



US010541466B2

(12) **United States Patent**
Yun

(10) **Patent No.:** **US 10,541,466 B2**

(45) **Date of Patent:** **Jan. 21, 2020**

(54) **ANTENNA APPARATUS OF MOBILE TERMINAL**

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

(72) Inventor: **Ju Hwan Yun**, Gyeongsangbuk-do
(KR)

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

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

(21) Appl. No.: **16/291,097**

(22) Filed: **Mar. 4, 2019**

(65) **Prior Publication Data**

US 2019/0207294 A1 Jul. 4, 2019

Related U.S. Application Data

(63) Continuation of application No. 14/559,072, filed on
Dec. 3, 2014, now Pat. No. 10,224,600, which is a
continuation of application No. 12/782,775, filed on
May 19, 2010, now Pat. No. 8,929,946.

(30) **Foreign Application Priority Data**

May 21, 2009 (KR) 10-2009-0044377

(51) **Int. Cl.**

H04W 88/06 (2009.01)

H01Q 1/24 (2006.01)

H04M 1/02 (2006.01)

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

CPC **H01Q 1/24** (2013.01); **H01Q 1/243**
(2013.01); **H04M 1/0208** (2013.01); **H04M**
1/0274 (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**

None
See application file for complete search history.

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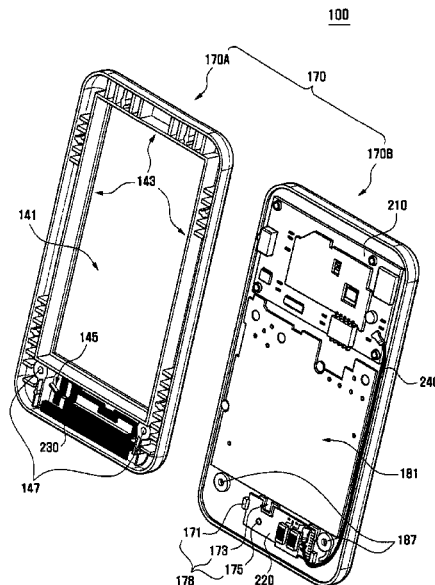
Primary Examiner — Suhail Khan

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

A mobile terminal and manufacture of same are provided. The mobile terminal includes: an antenna; a first case at which the antenna is disposed; a second case coupled to the first case; a main PCB disposed at one side of the second case; and a sub-PCB disposed at an opposite side of the second case, the sub-PCB being connected to the main PCB through a cable, wherein the sub-PCB is electrically coupled with the antenna when the first case and the second case are coupled together.

29 Claims, 4 Drawing Sheets





US010541475B2

(12) **United States Patent**
Caporal Del Barrio et al.

(10) **Patent No.:** **US 10,541,475 B2**
(45) **Date of Patent:** ***Jan. 21, 2020**

(54) **TUNABLE MULTIPLE-RESONANCE ANTENNA SYSTEMS, DEVICES, AND METHODS FOR HANDSETS OPERATING IN LOW LTE BANDS WITH WIDE DUPLEX SPACING**

(58) **Field of Classification Search**
CPC H01Q 5/314; H01Q 5/328; H01Q 5/378;
H01Q 5/385; H01Q 5/392; H01Q 5/321;
(Continued)

(71) Applicant: **wiSpry, Inc.**, Irvine, CA (US)

(56) **References Cited**

(72) Inventors: **Samantha Caporal Del Barrio**, Aalborg (DK); **Gert Frølund Pedersen**, Storvorde (DK); **Arthur S. Morris, III**, Raleigh, NC (US)

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(73) Assignee: **WISPRY, INC.**, Irvine, CA (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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This patent is subject to a terminal disclaimer.

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(21) Appl. No.: **16/189,769**

European Office Action for Application No. 15851082.6 dated Apr. 12, 2019.

(22) Filed: **Nov. 13, 2018**

(Continued)

(65) **Prior Publication Data**
US 2019/0190155 A1 Jun. 20, 2019

Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Jenkins, Wilson, Taylor & Hunt, P.A.

Related U.S. Application Data

(63) Continuation of application No. 14/885,779, filed on Oct. 16, 2015, now Pat. No. 10,128,573.
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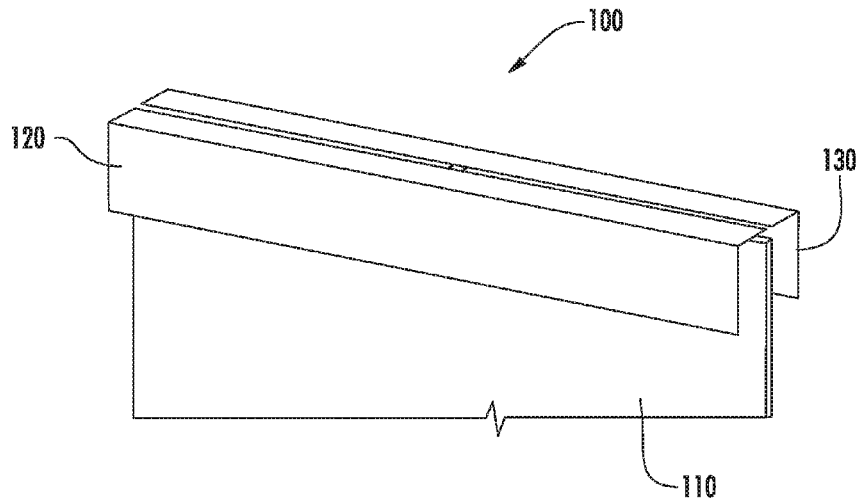
(57) **ABSTRACT**

The present subject matter relates to antenna systems, devices, and methods that provide efficient coverage of low frequency bands (e.g., 700 MHz-bands and 600 MHz-bands) for the new generations of mobile communication. For example, a dual-resonant radiating system can include a ground plane, a radiating coupler spaced apart from but in communication with the ground plane, and a ground plane extension in communication with the ground plane. In this arrangement, one or both of the radiating coupler and the ground plane extension are tunable to tune a dual-resonance frequency response.

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/328 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/314** (2015.01);
(Continued)

19 Claims, 7 Drawing Sheets



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

(10) **Patent No.:** **US 10,542,130 B1**
(45) **Date of Patent:** **Jan. 21, 2020**

(54) **MOBILE DEVICE**
(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)
(72) Inventors: **Wen-Yuan Lo**, Taoyuan (TW);
Mao-Liang Tien, Taoyuan (TW);
Jui-Chun Jao, Taoyuan (TW)

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(73) Assignee: **QUANTA COMPUTER INC.**,
Guishan Dist., Taoyuan (TW)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **16/410,262**

(22) Filed: **May 13, 2019**

(30) **Foreign Application Priority Data**

Jan. 18, 2019 (TW) 108101926 A

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

(52) **U.S. Cl.**
CPC **H04M 1/0277** (2013.01); **H04M 1/0266**
(2013.01)

(58) **Field of Classification Search**
CPC H04M 1/02
See application file for complete search history.

(56) **References Cited**

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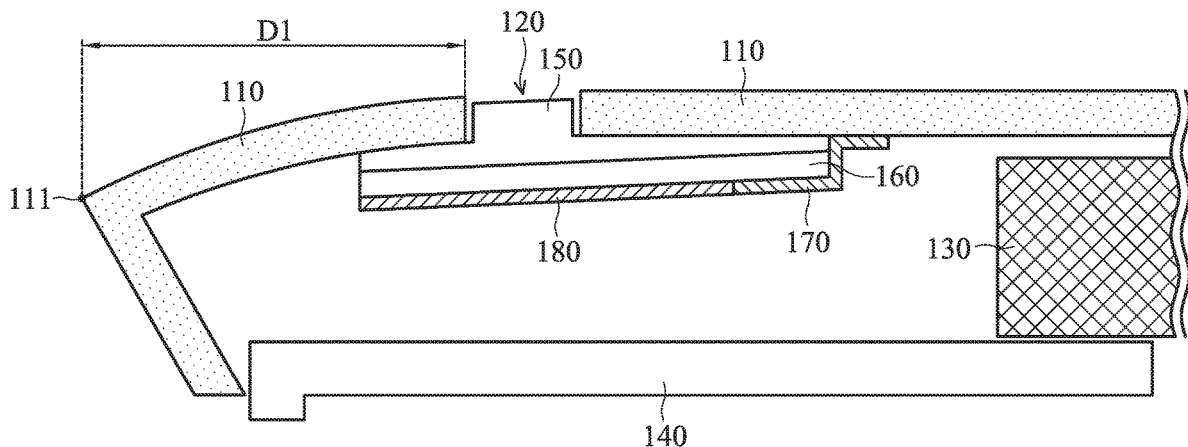
Primary Examiner — Michael T Vu
(74) *Attorney, Agent, or Firm* — McClure, Qualey &
Rodack, LLP

(57) **ABSTRACT**

A mobile device includes a metal back cover, a display device, a display frame, a nonconductive filling element, a dielectric substrate, a ground element, and a radiator. The metal back cover has a slot. The display device and the display frame are disposed opposite to the metal back cover. The nonconductive filling element is at least partially embedded in the slot. The dielectric substrate is disposed on the nonconductive filling element. The ground element is coupled to the metal back cover. The radiator is coupled to the ground element and is disposed on the dielectric substrate. An antenna structure is formed by the radiator and the slot of the metal back cover. The distance from the slot to an edge of the metal back cover is shorter than 10 mm.

9 Claims, 7 Drawing Sheets

100



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

(10) **Patent No.:** **US 10,547,099 B2**
(45) **Date of Patent:** **Jan. 28, 2020**

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

(56) **References Cited**

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

U.S. PATENT DOCUMENTS
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(72) Inventors: **Gyu Bok Park**, Gyeonggi-do (KR);
Kyung Moon Seol, Gyeonggi-do (KR);
Ji Ho Kim, Gyeonggi-do (KR); **Kyi Hyun Jang**, Seoul (KR); **Hyun Seock Roh**, Gyeonggi-do (KR); **Sang Bong Sung**, Gyeonggi-do (KR)

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

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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 185 days.

International Search Report dated Jan. 6, 2017 issued in counterpart application No. PCT/KR2016/010776, 12 pages.
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(21) Appl. No.: **15/285,068**

Primary Examiner — Hoang V Nguyen
Assistant Examiner — Awat M Salih

(22) Filed: **Oct. 4, 2016**

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

(65) **Prior Publication Data**
US 2017/0125887 A1 May 4, 2017

(30) **Foreign Application Priority Data**
Nov. 2, 2015 (KR) 10-2015-0153407

(57) **ABSTRACT**

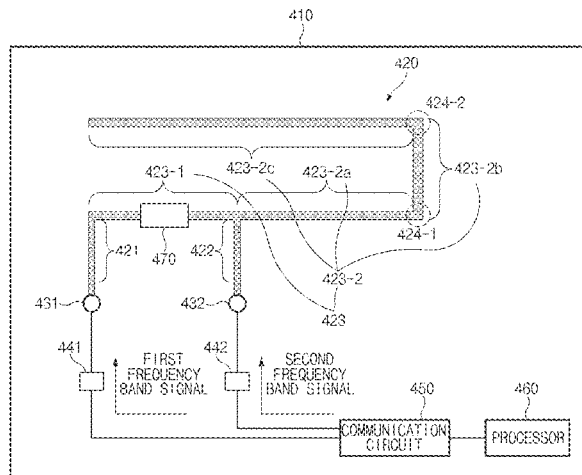
An antenna structure is provided for use in an electronic device. The antenna structure includes a first feeding part; a second feeding part; and an antenna radiator including a first connection pattern including a first end and a second end, the first end of the first connection pattern being electrically connected to the first feeding part; a second connection pattern including a first end and a second end, the first end of the second connection pattern being electrically connected to the second feeding part; a first pattern that connects the second end of the first connection pattern and the second end of the second connection pattern; and a second pattern that extends from at least one end of the first pattern. The first feeding part is configured to transmit or receive a signal of a first frequency band, and the second feeding part is configured to transmit or receive a signal of a second frequency band that at least partially overlaps the first frequency band.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/321 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/314** (2015.01); **H01Q 5/321** (2015.01); **H01Q 5/335** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/28; H01Q 5/35; H01Q 5/335; H01Q 5/321; H01Q 9/42;
(Continued)

18 Claims, 18 Drawing Sheets



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

(10) **Patent No.:** **US 10,547,100 B2**
(45) **Date of Patent:** **Jan. 28, 2020**

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 1/521;
H01Q 5/335; H01Q 5/371; H01Q 5/35;
(Continued)

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

(56) **References Cited**

(72) Inventors: **Yen-Hui Lin**, New Taipei (TW);
Yun-Jian Chang, New Taipei (TW);
Jung-Chin Lin, New Taipei (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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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 235 days.

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(21) Appl. No.: **15/657,049**

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(22) Filed: **Jul. 21, 2017**

Primary Examiner — Hoang V Nguyen
Assistant Examiner — Awat M Salih

(65) **Prior Publication Data**

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

US 2018/0026354 A1 Jan. 25, 2018

Related U.S. Application Data

(57) **ABSTRACT**

(60) Provisional application No. 62/364,880, filed on Jul. 21, 2016.

An antenna structure includes a metal housing, a first radiating portion, a second radiating portion, a third radiating portion, and a signal feed source. 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 groove and a gap. The metal housing is divided into at least an antenna section by the slot, the groove, and the gap. The first radiating portion, the second radiating portion, and the third radiating portion are spaced apart from each other. One of three radiating portions is electrically connected to the antenna section. The remaining of the three radiating portions are spaced apart from the antenna section. The signal feed source is electrically connected to one radiating portion and the radiating portions of the three radiating portions not electrically connected to the signal feed source are grounded.

(30) **Foreign Application Priority Data**

Jul. 7, 2017 (CN) 2017 1 0552467

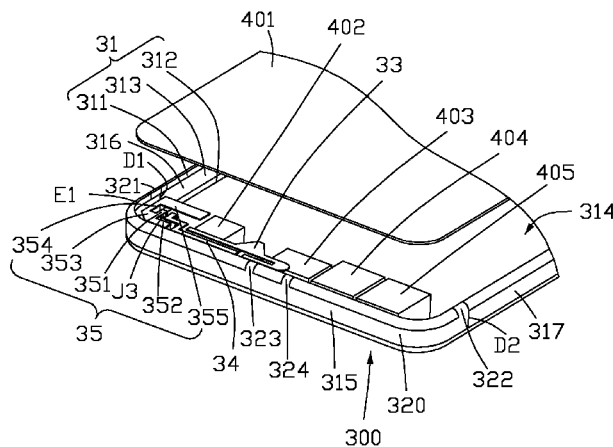
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/335** (2015.01); **H04M 1/0264** (2013.01); **H04M 1/0283** (2013.01)

34 Claims, 58 Drawing Sheets

400





US010547101B2

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

(10) **Patent No.:** **US 10,547,101 B2**
(45) **Date of Patent:** ***Jan. 28, 2020**

(54) **ANTENNA OF ELECTRONIC DEVICE**
(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)
(72) Inventors: **Soon Ho Hwang**, Seoul (KR); **Ui Chul Jeong**, Gyeonggi-do (KR); **Sung Koo Park**, Gyeonggi-do (KR); **Chan Kyu An**, Incheon (KR); **Joon Ho Byun**, Gyeonggi-do (KR); **Sang Keun Yoo**, Gyeonggi-do (KR); **Yoon Jae Lee**, Gyeonggi-do (KR); **Jin Woo Jung**, Seoul (KR); **Jae Bong Chun**, 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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/822,755**

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

(65) **Prior Publication Data**
US 2018/0090823 A1 Mar. 29, 2018

Related U.S. Application Data
(63) Continuation of application No. 14/829,305, filed on Aug. 18, 2015, now Pat. No. 9,859,607.

(30) **Foreign Application Priority Data**
Aug. 18, 2014 (KR) 10-2014-0106730

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/145** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 1/46; H01Q 9/0407; H01Q 9/145; H01Q 9/42;
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(56) **References Cited**
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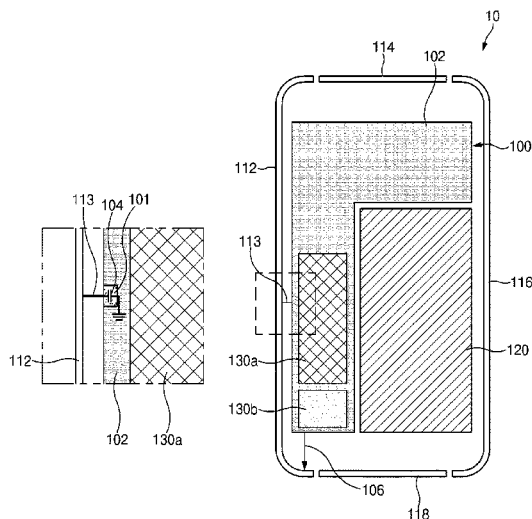
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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**
An antenna of an electronic device is provided, which includes a radiator including at least part of a metal housing of the electronic device; a capacitor connected to the radiator; a feeding part connected to the radiator; and a ground part connected to the capacitor.

15 Claims, 12 Drawing Sheets





US010547102B2

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

(10) **Patent No.:** **US 10,547,102 B2**
(45) **Date of Patent:** **Jan. 28, 2020**

- (54) **ANTENNA AND METHOD FOR STEERING ANTENNA BEAM DIRECTION FOR WIFI APPLICATIONS**
- (71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)
- (72) Inventors: **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, San Diego, CA (US); **Jeffrey Shamblin**, San Marcos, CA (US)
- (73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/048,987**
(22) Filed: **Jul. 30, 2018**

(65) **Prior Publication Data**
US 2018/0337441 A1 Nov. 22, 2018

Related U.S. Application Data
(63) Continuation of application No. 15/660,907, filed on Jul. 26, 2017, now Pat. No. 10,056,679, which is a continuation of application No. 14/965,881, filed on Dec. 10, 2015, now Pat. No. 9,748,637, which is a continuation-in-part of application No. 14/144,461, filed on Dec. 30, 2013, now Pat. No. 9,240,634, which is a continuation of application No. 13/726,477, filed on Dec. 24, 2012, now Pat. No. 8,648,755, which is a continuation of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402.

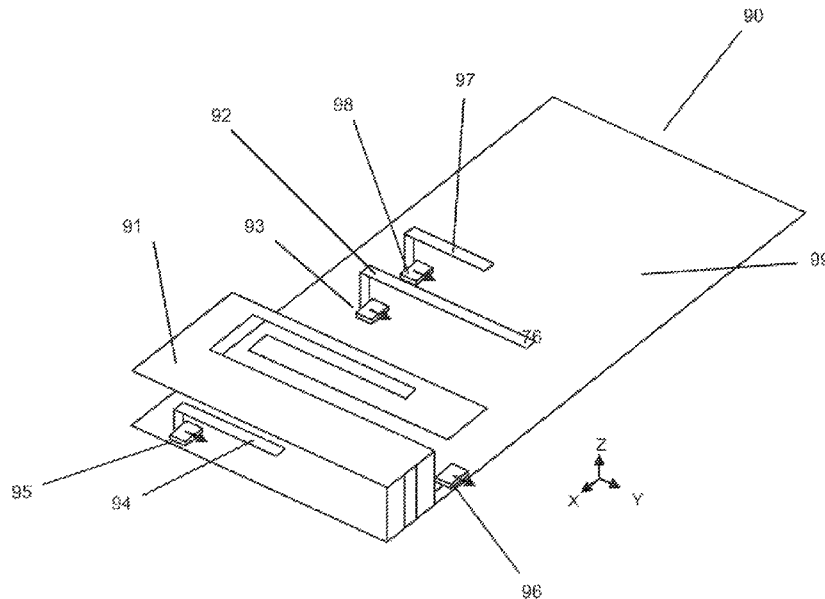
- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 3/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
- (52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 3/00* (2013.01); *H01Q 9/0421* (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/243; H01Q 1/36; H01Q 1/38; H01Q 1/48; H01Q 19/10; H01Q 3/00; H01Q 9/0421
See application file for complete search history.

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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**
An antenna comprising an IMD element and one or more parasitic and active tuning elements is disclosed. The IMD element, when used in combination with the active tuning and parasitic elements, allows antenna operation at multiple resonant frequencies. In addition, the direction of antenna radiation pattern may be arbitrarily rotated in accordance with the parasitic and active tuning elements. Unique antenna architectures for beam steering in Wi-Fi band applications is further described.

18 Claims, 16 Drawing Sheets



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

(10) **Patent No.:** **US 10,547,108 B2**
(45) **Date of Patent:** **Jan. 28, 2020**

- (54) **ANTENNA DEVICE AND ELECTRONIC DEVICE INCLUDING THE SAME**
- (71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si, Gyeonggi-do (KR)
- (72) Inventors: **Sin-Hyung Jeon**, Suwon-si (KR);
Kwang-Ho Kim, Yongin-si (KR);
Sang-Gi Oh, Yongin-si (KR);
Sang-Hyuk Wi, Yongin-si (KR);
Dong-Hyun Jeong, Suwon-si (KR);
Jeong-Nam Cheon, Seongnam-si (KR)
- (73) Assignee: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **15/698,538**

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

(65) **Prior Publication Data**
US 2018/0123242 A1 May 3, 2018

(30) **Foreign Application Priority Data**
Oct. 28, 2016 (KR) 10-2016-0142187

(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 21/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/30** (2015.01); **H01Q 1/24**
(2013.01); **H01Q 1/521** (2013.01); **H01Q**
21/28 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 1/521; H01Q 1/24;
H01Q 21/28
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- (56) **References Cited**
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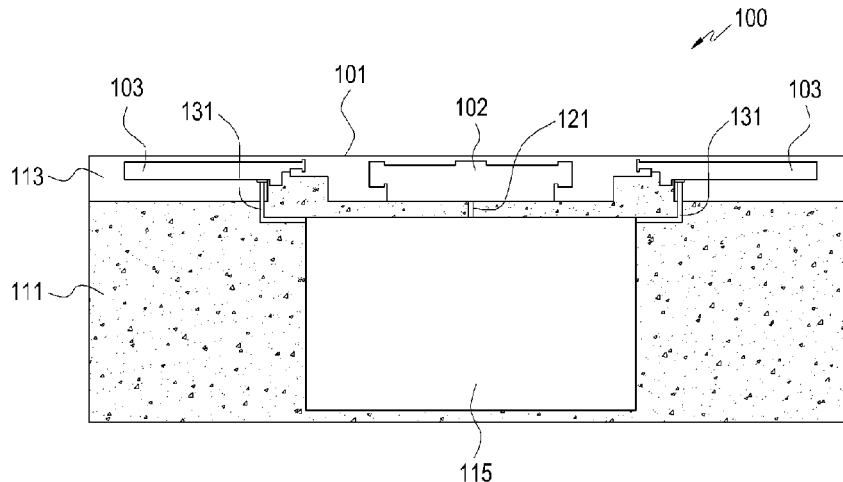
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Primary Examiner — Hai V Tran

(57) **ABSTRACT**

Various embodiments of the present disclosure provide an antenna device and/or an electronic device including the antenna device. The antenna device may include: a circuit board; a conductive layer disposed in a partial region of the circuit board; a first radiation conductor disposed at one side of the conductive layer on the circuit board; and second radiation conductors disposed at one side of the conductive layer on the circuit board, the second radiation conductors being respectively disposed at opposite sides of the first radiation conductor to be symmetrical to each other. The first radiation conductor may transmit or receive a wireless signal in a first frequency band, and the second radiation conductors may transmit or receive a wireless signal in a second frequency band that is different from the first frequency band.

19 Claims, 10 Drawing Sheets





US010547114B2

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

(10) **Patent No.:** **US 10,547,114 B2**

(45) **Date of Patent:** **Jan. 28, 2020**

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

(71) Applicant: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen, Guangdong (CN)

(72) Inventors: **Hanyang Wang**, Reading (GB); **Lijun Ying**, Shanghai (CN); **Xuefei Zhang**, Shenzhen (CN); **Chien-Ming Lee**, Shanghai (CN); **Dong Yu**, Shanghai (CN); **Liang Xue**, Shanghai (CN); **Lei Wang**, Shanghai (CN); **Chih-Hua Chang**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 108 days.

(21) Appl. No.: **15/566,518**

(22) PCT Filed: **Apr. 16, 2015**

(86) PCT No.: **PCT/CN2015/076786**

§ 371 (c)(1),
(2) Date: **Oct. 13, 2017**

(87) PCT Pub. No.: **WO2016/165113**

PCT Pub. Date: **Oct. 20, 2016**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 13/103** (2013.01); **H01Q 1/242** (2013.01); **H01Q 13/085** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/328; H01Q 13/103; H01Q 1/48

See application file for complete search history.

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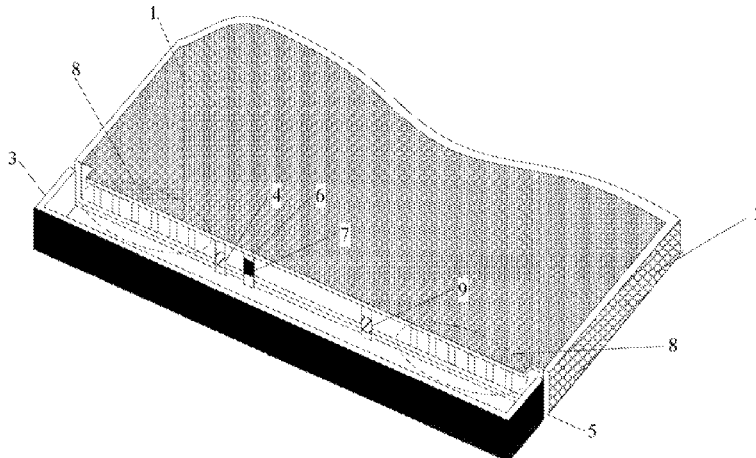
Primary Examiner — Ricardo I Magallanes

(74) *Attorney, Agent, or Firm* — Slater Masil, LLP

(57) **ABSTRACT**

Embodiments of the present invention relate to the field of antenna technologies, and provide a slot antenna and a mobile terminal, to generate different resonance frequencies, so as to cover required bands. The slot antenna includes a system circuit board, a grounding conductor, a radiator, and a first adjustable unit. The system circuit board is connected to the grounding conductor to form an electric conductor, and the radiator is opposite to the electric conductor to form a slot. A feeding end is disposed on the system circuit board, the feeding end is electrically connected to the radiator, one end of the first adjustable unit is connected to the system circuit board, the other end of the first adjustable unit is connected to the radiator, and the first adjustable unit is configured to adjust a resonance frequency of the slot antenna.

15 Claims, 12 Drawing Sheets





US010547115B2

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

(10) **Patent No.:** **US 10,547,115 B2**
(45) **Date of Patent:** **Jan. 28, 2020**

(54) **WIRE-PLATE ANTENNA HAVING A CAPACITIVE ROOF INCORPORATING A SLOT BETWEEN THE FEED PROBE AND THE SHORT-CIRCUIT WIRE**

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/36 (2006.01)

(71) Applicant: **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)

(52) **U.S. Cl.**
CPC *H01Q 13/106* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 9/36* (2013.01)

(72) Inventors: **Cyril Jouanlanne**, Grenoble (FR);
Christophe Delaveaud,
Saint-Jean-de-Moirans (FR);
Jean-François Pintos,
Saint-Blaise-du-Buis (FR)

(58) **Field of Classification Search**
CPC *H01Q 13/106*; *H01Q 9/0421*; *H01Q 13/16*
See application file for complete search history.

(73) Assignee: **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)

(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 0 days.

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(21) Appl. No.: **15/536,265**

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(22) PCT Filed: **Dec. 18, 2015**

International Search Report and Written Opinion dated Mar. 4, 2016 issued in corresponding application No. PCT/EP2015/080631; w/ English partial translation and partial machine translation (20 pages).
(Continued)

(86) PCT No.: **PCT/EP2015/080631**

§ 371 (c)(1),
(2) Date: **Jun. 15, 2017**

Primary Examiner — Ricardo I Magallanes
(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(87) PCT Pub. No.: **WO2016/097362**

PCT Pub. Date: **Jun. 23, 2016**

(57) **ABSTRACT**

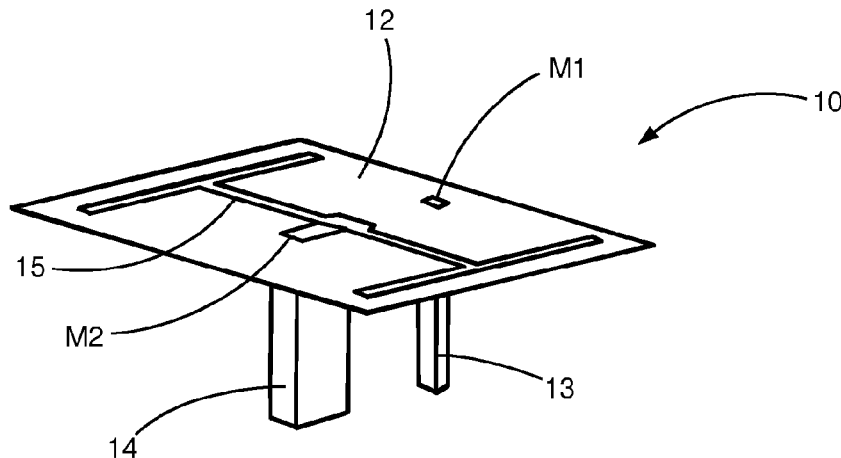
(65) **Prior Publication Data**

US 2017/0352962 A1 Dec. 7, 2017

A wire-plate antenna (10) comprises a ground plane (11), at least one capacitive roof (12), a feed probe (13) connected to the capacitive roof (12) and intended to be linked to a generator, and at least one electrically conductive short-circuit wire (14) linking the capacitive roof (12) and the ground plane (11). The capacitive roof (12) comprises at least one slit (15) consisting of an opening passing through
(Continued)

(30) **Foreign Application Priority Data**

Dec. 19, 2014 (FR) 14 63018



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

(10) **Patent No.:** **US 10,553,932 B2**
(45) **Date of Patent:** ***Feb. 4, 2020**

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

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

(72) 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 (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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/432,748**

(22) Filed: **Jun. 5, 2019**

(65) **Prior Publication Data**
US 2019/0288376 A1 Sep. 19, 2019

Related U.S. Application Data
(63) Continuation of application No. 15/943,067, filed on Apr. 2, 2018, now Pat. No. 10,355,341, which is a continuation of application No. 13/598,317, filed on Aug. 29, 2012, now Pat. No. 10,003,121.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/378 (2015.01)
H01Q 5/335 (2015.01)
H01Q 9/42 (2006.01)

(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.

(56) **References Cited**

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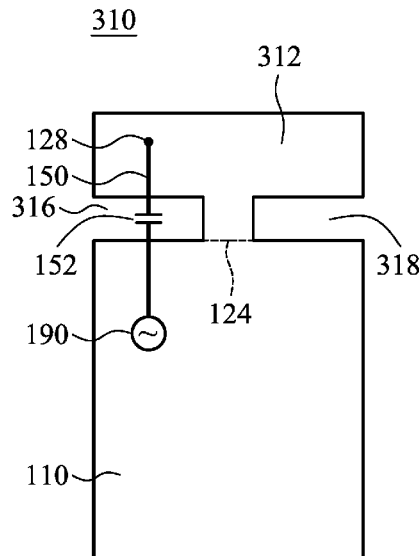
Primary Examiner — Daniel Munoz

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

(57) **ABSTRACT**

A mobile device including a ground plane, a grounding branch, wherein a slot is formed between the ground plane and the grounding branch, a connecting element, wherein the grounding branch is electrically coupled through the connecting element to the ground plane and a feeding element, extending across the slot, and electrically coupled between the grounding branch and a signal source, wherein an antenna structure is formed by the grounding branch and the feeding element.

11 Claims, 6 Drawing Sheets



(12) **United States Patent**
Chia

(10) **Patent No.:** US 10,553,948 B2
(45) **Date of Patent:** Feb. 4, 2020

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

(71) Applicant: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(72) Inventor: **Kai-Wei Chia**, New Taipei (TW)

(73) Assignee: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 178 days.

(21) Appl. No.: **15/869,117**

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

(65) **Prior Publication Data**
US 2019/0181551 A1 Jun. 13, 2019

(30) **Foreign Application Priority Data**
Dec. 7, 2017 (CN) 2017 1 1286617

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/35 (2015.01)
H01Q 9/04 (2006.01)
H01Q 5/50 (2015.01)
H01Q 21/00 (2006.01)
H01Q 5/328 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/35** (2015.01); **H01Q 5/328** (2015.01); **H01Q 5/50** (2015.01); **H01Q 9/0435** (2013.01); **H01Q 21/0031** (2013.01)

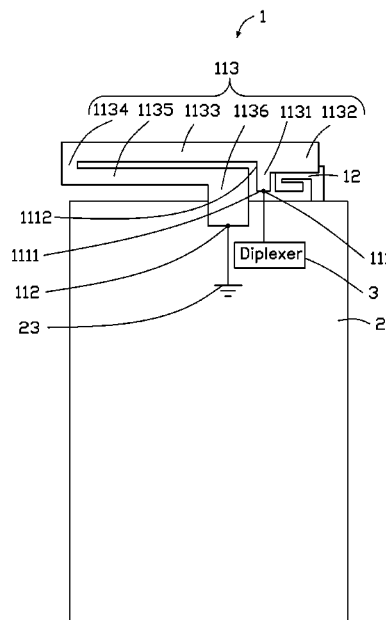
(58) **Field of Classification Search**
CPC H01Q 21/0031; H01Q 5/328; H01Q 1/24; H01Q 1/38; H01Q 5/35; H01Q 5/50; H01Q 9/0435
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**
An electronic device includes a base plate and a miniaturized multiband antenna. The multiband antenna is set on the base plate. The base plate includes a first side and a second side relative to the first side. The multiband antenna includes a first radiating part and a second radiating part. The first radiating part is set on the first side. The second radiating part is set on the second side. A gap is formed between the first radiating part and the second radiating part which facilitates a coupling oscillation between the first radiating part and the second radiating part, which enables the multiband antenna to work in at least one working band.

16 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 10,559,870 B2**
(45) **Date of Patent:** **Feb. 11, 2020**

- (54) **ANTENNA MODULE**
- (71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)
- (72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Ya-Jyun Li**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Cheng-Hsiung 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 336 days.

- (56) **References Cited**
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- (21) Appl. No.: **15/401,110**
- (22) Filed: **Jan. 9, 2017**
- (65) **Prior Publication Data**
US 2017/0229759 A1 Aug. 10, 2017

Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

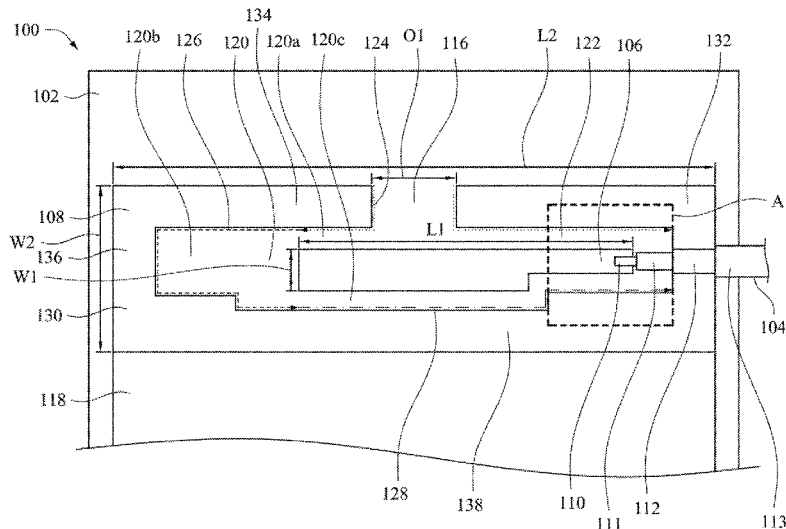
- (30) **Foreign Application Priority Data**
Feb. 5, 2016 (TW) 105104106 A

(57) **ABSTRACT**

An antenna module connected to a system ground of an electronic device includes a substrate, a coaxial-transmission line, a first radiator and a second radiator. The coaxial-transmission line includes a power feed-in terminal and a ground terminal. The first radiator is electrically connected to the power feed-in terminal. The second radiator is electrically connected to the ground terminal. One side of the second radiator is connected to the system ground, and the second radiator includes a first terminal and a second terminal. An opening is formed between the first terminal and the second terminal, so that the second radiator be partially surrounding to the first radiator. The first radiator and the second radiator are coplanarly disposed on the substrate.

- (51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 21/28 (2006.01)
H01Q 13/16 (2006.01)
H01Q 13/10 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 13/16** (2013.01); **H01Q 21/28** (2013.01); **H01Q 13/10** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/48; H01Q 13/16; H01Q 21/28; H01Q 13/10
See application file for complete search history.

14 Claims, 6 Drawing Sheets





US010559871B2

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

(10) **Patent No.:** **US 10,559,871 B2**

(45) **Date of Patent:** **Feb. 11, 2020**

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/16; H01Q 5/35
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Chang-Je Chen**, New Taipei (TW);
Shu-Cheng Lu, New Taipei (TW);
Yi-Ting Chen, New Taipei (TW);
Yen-Jung Tseng, New Taipei (TW);
Yi-Te Chou, New Taipei (TW)

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(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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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 208 days.

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(21) Appl. No.: **15/870,884**

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(22) Filed: **Jan. 13, 2018**

Primary Examiner — Robert Karacsony

(65) **Prior Publication Data**

US 2018/0248264 A1 Aug. 30, 2018

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

Related U.S. Application Data

(60) Provisional application No. 62/462,941, filed on Feb. 24, 2017.

(57) **ABSTRACT**

An antenna structure includes a housing, four feed sources, a first radiator, a second radiator, and a third radiator. The housing includes a first radiating portion and a second radiating portion. The first to third radiators are positioned in the housing. The first radiator is spaced apart from the second radiator. The four feed sources respectively connect to the first radiating portion, the second radiating portion, the first radiator, and the third radiator. The first radiating portion activates a first operation mode and a second operation mode. The second radiating portion activates a third operation mode. The first to third radiators activate a fourth operation mode, a fifth operation mode, and a sixth operation mode.

(30) **Foreign Application Priority Data**

Nov. 15, 2017 (CN) 2017 1 1133054

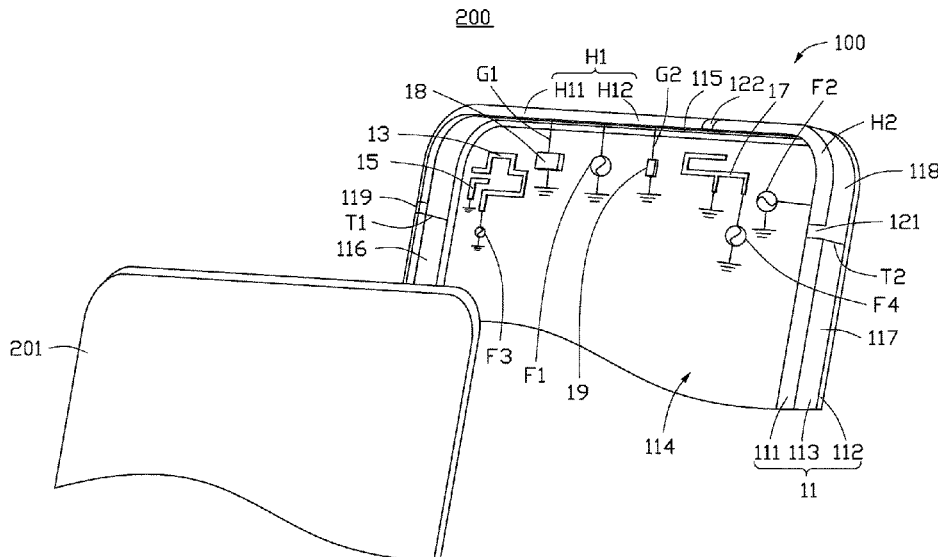
20 Claims, 14 Drawing Sheets

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/378 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 21/28** (2013.01)



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

(10) **Patent No.:** **US 10,559,882 B2**
(45) **Date of Patent:** **Feb. 11, 2020**

(54) **MOBILE DEVICE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)

(72) Inventors: **Kuan-Hsien Lee**, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Chin-Lung Tsai, Taoyuan (TW);
Ching-Hai Chiang, Taoyuan (TW);
Chung-Hung Lo, Taoyuan (TW);
Ying-Cong Deng, Taoyuan (TW);
Yi-Ling Tseng, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**,
Guishan Dist., Taoyuan (TW)

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

(21) Appl. No.: **15/987,149**

(22) Filed: **May 23, 2018**

(65) **Prior Publication Data**
US 2019/0131693 A1 May 2, 2019

(30) **Foreign Application Priority Data**
Oct. 27, 2017 (TW) 106137083 A

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 5/371 (2015.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 5/378; H01Q 5/392; H01Q 9/42

See application file for complete search history.

(56) **References Cited**

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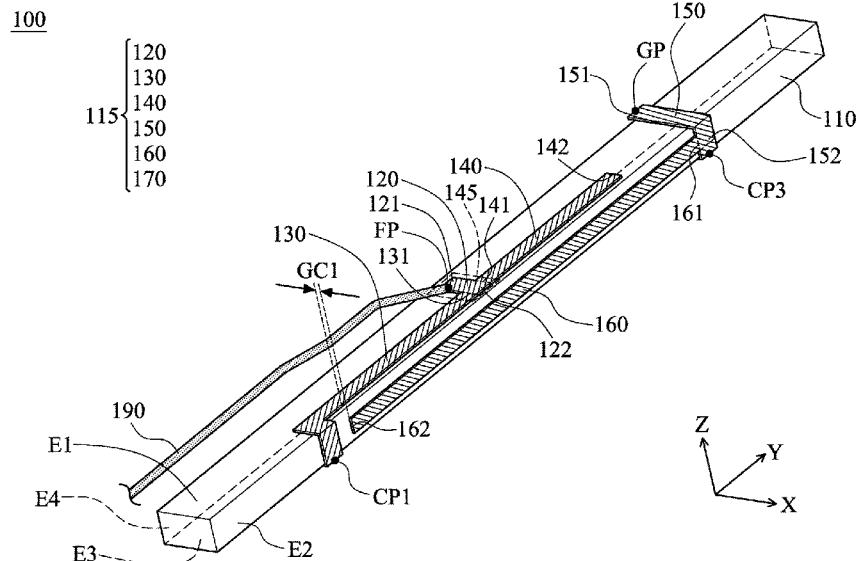
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

A mobile device includes a nonconductive mechanism element and an antenna structure. The antenna structure is formed over the nonconductive mechanism element. The antenna structure includes a feeding connection element, a first radiation element, a second radiation element, a grounding connection element, and a third radiation element. The feeding connection element is coupled to a feeding point. A first end of the first radiation element is coupled to the feeding connection element, and a second end of the first radiation element is open. A first end of the second radiation element is coupled to the feeding connection element, and a second end of the second radiation element is open. The grounding connection element is coupled to a grounding point. A first end of the third radiation element is coupled to the grounding connection element, and a second end of the third radiation element is open.

7 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 10,560,557 B2**
(45) **Date of Patent:** ***Feb. 11, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Kyongsun Hwang**, Seoul (KR); **Moonsoo Song**, Seoul (KR); **Yoonjae Won**, Seoul (KR); **Deuksu Choi**, Seoul (KR); **Chisang You**, 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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/383,399**

(22) Filed: **Apr. 12, 2019**

(65) **Prior Publication Data**

US 2019/0312960 A1 Oct. 10, 2019

Related U.S. Application Data

(63) Continuation of application No. 16/022,512, filed on Jun. 28, 2018, now Pat. No. 10,306,029.
(Continued)

(30) **Foreign Application Priority Data**

May 3, 2018 (KR) 10-2018-0051314

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04M 1/02 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H04M 1/0202** (2013.01); **H01Q 1/243** (2013.01); **H01Q 13/10** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H04M 1/0202; H01Q 1/243; H01Q 13/10; H01Q 5/35; H01Q 5/357; H01Q 1/44; H04B 1/3833; H04W 88/02
See application file for complete search history.

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Primary Examiner — Barry W Taylor

(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

There is disclosed a mobile terminal including: a display; a middle frame including a supporting portion and a side portion provided around the supporting portion to define a lateral external appearance; a main board including a ground; a first wireless communication unit configured to transceive a first signal; a second wireless communication unit configured to transceive a second signal; and a rear case configured to cover a rear surface of the main board, wherein the side portion includes a plurality of conductive members of which ends are divided into slits, and the plurality of the conductive members includes a common antenna electrically connectable with the first wireless communication unit

(Continued)

