



(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**

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

(72) Inventors: **Hosaeng Kim**, Gyeonggi-do (KR);
Hongil Kwon, Gyeonggi-do (KR);
Seonil Kim, Gyeonggi-do (KR);
Jae-Ho Lim, Gyeonggi-do (KR);
Seongeun Kim, Gyeonggi-do (KR);
Seunghwan Kim, Seoul (KR);
Younghoon Kim, Gyeonggi-do (KR);
Kicheol Sung, Seoul (KR);
Kyung-Jong Lee, Gyeonggi-do (KR);
Young-Min Joo, 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 93 days.

(21) Appl. No.: **15/585,550**

(22) Filed: **May 3, 2017**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 27, 2016 (KR) 10-2016-0065454

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/10 (2015.01)
(Continued)

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,282,433 B1 8/2001 Holshouser
7,889,139 B2 * 2/2011 Hobson H01Q 1/243
343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 104821428 8/2015
WO WO 2011/073506 6/2011

OTHER PUBLICATIONS

European Search Report dated Nov. 23, 2017 issued in counterpart application No. 17169988.7-1927, 19 pages.

(Continued)

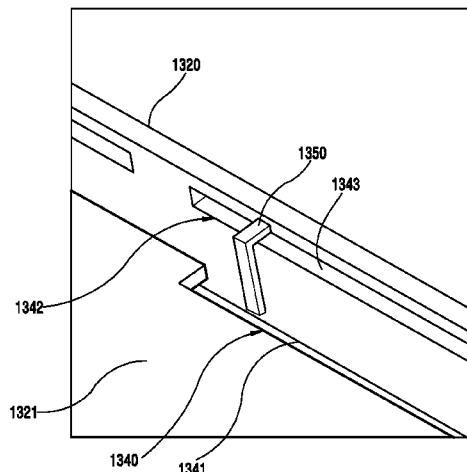
Primary Examiner — Tho G Phan

(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

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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**

U.S. PATENT DOCUMENTS

9,450,296 B2 * 9/2016 Lin **H01Q 1/243**
10,038,234 B2 * 7/2018 Tseng **H01Q 5/10**
(Continued)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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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**

US 2018/0375193 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482126

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
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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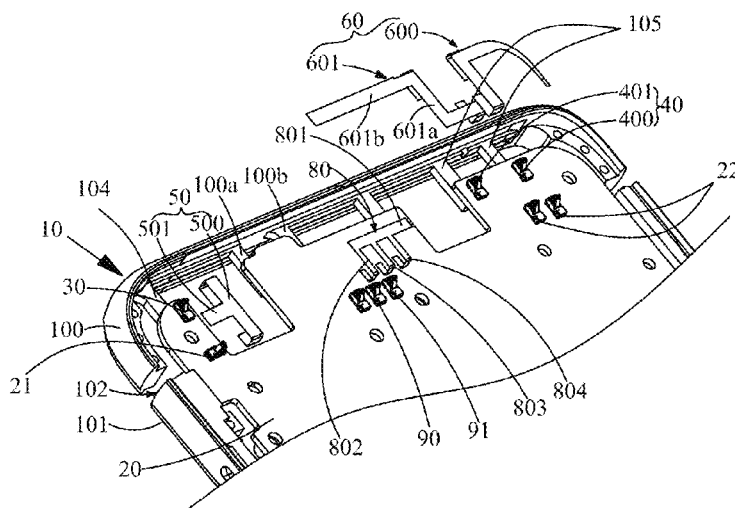
(52) **U.S. Cl.**

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





(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**

(71) Applicants: **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)

(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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Related U.S. Application Data

(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**

U.S. PATENT DOCUMENTS

2009/0066596 A1* 3/2009 Fujishima H01Q 1/243 343/767
2014/0266938 A1 9/2014 Ouyang et al.

FOREIGN PATENT DOCUMENTS

CN 105742823 7/2016
TW 201338269 9/2013

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application”, dated Nov. 14, 2018, p. 1-p. 6.

(Continued)

Primary Examiner — Hai V Tran

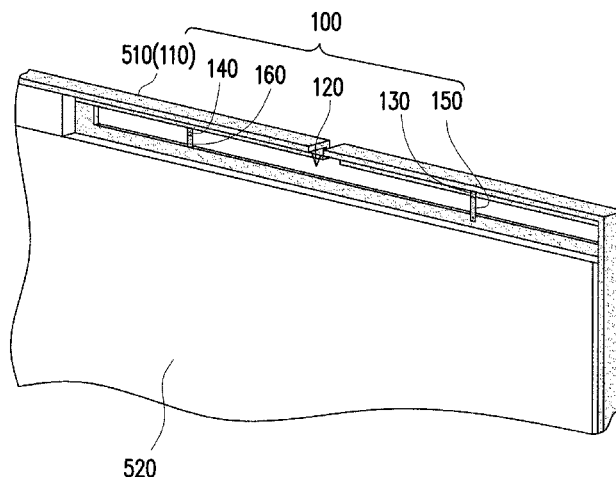
Assistant Examiner — Michael M Bouizza

(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**
US 2018/0034157 A1 Feb. 1, 2018

(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**

U.S. PATENT DOCUMENTS

5,926,150 A * 7/1999 McLean G01R 29/0821 343/700 MS
2011/0025575 A1 * 2/2011 Niederkorn H01Q 1/243 343/841
2012/0065946 A1 * 3/2012 Brown H01Q 1/00 703/1

(Continued)

Primary Examiner — Dameon E Levi

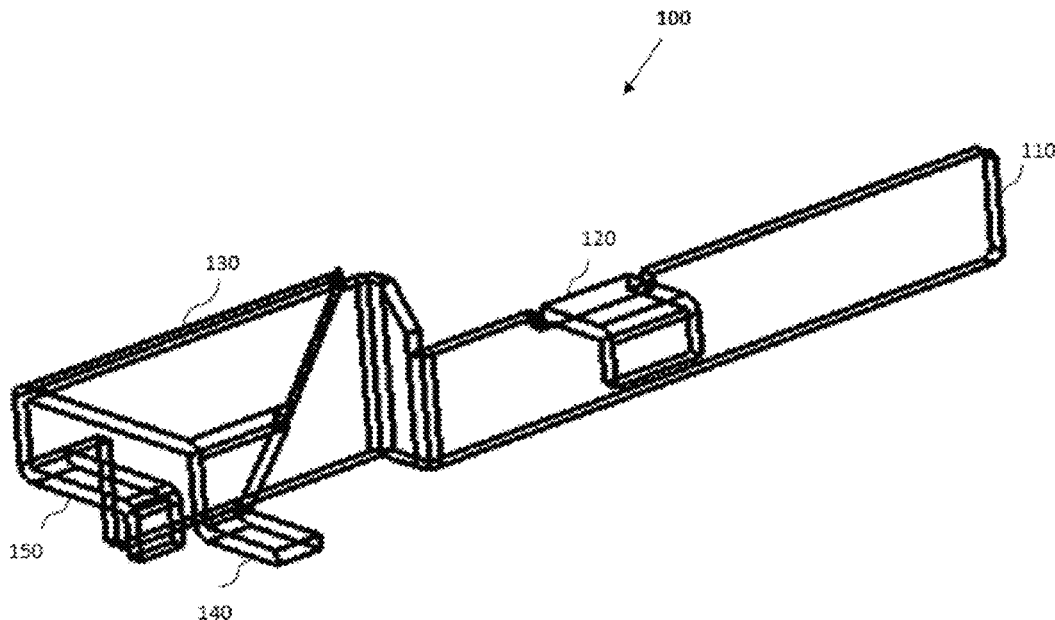
Assistant Examiner — David E Lotter

(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



(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

6,809,689 B1 * 10/2004 Chen H01Q 9/0421
343/700 MS
9,048,532 B2 6/2015 Yu et al.
2002/0190905 A1 * 12/2002 Flint H01Q 1/22
343/702
2004/0104853 A1 * 6/2004 Chen G06F 1/1616
343/702

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

(Continued)

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

FOREIGN PATENT DOCUMENTS

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

CN 1832256 9/2006
CN 103811853 5/2014

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

Primary Examiner — Dieu Hien T Duong

Assistant Examiner — Bamidele A Jegede

(74) *Attorney, Agent, or Firm* — JCIPRNET

(65) **Prior Publication Data**

US 2017/0170543 A1 Jun. 15, 2017

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Dec. 15, 2015 (TW) 104142046 A

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.

(51) **Int. Cl.**

H01Q 1/48 (2006.01)

H01Q 1/22 (2006.01)

H01Q 9/04 (2006.01)

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

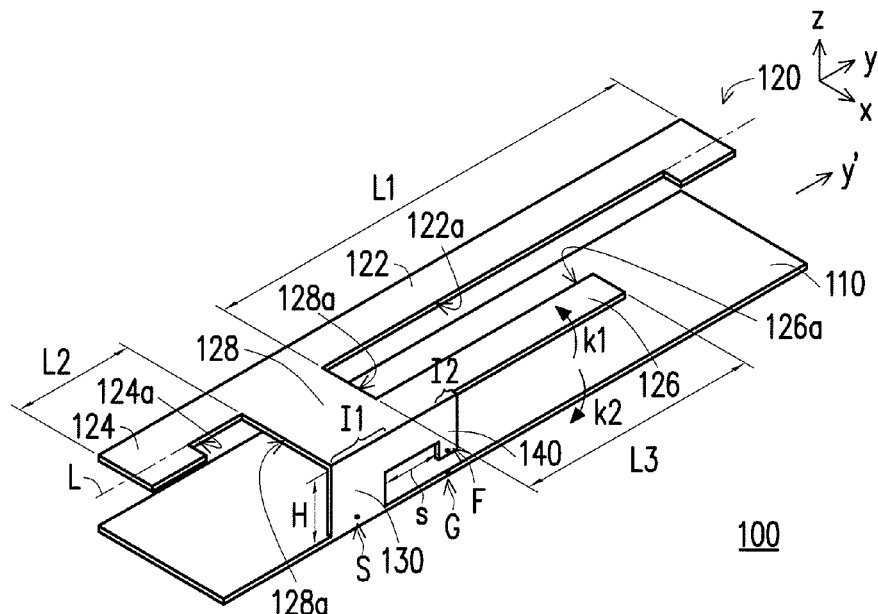
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/0421** (2013.01)

(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.

15 Claims, 4 Drawing Sheets





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**

(56) **References Cited**

(71) Applicant: **HEWLETT-PACKARD
DEVELOPMENT COMPANY, L.P.**,
Houston, TX (US)

U.S. PATENT DOCUMENTS

6,380,895 B1 4/2002 Moren et al.
7,825,863 B2* 11/2010 Martiskainen H01Q 1/243
343/700 MS

(72) Inventors: **Sung Oh**, Palo Alto, CA (US); **Philip
Wright**, San Diego, CA (US)

(Continued)

(73) Assignee: **Hewlett-Packard Development
Company, L.P.**, Spring, TX (US)

FOREIGN PATENT DOCUMENTS

CN 102683798 A 9/2012
KR 10-2010-0018910 A 2/2010

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 58 days.

(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **15/747,216**

Fang-Hsien Chu and Kin-Lu Wong, "Internal Handset Antenna
Integrated with USB Connector for WWAN/LTE Operation," 2011,
pp. 1-4.

(22) PCT Filed: **Sep. 29, 2015**

(86) PCT No.: **PCT/US2015/052958**

(Continued)

§ 371 (c)(1),

(2) Date: **Jan. 24, 2018**

Primary Examiner — Hai V Tran

(87) PCT Pub. No.: **WO2017/058176**

(74) *Attorney, Agent, or Firm* — HP Inc. Patent
Department

PCT Pub. Date: **Apr. 6, 2017**

(65) **Prior Publication Data**

US 2018/0219294 A1 Aug. 2, 2018

(51) **Int. Cl.**

H01Q 9/42 (2006.01)

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

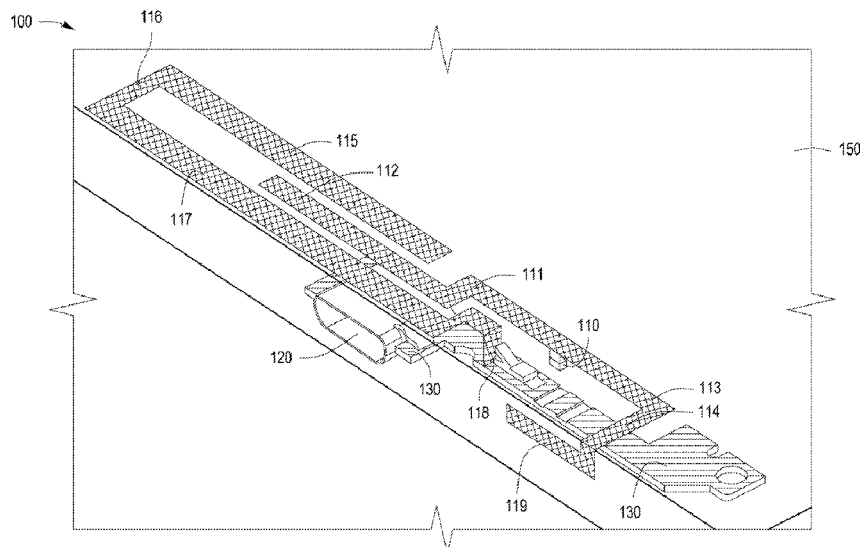
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(57)

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





US010644379B2

(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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(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.

4,733,245 A	3/1988	Mussler
5,768,217 A	6/1998	Sonoda
5,945,956 A	8/1999	Izawa et al.
2005/0024278 A1	2/2005	Amemiya et al.
2008/0074329 A1	3/2008	Caballero et al.
2009/0278749 A1	11/2009	Jow
2010/0103612 A1	4/2010	Weber et al.
2010/0231470 A1	9/2010	Lee et al.
2010/0316368 A1*	12/2010	Young G01S 19/14
		396/310
2010/0321253 A1*	12/2010	Ayala Vazquez H01Q 1/2258
		343/702
2011/0012796 A1	1/2011	Kim et al.
2011/0078749 A1	3/2011	Wleeck
2012/0027056 A1	2/2012	Shinkai et al.

(21) Appl. No.: **15/681,248**

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

(65) **Prior Publication Data**

US 2017/0346167 A1 Nov. 30, 2017

Related U.S. Application Data

(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.

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
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.

* cited by examiner

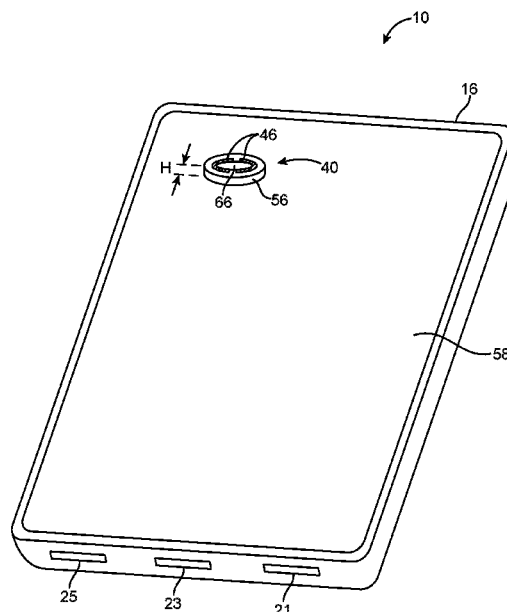
Primary Examiner — Andrea Lindgren Baltzell

(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**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 5, 2017 (CN) 2017 1 0663431

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0026360 A1* 1/2018 Lee H01Q 1/243
343/872

2018/0026370 A1 1/2018 Lee et al.

FOREIGN PATENT DOCUMENTS

CN 205960191 2/2017
TW 201401644 A 1/2014

* cited by examiner

Primary Examiner — Sam Bhattacharya

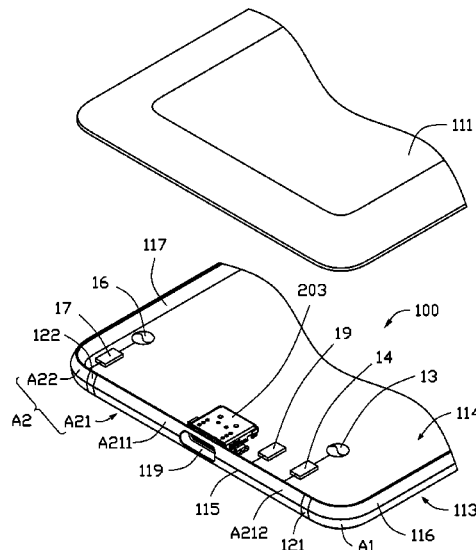
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(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





US010644382B2

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

(10) **Patent No.:** **US 10,644,382 B2**
(45) **Date of Patent:** **May 5, 2020**

(54) **ANTENNA ASSEMBLY AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**

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

(72) Inventors: **Yi-Chieh Lee, New Taipei (TW); Yen-Hui Lin, New Taipei (TW); Yun-Jian Chang, New Taipei (TW); Jung-Chin Lin, New Taipei (TW); Geng-Hong Liou, 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 62 days.

(21) Appl. No.: **16/137,567**

(22) Filed: **Sep. 21, 2018**

(65) **Prior Publication Data**
US 2019/0131694 A1 May 2, 2019

(30) **Foreign Application Priority Data**
Oct. 30, 2017 (CN) 2017 1 1035888

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
H01Q 13/10 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/335 (2015.01)
H01Q 9/42 (2006.01)
H01Q 5/35 (2015.01)
H01Q 21/06 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/335** (2015.01); **H01Q 7/00** (2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10** (2013.01); **H04M 1/0283** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 21/064** (2013.01)

(58) **Field of Classification Search**
CPC H01G 1/243; H01G 5/335; H01G 1/48; H01G 7/00; H01G 9/42; H01G 13/10; H01G 5/35; H01G 9/0421; H01G 21/064
See application file for complete search history.

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

CN	204289710 U	4/2015
CN	204885437 U	12/2015
CN	103219582 B	8/2016
WO	2017156906 A1	9/2017

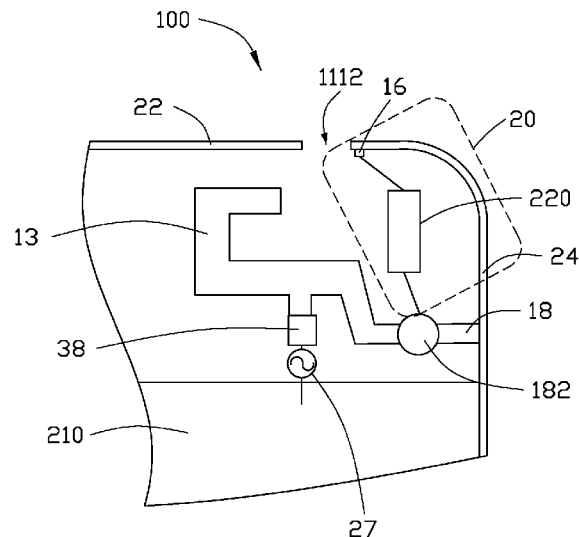
Primary Examiner — Graham P Smith

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

(57) **ABSTRACT**

An antenna assembly includes a side frame, a feed portion, a ground portion, a radiating portion, and a first matching circuit. The side frame defines a first gap to form a first radiating section from the first gap to a side portion. The radiating portion is inside the side frame and connects to the feed portion and the ground portion, the radiating portion is spaced apart from the side frame and connected to the first radiating section. One end of the first matching circuit connects to an end of the first radiating section adjacent to the first gap, another end connects to the ground portion. The feed portion feeds current into the radiating portion, two opposites ends of the first radiating section and the first matching circuit to activate radiating signals in a first frequency band. A wireless communication device employing the antenna assembly is also provided.

20 Claims, 10 Drawing Sheets



(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.

(21) Appl. No.: **16/035,849**

(22) Filed: **Jul. 16, 2018**

(65) **Prior Publication Data**

US 2019/0221943 A1 Jul. 18, 2019

Related U.S. Application Data

(60) Provisional application No. 62/617,292, filed on Jan. 14, 2018.

(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);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 13/103; H01Q 5/371;
H01Q 5/385; H01Q 13/106; H01Q 13/16
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,599,084 B2 * 12/2013 Wong H01Q 1/243
343/749
9,325,059 B2 * 4/2016 Wong H01Q 1/243
(Continued)

FOREIGN PATENT DOCUMENTS

TW 201401645 A 1/2014
TW 201703350 A 1/2017
TW 201735444 A 10/2017

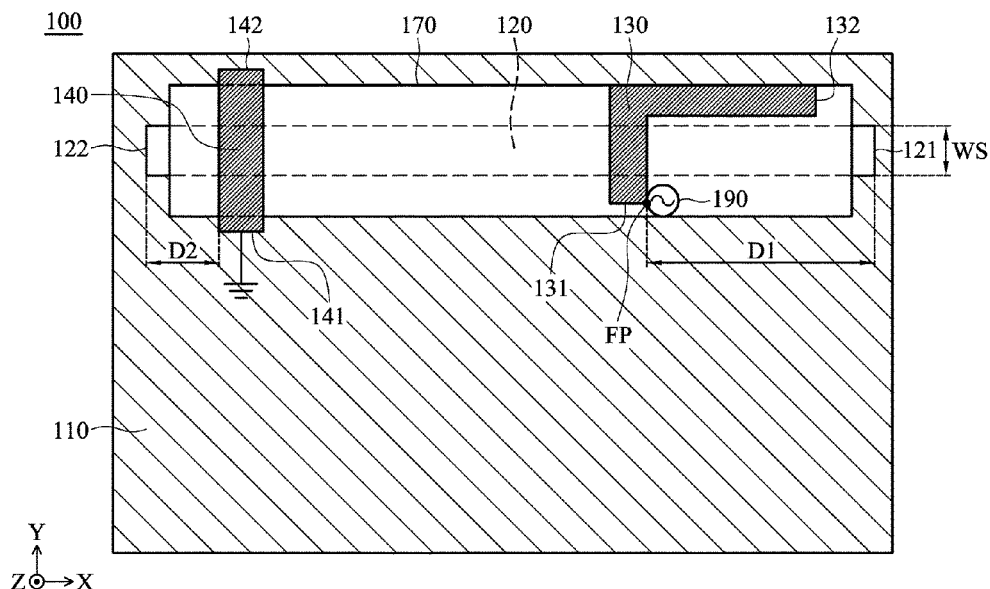
Primary Examiner — Huedung X Mancuso

(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





US010651542B2

(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**

U.S. PATENT DOCUMENTS

8,159,399 B2 4/2012 Dorsey et al.
8,270,914 B2 9/2012 Pascolini et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102110873 6/2011
CN 102544753 7/2012
(Continued)

OTHER PUBLICATIONS

European Search Report dated Jan. 22, 2018 issued in counterpart application No. 17189699.6-1205, 10 pages.

(Continued)

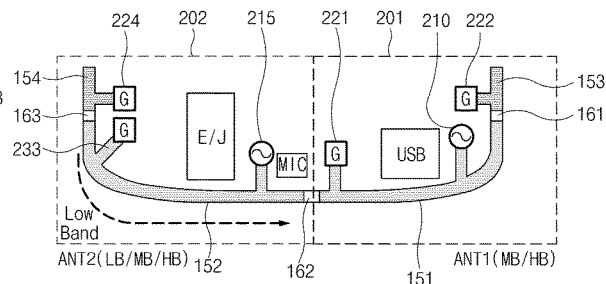
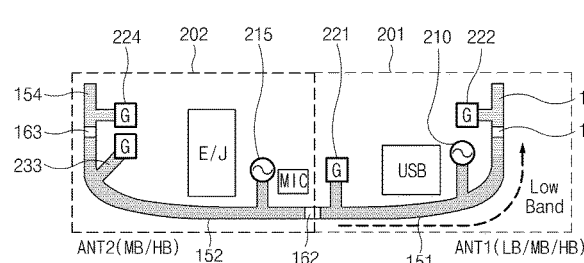
Primary Examiner — Hai V Tran

(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





(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**

U.S. PATENT DOCUMENTS

2013/0169490 A1* 7/2013 Pascolini H01Q 1/243
343/702
2017/0149118 A1* 5/2017 Wang H01Q 1/243

FOREIGN PATENT DOCUMENTS

CA 2953629 A1 10/2015
CN 203775569 U * 3/2014 H01Q 1/44
(Continued)

OTHER PUBLICATIONS

European Patent Application No. 17765885.3, Extended Search and
Opinion dated Sep. 27, 2018, 9 pages.
(Continued)

Primary Examiner — Daniel Munoz

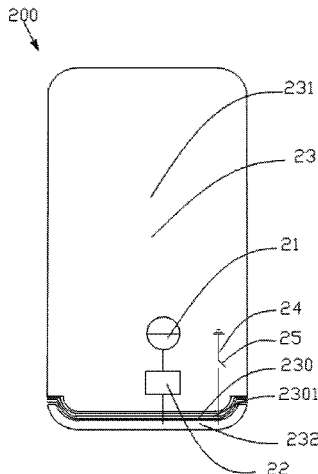
Assistant Examiner — Bamidele A Jegede

(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 elec-
trically coupled to the metal housing by means of the
matching circuit, such that the metal housing is used as a

(Continued)





US010651553B2

(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

6,943,738 B1 * 9/2005 Mattsson H01Q 1/243
343/700 MS
7,091,911 B2 * 8/2006 Qi H01Q 1/243
343/702

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 39 days.

CN 205029016 U 2/2016
CN 205104610 U 3/2016
(Continued)

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

Primary Examiner — Tho G Phan

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

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

(65) **Prior Publication Data**

US 2019/0372215 A1 Dec. 5, 2019

(30) **Foreign Application Priority Data**

May 30, 2018 (TW) 107118508 A

(57) **ABSTRACT**

(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**

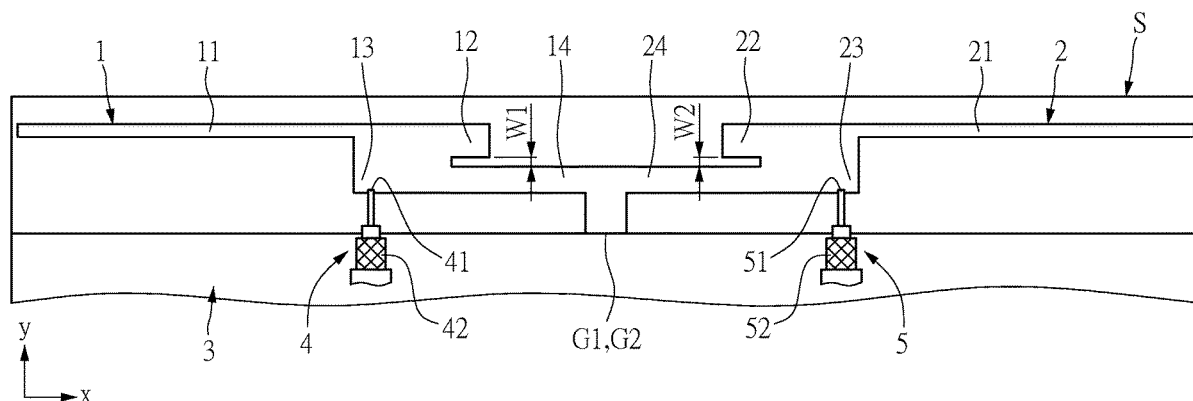
CPC .. H01Q 1/48; H01Q 1/38; H01Q 5/00; H01Q 1/52; H01Q 1/523; H01Q 5/35; H01Q 1/24; H01Q 1/243; H01Q 1/521; H01Q 5/37; H01Q 5/371; H01Q 5/378; H01Q 9/04; H01Q 9/42

See application file for complete search history.

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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US010651556B2

(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;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,835,067 A * 11/1998 Goodman H01Q 9/36 343/722
9,484,631 B1 * 11/2016 Napoles H01Q 1/243
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2007-088975 A 4/2007
JP 4233100 B2 12/2008
WO 2007/091554 A1 8/2007

OTHER PUBLICATIONS

The Extended European Search Report dated Jan. 23, 2019 for the related European Patent Application No. 17752865.0.

(Continued)

Primary Examiner — Graham P Smith

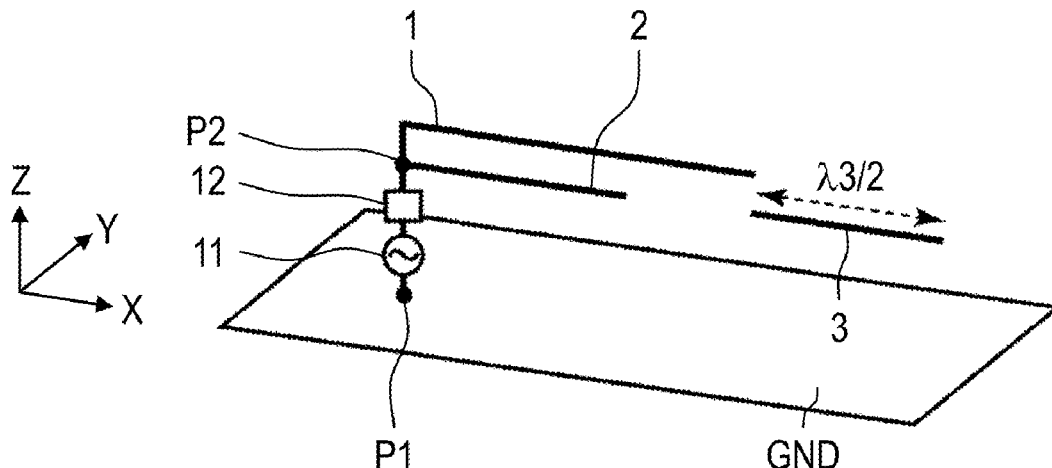
Assistant Examiner — Jae K Kim

(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)





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**

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

(72) Inventors: **Insu Song**, Seoul (KR); **Sukho Hong**,
Seoul (KR); **Dongjin Kim**, Seoul (KR);
Jaewook Lee, 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 120 days.

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

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

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

§ 371 (c)(1),

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

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

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

(65) **Prior Publication Data**

US 2018/0375973 A1 Dec. 27, 2018

(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)

(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);

(Continued)

(58) **Field of Classification Search**

CPC .. H01Q 1/38; H01Q 1/24; H01Q 1/48; H01Q
9/42

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0321253 A1* 12/2010 Ayala Vazquez H01Q 1/2258
343/702

2014/0078008 A1* 3/2014 Kang H01Q 5/35
343/702

(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2013-0022208 A 3/2013

KR 10-2014-0020670 A 2/2014

(Continued)

Primary Examiner — Andrea Lindgren Baltzell

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

(57) **ABSTRACT**

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.

18 Claims, 14 Drawing Sheets

