



US010658731B2

(12) **United States Patent**
Muhn

(10) **Patent No.:** **US 10,658,731 B2**

(45) **Date of Patent:** **May 19, 2020**

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

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

(72) Inventor: **Sung Jin Muhn**, Gyeonggi-do (KR)

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

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

(21) Appl. No.: **15/778,772**

(22) PCT Filed: **Nov. 17, 2016**

(86) PCT No.: **PCT/KR2016/013259**

§ 371 (c)(1),

(2) Date: **May 24, 2018**

(87) PCT Pub. No.: **WO2017/090936**

PCT Pub. Date: **Jun. 1, 2017**

(65) **Prior Publication Data**

US 2018/0351237 A1 Dec. 6, 2018

(30) **Foreign Application Priority Data**

Nov. 25, 2015 (KR) 10-2015-0165488

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 21/28 (2006.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/245**
(2013.01); **H01Q 1/44** (2013.01); **H01Q 13/10**
(2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/44; H01Q 13/10;
H01Q 13/18

See application file for complete search history.

(56) **References Cited**

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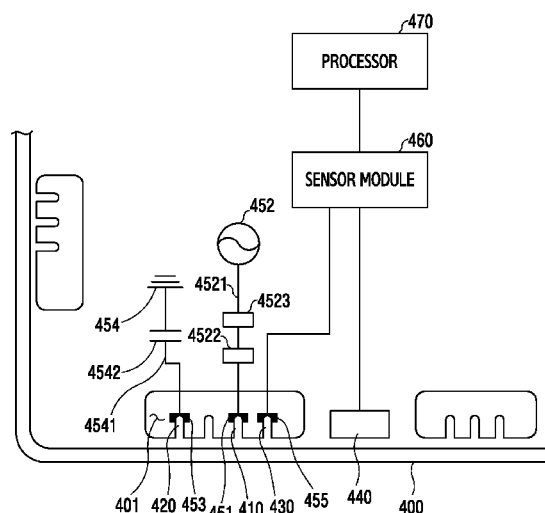
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

According to various embodiments, there may be provided an electronic device including a housing having a plurality of sides, a first conductive member constructing at least part of the plurality of sides, a second conductive member disposed inside the housing, a first sensor circuit which provides a first output indicating a first capacitance value related to the first conductive member and/or a change to the first capacitance value, a second sensor circuit which provides a second output indicating a second capacitance value related to the second conductive member and/or a change to the second capacitance value, and a control circuit which receives the first and second outputs from the first and second sensor circuits. In addition, other embodiments are also possible.

13 Claims, 11 Drawing Sheets





US010658733B2

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

(10) **Patent No.:** **US 10,658,733 B2**
(45) **Date of Patent:** ***May 19, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Youngjoon Lee**, Seoul (KR); **Taemin Kwon**, Seoul (KR); **Sangmo Kim**, Seoul (KR); **SooHo Bang**, Seoul (KR); **Geunsu Lee**, Seoul (KR); **Kyujin Choi**, Seoul (KR); **Baekbong Pyo**, Seoul (KR); **Changho Hong**, 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.: **16/383,278**

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

(65) **Prior Publication Data**

US 2019/0237855 A1 Aug. 1, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/865,380, filed on Jan. 9, 2018.

(30) **Foreign Application Priority Data**

May 2, 2017 (KR) 10-2017-0056485

(51) **Int. Cl.**

H04B 1/10 (2006.01)

H04B 1/38 (2015.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/245** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/371; H01Q 1/2291; H01Q 1/245; H01Q 1/38; H01Q 1/48; (Continued)

(56) **References Cited**

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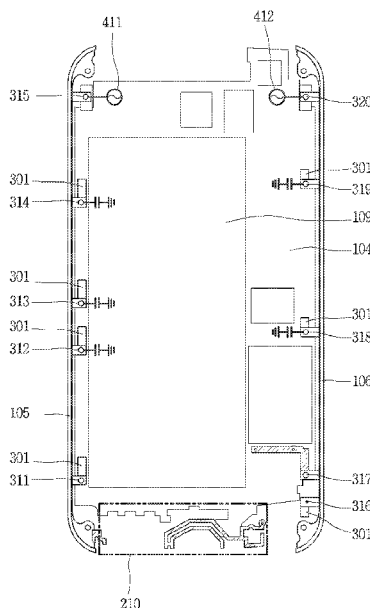
Primary Examiner — Pablo N Tran

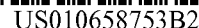
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile terminal can include a terminal body having a display unit disposed on one surface thereof; a frame supporting the display unit; a metal member spaced apart from the frame and exposed to an outside of the mobile terminal; a plurality of connecting members connecting the metal member to the frame and grounding the metal member; and an antenna unit disposed adjacent to the frame and including a radiator configured to radiate wireless signals in a first frequency band, in which the metal member is divided into specific areas by the plurality of connecting members, and one area located adjacent to the radiator, is configured to generate a parasitic resonance at a second frequency band different from the first frequency band, and the plurality of connecting members connected to the metal member are spaced apart from one another at different intervals.

11 Claims, 10 Drawing Sheets





(10) **Patent No.:** US 10,658,753 B2
(45) **Date of Patent:** May 19, 2020

(56) **References Cited**

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Primary Examiner — Robert Karacsony
(74) Attorney, Agent, or Firm — Li & Cai Intellectual
Property (USA) Office

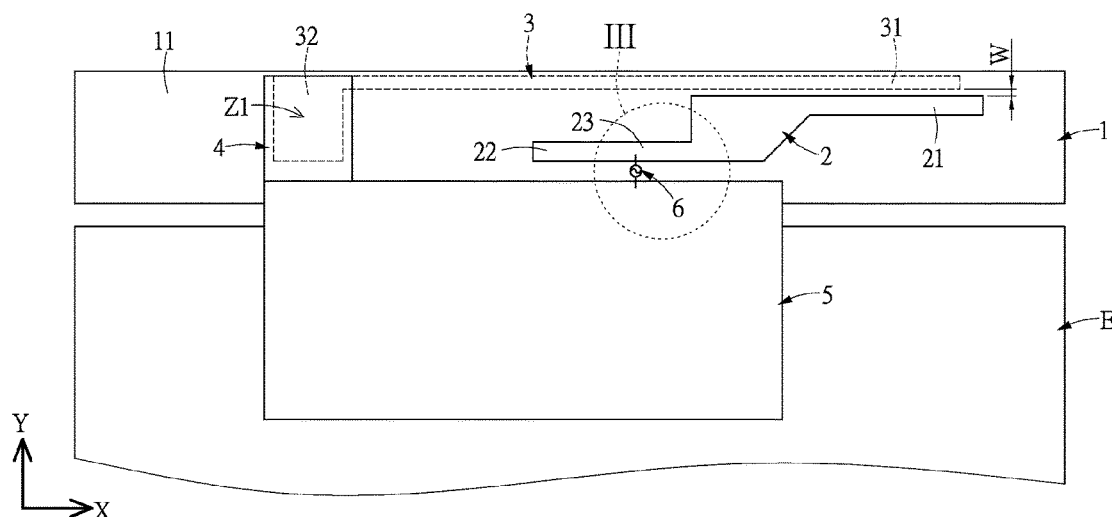
(57) **ABSTRACT**

The instant disclosure provides an antenna structure including a substrate, a first radiation element, a second radiation element, a coupling element, a grounding element, and a feeding element. The first radiation element is disposed on the substrate, including a first radiation portion, a second radiation portion, and a feeding portion connected between the first radiation portion and the second radiation portion. The second radiation element is disposed on the substrate, including a third radiation portion and a coupling portion connected with the third radiation portion. A gap is formed between the first radiation portion and the third radiation portion. The coupling element is disposed on the substrate. The coupling element is separated from the coupling portion and coupling to the coupling portion. The grounding element is coupled with the coupling element. The feeding element is coupled with the feeding portion and the grounding element.

20 Claims, 19 Drawing Sheets

U1

(58) **Field of Classification Search**
CPC H01Q 1/243;
 H01Q 1/38; H01Q 1/48; H01Q 1/2266;
 H01Q 1/245; H01Q 5/378;
 (Continued)





US010658754B2

(12) **United States Patent**
Ravishankar

(10) **Patent No.:** **US 10,658,754 B2**

(45) **Date of Patent:** **May 19, 2020**

(54) **ANTENNA ARRAY INCLUDING
SUPPRESSOR**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **QUALCOMM Incorporated**, San
Diego, CA (US)

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9,806,425 B2 10/2017 Apostolos et al.
2011/0260925 A1 10/2011 Chirila

(72) Inventor: **Arjun Ravishankar**, San Diego, CA
(US)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **QUALCOMM Incorporated**, San
Diego, 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 50 days.

Sengupta K., et al., "Designing Optimal Surface Currents for
Efficient on-Chip mm-Wave Radiators with Active Circuitry", IEEE
Transactions on Microwave Theory and Techniques, Jul. 2016, vol.
64, No. 7, pp. 1976-1988.

(21) Appl. No.: **16/146,432**

Primary Examiner — Graham P Smith

(22) Filed: **Sep. 28, 2018**

(74) *Attorney, Agent, or Firm* — Hunter Clark PLLC

(65) **Prior Publication Data**

US 2020/0106182 A1 Apr. 2, 2020

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 9/04 (2006.01)

H01Q 21/06 (2006.01)

H01Q 1/38 (2006.01)

H01Q 9/40 (2006.01)

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

CPC **H01Q 9/0407** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/40** (2013.01); **H01Q**
21/065 (2013.01)

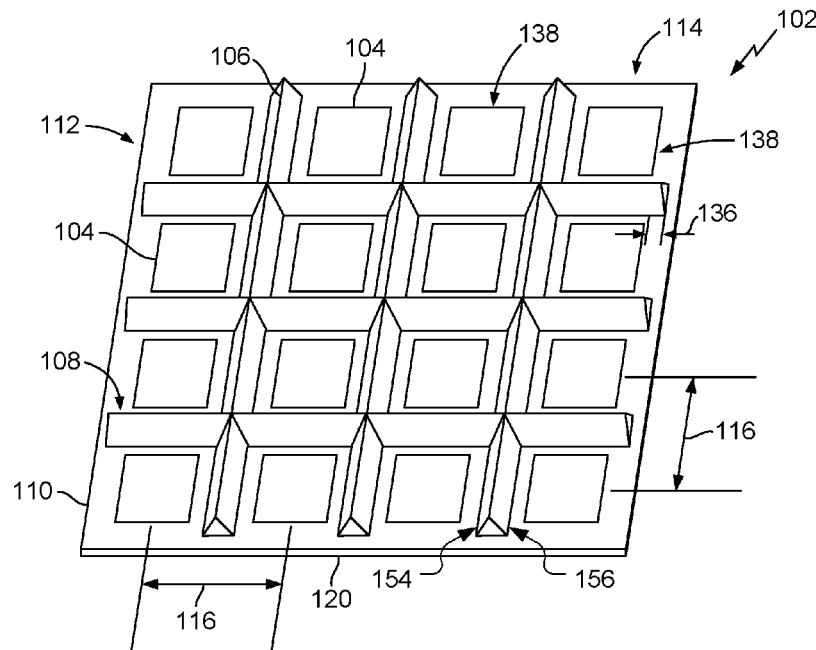
A millimeter-wave antenna system includes: an array of
radiators comprising a first radiator and a second radiator,
each of the first radiator and the second radiator being
configured to radiate millimeter-wave energy; and an insu-
lator disposed at least partially between the first radiator and
the second radiator and disposed and configured to intercept
first near-field energy radiated by the first radiator to inhibit
the first near-field energy from being received by the second
radiator, and to intercept second near-field energy radiated
by the second radiator to inhibit the second near-field energy
from being received by the first radiator, the insulator being
configured to reflect the first near-field energy away from the
first radiator and away from the second radiator and to reflect
the second near-field energy away from the first radiator and
away from the second radiator.

(58) **Field of Classification Search**

CPC H01Q 9/0407; H01Q 1/38; H01Q 9/40;
H01Q 21/065

See application file for complete search history.

24 Claims, 5 Drawing Sheets





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

(10) **Patent No.:** **US 10,658,762 B2**
(45) **Date of Patent:** **May 19, 2020**

(54) **MULTI-BAND MILLIMETER WAVE
ANTENNA ARRAYS**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

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(Continued)

(72) Inventors: **Simone Paulotto**, Redwood City, CA
(US); **Basim H. Noori**, San Jose, CA
(US); **Matthew A. Mow**, Los Altos, CA
(US)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Apple Inc.**, Cupertino, 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 161 days.

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(Continued)

(21) Appl. No.: **15/650,638**

Primary Examiner — Dieu Hien T Duong

(22) Filed: **Jul. 14, 2017**

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.;
Michael H. Lyons

(65) **Prior Publication Data**

US 2019/0020121 A1 Jan. 17, 2019

(57) **ABSTRACT**

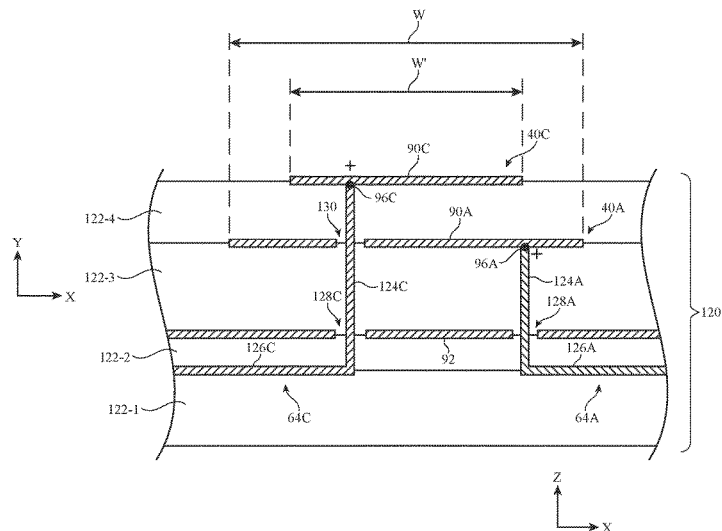
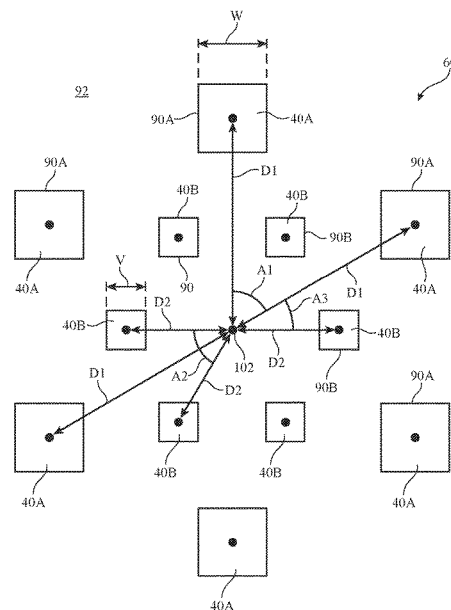
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 21/06 (2006.01)
(Continued)

An electronic device may be provided with wireless circuitry that includes a phased antenna array. The array may include first, second, and third rings of antennas on a dielectric substrate that cover respective first, second, and third communications bands greater than 10 GHz. The second ring of antennas may surround the first ring of antennas. The third ring of antennas may be formed over the second ring of antennas. Parasitic elements may be formed over the first ring of antennas to broaden the bandwidth of the first ring of antennas. Beam steering circuitry may be coupled to the rings of antennas. Control circuitry may control the beam steering circuitry to steer a beam of wireless signals in one or more of the first, second, and third communications bands. The array may exhibit relatively uniform antenna gain regardless of the direction in which the beam is steered.

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 5/392**
(2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 5/357; H01Q 5/364; H01Q 5/371;
H01Q 1/27; H01Q 1/3233; H01Q 9/0407;
(Continued)

19 Claims, 13 Drawing Sheets





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

(10) **Patent No.:** **US 10,665,925 B2**
(45) **Date of Patent:** **May 26, 2020**

(54) **ANTENNA APPARATUS AND METHOD WITH DIELECTRIC FOR PROVIDING CONTINUOUS INSULATION BETWEEN ANTENNA PORTIONS**

(71) Applicant: **Futurewei Technologies, Inc.**, Plano, TX (US)

(72) Inventors: **Hongwei Liu**, South Elgin, IL (US);
Wee Kian Toh, San Diego, CA (US);
Qinjiang Rao, San Diego, CA (US)

(73) Assignee: **Futurewei Technologies, Inc.**, Plano, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 506 days.

(21) Appl. No.: **15/411,898**

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

(65) **Prior Publication Data**

US 2017/0324150 A1 Nov. 9, 2017

Related U.S. Application Data

(60) Provisional application No. 62/332,634, filed on May 6, 2016.

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 5/357** (2015.01); **H01Q 13/10** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/52; H01Q 1/521; H01Q 21/28; H01Q 3/24

See application file for complete search history.

(56) **References Cited**

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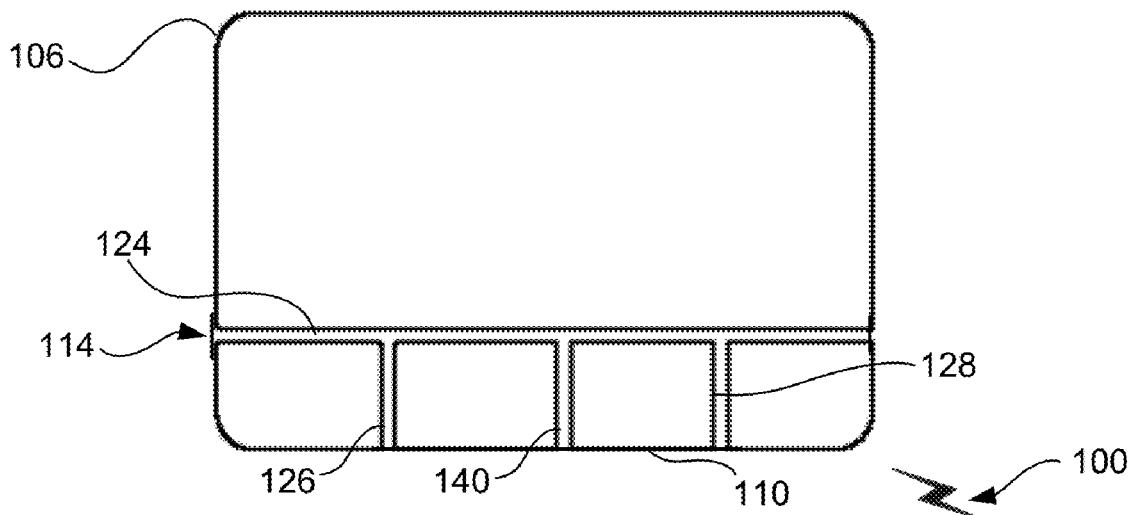
Primary Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

An apparatus is provided including a first antenna with a top face; a bottom face; and a periphery defined by an upper portion, a lower portion, and a pair of side portions. The first slot comprises a body, a first arm, and a second arm that divides the first antenna into a first portion, a second portion, a third portion, and a fourth portion. The first portion is larger than the third portion, and the third portion is larger than the second portion and the fourth portion. Further, the body of the first slot extends between the side portions of the periphery. Still yet, the first arm and the second arm extend between the body and one of the upper portion and the lower portion of the periphery. A dielectric is positioned in the first slot for providing continuous insulation between the first portion, the second portion, the third portion, and the fourth portion.

22 Claims, 10 Drawing Sheets





US010665926B2

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

(10) **Patent No.:** **US 10,665,926 B2**
(45) **Date of Patent:** **May 26, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Moonsoo Song**, Seoul (KR); **Namyong Kim**, Seoul (KR); **Byungeun Jeon**, Seoul (KR); **Kyoungsun Hwang**, Seoul (KR); **Changil Kim**, 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 126 days.

(21) Appl. No.: **15/762,974**

(22) PCT Filed: **Mar. 22, 2016**

(86) PCT No.: **PCT/KR2016/002883**

§ 371 (c)(1),

(2) Date: **Mar. 23, 2018**

(87) PCT Pub. No.: **WO2017/052015**

PCT Pub. Date: **Mar. 30, 2017**

(65) **Prior Publication Data**

US 2018/0287246 A1 Oct. 4, 2018

(30) **Foreign Application Priority Data**

Sep. 25, 2015 (KR) 10-2015-0137121

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 5/378 (2015.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/46** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/378** (2015.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/46; H01Q 1/24; H01Q 1/38; H01Q 1/48; H01Q 21/28; (Continued)

(56) **References Cited**

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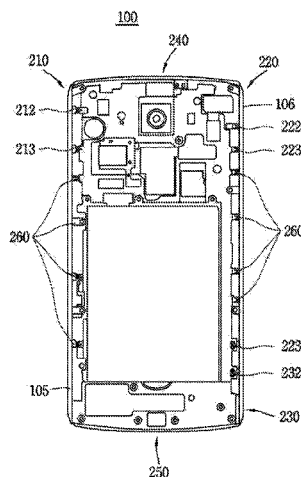
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

The present invention relates to a mobile terminal which comprises: a display unit; a frame for supporting the display unit; a printed circuit board formed on one side of the frame; a case formed on one side of the printed circuit board; first and second beam-shaped metal members arranged on both sides of the frame while being spaced apart from the frame and exposed to the outside; and a first antenna which is formed adjacent to the frame and implements a first frequency band, wherein the first antenna comprises: a first radiator including at least one end of the first metal member or the second metal member; a first power supply unit for supplying power to the first radiator; and a first ground unit for grounding the first radiator.

20 Claims, 26 Drawing Sheets





US010665927B2

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

(10) **Patent No.:** **US 10,665,927 B2**
(45) **Date of Patent:** **May 26, 2020**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA WHICH IS USING AN ELECTRICALLY CONDUCTIVE MATERIAL INCLUDED IN A HOUSING OF THE ELECTRONIC DEVICE**

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/422; H01Q 1/48;
H01Q 1/44; H01Q 9/0421; H01Q 9/0407;
H01Q 5/328; H04M 1/026
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Kyung Kyun Kang**, Suwon-si (KR); **Ji Ho Kim**, Anyang-si (KR); **Kyung Moon Seol**, Yongin-si (KR); **Gyu Bok Park**, Suwon-si (KR); **Hyun Jeong Lee**, Suwon-si (KR); **Kyi Hyun Jang**, Seoul (KR); **Hyo Seok Na**, Yongin-si (KR); **So Young Lee**, Gwacheon-si (KR); **Jae Bong Chun**, Suwon-si (KR)

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(73) Assignee: **Samsung Electronics Co., Ltd.**,
Suwon-si (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 79 days.

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Awat M Salih

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

(21) Appl. No.: **15/944,116**

(22) Filed: **Apr. 3, 2018**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2018/0294548 A1 Oct. 11, 2018

An electronic device is provided. The electronic device includes a housing comprising a first plate, a second plate, and a side member surrounding a space between the first and second plates, a wireless communication circuit that feeds a first feeding point in the second plate, a ground plane electrically coupled to a first ground point and a second ground point in the second plate, and a processor. The side member includes a first side, a second side, a third side, and a fourth side. The first feeding point is between the second side and the first ground point, the first feeding point being closer to the second side than the first ground point is to the second side, and the second ground point being closer to the second side than the first feeding point and the first ground point is to the second side, and is outside the region.

(30) **Foreign Application Priority Data**

Apr. 10, 2017 (KR) 10-2017-0046244

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

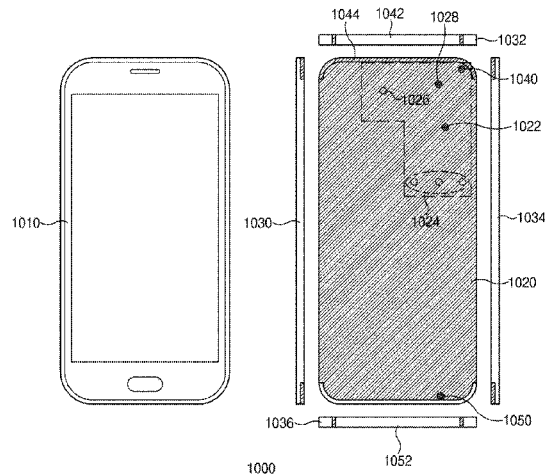
H01Q 9/04 (2006.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/422** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 5/328** (2015.01)

20 Claims, 16 Drawing Sheets



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

(10) **Patent No.:** **US 10,665,943 B2**
(45) **Date of Patent:** **May 26, 2020**

(54) **MOBILE DEVICES WITH INTEGRATED SLOT ANTENNAS**

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

(72) Inventors: **Ming-Ching Yen**, New Taipei (TW);
Kun-Sheng Chang, New Taipei (TW);
Ching-Chi Lin, New Taipei (TW)

(73) Assignee: **ACER INCORPORATED**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 380 days.

(21) Appl. No.: **15/784,245**

(22) Filed: **Oct. 16, 2017**

(65) **Prior Publication Data**

US 2018/0351254 A1 Dec. 6, 2018

(30) **Foreign Application Priority Data**

Jun. 5, 2017 (TW) 106118500 A

(51) **Int. Cl.**

H01Q 13/10 (2006.01)
H01Q 5/371 (2015.01)
H01Q 21/06 (2006.01)
H01Q 5/364 (2015.01)
H01Q 21/30 (2006.01)

(Continued)

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

CPC **H01Q 5/371** (2015.01); **H01Q 5/364** (2015.01); **H01Q 5/378** (2015.01); **H01Q 13/10** (2013.01); **H01Q 21/064** (2013.01); **H01Q 21/30** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 5/364; H01Q 5/378; H01Q 13/10; H01Q 21/064; H01Q 21/30; H01Q 1/2266; H01Q 1/243

See application file for complete search history.

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Primary Examiner — Dameon E Levi

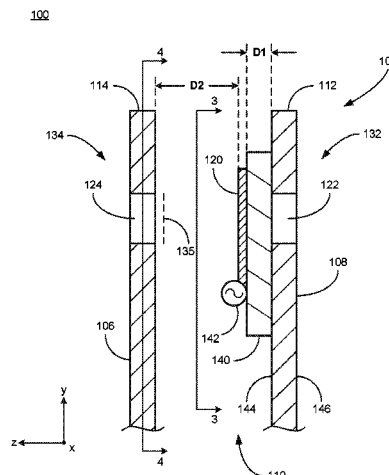
Assistant Examiner — David E Lotter

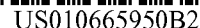
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

Mobile devices with integrated slot antennas are provided. A representative mobile device includes: an exterior housing having a front and a back and defining an interior; a display, mounted to the housing, configured to display images at the front of the housing; and an antenna structure positioned within the interior; the housing having a first portion and a second portion, each of which is formed of metal, the first portion being located at the back of the housing and defining a first slot such that the antenna structure and the first slot form a first slot antenna, the second portion being located at the front of the housing and defining a second slot such that the antenna structure and the second slot form a second slot antenna.

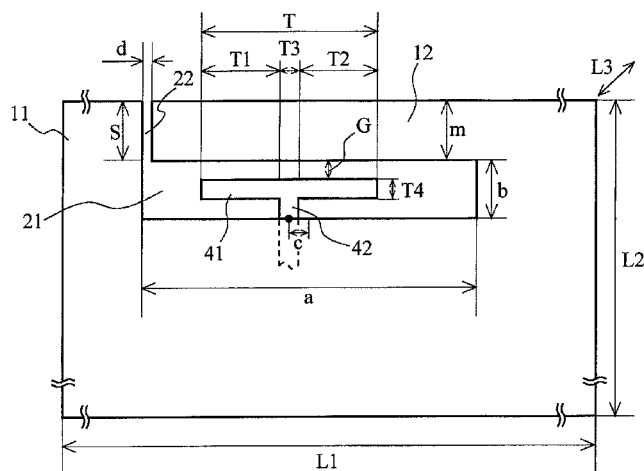
21 Claims, 10 Drawing Sheets





(45) **Date of Patent:** **May 26, 2020**

(Continued)





US010665951B2

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

(10) **Patent No.:** **US 10,665,951 B2**

(45) **Date of Patent:** **May 26, 2020**

(54) **ANTENNA FOR MOBILE PHONE AND
MOBILE PHONE HAVING THE SAME**

(71) Applicant: **BYD COMPANY LIMITED,**
Shenzhen (CN)

(72) Inventors: **Yijin Wang,** Shenzhen (CN); **Lianhua
Li,** Shenzhen (CN); **Wensong Wang,**
Shenzhen (CN); **Munyong Choi,**
Shenzhen (CN); **Faping Wang,**
Shenzhen (CN)

(73) Assignee: **BYD COMPANY LIMITED,**
Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 338 days.

(21) Appl. No.: **15/531,629**

(22) PCT Filed: **Nov. 20, 2015**

(86) PCT No.: **PCT/CN2015/095206**

§ 371 (c)(1),

(2) Date: **May 30, 2017**

(87) PCT Pub. No.: **WO2016/082719**

PCT Pub. Date: **Jun. 2, 2016**

(65) **Prior Publication Data**

US 2017/0331196 A1 Nov. 16, 2017

(30) **Foreign Application Priority Data**

Nov. 28, 2014 (CN) 2014 1 0709050

(51) **Int. Cl.**

H01Q 13/10 (2006.01)

H01Q 1/48 (2006.01)

(Continued)

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

CPC **H01Q 13/106** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48**
(2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/38; H01Q 9/0421;
H01Q 1/42; H01Q 1/12

(Continued)

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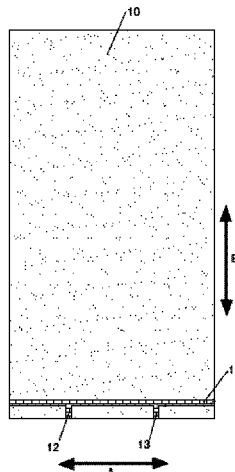
Primary Examiner — Daniel Munoz

(74) *Attorney, Agent, or Firm* — Anova Law Group,
PLLC

(57) **ABSTRACT**

An antenna for a mobile phone and a mobile phone having
the same are provided. The antenna for a mobile phone
includes: a metal mobile phone case provided with a first slot
and a second slot intersecting with the first slot; a circuit
board having a clearance zone and a parasitic branch stretch-
ing into the clearance zone, and disposed within the metal
mobile phone case; an exciting sheet disposed between the
circuit board and the metal mobile phone case, and across

(Continued)



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

(10) **Patent No.:** **US 10,673,124 B2**
(45) **Date of Patent:** **Jun. 2, 2020**

(54) **RADIO ANTENNA INTEGRATION IN A MOBILE COMPUTING DEVICE**

(71) Applicant: **INTEL CORPORATION**, Santa Clara, CA (US)

(72) Inventors: **Warren Lee**, San Jose, CA (US);
Kwan Ho Lee, Mountain View, CA (US); **Ulun Karacaoglu**, San Diego, CA (US); **Manish A. Hiranandani**, Santa Clara, CA (US); **Songnan Yang**, San Jose, CA (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 296 days.

(21) Appl. No.: **15/640,413**

(22) Filed: **Jun. 30, 2017**

(65) **Prior Publication Data**

US 2019/0006735 A1 Jan. 3, 2019

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **G06F 1/1601** (2013.01); **G06F 1/1656** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ... G06F 1/1601; G06F 1/1656; H01Q 1/2266;
H01Q 1/245; H01Q 9/42; H01Q 21/28;
H01Q 1/521; H01Q 5/371; H01Q 5/378
See application file for complete search history.

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Primary Examiner — Graham P Smith

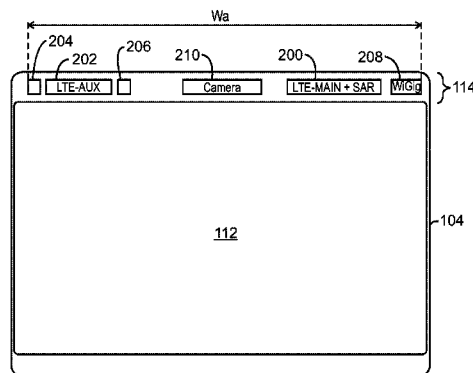
Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — International IP Law Group, P.L.L.C.

(57) **ABSTRACT**

Techniques for integrating a plurality of radio antennas in an electronic device are described. An example of an electronic device includes a display housing with a display screen and top bezel disposed above the display screen, and a plurality of components disposed in the top bezel. The plurality of components include a first cellular communication antenna disposed on a first side of the top bezel, and a second cellular communication antenna disposed on a second side of the top bezel opposite the first side. The plurality of components also include a first WiFi antenna disposed adjacent to the second cellular communication antenna, and a second WiFi antenna disposed adjacent to the second cellular communication antenna on an opposite side from the first WiFi antenna.

25 Claims, 13 Drawing Sheets





US010673126B2

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

(10) **Patent No.:** **US 10,673,126 B2**
(45) **Date of Patent:** **Jun. 2, 2020**

(54) **ANTENNA DEVICE FOR PORTABLE
TERMINAL**

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

(72) Inventors: **Soon-Ho Hwang**, Seoul (KR);
Sung-Koo Park, Suwon-si (KR);
Kyung-Jae Lee, Seoul (KR); **Joon-Ho
Byun**, Yongin-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 0 days.

(21) Appl. No.: **15/937,017**

(22) Filed: **Mar. 27, 2018**

(65) **Prior Publication Data**

US 2018/0212312 A1 Jul. 26, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/185,738, filed on
Jun. 17, 2016, now Pat. No. 10,211,515, which is a
(Continued)

(30) **Foreign Application Priority Data**

Jan. 30, 2013 (KR) 10-2013-0010477

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/242;
H01Q 1/243; H01Q 1/44; H01Q 1/48;
(Continued)

(56) **References Cited**

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Patent Application No. 10-2013-0010477.

Primary Examiner — Daniel Munoz

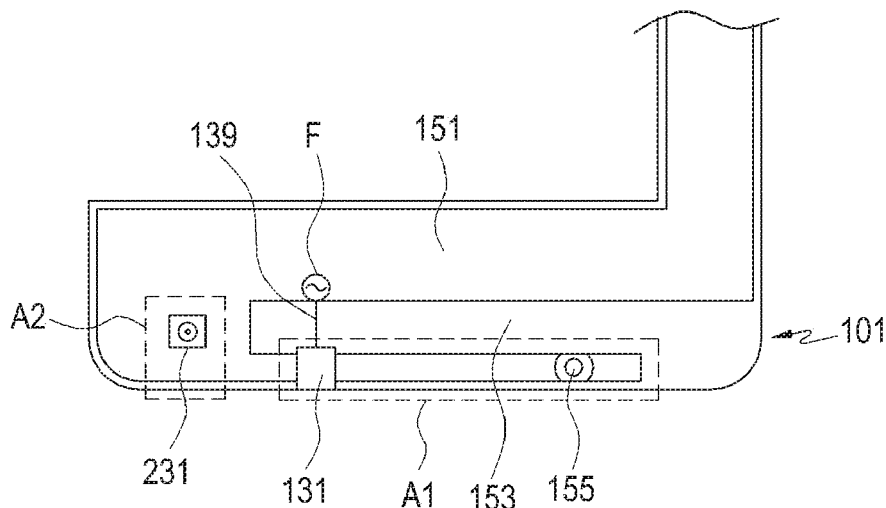
Assistant Examiner — Patrick R Holecek

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

(57) **ABSTRACT**

An antenna device of a portable terminal including conduc-
tive components is provided. The antenna device includes a
first radiator connected to a power feeding unit of the
portable terminal and a second radiator connected to each of
the power feeding unit and a ground part of the portable
terminal. At least one of the conductive components is
connected to at least one the first radiator and the second
radiator. The conductive components may be used as a
radiator of the antenna device such that the antenna device
may be easily installed within an inner space of a miniatur-
ized and lightened portable terminal and the inner space of
the portable terminal may be efficiently used.

20 Claims, 6 Drawing Sheets





US010678390B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 10,678,390 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

(54) **DISPLAY DEVICE**

2203/04105 (2013.01); G06F 2203/04107
(2013.01); H01L 27/323 (2013.01); H01Q 1/50
(2013.01)

(71) Applicant: **Samsung Display Co., Ltd.**, Yongin-si
(KR)

(58) **Field of Classification Search**

CPC H05K 9/0084; H04M 1/0266; H04M
2250/12; H01Q 9/30; H01Q 5/371; H01Q
5/30; H01Q 5/50; H01Q 5/44; H01Q
5/38; H01Q 5/243; H01L 41/1132; H01L
27/323; H01L 27/3276; G06F 3/044;
G06F 3/041; G06F 1/1626; G06F
2203/04105; G06F 2203/04107; G02F
1/13338

(72) Inventor: **Hee-Kwon Lee**, Asan-si (KR)

(73) Assignee: **Samsung Display Co., Ltd.**, Yongin-si
(KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 2 days.

See application file for complete search history.

(21) Appl. No.: **16/161,008**

(56)

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174/394

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

(65) **Prior Publication Data**

US 2019/0250734 A1 Aug. 15, 2019

(30) **Foreign Application Priority Data**

Feb. 14, 2018 (KR) 10-2018-0018514

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KR 10-2017-0056450 5/2017

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(51) **Int. Cl.**

G06F 3/044 (2006.01)
H01L 41/113 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/30 (2015.01)
G06F 3/041 (2006.01)
H01L 27/32 (2006.01)
H05K 9/00 (2006.01)

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Primary Examiner — Mihir K Rayan

(74) *Attorney, Agent, or Firm* — H.C. Park & Associates,
PLC

(57)

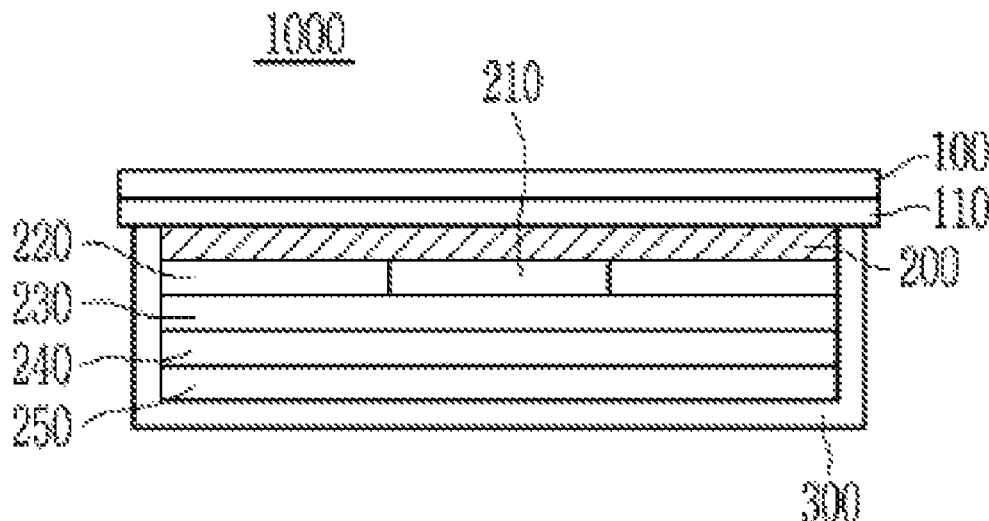
ABSTRACT

A display device includes: a display panel; a shielding layer positioned under the display panel, the shielding layer including a first antenna pattern; a pressure sensor electrode positioned under the shielding layer; an elastic layer positioned under the pressure sensor electrode, the elastic layer including a piezoelectric effect material; and a ground layer positioned under the elastic layer, wherein the pressure sensor electrode, the elastic layer, and the ground layer are configured to operate as a pressure sensor.

17 Claims, 9 Drawing Sheets

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

CPC **G06F 3/044** (2013.01); **G06F 1/1626**
(2013.01); **G06F 3/041** (2013.01); **H01L**
41/1132 (2013.01); **H01Q 1/243** (2013.01);
H01Q 1/38 (2013.01); **H01Q 5/30** (2015.01);
H04M 1/0266 (2013.01); **H05K 9/0084**
(2013.01); **G02F 1/13338** (2013.01); **G06F**





US010680314B2

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

(10) **Patent No.:** **US 10,680,314 B2**
(45) **Date of Patent:** ***Jun. 9, 2020**

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

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

(72) Inventors: **Sang Bong Sung**, Gyeongsangbuk-do
(KR); **In Jin Hwang**,
Gyeongsangbuk-do (KR); **Seung Hwan**
Kim, Gyeonggi-do (KR); **Jae Ho 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.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **16/359,268**

(22) Filed: **Mar. 20, 2019**

(65) **Prior Publication Data**

US 2019/0221920 A1 Jul. 18, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/337,961, filed on
Oct. 28, 2016, now Pat. No. 10,270,157, which is a
(Continued)

(30) **Foreign Application Priority Data**

Jun. 20, 2008 (KR) 10-2008-0058619

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/24**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48**
(2013.01);
(Continued)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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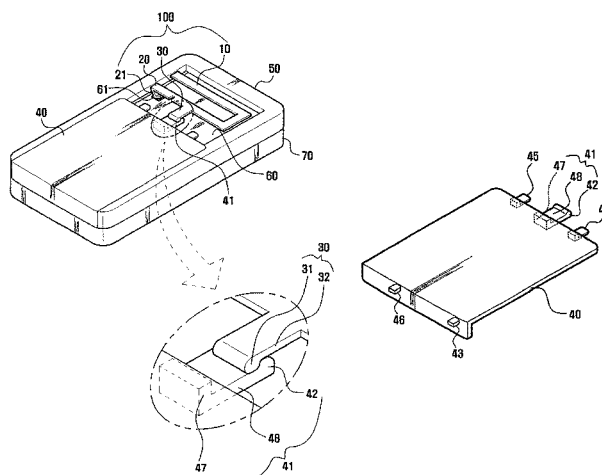
Primary Examiner — Trinh V Dinh

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

(57) **ABSTRACT**

An apparatus is provided that includes an outer front side having a display disposed therein, and an outer rear side including a conductive part and a non-conductive part. The apparatus also includes a battery disposed between the outer front side and the outer rear side, a circuit board, and an antenna. The antenna includes a radiation unit capable of receiving a signal, at least a portion of the radiation unit being disposed between the outer front side and the non-conductive part of the outer rear side. The antenna also includes a feeding unit which electrically connects the radiation unit to the circuit board. The antenna further includes a ground part which electrically connects the radiation unit to the conductive part of the outer rear side. The ground part is connected to the conductive part at a connection point spaced apart from a ground point connecting the circuit board with the conductive part.

15 Claims, 7 Drawing Sheets





US010680330B2

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

(10) **Patent No.:** **US 10,680,330 B2**

(45) **Date of Patent:** **Jun. 9, 2020**

(54) **ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventors: **Yuquan Su**, Beijing (CN); **Hai Zhao**, Beijing (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 60 days.

(21) Appl. No.: **16/019,204**

(22) Filed: **Jun. 26, 2018**

(65) **Prior Publication Data**

US 2018/0375209 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Jun. 27, 2017 (CN) 2017 1 0497977

(51) **Int. Cl.**

H01Q 5/30 (2015.01)

H01Q 7/00 (2006.01)

H01Q 5/328 (2015.01)

H01Q 1/44 (2006.01)

H01Q 5/335 (2015.01)

H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 5/30** (2015.01); **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/328** (2015.01); **H01Q 5/335** (2015.01); **H01Q 7/00** (2013.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/30; H01Q 5/335; H01Q 1/44; H01Q 5/328; H01Q 7/00; H01Q 9/0407; H01Q 1/48; H01Q 1/243; H01Q 1/38; H01Q 1/244

USPC 343/745

See application file for complete search history.

(56) **References Cited**

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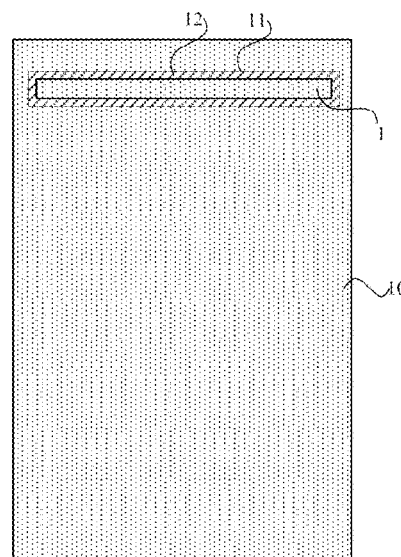
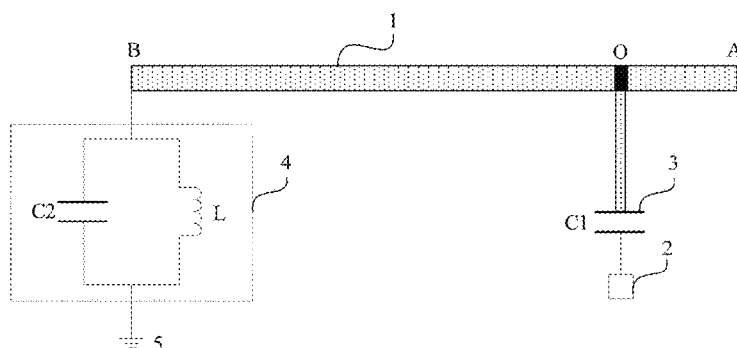
Primary Examiner — Khai M Nguyen

(74) *Attorney, Agent, or Firm* — Arch & Lake LLP

(57) **ABSTRACT**

The present disclosure provides an antenna and an electronic device. The antenna includes: a radiator, a feed terminal, a capacitive circuit, a resonant circuit, and a ground terminal. The feed terminal is electrically connected to a preset connection point on the radiator via the capacitive circuit. A first end of the resonant circuit is electrically connected to the radiator, and a second end of the resonant circuit is electrically connected to the ground terminal.

18 Claims, 8 Drawing Sheets



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

(10) **Patent No.:** **US 10,680,336 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

(54) **ANTENNA DEVICE**

(71) Applicant: **Molex, LLC**, Lisle, IL (US)

(72) Inventors: **Guang-Yong Zhong**, Shanghai (CN);
Qiang Liu, Shanghai (CN)

(73) Assignee: **Molex, LLC**, Lisle, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 139 days.

(21) Appl. No.: **15/456,738**

(22) Filed: **Mar. 13, 2017**

(65) **Prior Publication Data**

US 2017/0288311 A1 Oct. 5, 2017

(30) **Foreign Application Priority Data**

Mar. 31, 2016 (CN) 2016 1 0199979

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/30 (2015.01)
H01Q 9/04 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 1/38; H01Q 5/30; H01Q 5/307; H01Q 5/357; H01Q 5/364; H01Q 5/371; H01Q 5/50; H01Q 9/0421; H01Q 9/0442; H01Q 13/10

See application file for complete search history.

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Primary Examiner — Daniel Munoz

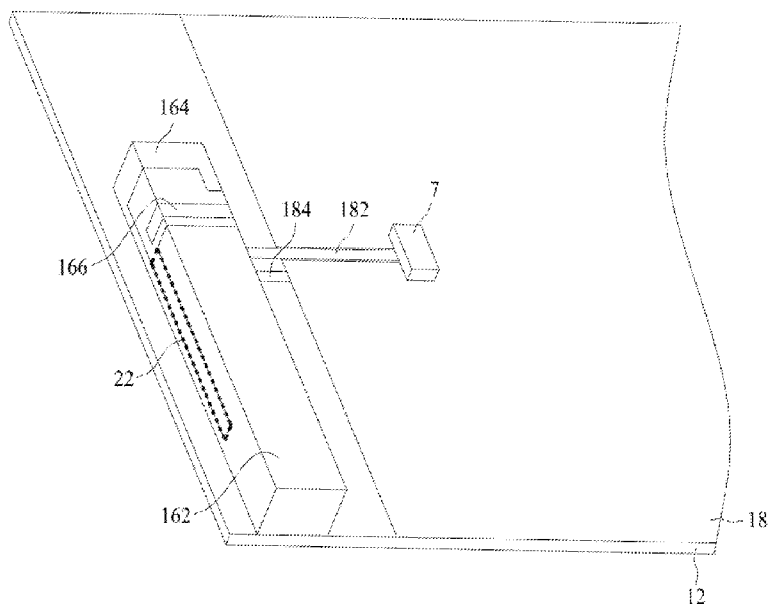
Assistant Examiner — Patrick R Holecek

(74) *Attorney, Agent, or Firm* — Molex, LLC

(57) **ABSTRACT**

An antenna device comprises a carrier, a first radiation portion, a second radiation portion and a coupling portion. The first radiation portion, the second radiation portion and the coupling portion are provided on the carrier. The second radiation portion electrically connects with the first radiation portion. The first radiation portion and the second radiation portion share a shared part, the shared part is directly connected to a reference grounding. The coupling portion capacitively couples an electrical signal to the first radiation portion and the second radiation portion. The first radiation portion and the second radiation portion convert the electrical signal into a radiation signal emitted by the antenna device.

23 Claims, 11 Drawing Sheets





US010680337B2

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

(10) **Patent No.:** **US 10,680,337 B2**

(45) **Date of Patent:** **Jun. 9, 2020**

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

USPC 455/562.1, 575.7, 168, 121, 129, 13.3,
455/82; 343/750, 843

See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Tae Gyu Kim**, Gyeonggi-do (KR); **Jin
Kyu Bang**, Gyeonggi-do (KR); **Hae
Yeon Kim**, Gyeonggi-do (KR); **Chong
O Yoon**, Gyeonggi-do (KR); **Dong
Hwan Kim**, Gyeonggi-do (KR)

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343/700 MS

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

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 380 days.

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(Continued)

(21) Appl. No.: **14/577,365**

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(22) Filed: **Dec. 19, 2014**

International Search Report dated Mar. 17, 2015 issued in counter-
part application No. PCT/KR2014/012787.

(65) **Prior Publication Data**

US 2015/0188230 A1 Jul. 2, 2015

(Continued)

(30) **Foreign Application Priority Data**

Dec. 26, 2013 (KR) 10-2013-0163926

Primary Examiner — Bobbak Safaipoor

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

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/50 (2015.01)

(Continued)

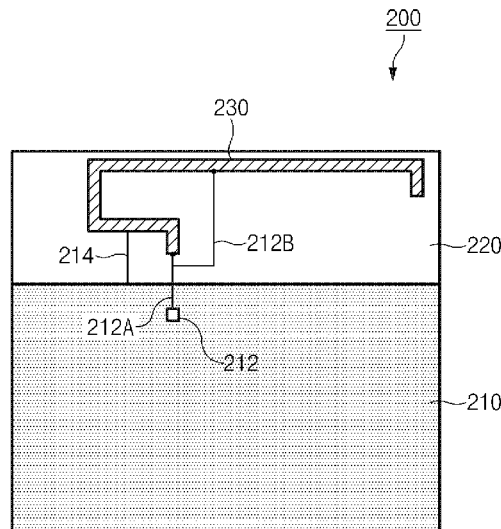
(57) **ABSTRACT**

An antenna device for an electronic device for wireless communication is provided. The antenna device includes an antenna area connected to a feeding line and a ground line, such that the antenna area is configured to transmit/receive a signal of a first frequency band; and a branching feeding pattern branching from the feeding line and connected to one side of the antenna area, such that the branching feeding pattern is configured to enable the antenna area to transmit/receive a signal of a second frequency band.

(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/00** (2013.01); **H01Q 5/364**
(2015.01); **H01Q 5/371** (2015.01); **H01Q 5/50**
(2015.01); **H01Q 9/0421** (2013.01); **H01Q**
13/10 (2013.01); **H04B 1/40** (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/0057; H03J 7/18; H04W 88/06;
H04W 48/16

20 Claims, 16 Drawing Sheets





US010680349B2

(12) **United States Patent**
Kwon

(10) **Patent No.:** **US 10,680,349 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

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

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

(72) Inventor: **Tae Wook Kwon**, 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 69 days.

(21) Appl. No.: **14/319,982**

(22) Filed: **Jun. 30, 2014**

(65) **Prior Publication Data**

US 2015/0214635 A1 Jul. 30, 2015

(30) **Foreign Application Priority Data**

Jan. 24, 2014 (KR) 10-2014-0008671

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 21/30 (2006.01)

H01Q 5/371 (2015.01)

H01Q 1/38 (2006.01)

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

CPC **H01Q 21/30** (2013.01); **H01Q 5/371**
(2015.01); **H01Q 1/243** (2013.01); **H01Q 1/38**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/30; H01Q 5/371; H01Q 9/045;
H01Q 21/0006; H01Q 1/243; H01Q 5/00;
H01Q 9/42; H01Q 9/46; H01Q
1/241-244; H01Q 5/48; H01Q 5/357
USPC 343/700 MS, 853, 702
See application file for complete search history.

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Primary Examiner — Hoang V Nguyen

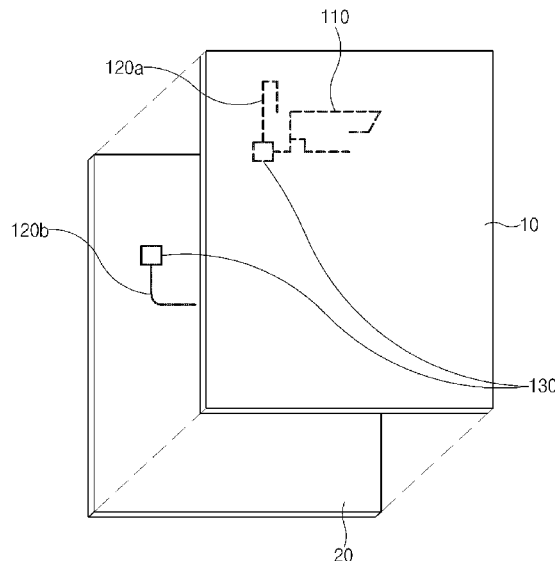
Assistant Examiner — Awat M Salih

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

(57) **ABSTRACT**

An antenna device is provided. The device includes a first
antenna unit having a plurality of resonant frequency bands,
a second antenna unit configured to shift a resonant fre-
quency of a part of the plurality of resonant frequency bands
of the first antenna unit, and a feeding unit configured to
connect the first and second antenna units and to supply
current thereto.

6 Claims, 7 Drawing Sheets





US010680661B2

(12) **United States Patent**
Harper

(10) **Patent No.:** **US 10,680,661 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

(54) **MONOPOLE AND SLOT ANTENNA ASSEMBLY**

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

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

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

(*) 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.: **15/838,150**

(22) Filed: **Dec. 11, 2017**

(65) **Prior Publication Data**

US 2019/0181891 A1 Jun. 13, 2019

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/00 (2006.01)
H04L 27/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/378 (2015.01)
H01Q 13/10 (2006.01)
H01Q 21/28 (2006.01)
H01Q 9/42 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H04B 1/0064** (2013.01); **H01Q 1/2258**
(2013.01); **H01Q 1/243** (2013.01); **H01Q**
5/307 (2015.01); **H01Q 5/378** (2015.01);
H01Q 7/00 (2013.01); **H01Q 9/42** (2013.01);
H01Q 13/10 (2013.01); **H01Q 13/16**
(2013.01); **H01Q 21/28** (2013.01); **H04L**
27/0002 (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/0064; H01Q 5/378; H01Q 1/2258;
H01Q 13/10

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Md K Talukder

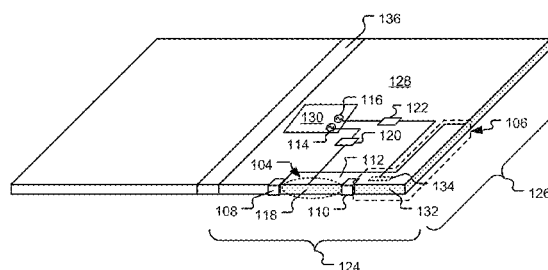
(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(57) **ABSTRACT**

The herein described technology provides a hybrid mono-
pole and slot antenna assembly including an electrically-
driven monopole antenna and a parasitic slot antenna. The
electrically-driven monopole antenna is fed by a feed line
coupled to a first metal portion of a device case exterior, and
the parasitic slot antenna is capacitively-driven by a radiat-
ing feed element embedded in a dielectric material that
resonates a second metal portion of the device case exterior.
The hybrid monopole and slot antenna assembly further
includes a dielectric gap insert electrically separating the
first metal portion of the device case exterior from the
second metal portion of the device case exterior, and a
modem that drives the electrically-driven monopole antenna
at a first frequency and the parasitic slot antenna at a second
different frequency.

22 Claims, 4 Drawing Sheets

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US010680668B2

(12) **United States Patent**
Hawaka

(10) **Patent No.:** **US 10,680,668 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

(54) **ELECTRONIC APPARATUS**

(56) **References Cited**

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

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(72) Inventor: **Shigekazu Hawaka**, Yokohama (JP)

2005/0285804 A1* 12/2005 Usui G06F 1/1616
343/702

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

2009/0073059 A1* 3/2009 Ikegaya H01Q 1/2266
343/702

(*) 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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343/721

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(21) Appl. No.: **16/107,279**

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JP 2014-211765 A 11/2014
WO 2015022859 A1 2/2015

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

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(65) **Prior Publication Data**

US 2019/0393911 A1 Dec. 26, 2019

Primary Examiner — Dameon E Levi

Assistant Examiner — Hasan Z Islam

(30) **Foreign Application Priority Data**

(74) *Attorney, Agent, or Firm* — Shimokaji IP

Jun. 22, 2018 (JP) 2018-119191

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 1/22 (2006.01)

H04B 1/10 (2006.01)

H04B 15/00 (2006.01)

An electronic apparatus includes: a chassis in which a display device is housed; a noise eliminating layer that is positioned between the chassis and the display device, and eliminates noise emitted from the display device; and an antenna for wireless communication that is housed in the chassis, in which the noise eliminating layer has a main body area and an auxiliary antenna area that extends from the main body area to the antenna and assists wireless communication of the antenna, and a portion of the auxiliary antenna area between one end on the side of the antenna and the other end on the side opposite to the one end is spaced apart from the main body area.

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

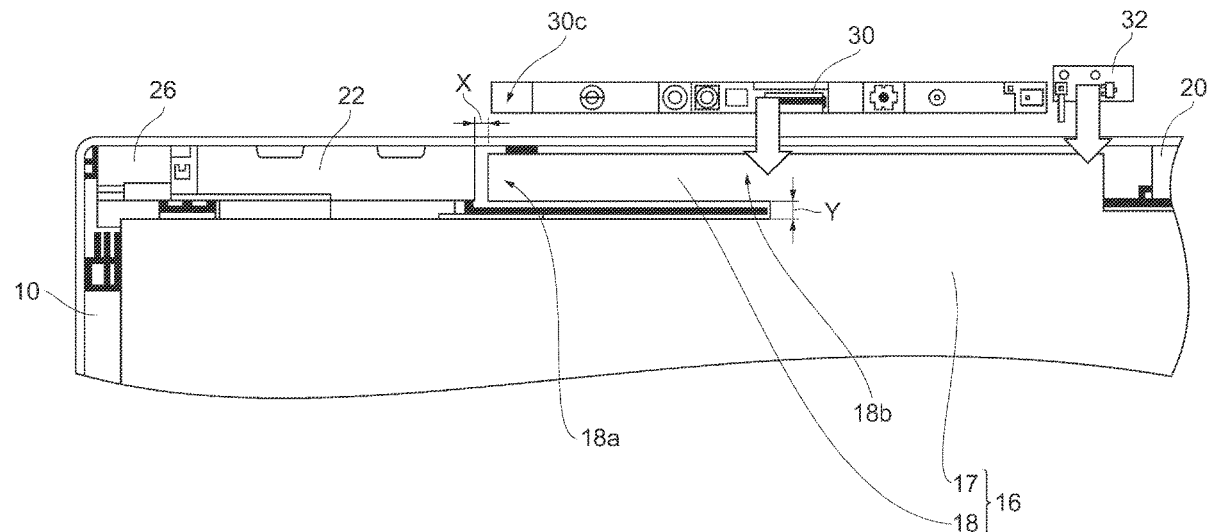
CPC **H04B 1/1009** (2013.01); **H01Q 1/2266**
(2013.01); **H04B 15/00** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 1/243; H04B 1/1009;
H04B 15/00

See application file for complete search history.

4 Claims, 5 Drawing Sheets





US010680671B2

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

(10) **Patent No.:** **US 10,680,671 B2**

(45) **Date of Patent:** ***Jun. 9, 2020**

(54) **SMALL ANTENNA APPARATUS AND METHOD FOR CONTROLLING THE SAME**

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

(72) Inventors: **Jungsik Park**, Bucheon-si (KR);
Sooung Chun, Suwon-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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/155,248**

(22) Filed: **Oct. 9, 2018**

(65) **Prior Publication Data**

US 2019/0044558 A1 Feb. 7, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/082,280, filed on Mar. 28, 2016, now Pat. No. 10,128,883, which is a (Continued)

(30) **Foreign Application Priority Data**

Jan. 13, 2012 (KR) 10-2012-0004448

(51) **Int. Cl.**
H04B 1/18 (2006.01)
H01Q 1/24 (2006.01)

(Continued)

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

CPC **H04B 1/18** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/145** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H04B 1/18; H04B 1/0458; H01Q 1/243; H01Q 1/48; H01Q 9/145; H01Q 9/16; H01Q 9/42; H04W 88/02

See application file for complete search history.

(56) **References Cited**

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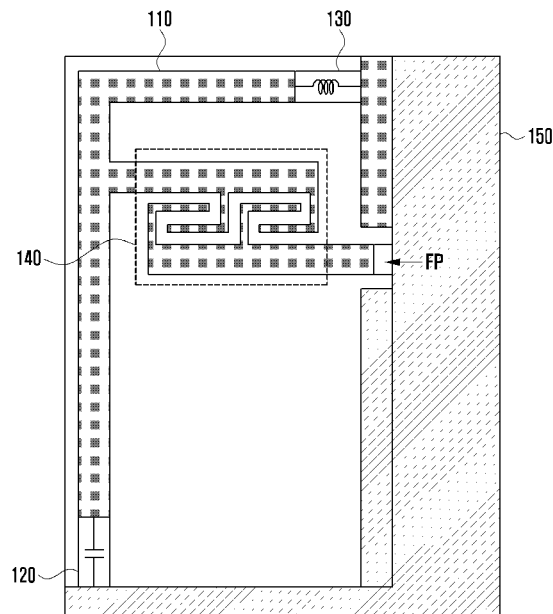
Primary Examiner — Nguyen T Vo

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

(57) **ABSTRACT**

An antenna apparatus for a mobile terminal is provided. The antenna apparatus includes an antenna pattern, a first electric circuit and a second electric circuit respectively connected between both ends of the antenna pattern and a system ground, and a third electric circuit disposed between the antenna pattern and a feeding line, wherein the first electric circuit and the second electric circuit extend electrical wavelengths of the antenna pattern and the third electric circuit increases input impedance matching.

17 Claims, 13 Drawing Sheets





US010684645B2

(12) **United States Patent**
Jang

(10) **Patent No.:** **US 10,684,645 B2**

(45) **Date of Patent:** **Jun. 16, 2020**

(54) **ELECTRONIC DEVICE FOR REDUCING NOISE**

H05K 1/189 (2013.01); **H05K 5/0069** (2013.01); **H04B 1/3838** (2013.01); **H05K 1/0243** (2013.01); **H05K 1/147** (2013.01)

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

(58) **Field of Classification Search**

CPC ... **G06F 1/1626**; **G06F 1/1698**; **H04B 1/0053**;
H04B 1/005; **H04B 1/006**; **H04M 1/0277**
See application file for complete search history.

(72) Inventor: **Seokmin Jang**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**,
Yeongtong-gu, Suwon-si, Gyeonggi-do (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 0 days.

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(21) Appl. No.: **16/254,685**

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(22) Filed: **Jan. 23, 2019**

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KR 10-1429412 B1 8/2014

(65) **Prior Publication Data**

US 2019/0235571 A1 Aug. 1, 2019

(Continued)

(30) **Foreign Application Priority Data**

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Jan. 30, 2018 (KR) 10-2018-0011124

International Search Report dated May 1, 2019.

(51) **Int. Cl.**

Primary Examiner — Tuan Pham

H04B 1/38 (2015.01)
G06F 1/16 (2006.01)
H05K 5/00 (2006.01)
H01Q 1/24 (2006.01)
H05K 1/18 (2006.01)
H04B 1/00 (2006.01)
H04M 1/02 (2006.01)
H05K 1/14 (2006.01)
H05K 1/02 (2006.01)
H04B 1/3827 (2015.01)

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

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

CPC **G06F 1/1626** (2013.01); **G06F 1/1698** (2013.01); **H01Q 1/243** (2013.01); **H04B 1/0053** (2013.01); **H04M 1/0277** (2013.01);

(57)

ABSTRACT

An electronic device includes an antenna, a display, a housing forming at least a portion of an exterior of the electronic device, a printed circuit board disposed within the housing, a connector disposed on the printed circuit board, a wire electrically connecting the connector and the display, a plurality of filters disposed on the printed circuit board, a switch selectively connecting the connector to one or more of the plurality of filters, and at least one processor electrically connected with the antenna, the display, and the switch.

19 Claims, 7 Drawing Sheets

