

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

(10) **Patent No.:** US 10,566,678 B2
(45) **Date of Patent:** Feb. 18, 2020

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

(71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Ching-Hsiang Ko**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 15 days.

(21) Appl. No.: **16/107,811**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 24, 2017 (TW) 106136586 A

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

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (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 5/371; H01Q 1/243; H01Q 1/38; H01Q 1/48; H01Q 7/00; H01Q 21/30
See application file for complete search history.

(56) **References Cited**

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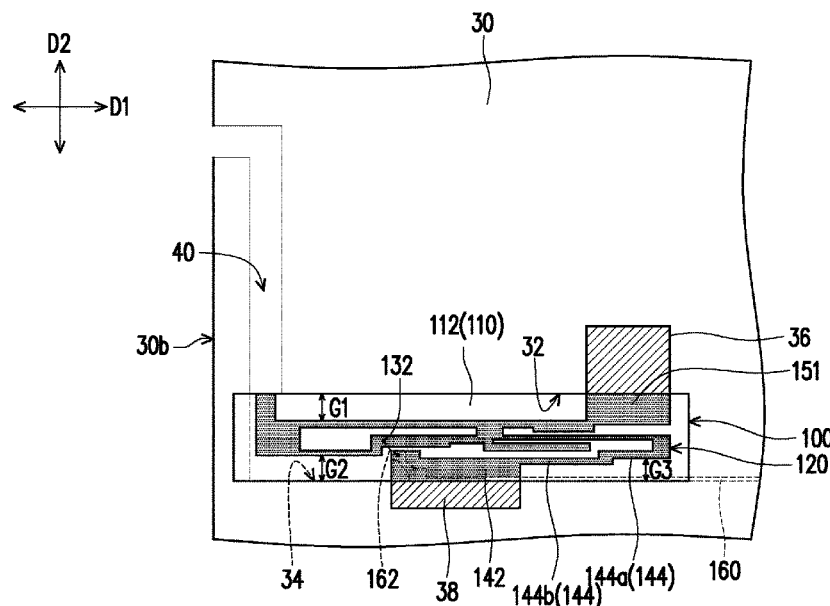
Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

An antenna structure including a metal outer cover and an antenna assembly is provided. The metal outer cover has a bent slit. The antenna assembly is stacked on the metal outer cover and covers a portion of the bent slit. The antenna assembly includes a substrate and an antenna pattern disposed on the substrate. The antenna pattern includes a feed end, a first ground end and a second ground end. In the antenna pattern, a first loop and a second loop are formed from the feed end to the first ground end in two respective paths. A third loop is formed from the feed end to the second ground end. The first loop and the third loop resonate with the bent slit to generate a low frequency band and a portion of a high frequency band. The second loop and the third loop resonate with the bent slit to generate another portion of the high frequency band. An electronic device having the antenna structure is further provided.

19 Claims, 12 Drawing Sheets





US010566681B2

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

(10) **Patent No.:** **US 10,566,681 B2**

(45) **Date of Patent:** **Feb. 18, 2020**

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

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

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 214 days.

(21) Appl. No.: **15/655,906**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

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

(30) **Foreign Application Priority Data**

Jul. 7, 2017 (CN) 2017 1 0553028

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

(52) **U.S. Cl.**
CPC **H01Q 1/242** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/10** (2015.01); **H01Q 5/50** (2015.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/242; H01Q 1/48; H01Q 1/243;
H01Q 1/521; H01Q 5/50; H01Q 5/10;
(Continued)

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Primary Examiner — Hoang V Nguyen

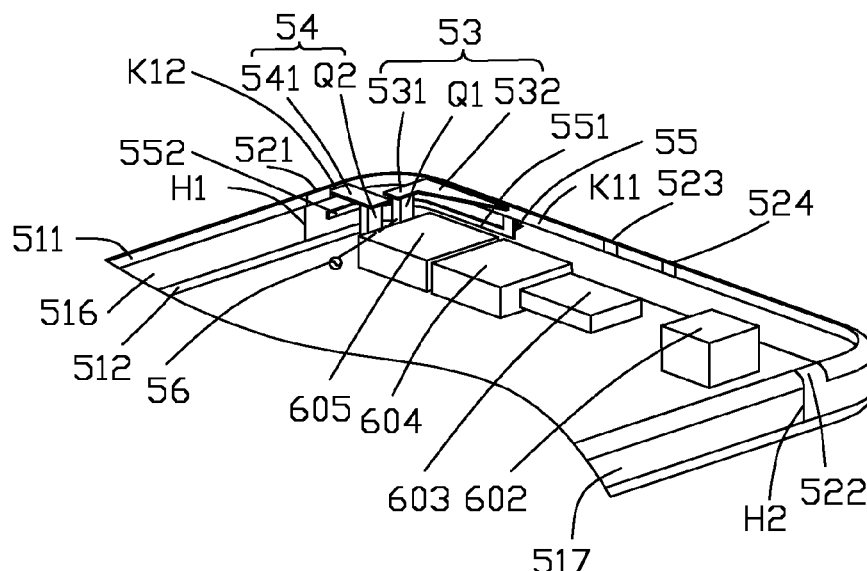
Assistant Examiner — Awat M Salih

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

(57) **ABSTRACT**

An antenna structure includes a metal housing, a first resonance portion, a second resonance portion, an extending portion, and a signal feed source. The metal housing includes a front frame, a backboard, and a side frame. The side frame defines a slot and the front frame defines a groove and a gap. The metal housing is divided into at least an antenna section by the slot, the groove, and the gap. The first and second resonance portions and the extending portion are spaced apart from each other. The first resonance portion and the extending portion are both directly and electrically connected to the antenna section or are spaced apart and electrically coupled to the antenna section. The second resonance portion is electrically connected to the antenna section. One resonance portion is electrically connected to the signal feed source and the other resonance portion is grounded.

24 Claims, 58 Drawing Sheets





US010566694B2

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

(10) **Patent No.:** **US 10,566,694 B2**
(45) **Date of Patent:** **Feb. 18, 2020**

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

(56) **References Cited**

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

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2016/0156101	A1	6/2016	Tsai et al.

(72) Inventors: **Geng-Hong Liou**, New Taipei (TW);
Yun-Jian Chang, 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 161 days.

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(21) Appl. No.: **15/810,246**

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

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(65) **Prior Publication Data**

US 2018/0159221 A1 Jun. 7, 2018

Primary Examiner — Dameon E Levi

Assistant Examiner — David E Lotter

(30) **Foreign Application Priority Data**

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

Dec. 7, 2016 (CN) 2016 1 1114590

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 5/371 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/50 (2015.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

A multi-frequency antenna structure includes a feed portion, a first ground portion, a first radiating portion, a second radiating portion, and a third radiating portion. The feed portion supplies current to the antenna structure. The first ground portion is spaced apart from the feed portion and grounds the antenna structure. The first radiating portion is electrically connected to the feed portion. The second radiating portion is spaced apart from the first radiating portion and is electrically connected to the first ground portion. The third radiating portion is spaced apart from the second radiating portion and is electrically connected to the feed portion and the first radiating portion.

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

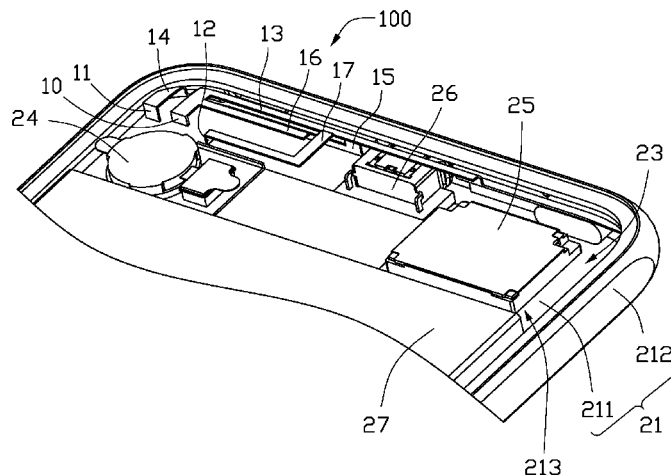
CPC **H01Q 5/371** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 5/50** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 5/378; H01Q 5/50; H01Q 1/243; H01Q 9/42
See application file for complete search history.

20 Claims, 16 Drawing Sheets

200





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

(10) **Patent No.:** **US 10,567,025 B2**

(45) **Date of Patent:** **Feb. 18, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Yeomin Youn**, Seoul (KR); **Jaehyun Choi**, Seoul (KR); **Jungsun Ahn**, Seoul (KR); **Changil Kim**, Seoul (KR); **Kangjae Jung**, 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.

(21) Appl. No.: **16/562,738**

(22) Filed: **Sep. 6, 2019**

(65) **Prior Publication Data**

US 2019/0393919 A1 Dec. 26, 2019

Related U.S. Application Data

(63) Continuation of application No. 16/122,600, filed on Sep. 5, 2018, which is a continuation of application
(Continued)

(30) **Foreign Application Priority Data**

Dec. 3, 2013 (KR) 10-2013-0149413

(51) **Int. Cl.**

H04M 1/00 (2006.01)

H04B 1/3888 (2015.01)

(Continued)

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

CPC **H04B 1/3888** (2013.01); **G06F 1/1626**
(2013.01); **G06F 1/1656** (2013.01);

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(58) **Field of Classification Search**

CPC H04B 1/3888; H04B 2001/3894; H04M 1/0202; H04M 1/0249; H04M 1/18;
(Continued)

(56) **References Cited**

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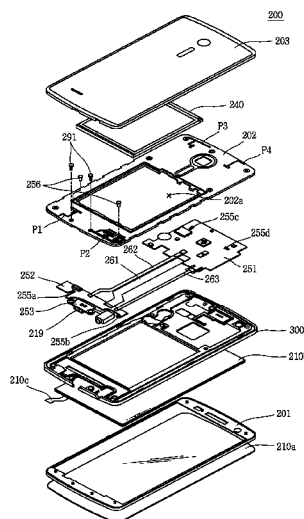
Primary Examiner — April G Gonzales

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

(57) **ABSTRACT**

A mobile terminal includes a metal frame including a base portion and an edge portion formed along the outer edge of the base portion, first and second cases bonded to the front and back sides of the metal frame so as to expose the edge portion to the outside, first and second waterproof layers formed between the cases and the metal frame, conductive members that operate a radiator for antennas, together with the edge portion, and are formed on one side of the second case, and feeding portions for feeding the conductive members, the feeding portions being disposed in an enclosed space formed by the waterproof layers.

13 Claims, 15 Drawing Sheets



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

(10) **Patent No.:** **US 10,573,956 B2**
(45) **Date of Patent:** **Feb. 25, 2020**

(54) **MOBILE DEVICE**

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

(72) Inventors: **Pei-Chi Ma**, New Taipei (TW);
Hsien-Chang Lin, New Taipei (TW);
Hsin-Wu Chiang, New Taipei (TW);
Wan-Chu Wei, 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 0 days.

(21) Appl. No.: **15/986,826**

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

(65) **Prior Publication Data**

US 2019/0140341 A1 May 9, 2019

(30) **Foreign Application Priority Data**

Nov. 9, 2017 (TW) 106138763 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H04B 1/40 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01); **H04B 1/40** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/521; H01Q 9/42;
H01Q 21/28; H01Q 1/38; H01Q 1/2291;
H04B 1/40

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hai V Tran

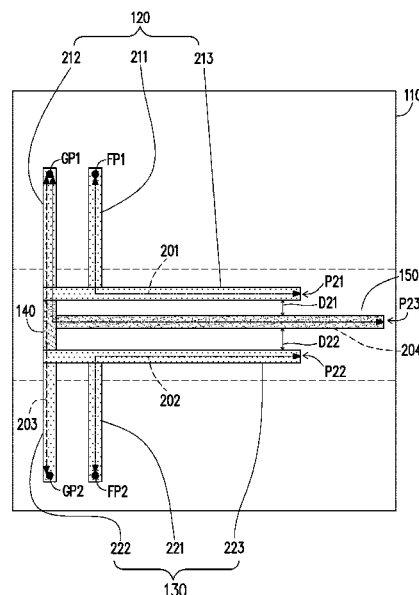
Assistant Examiner — Michael M Bouizza

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

(57) **ABSTRACT**

A mobile device includes a carrying element, a first antenna, a second antenna, a connection element, and an extension element. The first antenna and the second antenna are disposed on the carrying element. The first antenna operates in a first frequency band through a first resonance path. The second antenna operates in the first frequency band through a second resonance path. The connection element is electrically connected to the first antenna and the second antenna. The connection element, the first antenna and the second antenna form a connection path, and the connection path, the first resonance path and the second resonance path do not overlap one another. The extension element is electrically connected to the connection element. The extension element, the connection element and the first antenna form a third resonance path, and the first antenna operates in a second frequency band through the third resonance path.

9 Claims, 5 Drawing Sheets





US010573957B2

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

(10) **Patent No.:** **US 10,573,957 B2**
(45) **Date of Patent:** **Feb. 25, 2020**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Yunmo Kang**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Sungjoon Hong**, Seoul (KR); **Byungwoon Jung**, Seoul (KR); **Sungjung Rho**, 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.

(21) Appl. No.: **16/033,083**

(22) Filed: **Jul. 11, 2018**

(65) **Prior Publication Data**

US 2018/0323497 A1 Nov. 8, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/860,427, filed on Jan. 2, 2018, now Pat. No. 10,056,680, which is a (Continued)

(30) **Foreign Application Priority Data**

Sep. 19, 2012 (KR) 10-2012-0104152

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/242-245
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jessica Han

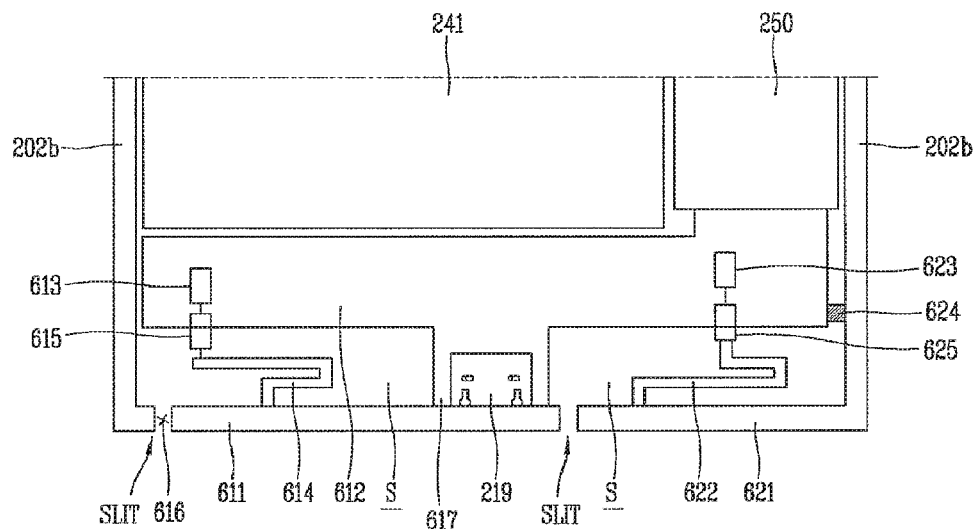
Assistant Examiner — Amal Patel

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

(57) **ABSTRACT**

A mobile terminal comprises: a terminal body; and a first antenna device and a second antenna device disposed at one side of the terminal body in an adjacent manner, and formed to operate at different frequency bands, wherein the first antenna device and the second antenna device are provided with conductive members each having a slit at one side thereof, and wherein the conductive members form part of an appearance of the terminal body.

7 Claims, 13 Drawing Sheets



(12) **United States Patent**
Lin

(10) **Patent No.:** **US 10,573,968 B1**
(45) **Date of Patent:** **Feb. 25, 2020**

(54) **MULTI-BAND ANTENNA WITH MULTIPLE FEED POINTS**

(71) Applicants: **INVENTEC (PUDONG) TECHNOLOGY CORPORATION**, Shanghai (CN); **INVENTEC CORPORATION**, Taipei (TW)

(72) Inventor: **Yuan Sheng Lin**, Taipei (TW)

(73) Assignees: **INVENTEC (PUDONG) TECHNOLOGY CORPORATION**, Shanghai (CN); **INVENTEC CORPORATION**, Taipei (TW)

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

(21) Appl. No.: **16/212,371**

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

(30) **Foreign Application Priority Data**

Nov. 27, 2018 (CN) 2018 1 1424731

(51) **Int. Cl.**
H01Q 5/35 (2015.01)
H01Q 5/371 (2015.01)
H01Q 21/06 (2006.01)
H01Q 9/30 (2006.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/2291** (2013.01); **H01Q 9/30** (2013.01); **H01Q 21/067** (2013.01); **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/35; H01Q 1/38; H01Q 5/371; H01Q 1/2291; H01Q 9/30; H01Q 21/067
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Graham P Smith

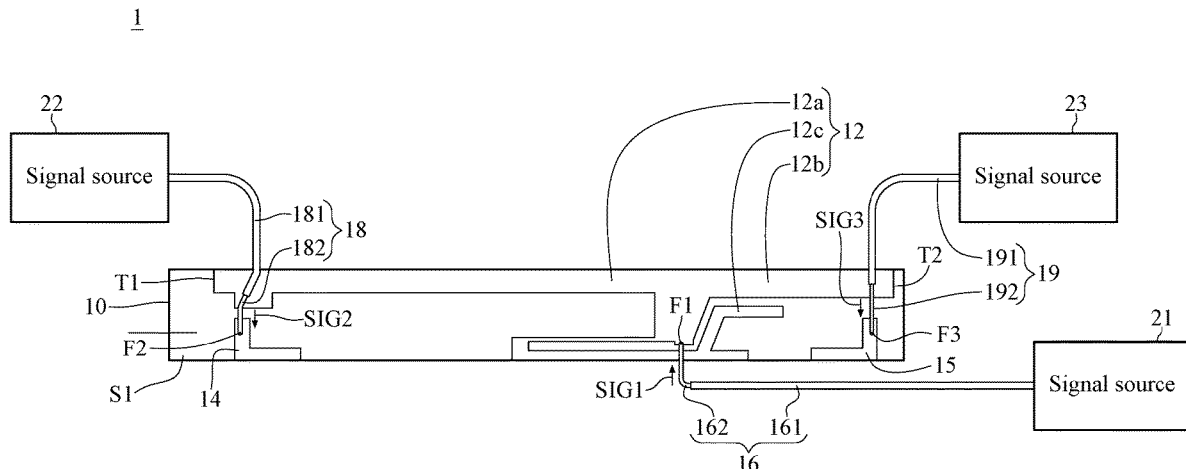
Assistant Examiner — Noel Maldonado

(74) *Attorney, Agent, or Firm* — Maschoff Brennan

(57) **ABSTRACT**

A multi-band antenna with multiple feed points includes a substrate, a main body, a branch body, a first and a second coaxial cable. The main body and the branch body are disposed on the substrate and respectively have a first and a second signal feed point. The first coaxial cable has a first outer conductor connected to a grounding layer and a first core conductor connected to the first signal feed point for feeding the first signal feed point with a first signal, so that the main body generates a RF signal of a first frequency band. The second coaxial cable has a second outer conductor connected to the main body and a second core conductor connected to the second signal feed point for feeding the second signal feed point with a second signal, so that the branch body generates a RF signal of a second frequency band.

11 Claims, 5 Drawing Sheets





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

(10) **Patent No.:** **US 10,573,970 B2**
(45) **Date of Patent:** **Feb. 25, 2020**

(54) **ANTENNA ARRANGEMENT ON A CIRCUIT BOARD**

(71) Applicant: **SONY MOBILE COMMUNICATIONS INC.**, Tokyo (JP)

(72) Inventors: **Zhinong Ying**, Lund (SE); **Thomas Bolin**, Lund (SE)

(73) Assignee: **Sony Corporation**, Tokyo (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.: **15/780,596**

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

(86) PCT No.: **PCT/IB2016/050431**

§ 371 (c)(1),

(2) Date: **May 31, 2018**

(87) PCT Pub. No.: **WO2017/130027**

PCT Pub. Date: **Aug. 3, 2017**

(65) **Prior Publication Data**

US 2018/0366832 A1 Dec. 20, 2018

(51) **Int. Cl.**

H01Q 13/16 (2006.01)

H01Q 1/48 (2006.01)

H04Q 1/38 (2006.01)

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

CPC **H01Q 13/16** (2013.01); **H01Q 1/48** (2013.01); **H04Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/16; H01Q 13/10; H01Q 1/243; H01Q 5/307; H01Q 9/04; H01Q 21/28; H01Q 21/30

See application file for complete search history.

(56) **References Cited**

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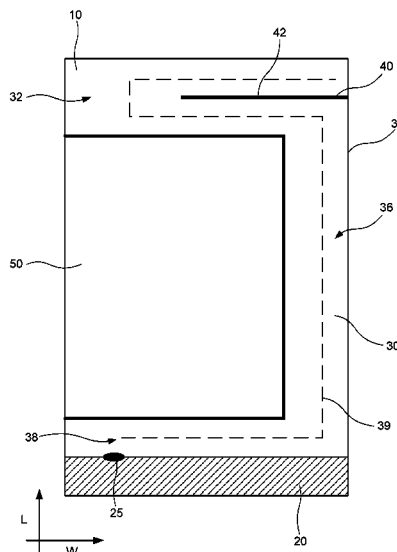
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Tucker Ellis LLP

(57) **ABSTRACT**

The present invention relates to an antenna arrangement on a circuit board (10) extending along a length direction, L, and a width direction, W, the width direction being orthogonal to the length direction. The antenna arrangement comprising: a cell-band antenna (20); a ground plane (30) associated with the cell-band antenna; and a slit antenna (40) arranged in a slit antenna portion (32) of the ground plane, the slit antenna comprising a slit (42) in the ground plane, the slit having in the width direction a slit extension extending from an in the length direction extending edge (34) of the ground plane, the slit extension being 50-95% of an in the width direction extending total width of the slit antenna portion.

15 Claims, 4 Drawing Sheets





US010567561B2

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

(10) **Patent No.:** **US 10,567,561 B2**
(45) **Date of Patent:** ***Feb. 18, 2020**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG Electronics Inc.**, Seoul (KR)

(72) Inventors: **Jaehyuk Kang**, Seoul (KR); **Jinho Jang**, Seoul (KR); **Hyunseok 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.: **16/260,800**

(22) Filed: **Jan. 29, 2019**

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Related U.S. Application Data

(63) Continuation of application No. 16/046,661, filed on Jul. 26, 2018, now Pat. No. 10,230,415, which is a (Continued)

(30) **Foreign Application Priority Data**

Oct. 17, 2013 (KR) 10-2013-0124166

(51) **Int. Cl.**
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(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1637** (2013.01);
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(58) **Field of Classification Search**

CPC G06F 1/1626; G06F 1/1656; G06F 1/203; H04M 1/18; H04M 1/01; H04M 1/02;
(Continued)

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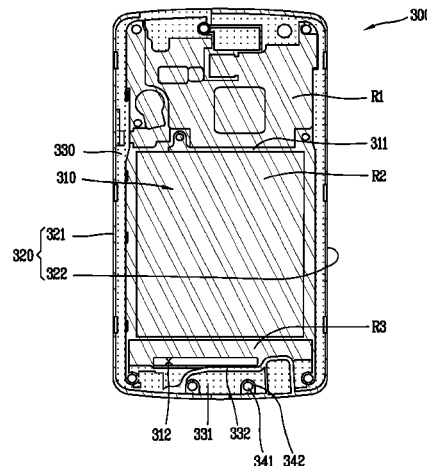
Primary Examiner — Quochien B Vuong

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

(57) **ABSTRACT**

A bar-type mobile terminal can include a wireless communication unit including one or more components which permit wireless communications between the bar type mobile terminal and a wireless communication system; a plurality of antennas configured to transmit or receive radio signals; a metallic frame having a front side and a rear side, the metallic frame including a base portion, an edge portion forming an appearance of the bar-type mobile terminal, an upper through hole disposed in an upper portion of the metallic frame, and a lower through hole disposed in a lower portion of the metallic frame; an upper non-metallic coupling disposed in the upper through hole of the metallic frame; a lower non-metallic coupling disposed in the lower through hole of the metallic frame; a window disposed on the front side of the metallic frame; a display module disposed between the window and the front side of the metallic frame; a first waterproof layer disposed between the window and a front side of the edge portion of the metallic frame; a cover disposed on the rear side of the metallic frame; a first printed circuit board (PCB) disposed between the cover and the rear side of the metallic frame, wherein the

(Continued)





US010581167B2

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

(10) **Patent No.:** **US 10,581,167 B2**
(45) **Date of Patent:** **Mar. 3, 2020**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Seungwoo Ryu**, Seoul (KR); **Joohee Lee**, Seoul (KR); **Wonwoo Lee**, Seoul (KR); **Junyoung Jung**, Seoul (KR); **Ansun Hyun**, 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 109 days.

(21) Appl. No.: **15/878,270**

(22) Filed: **Jan. 23, 2018**

(65) **Prior Publication Data**

US 2019/0013584 A1 Jan. 10, 2019

(30) **Foreign Application Priority Data**

Jul. 5, 2017 (KR) 10-2017-0085553

(51) **Int. Cl.**

H01Q 5/35 (2015.01)

H01Q 3/26 (2006.01)

H01Q 1/24 (2006.01)

H01Q 25/00 (2006.01)

H01Q 9/04 (2006.01)

H01Q 21/08 (2006.01)

H01Q 1/22 (2006.01)

H01Q 21/00 (2006.01)

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

CPC **H01Q 5/35** (2015.01); **H01Q 1/2283** (2013.01); **H01Q 1/243** (2013.01); **H01Q 3/26** (2013.01); **H01Q 9/0485** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 21/08** (2013.01); **H01Q 25/00** (2013.01)

(58) **Field of Classification Search**

CPC **H01Q 5/35**; **H01Q 21/0006**; **H01Q 1/2283**; **H01Q 1/243**; **H01Q 21/08**; **H01Q 3/26**; **H01Q 9/0485**; **H01Q 25/00**; **H01Q 1/24**

USPC 343/893

See application file for complete search history.

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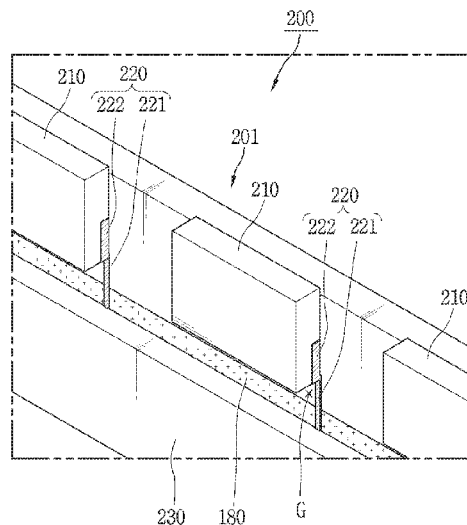
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

An electronic device includes: a body; a circuit board disposed in the body; and an antenna device mounted to one region of the body, and having first and second antenna units spaced apart from each other by a specific interval, in order to transceive a radio signal at a specific frequency band, wherein each of the first and second antenna units includes: a dielectric substance disposed to form a gap with the circuit board; an antenna chip disposed at the circuit board; and a pair of feeding portions for connecting the antenna chip with the dielectric substance.

14 Claims, 9 Drawing Sheets





US010581169B2

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

(10) **Patent No.:** **US 10,581,169 B2**
(45) **Date of Patent:** **Mar. 3, 2020**

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

5/371 (2015.01); *H01Q 7/00* (2013.01); *H01Q*
3/24 (2013.01); *H01Q 5/50* (2015.01); *H01Q*
21/00 (2013.01)

(71) Applicants: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR); **Industry-Academic
Cooperation Foundation, Yonsei
University**, Seoul (KR)

(58) **Field of Classification Search**
CPC *H01Q 1/243*; *H01Q 3/24*;
H01Q 5/50; *H01Q 21/00*
USPC 343/702, 700, 876, 853, 724, 725
See application file for complete search history.

(72) Inventors: **Sung-Soo Kim**, Gyeonggi-do (KR);
Young-Joong Yoon, Seoul (KR);
Seon-Ho Lim, Seoul (KR)

(56) **References Cited**

(73) Assignees: **Samsung Electronics Co., Ltd** (KR);
**Industry-Academic Cooperation
foundation, Yonsei University** (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 0 days.

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343/702

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(21) Appl. No.: **16/020,387**

Primary Examiner — Joseph J Lature

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

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

(65) **Prior Publication Data**

US 2019/0067821 A1 Feb. 28, 2019

(30) **Foreign Application Priority Data**

Aug. 25, 2017 (KR) 10-2017-0107845

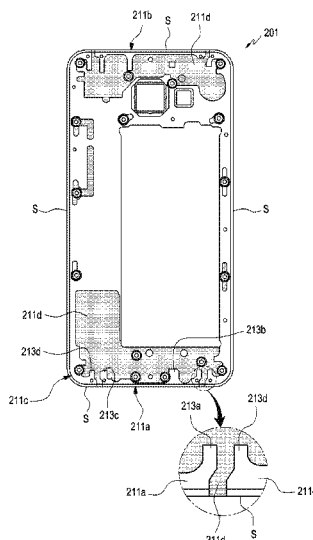
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/371 (2015.01)
H01Q 3/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 5/50 (2015.01)

An antenna device is provided. The antenna device includes a first radiating conductor including a feeding portion and a radiating portion extending from the feeding portion, the feeding portion including a feeding terminal and a shorting pin, a ground electrically connected with the first radiating conductor via the shorting pin and configured to provide a reference potential for the first radiating conductor, and a first switch circuit provided on a side of the radiating portion and configured to selectively connect the radiating portion with the ground. The first radiating conductor is configured to form at least part of an inverted-F antenna structure when the first switch circuit is open and to form at least part of a loop antenna structure when the first switch circuit is closed.

(52) **U.S. Cl.**
CPC *H01Q 9/0421* (2013.01); *H01Q 1/243*
(2013.01); *H01Q 3/247* (2013.01); *H01Q*

19 Claims, 5 Drawing Sheets





US010582031B2

(12) **United States Patent**
Hu

(10) **Patent No.:** **US 10,582,031 B2**
(45) **Date of Patent:** **Mar. 3, 2020**

(54) **ELECTRONIC DEVICE AND CONTROL METHOD THEREOF**

(56) **References Cited**

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

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(72) Inventor: **Jianghua Hu**, Dongguan (CN)

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

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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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Primary Examiner — Tuan A Tran

(74) *Attorney, Agent, or Firm* — Ladas & Parry, LLP

(57)

ABSTRACT

An electronic device is provided. The electronic device includes a first electronic component, a second electronic component, a holder, and an antenna assembly. The second electronic component is slidably coupled to the first electronic component. The holder is coupled to the second electronic component and inserted into the first electronic component. The antenna assembly includes a radio frequency (RF) module, an antenna radiator, and an RF cable. The RF module is disposed in the first electronic component. The antenna radiator is disposed in the second electronic component. An end of the RF cable is coupled to the antenna radiator and the holder, and another end of the RF cable is coupled to the radio frequency module. The RF cable is retracted and stretched when the holder is driven to slide by sliding the second electronic component. A control method of the electronic device is also provided.

20 Claims, 15 Drawing Sheets

(65) **Prior Publication Data**

US 2019/0306292 A1 Oct. 3, 2019

(30) **Foreign Application Priority Data**

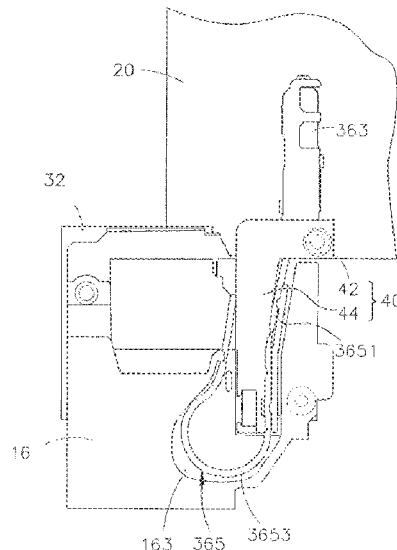
Mar. 30, 2018 (CN) 2018 1 0298360

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/0235** (2013.01); **H01Q 1/244**
(2013.01); **H04M 1/0264** (2013.01); **H04M**
1/0266 (2013.01)

(58) **Field of Classification Search**
None

See application file for complete search history.





US010587032B2

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

(10) **Patent No.:** **US 10,587,032 B2**
(45) **Date of Patent:** **Mar. 10, 2020**

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

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

(72) Inventors: **Woosup Lee**, Gyeonggi-do (KR);
Yeonwoo Kim, Gyeonggi-do (KR);
Jungsik Park, Gyeonggi-do (KR);
Seunggil Jeon, Gyeonggi-do (KR);
Juseok Noh, Gyeonggi-do (KR);
Jaebong Chun, Gyeonggi-do (KR);
Hyunju Hong, 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 11 days.

(21) Appl. No.: **15/846,544**

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

(65) **Prior Publication Data**
US 2018/0108977 A1 Apr. 19, 2018

Related U.S. Application Data
(63) Continuation of application No. 14/873,595, filed on
Oct. 2, 2015, now Pat. No. 9,853,348.

(30) **Foreign Application Priority Data**
Oct. 8, 2014 (KR) 10-2014-0135898

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/40**
(2013.01); **H01Q 1/42** (2013.01); **H01Q 9/26**
(2013.01);
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(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/40; H01Q 1/42;
H01Q 9/26; H01Q 9/42; H01Q 21/2821;
H01Q 21/29

See application file for complete search history.

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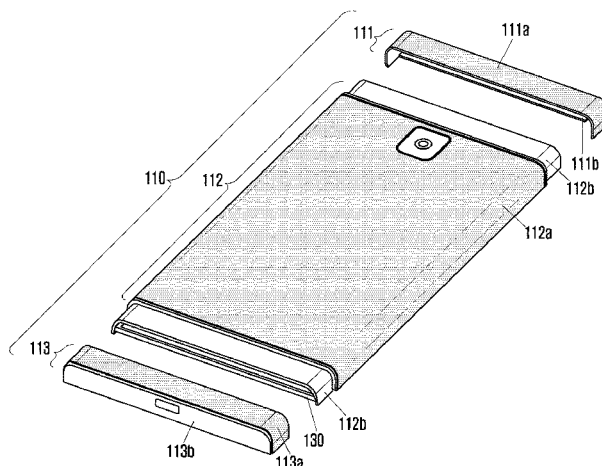
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An electronic device having a housing formed of a conductive material, and an antenna device thereof. The electronic device includes a housing provided with a plurality of housing modules, and a printed circuit board positioned inside the housing, and having an antenna power feeding unit electrically connected to the printed circuit board. The plurality of housing modules may be at least partially formed of a conductive material. At least one of the conductive materials of the plurality of housing modules may be electrically connected to the antenna power feeding unit of the printed circuit board so as to function as an antenna of the electronic device. Various embodiments may be made based on the technical idea of the present disclosure.

21 Claims, 12 Drawing Sheets





US010587045B2

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

(10) **Patent No.:** **US 10,587,045 B2**
(45) **Date of Patent:** **Mar. 10, 2020**

(54) **ANTENNA DEVICE**

(56) **References Cited**

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi,
Kanagawa (JP)

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(73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **16/046,771**

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

(65) **Prior Publication Data**

US 2018/0358700 A1 Dec. 13, 2018

Related U.S. Application Data

(63) Continuation of application No.
PCT/JP2016/052484, filed on Jan. 28, 2016.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 5/371 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 5/335** (2015.01); **H01Q 5/50**
(2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/24; H01Q 1/243;
H01Q 1/38; H01Q 1/44; H01Q 1/48;
(Continued)

Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Arent Fox LLP

(57) **ABSTRACT**

An antenna device includes: a ground plane having an edge;
a matching circuit; and a T-shaped antenna element includ-
ing a first element and a second element extending from a
feed point to a first and second end parts. The first element
has a resonance frequency that is higher than a first fre-
quency. The second element has a resonance frequency
between a second frequency and a third frequency. A first
value obtained by dividing a length from a corresponding
point to a first bend part by the first wavelength is less than
or equal to a second value obtained by dividing a length
from the corresponding point to a second bend part by the
second wavelength. An imaginary component of an imped-
ance of the matching circuit takes a positive value at the first

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