US010133462B2

(12) **United States Patent**
Nishioka

(10) **Patent No.: US 10,133,462 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ELECTRONIC DEVICE HAVING A SLOT ANTENNA**

(71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.**, Sinagpore (SG)

(72) Inventor: **Yoshio Nishioka**, Kanagawa-ken (JP)

(73) Assignee: **LENOVO (SINGAPORE) PTE LTD**, Singapore (SG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(21) Appl. No.: **15/332,762**

(22) Filed: **Oct. 24, 2016**

(65) **Prior Publication Data**

US 2017/0365930 A1 Dec. 21, 2017

(30) **Foreign Application Priority Data**

Jun. 20, 2016 (JP) 2016-121936

(51) **Int. Cl.**

H01Q 13/10	(2006.01)
G06F 3/0484	(2013.01)
G06F 3/14	(2006.01)
H01Q 1/22	(2006.01)
H01Q 21/28	(2006.01)
G06F 3/0487	(2013.01)
G09G 5/38	(2006.01)

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

CPC ***G06F 3/04845*** (2013.01); ***G06F 3/14*** (2013.01); ***G06F 3/1454*** (2013.01); ***H01Q 1/2258*** (2013.01); ***H01Q 1/2266*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/28*** (2013.01); *G06F 3/0487* (2013.01); *G06F 2203/04803* (2013.01); *G09G 5/38* (2013.01); *G09G 2340/12* (2013.01); *G09G 2370/00* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/2258

See application file for complete search history.

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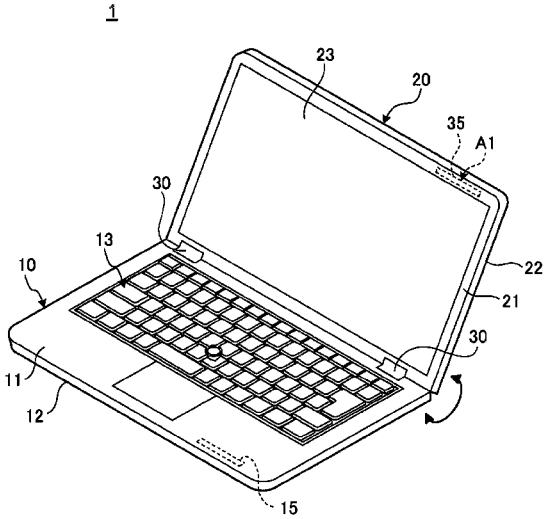
Primary Examiner — Dameon E Levi
Assistant Examiner — David Lotter
(74) *Attorney, Agent, or Firm* — Antony P. Ng; Russell Ng PLLC

(57) **ABSTRACT**

An electronic device having a slot antenna is disclosed. The electronic device includes a main unit chassis and a display chassis. The main unit chassis includes a base cover formed of a conductor, and a keyboard and a keyboard cover formed of a dielectric. The base cover includes a slot. The display chassis is connected to the main unit chassis through a hinge. The upper surface of the display chassis is covered by a display rear cover formed of a conductor. The lower surface of the display chassis is covered by a display unit and a bezel formed of a dielectric. A slot antenna is formed in a bezel area of the display rear cover. The slot of the base cover is located at a position that opposes a slot of the slot antenna when the display rear cover of the display chassis is overlapping with the main unit chassis.

20 Claims, 6 Drawing Sheets



US010135115B2

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

(10) **Patent No.: US 10,135,115 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **INTEGRATED MODULE HAVING ANTENNA**

(71) Applicant: **HONGBO WIRELESS COMMUNICATION TECHNOLOGY CO., LTD.**, Taipei (TW)

(72) Inventors: **Yu-Lin Shih**, Taipei (TW); **Kuan-Wei Lee**, Taipei (TW); **Yao-Yuan Chang**, Taipei (TW); **Tsung-Wen Chiu**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 49 days.

(21) Appl. No.: **15/371,110**

(22) Filed: **Dec. 6, 2016**

(65) **Prior Publication Data**

US 2017/0309990 A1 Oct. 26, 2017

(30) **Foreign Application Priority Data**

Apr. 26, 2016 (TW) ..... 105112884 A

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 5/35	(2015.01)
H01Q 5/371	(2015.01)
H01Q 9/42	(2006.01)
H01Q 9/04	(2006.01)
H01Q 1/44	(2006.01)

(Continued)

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

CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 5/35*** (2015.01); ***H01Q 5/371*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/28*** (2013.01); ***H01Q 21/29*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 5/35; H01Q 5/371; H01Q 9/42; H01Q 9/0421

See application file for complete search history.

(56) **References Cited**

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TW 201448349 A 12/2014

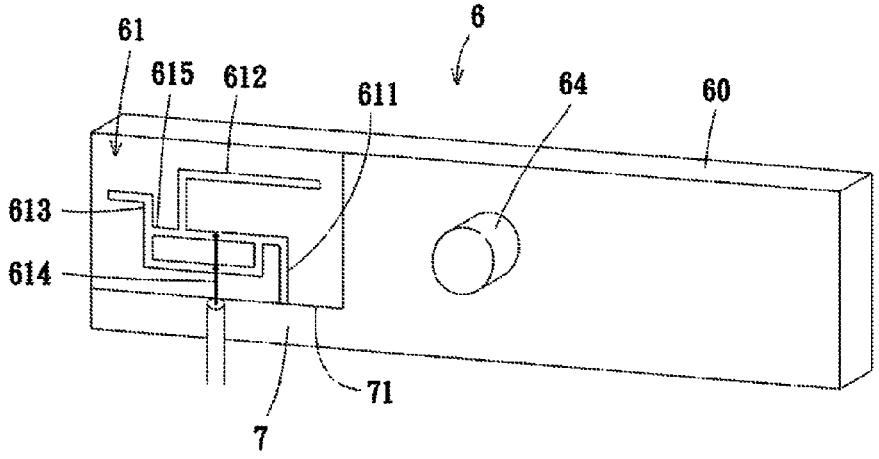
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — OPES IP Consulting Co. Ltd.

(57) **ABSTRACT**

An integrated module having an antenna comprises a module substrate, a camera module and the antenna disposed on the module substrate. The antenna comprises a grounding portion connected to ground plane, a low-frequency radiating arm, a high-frequency radiating arm, a feed-in line and a shorting portion. A connection portion of the low-frequency radiating arm and a connection portion of the high-frequency radiating arm are connected to the grounding portion. A free-end portion of the high-frequency radiating arm and a free-end portion of the low-frequency radiating arm are back-to-back and extend towards opposite directions. The feed-in line is perpendicular to an edge of the ground plane and extends away from the ground plane. The feed-in line crosses and connects the high-frequency radiating arm to provide a second feeding-point. The end of the feed-in line is connected to the connection portion of the low-frequency radiating arm to provide a first feeding-point.

10 Claims, 9 Drawing Sheets



US010135121B2

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

(10) **Patent No.: US 10,135,121 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ANTENNA FOR PORTABLE DEVICE**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)

(72) Inventors: **Hoon Park**, Seoul (KR); **Ho-Saeng Kim**, Gyeonggi-do (KR); **Yeon-Woo Kim**, Seoul (KR); **Seong-Tae Jeong**, Gyeonggi-do (KR); **Sang-Min Han**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 30 days.

(21) Appl. No.: **15/478,330**

(22) Filed: **Apr. 4, 2017**

(65) **Prior Publication Data**

US 2017/0207517 A1 Jul. 20, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/101,550, filed on Dec. 10, 2013, now Pat. No. 9,647,321.

(30) **Foreign Application Priority Data**

Mar. 28, 2013 (KR) 10-2013-0033475

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243
USPC 343/702
See application file for complete search history.

(56) **References Cited**

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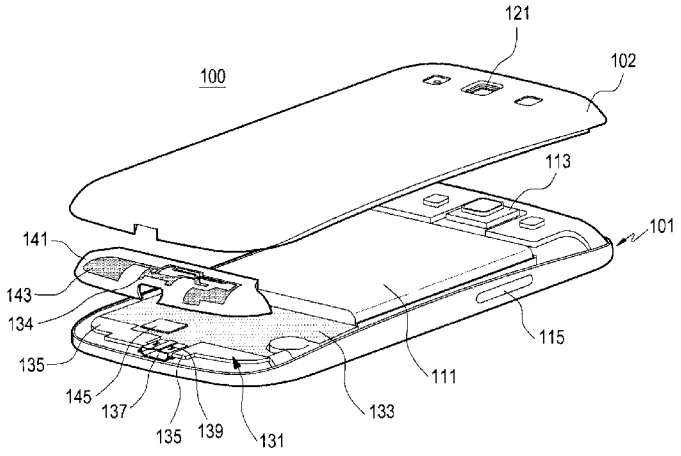
Primary Examiner — Dameon E Levi
Assistant Examiner — Walter Davis
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

An antenna device of a portable device such as a smartphone includes a connecting member having a conductive case and mounted on a circuit board of the portable device in a manner such that the case is connected to a ground surface of the circuit board; a radiator spaced from the circuit board; and at least one connecting pin provided between the case and the radiator. The radiator is connected to the ground surface through the connecting pin and the case. The antenna device advantageously may be easily installed in the internal space of a miniaturized, lightened and/or slimmed portable device by practically using a conductive component, e.g., the case, of the connecting member.

12 Claims, 7 Drawing Sheets



US010135125B2

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

(10) **Patent No.: US 10,135,125 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ULTRA-WIDEBAND (UWB) ANTENNA**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Artem Rudolfovich Vilenskiy**, Moscow (RU); **Andrey Vladimorovich Kletsov**, Moscow (RU); **Vladimir Yakovlevich Arkhipenkov**, Mytishchi (RU); **Dong Wook Kim**, Seoul (KR); **Jong Jin Kim**, Hwaseong-si (KR)

(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 129 days.

(21) Appl. No.: **14/097,742**

(22) Filed: **Dec. 5, 2013**

(65) **Prior Publication Data**

US 2014/0152514 A1 Jun. 5, 2014

(30) **Foreign Application Priority Data**

Dec. 5, 2012 (RU) 2012152251
Sep. 17, 2013 (KR) 10-2013-0111730

(51) **Int. Cl.**
H01Q 1/27 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/273*** (2013.01); ***H01Q 5/20*** (2015.01); ***H01Q 5/25*** (2015.01); ***H01Q 5/364*** (2015.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/273
(Continued)

(56) **References Cited**

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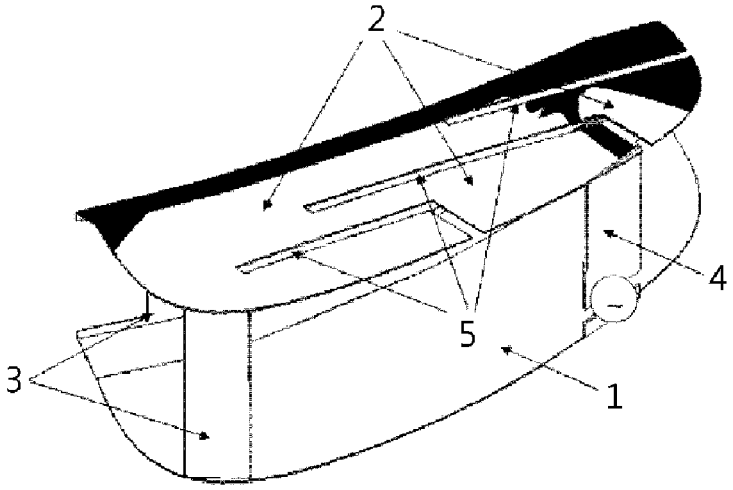
Primary Examiner — Daniel J Munoz
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

A small-sized ultra-wideband (UWB) antenna includes a radiating unit configured to have a contour of a first shape, a ground unit configured to have a contour of a shape substantially equal to the first shape, and disposed parallel to the radiating unit, at least one shorting pin connected orthogonal to the ground unit and the radiating unit to connect a first area of the ground unit and a first area of the radiating unit, and a feeding unit connected orthogonal to the ground unit and the radiating unit to connect a second area of the ground unit and a second area of the radiating unit.

20 Claims, 2 Drawing Sheets



US010135128B2

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

(10) **Patent No.: US 10,135,128 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ANTENNA MODULE**

(71) Applicant: **LG INNOTEK CO., LTD.**, Seoul (KR)

(72) Inventors: **Sang Bae Oh**, Seoul (KR); **In Pyo Park**, Seoul (KR)

(73) Assignee: **LG INNOTEK CO., LTD.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 40 days.

(21) Appl. No.: **15/137,479**

(22) Filed: **Apr. 25, 2016**

(65) **Prior Publication Data**

US 2016/0315390 A1 Oct. 27, 2016

(30) **Foreign Application Priority Data**

Apr. 24, 2015 (KR) 10-2015-0057841

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 5/328	(2015.01)
H01Q 1/36	(2006.01)
H01Q 1/38	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 1/36*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 9/42*** (2013.01); *H01Q 1/2291* (2013.01); *H01Q 5/328* (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/2291; H01Q 1/36; H01Q 1/38; H01Q 9/42; H01Q 5/30; H01Q 5/307; H01Q 5/314; H01Q 5/328; H01Q 5/378; H01Q 1/2258; H01Q 1/2266; H01Q 1/2275; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 9/0414; H01Q 5/392; H01Q 5/385; H01Q 1/48; H01Q 9/04; H01Q 9/0407; H01Q 9/0442

See application file for complete search history.

(56) **References Cited**

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2001/0043159	A1 *	11/2001	Masuda	H01Q 1/38 343/700 MS

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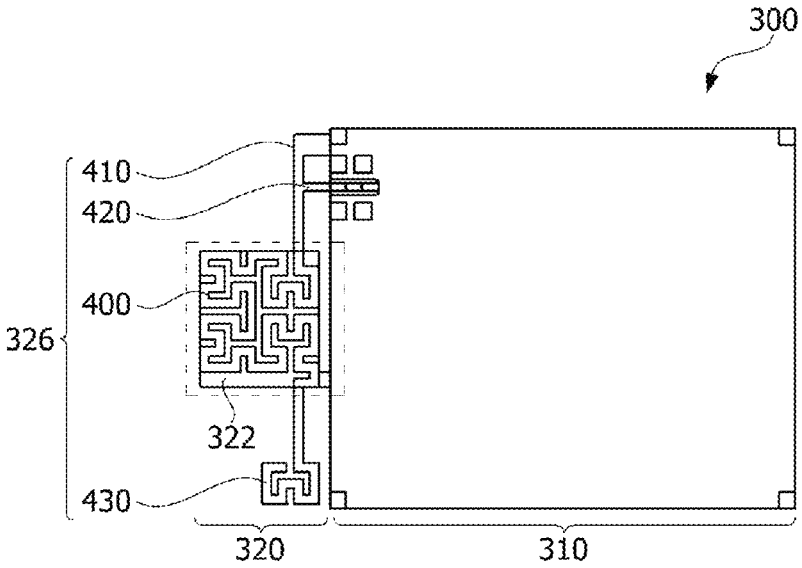
Primary Examiner — Tho G Phan
Assistant Examiner — Patrick Holecek
(74) *Attorney, Agent, or Firm* — Saliwanchik, Lloyd & Eisenschenk

(57) **ABSTRACT**

An antenna module is provided. The antenna module according to one embodiment of the present invention includes a ground portion which has a lower ground plane, a dielectric layer disposed on the lower ground plane, and an upper ground plane disposed on the dielectric layer, and an antenna portion disposed at an adjoining surface of the ground portion and configured to have a patch layer, a dielectric layer disposed on the patch layer, and an antenna layer disposed on the dielectric layer, and having a plurality of unit patterns which continuously repeat.

9 Claims, 15 Drawing Sheets



US010135129B2

(12) **United States Patent**
Zuniga-Juarez

(10) **Patent No.: US 10,135,129 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **LOW-COST ULTRA WIDEBAND LTE ANTENNA**

(71) Applicant: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy, County Wexford (IE)

(72) Inventor: **Jose Eleazar Zuniga-Juarez**, Ensenada (MX)

(73) Assignee: **TAOGLAS GROUP HOLDING LIMITED**, Enniscorthy (IE)

(*) 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.: **15/922,582**

(22) Filed: **Mar. 15, 2018**

(65) **Prior Publication Data**

US 2018/0233814 A1 Aug. 16, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/298,932, filed on Oct. 20, 2016, which is a continuation-in-part of application No. 14/438,611, filed as application No. PCT/US2013/063947 on Oct. 8, 2013, now Pat. No. 9,502,757.

(60) Provisional application No. 61/711,196, filed on Oct. 8, 2012.

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 9/06	(2006.01)
H01Q 5/371	(2015.01)
H01Q 1/24	(2006.01)
H01Q 7/00	(2006.01)
H01Q 9/42	(2006.01)
H01Q 21/28	(2006.01)

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

CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/065*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 5/371

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

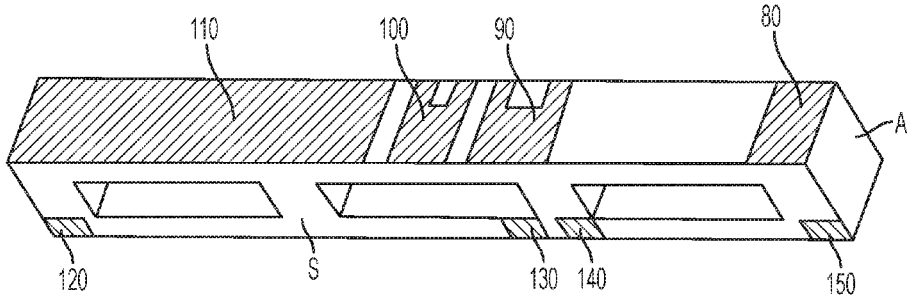
Assistant Examiner — David Lotter

(74) *Attorney, Agent, or Firm* — Shartsis Friese, LLP; Cecily Anne O'Regan; Kevin J. Everett, Jr.

(57) **ABSTRACT**

An antenna system capable of operating among all LTE bands, and also capable of operation among all remote side cellular applications, such as GSM, AMPS, GPRS, CDMA, WCDMA, UMTS, and HSPA among others. The antenna provides a low cost alternative to active-tunable antennas suggested in the prior art for the same multi-platform objective.

20 Claims, 15 Drawing Sheets



US010135132B2

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

(10) **Patent No.: US 10,135,132 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ANTENNA EQUIPMENT AND TERMINAL**

(71) Applicant: **Huawei Technologies Co., Ltd.**, Shenzhen (CN)

(72) Inventors: **Zhengyan Mao**, Wuhan (CN); **Kemeng Wang**, Wuhan (CN); **Dejin Zhu**, Shenzhen (CN); **Xiaoping Gao**, Wuhan (CN); **Yiwen Gong**, Mountain View, CA (US); **Song Wu**, Wuhan (CN); **Wei Wang**, Wuhan (CN)

(73) Assignee: **Huawei Technologies Co., Ltd.**, Shenzhen (CN)

(*) 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.: **15/540,914**

(22) PCT Filed: **Dec. 30, 2014**

(86) PCT No.: **PCT/CN2014/095697**

§ 371 (c)(1),
(2) Date: **Jun. 29, 2017**

(87) PCT Pub. No.: **WO2016/106612**

PCT Pub. Date: **Jul. 7, 2016**

(65) **Prior Publication Data**

US 2017/0338552 A1 Nov. 23, 2017

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/52 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/48*** (2013.01); ***H01Q 1/52*** (2013.01); ***H01Q 3/00*** (2013.01); *H01Q 1/243* (2013.01); *H01Q 1/38* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 3/00
(Continued)

(56) **References Cited**

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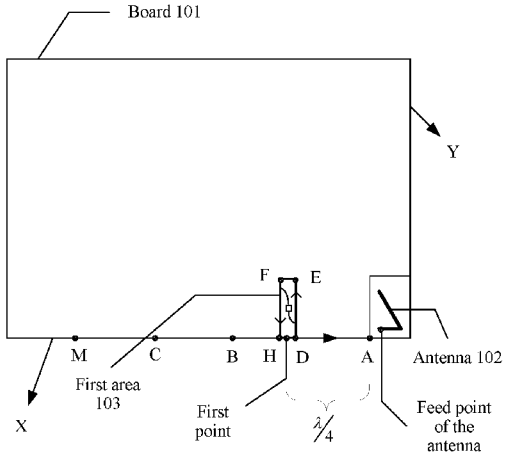
CN 102349196 A 2/2012
(Continued)

Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

An antenna equipment includes an antenna and a board on which the antenna is disposed, and includes an area that is disposed on the board and that is not covered by a metal layer. A first edge of the board is a longer edge of the board in two edges of the board that are close to the antenna, a point that is on the first edge and whose distance with a current maximum point on the first edge is λ/4 is a first point, the current maximum point is on the first edge and that is closest to a feed point of the antenna, and λ is an operating wavelength of the antenna. The area that is not covered by a metal layer includes the first point, and a maximum distance from an edge of the area to the first edge of the board is λ/4.

16 Claims, 3 Drawing Sheets



US010135141B2

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

(10) **Patent No.: US 10,135,141 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **MOBILE DEVICE**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Shih-Ting Huang**, New Taipei (TW); **Kun-Sheng Chang**, New Taipei (TW); **Ching-Chi Lin**, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, 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 1 day.

(21) Appl. No.: **15/436,346**

(22) Filed: **Feb. 17, 2017**

(65) **Prior Publication Data**

US 2018/0131075 A1 May 10, 2018

(30) **Foreign Application Priority Data**

Nov. 4, 2016 (TW) ..... 105135839 A

(51) **Int. Cl.**

H01Q 9/04	(2006.01)
H01Q 7/00	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/364	(2015.01)
H01Q 5/371	(2015.01)
H01Q 1/48	(2006.01)

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

CPC ***H01Q 9/0421*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 5/371*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01); *H01Q 1/48* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38

See application file for complete search history.

(56) **References Cited**

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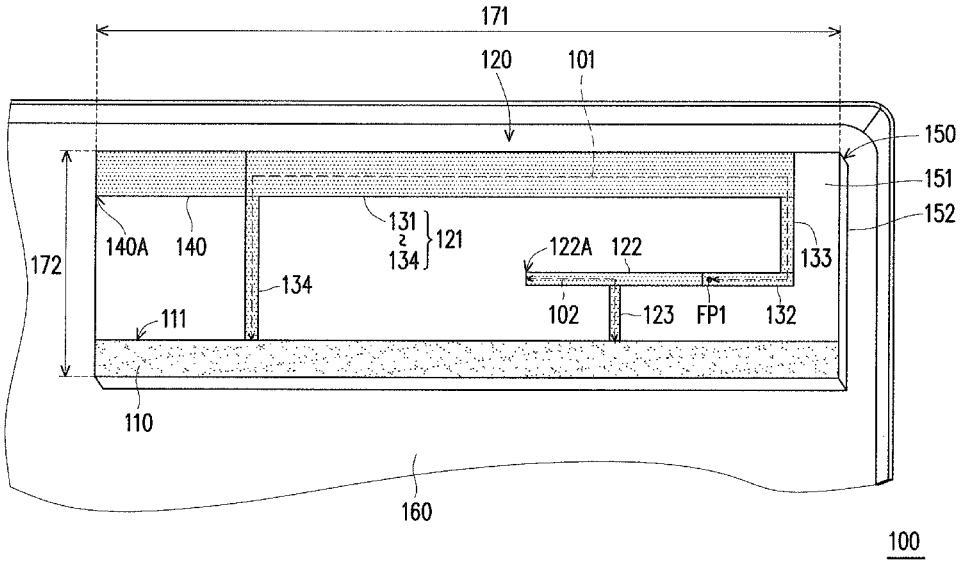
Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

A mobile device includes a ground element and an antenna element. The antenna element includes a first radiation portion, a second radiation portion, and a third radiation portion. The first radiation portion is electrically connected between a feeding point and an edge of the ground element, and the antenna element operates in a first frequency band through a first path formed by the first radiation portion. A first end of the second radiation portion is electrically connected to the first radiation portion, and a second end of the second radiation portion is a first open end. The third radiation portion is electrically connected between the second radiation portion and the edge of the ground element. The antenna element operates in a second frequency band through a second path formed by the second radiation portion and the third radiation portion.

18 Claims, 3 Drawing Sheets



US010135152B2

(12) **United States Patent**
Ito

(10) **Patent No.: US 10,135,152 B2**
(45) **Date of Patent: Nov. 20, 2018**

(54) **ANTENNA DEVICE AND ELECTRONIC DEVICE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventor: **Hiromitsu Ito**, Nagaokakyo (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 0 days.

(21) Appl. No.: **15/652,286**

(22) Filed: **Jul. 18, 2017**

(65) **Prior Publication Data**

US 2017/0317425 A1 Nov. 2, 2017

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2016/069837, filed on Jul. 5, 2016.

(30) **Foreign Application Priority Data**

Jul. 6, 2015 (JP) 2015-135044

(51) **Int. Cl.**
H01Q 19/00 (2006.01)
G06K 19/077 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 19/00*** (2013.01); ***G06K 19/077*** (2013.01); ***H01Q 7/00*** (2013.01); *H01Q 5/378* (2015.01); *H01Q 13/106* (2013.01); *H01Q 21/28* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 19/00; H01Q 7/00; H01Q 5/378; H01Q 13/106; H01Q 21/28
(Continued)

(56) **References Cited**

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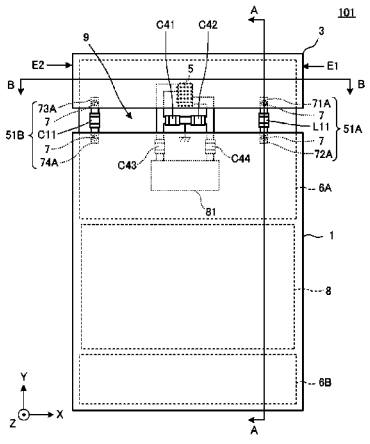
(Continued)

Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna device includes a power supply coil coupled to a first power supply circuit operating in a first frequency band, a first conductive member including a first main surface, a second conductive member including a second main surface, a third conductive member, and first connections. The second main surface of the second conductive member is disposed with at least a portion thereof opposing the first main surface. The third conductive member has an area that is smaller than an area of the first conductive member when viewed in a direction perpendicular or substantially perpendicular to the first main surface. The first conductive member, the third conductive member, and the first connections define a loop of a magnetic field antenna in the first frequency band. The power supply coil is closer to the third conductive member than to the first conductive member when viewed in the Z-direction.

10 Claims, 22 Drawing Sheets



US010141632B2

(12) **United States Patent**
Galeev

(10) **Patent No.: US 10,141,632 B2**
(45) **Date of Patent: Nov. 27, 2018**

(54) **WIRELESS ELECTRONIC DEVICES WITH METAL PERIMETER PORTIONS INCLUDING A PLURALITY OF ANTENNAS**

(71) Applicant: **Sony Corporation**, Tokyo (JP)

(72) Inventor: **Roustem Galeev**, Lund (SE)

(73) Assignee: **SONY MOBILE COMMUNICATIONS INC.**, Tokyo (JP)

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

(21) Appl. No.: **14/355,703**

(22) PCT Filed: **Jun. 27, 2013**

(86) PCT No.: **PCT/JP2013/068306**
§ 371 (c)(1),
(2) Date: **May 1, 2014**

(87) PCT Pub. No.: **WO2014/207945**
PCT Pub. Date: **Dec. 31, 2014**

(65) **Prior Publication Data**

US 2015/0244061 A1 Aug. 27, 2015

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/50
USPC 343/702
See application file for complete search history.

(56) **References Cited**

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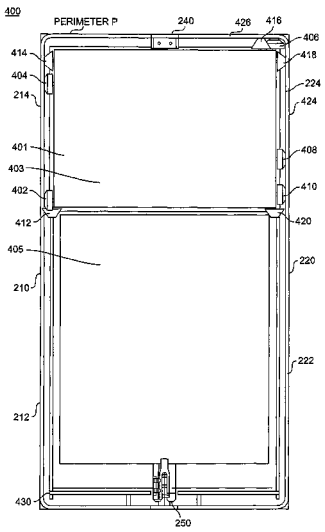
Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

(57) **ABSTRACT**

Wireless electronic devices may include a ground plane and metal antenna portions separated by input connector portions improving the metal look and feel of the wireless electronic device.

22 Claims, 12 Drawing Sheets



US010141634B2

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

(10) **Patent No.: US 10,141,634 B2**
(45) **Date of Patent: Nov. 27, 2018**

(54) **ANTENNA FOR USE IN MOBILE TERMINAL**

(71) Applicant: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

(72) Inventors: **Zonglin Xue**, Beijing (CN); **Linchuan Wang**, Beijing (CN); **Xiaofeng Xiong**, Beijing (CN)

(73) Assignee: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 20 days.

(21) Appl. No.: **15/407,346**

(22) Filed: **Jan. 17, 2017**

(65) **Prior Publication Data**

US 2017/0222304 A1 Aug. 3, 2017

(30) **Foreign Application Priority Data**

Jan. 29, 2016 (CN) 2016 1 0066990

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/42	(2006.01)
H01Q 5/385	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 5/385*** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/385; H01Q 1/38; H01Q 1/42

USPC 343/702

See application file for complete search history.

(56) **References Cited**

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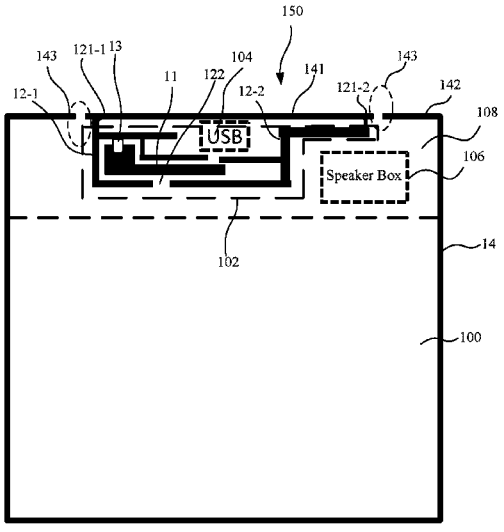
Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — Finnegan, Henderson, Farabow, Garrett & Dunner LLP

(57) **ABSTRACT**

An antenna for use in a mobile terminal includes a first radiation unit including a feed portion for inputting energy, the feed portion being provided at one end of the first radiation unit, and at least one coupling branch. The first radiation unit and the at least one coupling branch form a coupled feeding structure between each other. A first end portion of the at least one coupling branch is connected to a metal frame of the mobile terminal. The at least one coupling branch is disposed around the first radiation unit. The at least one coupling branch and the first radiation unit are not in contact with each other. The at least one coupling branch has an opening.

4 Claims, 3 Drawing Sheets



US010141652B2

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

(10) **Patent No.: US 10,141,652 B2**
(45) **Date of Patent: Nov. 27, 2018**

(54) **ANTENNA APPARATUS AND DEVICE**

(71) Applicant: **Huawei Technologies Co., Ltd.**, Shenzhen (CN)

(72) Inventors: **Qing Liu**, Shenzhen (CN); **Yuzhen Zhang**, Wuhan (CN); **Yao Lan**, Shenzhen (CN); **Dingjie Wang**, Shenzhen (CN)

(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 38 days.

(21) Appl. No.: **15/507,313**

(22) PCT Filed: **Aug. 28, 2014**

(86) PCT No.: **PCT/CN2014/085401**

§ 371 (c)(1),
(2) Date: **Feb. 28, 2017**

(87) PCT Pub. No.: **WO2016/029404**

PCT Pub. Date: **Mar. 3, 2016**

(65) **Prior Publication Data**

US 2017/0288310 A1 Oct. 5, 2017

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 9/42 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0421*** (2013.01); ***B32B 38/1841*** (2013.01); ***H01L 21/67144*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 9/0421; H01Q 5/335; H01Q 5/342; B32B 38/1841; H01L 21/67144
See application file for complete search history.

(56) **References Cited**

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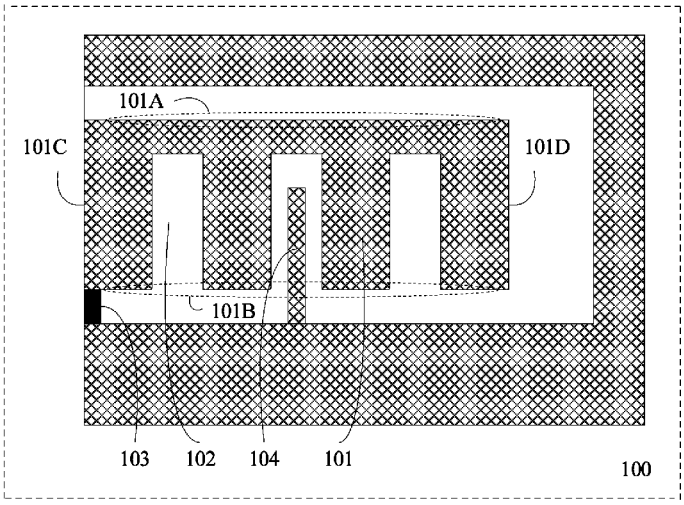
Primary Examiner — Dameon E Levi
Assistant Examiner — David Lotter
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna apparatus includes: an antenna radiator, at least one antenna cable trough, a feedpoint, and at least one first protruding metal strip; where the at least one antenna cable trough is disposed on the antenna radiator; the at least one antenna cable trough extends along a top edge to a bottom edge of the antenna radiator; the feedpoint is further disposed on the antenna radiator, and the feedpoint is disposed at an end of the bottom edge of the antenna radiator and is near a side edge of the antenna radiator; and the at least one first protruding metal strip is inserted in the antenna cable trough and is separated from the antenna radiator.

11 Claims, 5 Drawing Sheets



US010148011B2

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

(10) **Patent No.: US 10,148,011 B2**
(45) **Date of Patent: Dec. 4, 2018**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Arcadyan Technology Corporation**, Hsinchu (TW)

(72) Inventors: **Min-Chi Wu**, Zhubei (TW); **I-Min Chen**, Kaohsiung (TW)

(73) Assignee: **Arcadyan Technology Corporation** (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.: **15/673,113**

(22) Filed: **Aug. 9, 2017**

(65) **Prior Publication Data**

US 2018/0269578 A1 Sep. 20, 2018

(30) **Foreign Application Priority Data**

Mar. 15, 2017 (TW) ..... 106108590 A

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/52	(2006.01)
H01Q 5/35	(2015.01)
H01Q 5/40	(2015.01)
H01Q 9/42	(2006.01)
H01Q 21/28	(2006.01)

(Continued)

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

CPC ***H01Q 5/40*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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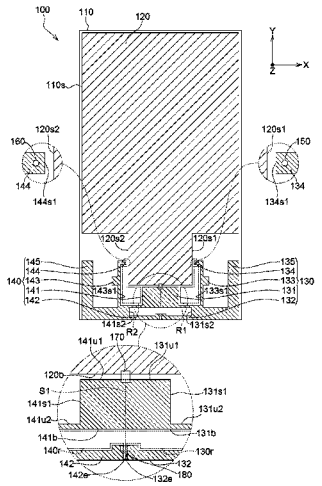
Primary Examiner — Howard Williams

(74) *Attorney, Agent, or Firm* — Innovation Counsel LLP

(57) **ABSTRACT**

An antenna structure including a substrate, a grounding layer, a first antenna layer, a second antenna layer, an inductance element and a capacitance element is provided. The substrate has a surface. The grounding layer is formed on the surface of the substrate. The first antenna layer includes a first radiating portion and a second radiating portion. The second antenna layer includes a third radiating portion and a fourth radiating portion. The third radiating portion is connected to the first radiating portion at a connection portion. The connection portion is separated from the grounding player, and the fourth radiating portion and the second radiating portion are disposed oppositely and separated from each other. The inductance element bridges the grounding layer and the connection portion. The capacitance element bridges the fourth radiating portion and the second radiating portion.

20 Claims, 12 Drawing Sheets



US010153539B2

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

(10) **Patent No.: US 10,153,539 B2**
(45) **Date of Patent: Dec. 11, 2018**

(54) **ANTENNA DEVICE AND ELECTRONIC DEVICE HAVING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)

(72) Inventors: **Jung-Hoon Seo**, Gyeonggi-do (KR); **Ui-Chul Jeong**, Gyeonggi-do (KR); **Se-Hyun Park**, Gyeonggi-do (KR); **Jae-Ho Lim**, Seoul (KR)

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

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

(21) Appl. No.: **15/056,419**

(22) Filed: **Feb. 29, 2016**

(65) **Prior Publication Data**

US 2016/0254590 A1 Sep. 1, 2016

(30) **Foreign Application Priority Data**

Feb. 27, 2015 (KR) 10-2015-0028663

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/00	(2015.01)
H04B 1/00	(2006.01)
H01Q 5/335	(2015.01)
H01Q 5/364	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/364*** (2015.01); ***H01Q 9/42*** (2013.01); ***H04B 1/006*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/357; H01Q 5/364; H01Q 5/371; H01Q 5/378; H01Q 5/385; H01Q 5/392

See application file for complete search history.

(56) **References Cited**

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(Continued)

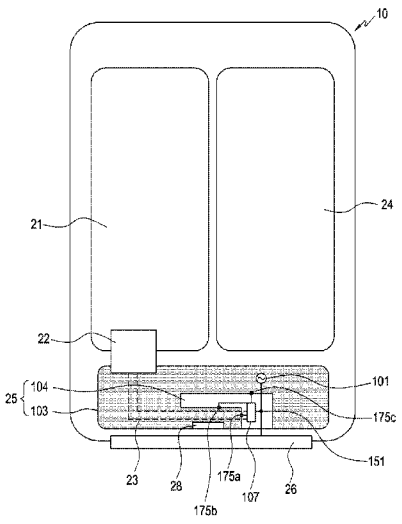
Primary Examiner — Daniel J Munoz

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

(57) **ABSTRACT**

Disclosed are an antenna device and an electronic device that includes the antenna device. The antenna device includes a power feeding unit, a ground unit, a radiating unit that is electrically connected to the power feeding unit, and a switching element that selects one or more points from a plurality of different points of the ground unit and connects the radiating unit to the selected one or more points.

18 Claims, 17 Drawing Sheets



US010158163B2

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

(10) **Patent No.: US 10,158,163 B2**
(45) **Date of Patent: Dec. 18, 2018**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(72) Inventors: **Cheolgu Gang**, Seoul (KR); **Hyunsuk Yang**, Seoul (KR); **Jongmo Kang**, Seoul (KR); **Jinho Jang**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 42 days.

(21) Appl. No.: **15/241,605**

(22) Filed: **Aug. 19, 2016**

(65) **Prior Publication Data**

US 2017/0054199 A1 Feb. 23, 2017

(30) **Foreign Application Priority Data**

Aug. 20, 2015 (KR) 10-2015-0117416

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

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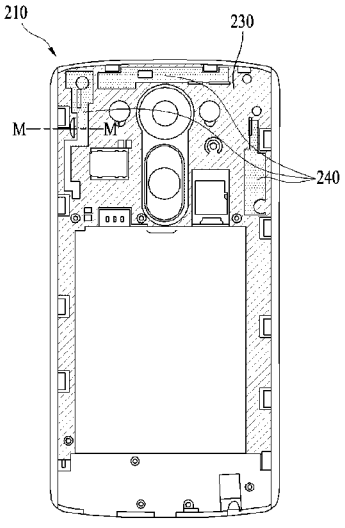
Primary Examiner — Hoang Nguyen
Assistant Examiner — Awat Salih
(74) *Attorney, Agent, or Firm* — KED & Associates, LLP

(57) **ABSTRACT**

Disclosed is a mobile terminal, by which extensibility of an antenna pattern and radiation efficiency of an antenna can be increased. The present invention includes a display, a frame configured to support a back of the display, a first antenna to be provided to at least one side of a top portion and a bottom portion of the frame, a rear case to attach to a back of the frame, a second antenna provided to at least one of an inner side and an outer side of the rear case, and a third antenna configured in a beam shape to be attached to at least one of a right lateral side and a left lateral side of the frame, the third antenna configured to be electrically connected to either the first antenna or the second antenna.

18 Claims, 14 Drawing Sheets



US010158164B2

(12) **United States Patent**
Gagne-Keats

(10) **Patent No.: US 10,158,164 B2**
(45) **Date of Patent: Dec. 18, 2018**

(54) **HANDHELD MOBILE DEVICE WITH HIDDEN ANTENNA FORMED OF METAL INJECTION MOLDED SUBSTRATE**

(71) Applicant: **Essential Products, Inc.**, Palo Alto, CA (US)

(72) Inventor: **Jason Sean Gagne-Keats**, Cupertino, CA (US)

(73) Assignee: **ESSENTIAL PRODUCTS, INC.**, Palo Alto, 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.: **15/697,373**

(22) Filed: **Sep. 6, 2017**

(65) **Prior Publication Data**

US 2017/0373377 A1 Dec. 28, 2017

Related U.S. Application Data

(63) Continuation-in-part of application No. 15/336,701, filed on Oct. 27, 2016, now Pat. No. 9,896,777.
(Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
B32B 7/12 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***B32B 7/12*** (2013.01); ***B32B 15/00*** (2013.01); ***C23C 22/00*** (2013.01); ***C25D 11/026*** (2013.01); ***C25D 11/16*** (2013.01); ***C25D 11/26*** (2013.01); ***C25D 11/30*** (2013.01); ***C25F 3/08*** (2013.01); *B23H 3/00* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01C 1/243; H01C 1/2283
See application file for complete search history.

(56) **References Cited**

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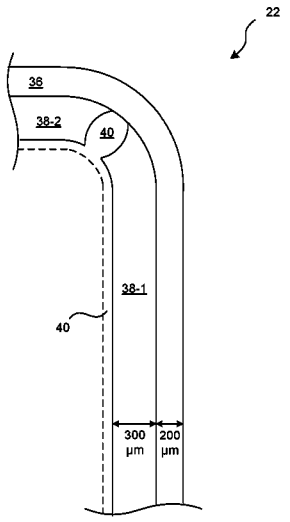
Primary Examiner — Hoang Nguyen
Assistant Examiner — Awat Salih
(74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(57) **ABSTRACT**

The disclosed embodiments include a housing of a handheld mobile device. The housing includes a ceramic layer forming a continuous outermost surface of the handheld mobile device, and an antenna layer adjacent to the ceramic layer. The antenna layer including conductive elements formed from a metal injection molded substrate, and an antenna break formed of non-conductive material electrically separating the conductive elements to collectively form an antenna of the handheld mobile device that is hidden by the ceramic layer from an exterior view of the handheld mobile device.

19 Claims, 7 Drawing Sheets



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

(10) **Patent No.: US 10,158,381 B2**
(45) **Date of Patent: Dec. 18, 2018**

(54) **WIRELESS COMMUNICATION DEVICE**

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(73) Assignee: **HTC CORPORATION**, Taoyuan (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.: **15/821,777**

(22) Filed: **Nov. 23, 2017**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

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H04B 1/00	(2006.01)
H04B 1/40	(2015.01)
H04W 88/06	(2009.01)

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

CPC ***H04B 1/006*** (2013.01); ***H04B 1/40*** (2013.01); *H04W 88/06* (2013.01)

(58) **Field of Classification Search**

CPC H04B 1/0053; H04B 1/0064; H01Q 1/00; H01Q 5/00

See application file for complete search history.

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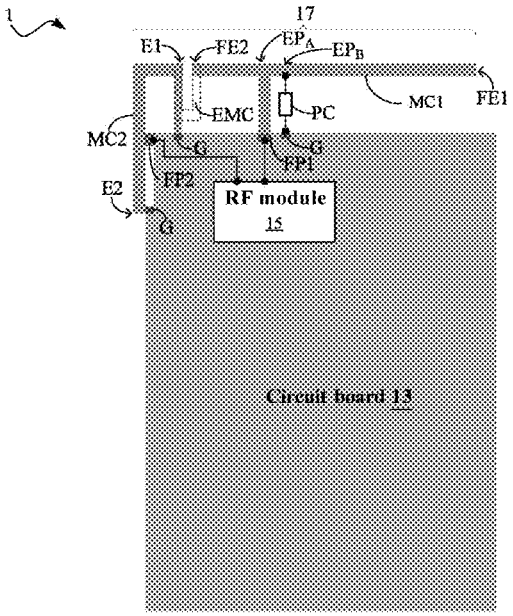
Primary Examiner — Tuan Pham

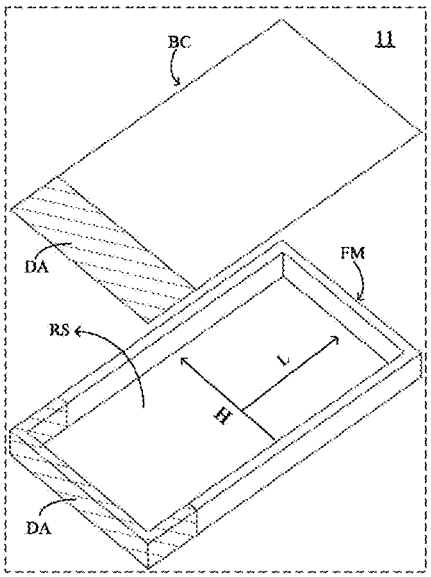
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A wireless communication device is provided. The wireless communication device includes a housing, a circuit board, a radio frequency module and an antenna. The housing has a frame and a back cover to define a receiving space. The circuit board is disposed in the receiving space, and defines a clearance area from the housing in the receiving space. The circuit board includes a ground terminal, a first feeding point, and a second feeding point. The antenna includes at least one metal conductor coupled to the first feeding point and the second feeding point, respectively, to provide a low frequency resonant path, a first middle frequency resonant path, a second middle frequency resonant path and a high frequency resonant path.

12 Claims, 22 Drawing Sheets





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

(10) **Patent No.: US 10,158,384 B1**
(45) **Date of Patent: Dec. 18, 2018**

(54) **ELECTRONIC DEVICES WITH INDIRECTLY-FED ADJUSTABLE SLOT ELEMENTS**

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

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(21) Appl. No.: **15/699,869**

(22) Filed: **Sep. 8, 2017**

(51) **Int. Cl.**

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H04B 1/04	(2006.01)
H01Q 1/24	(2006.01)

(52) **U.S. Cl.**
CPC ***H04B 1/0483*** (2013.01); ***H01Q 1/243*** (2013.01); ***H04B 1/0458*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/0483; H04B 1/0458
USPC 455/575.7
See application file for complete search history.

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Primary Examiner — April G Gonzales
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(57) **ABSTRACT**

An electronic device may be provided with wireless circuitry and control circuitry. The wireless circuitry may include multiple antennas and transceiver circuitry. An antenna in the electronic device may have an inverted-F antenna resonating element formed from portions of a peripheral conductive electronic device housing structure and may have an antenna ground that is separated from the antenna resonating element by a gap. The antenna may also include an indirectly-fed antenna resonating element that is indirectly fed by a harmonic mode of the inverted-F antenna resonating element via near field electromagnetic coupling. The indirectly-fed antenna resonating element may be a slot. The antenna ground may define at least three edges of the slot and the slot may be aligned with a dielectric-filled gap in the peripheral conductive housing structures. An adjustable circuit may be coupled across the slot to tune the indirectly-fed antenna resonating element.

20 Claims, 10 Drawing Sheets