US010033089B2

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

(10) **Patent No.: US 10,033,089 B2**
(45) **Date of Patent: Jul. 24, 2018**

(54) **ANTENNA DEVICE AND ELECTRONIC APPARATUS INCLUDING ANTENNA DEVICE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventors: **Shinichi Nakano**, Nagaokakyo (JP); **Masahiro Ozawa**, Nagaokakyo (JP); **Nobuhito Tsubaki**, Nagaokakyo (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

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

(21) Appl. No.: **15/843,105**

(22) Filed: **Dec. 15, 2017**

(65) **Prior Publication Data**

US 2018/0123223 A1 May 3, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/257,982, filed on Sep. 7, 2016, now Pat. No. 9,876,275, which is a (Continued)

(30) **Foreign Application Priority Data**

Sep. 26, 2012 (JP) 2012-211709
Jul. 5, 2013 (JP) 2013-141969

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/50	(2006.01)
H04B 5/00	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/36	(2006.01)
H04M 1/02	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 13/10*** (2013.01); ***H04B 5/0031*** (2013.01); *H04M 1/0202* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/241; H01Q 1/243; H01Q 1/36; H01Q 1/50; H01Q 13/10
See application file for complete search history.

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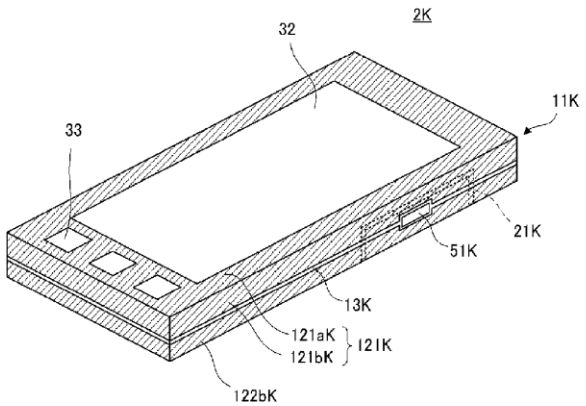
Primary Examiner — Hoang Nguyen
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna device includes a casing including a metal casing portion and a feed coil. The metal casing portion includes a main surface, a side surface connected to the main surfaces, and a notch portion located in the side surface. The feed coil is disposed inside the casing to be coupled with the metal casing portion by a magnetic field, and includes a winding central portion forming a coil opening portion. The feed coil is disposed near the notch portion, with the coil opening portion directed to a region including the notch portion.

4 Claims, 16 Drawing Sheets



US010033097B2

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

(10) **Patent No.: US 10,033,097 B2**
(45) **Date of Patent: Jul. 24, 2018**

(54) **INTEGRATED ANTENNA BEAM STEERING SYSTEM**

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

(72) Inventors: **Laurent Desclos**, San Diego, CA (US); **Abhishek Singh**, 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 423 days.

(21) Appl. No.: **14/930,651**

(22) Filed: **Nov. 2, 2015**

(65) **Prior Publication Data**

US 2016/0190685 A1 Jun. 30, 2016

Related U.S. Application Data

(63) 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, application No. 14/930,651, which is a continuation-in-part of application No. 13/609,138, filed on Sep. 10, 2012, now Pat. No. 9,859,617, said application No. 13/726,477 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.

(Continued)

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 3/22	(2006.01)
H04W 16/28	(2009.01)
H01Q 23/00	(2006.01)
H01Q 3/24	(2006.01)
H01Q 3/44	(2006.01)

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

CPC ***H01Q 3/22*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 3/247*** (2013.01); ***H01Q 3/44*** (2013.01); ***H01Q 23/00*** (2013.01); ***H04W 16/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 23/00; H01Q 3/22; H01Q 3/44; H04W 16/28

See application file for complete search history.

(56) **References Cited**

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(Continued)

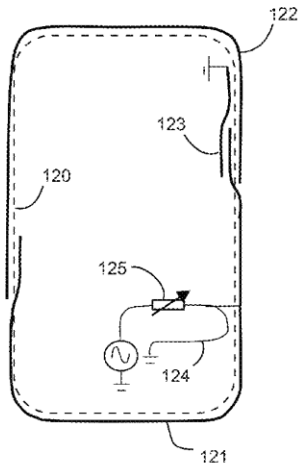
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

The disclosure concerns a beam steering antenna system that can be integrated into a portion of a mobile device, such as a ring conductor that encompasses the device or traverses a portion of the periphery of the mobile device. The single port antenna is capable of generating multiple radiation modes which possess different radiation pattern characteristics. An offset parasitic is implemented to couple to the main radiating element and alter the current distribution to affect a change in radiation mode. The coupling typically occurs at a coupling region designed into the conductive ring used as the antenna in a wireless device.

26 Claims, 20 Drawing Sheets



US010033109B1

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

(10) **Patent No.: US 10,033,109 B1**
(45) **Date of Patent: Jul. 24, 2018**

(54) **SWITCHING A SLOT ANTENNA**

(71) Applicant: **GOOGLE INC.**, Mountain View, CA (US)

(72) Inventors: **Ajay Chandra Venkata Gummalla**, Sunnyvale, CA (US); **Huan Liao**, Mountain View, CA (US)

(73) Assignee: **GOOGLE LLC**, Mountain View, CA (US)

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

(21) Appl. No.: **15/297,965**

(22) Filed: **Oct. 19, 2016**

Related U.S. Application Data

(62) Division of application No. 14/254,546, filed on Apr. 16, 2014, now Pat. No. 9,502,775.

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 3/24 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 13/103*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 3/247*** (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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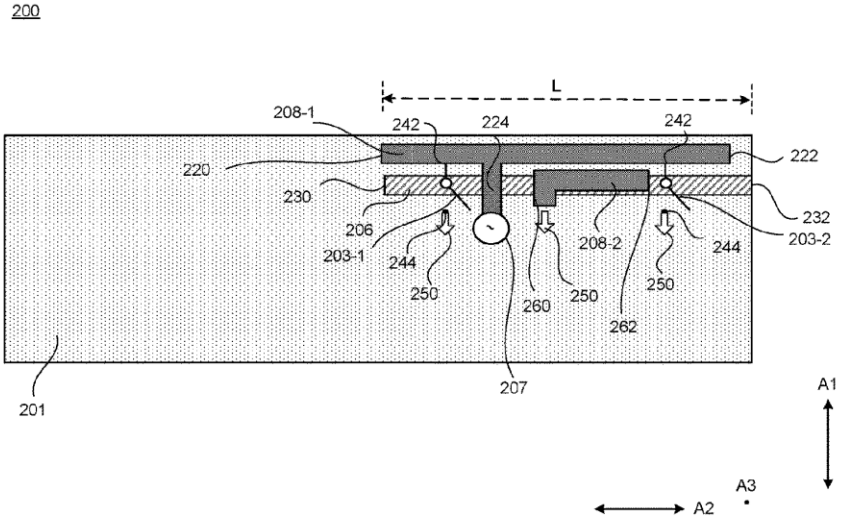
Primary Examiner — David Bilodeau
(74) *Attorney, Agent, or Firm* — Brake Hughes Bellermann LLP

(57) **ABSTRACT**

A computing device may include a conductive member, a slot antenna including a slot defined by the conductive member, and an antenna pattern portion disposed proximate to the slot. The computing device includes an antenna switch configured to switch the antenna pattern portion. The antenna switch has a first terminal coupled to the antenna pattern portion and a second terminal coupled to a ground contact. The antenna switch is switchable between a first configuration in which the first and second terminals are electrically connected and a second configuration in which the first and second terminals are not electrically connected. The computing device includes a switching controller configured to switch the antenna switch between the first and second configurations.

17 Claims, 5 Drawing Sheets



US010033113B2

(12) **United States Patent**
Yosui

(10) **Patent No.: US 10,033,113 B2**
(45) **Date of Patent: *Jul. 24, 2018**

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

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventor: **Kuniaki Yosui**, Nagaokakyo (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/807,697**

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

(65) **Prior Publication Data**

US 2018/0069325 A1 Mar. 8, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/592,984, filed on Jan. 9, 2015, now Pat. No. 9,847,585, which is a (Continued)

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 21/28	(2006.01)
H01Q 5/371	(2015.01)
H01Q 5/335	(2015.01)
H01Q 5/328	(2015.01)
H01Q 9/42	(2006.01)

(Continued)

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

CPC ***H01Q 21/28*** (2013.01); ***H01Q 1/2208*** (2013.01); ***H01Q 1/2216*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/371*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2216; H01Q 9/42; H01Q 5/335; H01Q 5/371; H01Q 21/28; H01Q 5/328; H01Q 1/2208; H01Q 1/243; H01Q 7/00

See application file for complete search history.

(56) **References Cited**

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2014/0139380	A1 *	5/2014	Ouyang	H01Q 7/00 343/702

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Yosui, "Antenna device and electronic apparatus", U.S. Appl. No. 14/592,984, filed Jan. 9, 2015.

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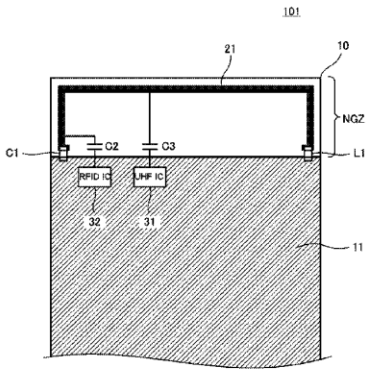
Primary Examiner — Graham Smith
Assistant Examiner — Jae Kim
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A square bracket-shaped radiation element is in a non-ground region of a board. A first reactance element that equivalently enters a short-circuited state in a second frequency band is connected between a second end of the radiation element and a ground conductor. A second reactance element that equivalently enters a short-circuited state in a first frequency band s connected between a first end of the radiation element and the ground conductor. In the UHF band, the radiation element and the ground conductor function as an inverted F antenna that contributes to field emission. In the HF band, a loop including the radiation (Continued)



US010038234B2

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

(10) **Patent No.: US 10,038,234 B2**
(45) **Date of Patent: Jul. 31, 2018**

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

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

(72) Inventors: **Yu-Kai Tseng**, New Taipei (TW); **Kuo-Lun Huang**, New Taipei (TW); **Ming-Yu Chou**, New Taipei (TW)

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

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

(21) Appl. No.: **15/653,679**

(22) Filed: **Jul. 19, 2017**

(65) **Prior Publication Data**

US 2018/0026353 A1 Jan. 25, 2018

Related U.S. Application Data

(60) Provisional application No. 62/382,762, filed on Sep. 1, 2016, provisional application No. 62/364,881, filed on Jul. 21, 2016.

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482507

(51) **Int. Cl.**

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

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

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

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/243; H01Q 5/10; H01Q 5/371

See application file for complete search history.

(56) **References Cited**

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9,105,968	B2 *	8/2015	Hong	H01Q 1/243
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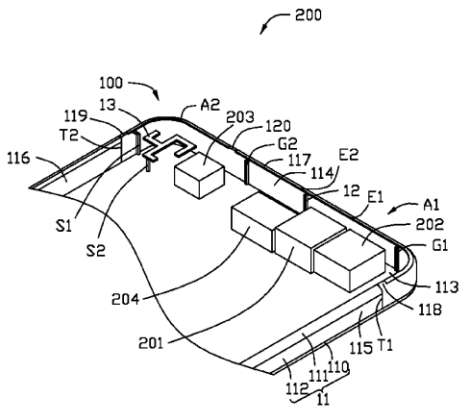
(Continued)

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

(57) **ABSTRACT**

An antenna structure includes a housing, a first feed portion, a first ground portion, and a second ground portion. The housing defines a slot, a first groove, and a gap. The housing is divided into a first portion and a second portion by the slot, the first groove, and the gap. The first portion is further divided into a first radiating portion and a second radiating portion by the first feed portion. A first portion of the housing extending from the first feed portion to the first gap forms the first radiating portion. A second portion of the housing extending from the first feed portion to the groove forms the second radiating portion. The second radiating portion is shorter than the second portion. The second portion is shorter than the first radiating portion. The first portion activates a first operation mode and the second portion activates a second operation mode.

42 Claims, 27 Drawing Sheets



US010038245B2

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

(10) **Patent No.: US 10,038,245 B2**
(45) **Date of Patent: Jul. 31, 2018**

(54) **ANTENNA MODULE AND MOBILE TERMINAL HAVING THE SAME**

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

(72) Inventors: **Jaehyun Choi**, Seoul (KR); **Hyengcheul 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 325 days.

(21) Appl. No.: **14/868,138**

(22) Filed: **Sep. 28, 2015**

(65) **Prior Publication Data**

US 2016/0197403 A1 Jul. 7, 2016

(30) **Foreign Application Priority Data**

Jan. 5, 2015 (KR) 10-2015-0000772

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/42*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 7/00; H01Q 5/364; H01Q 9/42; H01Q 9/045
See application file for complete search history.

(56) **References Cited**

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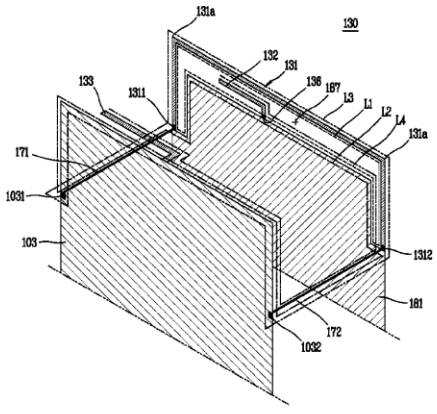
Primary Examiner — Dameon E Levi
Assistant Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

Disclosed are an antenna module and a mobile terminal having the same. The antenna module includes a ground plate; a metal plate spaced apart from the ground plate by a distance such that a surface of the metal plate faces a surface of the ground plate; a first conductive member spaced apart from an edge of the ground plate by a distance, the first conductive member encompassing the edge; a feeding part formed on the ground plate; a second conductive member formed on the ground plate and coupled to the feeding part, wherein the second conductive member indirectly feeds the first conductive member and the metal plate; and a first connection member and a second connection member that couple the ground plate to the metal plate.

17 Claims, 8 Drawing Sheets



US010044096B2

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

(10) **Patent No.: US 10,044,096 B2**
(45) **Date of Patent: Aug. 7, 2018**

(54) **MOBILE DEVICE AND MANUFACTURING METHOD THEREOF**

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

(72) Inventors: **Tiao-Hsing Tsai**, Taoyuan (TW); **Chien-Pin Chiu**, Taoyuan (TW); **Hsiao-Wei Wu**, Taoyuan (TW); **Yi-Hsiang Kung**, Taoyuan (TW); **Li-Yuan Fang**, 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.

(21) Appl. No.: **15/292,272**

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

(65) **Prior Publication Data**

US 2017/0033443 A1 Feb. 2, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/666,450, filed on Mar. 24, 2015, now Pat. No. 9,502,773.

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 13/10	(2006.01)
H01Q 9/04	(2006.01)
H01Q 9/42	(2006.01)
H01Q 21/28	(2006.01)
H01Q 5/40	(2015.01)
H01Q 5/20	(2015.01)
H01Q 5/30	(2015.01)

(Continued)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/20*** (2015.01); ***H01Q 5/30*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 5/40*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 9/0442*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 13/106*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 5/20; H01Q 5/30; H01Q 5/35; H01Q 5/40; H01Q 5/50; H01Q 9/0442; H01Q 13/10; H01Q 13/106; H01Q 21/28

See application file for complete search history.

(56) **References Cited**

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(Continued)

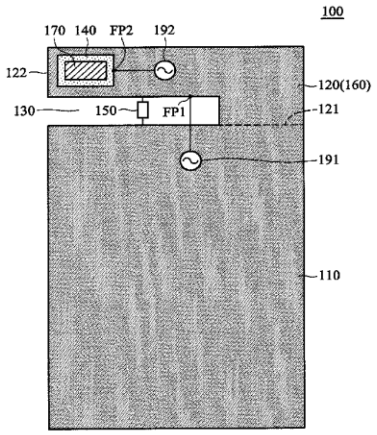
Primary Examiner — Hoang Nguyen

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

(57) **ABSTRACT**

A mobile device includes a metal housing and an antenna structure. A ground plane and a ground branch form at least a portion of the metal housing. The ground branch is coupled to the ground plane. A slot is formed between the ground branch and the ground plane. A circuit element is coupled to the ground branch and the ground plane. The antenna structure is formed by the ground branch. The antenna structure is excited by a signal source.

30 Claims, 8 Drawing Sheets



US010044097B2

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

(10) **Patent No.: US 10,044,097 B2**
(45) **Date of Patent: Aug. 7, 2018**

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

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

(72) Inventors: **Men-Hsueh Tsai**, New Taipei (TW); **Cho-Kang Hsu**, New Taipei (TW); **Kai-Ting Hung**, New Taipei (TW)

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

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

(21) Appl. No.: **15/651,041**

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

(65) **Prior Publication Data**

US 2018/0026351 A1 Jan. 25, 2018

Related U.S. Application Data

(60) Provisional application No. 62/364,876, filed on Jul. 21, 2016.

(30) **Foreign Application Priority Data**

Jun. 14, 2017 (TW) ..... 106119896 A

(51) **Int. Cl.**

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

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

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

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/243; H01Q 5/10; H01Q 5/371

See application file for complete search history.

(56) **References Cited**

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8,954,122	B2 *	2/2015	Wilmhoff	H01Q 1/245 342/375
9,035,840	B1 *	5/2015	Lee	H01Q 1/243 343/702
9,105,968	B2 *	8/2015	Hong	H01Q 1/243
9,124,679	B2 *	9/2015	Ash, Jr.	H01Q 1/243
9,196,952	B2 *	11/2015	Tran	H01Q 1/243

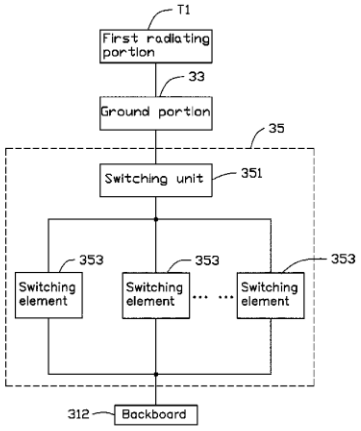
(Continued)

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

(57) **ABSTRACT**

An antenna structure includes a metal housing, a feed portion, and a ground portion. The metal housing includes a front frame, a backboard, and a side frame. The side frame defines a slot and the front frame defines a first gap and a second gap. The metal housing is divided into at least a first radiating portion and a second radiating portion by the slot and the first and second gaps. The feed portion is electrically connected to the first radiating portion. The ground portion is electrically connected to the first radiating portion. The second radiating portion includes a first radiating section, a second radiating section, and a connecting section perpendicularly connected to the first radiating section, the second radiating section, and the backboard. The first radiating section and the second radiating section are both parallel to the first radiating portion.

23 Claims, 21 Drawing Sheets



US010044110B2

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

(10) **Patent No.: US 10,044,110 B2**
(45) **Date of Patent: Aug. 7, 2018**

(54) **ANTENNAS WITH SHARED GROUNDING STRUCTURE**

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

(72) Inventors: **Yuandan Dong**, San Diego, CA (US); **Guining Shi**, San Diego, CA (US); **Allen Minh-Triet Tran**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, 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 169 days.

(21) Appl. No.: **13/932,105**

(22) Filed: **Jul. 1, 2013**

(65) **Prior Publication Data**

US 2015/0002359 A1 Jan. 1, 2015

(51) **Int. Cl.**

H01Q 21/00	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/52	(2006.01)
H01Q 21/28	(2006.01)

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

CPC ***H01Q 21/0006*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 21/28*** (2013.01); *Y10T 29/49016* (2015.01)

(58) **Field of Classification Search**

CPC H01Q 21/0006
USPC 343/853
See application file for complete search history.

(56) **References Cited**

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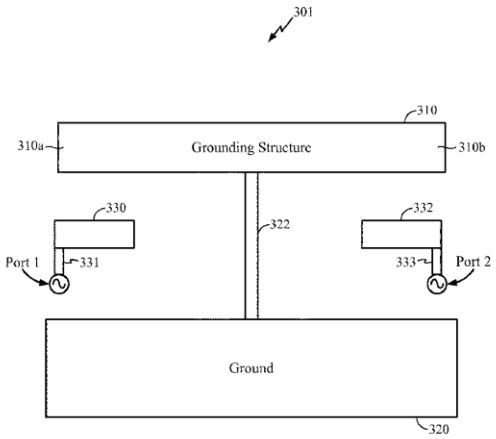
Primary Examiner — Dameon E Levi
Assistant Examiner — Walter Davis
(74) *Attorney, Agent, or Firm* — Qualcomm Incorporated—Toler

(57) **ABSTRACT**

Techniques for providing multiple antennas in a wireless device using a compact configuration to achieve good isolation and broad bandwidth. In an aspect, first and second monopole elements that may be separately driven are provided on opposite sides of a grounding strip conductively coupled to a common grounding structure. By capacitively coupling the first and second monopole elements to the common grounding structure, the effective resonator size of each monopole antenna is increased, thus achieving better performance for the antenna structure. Illustrative patterns for the common grounding structure and other antenna elements are further disclosed.

20 Claims, 12 Drawing Sheets



US010050331B2

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

(10) **Patent No.: US 10,050,331 B2**
(45) **Date of Patent: Aug. 14, 2018**

(54) **ANTENNA STRUCTURE FOR MOBILE PHONE**

(71) Applicant: **Luxshare Precision Industry Co., Ltd.**, Shenzhen, Guangdong Province (CN)

(72) Inventors: **Chun-Long Zhou**, Kunshan (CN); **Fang-Fang Zhang**, Kunshan (CN)

(73) Assignee: **LUXSHARE PRECISION INDUSTRY CO., LTD.**, Shenzhen, Guangdong Province (CN)

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

(21) Appl. No.: **15/201,627**

(22) Filed: **Jul. 5, 2016**

(65) **Prior Publication Data**

US 2017/0012348 A1 Jan. 12, 2017

(30) **Foreign Application Priority Data**

Jul. 6, 2015 (CN) 2015 1 0388105

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/0421
See application file for complete search history.

(56) **References Cited**

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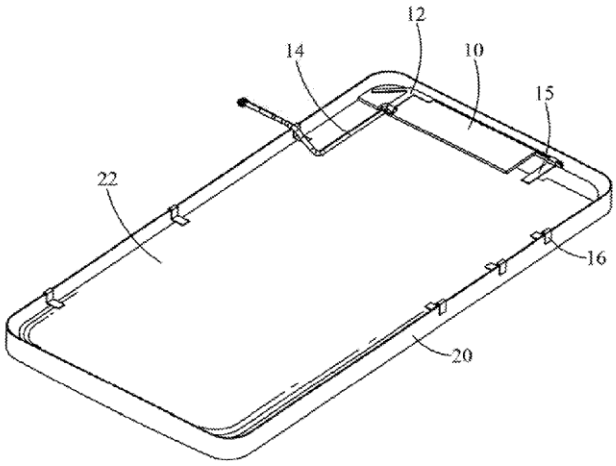
Primary Examiner — Daniel J Munoz
(74) *Attorney, Agent, or Firm* — Cheng-Ju Chiang

(57) **ABSTRACT**

An antenna structure for mobile phone includes a branch antenna acting with a metal shell of the mobile phone, an insulating body located in the metal shell, a main antenna disposed on the insulating body to be coupled to the metal shell and having a feed portion, and a feed-line including a conductive portion welded with the feed portion. The metal shell has a back cover and a ring-shaped metal frame integrated with the back cover. A circuit board is located in the metal shell. The main antenna has a ground portion connected to a ground circuit of the circuit board, and the feed-line includes a braid portion connected with the ground circuit. The metal frame is formed into a continuous metallic loop configuration to ensure integrality and beauty of the metal shell for the mobile phone.

7 Claims, 3 Drawing Sheets



US010050332B2

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

(10) **Patent No.: US 10,050,332 B2**
(45) **Date of Patent: Aug. 14, 2018**

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

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

(72) Inventors: **Min-Seok Kim**, Seoul (KR); **Hyuncheol Jin**, Gyeonggi-do (KR); **Sung-Won Park**, Gyeonggi-do (KR); **Sungchul Park**, Seoul (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

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

(21) Appl. No.: **15/237,608**

(22) Filed: **Aug. 15, 2016**

(65) **Prior Publication Data**

US 2017/0047641 A1 Feb. 16, 2017

(30) **Foreign Application Priority Data**

Aug. 13, 2015 (KR) 10-2015-0114252

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/50	(2006.01)
H01Q 13/10	(2006.01)
H01Q 5/364	(2015.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 13/103*** (2013.01); *H01Q 1/245* (2013.01); *H01Q 9/0421* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/50; H01Q 13/103; H01Q 1/245; H01Q 1/48; H01Q 1/521; H01Q 5/364; H01Q 9/0421

See application file for complete search history.

(56) **References Cited**

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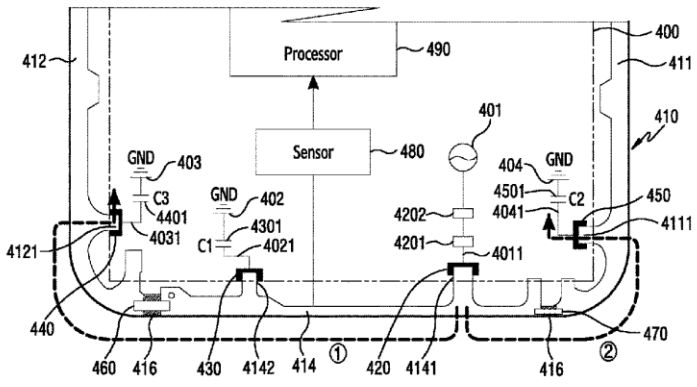
Primary Examiner — Tho G Phan

(57) **ABSTRACT**

According to various embodiments, there is provided an electronic device including: a housing; a first conductive member that forms a portion of the housing and is at least partially disposed within the housing; a second conductive member that forms another portion of the housing and includes a portion disposed adjacent to a portion of the first conductive member; a non-conductive member disposed between the portion of the first conductive member and a portion of the second conductive member; a capacitive coupling structure coupled between the first conductive member and the second conductive member; a communication circuit electrically coupled to the first conductive member; and a sensor electrically coupled to the first conductive member. Various other embodiments may be made.

19 Claims, 11 Drawing Sheets



US010050334B2

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

(10) **Patent No.: US 10,050,334 B2**
(45) **Date of Patent: Aug. 14, 2018**

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

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

(72) Inventors: **Linchuan Wang**, Beijing (CN); **Zonglin Xue**, Beijing (CN); **Xiaofeng Xiong**, 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 31 days.

(21) Appl. No.: **15/347,297**

(22) Filed: **Nov. 9, 2016**

(65) **Prior Publication Data**

US 2017/0288297 A1 Oct. 5, 2017

(30) **Foreign Application Priority Data**

Mar. 29, 2016 (CN) 2016 1 0188058

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/42; H01Q 1/521; H01Q 1/48; H01Q 1/2291; H01Q 5/385; H01Q 7/00
See application file for complete search history.

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

(57) **ABSTRACT**

An antenna is provided to be applied in a mobile terminal having a metal body. The antenna includes: a feed point; a first ground point; and a metal dome connected with the feed point. A metal frame is extended from an upper side of the metal body. The metal frame is provided with a slit. The metal dome is fixedly connected with the metal frame at an end near the slit. The feed point is disposed on the metal body and under the metal dome. The first ground point is disposed on the metal body and connected with the metal frame.

18 Claims, 1 Drawing Sheet