US010003121B2

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

(10) **Patent No.: US 10,003,121 B2**
(45) **Date of Patent: Jun. 19, 2018**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE**

(75) Inventors: **Tiao-Hsing Tsai**, Taoyuan (TW); **Chien-Pin Chiu**, Taoyuan (TW); **Hsiao-Wei Wu**, Taoyuan (TW); **Ying-Chih Wang**, Taoyuan (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 110 days.

(21) Appl. No.: **13/598,317**

(22) Filed: **Aug. 29, 2012**

(65) **Prior Publication Data**

US 2014/0062818 A1 Mar. 6, 2014

(51) **Int. Cl.**

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H01Q 9/42	(2006.01)
H01Q 5/00	(2015.01)
H01Q 5/335	(2015.01)
H01Q 5/378	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/335
USPC ..... 343/700 MS, 702
See application file for complete search history.

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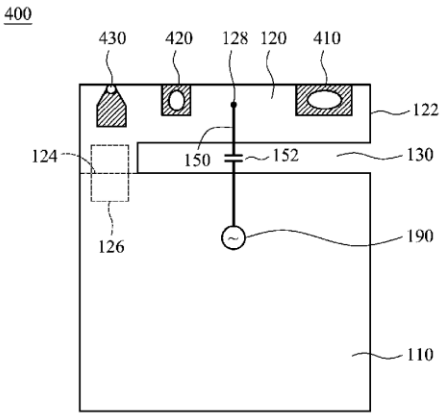
Primary Examiner — Daniel J Munoz
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile device includes a ground plane, a grounding branch, and a feeding element. The grounding branch is coupled to the ground plane, wherein a slot is formed between the ground plane and the grounding branch. The feeding element extends across the slot. The feeding element is coupled between the grounding branch and a signal source. An antenna structure is formed by the feeding element and the grounding branch.

18 Claims, 6 Drawing Sheets



US010003122B2

(12) **United States Patent**
Hsiao

(10) **Patent No.: US 10,003,122 B2**
(45) **Date of Patent: Jun. 19, 2018**

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

(71) Applicants: **Qisda (Suzhou) Co., Ltd.**, Suzhou, Jiangsu (CN); **Qisda Corporation**, Taoyuan (TW)

(72) Inventor: **Ho-Chen Hsiao**, New Taipei (TW)

(73) Assignees: **Qisda (Suzhou) Co., Ltd.**, Suzhou (CN); **Qisda 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 210 days.

(21) Appl. No.: **15/007,229**

(22) Filed: **Jan. 27, 2016**

(65) **Prior Publication Data**

US 2016/0226147 A1 Aug. 4, 2016

(30) **Foreign Application Priority Data**

Feb. 2, 2015 (TW) ..... 104103397 A

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 5/378*** (2015.01)

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

(56) **References Cited**

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CN 104253309 12/2014

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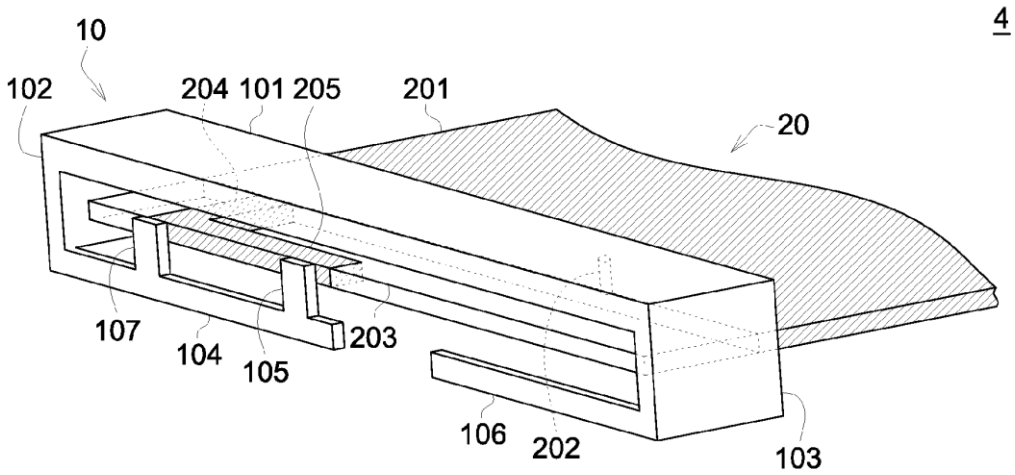
Primary Examiner — Jessica Han
Assistant Examiner — Amal Patel

(57) **ABSTRACT**

An antenna device includes a radiation part and a circuit board. The radiation part includes first to third sidewalls, an extension part and a protrusion part. The second and third sidewalls are connected to the first sidewall and opposite to each other. The extension part extends toward the third sidewall from the second sidewall. The protrusion part extends toward the first sidewall from the extension part. The circuit board includes a ground layer, a feed point, a clearance area, first metal and second metal sheets. The feed point is electrically connected to the radiation part. The clearance area is in a containing space formed by the first to third sidewalls. The first metal sheet is in the clearance area and extends from the ground layer. The second metal sheet is in the clearance area, connected to the first metal sheet and the protrusion part, and parallel to the extension part.

13 Claims, 4 Drawing Sheets



US010003130B2

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

(10) **Patent No.: US 10,003,130 B2**
(45) **Date of Patent: Jun. 19, 2018**

(54) **COMMUNICATION DEVICE WITH RECONFIGURABLE LOW-PROFILE ANTENNA ELEMENT**

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

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW); **Meng-Ting Chen**, 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 17 days.

(21) Appl. No.: **15/403,077**

(22) Filed: **Jan. 10, 2017**

(65) **Prior Publication Data**

US 2017/0149139 A1 May 25, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/071,660, filed on Nov. 5, 2013, now abandoned.

(30) **Foreign Application Priority Data**

Jun. 27, 2013 (TW) ..... 102122988 A

(51) **Int. Cl.**

H01Q 9/04	(2006.01)
H01Q 1/48	(2006.01)
H01Q 7/00	(2006.01)
H01Q 5/50	(2015.01)
H01Q 1/24	(2006.01)

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

CPC ***H01Q 9/0421*** (2013.01); ***H01Q 1/242*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/50*** (2015.01); ***H01Q 7/00*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0421; H01Q 5/50; H01Q 1/242; H01Q 1/48; H01Q 7/00

See application file for complete search history.

(56) **References Cited**

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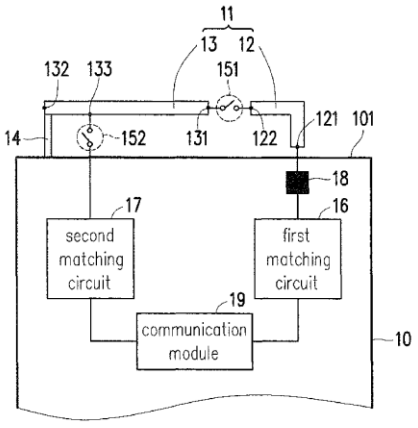
Primary Examiner — Dieu H Duong
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A communication device including a ground element and an antenna element is provided. The antenna element is disposed adjacent to an edge of the ground element, and a loop structure is formed by the antenna element and the edge of the ground element. The antenna element includes a first and a second metal portions, and a first and second switches. When the first switch is turned on and the second switch is turned off, the first metal portion, the second metal portion, a shorting metal portion and the first switch form a loop antenna with the ground element. When the second switch is turned on and the first switch is turned off, an inverted-F antenna is formed by the second metal portion.

7 Claims, 5 Drawing Sheets



US010008762B2

(12) **United States Patent**
Andujar Linares et al.

(10) **Patent No.: US 10,008,762 B2**
(45) **Date of Patent: Jun. 26, 2018**

(54) **WIRELESS DEVICE INCLUDING OPTIMIZED ANTENNA SYSTEM ON METAL FRAME**

(71) Applicant: **Fractus Antennas, S.L.**, Barcelona (ES)

(72) Inventors: **Aurora Andujar Linares**, Barcelona (ES); **Yolanda Cobo**, Barcelona (ES); **Jaume Anguera Pros**, Vinaros (ES)

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

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

(21) Appl. No.: **15/411,414**

(22) Filed: **Jan. 20, 2017**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 62/281,749, filed on Jan. 22, 2016.

(51) **Int. Cl.**

H01Q 1/12	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/335	(2015.01)
H01Q 5/378	(2015.01)

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

CPC ***H01Q 1/24*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H04M 1/026; H01Q 1/12

USPC 455/66.1, 575.6, 575.5, 277.1, 276.1, 455/67.11; 343/767

See application file for complete search history.

(56) **References Cited**

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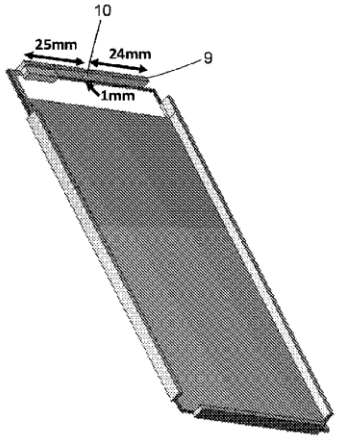
Primary Examiner — John J Lee
(74) *Attorney, Agent, or Firm* — Edell, Shapiro & Finnan LLC

(57) **ABSTRACT**

A wireless device such as a mobile device comprises a metal frame antenna (MFA) solution developed to cover the multiple range of frequencies required in the wireless device. An MFA includes a ground plane layer, at least a single-strip metal frame element spaced apart from an edge of the ground plane layer, and at least a feeding system that connects the at least one single-strip metal frame element to an RF transceiver of the wireless device.

5 Claims, 5 Drawing Sheets



US010008763B2

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

(10) **Patent No.: US 10,008,763 B2**
(45) **Date of Patent: Jun. 26, 2018**

(54) **MULTI-BAND ANTENNA**

(71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)

(72) Inventors: **Chin-Ting Huang**, Taipei (TW); **Hsiao-Wen Wu**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

(21) Appl. No.: **14/958,618**

(22) Filed: **Dec. 3, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 9, 2014 (TW) ..... 103142817 A

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/44	(2006.01)
H01Q 5/30	(2015.01)
H01Q 9/40	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/378	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/40*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0407; H01Q 1/38; H01Q 1/243; H01Q 5/378; H01Q 5/357; H01Q 5/364; H01Q 5/371; H01Q 1/44

See application file for complete search history.

(56) **References Cited**

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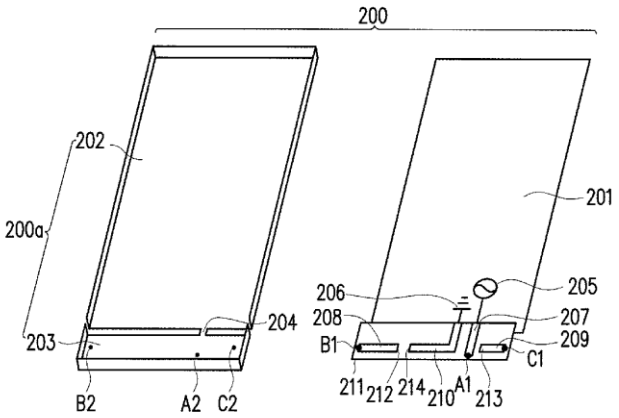
Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

A multi-band antenna includes a conductive cap, a ground plane element, a supporting frame, a first radiating conductive element, a second radiating conductive element, a third radiating conductive element, and a plurality of conductive pieces. The multi-band antenna of the disclosure makes the radiating conductive element contact with the conductive cap physically via the conductive piece. Therefore, although a gap similar to a slot is formed, the resonant mode of the multi-band antenna is not excited via the slot.

9 Claims, 4 Drawing Sheets



US010008765B2

(12) **United States Patent**
Lin

(10) **Patent No.: US 10,008,765 B2**
(45) **Date of Patent: Jun. 26, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventor: **Yen-Hui Lin**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, 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. days.

(21) Appl. No.: **15/356,623**

(22) Filed: **Nov. 20, 2016**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 30, 2015 (CN) 2015 1 0858013

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/392 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/392*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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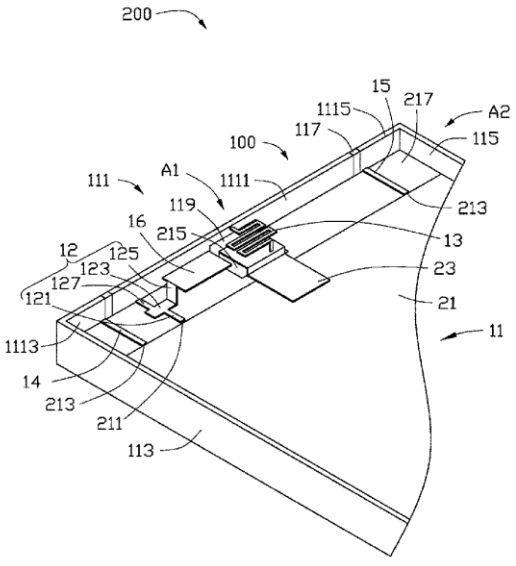
Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a metallic member, a radiating portion, and a meander portion. The metallic member defines at least one slot and is divided into a first metallic portion and a second metallic portion by the at least one slot. The radiating portion is electrically connected to the first metallic portion and is configured to feed current to the first metallic portion. The meander portion is configured to activate a low-frequency mode of the antenna structure and maintain high-frequency characteristics of the antenna structure. The second metallic portion is spaced apart from the first metallic portion and is grounded. The meander portion includes a first end and a second end. The first end of the meander portion is electrically connected to the first metallic portion, and the second end of the meander portion is grounded.

20 Claims, 6 Drawing Sheets



US010008776B2

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

(10) **Patent No.: US 10,008,776 B2**
(45) **Date of Patent: Jun. 26, 2018**

(54) **WIDEBAND ANTENNA**

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(72) Inventors: **Chung-Hsuan Chen**, Hsinchu (TW); **Kuan-Chung Chen**, Hsinchu (TW); **Yung-Jen Cheng**, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 193 days.

(21) Appl. No.: **14/874,484**

(22) Filed: **Oct. 5, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 4, 2014 (TW) ..... 103221506 U

(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/378*** (2015.01); ***H01Q 1/243*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 5/385; H01Q 5/392
See application file for complete search history.

(56) **References Cited**

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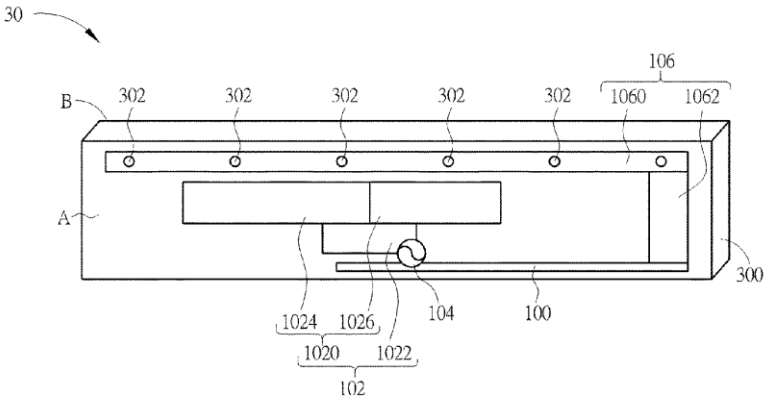
Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — Winston Hsu

(57) **ABSTRACT**

A wideband antenna includes a grounding terminal, a first radiator disposed on a first plane, a feeding terminal formed on the first radiator, where the feeding terminal is to transmit and receive radio signals via the first radiator, and a second radiator disposed on the first plane, electrically connected to the grounding terminal, and including a part parallel to a side of the first radiator, wherein a minimum gap between the second radiator and the first radiator allows the second radiator and the first radiator to generate a coupling effect therebetween, so as to exchange radio signals between the second radiator and the first radiator.

10 Claims, 11 Drawing Sheets



US010014575B2

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

(10) **Patent No.: US 10,014,575 B2**
(45) **Date of Patent: Jul. 3, 2018**

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

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

(72) Inventors: **Sung-Wu Park**, Daegu (KR); **Soon-Sang Park**, Daegu (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 160 days.

(21) Appl. No.: **14/301,997**

(22) Filed: **Jun. 11, 2014**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 8, 2013 (KR) 10-2013-0079699

(51) **Int. Cl.**

H01Q 3/24	(2006.01)
H01Q 1/50	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 1/50*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/50; H01Q 1/48; H01Q 9/42; H01Q 1/243

See application file for complete search history.

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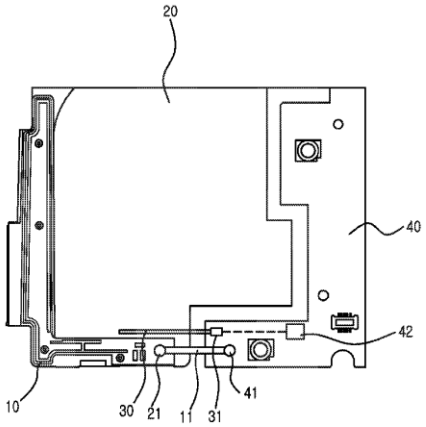
Primary Examiner — Trinh Dinh

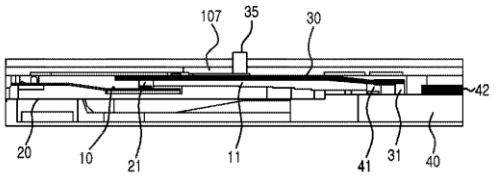
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes an antenna radiator configured to operate in at least one frequency band, a ground stub disposed at a coupling location in proximity to the antenna radiator, and a switching device configured to selectively ground the ground stub and a ground of a main board. Thus, the present disclosure is easily applicable without design constraints in terms of space use when the main board and the antenna radiator are separated, and simplifies the assembly and reduces the cost without a separate sub-board.

11 Claims, 10 Drawing Sheets





US010014582B2

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

(10) **Patent No.: US 10,014,582 B2**
(45) **Date of Patent: Jul. 3, 2018**

(54) **ANTENNA MODULE AND MOBILE TERMINAL INCLUDING SAME**

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

(72) Inventors: **Seungwoo Ryu**, Seoul (KR); **Hyengcheul Choi**, Seoul (KR); **Chisang You**, Seoul (KR); **Soyeon Lee**, Seoul (KR); **Kyoungsun Hwang**, Seoul (KR); **Songyi Lee**, Seoul (KR); **Byungeun Jeon**, 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 295 days.

(21) Appl. No.: **14/765,262**

(22) PCT Filed: **Oct. 24, 2013**

(86) PCT No.: **PCT/KR2013/009501**
§ 371 (c)(1),
(2) Date: **Jul. 31, 2015**

(87) PCT Pub. No.: **WO2014/142411**
PCT Pub. Date: **Sep. 18, 2014**

(65) **Prior Publication Data**

US 2015/0380825 A1 Dec. 31, 2015

(30) **Foreign Application Priority Data**

Mar. 15, 2013 (KR) 10-2013-0028206
Apr. 15, 2013 (KR) 10-2013-0041137

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 9/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/16*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/40*** (2015.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/30*** (2013.01)

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

(56) **References Cited**

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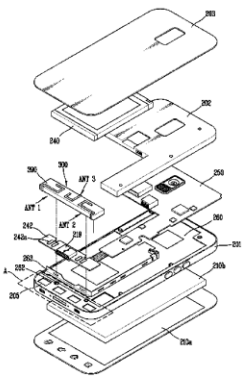
Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Disclosed are an antenna module and a mobile terminal having the same. The antenna module includes: a first member and a second member configured to operate as radiators of an antenna for transmitting/receiving radio signals; a first feeding unit configured to feed the first and second members; and a transmission line configured to connect the second member to the first feeding unit so that, when the first member forms a magnetic field in a near field, the second member forms an electric field.

21 Claims, 12 Drawing Sheets



US010015294B2

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

(10) **Patent No.: US 10,015,294 B2**
(45) **Date of Patent: Jul. 3, 2018**

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

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

(72) Inventors: **Hyung Joo Lee**, Seongnam-si (KR); **Gyu Sub Kim**, Seoul (KR); **Dong Yeon Kim**, Suwon-si (KR); **Chae Up Yoo**, Seoul (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 0 days.

(21) Appl. No.: **15/673,097**

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

(65) **Prior Publication Data**

US 2017/0374182 A1 Dec. 28, 2017

Related U.S. Application Data

(63) Continuation of application No. 15/234,547, filed on Aug. 11, 2016, now Pat. No. 9,762,710.

(30) **Foreign Application Priority Data**

Aug. 13, 2015 (KR) 10-2015-0114638

(51) **Int. Cl.**
H04B 1/44 (2006.01)
H04M 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04M 1/0202*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

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

(56) **References Cited**

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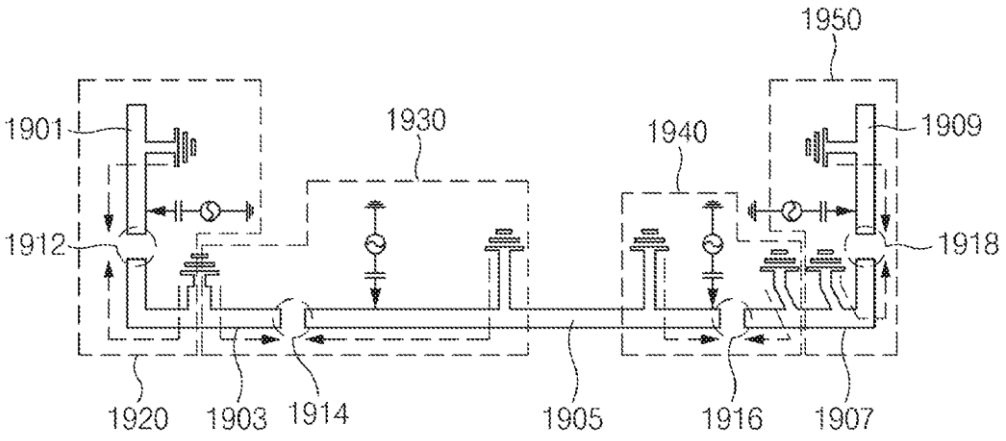
Primary Examiner — Tuan A Tran
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a first surface, a second surface disposed facing an opposite side of the first surface, and a side surface configured to surround at least a portion of a space between the first surface and the second surface, a first elongated metal member configured to form a first portion of the side surface and including a first end and a second end, at least one communication circuit electrically connected to a first point of the first elongated metal member through a capacitive element, at least one ground member disposed in an interior of the housing, and a first conductive member configured to electrically connect a second point of the first elongated metal member to the ground member. The second point of the first elongated metal member is disposed closer to the second end than to the first point.

20 Claims, 42 Drawing Sheets



US010020562B2

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

(10) **Patent No.: US 10,020,562 B2**
(45) **Date of Patent: Jul. 10, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Cheng-Han Lee**, New Taipei (TW); **Yi-Wen Hsu**, New Taipei (TW); **Wei-Xuan Ye**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, 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.: **15/651,035**

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

(65) **Prior Publication Data**

US 2018/0026349 A1 Jan. 25, 2018

Related U.S. Application Data

(60) Provisional application No. 62/364,298, filed on Jul. 19, 2016.

(30) **Foreign Application Priority Data**

Jun. 27, 2017 (TW) ..... 106121492 A

(51) **Int. Cl.**

H04M 1/00	(2006.01)
H01Q 1/24	(2006.01)
H01Q 5/371	(2015.01)
H01Q 5/10	(2015.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/10*** (2015.01); ***H01Q 5/371*** (2015.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H04Q 1/245
USPC 455/575.7
See application file for complete search history.

(56) **References Cited**

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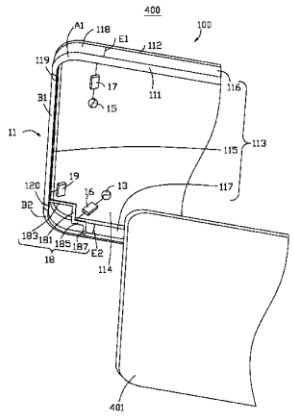
WO	2016/015284	A1	2/2016

Primary Examiner — April G Gonzales
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a metal housing, a first feed source, and a first switching circuit. The metal housing includes a front frame, a backboard, and a side frame. The side frame defines a slot and the front frame defines a first gap and a second gap. The metal housing is divided into at least a first branch and a second branch by the slot, the first gap, and the second gap. The first feed source is electrically connected to the first branch. One end of the first switching circuit is electrically connected to the first branch. Another end of the first switching circuit is grounded.

26 Claims, 36 Drawing Sheets



US010020563B2

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

(10) **Patent No.: US 10,020,563 B2**
(45) **Date of Patent: Jul. 10, 2018**

(54) **ANTENNA SYSTEM WITH ANTENNA SWAPPING AND ANTENNA TUNING**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Ruben Caballero**, San Jose, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Mohit Narang**, Cupertino, CA (US); **Matt A. Mow**, Los Altos, CA (US); **Robert W. Schlub**, Cupertino, CA (US)

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

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

(21) Appl. No.: **15/795,810**

(22) Filed: **Oct. 27, 2017**

(65) **Prior Publication Data**

US 2018/0053990 A1 Feb. 22, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/608,048, filed on Jan. 28, 2015, now Pat. No. 9,806,401, which is a (Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/42*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 21/28; H01Q 1/44
(Continued)

(56) **References Cited**

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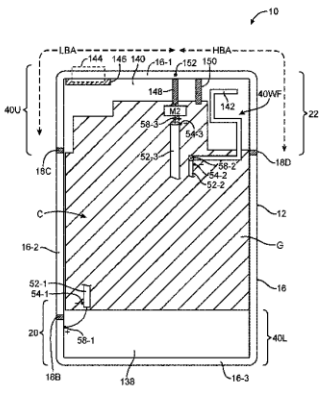
Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and first and second antennas. An electronic device may include a housing. The first antenna may be located at an upper end of the housing and the second antenna may be located at a lower end of the housing. A peripheral conductive member may run around the edges of the housing and may be used in forming the first and second antennas. The radio-frequency transceiver circuitry may have a transmit-receive port and a receive port. Switching circuitry may connect the first antenna to the transmit-receive port and the second antenna to the receiver port or may connect the first antenna to the receive port and the second antenna to the transmit-receive port.

20 Claims, 8 Drawing Sheets



US010020579B1

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

(10) **Patent No.: US 10,020,579 B1**
(45) **Date of Patent: Jul. 10, 2018**

(54) **WIRELESS LOCAL AREA NETWORK ANTENNA FOR A METAL HOUSING**

(71) Applicant: **Amazon Technologies, Inc.**, Seattle, WA (US)

(72) Inventors: **Ming Zheng**, Cupertino, CA (US); **Peter Eli Renner**, Sunnyvale, CA (US); **Adrian Napoles**, Cupertino, CA (US); **Khaled Ahmad Obeidat**, Santa Clara, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Seattle, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 300 days.

(21) Appl. No.: **14/856,423**

(22) Filed: **Sep. 16, 2015**

(51) **Int. Cl.**

H01Q 5/50	(2015.01)
H01Q 1/24	(2006.01)
H01Q 9/04	(2006.01)
H04B 1/3827	(2015.01)
H01Q 1/50	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/50*** (2015.01); ***H01Q 1/24*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 9/04*** (2013.01); ***H04B 1/3833*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243–1/244
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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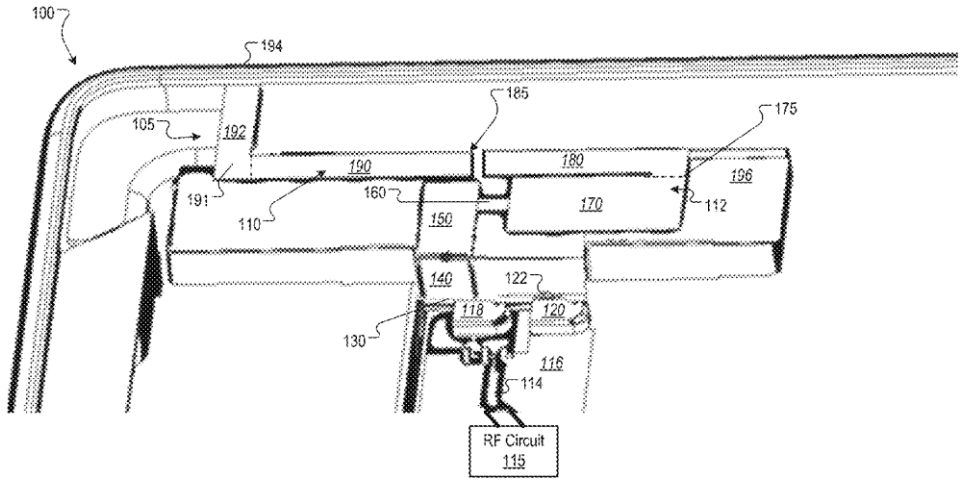
* cited by examiner

Primary Examiner — Jessica Han
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

Antenna structures and methods of operating the same are described. One antenna structure includes a ground plane, a feed point, an antenna element, and a parasitic element. The feed point can be coupled to the antenna element and can receive a signal to cause the antenna structure to radiate electromagnetic energy. The antenna element includes: a first portion that extends in a first direction from the feeding point at the RF feed; a second portion that extends from a distal end of the first portion; a third portion that extends from a side of the second portion; a fourth portion that extends from the third portion; and a fifth portion that extends from the fourth portion. The parasitic element includes: a sixth portion that extends from the fourth portion; and the seventh portion that extends from the sixth portion to the ground plane.

20 Claims, 11 Drawing Sheets



US010027019B2

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

(10) **Patent No.: US 10,027,019 B2**
(45) **Date of Patent: Jul. 17, 2018**

(54) **ANTENNA USING CONDUCTOR AND ELECTRONIC DEVICE THEREFOR**

(71) Applicants: **HongJuan Han**, Shenzhen (CN); **YueHua Yue**, Shenzhen (CN)

(72) Inventors: **HongJuan Han**, Shenzhen (CN); **YueHua Yue**, Shenzhen (CN)

(73) Assignee: **AAC TECHNOLOGIES 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 37 days.

(21) Appl. No.: **15/417,129**

(22) Filed: **Jan. 26, 2017**

(65) **Prior Publication Data**

US 2017/0346162 A1 Nov. 30, 2017

(30) **Foreign Application Priority Data**

May 27, 2016 (CN) ..... 2016 2 0505748 U

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/40 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/40*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/40
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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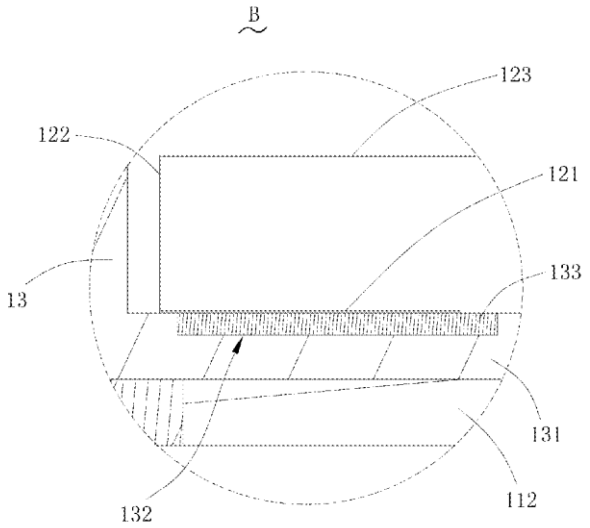
* cited by examiner

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Na Xu; IPro, PLLC

(57) **ABSTRACT**

The present disclosure provides an antenna device, including a housing having accommodating space and an LDS antenna accommodated in the hosing, the housing includes a metal shell, a metal cover and a metal ring which cooperate and are spaced with each other, wherein inner walls of the metal shell, the metal cover and the metal ring are respectively provided with an adhesive coated layer, the adhesive coated layer includes an adhesive coated layer body, a groove provided at a side of the adhesive coated layer body far away from the metal cover, and a modified layer assembled in the groove, the LDS antenna is laser etched on the modified layer and is coupled with the metal cover. The antenna device of the present disclosure avoids frequency offset caused by gap size difference due to assembling errors between coupled antennas, so that the coupled antennas show better performance and consistency.

9 Claims, 7 Drawing Sheets



US010027025B2

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

(10) **Patent No.: US 10,027,025 B2**
(45) **Date of Patent: Jul. 17, 2018**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE THEREIN**

(71) Applicant: **HTC Corporation**, Taoyuan, Taoyuan County (TW)

(72) Inventors: **Tiao-Hsing Tsai**, Taipei (TW); **Chien-Pin Chiu**, Taipei (TW); **Wei-Yang Wu**, Taoyuan (TW); **Hsiao-Wei Wu**, Taoyuan (TW)

(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 137 days.

(21) Appl. No.: **13/939,856**

(22) Filed: **Jul. 11, 2013**

(65) **Prior Publication Data**

US 2014/0062815 A1 Mar. 6, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/598,317, filed on Aug. 29, 2012.

(51) **Int. Cl.**

H01Q 1/50	(2006.01)
H01Q 5/335	(2015.01)
H01Q 5/50	(2015.01)
H01Q 13/10	(2006.01)
H01Q 1/24	(2006.01)

(Continued)

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

CPC ***H01Q 1/50*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 9/0442*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/103*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/50; H01Q 1/243; H01Q 5/335; H01Q 5/50; H01Q 9/0442; H01Q 13/103

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jessica Han
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile device includes an antenna structure, a signal source, a tunable circuit element, and a tuner. The antenna structure includes a radiation element. The tunable circuit element is coupled to the radiation element. The antenna structure and the tunable circuit element are disposed in a clearance region of the mobile device. The tuner has a variable impedance value, and is coupled between the tunable circuit element and the signal source. The tuner and the signal source are disposed in a circuit board region of the mobile device.

13 Claims, 22 Drawing Sheets