



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

(10) **Patent No.:** **US 10,629,982 B2**
(45) **Date of Patent:** **Apr. 21, 2020**

(54) **ELECTRONIC DEVICE WITH MULTI-SLOT ANTENNA**

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Young-Min Joo, Seoul (KR)

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

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 1/24 (2006.01)
H01Q 5/10 (2015.01)
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(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 5/10** (2015.01); **H01Q 13/10**
(2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/24; H01Q 1/243;
H01Q 1/38; H01Q 1/48; H01Q 5/10;
H94B 1/3888; H04M 1/02; H04M 1/0266
See application file for complete search history.

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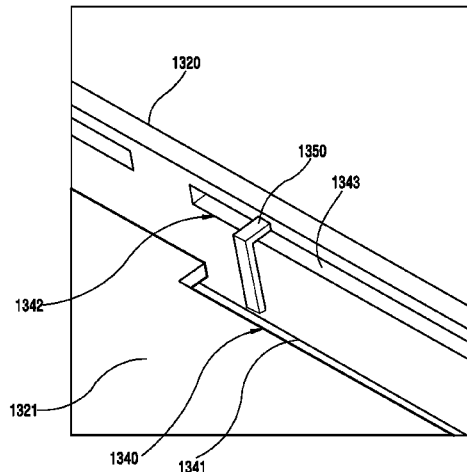
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An electronic device with a multi-slot antenna is provided. The electronic device includes a first housing including a first side, a second side facing in a second direction opposite to the first direction, and a first lateral side surrounded by a portion of a space between the first and second sides, a second housing including a third side facing in a third direction and a fourth side facing in a fourth direction opposite to the third direction, a first conductive member forming at least a portion of the first lateral side and including a slot, an intermediate plate located inside the first housing and including a portion adjacent to a slot of the first conductive member, wherein the portion comprises or forms an opening facing in the first or second direction, and a

(Continued)





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

(10) **Patent No.:** **US 10,629,983 B2**
(45) **Date of Patent:** **Apr. 21, 2020**

(54) **ANTENNA SYSTEM AND MOBILE TERMINAL**

(2015.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01); **H01Q 1/521** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

(58) **Field of Classification Search**
CPC **H01Q 1/243**; **H01Q 1/38**; **H01Q 1/521**;
H01Q 5/30; **H01Q 5/378**; **H01Q 5/40**;
H01Q 9/42; **H01Q 21/28**
See application file for complete search history.

(72) Inventors: **Liwan Zhang**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN)

(73) Assignee: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 209 days.

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(21) Appl. No.: **15/828,572**

(22) Filed: **Dec. 1, 2017**

Primary Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — IPro, PLLC; Na Xu

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482126

(51) **Int. Cl.**

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H01Q 1/38 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/30 (2015.01)
H01Q 5/50 (2015.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/378 (2015.01)
H01Q 5/40 (2015.01)

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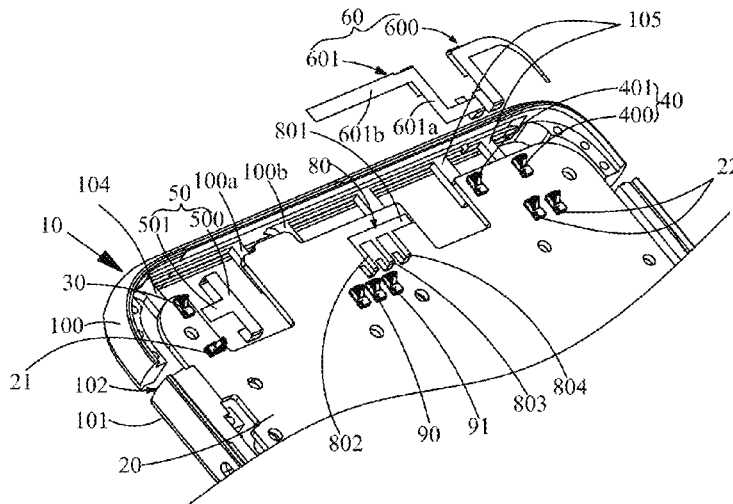
(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/30** (2015.01); **H01Q 5/335** (2015.01); **H01Q 5/35** (2015.01); **H01Q 5/378** (2015.01); **H01Q 5/40** (2015.01); **H01Q 5/50**

(57) **ABSTRACT**

An antenna system, including a metal frame including a radiation portion and a grounding portion separately arranged, and a gap zone is defined therebetween; a main board including a system ground, a first radio frequency feeding end and a second radio frequency feeding end; a first conductive member; a second conductive member; a three-in-one antenna unit; and a diversity antenna unit; the three-in-one antenna unit is connected with the first radio frequency feeding end, and the diversity antenna unit is electrically connected with the second radio frequency feeding end; the three-in-one antenna unit and the diversity antenna unit are connected with the radiation portion respectively through the first conductive member and the second conductive member; the radiation portion includes a first grounding point and a second grounding point which are connected with the system ground and arranged between the diversity antenna unit and the three-in-one antenna unit.

10 Claims, 7 Drawing Sheets





US010629990B2

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

(10) **Patent No.:** **US 10,629,990 B2**
(45) **Date of Patent:** **Apr. 21, 2020**

(54) **ANTENNA STRUCTURE**

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(72) Inventors: **Li-Chun Lee**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Jhin-Ciang Chen**, Taipei (TW); **Chao-Lin Wu**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(73) Assignee: **COMPAL ELECTRONICS, INC.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 70 days.

(21) Appl. No.: **15/719,567**

(22) Filed: **Sep. 29, 2017**

(65) **Prior Publication Data**
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(60) Provisional application No. 62/401,831, filed on Sep. 29, 2016.

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 13/10 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 21/30; H01Q 13/106; H01Q 9/0421; H01Q 1/2266;
(Continued)

(56) **References Cited**
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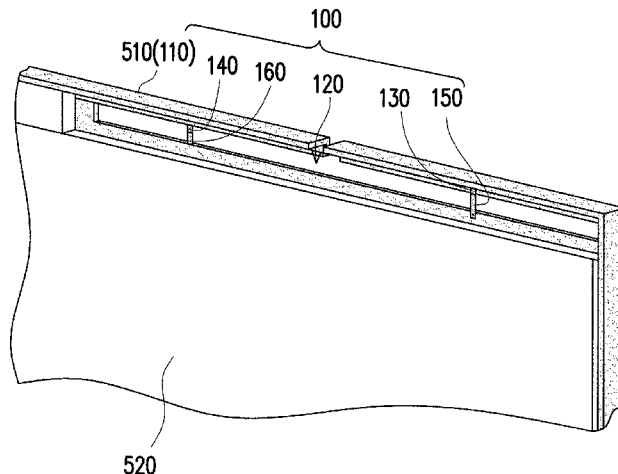
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Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**
An antenna structure including a metal element, a first capacitor, a second capacitor, a feeding element and an adjustment element is provided. The metal element has an open slot, and the open slot has an open end, a first slot and a second slot. The first slot and the second slot are respectively disposed on two opposite sides of the open end. The feeding element crosses the first slot. A first end of the feeding element has a feeding point, and a second end of the feeding element is electrically connected to the metal element through the first capacitor. The adjustment element is disposed in the second slot. A first end of the adjustment element is electrically connected to the metal element, and a second end of the adjustment element is electrically connected to the metal element through the second capacitor.

12 Claims, 5 Drawing Sheets





US010629992B2

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

(10) **Patent No.:** **US 10,629,992 B2**
(45) **Date of Patent:** **Apr. 21, 2020**

(54) **ANTENNA SYSTEM FOR MATCHING AN IMPEDANCE**

(71) Applicant: **RELIANCE JIO INFOCOMM LIMITED**, Mumbai (IN)

(72) Inventors: **Brijesh Ishvarlal Shah**, Navi Mumbai (IN); **Kailash Kashyap**, Navi Mumbai (IN); **Praveen Kumar Penta**, Navi Mumbai (IN); **Vijay Mohan Verma**, Navi Mumbai (IN)

(73) Assignee: **RELIANCE JIO INFOCOMM LIMITED**, Mumbai, Maharashtra (IN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 251 days.

(21) Appl. No.: **15/659,416**

(22) Filed: **Jul. 25, 2017**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Jul. 26, 2016 (IN) 201621025573

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/335 (2015.01)
H01Q 1/52 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/52** (2013.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 19/0421; H01Q 5/335; H01Q 1/38; H01Q 1/52
See application file for complete search history.

(56) **References Cited**

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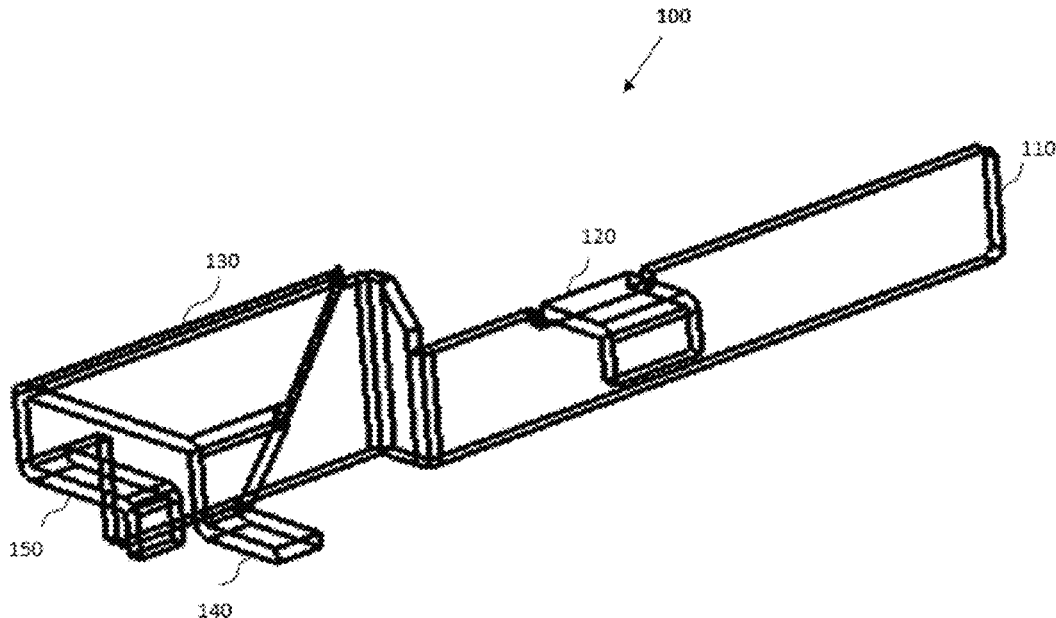
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Primary Examiner — Dameon E Levi
Assistant Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Ladas & Parry, LLP

(57) **ABSTRACT**

Embodiments of the present invention relate to an antenna [100] for matching an impedance between a feed point [140] and a radiator [110], comprising: the radiator [110] mounted, over a printed circuit board, has a first end and a second end; a flare [130] for matching the impedance, wherein the flare [130] has a first end and a second end, and the flare [130] is taper-shaped from the first end to the second end of the flare [130]; the feed point [140] comprises a first end and a second end, wherein the first end of the feed point [140] is connected to the second end of the flare [130], and the second end of the feed point [140] is connected to the printed circuit board; and a shorting stub [150] placed between the flare [130] and the printed circuit board for grounding a capacitance induced by the antenna [100].

13 Claims, 11 Drawing Sheets





US010637126B2

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

(10) **Patent No.:** US 10,637,126 B2
(45) **Date of Patent:** Apr. 28, 2020

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

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(72) Inventors: **Cheng-Tse Lee**, Taipei (TW);
Saou-Wen Su, Taipei (TW)

(73) Assignee: **ASUSTeK COMPUTER INC.**, Taipei (TW)

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

(21) Appl. No.: **15/376,682**

(22) Filed: **Dec. 13, 2016**

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(30) **Foreign Application Priority Data**
Dec. 15, 2015 (TW) 104142046 A

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/48; H01Q 9/0421; H01Q 5/371; H01Q 9/42; H01Q 1/38; H01Q 1/243

See application file for complete search history.

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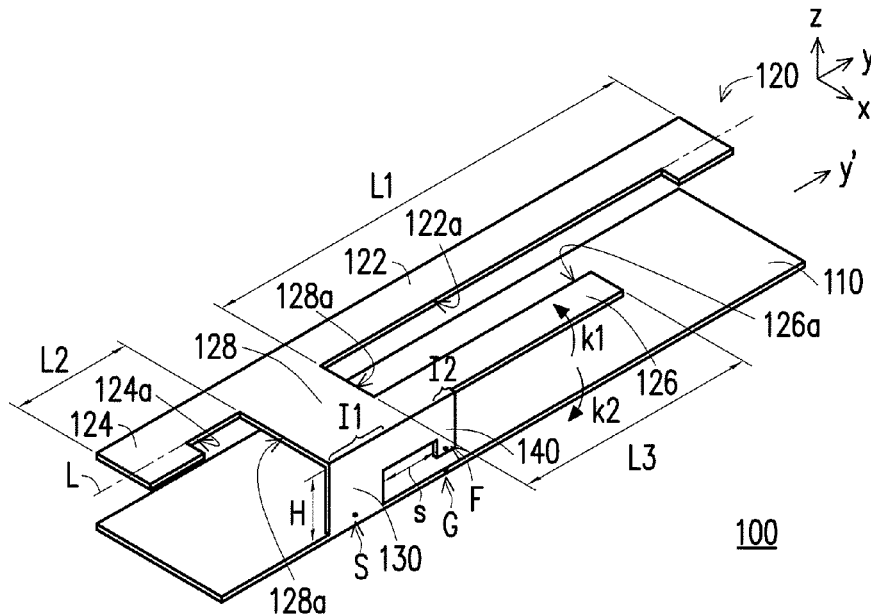
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Primary Examiner — Dieu Hien T Duong
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An antenna is provided. The antenna includes: an antenna ground plane; a radiating unit parallel to the antenna ground plane, the radiating unit including: a common unit; a first branch extended from the common unit along a first direction; a second branch extended from the common unit along a second direction, wherein the first direction and the second direction are inverse; a third branch separated from the first branch and the second branch and extending outwardly from the common unit; a shorting unit located between a plane of radiating unit located and a plane of the antenna ground plane and connected to the common unit and the antenna ground plane; and a feeding unit located between a plane of the radiating unit and a plane of the antenna ground plane, wherein the feeding unit is separated from the shorting unit and connected to the third branch, and the shorting unit and the feeding unit are located on the same side.

15 Claims, 4 Drawing Sheets



100



US010637147B2

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

(10) **Patent No.:** **US 10,637,147 B2**
(45) **Date of Patent:** **Apr. 28, 2020**

(54) **WIDEBAND ANTENNAS**
(71) Applicant: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.**, Houston, TX (US)
(72) Inventors: **Sung Oh**, Palo Alto, CA (US); **Philip Wright**, San Diego, CA (US)
(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 58 days.

(56) **References Cited**
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Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — HP Inc. Patent Department

(21) Appl. No.: **15/747,216**
(22) PCT Filed: **Sep. 29, 2015**
(86) PCT No.: **PCT/US2015/052958**
§ 371 (c)(1),
(2) Date: **Jan. 24, 2018**
(87) PCT Pub. No.: **WO2017/058176**
PCT Pub. Date: **Apr. 6, 2017**

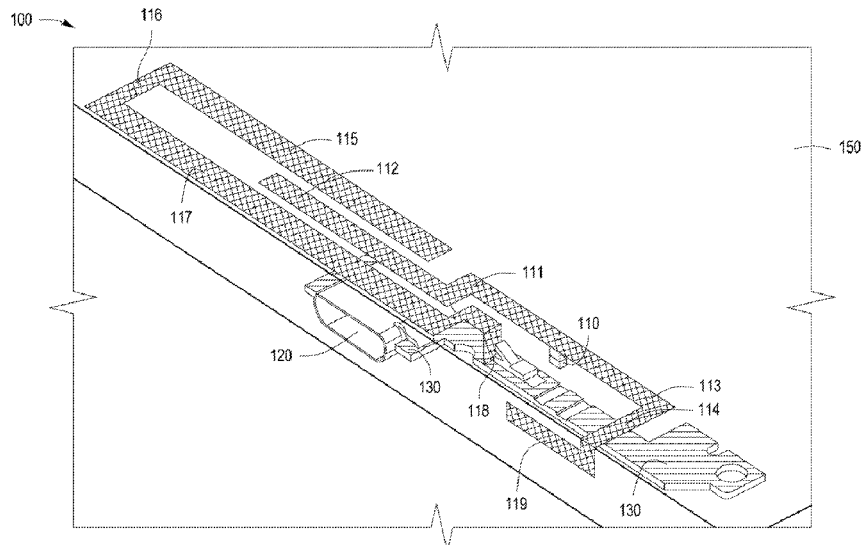
(65) **Prior Publication Data**
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H01Q 5/378 (2015.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 5/378** (2015.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/42; H01Q 5/378; H01Q 1/243
(Continued)

(57) **ABSTRACT**
Examples described herein include examples of an antenna that includes a planar conductive body disposed in a first plane, a signal source connection disposed on the planar conductive body, a direct feed antenna arm coupled to the signal source connection and disposed in a second plane parallel to the first plane, a coupled antenna arm disposed in the second plane and in proximity to a portion of the direct feed antenna arm, and a conductive interconnect element coupled to a region of the planar conductive body disposed in the first plane and the coupled antenna arm disposed in the second plane.

15 Claims, 7 Drawing Sheets



(12) **United States Patent**
Dabov

(10) **Patent No.:** **US 10,644,379 B2**
(45) **Date of Patent:** **May 5, 2020**

(54) **ELECTRONIC DEVICE WITH COMPONENT TRIM ANTENNA**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
 (72) Inventor: **Teodor Dabov**, San Francisco, 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 337 days.

(21) Appl. No.: **15/681,248**
 (22) Filed: **Aug. 18, 2017**

(65) **Prior Publication Data**
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 (63) Continuation of application No. 14/340,983, filed on Jul. 25, 2014, now Pat. No. 9,748,635, which is a continuation of application No. 13/396,499, filed on Feb. 14, 2012, now Pat. No. 8,803,745.

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H01Q 1/24 (2006.01)
 (52) **U.S. Cl.**
 CPC **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01)

(58) **Field of Classification Search**
 CPC H01Q 1/243; H01Q 7/00
 USPC 343/702
 See application file for complete search history.

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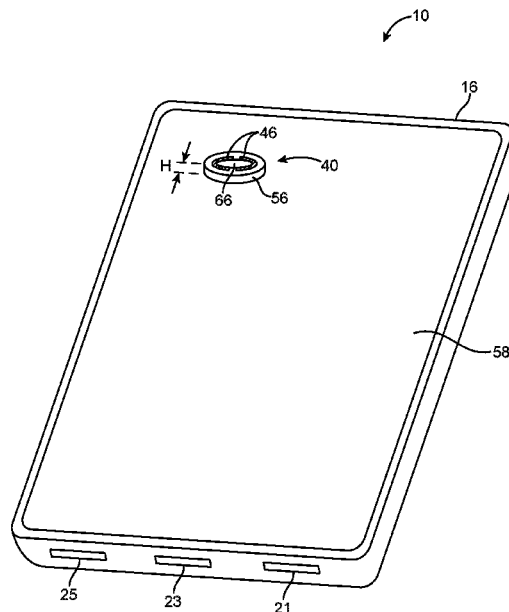
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Primary Examiner — Andrea Lindgren Baltzell
 (74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.;
 G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

An optical component such as a camera, an acoustic component such as a speaker, or other electrical component may be mounted on the surface of an electronic device housing. A window structure may overlap the component. The window structure may be formed from an optically transparent material to allow light to pass or may be formed from an acoustically transparent material to allow acoustic signals to pass. A conductive structure such as a metal member may surround at least part of the periphery of the window structure. The conductive structure may serve as an antenna structure for an antenna. Radio-frequency transceiver circuitry may be coupled to an antenna feed for the antenna using a radio-frequency transmission line. The conductive structure may serve as a cosmetic trim for the electrical component.

20 Claims, 12 Drawing Sheets





US010644381B2

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

(10) **Patent No.:** **US 10,644,381 B2**
(45) **Date of Patent:** **May 5, 2020**

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

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

(72) Inventors: **Wei-Xuan Ye**, New Taipei (TW);
Wen-Chang Hsu, New Taipei (TW);
Te-Chang 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 28 days.

(21) Appl. No.: **16/006,815**

(22) Filed: **Jun. 12, 2018**

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(30) **Foreign Application Priority Data**

Aug. 5, 2017 (CN) 2017 1 0663431

(51) **Int. Cl.**

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H04W 88/06 (2009.01)
H01Q 5/35 (2015.01)
H01Q 5/385 (2015.01)
H01Q 5/50 (2015.01)
H01Q 1/22 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 5/385** (2015.01); **H01Q 5/50** (2015.01); **H04W 88/06** (2013.01); **H01Q 1/2291** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/50; H01Q 5/35; H01Q 5/385; H04W 88/06
See application file for complete search history.

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Primary Examiner — Sam Bhattacharya

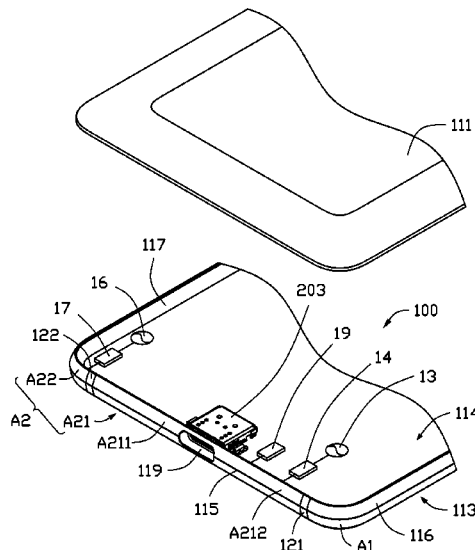
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a housing, a first feed source, a first radiator, a second radiator, and a second feed source. The housing includes a first radiating portion. The first feed source feeds current to the first radiating portion and the first radiating portion activates a first mode to generate radiation signals in a first frequency band. The first radiator is positioned in the housing. The first radiating portion further couples the current to the first radiator and the first radiator activates a second mode to generate radiation signals in a second frequency band. The second radiator is positioned in a space formed by the first radiator. The second feed source feeds current to the second radiator and the second radiator activates a third mode to generate radiation signals in a third frequency band.

30 Claims, 26 Drawing Sheets

200



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

(10) **Patent No.:** **US 10,644,407 B2**
(45) **Date of Patent:** **May 5, 2020**

(54) **COMMUNICATION DEVICE**
(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)
(72) Inventors: **Yan-Ting Wu**, Hsinchu (TW); **Cheng-Da Yang**, Hsinchu (TW); **Yu-Yu Chiang**, Hsinchu (TW)
(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 88 days.
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(22) Filed: **Jul. 16, 2018**
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(30) **Foreign Application Priority Data**
Mar. 28, 2018 (TW) 107110710 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)
(Continued)
(52) **U.S. Cl.**
CPC **H01Q 13/103** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/371** (2015.01); **H01Q 5/385** (2015.01);
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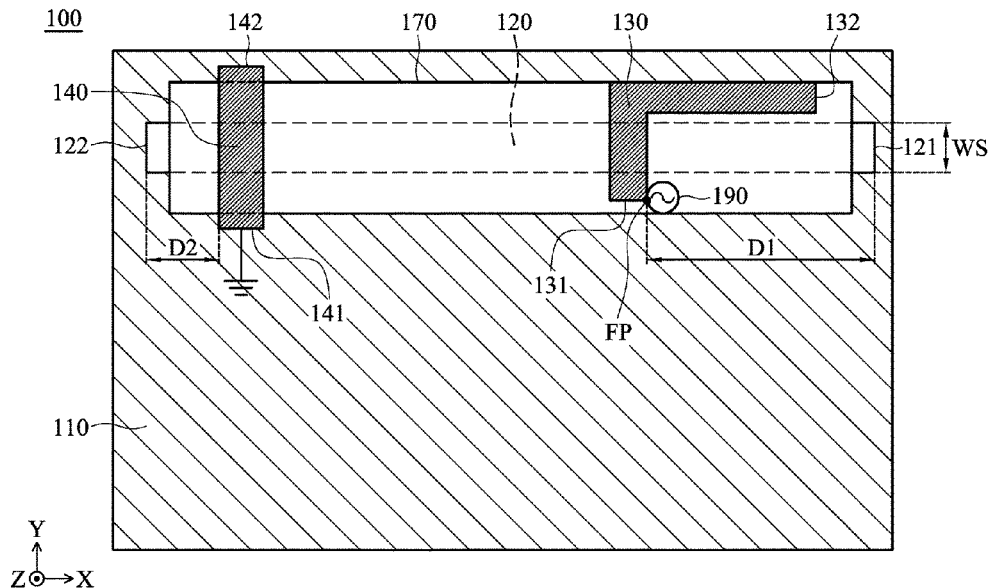
(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 13/103; H01Q 5/371; H01Q 5/385; H01Q 13/106; H01Q 13/16
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TW 201735444 A 10/2017
Primary Examiner — Huedung X Mancuso
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**
A communication device includes a metal mechanism element, a feeding radiation element, a tuning radiation element, and a dielectric substrate. The metal mechanism element has a closed slot. The feeding radiation element extends across the closed slot. The feeding radiation element has a feeding point. The tuning radiation element extends across the closed slot. The first end of the tuning radiation element is coupled to the metal mechanism element. The second end of the tuning radiation element is adjacent to the metal mechanism element or is coupled to the metal mechanism element. The dielectric substrate is adjacent to the metal mechanism element. The feeding radiation element and the tuning radiation element are both disposed on the dielectric substrate. An antenna structure is formed by the feeding radiation element, the tuning radiation element, and the closed slot of the metal mechanism element.

19 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 10,651,542 B2**
(45) **Date of Patent:** **May 12, 2020**

- (54) **ANTENNA FOR WIRELESS COMMUNICATION AND ELECTRONIC DEVICE INCLUDING THE SAME**
- (71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)
- (72) Inventors: **Nak Chung Choi**, Seoul (KR); **Gyu Sub Kim**, Seoul (KR); **Hyung Joo Lee**, Gyeonggi-do (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.: **15/698,187**

(22) Filed: **Sep. 7, 2017**

(65) **Prior Publication Data**
US 2018/0069301 A1 Mar. 8, 2018

(30) **Foreign Application Priority Data**
Sep. 7, 2016 (KR) 10-2016-0114921

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/245** (2013.01); **H01Q 3/247** (2013.01); **H01Q 5/364** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/245; H01Q 1/24; H01Q 9/00; H01Q 21/28; H01Q 5/364;
(Continued)

(56) **References Cited**
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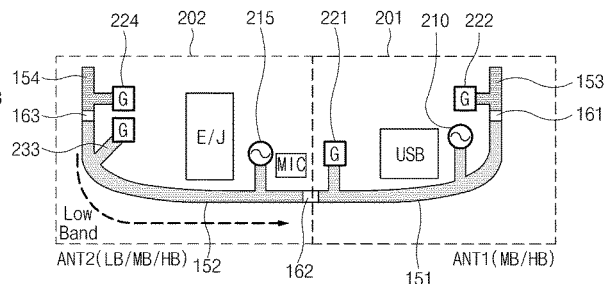
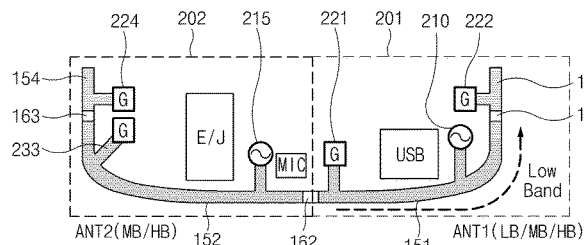
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

An electronic device is provided, which includes a housing; a conductive member forming at least a part of the housing; first to third nonconductive members separating the conductive member, wherein the conductive member includes a first conductive pattern disposed between the first nonconductive member and the second nonconductive member, and a second conductive pattern disposed between the second nonconductive member and the third nonconductive member; a first feeding part connected to the first conductive pattern; a second feeding part connected to the second conductive pattern; a first ground part connected to the first conductive pattern at a point adjacent to the second nonconductive member; and a communication circuit electrically connected with the conductive member.

21 Claims, 14 Drawing Sheets





US010651543B2

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

(10) **Patent No.:** **US 10,651,543 B2**
(45) **Date of Patent:** **May 12, 2020**

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

(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

(72) Inventors: **Xinbao Wang**, Dongguan (CN); **Ning Zhao**, Dongguan (CN); **Shengzhao Xiang**, Dongguan (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan, Guangdong (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.: **15/749,047**

(22) PCT Filed: **Mar. 18, 2017**

(86) PCT No.: **PCT/CN2017/077163**
§ 371 (c)(1),
(2) Date: **Jan. 30, 2018**

(87) PCT Pub. No.: **WO2017/157343**
PCT Pub. Date: **Sep. 21, 2017**

(65) **Prior Publication Data**
US 2018/0219274 A1 Aug. 2, 2018

(30) **Foreign Application Priority Data**
Mar. 18, 2016 (CN) 2016 1 0161254

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/50** (2013.01); **H01Q 23/00** (2013.01); **H04B 1/48** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 1/50; H01Q 23/00; H04B 1/48
See application file for complete search history.

(56) **References Cited**

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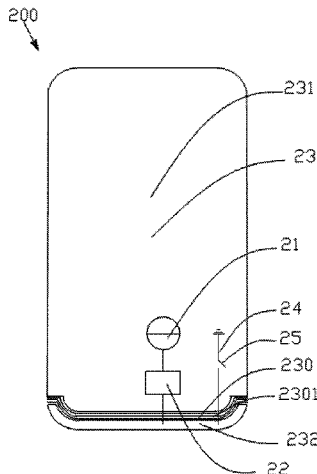
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Primary Examiner — Daniel Munoz
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Lathrop GPM LLP

(57) **ABSTRACT**

The present disclosure provides an antenna device including a radio frequency transceiving circuit; a matching circuit, electrically coupled to the radio frequency transceiving circuit; and a metal housing, the edge of the metal housing including an arc-shaped section, the metal housing being provided with at least one micro-seam band, the at least one micro-seam band including an arc-shaped part, said arc-shaped part matching the arc-shaped section of the metal housing, the radio frequency transceiving circuit being electrically coupled to the metal housing by means of the matching circuit, such that the metal housing is used as a

(Continued)



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

(10) **Patent No.:** **US 10,651,553 B2**
(45) **Date of Patent:** **May 12, 2020**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(72) Inventors: **Yun-Tsan Lee**, Hsinchu (TW);
Shih-Hsien Tseng, 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 39 days.

(21) Appl. No.: **16/214,315**

(22) Filed: **Dec. 10, 2018**

(65) **Prior Publication Data**
US 2019/0372215 A1 Dec. 5, 2019

(30) **Foreign Application Priority Data**
May 30, 2018 (TW) 107118508 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/35 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/48; H01Q 1/38; H01Q 5/00; H01Q 1/52; H01Q 1/523; H01Q 5/35; H01Q 1/24; H01Q 1/243; H01Q 1/521; H01Q 5/37; H01Q 5/371; H01Q 5/378; H01Q 9/04; H01Q 9/42

See application file for complete search history.

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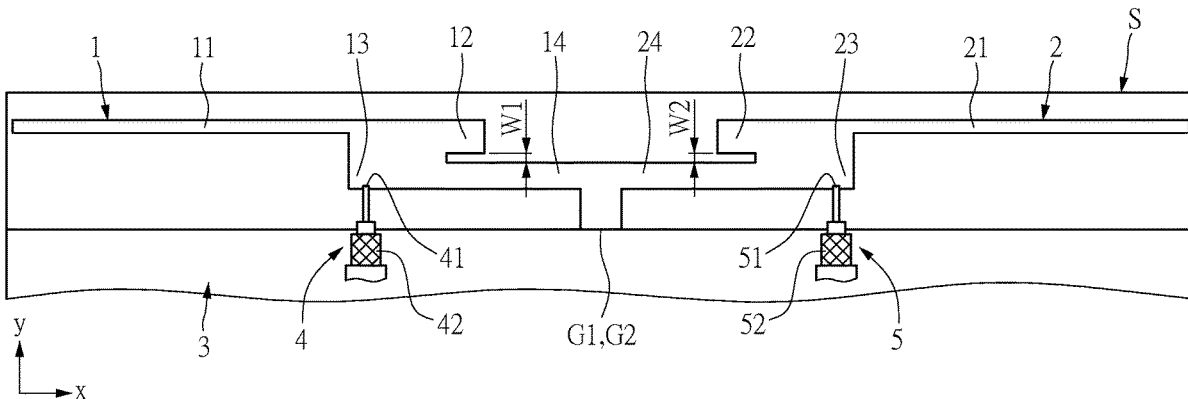
Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a substrate, a first antenna disposed on the substrate, a second antenna disposed on the substrate, a grounding member, a first feeding member and a second feeding member. The first antenna includes a first radiation portion, a second radiation portion, a first fed-in portion, and a first grounding portion spaced from the second radiation portion by a first gap. The second antenna includes a third radiation portion, a fourth radiation portion, a second fed-in portion and a second grounding portion spaced from the fourth radiation portion by a second gap. The first feeding member includes a first feed end coupled to the first fed-in portion and a first ground end coupled to the grounding member. The second feeding member includes a second feed end coupled to the second fed-in portion and a second ground end coupled to the grounding member.

17 Claims, 9 Drawing Sheets

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

(10) **Patent No.:** **US 10,651,556 B2**
(45) **Date of Patent:** **May 12, 2020**

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

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

(72) Inventors: **Kenji Nishikawa**, Hyogo (JP); **Shingo Sumi**, Miyagi (JP); **Yasunori Komukai**, Miyagi (JP); **Yukinari Takahashi**, Miyagi (JP); **Yu Ono**, Miyagi (JP)

(73) Assignee: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (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.: **15/990,006**

(22) Filed: **May 25, 2018**

(65) **Prior Publication Data**

US 2018/0277951 A1 Sep. 27, 2018

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2017/001159, filed on Jan. 16, 2017.

(30) **Foreign Application Priority Data**

Feb. 18, 2016 (JP) 2016-029294

(51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 1/48 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/307** (2015.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/328** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 5/378; H01Q 5/307; H01Q 5/328; H01Q 5/385;
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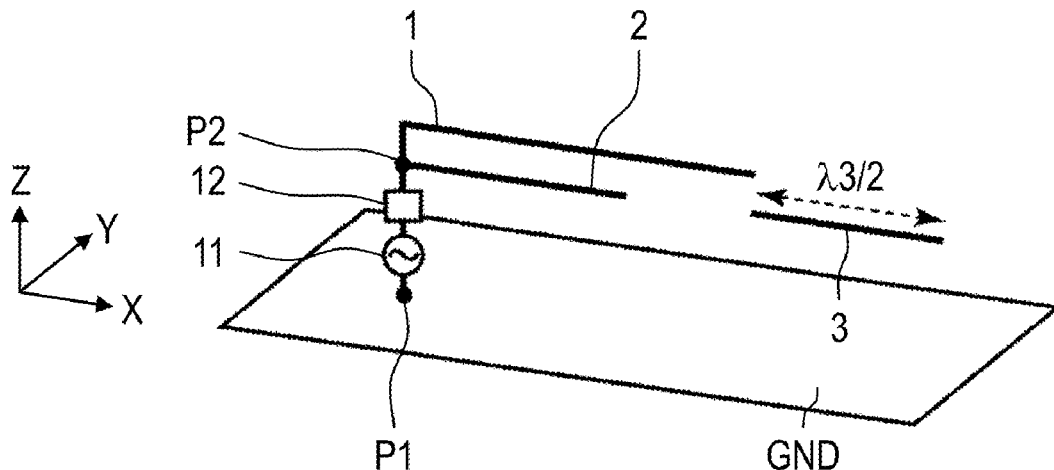
Primary Examiner — Graham P Smith
Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Renner, Otto, Boisselle & Sklar, LLP

(57) **ABSTRACT**

An antenna unit includes a conductive ground plate, a first antenna element, and a second antenna element. The first antenna element includes a first end connected to a feedpoint and a second end containing an open end. A part of the first antenna element is disposed along the conductive ground plate. The second antenna element branches off the first antenna element at a branch point on the first antenna element. The second antenna element is disposed between the part of the first antenna element disposed along the conductive ground plate and the conductive ground plate. The first antenna element resonates at a first frequency. The second antenna element and a segment between the first end

(Continued)



(12) **United States Patent**
Harper

(10) **Patent No.:** **US 10,651,565 B1**
(45) **Date of Patent:** **May 12, 2020**

(54) **ANTENNA POLARIZATION DIVERSITY**

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343/700 MS
2006/0114159 A1* 6/2006 Yoshikawa H01Q 1/24
343/702

(71) Applicant: **Microsoft Technology Licensing, LLC**,
Redmond, WA (US)

(72) Inventor: **Marc Harper**, Snohomish, WA (US)

(Continued)

(73) Assignee: **Microsoft Technology Licensing, LLC**,
Redmond, WA (US)

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

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Primary Examiner — David Bilodeau

(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(21) Appl. No.: **16/397,329**

(22) Filed: **Apr. 29, 2019**

(51) **Int. Cl.**

H01Q 21/24 (2006.01)
H01Q 21/06 (2006.01)
H04B 7/10 (2017.01)
H04B 7/0413 (2017.01)

(57) **ABSTRACT**

Antenna polarization diversity enhances the MIMO performance of multiple antennas, especially when the multiple antennas do not exhibit significant placement diversity. An antenna assembly provides selectable antenna polarization in the antenna assembly on a ground plane. An antenna element of the antenna assembly drives a first electrical configuration with a radiofrequency signal to radiate with a polarization predominately in a first direction of propagation. The antenna assembly is selectively modified from the first electrical configuration to a second electrical configuration, responsive to driving the antenna element of the antenna assembly in the first electrical configuration. The antenna element of the antenna assembly is driving in the second electrical configuration with the radiofrequency signal to radiate with a polarization predominately in a second direction of propagation, responsive to selectively modifying the antenna assembly from the first electrical configuration to the second electrical configuration.

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

CPC **H01Q 21/061** (2013.01); **H01Q 21/245** (2013.01); **H04B 7/0413** (2013.01); **H04B 7/10** (2013.01)

(58) **Field of Classification Search**

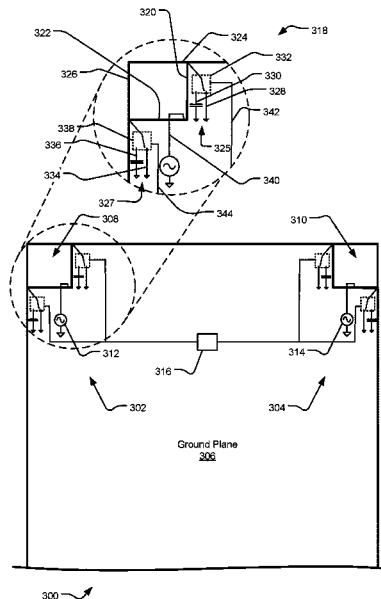
CPC H01Q 21/24
See application file for complete search history.

(56) **References Cited**

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343/700 MS
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20 Claims, 7 Drawing Sheets





US010652374B2

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

(10) **Patent No.:** **US 10,652,374 B2**
(45) **Date of Patent:** **May 12, 2020**

(54) **MOBILE TERMINAL HAVING CASE, METHOD FOR MANUFACTURING SAME**

(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **B21D 51/16** (2013.01); **B22D 17/00** (2013.01); **B29C 45/14** (2013.01);

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

(Continued)

(72) Inventors: **Insu Song**, Seoul (KR); **Sukho Hong**, Seoul (KR); **Dongjin Kim**, Seoul (KR); **Jaewook Lee**, Seoul (KR)

(58) **Field of Classification Search**
CPC .. H01Q 1/38; H01Q 1/24; H01Q 1/48; H01Q 9/42

(Continued)

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

(56) **References Cited**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 120 days.

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(21) Appl. No.: **16/062,299**

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(22) PCT Filed: **Sep. 28, 2016**

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(86) PCT No.: **PCT/KR2016/010840**

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§ 371 (c)(1),

Primary Examiner — Andrea Lindgren Baltzell

(2) Date: **Jun. 14, 2018**

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

(87) PCT Pub. No.: **WO2017/104950**

PCT Pub. Date: **Jun. 22, 2017**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2018/0375973 A1 Dec. 27, 2018

The mobile terminal having a conductive case which forms an external appearance of a terminal body, according to the present invention, comprises: a rear base which comprises a first side part; and an inner case which is mounted on the inside of the rear case and comprises a second side part, wherein the first side part and the second side part are electrically separated from each other, and the first side part and the second side part comprise a first conductive member and a second conductive member which are electrically separated from each other. Thus, it is possible to provide various forms of antennas by using a plurality of conductive members provided on the side parts.

(30) **Foreign Application Priority Data**

Dec. 17, 2015 (KR) 10-2015-0181239
Sep. 20, 2016 (KR) 10-2016-0120017

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H04M 1/02 (2006.01)

(Continued)

18 Claims, 14 Drawing Sheets

