US011588220B2

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

(10) **Patent No.: US 11,588,220 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA MODULE TO WHICH DIELECTRIC SHEET IS ATTACHED**

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

(72) Inventors: **Yunbum Lee**, Suwon-si (KR); **Seongbeom Hong**, Suwon-si (KR); **Kyunghoon Moon**, Suwon-si (KR); **Seunggil Jeon**, Suwon-si (KR); **Jaeyoung Huh**, Suwon-si (KR); **Jinsang Kim**, Suwon-si (KR); **Sungchul Park**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 132 days.

(21) Appl. No.: **17/162,110**

(22) Filed: **Jan. 29, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 1/02 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/02*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/40*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/02; H01Q 1/243; H01Q 1/2283; H01Q 1/40; H01Q 9/0407; H01Q 19/09; H01Q 21/08; H01Q 21/28; H01Q 23/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,926,136 A 7/1999 Ohtsuka et al.
10,141,625 B1 11/2018 Ryu et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2019097026 A 6/2019
KR 10-2020-0011183 A 2/2020

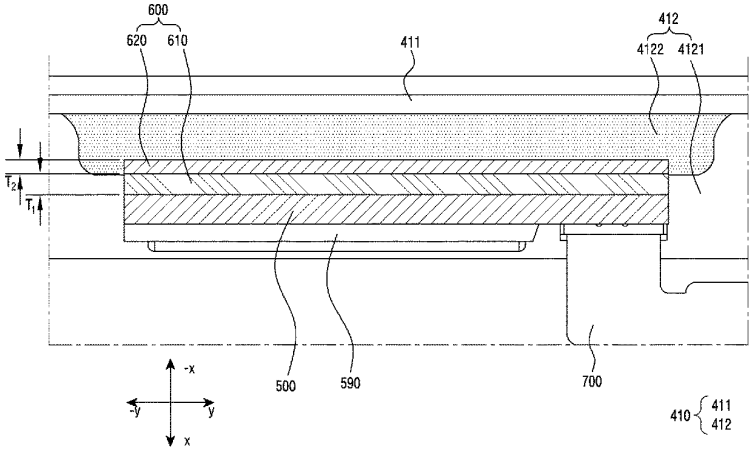
OTHER PUBLICATIONS

International Search Report and written opinion dated May 26, 2021, issued in International Application No. PCT/KR2021/001235.
(Continued)

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a display having a first surface, a metal frame structure configured to form a side surface of the electronic device, a rear plate having a second surface facing a third direction, at least one antenna module disposed inside the side surface and having a radiation surface, at least one dielectric layer having at least a partial region attached to the radiation surface, and a wireless communication circuit configured to transmit or receive an radio frequency (RF) signal to or from the at least one antenna module, in which the at least one dielectric layer includes a first dielectric sheet and a second dielectric sheet, in which the first dielectric sheet is made of a thermal conductive material having a first permittivity and the second dielectric sheet is
(Continued)



US011588244B2

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

(10) **Patent No.: US 11,588,244 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **ANTENNA STRUCTURE**

(71) Applicants: **Chun-Cheng Chan**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Chao-Lin Wu**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW); **Chih-Heng Lin**, Taipei (TW)

(72) Inventors: **Chun-Cheng Chan**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Chao-Lin Wu**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW); **Chih-Heng Lin**, Taipei (TW)

(73) Assignee: **COMPAL ELECTRONICS, INC.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 278 days.

(21) Appl. No.: **16/995,784**

(22) Filed: **Aug. 17, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 3, 2020 (TW) 109106932

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 5/371 (2015.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/371*** (2015.01); ***H01Q 1/521*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 1/38; H01Q 9/0407; H01Q 9/42; H01Q 1/521; H01Q 1/12;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,330,156 B2 2/2008 Arkko et al.
2016/0285161 A1 * 9/2016 Apaydin H01Q 1/525
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102832448 12/2012
TW 201301660 1/2013
(Continued)

OTHER PUBLICATIONS

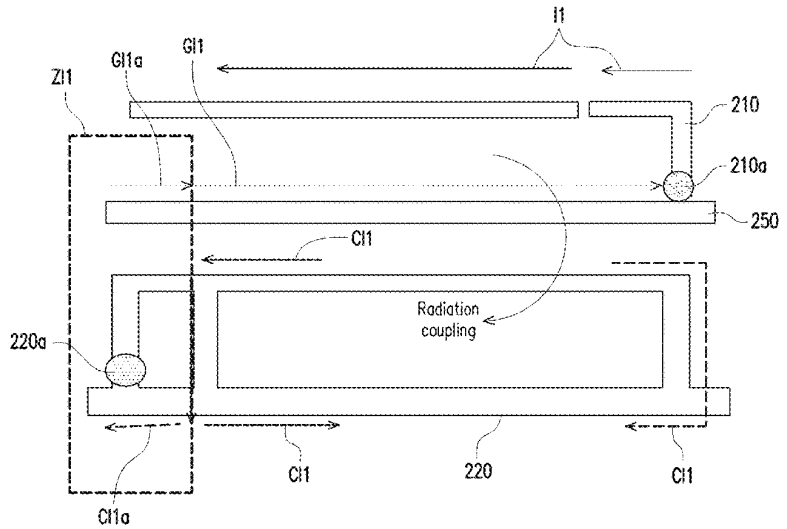
"Office Action of Taiwan Counterpart Application", dated Nov. 13, 2020, p. 1-p. 8.
(Continued)

Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

The disclosure provides an antenna structure, including at least one supporting module, a first antenna, and a second antenna. The first antenna is disposed on the at least one supporting module and includes a first feeding point and a first zero-current zone. The first antenna is connected to a ground plane. The second antenna is disposed on the at least one supporting module and includes a second feeding point and a second zero-current zone. The second antenna is connected to the ground plane. The first feeding point of the first antenna is disposed in the second zero-current zone of the second antenna, and the second feeding point of the second antenna is disposed in the first zero-current zone of the first antenna.

22 Claims, 24 Drawing Sheets



US011588245B2

(12) **United States Patent**
Wei

(10) **Patent No.: US 11,588,245 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **MOBILE DEVICE**

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(72) Inventor: **Shih-Chiang Wei**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 785 days.

(21) Appl. No.: **16/655,926**

(22) Filed: **Oct. 17, 2019**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 28, 2018 (TW) 107142393

(51) **Int. Cl.**

H01Q 5/392	(2015.01)
H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/15	(2015.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 5/392*** (2015.01); ***H01Q 1/24*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/15*** (2015.01); ***H01Q 13/10*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 1/38; H01Q 5/392; H01Q 5/15; H01Q 13/106; H01Q 1/24; H01Q 13/10

USPC ..... 343/700 MS

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,099,766	B2	8/2015	Chan et al.	
10,056,696	B2	8/2018	Tseng et al.	
2009/0153407	A1	6/2009	Zhang et al.	
2010/0207835	A1 *	8/2010	Taura	H01Q 13/10 343/770

(Continued)

FOREIGN PATENT DOCUMENTS

CN	104617379 A	5/2015
CN	206076499 U	4/2017
TW	M537316 U	2/2017

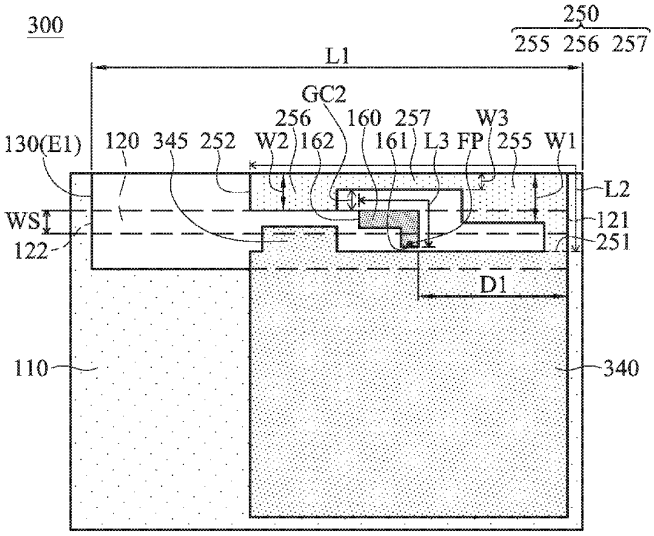
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a dielectric substrate, a ground plane, a parasitic radiation element, and a feeding radiation element. A connection end of the parasitic radiation element is coupled to the ground plane. The parasitic radiation element includes a first widening portion, which is positioned at a bend of the parasitic radiation element. The parasitic radiation element has a vertical projection on the metal mechanism element. The vertical projection at least partially overlaps a first closed end of the slot. The feeding radiation element is disposed between the parasitic radiation element and the ground plane. The dielectric substrate is adjacent to the metal mechanism element. The parasitic radiation element and the feeding radiation element are disposed on the dielectric substrate. An antenna structure is formed by the parasitic radiation element, the feeding radiation element, and the slot of the metal mechanism element.

19 Claims, 7 Drawing Sheets



US011588247B2

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

(10) **Patent No.: US 11,588,247 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **ANTENNA APPARATUS**

(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Woncheol Lee**, Suwon-si (KR); **Youngsik Hur**, Suwon-si (KR); **Wongi Kim**, Suwon-si (KR); **Jeongki Ryoo**, Suwon-si (KR); **Nam Ki Kim**, Suwon-si (KR); **Sungyong An**, Suwon-si (KR); **Jaemin Keum**, Suwon-si (KR); **Dongok Ko**, Suwon-si (KR)

(73) Assignee: **Samsung Electro-Mechanics 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 58 days.

(21) Appl. No.: **17/031,163**

(22) Filed: **Sep. 24, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 9, 2020 (KR) 10-2020-0084527

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/35 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/35*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 1/48; H01Q 5/35
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,153,600 A * 10/1992 Metzler ..... H01Q 9/0414 343/700 MS
6,384,785 B1 5/2002 Kamogawa et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 203883119 U * 10/2014
KR 10-2009-0130922 12/2009
KR 10-1844839 B1 4/2018

OTHER PUBLICATIONS

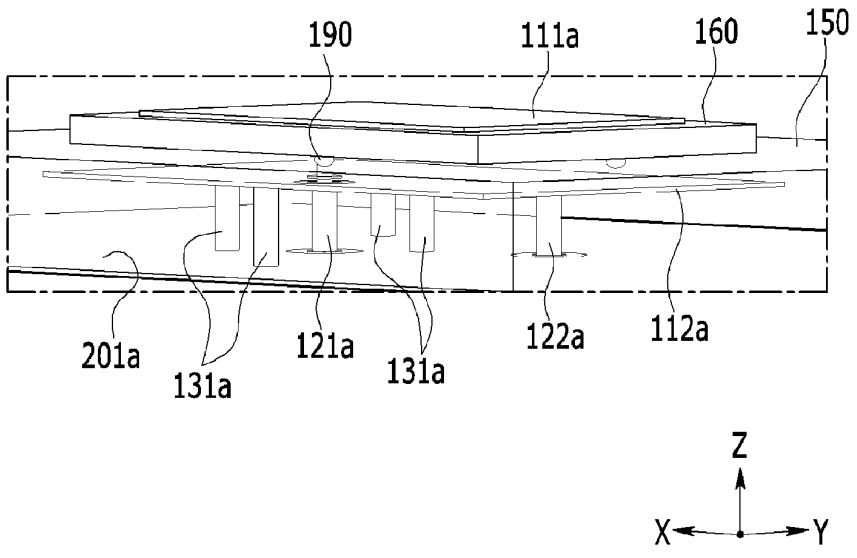
Sharma, Devendra Kumar, et al. "Shared Aperture Dual Band Dual Polarization Microstrip Patch Antenna", *Microwave and Optical Technology Letters*, vol. 55, Issue 4, 2013 (pp. 917-922).
(Continued)

Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

An antenna apparatus includes: a first dielectric layer having a first dielectric constant; a first patch antenna pattern disposed in the first dielectric layer; a second dielectric layer having a second dielectric constant; a second patch antenna pattern disposed on the second dielectric layer; a first feed via coupled to the first patch antenna pattern; and a second feed via coupled to the second patch antenna pattern. The first dielectric constant is higher than the second dielectric constant, and a frequency of a signal transmitted/received by the first patch antenna pattern is lower than a frequency of a signal transmitted/received by the second patch antenna pattern.

17 Claims, 12 Drawing Sheets



US011588253B2

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

(10) **Patent No.: US 11,588,253 B2**
(45) **Date of Patent: Feb. 21, 2023**

(54) **ANTENNA INCLUDING CONDUCTIVE PATTERN AND ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Donghun Shin**, Suwon-si (KR); **Mincheol Seo**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR); **Yoonjae Lee**, Suwon-si (KR); **Byungman Lim**, Suwon-si (KR); **Jaebong Chun**, Suwon-si (KR)

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

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

(21) Appl. No.: **17/748,670**

(22) Filed: **May 19, 2022**

(65) **Prior Publication Data**

US 2022/0285854 A1 Sep. 8, 2022

Related U.S. Application Data

(63) Continuation of application No. 17/397,113, filed on Aug. 9, 2021, now Pat. No. 11,367,966, which is a (Continued)

(30) **Foreign Application Priority Data**

Feb. 19, 2019 (KR) 10-2019-0019113

(51) **Int. Cl.**
H01Q 9/44 (2006.01)
H01Q 21/06 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/062*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/065*** (2013.01); *H01Q 1/24* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 21/062; H01Q 1/38; H01Q 21/065; H01Q 1/243; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,119,748 B2 10/2006 Autti
7,623,073 B2 11/2009 Teshirogi et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101103491 A 1/2008
CN 102823062 A 12/2012
(Continued)

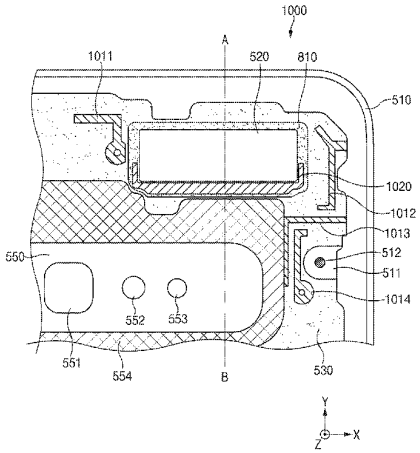
OTHER PUBLICATIONS

Extended European Search Report dated Jun. 30, 2020, issued in European Patent Application No. 20158178.2.
(Continued)

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

(57) **ABSTRACT**

An electronic device including an antenna and a conductive pattern formed around the antenna is provided. The electronic device includes a housing including a first plate, a second plate facing away from the first plate, and a side member surrounding a space between the first plate and the second plate, connected to the second plate or integrally formed with the second plate, and including a conductive material, an injection-molding material disposed in the space between the first plate and the second plate in the housing and formed of a non-conductive material, an
(Continued)



US011594157B2

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

(10) **Patent No.: US 11,594,157 B2**
(45) **Date of Patent: *Feb. 28, 2023**

(54) **FOLDABLE ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Hojin Jung**, Suwon-si (KR); **Boochul Bae**, Suwon-si (KR); **Jongoh Lim**, Suwon-si (KR)

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/377,501**

(22) Filed: **Jul. 16, 2021**

(65) **Prior Publication Data**

US 2021/0343195 A1 Nov. 4, 2021

Related U.S. Application Data

(63) Continuation of application No. 16/536,558, filed on Aug. 9, 2019, now Pat. No. 11,069,265.

(30) **Foreign Application Priority Data**

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Aug. 2, 2019 (KR) 10-2019-0094397

(51) **Int. Cl.**
G06F 1/16 (2006.01)
G09F 9/30 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G09F 9/301*** (2013.01); ***G06F 1/1656*** (2013.01); ***G06F 1/1681*** (2013.01); *H01Q 1/08* (2013.01); *H01Q 1/22* (2013.01); *H04M 1/0214* (2013.01)

(58) **Field of Classification Search**
CPC G06F 1/1652; G06F 1/1681; G06F 1/1698
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,359,707 A * 11/1982 Spannhake H04N 9/29 361/150
5,394,160 A * 2/1995 Iwasaki H04B 1/38 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

EP 2 690 844 1/2014
EP 3 343 693 7/2018

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 16/536,558, filed Aug. 9, 2019; Jung et al.

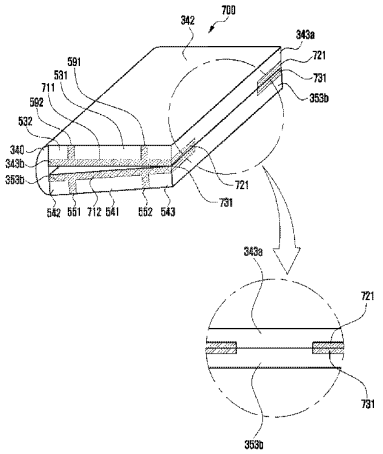
(Continued)

Primary Examiner — Adrian S Wilson
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

Various embodiments relate to an electronic device including an antenna. The electronic device may include: a foldable housing; a flexible display disposed on the foldable housing wherein at least a part of the flexible display is configured to be folded; and a frame disposed on a boundary portion of the flexible display and coupled to a side member of the foldable housing. The side member may include a conductive portion electrically connected to a communication circuit, and the frame may include a low-permittivity material.

18 Claims, 16 Drawing Sheets



US011594806B2

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

(10) **Patent No.: US 11,594,806 B2**
(45) **Date of Patent: Feb. 28, 2023**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA MODULE**

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

(72) Inventors: **Jaewoong Jeon**, Suwon-si (KR); **Jaewun Lee**, Suwon-si (KR); **Jaeyoung Huh**, Suwon-si (KR); **Chanyoul Park**, Suwon-si (KR); **Hojong Kim**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 221 days.

(21) Appl. No.: **17/154,811**

(22) Filed: **Jan. 21, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 1/42	(2006.01)
H05K 7/14	(2006.01)
H05K 5/00	(2006.01)
H04B 1/3827	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/42*** (2013.01); ***H05K 5/0017*** (2013.01); ***H05K 7/1427*** (2013.01); *H04B 1/3827* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/42; H05K 5/00; H05K 7/14; H04B 1/38

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,859,607 B2	1/2018	Hwang et al.
10,056,695 B2	8/2018	Ayala Vazquez et al.
2004/0145521 A1	7/2004	Hebron et al.

(Continued)

OTHER PUBLICATIONS

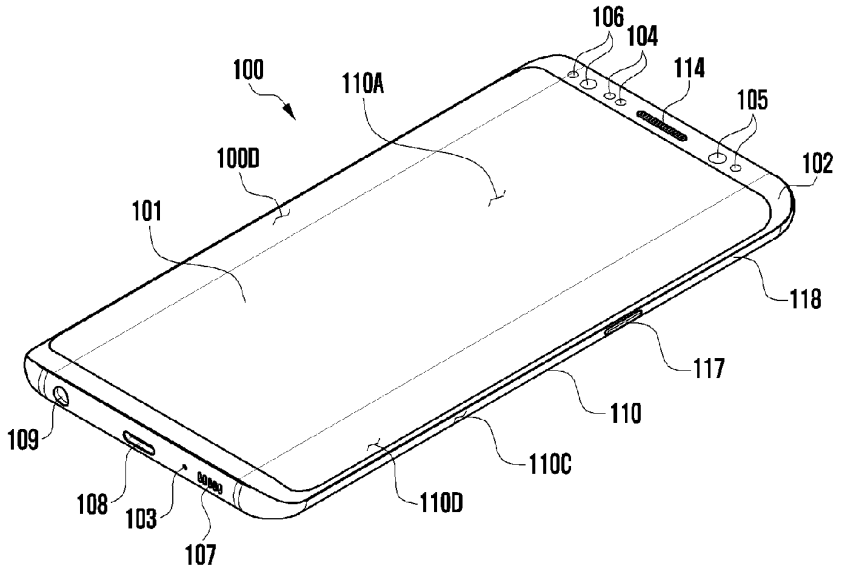
International Search Report and Written Opinion of the International Searching Authority in connection with International Application No. PCT/KR2020/017911 dated Mar. 15, 2021, 6 pages.

Primary Examiner — Andrea Lindgren Baltzell

(57) **ABSTRACT**

Provided is an electronic device including an antenna module. The electronic device may include: a housing constituting an external appearance of the electronic device, a support member including a first bridge, a printed circuit board coupled to one surface of the support member, a first antenna constituting a first part of the housing and connected to the support member through the first bridge, a second antenna constituting a second part of the housing, a cut-off portion separating the first antenna and the second antenna, and a first connection member and a second connection member coupled to the first bridge. The first connection member may be connected to a ground of the printed circuit board through a first capacitor and may be disposed closer to the cut-off portion than the second connection member connected to the ground of the printed circuit board through a second capacitor. Other embodiments are also possible.

20 Claims, 14 Drawing Sheets



US011600913B2

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

(10) **Patent No.: US 11,600,913 B2**
(45) **Date of Patent: Mar. 7, 2023**

(54) **ANTENNA BOARD**

(71) Applicant: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR)

(72) Inventors: **Ju Ho Kim**, Suwon-si (KR); **Chan Jin Park**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRO-MECHANICS 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 167 days.

(21) Appl. No.: **17/182,671**

(22) Filed: **Feb. 23, 2021**

(65) **Prior Publication Data**

US 2022/0209397 A1 Jun. 30, 2022

(30) **Foreign Application Priority Data**

Dec. 30, 2020 (KR) 10-2020-0187396

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 5/335 (2015.01)
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 9/0407*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/243; H01Q 5/335; H01Q 9/0407; H01Q 1/2283; H01Q 21/28; H01Q 9/0414; H05K 1/0298; H05K 1/03; H05K 1/16; H05K 1/18
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2019/0027804	A1*	1/2019	Kim	H01L 24/20
2019/0051989	A1	2/2019	Kim et al.	
2019/0221917	A1*	7/2019	Kim	H01Q 1/2283
2020/0259267	A1*	8/2020	Park	H01Q 21/0025
2020/0335860	A1*	10/2020	Hasegawa	H01Q 1/40
2021/0066814	A1*	3/2021	Kim	H01Q 21/065
2021/0175609	A1*	6/2021	Ryoo	H01Q 1/2283
2021/0320416	A1*	10/2021	Cho	H01Q 21/065

FOREIGN PATENT DOCUMENTS

JP	4905231 B2	3/2012
KR	10-2019951 B1	9/2019

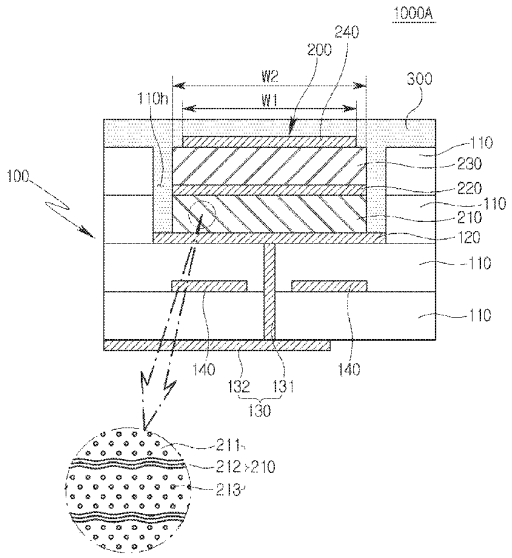
* cited by examiner

Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

An antenna board includes a first base board unit including a first insulating layer having a first receiving groove; a first antenna board unit disposed in the first receiving groove, including a second insulating layer and a third insulating layer disposed on the second insulating layer, and further including at least one of a first patch pattern disposed on the second insulating layer and covered by the third insulating layer and a second patch pattern disposed on the third insulating layer; and a first encapsulant covering at least a portion of the first antenna board unit and filling at least a portion of the first receiving groove, wherein a dielectric constant of the second insulating layer is different from a dielectric constant of the third insulating layer.

17 Claims, 8 Drawing Sheets



US011600921B1

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

(10) **Patent No.: US 11,600,921 B1**
(45) **Date of Patent: Mar. 7, 2023**

(54) **DUAL BAND ANTENNA AND ELECTRONIC DEVICE USING THE SAME**

(71) Applicant: **USI Science and Technology (Shenzhen) Co., Ltd.**, Shenzhen (CN)

(72) Inventors: **Shing-Hau Chen**, Shenzhen (CN); **Hung-Wei Chiu**, Shenzhen (CN); **Jui-Chih Chien**, Shenzhen (CN); **Shun-Chuan Yu**, Shenzhen (CN)

(73) Assignee: **USI SCIENCE AND TECHNOLOGY (SHENZHEN) CO., LTD.**, Shenzhen (CN)

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

(21) Appl. No.: **17/565,537**

(22) Filed: **Dec. 30, 2021**

(30) **Foreign Application Priority Data**

Oct. 15, 2021 (CN) 202111202089.6

(51) **Int. Cl.**

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H01Q 1/24	(2006.01)
H01Q 7/00	(2006.01)
H01Q 9/40	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/364*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/40*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/364; H01Q 1/243; H01Q 7/00; H01Q 9/40
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0237307 A1* 9/2009 Tsai ..... H01Q 1/38 343/700 MS
2018/0131075 A1* 5/2018 Huang H01Q 9/42
2018/0278287 A1 9/2018 Nishikawa et al.

FOREIGN PATENT DOCUMENTS

CN 108123729 A 6/2018
TW I347038 B 8/2011
TW I366950 B 6/2012

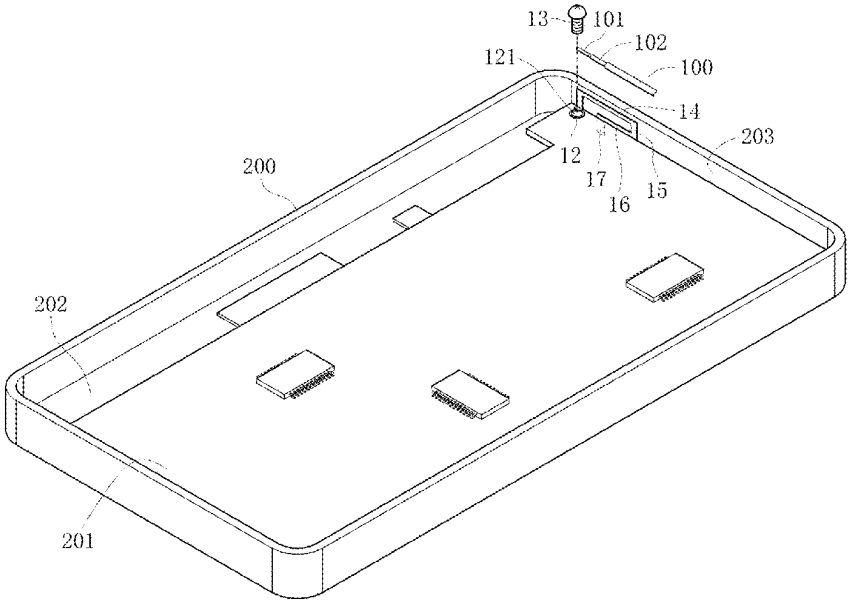
* cited by examiner

Primary Examiner — Daniel Munoz
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A dual band antenna and an electronic device are provided. The dual band antenna includes a feed end, an annular connection end, a metal screw, a first extension path, a second extension path, a third extension path, and a grounding part. The annular connection end has an opening and is connected to the feed end. The metal screw has a threaded stud passing through the opening, so that the metal screw is electrically connected to the annular connection end. The feed end, the first extension path, the second extension path, the third extension path, and the grounding part are sequentially connected to each other. The dual band antenna is configured to have a monopole antenna and a loop antenna, so that the dual band antenna has a wide operating frequency band, and the monopole antenna operates at 3.6 GHz and the loop antenna operates at 4.6 GHz.

11 Claims, 6 Drawing Sheets



US011600925B2

(12) **United States Patent**
Huang

(10) **Patent No.: US 11,600,925 B2**
(45) **Date of Patent: Mar. 7, 2023**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(72) Inventor: **Chun-Lin Huang**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (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.: **17/335,329**

(22) Filed: **Jun. 1, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 20, 2020 (TW) 109124394

(51) **Int. Cl.**
H01Q 7/04 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/10 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 7/04*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/36; H01Q 1/38; H01Q 5/10; H01Q 5/20; H01Q 5/307; H01Q 5/385; H01Q 7/00; H01Q 7/04; H01Q 9/30; H01Q 9/42; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,490,541 B2 * 11/2016 Tayama H01Q 5/357
2010/0156736 A1 * 6/2010 Chung H01Q 1/2208 343/793

FOREIGN PATENT DOCUMENTS

CN 206650166 U * 11/2017
CN 206650166 U 11/2017
CN 108987919 A * 12/2018
CN 109687121 A * 4/2019
KR 100724491 B1 * 6/2007
KR 20220050589 A * 4/2022

* cited by examiner

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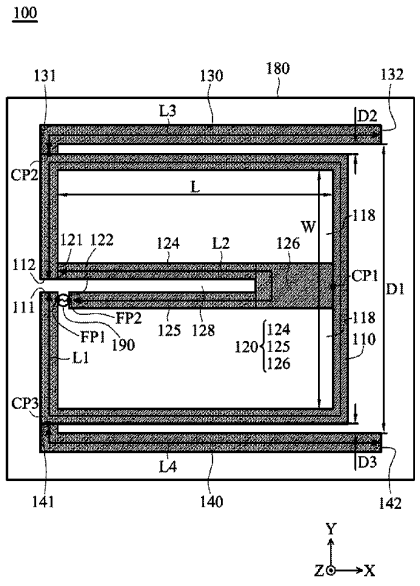
Assistant Examiner — Leah Rosenberg
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a loop radiation element, a balance radiation element, a first additional radiation element, and a second additional radiation element. The loop radiation element has a first feeding point. The balance radiation element has a second feeding point. The balance radiation element is coupled to at least a first connection point on the loop radiation element. The balance radiation element is substantially surrounded by the loop radiation element. The first additional radiation element is coupled to a second connection point on the loop radiation element. The second additional radiation element is coupled to a third connection point on the loop radiation element. The loop radiation element is disposed between the first additional radiation element and the second additional radiation element.

20 Claims, 9 Drawing Sheets



US011604273B2

(12) **United States Patent**
Wintermantel

(10) **Patent No.: US 11,604,273 B2**
(45) **Date of Patent: Mar. 14, 2023**

(54) **RADAR SYSTEM FOR DETECTING THE ENVIRONMENT OF A MOTOR VEHICLE HAVING A PLASTIC ANTENNA**

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(72) Inventor: **Markus Wintermantel**, Lindau (DE)

(73) Assignee: **Conti Temic microelectronic GmbH**, Nüremberg (DE)

(*) 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.: **17/007,725**

(22) Filed: **Aug. 31, 2020**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/DE2019/200010, filed on Feb. 5, 2019.

(30) **Foreign Application Priority Data**

Mar. 1, 2018 (DE) 10 2018 203 106.1

(51) **Int. Cl.**
G01S 13/931 (2020.01)
G01S 13/87 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G01S 13/931*** (2013.01); ***G01S 13/87*** (2013.01); ***H01Q 1/3283*** (2013.01)

(58) **Field of Classification Search**
CPC G06K 19/0704
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,050,494 A * 4/2000 Song G06K 19/0704 349/1
6,097,271 A * 8/2000 Kozakoff H01Q 1/38 428/323

(Continued)

FOREIGN PATENT DOCUMENTS

DE 19859999 C1 8/2000
DE 102014200660 A1 1/2012

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion dated May 21, 2019 from corresponding International Patent Application No. PCT/DE2019/200010.

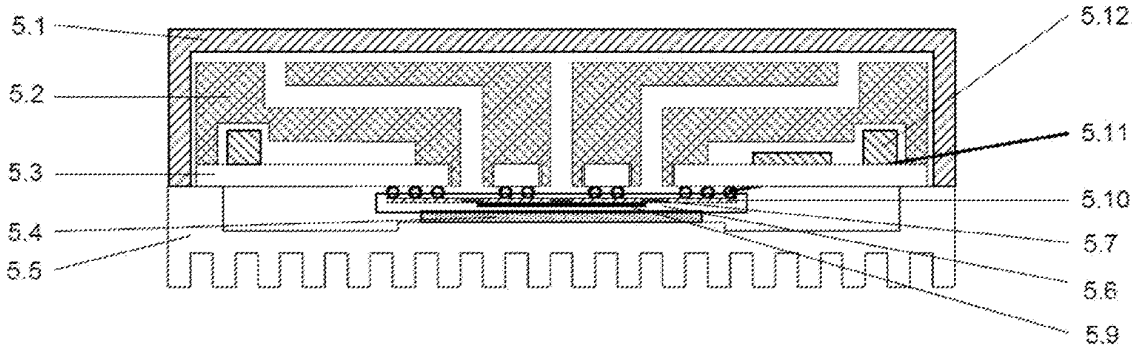
(Continued)

Primary Examiner — Bernarr E Gregory

(57) **ABSTRACT**

A radar system for detecting the environment of a motor vehicle includes an antenna assembly comprising plastic and including one or more individual antennas for transmitting and/or receiving radar signals. A circuit board includes at least one area that is permeable by radar waves. At least one high-frequency component is coupled to one side of the circuit board and includes at least one radiating element for direct emission or receipt of radar waves in the direction of the circuit board in the least one area that is permeable by radar waves. The antenna assembly is disposed on the other side of the circuit board opposite the at least one high-frequency component. The antenna assembly includes a coupling/decoupling point disposed in the at least one area of the circuit board permeable by radar waves.

7 Claims, 4 Drawing Sheets



US011605888B2

(12) **United States Patent**
Li

(10) **Patent No.: US 11,605,888 B2**
(45) **Date of Patent: Mar. 14, 2023**

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

(71) Applicant: **VIVO MOBILE COMMUNICATION CO., LTD.**, Chang'an Dongguan (CN)

(72) Inventor: **Rihui Li**, Chang'an Dongguan (CN)

(73) Assignee: **VIVO MOBILE COMMUNICATION CO., LTD.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 626 days.

(21) Appl. No.: **16/625,523**

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

(86) PCT No.: **PCT/CN2018/087637**
§ 371 (c)(1),
(2) Date: **Dec. 20, 2019**

(87) PCT Pub. No.: **WO2018/233420**
PCT Pub. Date: **Dec. 27, 2018**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 201710481298.6

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/328; H01Q 5/335
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0306855 A1 10/2014 Tsai et al.
2014/0335916 A1 11/2014 Thorson et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 103904433 A 7/2014
CN 105896083 A 8/2016
(Continued)

OTHER PUBLICATIONS

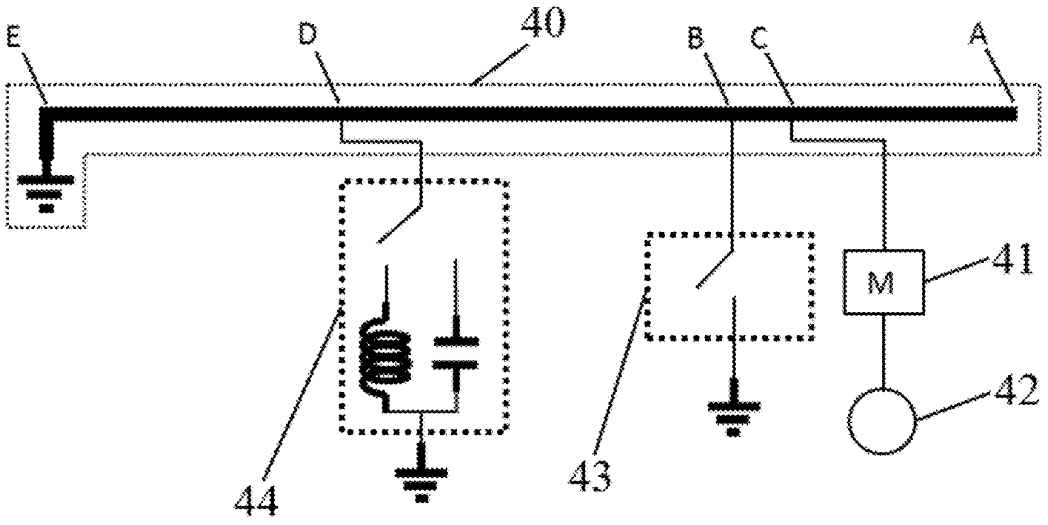
Extended European Search Report related to Application No. 18820854.0 dated May 8, 2020.
(Continued)

Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — von Briesen & Roper, s.c.

(57) **ABSTRACT**

The present disclosure provides an antenna circuit and a mobile terminal. The antenna circuit includes: an antenna unit; a switching circuit connection point and a feed point are arranged on the antenna unit; an antenna feed is connected with the feed point; a first tuning circuit is connected with the switching circuit connection point, the first tuning circuit is configured to increase a bandwidth of a single resonant mode in an intermediate-high frequency and/or to tune a resonant frequency in the intermediate-high frequency; wherein a distance from the feed point to the end of the antenna unit is larger than a distance from the switching circuit connection point to the end of the antenna unit.

19 Claims, 14 Drawing Sheets



US011605903B2

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

(10) **Patent No.: US 11,605,903 B2**
(45) **Date of Patent: Mar. 14, 2023**

(54) **ARRAY ANTENNA APPARATUS AND METHOD FOR MANUFACTURING ARRAY ANTENNA APPARATUS**

(71) Applicant: **Mitsubishi Electric Corporation**, Chiyoda-ku (JP)

(72) Inventors: **Hikaru Watanabe**, Chiyoda-ku (JP); **Takashi Maruyama**, Chiyoda-ku (JP); **Masataka Otsuka**, Chiyoda-ku (JP); **Yu Ushijima**, Chiyoda-ku (JP); **Kazunari Kihira**, Chiyoda-ku (JP)

(73) Assignee: **Mitsubishi Electric Corporation**, Chiyoda-ku (JP)

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(21) Appl. No.: **16/318,924**

(22) PCT Filed: **Aug. 10, 2016**

(86) PCT No.: **PCT/JP2016/073575**
§ 371 (c)(1),
(2) Date: **Jan. 18, 2019**

(87) PCT Pub. No.: **WO2018/029807**
PCT Pub. Date: **Feb. 15, 2018**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 13/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/005*** (2013.01); ***H01Q 5/42*** (2015.01); ***H01Q 13/22*** (2013.01); ***H01Q 21/24*** (2013.01); *H01P 3/123* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/005; H01Q 5/42; H01Q 13/22; H01Q 21/24; H01P 3/123
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,193,830 A 7/1965 Provencher
5,638,079 A 6/1997 Kastner et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 53-47987 4/1978
JP 2-280504 A 11/1990
(Continued)

OTHER PUBLICATIONS

Extended European Search Report dated Jul. 22, 2019 in European Patent Application No. 16912688.5 citing documents AA-AD therein, 8 pages.
(Continued)

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

Waveguide slot array antennas each having slots, that transmit or receive electromagnetic waves and that are formed in a front surface of a waveguide and waveguide slot array antennas each having slots that transmit or receive electromagnetic waves and that are formed in a front surface of a waveguide, and the waveguide slot array antennas and the waveguide slot array antennas are alternately arranged, the waveguide is a ridge waveguide having a ridge formed inside the waveguide, and the waveguide is a ridge waveguide having ridges, formed inside the waveguide.

4 Claims, 13 Drawing Sheets