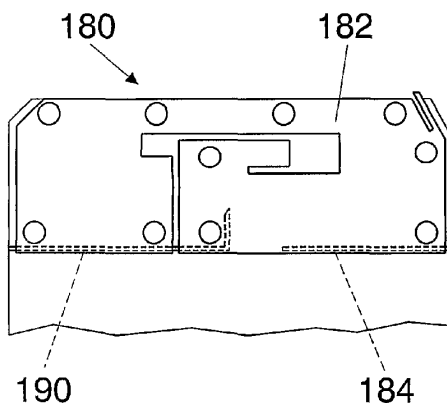
Assistant Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

In accordance with the teachings described herein, a multi-level ground-plane for a mobile device is provided. The multi-level ground-plane includes a first conductive surface, a second conductive surface, and a conducting strip that couples the first conducting surface to the second conducting surface. A mobile device having a multilevel ground-plane may include a printed circuit board, an antenna radiating element attached to a surface of the printed circuit board, and the multilevel ground plane integral with the printed circuit board and electromagnetically coupled to the antenna radiating element.

33 Claims, 23 Drawing Sheets



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US007928916B2

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

(10) **Patent No.:** **US 7,928,916 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **MULTI-BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Chen-Ta Hung**, Tu-cheng (TW);
Shang-Jen Chen, Tu-cheng (TW);
Chun-Ming Chiu, Tu-cheng (TW)

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(73) Assignee: **Hon Hai Precision Ind. 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 350 days.

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Primary Examiner — Hoang V Nguyen

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

(21) Appl. No.: **12/290,078**

(22) Filed: **Oct. 27, 2008**

(65) **Prior Publication Data**

US 2009/0109098 A1 Apr. 30, 2009

(30) **Foreign Application Priority Data**

Oct. 26, 2007 (TW) 96140331 A

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

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

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

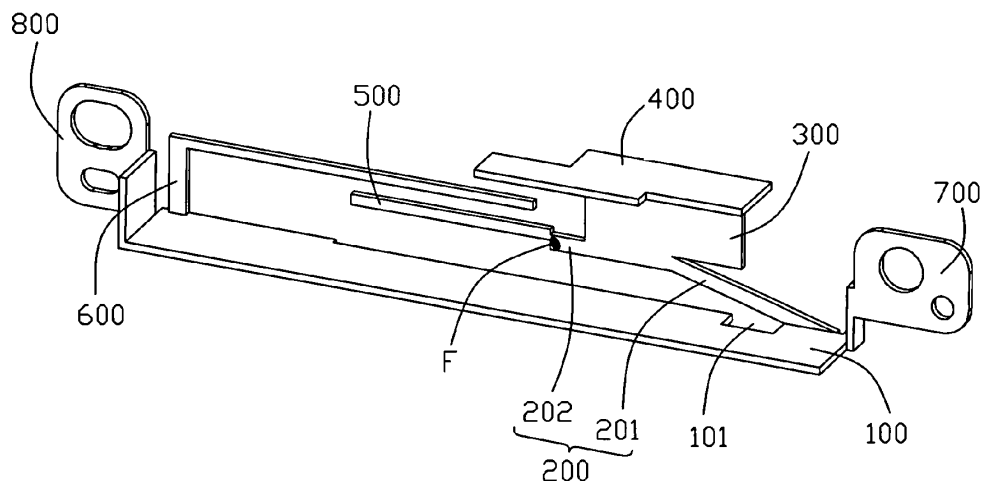
See application file for complete search history.

(57) **ABSTRACT**

A multi-band antenna includes a grounding element, a connecting element extending from one end of the grounding element, a first conductive portion extending from the connecting element, a second conductive portion extending from the first conductive portion and narrower than the first conductive portion, a first coupling portion extending from the connecting element in a first direction, a second coupling portion extending from the other end of the grounding element and opposite to the connecting element. The second coupling portion extending in a second direction opposite to the first direction and overlap the first coupling portion.

17 Claims, 3 Drawing Sheets

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US007928919B2

(12) **United States Patent**
Margomenos

(10) **Patent No.:** **US 7,928,919 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **MICROWAVE ANTENNA AND METHOD FOR MAKING SAME**

(75) Inventor: **Alexandros Margomenos**, Pasadena, CA (US)

(73) Assignee: **Toyota Motor Engineering & Manufacturing North America, Inc.**, Erlanger, KY (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.: **12/888,473**

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

(65) **Prior Publication Data**

US 2011/0010926 A1 Jan. 20, 2011

Related U.S. Application Data

(62) Division of application No. 12/098,663, filed on Apr. 7, 2008, now Pat. No. 7,817,097.

(51) **Int. Cl.**
H01Q 13/00 (2006.01)

(52) **U.S. Cl.** **343/786; 343/772**

(58) **Field of Classification Search** 343/771, 343/772, 786

See application file for complete search history.

(56) **References Cited**

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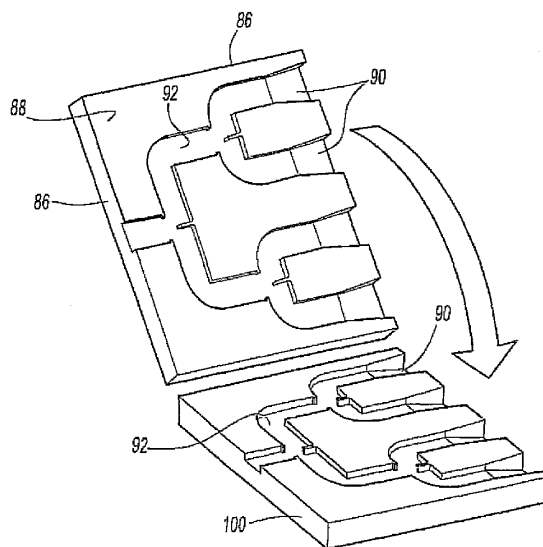
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Gifford, Krass, Sprinkle, Anderson & Citkowski, P.C.

(57) **ABSTRACT**

A method for fabricating a microwave horn antenna in which a thermoplastic sacrificial layer is mounted to a thermoplastic horn layer. A heated horn embossing plate having at least one horn shaped embossing element is then moved into the horn layer so that the horn element penetrates through the horn layer and extends partially into the sacrificial layer thus forming a horn opening in the horn layer complementary in shape to the horn element. The horn layer and sacrificial layer are then separated from each other and the horn opening and at least a portion of the back surface of the horn layer is covered with a metal coating. A thermoplastic wave guide layer formed by embossing wave guide channels into the layer is covered with metal and attached to the back side of the horn layer to form the antenna. Alternatively, a portion of the horn and the remaining portion of a microwave channel are formed in both a first and second thermoplastic section. These portions of the microwave guide channel and horn are then coated with a metal material and the sections are secured together in a facing relationship so that the horn portions and wave guide channel portions on both the first and second sections register with each other.

6 Claims, 2 Drawing Sheets



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US007928920B2

(12) **United States Patent**
Yagi

(10) **Patent No.:** **US 7,928,920 B2**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **FILM ANTENNA AND ELECTRONIC EQUIPMENT**

(75) Inventor: **Shigeru Yagi**, Tokyo (JP)

(73) Assignee: **Casio Computer Co., Ltd.**, Tokyo (JP)

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

(21) Appl. No.: **12/117,042**

(22) Filed: **May 8, 2008**

(65) **Prior Publication Data**

US 2008/0284662 A1 Nov. 20, 2008

(30) **Foreign Application Priority Data**

May 17, 2007 (JP) 2007-131729

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

(52) **U.S. Cl.** 343/793; 343/702; 343/873; 343/820

(58) **Field of Classification Search** 343/793, 343/795, 702, 700 MS, 872, 873, 820
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

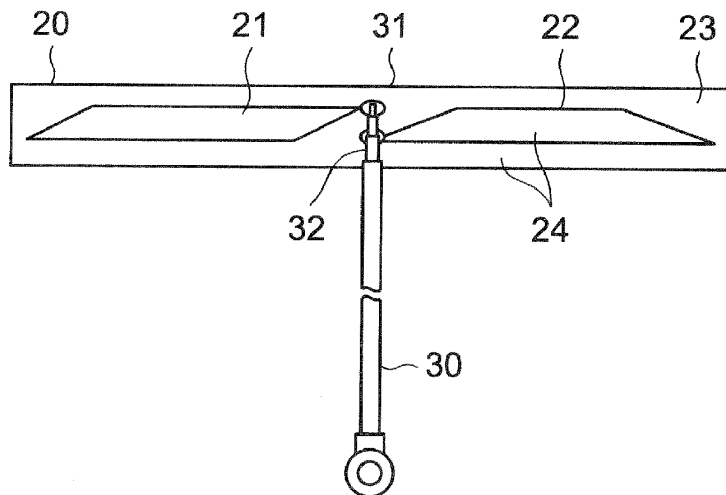
Assistant Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

A film antenna comprises a base film formed of an insulating material; and first and second antenna elements of film-like electric conductors formed on the base film, wherein each of the first and second antenna elements is a planar shape in which two end faces from a feed point to a tip have two different lengths or a planar shape in which an end face and a diagonal line from a feed point to a tip have two different lengths, a core wire of a coaxial cable is connected to the first antenna element at the feed point, an external conductor of the coaxial cable is connected to the second antenna element at the feed point, and the first and second antenna elements have an area as a capacitor for performing impedance matching.

14 Claims, 6 Drawing Sheets



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US007929311B1

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

(10) **Patent No.:** **US 7,929,311 B1**
(45) **Date of Patent:** **Apr. 19, 2011**

(54) **PORTABLE ELECTRONIC DEVICE**

(75) Inventors: **Yen-Jung Tseng**, Tu-Cheng (TW);
Cho-Kang Hsu, 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 0 days.

(21) Appl. No.: **12/814,558**

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

(30) **Foreign Application Priority Data**

Sep. 30, 2009 (CN) 2009 1 0308055

(51) **Int. Cl.**
H05K 1/14 (2006.01)

(52) **U.S. Cl.** **361/737**; 361/732; 361/769; 361/785;
439/64; 439/153; 439/159; 439/267; 439/329;
439/374; 439/626; 439/630; 343/702; 343/841;
343/860; 343/873

(58) **Field of Classification Search** 361/737,
361/732, 769, 785; 439/64, 153, 159, 267,
439/329, 374, 626, 630; 343/702, 841, 860,
343/873

See application file for complete search history.

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Primary Examiner — Ishwarbhai B Patel

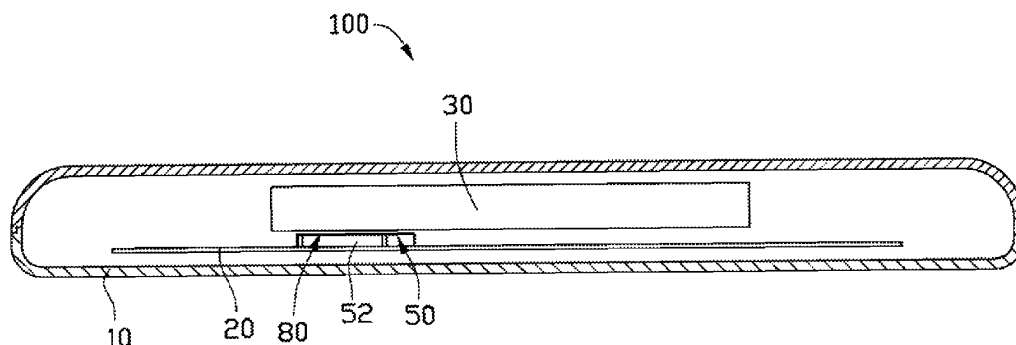
Assistant Examiner — Xiaoliang Chen

(74) *Attorney, Agent, or Firm* — Steven M. Reiss

(57) **ABSTRACT**

A portable electronic device includes a housing, a circuit board received in the housing, and a memory card retaining mechanism received in the housing. The memory card retaining mechanism includes a plurality of conductive parts. The plurality of conductive parts cooperatively form an antenna integrated with the memory card retaining mechanism and connected to the circuit board.

6 Claims, 7 Drawing Sheets



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US007932861B2

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

(10) **Patent No.:** **US 7,932,861 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **COMPLEX ANTENNA**

(75) Inventors: **Chen-Ta Hung**, Tu-cheng (TW);
Lung-Sheng Tai, Tu-cheng (TW);
Wen-Fong Su, Tu-cheng (TW)

(73) Assignee: **Hon Hai Precision Ind. 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 423 days.

(21) Appl. No.: **12/148,029**

(22) Filed: **Apr. 16, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 16, 2007 (TW) 96113284 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/829; 343/846**

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

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Primary Examiner — Douglas W Owens

Assistant Examiner — Chuc D Tran

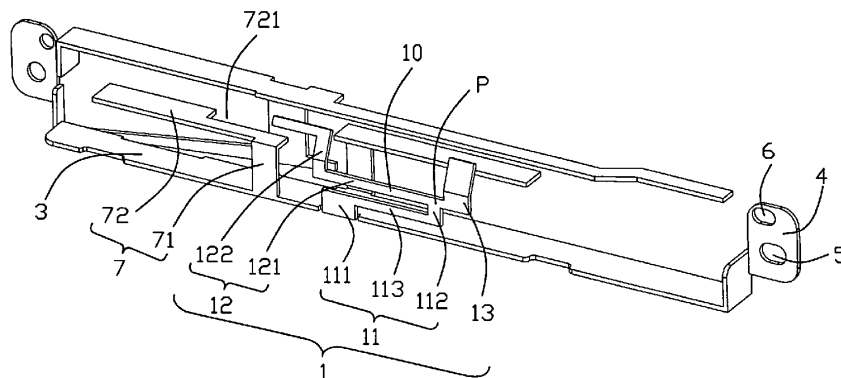
(74) *Attorney, Agent, or Firm* — Wei Te Chung; Andrew C. Cheng; Ming Chieh Chang

(57) **ABSTRACT**

A complex antenna comprising a grounding element having a first and second longitudinal sides; a first antenna, operating in a first wireless network, comprising a first radiating body spaced apart from the grounding element and a first connecting element connecting the first radiating body and the grounding element; a second antenna, operating in a second wireless network, comprising a second radiating body spaced apart from the grounding element and a second connecting element connecting the second radiating body and the grounding element; wherein the first antenna extending from the first side of the grounding element and working in a first lower frequency band and a first higher frequency band; the second antenna extends from the second side of the grounding element and working in a second lower frequency band and a second higher frequency band.

19 Claims, 8 Drawing Sheets

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US007932862B2

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

(10) **Patent No.:** **US 7,932,862 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **ANTENNA FOR A WIRELESS PERSONAL
AREA NETWORK AND A WIRELESS LOCAL
AREA NETWORK**

(75) Inventors: **Tiao-Hsing Tsai**, Taiwan (TW);
Chih-Wei Liao, Tao Yuan Shien (TW);
Chao-Hsu Wu, Tao Yuan Shien (TW);
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(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 139 days.

(21) Appl. No.: **12/174,480**

(22) Filed: **Jul. 16, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 1, 2008 (TW) 97111857 A

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/795**

(58) **Field of Classification Search** **343/700 MS,**
343/702, 795

See application file for complete search history.

(56) **References Cited**

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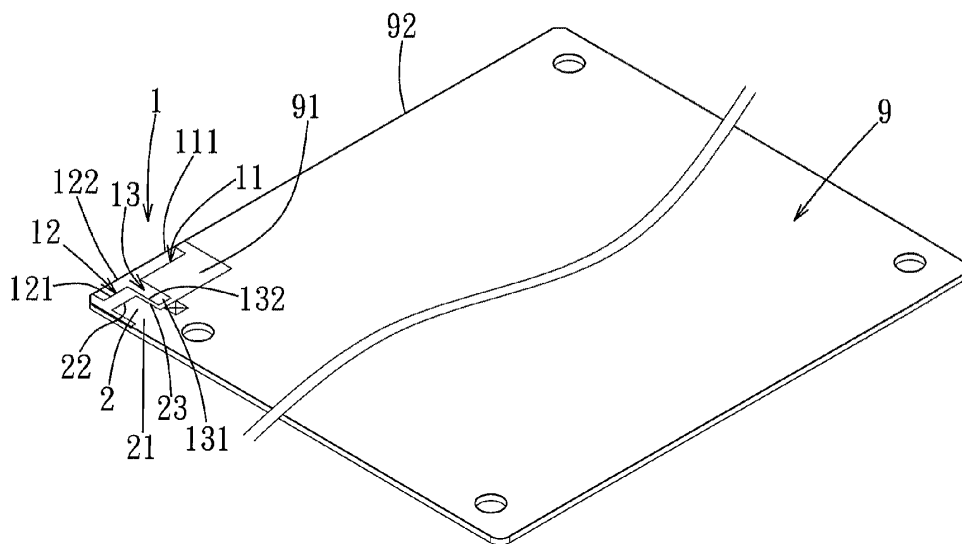
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Ladas & Parry, LLP

(57) **ABSTRACT**

An antenna includes a T-shaped radiating element and a coupling element. The radiating element includes opposite first and second radiating portions, and a feeding portion that extends transversely to the first and second radiating portions and that is connected to a junction of the first and second radiating portions. The coupling element is disposed between the second radiating portion and the feeding portion of the radiating element, and is coupled electromagnetically to at least one of the second radiating portion and the feeding portion of the radiating element.

9 Claims, 7 Drawing Sheets



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US007932863B2

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

(10) **Patent No.:** **US 7,932,863 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **SHAPED GROUND PLANE FOR RADIO APPARATUS**

(75) Inventors: **Jaume Anguera Pros**, Castellon (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 687 days.

(21) Appl. No.: **11/793,406**

(22) PCT Filed: **Dec. 29, 2005**

(86) PCT No.: **PCT/EP2005/057215**
§ 371 (c)(1),
(2), (4) Date: **Jul. 19, 2007**

(87) PCT Pub. No.: **WO2006/070017**
PCT Pub. Date: **Jul. 6, 2006**

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

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(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, 846**

See application file for complete search history.

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Primary Examiner — Douglas W Owens

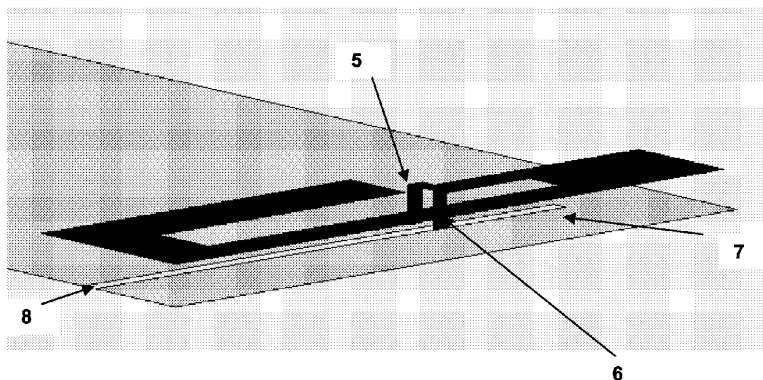
Assistant Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

This invention refers to an antenna structure for a wireless device comprising a ground plane and an antenna element, wherein the ground plane has a slot with at least a short end, an open end and a length substantially close to a quarter wavelength. The feeding and ground connections of the antenna structure are placed at the two different sides of said slot and the distance of at least one of them to the short end of the slot is equal or smaller than an eighth of the wavelength. The invention further refers to an antenna structure for a wireless device comprising a ground plane and an antenna element, wherein the ground plane has a slot with at least two short ends, and a length substantially close to half wavelength. The feeding and ground connections of the antenna structure are placed at the two different sides of said slot and the distance of at least one of them to a short end of the slot is equal or smaller than a quarter of the wavelength. Further the invention refers to a corresponding wireless device, a corresponding mobile phone and to a method for integrating such an antenna structure within a wireless device.

41 Claims, 14 Drawing Sheets



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US007932864B2

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

(10) **Patent No.:** **US 7,932,864 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE WITH ANTENNA CONTACT
HAVING REDUCED RF INDUCTANCE**

(75) Inventors: **Lizhong Zhu**, Waterloo (CA); **George Mankaruse**, Kitchener (CA); **Michael Corrigan**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Jun Jun Xu**, 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 453 days.

(21) Appl. No.: **12/173,043**

(22) Filed: **Jul. 15, 2008**

(65) **Prior Publication Data**
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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702**; 343/906; 455/575.7
(58) **Field of Classification Search** 343/702,
343/841, 906; 439/607.02, 876, 916; 174/351,
174/359; 455/575.5, 575.7
See application file for complete search history.

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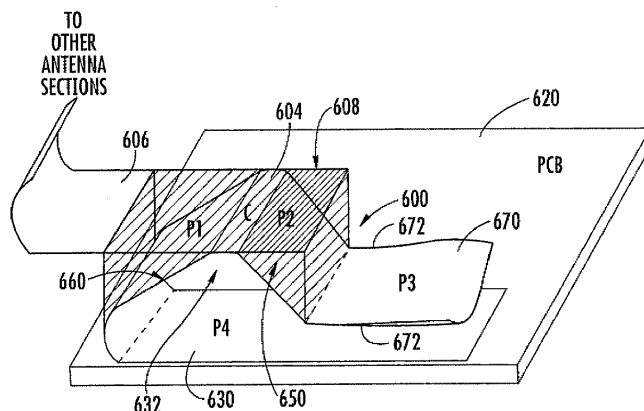
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

A mobile wireless communications device includes a housing and at least one circuit board. Radio frequency (RF) circuitry is carried by the circuit board and includes a transceiver. A processor is carried by the at least one circuit board and operative with the RF circuitry. An antenna is mounted within the housing. An antenna contact is secured on the at least one circuit board and operatively connects the RF circuitry and engages the antenna at an antenna contact point. Electromagnetic interference (EMI) shielding is positioned at the antenna contact point and reduces RF inductance effects.

24 Claims, 11 Drawing Sheets



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US007932865B2

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

(10) **Patent No.:** **US 7,932,865 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **COPLANAR COUPLED-FED MULTIBAND ANTENNA FOR THE MOBILE DEVICE**

(75) Inventors: **Kin-Lu Wong**, Kaohsiung (TW);
Chih-Hung Huang, Taipei (TW)

(73) Assignee: **Acer Incorporated**, 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 315 days.

(21) Appl. No.: **12/232,587**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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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.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

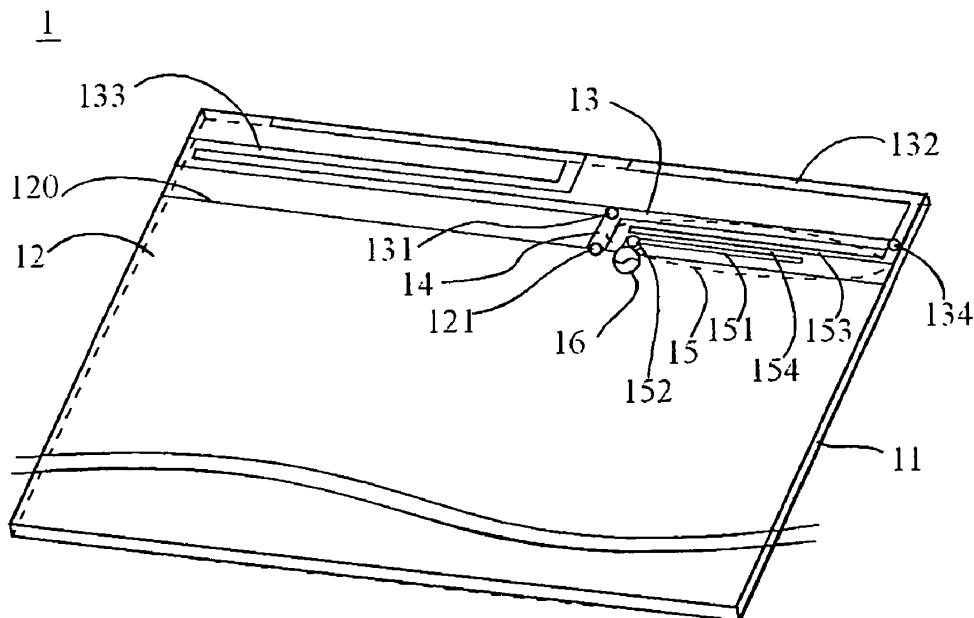
Assistant Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

The present invention is related to a coplanar coupled-fed multiband antenna for the mobile communication device. The antenna mainly comprises a dielectric substrate, a ground plane located on one surface of the dielectric substrate, and a radiating portion, a shorting metal portion, and a feeding portion, which are all on the same surface of the dielectric substrate near one edge of the ground plane. One end of the shorting metal portion is connected to the radiating portion, and the other end is connected to the ground plane. The feeding portion comprises a first feeding metal portion and a second feeding metal portion. The first feeding metal portion has a feeding point for the antenna. One end of the second feeding metal portion is connected to the radiating portion, and there is a gap between the second feeding metal portion and the first feeding metal portion.

13 Claims, 9 Drawing Sheets



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US007932866B2

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

(10) **Patent No.:** **US 7,932,866 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **ANTENNA**

(75) Inventors: **Jiunn-Ming Huang**, Taipei (TW);
Shen-Pin Wei, Taipei (TW); **Yuan-Li Chang**, Taipei (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 44 days.

(21) Appl. No.: **12/492,002**

(22) Filed: **Jun. 25, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 11/769,638, filed on Jun. 27, 2007, now Pat. No. 7,646,342.

(30) **Foreign Application Priority Data**

Oct. 31, 2006 (TW) 95140196 A

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

H01Q 1/38 (2006.01)

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

(58) **Field of Classification Search** 343/700 MS, 343/702, 895, 725, 846

See application file for complete search history.

(56) **References Cited**

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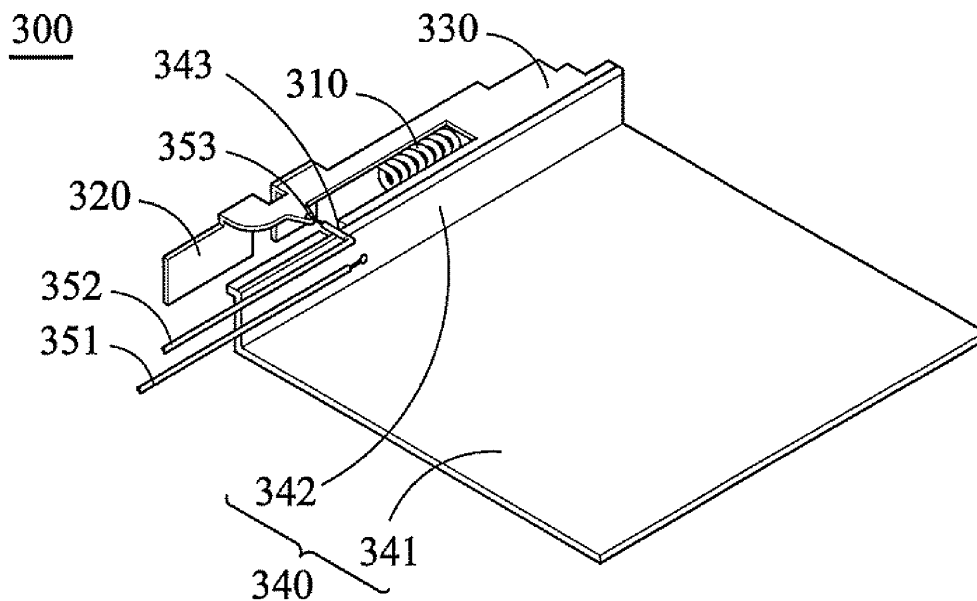
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Primary Examiner — Hoang V Nguyen

(57) **ABSTRACT**

An antenna comprises a first transmission element, a second transmission element, a conductive element, a ground element, a ground line and a signal line. The conductive element is connected to the ground element. The first transmission element is connected to the conductive element. The first transmission element comprises a first spiral structure and a first axis. The second transmission element is connected to the conductive element. The ground line is electrically connected to the ground element. The signal line is electrically connected to the conductive element at a feed point.

14 Claims, 10 Drawing Sheets



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US007932869B2

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

(10) **Patent No.:** **US 7,932,869 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **ANTENNA WITH VOLUME OF MATERIAL**

(75) Inventors: **Chulmin Han**, San Diego, CA (US);
Rowland Jones, Carlsbad, CA (US);
Jeffrey Shamblin, San Marcos, CA
(US); **Sabastian Rowson**, San Diego,
CA (US); **Laurent Desclos**, San Diego,
CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/840,861**

(22) Filed: **Aug. 17, 2007**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.** **343/787**; 343/873; 343/895

(58) **Field of Classification Search** 343/700 MS,
343/702, 787, 873, 895, 741, 867, 872
See application file for complete search history.

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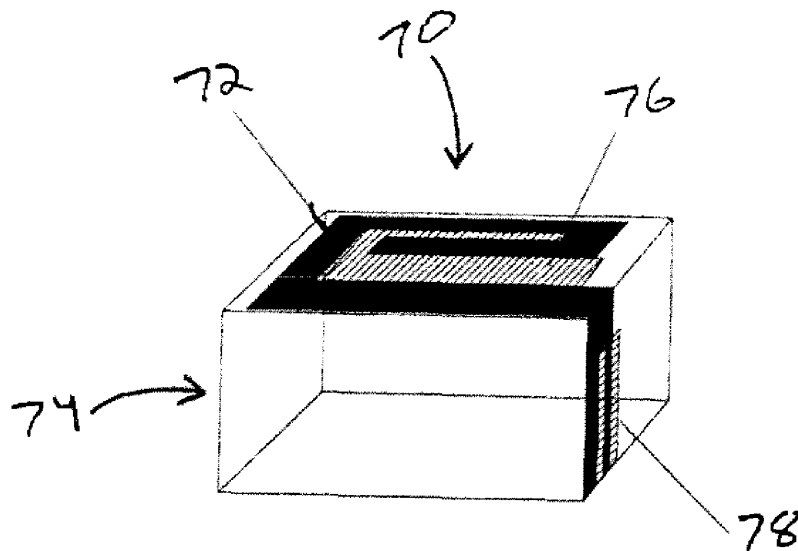
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Coastal Patent Agency;
Joshua S. Schoonover

(57) **ABSTRACT**

An antenna includes one or more antenna elements and a
volume of material contained at least partly within a volume
of the one or more antenna elements. The volume of material
has at least one electromagnetic property that is different from
free space. The volume of material may include dielectric
material and/or ferrite material. The antenna elements may be
isolated magnetic dipole (IMD) antenna elements. The elec-
tromagnetic property may be permeability and/or permittiv-
ity.

27 Claims, 8 Drawing Sheets



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