US010594022B2

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

(10) **Patent No.: US 10,594,022 B2**
(45) **Date of Patent: Mar. 17, 2020**

(54) **TRIBAND ANTENNA**

(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)

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

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

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

(21) Appl. No.: **15/772,075**

(22) PCT Filed: **Feb. 19, 2016**

(86) PCT No.: **PCT/US2016/018678**
§ 371 (c)(1),
(2) Date: **Apr. 30, 2018**

(87) PCT Pub. No.: **WO2017/142552**
PCT Pub. Date: **Aug. 24, 2017**

(65) **Prior Publication Data**

US 2018/0342790 A1 Nov. 29, 2018

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 5/378	(2015.01)
H01Q 9/42	(2006.01)
H01Q 5/357	(2015.01)
H01Q 7/00	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/357*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/357; H01Q 1/38; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,197,270	B2	11/2015	Ying et al.
2005/0110692	A1	5/2005	Andersson
2012/0262345	A1	10/2012	Kim et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN	103811864 A	5/2014
TW	201431179 A	8/2014
WO	WO-2013033958 A1	3/2013

OTHER PUBLICATIONS

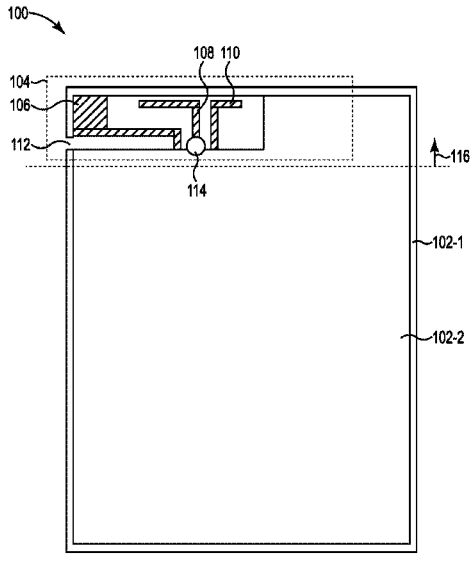
Hsiao, F.R. et al, "Dual-band Slot Antenna Suitable for Ultrabook Application with Metal Housing", Dec. 2-5, 2014.

Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Brooks Cameron & Huebsch PLLC (US LC)—USD

(57) **ABSTRACT**

Example implementations relate to a triband antenna. In one example, a triband antenna system as described herein can include a grounding system including a conductive housing of a wireless communication device and a ground slot structure. The triband antenna system may further include a triband antenna coupled to the grounding system, wherein the triband antenna includes a loop element coupled to the conductive housing, a feeding element, and a parasitic element located within a threshold distance of the feeding element.

13 Claims, 3 Drawing Sheets



US010623029B2

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

(10) **Patent No.: US 10,623,029 B2**
(45) **Date of Patent: Apr. 14, 2020**

(54) **METHOD AND ELECTRONIC DEVICE FOR DYNAMICALLY CHANGING GROUND POINTS OF A PLURALITY OF ANTENNAS OF THE ELECTRONIC DEVICE**

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

(72) Inventors: **Min Cheol Seo**, Seoul (KR); **Him Chan Yun**, Gyeonggi-do (KR); **Ho Jung Nam**, Gyeonggi-do (KR); **Joon Ho Byun**, Gyeonggi-do (KR); **Yoon Jae Lee**, Gyeonggi-do (KR); **Jong Hyuck Lee**, Gyeonggi-do (KR)

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

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

(21) Appl. No.: **16/103,440**

(22) Filed: **Aug. 14, 2018**

(65) **Prior Publication Data**

US 2019/0052292 A1 Feb. 14, 2019

(30) **Foreign Application Priority Data**

Aug. 14, 2017 (KR) 10-2017-0102872

(51) **Int. Cl.**
H04B 1/00 (2006.01)
H01Q 5/371 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 1/0064*** (2013.01); ***H01Q 1/243*** (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**

U.S. PATENT DOCUMENTS

6,771,223 B1 8/2004 Shoji et al.
7,616,158 B2 11/2009 Mak et al.
(Continued)

FOREIGN PATENT DOCUMENTS

KR 20170098107 8/2017
KR 20180013615 2/2018
(Continued)

OTHER PUBLICATIONS

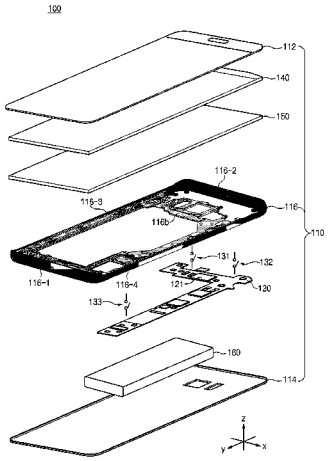
International Search Report dated Dec. 4, 2018 issued in counterpart application No. PCT/KR2018/009309, 3 pages.
(Continued)

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

(57) **ABSTRACT**

An electronic device is provided and includes a housing, a support member including a first ground region, a printed circuit board including a second ground region, a plurality of switches electrically connecting the first ground region and the second ground region, a first antenna element including at least a portion of a first edge of the housing and electrically connected with the first ground region of the support member, a second antenna element including at least a portion of a second edge of the housing and electrically connected with the second ground region of the printed circuit board, and a wireless communication circuit configured to transmit/receive in a first frequency band based on a first electrical path, transmit/receive in a second frequency band based on a second electrical path, set ON/OF states of the plurality of switches to a first arrangement and a second arrangement, wherein at least one switch of the plurality of switches is set to an ON state in each of the first arrangement and the second arrangement.

16 Claims, 21 Drawing Sheets



US010594018B2

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

(10) **Patent No.: US 10,594,018 B2**
(45) **Date of Patent: Mar. 17, 2020**

(54) **ANTENNA STRUCTURE OF A COMMUNICATIONS DEVICE**

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

(72) Inventors: **Hui Lin**, Taoyuan (TW); **Chun-I Lin**, Taoyuan (TW); **Hung-Ren Hsu**, Taoyuan (TW); **Jun-Yu Lu**, Taoyuan (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 127 days.

(21) Appl. No.: **15/792,999**

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

(65) **Prior Publication Data**

US 2019/0044215 A1 Feb. 7, 2019

(30) **Foreign Application Priority Data**

Aug. 3, 2017 (TW) ..... 106126207 A

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H05K 5/02	(2006.01)
H01Q 3/44	(2006.01)
G06F 1/16	(2006.01)
H01Q 1/50	(2006.01)
H01Q 1/24	(2006.01)

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

CPC ***H01Q 1/2266*** (2013.01); ***G06F 1/1698*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 3/44*** (2013.01); ***H05K 5/02*** (2013.01); ***H05K 5/0247*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 1/22; H01Q 1/243; H01Q 1/526; H01Q 3/44; H01Q 1/50; H01P 11/00; H05K 5/0247; H05K 5/02; G06F 1/1698

USPC 343/702

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,780,436 B2	1/2017	Lai et al.	
2008/0036671 A1*	2/2008	Gonda	C04B 35/2633 343/787

(Continued)

FOREIGN PATENT DOCUMENTS

TW	201702789 A	1/2017
WO	2007/037494 A1	4/2007

OTHER PUBLICATIONS

Chinese language office action dated Nov. 20, 2018, issued in application No. TW 106126207.

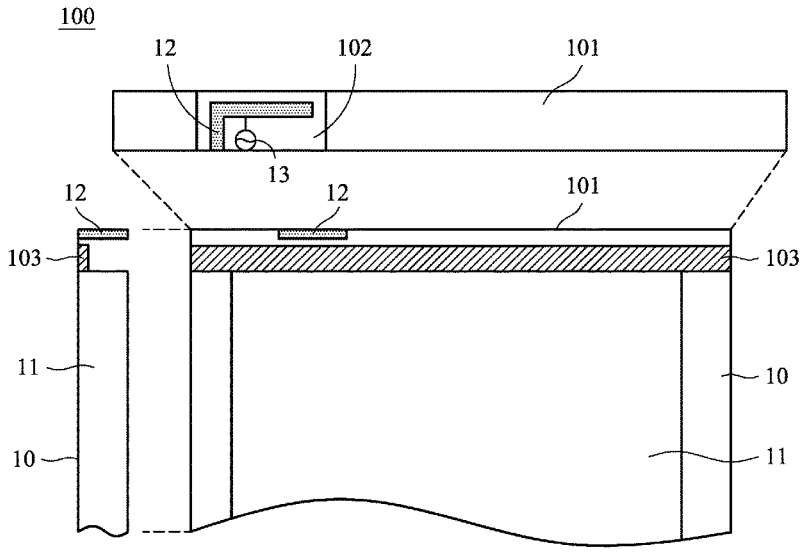
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

A communications device includes a system ground plane, a signal source, a device frame, a magnetic conductive material and an antenna. The signal source is electrically coupled to the system ground plane. The device frame is perpendicular to the system ground plane. The antenna is electrically coupled to the signal source and is disposed on the device frame. The magnetic conductive material is disposed adjacent to the antenna but spaced apart by a first predetermined distance from the antenna. The magnetic line of force induced by the antenna is directed in a predetermined direction by the magnetic conductive material.

8 Claims, 10 Drawing Sheets



US010594020B2

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

(10) **Patent No.: US 10,594,020 B2**
(45) **Date of Patent: Mar. 17, 2020**

(54) **ELECTRONIC DEVICE HAVING ANTENNA ELEMENT AND METHOD FOR MANUFACTURING THE SAME**

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

(72) Inventors: **Young-hoon Min**, Yongin-si (KR); **Keon Kuk**, Yongin-si (KR); **In-hak Na**, 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.: **16/020,386**

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

(65) **Prior Publication Data**

US 2019/0027805 A1 Jan. 24, 2019

Related U.S. Application Data

(60) Provisional application No. 62/534,327, filed on Jul. 19, 2017.

(30) **Foreign Application Priority Data**

Mar. 20, 2018 (KR) 10-2018-0032050

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/2283*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/243*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 13/10; H01Q 13/02; H01Q 21/00; H01Q 9/065; H01Q 9/28
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,436,203 A 7/1995 Lin
5,641,438 A 6/1997 Bunyan et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101785097 A 7/2010
EP 2 187 435 A1 5/2010
(Continued)

OTHER PUBLICATIONS

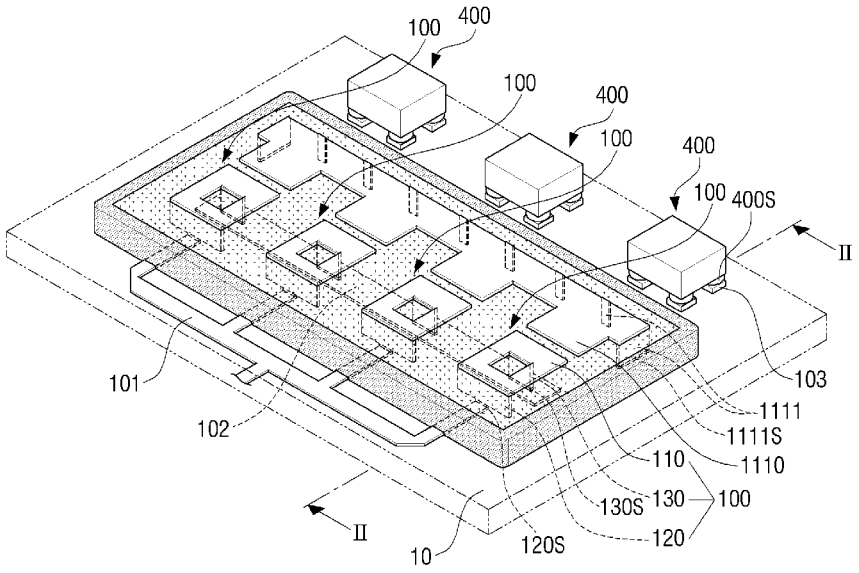
Kim et al.; Onset condition of pulsating cone-jet mode of electrohydrodynamic jetting for plane, hole, and pin type electrodes; Journal of Applied Physics; Introducing Invited Perspectives; Ultrafast magnetism and THz spitronics; Nov. 24, 2010; vol. 108; American Institute of Physics; Seoul, KR.
(Continued)

Primary Examiner — Joseph J Lauture
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device having an antenna element is provided. The electronic device includes a printed circuit board on which a plurality of components are mounted, at least one antenna element mounted on the printed circuit board, an insulating dam formed on the printed circuit board and configured to surround the at least one antenna element, and a dielectric part configured to fill an inside of the insulating dam and to support the at least one antenna element.

20 Claims, 20 Drawing Sheets



US010594023B2

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

(10) **Patent No.: US 10,594,023 B2**
(45) **Date of Patent: Mar. 17, 2020**

(54) **ELECTRONIC DEVICE INCLUDING CONDUCTIVE MEMBER ELECTRICALLY COUPLED TO OPENING OF BRACKET FOR ADJUSTING RESONANCE GENERATED FROM THE OPENING**

(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si, Gyeonggi-do (KR)

(72) Inventors: **Jaewoong Jeon**, Suwon-si (KR); **Jungsik Park**, Suwon-si (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, 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.: **16/274,508**

(22) Filed: **Feb. 13, 2019**

(65) **Prior Publication Data**

US 2019/0252766 A1 Aug. 15, 2019

(30) **Foreign Application Priority Data**

Feb. 14, 2018 (KR) 10-2018-0018586

(51) **Int. Cl.**
H04B 1/3888 (2015.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H04B 1/3888*** (2013.01); ***H04M 1/0262*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04W 52/0216; H04W 52/0203; H04W 52/0209; H04W 76/10; H04W 88/02;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,929,510 A * 7/1999 Geller H01L 23/66 257/635
8,318,339 B2 11/2012 Sennami et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2008-269954 11/2008
JP 2013-187884 9/2013
(Continued)

OTHER PUBLICATIONS

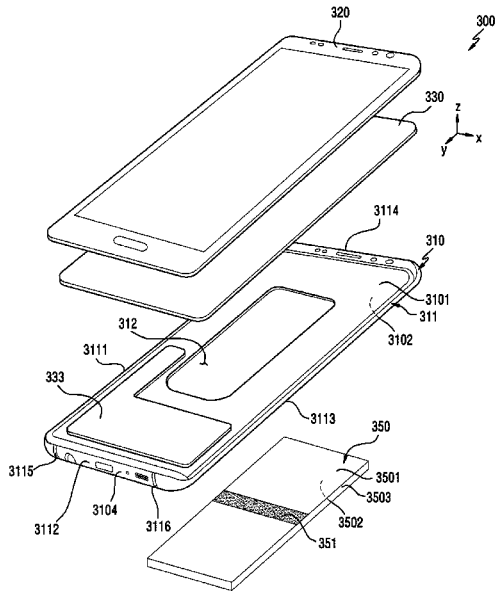
Search Report and Written Opinion dated May 20, 2019 in counterpart International Patent Application No. PCT/KR2019/001756.

Primary Examiner — Jean A Gelin
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

According to various embodiments, an electronic device may include a conductive bracket including an opening in at least part of the bracket, a display disposed on one surface of the bracket, a battery disposed on another surface of the bracket to face at least part of the opening, an antenna disposed within a specified range of the bracket and configure to output a signal of a first frequency band, and a conductive member comprising conductive material electrically coupled to the bracket by crossing at least part of the opening, wherein the opening is divided into a plurality of openings, to adjust resonance of a second frequency band of the opening generated by the signal output from the antenna.

20 Claims, 22 Drawing Sheets



US010594344B2

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

(10) **Patent No.: US 10,594,344 B2**
(45) **Date of Patent: Mar. 17, 2020**

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

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

(72) Inventors: **Gunhee Son**, Gumi-si (KR); **Hyeongwoo Kim**, Busan (KR); **Soon-Sang Park**, Daegu (KR); **Seunghyun Yeo**, Daegu (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.: **16/284,966**

(22) Filed: **Feb. 25, 2019**

(65) **Prior Publication Data**

US 2019/0260405 A1 Aug. 22, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/222,899, filed on Jul. 28, 2016, now Pat. No. 10,218,396.

(30) **Foreign Application Priority Data**

Jul. 28, 2015 (KR) 10-2015-0106687

(51) **Int. Cl.**
H04B 1/04 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 1/0483*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/371*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,130,279 B1 9/2015 Lee et al.
9,337,539 B1 5/2016 Ananthanarayanan et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101488772 A 7/2009
CN 103326124 A 9/2013
(Continued)

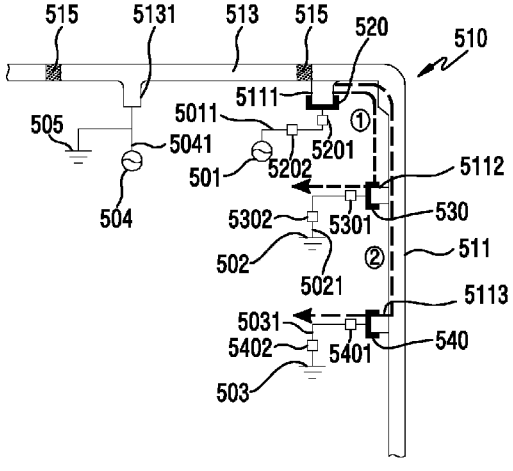
OTHER PUBLICATIONS

The International Searching Authority , "International Search Report," International Application No. PCT/KR2016/008184, dated Nov. 10, 2016, 3 pages, publisher The ISA/KR, International Application Division, Korean Intellectual Property Office, Daejeon, Republic of Korea.
(Continued)

Primary Examiner — Junpeng Chen

(57) **ABSTRACT**

Various embodiments provide an antenna device that includes: a metal member configured to have a length that contributes to at least a part of an electronic device; a printed circuit board (PCB) configured to be feed-connected to a preset position of the metal member in order to apply the metal member as an antenna radiator; and at least one electronic component electrically connected to a position different from the feeding position of the metal member and grounded to the PCB, and provide an electronic device that includes the same. Accordingly, the antenna device is grounded to the PCB in a desired position of the metal member by using the basically provided electronic component so that it is possible to exclude a separate electrical connection member, thereby reducing the cost, increasing
(Continued)



US010601112B2

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

(10) **Patent No.: US 10,601,112 B2**
(45) **Date of Patent: Mar. 24, 2020**

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

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

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 131 days.

(21) Appl. No.: **15/828,627**

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

(65) **Prior Publication Data**

US 2018/0375194 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482128

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/335	(2015.01)
H01Q 21/28	(2006.01)
H01Q 9/42	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)

(Continued)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 5/40*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); *H01Q 1/521* (2013.01); *H01Q 21/28* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 1/38; H01Q 1/48; H01Q 1/521; H01Q 5/314; H01Q 5/328; H01Q 5/335; H01Q 5/35; H01Q 5/40; H01Q 5/50; H01Q 21/28; H01Q 9/42; H01Q 13/10

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,798,554	B2 *	8/2014	Darnell	H01Q 1/243 455/77
9,692,099	B2 *	6/2017	Kato	H01P 1/213

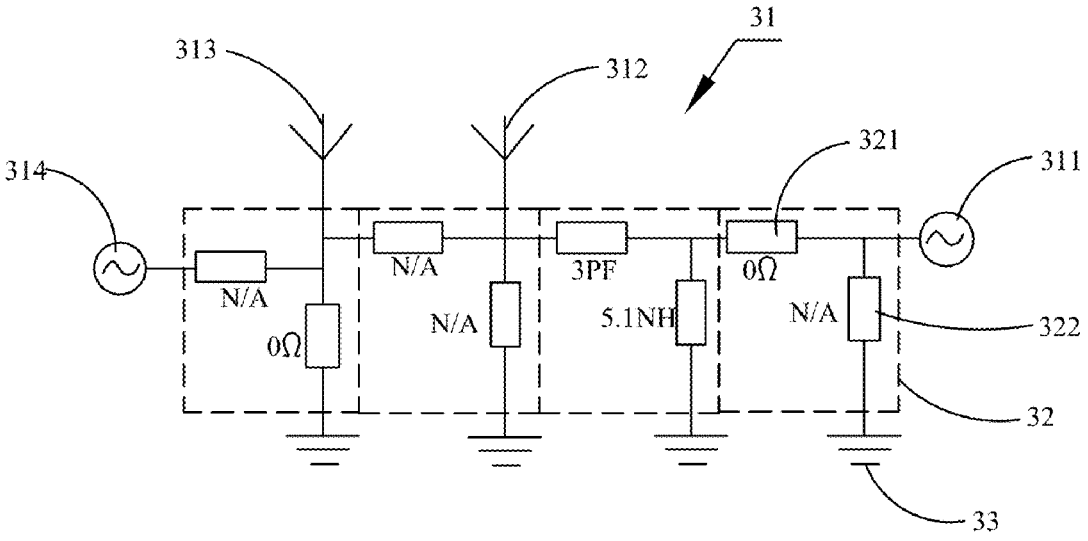
(Continued)

Primary Examiner — Daniel Munoz
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — IPro, PLLC; Na Xu

(57) **ABSTRACT**

An antenna system and a mobile terminal, the antenna system includes a metal shell, a system ground, a mainboard and an antenna unit, the system ground is connected with the metal shell; the mainboard is provided with a mainboard ground connected with the system ground, a main circuit and a matching network, the matching network includes a first and second matching element; the main circuit includes a first radio frequency source, a first antenna terminal, a second antenna terminal and a second radio frequency source which are successively connected in series, and at least one matching network is provided between any adjacent two of them, the antenna unit is connected with the mainboard through the first and/or the second antenna terminal, so that the antenna unit is coupled with the top frame or the bottom frame to form a first antenna, a second antenna and a third antenna.

8 Claims, 8 Drawing Sheets



US010601115B2

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

(10) **Patent No.: US 10,601,115 B2**
(45) **Date of Patent: *Mar. 24, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Minseok Kim**, Seoul (KR); **Hansu Kim**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Youngbae Kwon**, Seoul (KR); **Sungjung Rho**, Seoul (KR); **Changwon Yun**, Seoul (KR); **Kyoungwon Jeon**, Seoul (KR); **Duckyun Kim**, Seoul (KR); **Hyoungwook Lim**, Seoul (KR); **Yunmo Kang**, Seoul (KR); **Hayong 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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/356,647**

(22) Filed: **Mar. 18, 2019**

(65) **Prior Publication Data**

US 2019/0214707 A1 Jul. 11, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/244,963, filed on Aug. 23, 2016, now Pat. No. 10,256,527.

(30) **Foreign Application Priority Data**

Jan. 11, 2016 (KR) 10-2016-0003385
Jan. 12, 2016 (KR) 10-2016-0003901

(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 1/38*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 7/00; H01Q 9/045; H01Q 9/42; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,318,793 B2 4/2016 Zhu et al.
10,256,527 B2 * 4/2019 Kim H01Q 9/42
(Continued)

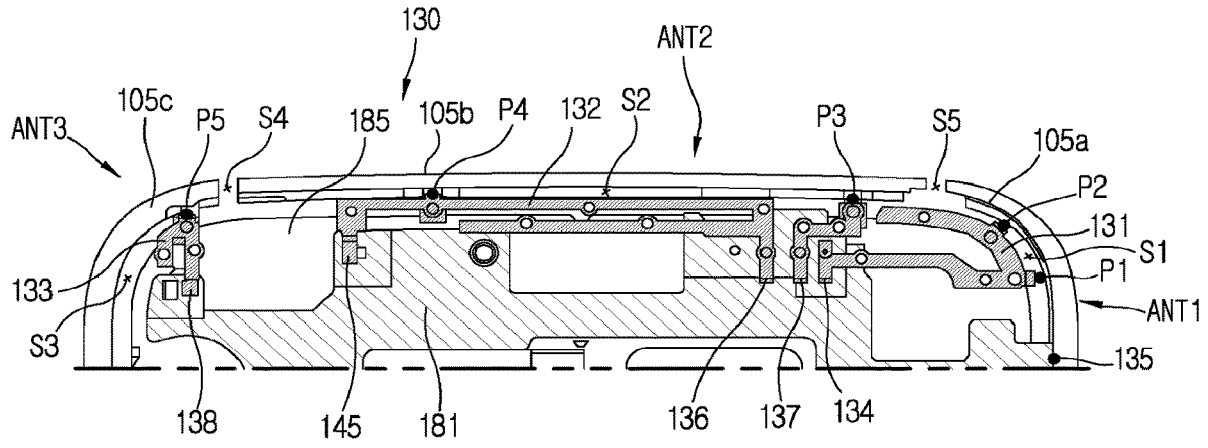
FOREIGN PATENT DOCUMENTS

EP 1258944 A2 11/2002
EP 2629361 A2 8/2013
(Continued)

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, L.L.P.

(57) **ABSTRACT**

A mobile terminal includes a window including a transparent region and an opaque region surrounding the transparent region, a metal case provided below the window to accommodate the window, having a rear surface portion facing the window and a side surface portion formed to extend from the rear surface portion toward a front surface, and exposed outwardly, a non-metal member formed in a region formed by cut away a portion of the case and having a slot formation portion spaced apart from the side surface portion at a predetermined interval and a pair of sectioning portions extending from the slot formation portion and traversing the side surface portion to section the side surface portion into first to third members, and first to third antenna patterns
(Continued)



US010601117B2

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

(10) **Patent No.: US 10,601,117 B2**
(45) **Date of Patent: Mar. 24, 2020**

(54) **ANTENNA AND MOBILE TERMINAL**

(71) Applicant: **Huawei Device Co., Ltd.**, Dongguan, Guangdong (CN)

(72) Inventors: **Hanyang Wang**, Reading (GB); **Jianming Li**, Shanghai (CN)

(73) Assignee: **HUAWEI DEVICE CO., LTD.**, Dongguan (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.: **16/403,822**

(22) Filed: **May 6, 2019**

(65) **Prior Publication Data**

US 2019/0260113 A1 Aug. 22, 2019

Related U.S. Application Data

(63) Continuation of application No. 16/057,374, filed on Aug. 7, 2018, now Pat. No. 10,320,060, which is a (Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/00 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/243; H01Q 1/38; H01Q 1/36; H01Q 9/42; H01Q 9/0414;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,466,170 B2 10/2002 Zhou
7,768,466 B2 * 8/2010 Chi ..... H01Q 9/26 343/700 MS
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101835282 A 9/2010
CN 102315513 A 1/2012
(Continued)

OTHER PUBLICATIONS

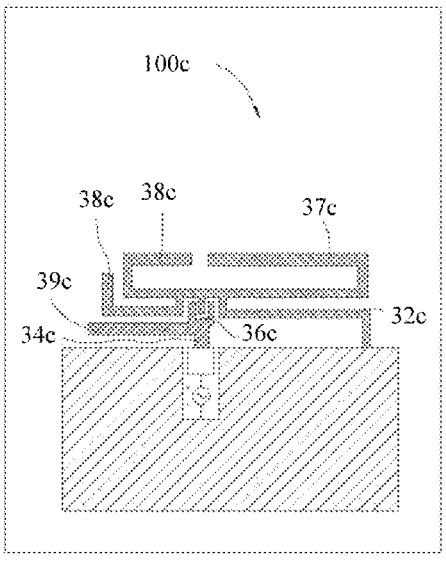
Machine Translation and Abstract of Chinese Publication No. CN103545599, Jan. 29, 2014, 11 pages.
(Continued)

Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna includes a first radiation part, a matching circuit, and a feed source, where the first radiation part includes a first radiator, a second radiator, and a capacitor structure. A first end of the first radiator is connected to the feed source using the matching circuit, the feed source is connected to a grounding part, a second end of the first radiator is connected to a first end of the second radiator using the capacitor structure, a second end of the second radiator is connected to the grounding part, the first radiation part is configured to generate a first resonance frequency, and a length of the second radiator is one-eighth of a wavelength corresponding to the first resonance frequency which helps to reduce an antenna length, and a volume of a mobile terminal.

20 Claims, 7 Drawing Sheets



US010601118B2

(12) **United States Patent**
Wang

(10) **Patent No.: US 10,601,118 B2**
(45) **Date of Patent: Mar. 24, 2020**

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

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

(72) Inventor: **Aqi Wang**, Shenzhen (CN)

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

(*) 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.: **16/524,048**

(22) Filed: **Jul. 27, 2019**

(65) **Prior Publication Data**

US 2020/0044312 A1 Feb. 6, 2020

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 2018 2 1255117 U

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 7/00	(2006.01)
H01Q 21/30	(2006.01)
H01Q 1/22	(2006.01)
H01Q 9/04	(2006.01)
G06F 13/38	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***G06F 13/387*** (2013.01); ***H01Q 1/2258*** (2013.01); ***H01Q 9/0442*** (2013.01); *G06F 2213/3814* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,970,434	B2 *	3/2015	Kanj	H01Q 1/243 343/700 MS
9,590,291	B2 *	3/2017	Lee	H01Q 7/00
9,774,083	B2 *	9/2017	Liu	H04L 25/02
10,090,581	B2 *	10/2018	Wu	H01Q 1/243
10,199,719	B2 *	2/2019	Kim	H01Q 1/243
10,439,267	B2 *	10/2019	Seo	H01Q 21/28
2015/0372384	A1 *	12/2015	Liu	H04L 25/02 343/860
2016/0056531	A1 *	2/2016	Lee	H01Q 7/00 343/702
2016/0301138	A1 *	10/2016	Hwang	H01Q 9/42
2017/0170562	A1 *	6/2017	Lee	H01Q 1/243

* cited by examiner

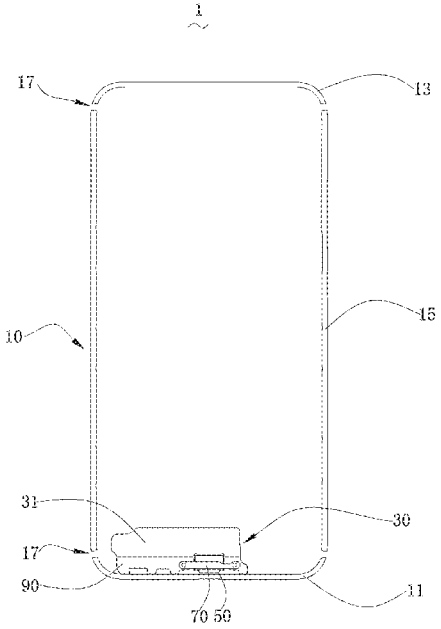
Primary Examiner — Tuan A Tran

(74) *Attorney, Agent, or Firm* — W&G Law Group LLP

(57) **ABSTRACT**

An antenna system and a mobile terminal are provided. The antenna system includes a metal frame including a bottom frame located at the bottom thereof; a main board received in the metal frame, the main board including a system ground and a feeding point; a tuning switch arranged on the main board; a USB interface provided on the main board and having a metal shell; and a metal part arranged across one side of the USB interface facing away from the main board. A clearance region is formed by the bottom frame and the mainboard. The USB interface and the metal part are coupled to the bottom frame to form an antenna radiator, and the USB interface, the metal part, the bottom frame, the feeding point, the tuning switch and the system ground together constitute an antenna unit.

16 Claims, 6 Drawing Sheets



US010601119B2

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

(10) **Patent No.: US 10,601,119 B2**
(45) **Date of Patent: Mar. 24, 2020**

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

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

(72) Inventors: **Dawei Shi**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN); **Mingjun Hang**, Shenzhen (CN); **Yufei Zhu**, Shenzhen (CN)

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

(*) 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.: **16/524,088**

(22) Filed: **Jul. 28, 2019**

(65) **Prior Publication Data**

US 2020/0052380 A1 Feb. 13, 2020

(30) **Foreign Application Priority Data**

Aug. 12, 2018 (CN) ..... 2018 2 1294952 U

(51) **Int. Cl.**

H04M 1/00	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/36	(2006.01)
H01Q 21/30	(2006.01)
H01Q 9/04	(2006.01)
H01Q 21/00	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 9/0414*** (2013.01); ***H01Q 9/0442*** (2013.01); ***H01Q 21/0006*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/242; H01Q 13/106; H01Q 1/50; H01Q 1/36; H01Q 9/0414; H01Q 9/0442; H01Q 21/0006; H01Q 21/30

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,874,920 A *	2/1999	Araki	H01Q 1/243	343/702
8,599,086 B2 *	12/2013	Wong	H01Q 1/243	343/702
9,799,964 B2 *	10/2017	Jang	H01Q 21/30	
10,038,245 B2 *	7/2018	Choi	H01Q 1/243	
10,297,906 B2 *	5/2019	Lee	H04M 1/026	

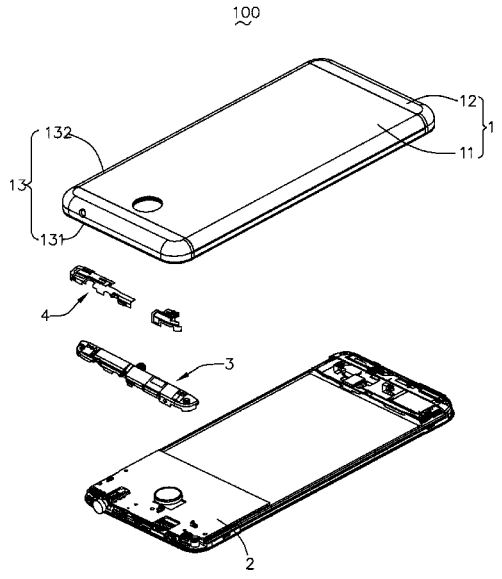
* cited by examiner

Primary Examiner — Nhan T Le
(74) *Attorney, Agent, or Firm* — W&G Law Group LLP

(57) **ABSTRACT**

An antenna system applied to a mobile terminal. The mobile terminal comprises a back shell, a main board received in the back shell, a bracket arranged between the back shell and the main board, and a metal wiring arranged on the surface of the bracket. A clearance area is arranged at one end of the main board; an orthographic projection of the metal wiring on the main board is located in the clearance area. The main board is provided with a grounding switch and a feeding point. The metal wiring comprises a body part, a first branch for generating low-frequency resonance, a second branch for generating high-frequency resonance and a third branch for generating medium-frequency resonance. The first branch, the second branch and the third branch respectively extend from the body part to two sides. The grounding switch and the feeding point are connected with the body part.

18 Claims, 6 Drawing Sheets



US010601129B2

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

(10) **Patent No.: US 10,601,129 B2**
(45) **Date of Patent: Mar. 24, 2020**

(54) **MIMO ANTENNA DEVICE AND MOBILE COMMUNICATION DEVICE**

(71) Applicants: **Molex Interconnect (Shanghai) Co., Ltd.**, Pudong (CN); **Shanghai University**, Shanghai (CN)

(72) Inventors: **Guang Li Yang**, Shanghai (CN); **Yi Xin Li**, Shanghai (CN); **Yu Mei Yu**, Shanghai (CN); **Xiao Jun Tang**, Shanghai (CN); **Hua Feng Shen**, 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 197 days.

(21) Appl. No.: **15/860,723**

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

(65) **Prior Publication Data**

US 2018/0212321 A1 Jul. 26, 2018

(30) **Foreign Application Priority Data**

Jan. 20, 2017 (CN) 2017 1 0048013

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/52 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/52*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/241; H01Q 13/103; H01Q 21/0006
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0181482 A1 7/2011 Adams et al.

FOREIGN PATENT DOCUMENTS

CN 104064866 A 9/2014
CN 205016663 U 2/2016
(Continued)

OTHER PUBLICATIONS

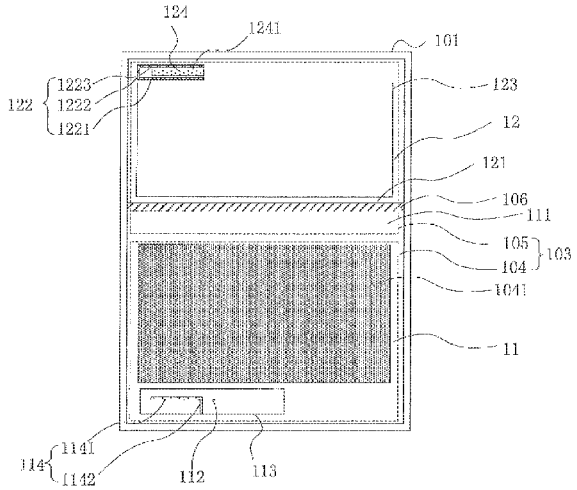
Office Action received for Japanese application No. 2018-005334, dated Jan. 22, 2019, 7 pages. (4 pages of English Translation and 3 pages of Official copy).
(Continued)

Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Molex, LLC

(57) **ABSTRACT**

The present disclosure provides a MIMO antenna device and a mobile communication device which comprises a metal shell and a metal piece, the metal shell comprises a metal back plate and a metal frame which are integrally formed, the metal frame surrounds the metal back plate, the metal piece and the metal shell enclose to form a metal cavity, the metal cavity comprises a battery region used to place a battery assembly and a non-battery region outside the battery region; a metal isolate wall is provided between the metal shell and the metal piece, the metal isolate wall partitions the metal cavity into a first cavity and a second cavity, the first cavity contains the battery region; a first feed unit feeds toward the first cavity to form a first antenna; and a second feed unit feeds toward the second cavity to form a second antenna. The MIMO antenna device and the mobile communication device in the present disclosure form a MIMO antenna device with high isolation through the first antenna and the second antenna, so as to achieve communication in the case of a full-metal outer shell.

21 Claims, 10 Drawing Sheets



US010601135B2

(12) **United States Patent**
Yang

(10) **Patent No.: US 10,601,135 B2**
(45) **Date of Patent: Mar. 24, 2020**

(54) **TEN-FREQUENCY BAND ANTENNA**

(71) Applicant: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy, County Wexford (IE)

(72) Inventor: **Tsai-Yi Yang**, Tainan (TW)

(73) Assignee: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy, County Wexford (IE)

(*) 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.: **15/689,292**

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

(65) **Prior Publication Data**

US 2017/0358861 A1 Dec. 14, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/948,226, filed on Nov. 20, 2015, now Pat. No. 9,755,310.

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

(52) **U.S. Cl.**
CPC ***H01Q 9/04*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/371*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/2266; H01Q 1/2275; H01Q 1/2291; H01Q 1/24;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,198,442 B1 * 3/2001 Rutkowski H01Q 1/242 343/702
6,323,811 B1 11/2001 Tsubaki et al.
(Continued)

FOREIGN PATENT DOCUMENTS

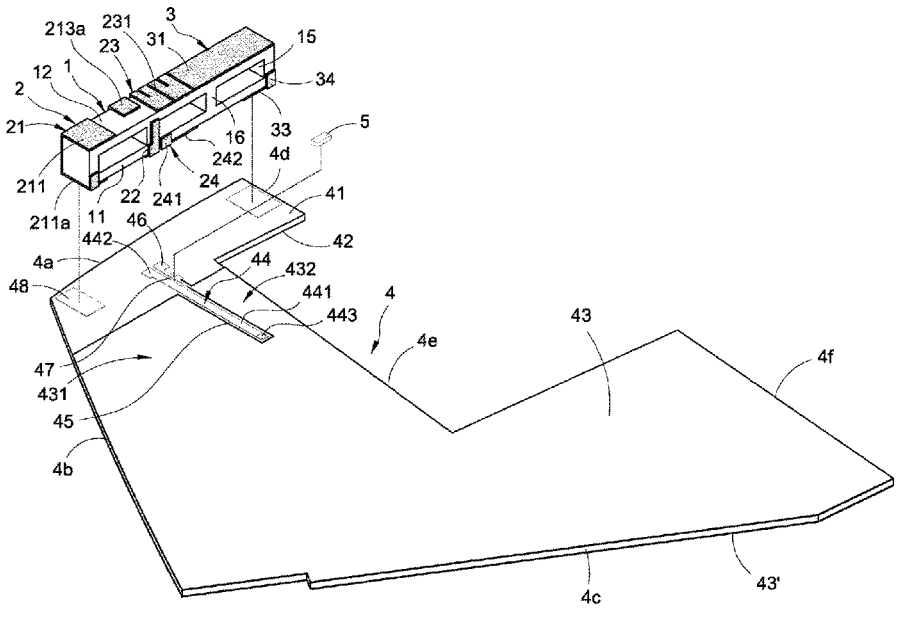
CA 2887126 A1 * 4/2014 ..... H01Q 1/38
CN 1485950 A 3/2004
(Continued)

Primary Examiner — Daniel Munoz
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear, LLP; Kevin J. Everett

(57) **ABSTRACT**

A ten-frequency band antenna includes a carrier, a high-frequency segment, a low-frequency segment, a printed circuit board (PCB) and an inductor. The high-frequency segment is arranged on left side of the carrier and the low-frequency segment is arranged on right side of the carrier. The radiator on the bottom face of the carrier electrically connects with the micro strip of the PCB and the ground line of the ground metal when the carrier is fixed to the PCB. The low-frequency segment is located at an opened area and corresponding to a metal face with smaller area such that the low-frequency segment is at a free space to enhance the frequency response of the low-frequency segment and the bandwidth of the high-frequency segment. The area and the volume of blind hole on the carrier can adjust the effective dielectric constant to adjust the resonant frequency and bandwidth of the antenna.

11 Claims, 9 Drawing Sheets



US010608322B2

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

(10) **Patent No.: US 10,608,322 B2**
(45) **Date of Patent: Mar. 31, 2020**

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

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

(72) Inventors: **Xiaoming Bao**, Dongguan (CN); **Maozhao Huang**, Dongguan (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 261 days.

(21) Appl. No.: **15/681,712**

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

(65) **Prior Publication Data**

US 2018/0175483 A1 Jun. 21, 2018

(30) **Foreign Application Priority Data**

Dec. 15, 2016 (CN) ..... 2016 2 1376937 U

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 9/065*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/065
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0315789 A1* 12/2009 Sung H01Q 1/243 343/702
2013/0249744 A1* 9/2013 Jang H01Q 21/30 343/702
2016/0056531 A1* 2/2016 Lee H01Q 7/00 343/702
2016/0218422 A1* 7/2016 Choi H01Q 1/38

FOREIGN PATENT DOCUMENTS

CN 103401059 A 11/2013
CN 105932397 A 9/2016

OTHER PUBLICATIONS

PCT/CN2017/099536 International Search Report & Written Opinion, dated Oct. 30, 2017, 13 pages.

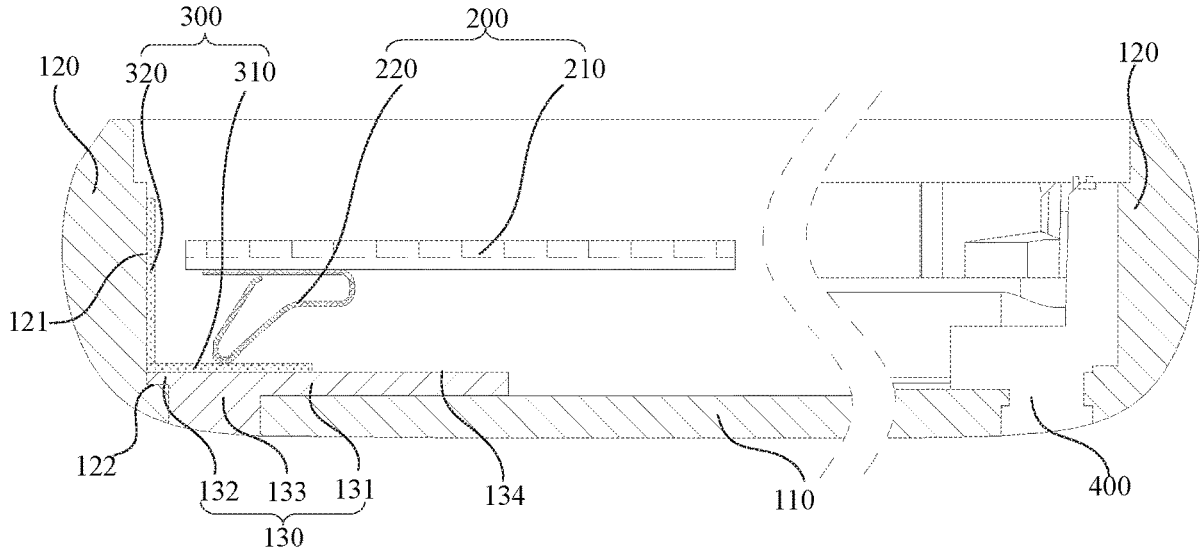
* cited by examiner

Primary Examiner — Graham P Smith
Assistant Examiner — Jae K Kim
(74) *Attorney, Agent, or Firm* — Lathrop GPM LLP

(57) **ABSTRACT**

An antenna component includes an antenna body and a conductor. The antenna body includes a PCB board and a spring piece, and a first end of the spring piece is connected to the PCB board. The conductor is configured to be connected to an insulator and an end metal piece, and includes a first conductive portion opposite to the insulator, and a second conductive portion connected to the first conductive portion and opposite to the end metal piece, and the first conductive portion abuts against a second end of the spring piece. A mobile terminal including an antenna component is further provided.

19 Claims, 2 Drawing Sheets



US010608324B2

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

(10) **Patent No.: US 10,608,324 B2**
(45) **Date of Patent: Mar. 31, 2020**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Sang Ha Lee**, Gyeonggi-do (KR); **Kyung Jae Lee**, Seoul (KR); **Jae Ho Lim**, Gyeonggi-do (KR); **Dong Hwan Kim**, Gyeonggi-do (KR); **Young Jun Kim**, Gwangju (KR); **Un Kim**, Gyeonggi-do (KR); **Jong Hoon Kim**, Gyeonggi-do (KR); **Min Seok Park**, Seoul (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 96 days.

(21) Appl. No.: **15/720,872**

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

(65) **Prior Publication Data**

US 2018/0090821 A1 Mar. 29, 2018

(30) **Foreign Application Priority Data**

Sep. 29, 2016 (KR) 10-2016-0125917

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/35*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 5/35; H01Q 5/40; H01Q 1/38; H01Q 5/328; H01Q 9/04; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,648,752 B2 2/2014 Ramachandran et al.
9,172,139 B2 10/2015 Pascolini et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 2 498 336 9/2012
EP 2 858 172 4/2015
KR 1020140037687 3/2014

OTHER PUBLICATIONS

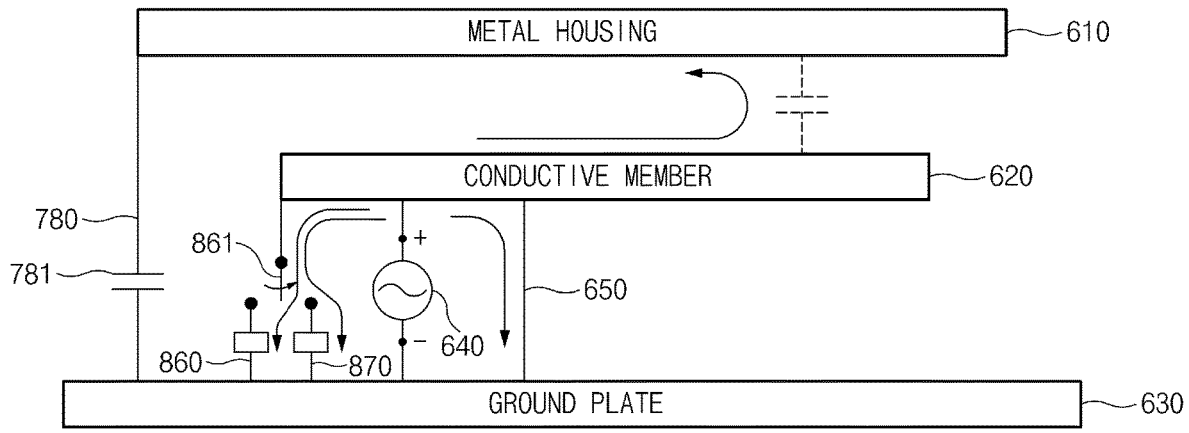
international Search Report dated Jan. 17, 2018 issued in counterpart application No. PCT/KR2017/010973, 11 pages.
(Continued)

Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An electronic device includes a metal housing, a conductive member disposed adjacent to the metal housing, a plurality of ground parts including a first ground part electrically connected with a first point of the conductive member and a second ground part electrically connected with a second point of the conductive member, a ground plate electrically connected with the metal housing and electrically connected with the conductive member via the plurality of ground parts, and a feeding part electrically connected with the conductive member.

16 Claims, 15 Drawing Sheets



US010608325B2

(12) **United States Patent**
Hashizume

(10) **Patent No.: US 10,608,325 B2**
(45) **Date of Patent: Mar. 31, 2020**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **KYOCERA Corporation**, Kyoto (JP)

(72) Inventor: **Takanori Hashizume**, Machida (JP)

(73) Assignee: **KYOCERA Corporation**, 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.: **15/985,059**

(22) Filed: **May 21, 2018**

(65) **Prior Publication Data**

US 2018/0342792 A1 Nov. 29, 2018

(30) **Foreign Application Priority Data**

May 25, 2017 (JP) 2017-103248

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
G02F 1/1333	(2006.01)
H01Q 9/42	(2006.01)
H01Q 21/28	(2006.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***G02F 1/133308*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/28*** (2013.01); *G02F 2001/133314* (2013.01); *G02F 2001/133317* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 9/42; H01Q 13/10; H01Q 21/28; H01Q 1/24; G02F 1/133308; G02F 2001/133314; G02F 2001/133317; G02F 1/1333

USPC 343/702

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0273342 A1* 11/2011 Park H01Q 1/243 343/702

2017/0054196 A1* 2/2017 Hu H01Q 1/243

FOREIGN PATENT DOCUMENTS

JP 2015-122657 A 7/2015

* cited by examiner

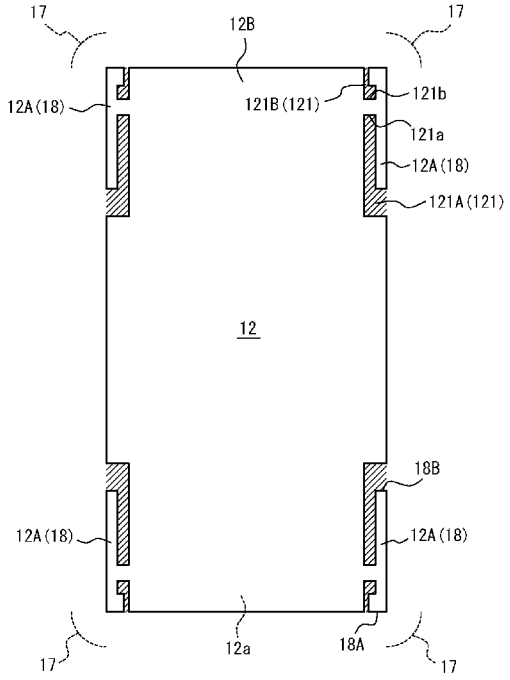
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

In order to further improve the communication quality, the electronic device (**10**) according to this disclosure includes the antenna (**17**) disposed on the case back (**15**) provided at the back side of the device, the display (**11**) provided on the front side of the device and the sheet metal member (**12**) that is provided at the front side of the device and is configured to protect the display (**11**). The sheet metal member (**12**) has a notch (**121**) extending in a specific direction, and the notch (**121**) divides the sheet metal member (**12**) into the external part (**12**A) and the internal part (**12**B) of the notch in the direction intersecting with a specific direction, and the external part (**12**A) functions as the antenna (**18**).

3 Claims, 5 Drawing Sheets



US010608326B2

(12) **United States Patent**
Dabov

(10) **Patent No.: US 10,608,326 B2**
(45) **Date of Patent: Mar. 31, 2020**

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

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

(72) Inventor: **Teodor Dabov**, San Francisco, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

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

(21) Appl. No.: **16/281,533**

(22) Filed: **Feb. 21, 2019**

(65) **Prior Publication Data**

US 2019/0190123 A1 Jun. 20, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/681,248, filed on Aug. 18, 2017, and a continuation of application No. 14/340,983, filed on Jul. 25, 2014, now Pat. No. 9,748,635, and a continuation of application No. 13/396,499, filed on Feb. 14, 2012, now Pat. No. 8,803,745.

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 1/24 (2006.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 7/00
USPC 343/702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,733,245	A	3/1988	Mussler	
5,768,217	A	6/1998	Sonoda	
5,945,956	A	8/1999	Izawa et al.	
2005/0024278	A1	2/2005	Amemlya et al.	
2008/0074329	A1	3/2008	Caballero et al.	
2009/0278749	A1	11/2009	Jow	
2010/0103612	A1	4/2010	Weber et al.	
2010/0231470	A1	9/2010	Lee et al.	
2010/0316368	A1	12/2010	Young et al.	
2010/0321253	A1	12/2010	Ayala Vazquez et al.	
2011/0012796	A1*	1/2011	Kim	H01Q 1/273 343/702
2011/0078749	A1*	3/2011	Wieck	H01Q 1/22 725/81
2012/0027056	A1	2/2012	Shinkai et al.	

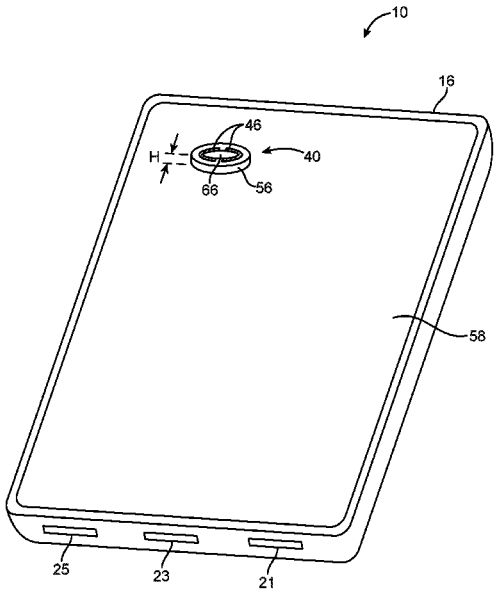
* cited by examiner

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

(57) **ABSTRACT**

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

21 Claims, 12 Drawing Sheets



US010615485B2

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

(10) **Patent No.: US 10,615,485 B2**
(45) **Date of Patent: Apr. 7, 2020**

(54) **PORTABLE TERMINAL WITH ANTENNA DEVICE FOR DISPLAY ELEMENT OR DISPLAY ASSEMBLY INCLUDING FLEXIBLE FUNCTIONAL REGION**

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

(72) Inventors: **Jae-Bong Chun**, Suwon-si (KR); **Jin-Woo Jung**, 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 0 days.

(21) Appl. No.: **15/998,479**

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

(65) **Prior Publication Data**

US 2018/0358684 A1 Dec. 13, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/082,900, filed on Nov. 18, 2013, now Pat. No. 10,079,425.

(30) **Foreign Application Priority Data**

Feb. 25, 2013 (KR) 10-2013-0019585

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

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/22; H01Q 1/44; H01Q 21/28; H01Q 5/378; H01Q 5/392; G06F 1/1652
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,806,835 B2 * 10/2004 Iwai H01Q 1/08 343/702
7,508,349 B2 * 3/2009 Kanazawa H01Q 1/243 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2005-0023203 A 3/2005
KR 10-0818170 B1 4/2008

(Continued)

OTHER PUBLICATIONS

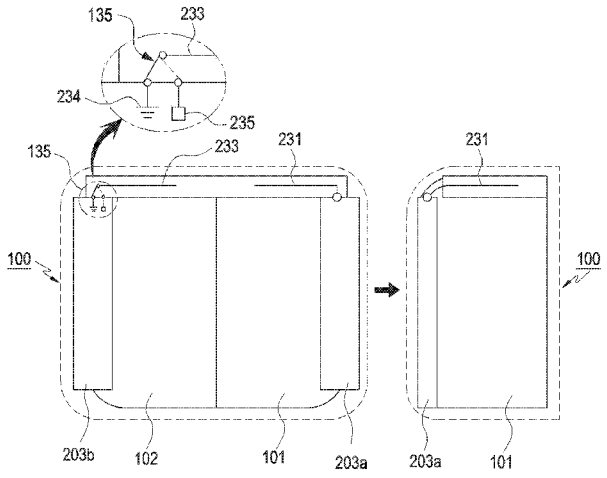
Korean Office Action dated Mar. 11, 2019, issued in a counterpart Korean application No. 10-2013-0019585.

Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A portable terminal is provided. The portable terminal includes a flexible display element, a first antenna element disposed at a first region on the display element, a second antenna element disposed at a foldable second region on the display element to face the first region, and a switch element configured to selectively connect the second antenna element. When the display element is folded or rolled, the first and second antenna elements at least partially overlap each other, and the switch element disconnects the second antenna element. The portable terminal including the antenna device as described above may maintain a stable transmission/reception performance although it includes a flexible display element or a display assembly. When a plurality of antenna elements are provided, the portable terminal may implement a Multiple Input Multiple Output (MIMO) antenna device in a state where the display element is extended.

17 Claims, 10 Drawing Sheets



US010622702B2

(12) **United States Patent**
Guo

(10) **Patent No.: US 10,622,702 B2**
(45) **Date of Patent: Apr. 14, 2020**

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

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

(72) Inventor: **Qingyu Guo**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 275 days.

(21) Appl. No.: **15/531,074**

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

(86) PCT No.: **PCT/CN2015/098286**
§ 371 (c)(1),
(2) Date: **May 26, 2017**

(87) PCT Pub. No.: **WO2016/101871**
PCT Pub. Date: **Jun. 30, 2016**

(65) **Prior Publication Data**

US 2017/0338545 A1 Nov. 23, 2017

(30) **Foreign Application Priority Data**

Dec. 26, 2014 (CN) 2014 1 0833452
Dec. 26, 2014 (CN) ..... 2014 2 0840199 U

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/242*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243; H01Q 5/335; H01Q 5/378; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,315,289 B2 * 1/2008 Puente Baliarda H01Q 1/36 343/817
8,270,914 B2 * 9/2012 Pascolini H01Q 1/243 455/90.2

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102570027 A 7/2012
CN 102738556 A 10/2012

(Continued)

OTHER PUBLICATIONS

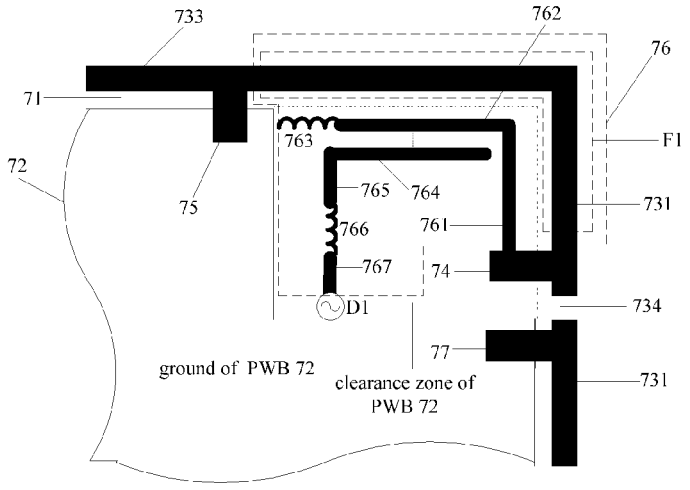
International Search Report and Written Opinion from PCT/CN2015/098286 dated Mar. 11, 2016.

Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Calfee Halter & Griswold LLP

(57) **ABSTRACT**

A mobile terminal and an antenna of a mobile terminal are provided. The mobile terminal includes: a printed wiring board; a housing; a metal frame surrounding the housing, having a first frame, a second frame and a third frame, the first frame having a first gap; a first connector connected with a part of the first frame; a second connector connected with the third frame and a ground of the printed wiring board; and a first antenna, including: a main radiator; a first part; a second part; a first inductor; a third part; a fourth part a second inductor connected with the fourth part and a fifth part connected with the second inductor and a first feed terminal of the printed wiring board.

11 Claims, 6 Drawing Sheets



US010622704B2

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

(10) **Patent No.: US 10,622,704 B2**
(45) **Date of Patent: Apr. 14, 2020**

(54) **EMBEDDED ANTENNA**

(71) Applicant: **EMW CO., LTD.**, Incheon (KR)

(72) Inventors: **Chang Ho Hong**, Seoul (KR); **Won Mo Seong**, Gyeonggi-do (KR)

(73) Assignee: **EMW CO., LTD.**, Incheon (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.: **15/107,564**

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

(86) PCT No.: **PCT/KR2014/012667**
§ 371 (c)(1),
(2) Date: **Jun. 23, 2016**

(87) PCT Pub. No.: **WO2015/099388**
PCT Pub. Date: **Jul. 2, 2015**

(65) **Prior Publication Data**

US 2016/0329627 A1 Nov. 10, 2016

(30) **Foreign Application Priority Data**

Dec. 23, 2013 (KR) 10-2013-0161479

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/357 (2015.01)
H01Q 5/371 (2015.01)
H01Q 5/364 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/357*** (2015.01); ***H01Q 5/364*** (2015.01); ***H01Q 5/371*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/357; H01Q 5/364; H01Q 5/371
USPC 343/702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,447,530 B2 * 11/2008 Iwai H01Q 1/24 343/702
8,471,771 B2 * 6/2013 Su ..... H01Q 1/243 343/700 MS
8,587,485 B2 * 11/2013 Tahk H01Q 1/243 343/702
8,618,989 B2 * 12/2013 Sung B29C 45/14065 343/702
8,624,783 B2 * 1/2014 Kim ..... H01Q 1/243 343/700 MS
8,842,048 B2 * 9/2014 Kim H01Q 1/243 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102800931 A 11/2012
CN 103094717 A 5/2013

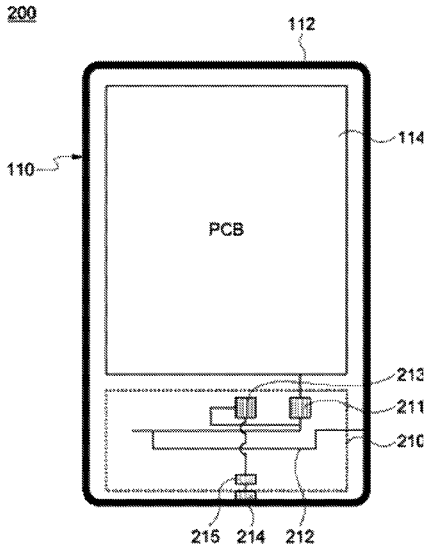
(Continued)

Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

An embedded antenna includes a power transfer pad connected to a circuit inside a portable terminal having a metal exterior, and a first radiation unit which is connected to the power transfer pad so as to radiate a signal of a first passband, and a second radiation unit which is connected to the metal exterior so as to radiate a signal of a second passband.

13 Claims, 6 Drawing Sheets



US010622717B2

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

(10) **Patent No.: US 10,622,717 B2**
(45) **Date of Patent: Apr. 14, 2020**

(54) **MOBILE DEVICE**

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

(72) Inventors: **Ming-Ching Yen**, New Taipei (TW); **Shih-Ting Huang**, 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 31 days.

(21) Appl. No.: **16/000,971**

(22) Filed: **Jun. 6, 2018**

(65) **Prior Publication Data**

US 2019/0296438 A1 Sep. 26, 2019

(30) **Foreign Application Priority Data**

Mar. 26, 2018 (TW) ..... 107110286 A

(51) **Int. Cl.**
H05K 7/00 (2006.01)
H01Q 5/50 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/50*** (2015.01); ***H01Q 1/2266*** (2013.01); ***H01Q 1/38*** (2013.01); *H01Q 3/443* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 13/16; H01Q 13/10; H01Q 3/443; H01Q 7/00; H01Q 13/18; H01Q 21/064;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,625,212 A * 11/1986 Oda H01Q 1/243 343/702
5,936,583 A * 8/1999 Sekine H01Q 1/245 343/702
(Continued)

FOREIGN PATENT DOCUMENTS

TW 201703350 A 1/2017

OTHER PUBLICATIONS

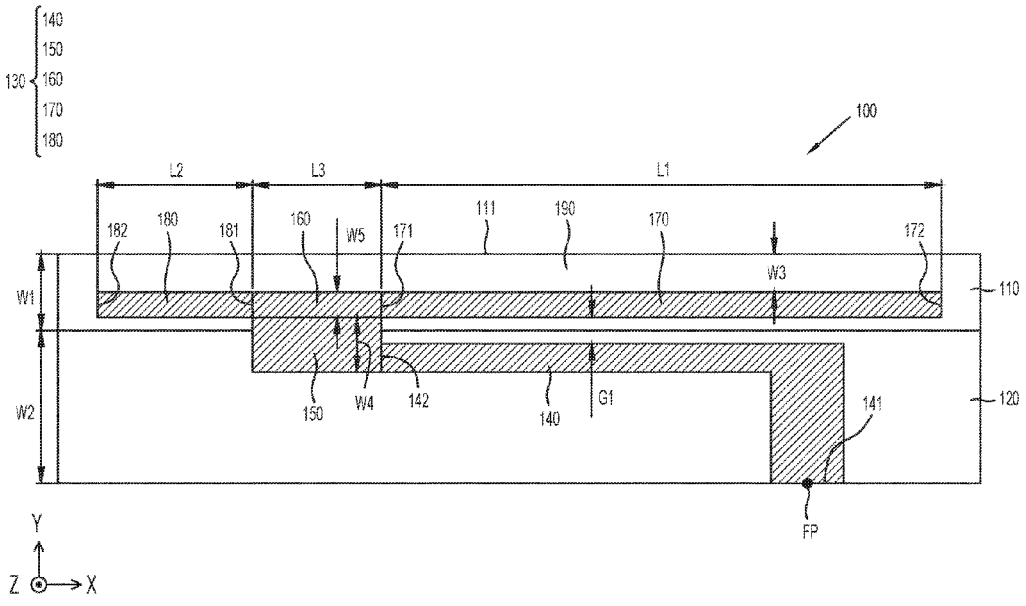
TW Office Action, dated Mar. 8, 2019, 6 pages.
TW Search Report, dated Mar. 6, 2019, 1 page.

Primary Examiner — Binh B Tran
(74) *Attorney, Agent, or Firm* — Edell, Shapiro & Finnan, LLC

(57) **ABSTRACT**

A mobile device includes a first nonconductive support member, a second nonconductive support member adjacent to, and lower than, the first nonconductive supporting member, and an antenna structure that includes a first radiating portion disposed on the first nonconductive support member, a second radiating portion disposed on the first nonconductive support member and extending in a direction opposite to the first radiating portion, a feeding element, and a connecting portion disposed on the first nonconductive support member and the second nonconductive support member that couples the first radiating portion and the second radiating portion to each other and to the feeding element, wherein the first nonconductive support member is part of a visible outside edge portion of the mobile device.

19 Claims, 7 Drawing Sheets



US010622728B2

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

(10) **Patent No.: US 10,622,728 B2**
(45) **Date of Patent: Apr. 14, 2020**

(54) **SYSTEM AND METHOD FOR A MOBILE ANTENNA WITH ADJUSTABLE RESONANT FREQUENCIES AND RADIATION PATTERN**

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

(72) Inventors: **Chun Kit Lai**, LaJolla, CA (US); **Wee Kian Toh**, San Diego, CA (US); **Ning Ma**, 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 3 days.

(21) Appl. No.: **15/986,096**

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

(65) **Prior Publication Data**

US 2018/0269595 A1 Sep. 20, 2018

Related U.S. Application Data

(63) Continuation of application No. 13/971,628, filed on Aug. 20, 2013, now Pat. No. 9,979,096.

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 21/30 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 3/24*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 21/30; H01Q 3/24; H01Q 1/243; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,079,079 B2 7/2006 Jo et al.
7,612,725 B2 * 11/2009 Hill H01Q 1/243 343/702
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101223672 A 7/2008
CN 101562273 A 10/2009
(Continued)

OTHER PUBLICATIONS

Bahramzy, P., et al., "Dual-feed ultra-compact reconfigurable handset antenna for penta-band operation." Antennas and Propagation Society International Symposium (APSURSI), IEEE. Jul. 11-17, 2010, pp. 1-4, doi: 10.1109/APS.2010.5562324.
(Continued)

Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Z Islam
(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(57) **ABSTRACT**

Embodiments are provided for an efficient antenna design and operation method to adjust or add frequency bands at mobile devices using the available limited antenna size. The embodiments include electrically coupling to the antenna elements at a mobile or radio device a tuning stub or element through a printed circuit board (PCB) or a metal chassis. The PCB is placed between the antenna elements and the tuning stub and is connected to the antenna elements. The tuning stub, e.g., at a corner of the PCB, is connected or disconnected via a switch from the PCB, and hence the antenna elements, to shift the radiation of the antenna at different frequencies and also provide an additional mode of radiation. The tuning stub can also be switched to vary the radiation pattern of the antenna.

20 Claims, 4 Drawing Sheets