



US011986238B2

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

(10) **Patent No.:** **US 11,986,238 B2**
(45) **Date of Patent:** **May 21, 2024**

(54) **NON-PUNCTURING MICROWAVE ABLATION ANTENNA AND APPLICATION THEREOF**

(58) **Field of Classification Search**
CPC A61B 18/1815; A61B 2018/183; A61B 17/3496; A61B 2017/00862;
(Continued)

(71) Applicant: **MIMA-PRO (NAN TONG) SCIENTIFIC INC.**, Nantong (CN)

(56) **References Cited**

(72) Inventors: **Jiachang Chi**, Nantong (CN); **Bo Zhai**, Nantong (CN); **Peng Zhang**, Nantong (CN); **Ting Yang**, Nantong (CN)

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(73) Assignee: **MIMA-PRO (NAN TONG) SCIENTIFIC INC.**, Nantong (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 858 days.

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(21) Appl. No.: **17/044,145**

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(22) PCT Filed: **Mar. 12, 2019**

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(86) PCT No.: **PCT/CN2019/077763**
§ 371 (c)(1),
(2) Date: **Sep. 30, 2020**

Primary Examiner — Sean W Collins
(74) *Attorney, Agent, or Firm* — Bayramoglu Law Offices LLC

(87) PCT Pub. No.: **WO2019/223400**
PCT Pub. Date: **Nov. 28, 2019**

(57) **ABSTRACT**

(65) **Prior Publication Data**
US 2021/0113267 A1 Apr. 22, 2021

A non-puncturing microwave ablation antenna, including an irradiator located at a front end of the antenna and an irradiator cover sleeved on the irradiator, where a front end of the irradiator cover is blunt. Because the front end of the irradiator cover is designed to be blunt, the special non-puncturing appearance of the irradiator cover enables the antenna to freely penetrate inside the lung tissue without puncturing blood vessels and bronchi in the lungs. In addition, blood vessels of tumor existing in the Ground-Glass Opacity (GGO) would not be damaged by the blunt head and bleed, thereby reducing a rate of surgery failure caused by that a lesion cannot be identified because of bleeding inside the lung, and in addition, avoiding a possibility that tumor cells spread through a puncturing passage or bleeding blood vessels.

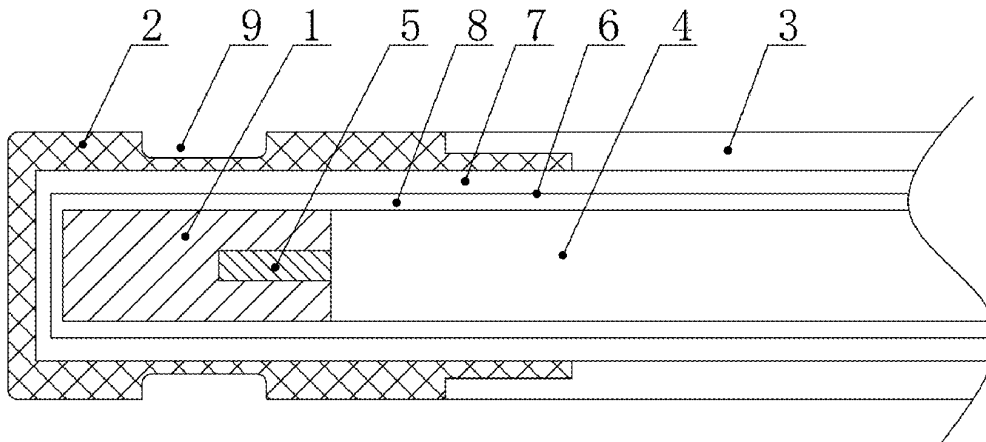
(30) **Foreign Application Priority Data**
May 25, 2018 (CN) 201810516456.1

(51) **Int. Cl.**
A61B 18/18 (2006.01)
A61B 17/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **A61B 18/1815** (2013.01); **A61B 2017/00862** (2013.01); **A61B 2017/3456** (2013.01);

(Continued)

16 Claims, 1 Drawing Sheet





US011996610B2

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

(10) **Patent No.:** **US 11,996,610 B2**
(45) **Date of Patent:** **May 28, 2024**

(54) **ANTENNA AND MANUFACTURING METHOD THEREOF**

(71) Applicant: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Yali Wang**, Beijing (CN); **Dongdong Zhang**, Beijing (CN); **Feng Qu**, Beijing (CN)

(73) Assignee: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 161 days.

(21) Appl. No.: **17/605,630**

(22) PCT Filed: **Nov. 10, 2020**

(86) PCT No.: **PCT/CN2020/127853**

§ 371 (c)(1),
(2) Date: **Oct. 22, 2021**

(87) PCT Pub. No.: **WO2022/099473**

PCT Pub. Date: **May 19, 2022**

(65) **Prior Publication Data**

US 2022/0352623 A1 Nov. 3, 2022

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01P 3/08 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/36** (2013.01); **H01P 3/081** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/36; H01Q 9/04; H01Q 9/0457; H01Q 9/0421; H01P 3/08; H01P 3/081; G02F 1/13
See application file for complete search history.

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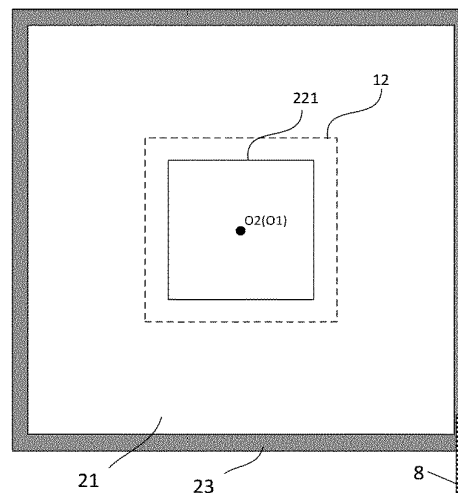
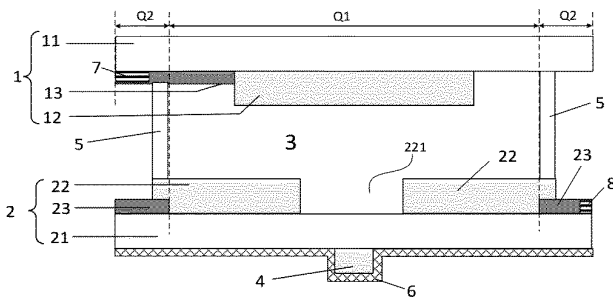
Primary Examiner — Thai Pham

(74) Attorney, Agent, or Firm — HOUTTEMAN LAW LLC

(57) **ABSTRACT**

The present disclosure provides an antenna and a manufacturing method thereof, and belongs to the field of communication technology. The antenna provided by an embodiment of the present disclosure includes: a first substrate and a second substrate opposite to each other, a dielectric layer provided therebetween, and a feed unit on a side of the second substrate away from the first substrate. The first substrate includes: a first base substrate; and a radiation unit on a side of the first base substrate close to the second substrate. The second substrate includes: a second base substrate; and a reference electrode layer on a side of the second base substrate away from the feed unit, the reference electrode layer has an opening, an orthographic projection of the opening on the second base substrate is at least partially overlapped with an orthographic projection of the radiation unit on the second base substrate.

19 Claims, 6 Drawing Sheets





US011996625B2

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

(10) **Patent No.:** **US 11,996,625 B2**
(45) **Date of Patent:** **May 28, 2024**

(54) **MULTI-ANTENNA SYSTEM AND ELECTRONIC DEVICE**

(52) **U.S. Cl.**
CPC **H01Q 3/24** (2013.01); **H01Q 5/314** (2015.01); **H01Q 9/42** (2013.01);
(Continued)

(71) Applicant: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 9/42; H01Q 5/328; H01Q 21/28; H01Q 5/35;
(Continued)

(72) Inventors: **Jiaqing You**, Shanghai (CN); **Hanyang Wang**, Reading (GB); **Xianbin Zhu**, Shanghai (CN); **Yan Wang**, Shenzhen (CN); **Laiwei Shen**, Shanghai (CN); **Liang Xue**, Shanghai (CN); **Qiuliang Xu**, Shenzhen (CN)

(56) **References Cited**

(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (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 131 days.

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(21) Appl. No.: **17/641,198**

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(Continued)

(22) PCT Filed: **Sep. 18, 2020**

(86) PCT No.: **PCT/CN2020/116291**

§ 371 (c)(1),
(2) Date: **Mar. 8, 2022**

Primary Examiner — Linh V Nguyen

(74) *Attorney, Agent, or Firm* — Maier & Maier, PLLC

(87) PCT Pub. No.: **WO2021/052483**

PCT Pub. Date: **Mar. 25, 2021**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2022/0344807 A1 Oct. 27, 2022

A multi-antenna system and an electronic device comprising the same. An intelligent multi-antenna solution in which antennas are laid out at the top, the side, and the bottom of an electronic device is used, so that three antenna groups including a top antenna group, a middle antenna group, and a bottom antenna group are respectively formed, and antenna performance in a plurality of scenarios such as a free-space scenario, a portrait-mode holding scenario, and a landscape-mode holding scenario is considered, to improve antenna radiation efficiency.

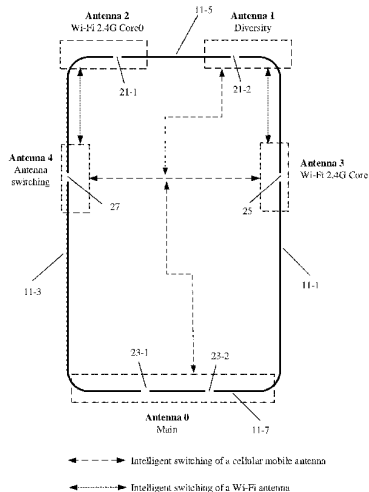
(30) **Foreign Application Priority Data**

Sep. 18, 2019 (CN) 201910883759.1

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

(Continued)

10 Claims, 37 Drawing Sheets





US011996630B2

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

(10) **Patent No.:** **US 11,996,630 B2**
(45) **Date of Patent:** **May 28, 2024**

(54) **ANTENNA STRUCTURE**
(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)
(72) Inventors: **Yu-Chen Zhao**, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Chin-Lung Tsai, Taoyuan (TW);
Ying-Cong Deng, Taoyuan (TW);
Kuan-Hsien Lee, Taoyuan (TW);
Yi-Chih Lo, Taoyuan (TW);
Kai-Hsiang Chang, Taoyuan (TW);
Chun-I Cheng, Taoyuan (TW);
Yan-Cheng Huang, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**,
Taoyuan (TW)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 140 days.

(21) Appl. No.: **17/929,342**

(22) Filed: **Sep. 2, 2022**

(65) **Prior Publication Data**
US 2024/0021988 A1 Jan. 18, 2024

(30) **Foreign Application Priority Data**
Jul. 13, 2022 (TW) 111126333

(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 1/48 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/30** (2015.01); **H01Q 1/48**
(2013.01); **H01Q 5/25** (2015.01); **H01Q 5/50**
(2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/42; H01Q 1/243; H01Q 1/38; H01Q
5/30; H01Q 1/241; H01Q 1/242;
(Continued)

(56) **References Cited**
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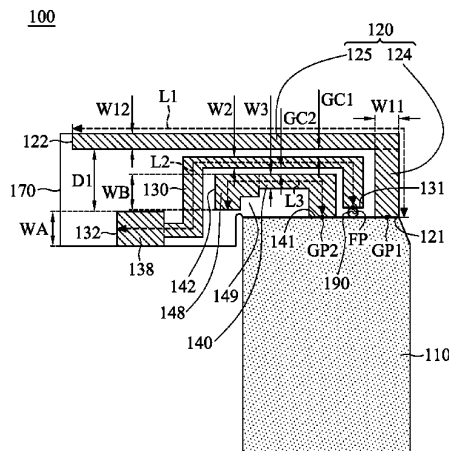
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application No. TW 111126333.

Primary Examiner — Vibol Tan
(74) *Attorney, Agent, or Firm* — McClure, Qualey &
Rodack, LLP

(57) **ABSTRACT**
An antenna structure includes a ground element, a first
radiation element, a second radiation element, a third radiation
element, and a nonconductive support element. The first
radiation element is coupled to a first grounding point on the
ground element. The second radiation element has a feeding
point. The second radiation element is adjacent to the first
radiation element. The third radiation element is coupled to
a second grounding point on the ground element. The third
radiation element is adjacent to the second radiation ele-
ment. The first radiation element, the second radiation
element, and the third radiation element are disposed on the
nonconductive support element. The second radiation ele-
ment is at least partially surrounded by the first radiation
element. The third radiation element is at least partially
surrounded by the second radiation element.

10 Claims, 2 Drawing Sheets





US011996633B2

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

(10) **Patent No.:** **US 11,996,633 B2**
(45) **Date of Patent:** **May 28, 2024**

(54) **WEARABLE DEVICE WITH ANTENNA STRUCTURE THEREIN**
(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)
(72) Inventors: **Chun-I Cheng**, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Chin-Lung Tsai, Taoyuan (TW);
Kuan-Hsien Lee, Taoyuan (TW);
Yu-Chen Zhao, Taoyuan (TW);
Kai-Hsiang Chang, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**,
Taoyuan (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 117 days.

(21) Appl. No.: **17/929,900**
(22) Filed: **Sep. 6, 2022**

(65) **Prior Publication Data**
US 2024/0030615 A1 Jan. 25, 2024

(30) **Foreign Application Priority Data**
Jul. 19, 2022 (TW) 111127026

(51) **Int. Cl.**
H01Q 1/27 (2006.01)
H01Q 5/20 (2015.01)
(Continued)
(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 1/273**
(2013.01); **H01Q 5/20** (2015.01); **H01Q 5/371**
(2015.01)

(58) **Field of Classification Search**
CPC ... H01Q 1/243; H01Q 1/273; H01Q 5/30-392
See application file for complete search history.

(56) **References Cited**
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343/700 MS

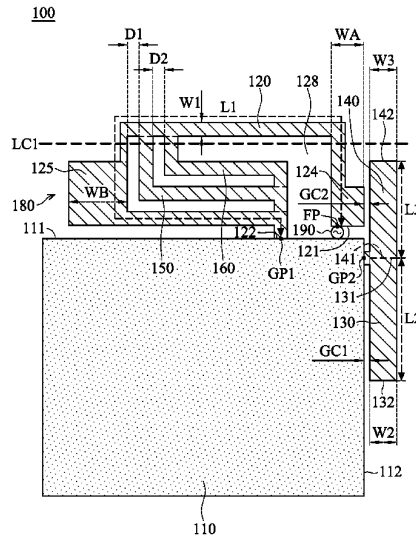
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Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**
A wearable device includes a ground element, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, and a fifth radiation element. The first radiation element has a feeding point, and is coupled to a first grounding point on the ground element. A slot region is surrounded by the first radiation element and the ground element. The second radiation element is coupled to a second grounding point on the ground element. The third radiation element is coupled to the second grounding point. The third radiation element and the second radiation element substantially extend in opposite directions. The fourth radiation element and the fifth radiation element are disposed inside the slot region. An antenna structure is formed by the first radiation element, the second radiation element, the third radiation element, the fourth radiation element, and the fifth radiation element.

9 Claims, 3 Drawing Sheets





US011996637B2

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

(10) **Patent No.:** **US 11,996,637 B2**
(45) **Date of Patent:** **May 28, 2024**

(54) **ANTENNA UNIT, PREPARATION METHOD THEREOF, AND ELECTRONIC DEVICE**

(71) Applicants: **Beijing BOE Technology Development Co., Ltd.**, Beijing (CN); **BOE Technology Group Co., Ltd.**, Beijing (CN)

(72) Inventors: **Yali Wang**, Beijing (CN); **Dongdong Zhang**, Beijing (CN); **Feng Qu**, Beijing (CN)

(73) Assignees: **Beijing BOE Technology Development Co., Ltd.**, Beijing (CN); **BOE Technology Group Co., Ltd.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 208 days.

(21) Appl. No.: **17/503,387**

(22) Filed: **Oct. 18, 2021**

(65) **Prior Publication Data**
US 2022/0311141 A1 Sep. 29, 2022

(30) **Foreign Application Priority Data**
Mar. 23, 2021 (CN) 202110310376.2

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

(52) **U.S. Cl.**
CPC **H01Q 9/0457** (2013.01); **H01Q 5/50** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 9/0457; H01Q 5/50
See application file for complete search history.

(56) **References Cited**

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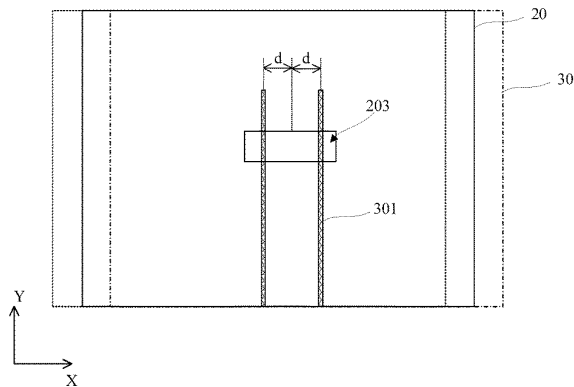
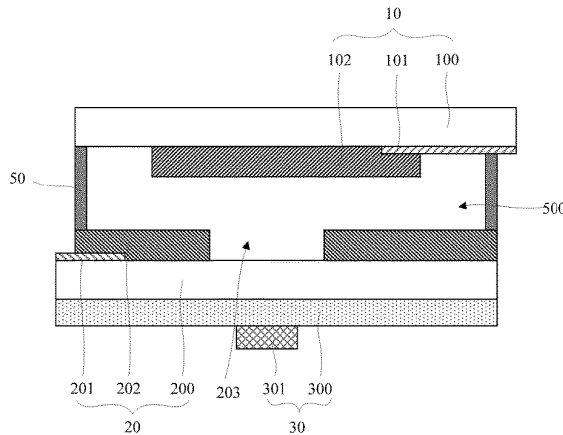
Primary Examiner — Daniel Munoz

(74) *Attorney, Agent, or Firm* — Ling Wu; Stephen Yang; Ling and Yang Intellectual Property

(57) **ABSTRACT**

Provided is an antenna unit, including a first substrate and a second substrate that are oppositely disposed, a liquid crystal layer located between the first substrate and the second substrate, and a third substrate located on a side of the second substrate away from the liquid crystal layer. The first substrate includes a first base substrate and a radiation unit layer. The second substrate includes a second base substrate and a ground layer. The radiation unit layer and the ground layer face the liquid crystal layer. The third substrate includes a third base substrate and a feed structure layer, wherein the feed structure layer is located on a side of the third base substrate away from the second substrate.

18 Claims, 7 Drawing Sheets





US011997227B2

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

(10) **Patent No.:** **US 11,997,227 B2**
(45) **Date of Patent:** **May 28, 2024**

- (54) **ELECTRONIC DEVICE**
- (71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)
- (72) Inventors: **Chin-Ting Huang**, Taipei (TW); **Hsiao-Wen Wu**, 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 316 days.

- (56) **References Cited**
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343/700 MS

- (21) Appl. No.: **17/522,626**
- (22) Filed: **Nov. 9, 2021**
- (65) **Prior Publication Data**
US 2022/0210255 A1 Jun. 30, 2022

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- CN 109037918 12/2018
- CN 111478021 7/2020

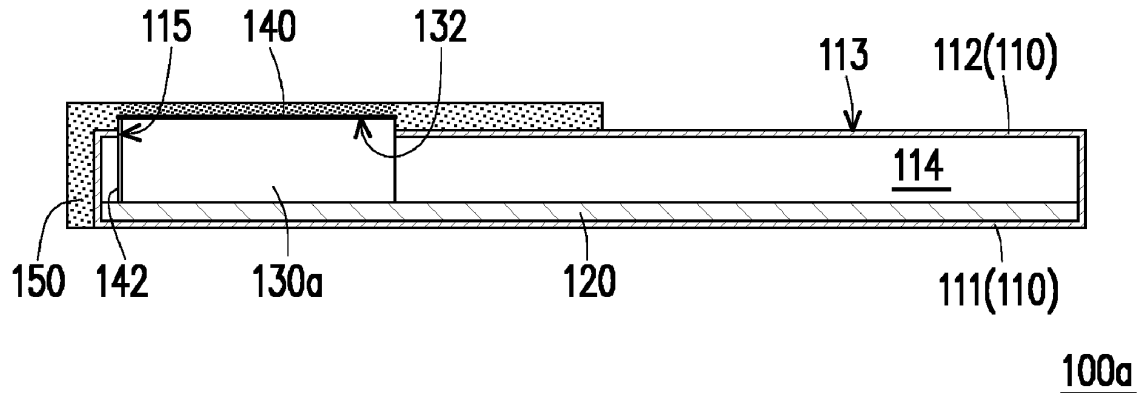
- (30) **Foreign Application Priority Data**
Dec. 29, 2020 (TW) 109146654
- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
- (52) **U.S. Cl.**
CPC **H04M 1/0277** (2013.01); **H01Q 1/243** (2013.01)

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Primary Examiner — Tuan A Tran
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

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

(57) **ABSTRACT**
An electronic device including a casing, a circuit board, a bracket, an antenna, and a protective member is provided. The casing has an accommodating space and a hole communicating with the accommodating space. The circuit board is disposed in the accommodating space. The bracket is disposed above the circuit board, and at least part of the bracket is located in the accommodating space and the hole. At least part of the antenna is disposed on a portion of the bracket extending out of the accommodating space. The protective member is disposed on at least one surface of the casing and covers the hole, the bracket, and the antenna.

10 Claims, 2 Drawing Sheets



100a



US012003017B2

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

(10) **Patent No.:** **US 12,003,017 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **RADIATOR SHARING ANTENNA AND ELECTRONIC DEVICE**

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/35; H01Q 1/48; H01Q 5/378-392
See application file for complete search history.

(71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)

(72) Inventors: **Qiao Sun**, Xi'an (CN); **Kun Li**, Xi'an (CN); **Liang Lu**, Xi'an (CN)

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(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (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 333 days.

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(22) PCT Filed: **Feb. 10, 2020**

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(86) PCT No.: **PCT/CN2020/074608**

§ 371 (c)(1),
(2) Date: **Aug. 20, 2021**

Zhou Qiangqiang, "Common-metal-frame MIMO Antenna for Terminal Device," 2017, with an English Abstract, 78 pages.

(87) PCT Pub. No.: **WO2020/173294**

PCT Pub. Date: **Sep. 3, 2020**

Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(65) **Prior Publication Data**
US 2022/0140471 A1 May 5, 2022

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

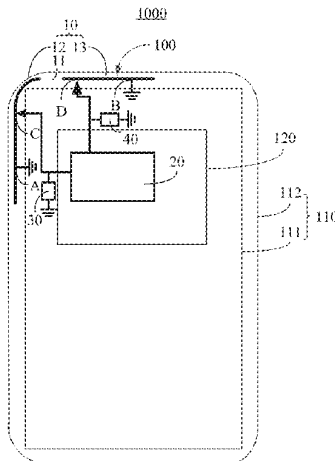
Feb. 27, 2019 (CN) 201910146738.1
Apr. 4, 2019 (CN) 201910278901.X

A radiator sharing antenna and mobile terminal including the radiator sharing antenna includes a radiator divided into a first sub-radiator and a second sub-radiator by a gap, a first feeding point, and a second feeding point. A radio frequency signal is fed through the first feeding point on the first sub-radiator, and a radio frequency signal is fed through the second feeding point on the second sub-radiator. The radiator sharing antenna is adapted to generate a plurality of antenna operating bands through the resonance generated by the first sub-radiator and the second sub-radiator and the parasitic resonance generated through mutual influence between the first sub-radiator and the second sub-radiator.

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01); **H04M 1/0281** (2013.01)

20 Claims, 10 Drawing Sheets





US012003027B2

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

(10) **Patent No.:** **US 12,003,027 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **MAGNETO-ELECTRIC DIPOLE ANTENNA**

(58) **Field of Classification Search**

(71) Applicant: **SUN DIAL TECHNOLOGY LIMITED**, Hong Kong (CN)

CPC H01F 38/14; H01F 27/36; H01F 27/366; H01F 27/361; H01F 27/363;
(Continued)

(72) Inventors: **Kungbo Ng**, Hong Kong (CN); **Hang Wong**, Hong Kong (CN); **Quanwei Lin**, Hong Kong (CN)

(56) **References Cited**

(73) Assignee: **SUN DIAL TECHNOLOGY LIMITED**, Hong Kong (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 75 days.

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(21) Appl. No.: **17/794,653**

CN 106299664 A 1/2017
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CN 107799891 A 3/2018

(22) PCT Filed: **Sep. 16, 2020**

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(86) PCT No.: **PCT/IB2020/058603**

§ 371 (c)(1),
(2) Date: **Jul. 22, 2022**

International Search Report for PCT/IB2020/058603, Prepared by the National Intellectual Property Administration, PRC, dated Dec. 30, 2020, 3 Pages.

(87) PCT Pub. No.: **WO2021/148858**

PCT Pub. Date: **Jul. 29, 2021**

Primary Examiner — Monica C King

(65) **Prior Publication Data**

US 2023/0075273 A1 Mar. 9, 2023

(74) *Attorney, Agent, or Firm* — Brooks Kushman P. C.; John E. Nemazi

(30) **Foreign Application Priority Data**

Jan. 24, 2020 (HK) 32020002028.9

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 19/10 (2006.01)

H01Q 1/12 (2006.01)

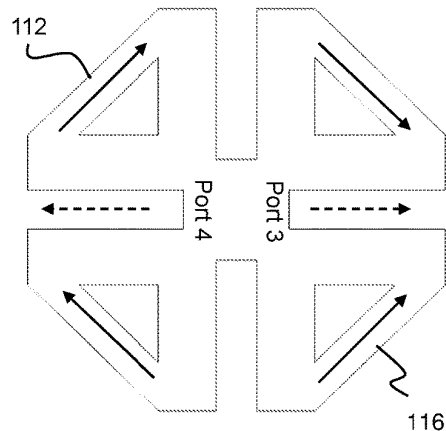
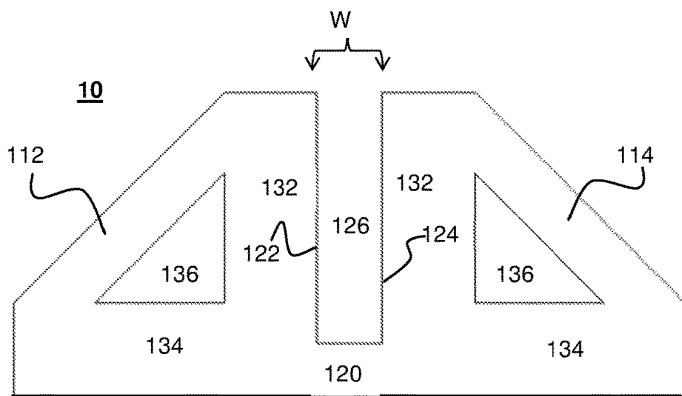
(Continued)

A magneto-electric dipole antenna comprising a magnetic dipole antenna portion and an electric dipole antenna portion arranged to form a complementary antenna is disclosed. The electric dipole antenna portion comprises a plurality of electric patch portions. Each electric patch portion comprises a first patch region of a first conductivity and a second patch region of a second conductivity lower than the first conductivity, and wherein the first patch region and the second patch region cooperate to define an electrical current path of the dipole antenna portion.

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

CPC **H01Q 19/108** (2013.01); **H01Q 1/12** (2013.01); **H01Q 1/36** (2013.01); **H01Q 21/26** (2013.01)

20 Claims, 10 Drawing Sheets



116



US012003032B2

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

(10) **Patent No.:** **US 12,003,032 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **HYBRID NETWORK ANTENNA**
(71) Applicants: **PROSE TECHNOLOGIES (SUZHOU) CO., LTD.**, Suzhou (CN); **PROSE TECHNOLOGIES LLC**, Mount Olive, NJ (US)

(72) Inventors: **He Sun**, Suzhou (CN); **Shengguang Wang**, Suzhou (CN); **Zhongcao Yang**, Suzhou (CN); **Haixia Zhang**, Suzhou (CN); **Linfeng Sheng**, Suzhou (CN)

(73) Assignees: **PROSE TECHNOLOGIES (SUZHOU) CO., LTD.**, Suzhou (CN); **PROSE TECHNOLOGIES LLC**, Mount Olive, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

(21) Appl. No.: **17/564,671**

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

(65) **Prior Publication Data**
US 2022/0123482 A1 Apr. 21, 2022

Related U.S. Application Data
(63) Continuation of application No. PCT/CN2020/103841, filed on Jul. 23, 2020.

(51) **Int. Cl.**
H01Q 21/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/24** (2013.01); **H01Q 9/0414** (2013.01); **H01Q 21/065** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 19/10; H01Q 21/00; H01Q 21/06; H01Q 21/24
See application file for complete search history.

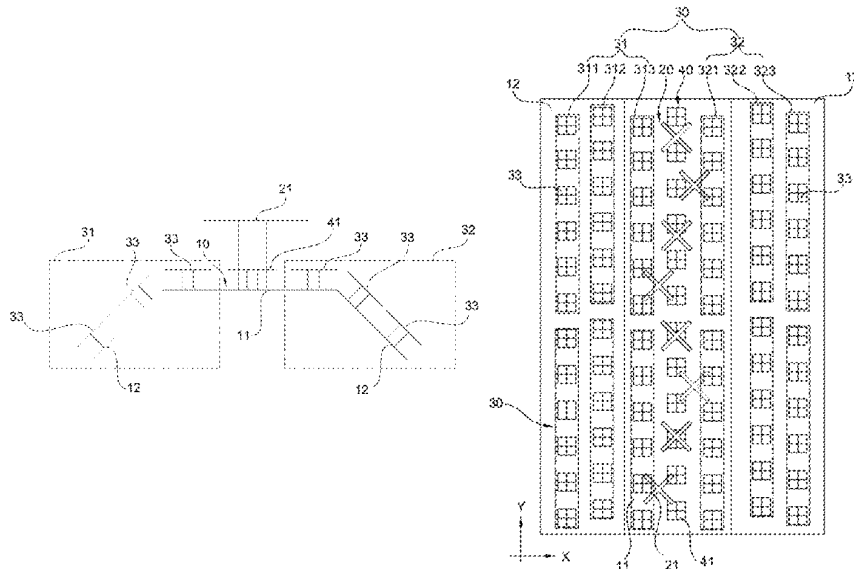
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(Continued)

Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — ANOVA LAW GROUP, PLLC

(57) **ABSTRACT**
A hybrid network antenna includes a reflection plate, a low frequency antenna array, and a dual-beam antenna array. The reflection plate includes a flat member and bending members formed by bending the two ends of the flat member. The low frequency antenna array is arranged on the flat member. The dual-beam antenna array include beam antenna sub-arrays located on both sides of the low frequency antenna array. The beam antenna sub-array on each side of the low frequency array includes a plurality of first high frequency radiating element arrays disposed in intervals along the width direction of the reflection plate. The plurality of high frequency radiating element arrays of each beam antenna sub-array are arranged on the reflection plate in different planes or a common plane.

18 Claims, 4 Drawing Sheets





US012003039B2

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

(10) **Patent No.:** **US 12,003,039 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **PHASED ARRAY ANTENNA DEVICE**

(56) **References Cited**

(71) Applicant: **BEIJING BOE SENSOR TECHNOLOGY CO., LTD.**, Beijing (CN)

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6,377,217 B1 * 4/2002 Zhu H01P 1/181 343/771

(72) Inventors: **Arshad Mehmood**, Darmstadt (DE); **Ahmet Kenan Keskin**, Pendik/Istanbul (TR)

2002/0126048 A1 9/2002 Zhu et al. (Continued)

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(73) Assignee: **BEIJING BOE SENSOR TECHNOLOGY CO., LTD.**, Beijing (CN)

EP 1212809 B1 3/2004

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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.

Arshad Mehmood et al., Co-pending U.S. Appl. No. 17/814,053.

Primary Examiner — Awat M Salih

(74) *Attorney, Agent, or Firm* — Dilworth & Barrese, LLP.; Michael J. Musella, Esq.

(21) Appl. No.: **17/814,040**

(57) **ABSTRACT**

(22) Filed: **Jul. 21, 2022**

A phased array antenna device comprises antenna elements arranged in a spatial distribution to emit and receive superposing radio frequency signals to and from different directions. Each antenna element is positioned within a corresponding unit cell. The unit cells are arranged in a non-overlapping manner next to each other. A feeding network for transmitting the antenna signals between a common feeding point and the respective antenna element comprises a plurality of antenna element transmission line segments each running into an antenna element and a corresponding plurality of phase shifting devices. The feeding transmission line segments each comprises more than two transition structures distributed along the feeding transmission line segment. Each transition structure provides for a signal coupling between the feeding transmission line segment and the corresponding antenna element transmission line segment, thereby connecting several dedicated antenna element transmission line segments with the same feeding transmission line segment.

(65) **Prior Publication Data**

US 2023/0028570 A1 Jan. 26, 2023

(30) **Foreign Application Priority Data**

Jul. 23, 2021 (EP) 21187563

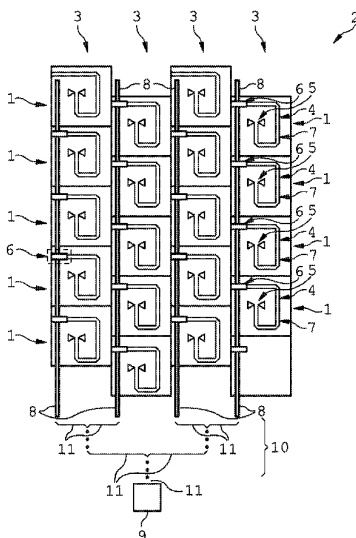
(51) **Int. Cl.**
H01Q 3/36 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/36** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/36; H01Q 3/44; H01Q 21/0075; H01Q 21/065; H01Q 13/206

See application file for complete search history.

8 Claims, 6 Drawing Sheets





US012003040B2

(12) **United States Patent**
Foglia Manzillo et al.

(10) **Patent No.:** **US 12,003,040 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **TRANSMITARRAY ANTENNA CELL**

(71) Applicant: **Commissariat à l'Energie Atomique et aux Energies Alternatives**, Paris (FR)

(72) Inventors: **Francesco Foglia Manzillo**, Grenoble (FR); **Antonio Clemente**, Grenoble (FR); **Maciej Smierzchalski**, Grenoble (FR)

(73) Assignee: **COMMISSARIAT À L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 283 days.

(21) Appl. No.: **17/660,849**

(22) Filed: **Apr. 27, 2022**

(65) **Prior Publication Data**
US 2022/0359982 A1 Nov. 10, 2022

(30) **Foreign Application Priority Data**
May 7, 2021 (FR) 2104867

(51) **Int. Cl.**
H01Q 3/46 (2006.01)
H01Q 1/28 (2006.01)
H01Q 15/02 (2006.01)
H01Q 15/24 (2006.01)
H01Q 19/06 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/46** (2013.01); **H01Q 15/02** (2013.01); **H01Q 15/242** (2013.01); **H01Q 19/06** (2013.01); **H01Q 1/288** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/288; H01Q 3/44; H01Q 3/46; H01Q 15/02; H01Q 15/24; H01Q 15/242; H01Q 15/244; H01Q 15/246; H01Q 19/06; H01Q 21/24; H01Q 21/245
See application file for complete search history.

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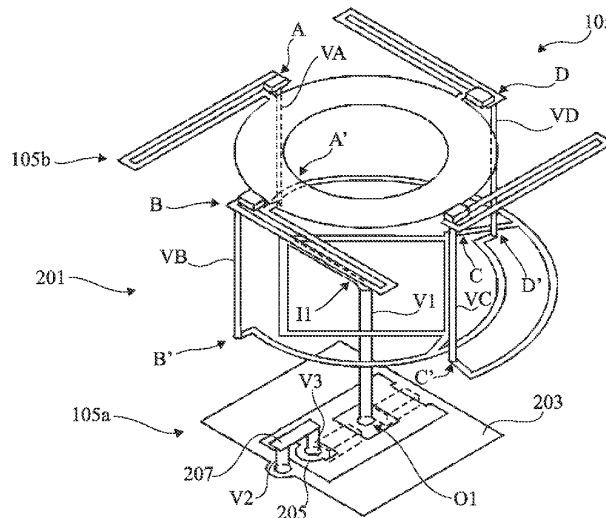
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Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Jordan IP Law, LLC

(57) **ABSTRACT**
A transmitarray cell (105) comprises a first antenna element (105a) adapted to switching between two phase states, a second antenna element (105b) adapted to switching between two other phase states and between two circular polarization directions and a coupler (201) coupling the first antenna element to the second antenna element.

13 Claims, 4 Drawing Sheets





US012003257B2

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

(10) **Patent No.:** **US 12,003,257 B2**
(45) **Date of Patent:** **Jun. 4, 2024**

(54) **ELECTRONIC DEVICE HAVING 5G ANTENNA**
(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)
(72) Inventors: **Songyi Lee**, Seoul (KR); **Moonsoo Song**, Seoul (KR); **Chisang You**, Seoul (KR); **Yoonjae Won**, Seoul (KR); **Deuksu Choi**, Seoul (KR)
(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(56) **References Cited**
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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 170 days.

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(Continued)

(21) Appl. No.: **17/773,016**
(22) PCT Filed: **Oct. 30, 2019**
(86) PCT No.: **PCT/KR2019/014414**
§ 371 (c)(1),
(2) Date: **Apr. 28, 2022**
(87) PCT Pub. No.: **WO2021/085666**
PCT Pub. Date: **May 6, 2021**

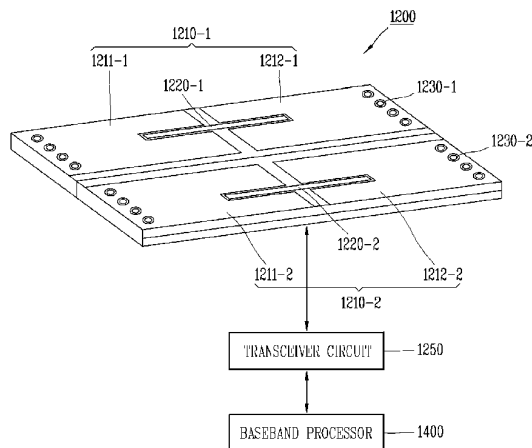
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — LEE, HONG, DEGERMAN, KANG & WAIMEY

(65) **Prior Publication Data**
US 2022/0393705 A1 Dec. 8, 2022

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 1/48 (2006.01)
(Continued)
(52) **U.S. Cl.**
CPC **H04B 1/0064** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/521** (2013.01);
(Continued)
(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/243; H01Q 1/48; H01Q 1/521; H01Q 5/40; H01Q 9/0407;
(Continued)

(57) **ABSTRACT**
An electronic device having a 5G antenna, according to the present invention, is provided. The electronic device has the antenna comprising: a metal pattern in which metal having a predetermined length and width is printed and disposed on the front surface of a substrate, and which is configured to emit a first signal; and a feeding pattern which is disposed in an area in which the metal pattern is separated and spaced apart from the feeding pattern, and which is configured to coupling-feed the first signal to the metal pattern. In addition, the electronic device further comprises a second antenna which has a metal pattern and a second feeding pattern that are disposed to be symmetrical to those of the first antenna on the front surface of the substrate, and which is configured to emit a second signal.

16 Claims, 19 Drawing Sheets





US012009577B2

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

(10) **Patent No.:** **US 12,009,577 B2**
(45) **Date of Patent:** **Jun. 11, 2024**

(54) **ELECTRONIC DEVICE INCLUDING AN ANTENNA**
(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)
(72) Inventors: **Soonheung Kwon**, Suwon-si (KR); **Sumin Yun**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR); **Hyunjeong Lee**, Suwon-si (KR); **Hyunjoo Lee**, Suwon-si (KR)
(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, 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 68 days.

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

(56) **References Cited**
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Primary Examiner — Wilson Lee

(74) *Attorney, Agent, or Firm* — CANTOR COLBURN LLP

(57) **ABSTRACT**

An electronic device includes a housing providing a front surface and a rear surface, an antenna including a printed circuit board within the housing and including a first surface facing the front surface and a second surface facing the rear surface. The printed circuit board includes a first conductive layer including a first antenna element and a second antenna element that do not overlap each other when viewed from above the first surface, a second conductive layer operating as a ground plane, and a dielectric between the first and second conductive layers. A conductive pattern is located between the front surface and the second surface when the first surface faces the rear surface and is located between the rear surface and the second surface when the first surface faces the front surface. The conductive pattern overlaps a part of the second conductive layer when viewed from above the first surface.

20 Claims, 24 Drawing Sheets

(65) **Prior Publication Data**
US 2023/0089687 A1 Mar. 23, 2023

Related U.S. Application Data

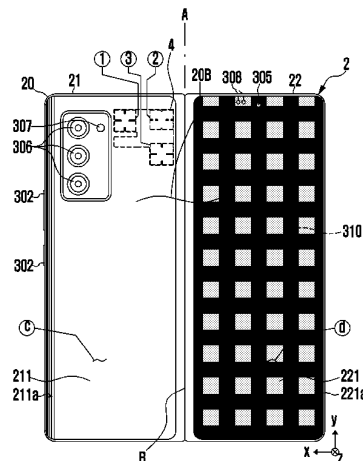
(63) Continuation of application No. PCT/KR2022/011884, filed on Aug. 9, 2022.

(30) **Foreign Application Priority Data**

Aug. 10, 2021 (KR) 10-2021-0105054
Dec. 8, 2021 (KR) 10-2021-0175089

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/25** (2015.01); **H01Q 5/307** (2015.01); **H01Q 9/0407** (2013.01)





US012009598B2

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

(10) **Patent No.:** **US 12,009,598 B2**
(45) **Date of Patent:** **Jun. 11, 2024**

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

(71) Applicant: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(72) Inventors: **Ying-Sheng Fang**, Hsinchu (TW);
Shang-Sian You, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 112 days.

(21) Appl. No.: **18/053,770**

(22) Filed: **Nov. 9, 2022**

(65) **Prior Publication Data**
US 2023/0335918 A1 Oct. 19, 2023

(30) **Foreign Application Priority Data**
Apr. 14, 2022 (TW) 111114142

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/22** (2013.01); **H01Q 21/0037** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/22; H01Q 1/2266; H01Q 5/357; H01Q 13/10; H01Q 21/0037; H01Q 21/065

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An electronic device and an antenna structure are provided. The electronic device includes a metal housing, and the antenna structure is disposed in the metal housing. The antenna structure includes a printed circuit board, two radiating elements, two feeding transmission lines and a connector. The two radiating elements are disposed on the printed circuit board and are close to the two slots. Projections of the two radiating elements projected onto the metal housing at least partially overlap with the two slots. The two feeding transmission lines are disposed in the printed circuit board. The two feeding transmission lines are electrically connected to the two radiating elements, respectively, and lengths of the two feeding transmission lines are the same. The connector is connected to the printed circuit board and electrically connected to the two feeding transmission lines.

15 Claims, 8 Drawing Sheets

