



US012015198B2

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

(10) **Patent No.:** **US 12,015,198 B2**
(45) **Date of Patent:** **Jun. 18, 2024**

(54) **ANTENNA UNIT AND MANUFACTURING METHOD THEREOF, DISPLAY DEVICE, AND ELECTRONIC APPARATUS**

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **G02F 1/133305** (2013.01); **G02F 1/13338** (2013.01);
(Continued)

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 21/28; H01Q 1/521; H01Q 9/42; H01Q 1/38; H01Q 9/0414;
(Continued)

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(73) Assignee: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (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 378 days.

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(21) Appl. No.: **17/289,542**

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

(86) PCT No.: **PCT/CN2021/073030**

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(2) Date: **Apr. 28, 2021**

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Extended European Search Report dated Jan. 31, 2024 received in European Patent Application No. EP 21712702.6.

Primary Examiner — Linh V Nguyen

(65) **Prior Publication Data**

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(74) *Attorney, Agent, or Firm* — Scully, Scott, Murphy & Presser, P.C.

(30) **Foreign Application Priority Data**

Jan. 22, 2020 (WO) PCT/CN2020/073931
Apr. 30, 2020 (CN) 202010370108.5

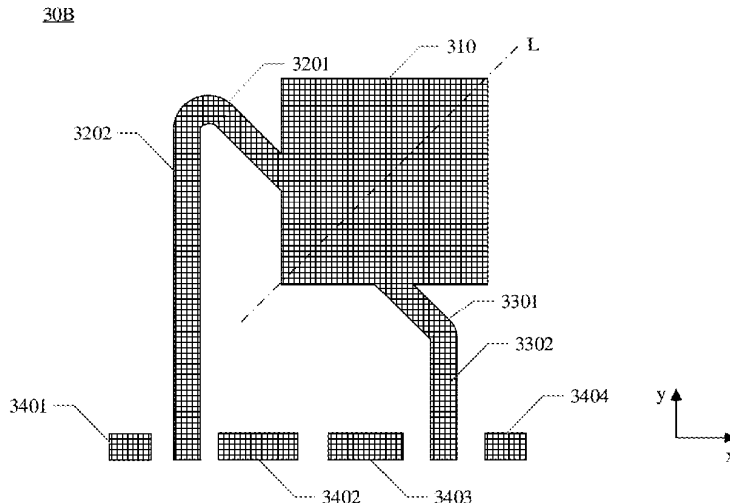
(57) **ABSTRACT**

An antenna unit, a manufacturing method thereof, a display device, and an electronic apparatus. The antenna unit includes a radiation main body, at least one feed line, and a plurality of grounding portions. The at least one feed line and the radiation main body are electrically connected, the radiation main body, the at least one feed line, and the plurality of grounding portions are provided in a same layer.

(51) **Int. Cl.**
H01Q 21/24 (2006.01)
G02F 1/1333 (2006.01)

(Continued)

20 Claims, 23 Drawing Sheets





US012015208B2

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

(10) **Patent No.:** **US 12,015,208 B2**
(45) **Date of Patent:** **Jun. 18, 2024**

(54) **ELECTRONIC DEVICE HAVING ANTENNA**

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

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Namyong Kim**, Seoul (KR); **Sungwon Kim**, Seoul (KR); **Jihun Ha**, Seoul (KR); **Youngbae Kwon**, Seoul (KR); **Byungwoon 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.: **18/556,020**

(22) PCT Filed: **Apr. 20, 2021**

(86) PCT No.: **PCT/KR2021/004944**
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(65) **Prior Publication Data**
US 2024/0097322 A1 Mar. 21, 2024

(51) **Int. Cl.**
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H01Q 1/24 (2006.01)
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(52) **U.S. Cl.**
CPC **H01Q 3/12** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/46** (2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/24; H01Q 1/38; H01Q 1/46; H01Q 1/48; H01Q 3/12

(Continued)

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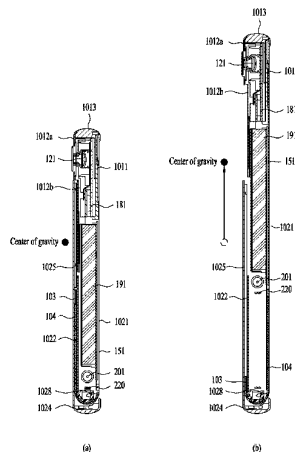
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — LEE, HONG, DEGERMAN, KANG & WAIMEY

(57) **ABSTRACT**

A mobile terminal having an antenna according to one embodiment is provided. The mobile terminal comprises: a first metal housing having a left side surface and a right side surface that define the exterior; and a second metal housing having a left side surface, a right side surface, and a bottom side surface that define the exterior. A first conductive member and a second conductive member of the second metal housing each include a first sub member disposed on a lower side surface and a second sub member disposed on a left side surface or a right side surface; the left side surface of the first metal housing and the second sub member of the second metal housing overlap; the overlapping first metal housing is not exposed to the exterior, while the second sub member may be exposed to the exterior.

20 Claims, 35 Drawing Sheets





US012015211B2

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

(10) **Patent No.:** **US 12,015,211 B2**
(45) **Date of Patent:** **Jun. 18, 2024**

(54) **ANTENNA SYSTEM**
(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)
(72) Inventors: **Wen Yuan Lo**, Taoyuan (TW); **Hui Lin**, 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 59 days.

(21) Appl. No.: **18/051,025**
(22) Filed: **Oct. 31, 2022**
(65) **Prior Publication Data**
US 2024/0097330 A1 Mar. 21, 2024
(30) **Foreign Application Priority Data**
Sep. 20, 2022 (TW) 111210216

(51) **Int. Cl.**
H01Q 5/385 (2015.01)
H01Q 5/307 (2015.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/307** (2015.01); **H01Q 5/385** (2015.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/385; H01Q 9/42; H01Q 21/28
See application file for complete search history.

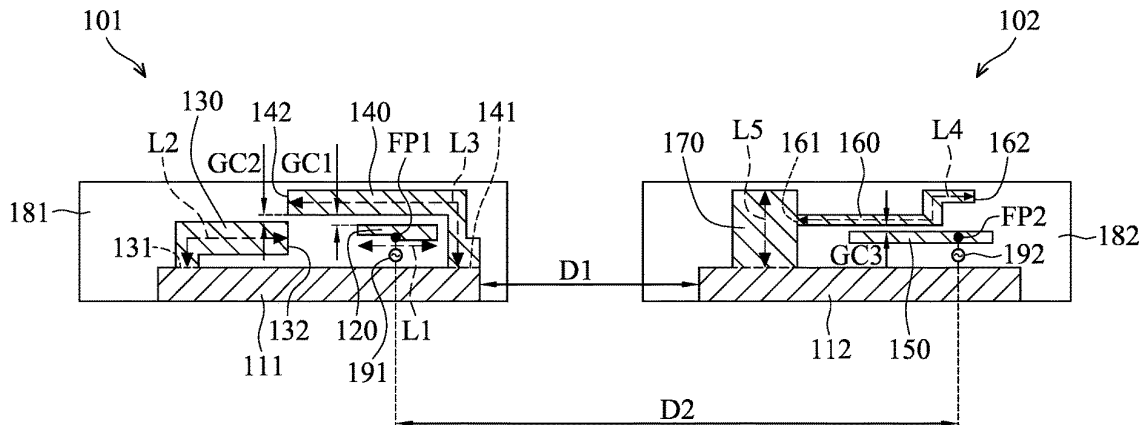
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Primary Examiner — Dameon E Levi
Assistant Examiner — Leah Rosenberg
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**
An antenna system includes a first antenna element and a second antenna element. The first antenna element includes a first ground element, a first radiation element, a second radiation element, and a third radiation element. The first radiation element has a first feeding point. The second radiation element is coupled to the first ground element. The third radiation element is coupled to the first ground element. The third radiation element is adjacent to the first radiation element and the second radiation element. The second antenna element includes a second ground element, a fourth radiation element, a fifth radiation element, and a sixth radiation element. The fourth radiation element has a second feeding point. The fifth radiation element is adjacent to the fourth radiation element. The fifth radiation element is coupled through the sixth radiation element to the second ground element.

10 Claims, 5 Drawing Sheets

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US012015214B2

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

(10) **Patent No.:** **US 12,015,214 B2**
(45) **Date of Patent:** **Jun. 18, 2024**

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

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

(72) Inventors: **Chia-Hao Chang**, Hsinchu (TW);
Chung-Che Lien, Hsinchu (TW);
Ting-Han Shih, 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 154 days.

(21) Appl. No.: **18/045,840**

(22) Filed: **Oct. 12, 2022**

(65) **Prior Publication Data**
US 2024/0030608 A1 Jan. 25, 2024

(30) **Foreign Application Priority Data**
Jul. 19, 2022 (TW) 111126939

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
G01V 3/12 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **G01V 3/12** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/307** (2015.01); **H01Q 9/045** (2013.01)

(58) **Field of Classification Search**
CPC G01V 3/12; H01Q 1/22; H01Q 1/2266; H01Q 1/24; H01Q 1/38; H01Q 1/48;
(Continued)

(56) **References Cited**

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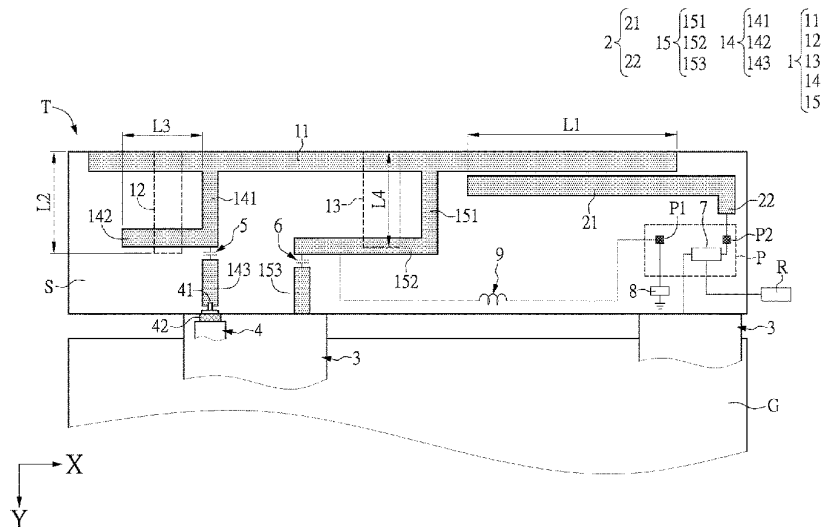
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna structure and an electronic device are provided. The antenna structure includes a substrate with opposing first and second surfaces, a first radiating element with a first radiating portion and a second radiating portion, a third radiating portion, a feeding portion, and a grounding portion that are connected to the first radiating portion, a second radiating element separate from but coupling with the first radiating portion, a grounding element connected to the grounding portion, and a feeding element. The first radiating portion, the feeding portion, and the grounding portion are disposed on the first surface. The second radiating portion and the third radiating portion are disposed on the second surface. A projected area of the second radiating portion onto the first surface partially overlaps with the feeding portion. A projected area of the third radiating portion onto the first surface partially overlaps with the grounding portion.

19 Claims, 5 Drawing Sheets





US012021296B2

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

(10) **Patent No.:** **US 12,021,296 B2**
(45) **Date of Patent:** **Jun. 25, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Jangsun Yoo**, Gyeonggi-do (KR);
Jingyu Choi, Gyeonggi-do (KR);
Jongmyung Kim, Gyeonggi-do (KR);
Jihye Moon, Gyeonggi-do (KR);
Cheehwan Yang, Gyeonggi-do (KR);
Kwangyong Lee, Gyeonggi-do (KR);
Myeonggil Lee, Gyeonggi-do (KR);
Seungwoon Lee, Gyeonggi-do (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 211 days.

(21) Appl. No.: **17/438,976**

(22) PCT Filed: **Mar. 13, 2020**

(86) PCT No.: **PCT/KR2020/003563**

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PCT Pub. Date: **Sep. 24, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 15, 2019 (KR) 10-2019-0030140

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H01Q 1/48 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 7/00; H01Q 9/00;
H01Q 9/065; H01Q 1/2208; H01Q
1/2291;

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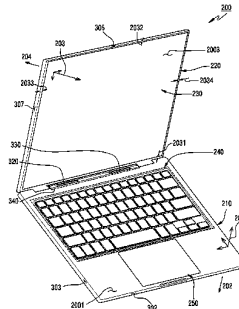
Primary Examiner — Wei (Victor) Y Chan

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

(57) **ABSTRACT**

According to an embodiment, an electronic device may comprise: a first housing structure comprising a first surface facing in a first direction, a second surface facing in a second direction opposite to the first direction, a first side surface and a second side surface facing opposite to each other and surrounding at least a part of the space between the first surface and the second surface, and a third side surface and a fourth side surface facing opposite to each other while being perpendicular to the first side surface; a second housing structure comprising a third surface facing in a third direction, a fourth surface facing in a fourth direction opposite to the third direction, a fifth side surface and a sixth side surface facing opposite to each other and surrounding at least a part of the space between the third surface and the fourth surface, and a seventh side surface and an eighth side surface facing opposite to each other while being perpendicular to the fifth side surface; a hinge structure connecting between the first side surface and the fifth side surface; a display disposed along at least a part of the third surface; at least one antenna disposed near the first side surface inside the first housing structure; and at least one wireless communication module configured to transmit and/or receive a signal in a selected or designated frequency band through the at least one antenna. Various other embodiments may be possible.

12 Claims, 19 Drawing Sheets





US012021316B2

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

(10) **Patent No.:** **US 12,021,316 B2**
(45) **Date of Patent:** **Jun. 25, 2024**

(54) **ANTENNA UNIT AND TERMINAL DEVICE**
(71) Applicant: **VIVO MOBILE COMMUNICATION CO., LTD.**, Guangdong (CN)
(72) Inventors: **Xianjing Jian**, Chang'an Dongguan (CN); **Huan-Chu Huang**, Chang'an Dongguan (CN); **Yijin Wang**, 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 284 days.

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(21) Appl. No.: **17/531,742**

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(22) Filed: **Nov. 20, 2021**

(65) **Prior Publication Data**
US 2022/0085501 A1 Mar. 17, 2022

Primary Examiner — Raymond R Chai
(74) *Attorney, Agent, or Firm* — Price Heneveld LLP

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/090102, filed on May 13, 2020.

Foreign Application Priority Data

May 22, 2019 (CN) 201910430964.2

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 5/50 (2015.01)
H01Q 9/04 (2006.01)

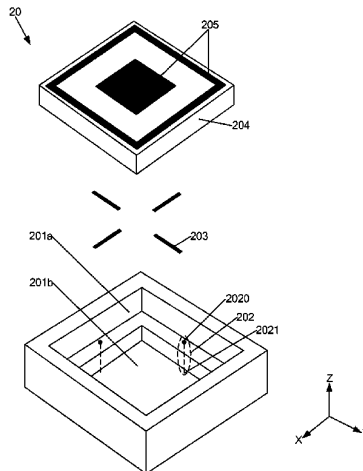
(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 5/50** (2015.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/242; H01Q 1/36; H01Q 1/44; H01Q 1/50;
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(57) **ABSTRACT**

An antenna unit and a terminal device are provided. The antenna unit includes a target metal groove, M feed portions arranged at the bottom of the target metal groove, M coupling bodies and a first insulator which are arranged in the target metal groove, and at least two radiating bodies borne by the first insulator, wherein the M feed portions are insulated from the target metal groove, the M coupling bodies are located between the bottom of the target metal groove and the first insulator, each of the M feed portions is electrically connected to one coupling body respectively, each of the M coupling bodies is coupled with the at least two radiating bodies and the target metal groove, different radiating bodies have different resonance frequencies, and M is a positive integer.

16 Claims, 11 Drawing Sheets





US012027752B2

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

(10) **Patent No.:** **US 12,027,752 B2**
(45) **Date of Patent:** **Jul. 2, 2024**

(54) **ELECTRONIC DEVICE**

(71) Applicants: **Jhih-Ciang Chen**, Taipei (TW);
Shih-Chia Liu, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Chih-Heng Lin**, Taipei (TW); **Je-Wei Liao**, Taipei (TW); **Chun-Cheng Chan**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(72) Inventors: **Jhih-Ciang Chen**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Chih-Heng Lin**, Taipei (TW); **Je-Wei Liao**, Taipei (TW); **Chun-Cheng Chan**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

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

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(21) Appl. No.: **17/506,687**

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

(65) **Prior Publication Data**
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Related U.S. Application Data
(60) Provisional application No. 63/137,121, filed on Jan. 13, 2021.

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 13/18 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/18** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/38; H01Q 13/18; H01Q 9/42; H01Q 1/24
See application file for complete search history.

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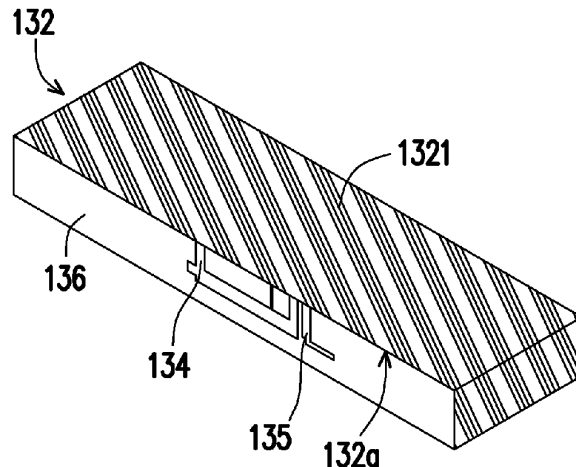
Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

An electronic device including a first body, a second body, and at least one cavity antenna module is provided. The second body has a pivot side and a plurality of non-pivot sides, and the pivot side is connected pivotally to the first body. The cavity antenna module includes a metal cavity body and a first antenna structure. The metal cavity body is disposed in the second body and has an opening. A distance between one of the non-pivot sides and the metal cavity body is smaller than a distance between the pivot side and the metal cavity body, and the opening faces the one of the non-pivot sides. The first antenna structure is disposed in the opening of the metal cavity body, and the first antenna structure includes a feeding portion, a radiating portion, and a ground portion connected with one another.

9 Claims, 10 Drawing Sheets





US012027754B2

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

(10) **Patent No.:** **US 12,027,754 B2**
(45) **Date of Patent:** **Jul. 2, 2024**

(54) **ANTENNA SUBSTRATE, ANTENNA MODULE, AND METHOD OF MANUFACTURING ANTENNA SUBSTRATE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo (JP)

(72) Inventors: **Shun Sakaida**, Nagaokakyo (JP); **Kengo Onaka**, Nagaokakyo (JP)

(73) Assignee: **MURATA MANUFACTURING CO., LTD.**, Nagaokakyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 310 days.

(21) Appl. No.: **17/702,804**

(22) Filed: **Mar. 24, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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C22F 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2283** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/20** (2013.01); **H05K 1/028** (2013.01); **H05K 1/09** (2013.01)

(58) **Field of Classification Search**
CPC H05K 1/02; H05K 1/0218; H05K 1/028; H05K 1/09; H05K 3/046; H05K 3/46;
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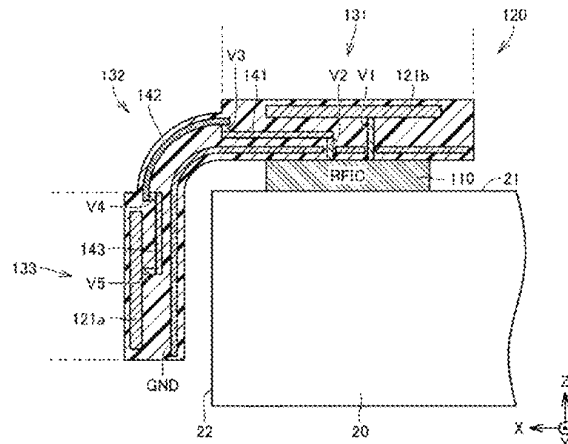
Primary Examiner — Xiaoliang Chen

(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

An antenna substrate includes a flat section where a radiating element is disposed, a flexible section disposed adjacent to the flat section, a first electrical conductor having one end portion connected to the radiating element inside the flat section, and a second electrical conductor having one end portion connected to the other end portion of the electrical conductor inside the flexible section. The average or median grain size in the extension direction of the first electrical conductor is larger than the average or median grain size in the extension direction of the second electrical conductor, and the average or median aspect ratio of the electrical conductor is larger than the average or median aspect ratio of the electrical conductor.

12 Claims, 7 Drawing Sheets





US012027782B2

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

(10) **Patent No.:** **US 12,027,782 B2**
(45) **Date of Patent:** **Jul. 2, 2024**

(54) **ELECTRONIC DEVICE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Hsieh-Chih Lin**, Hsinchu (TW);
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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 432 days.

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(21) Appl. No.: **17/153,045**

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(22) Filed: **Jan. 20, 2021**

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Primary Examiner — Dieu Hien T Duong

Assistant Examiner — Michael M Bouizza

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

(65) **Prior Publication Data**

US 2021/0351509 A1 Nov. 11, 2021

(30) **Foreign Application Priority Data**

May 7, 2020 (TW) 109115256

(57) **ABSTRACT**

An electronic device including an antenna structure and a switching circuit is provided. The antenna structure includes a first radiating element, a second radiating element, a feeding element and a grounding element. The first radiating element includes a first radiating part and a feeding part. The second radiating element is coupled with the first radiating element, and includes a main body and an arm that is electrically connected to the switching circuit. The feeding element includes a feeding end electrically connected to the feeding part, and a grounding end electrically connected to the grounding element. The antenna structure generates a first operation bandwidth and second operation bandwidth when the switching circuit is switched to a first and second mode, respectively. A central frequency of the first operation bandwidth is different from that of the second operation bandwidth.

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 5/314 (2015.01)

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

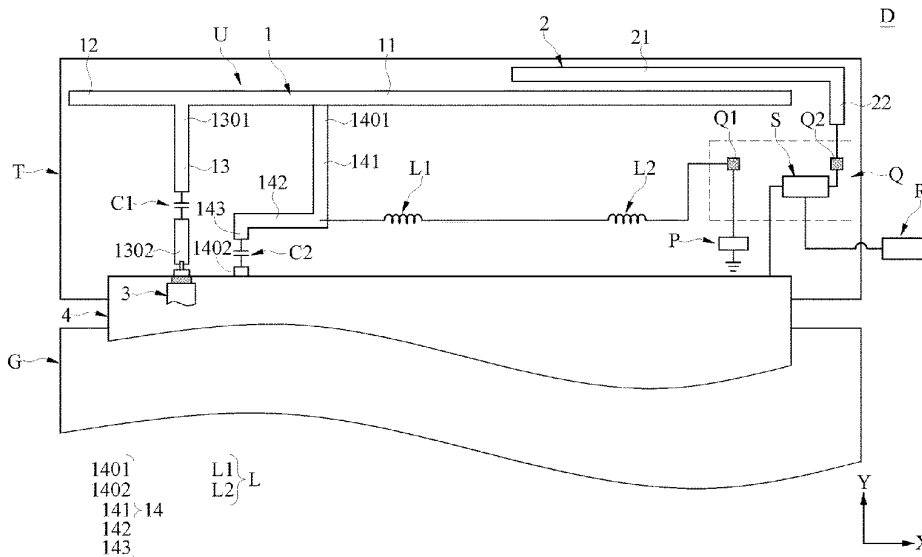
CPC **H01Q 5/314** (2015.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/314; H01Q 1/38; H01Q 1/245; H01Q 5/328; H01Q 5/371; H01Q 5/378; H01Q 9/0421

See application file for complete search history.

6 Claims, 14 Drawing Sheets





US012027783B2

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

(10) **Patent No.:** **US 12,027,783 B2**
(45) **Date of Patent:** **Jul. 2, 2024**

(54) **MULTI-LOOP RESONANCE STRUCTURE AND MULTIPLE-INPUT AND MULTIPLE-OUTPUT (MIMO) ANTENNA COMMUNICATION SYSTEM**

(71) Applicant: **Anhui University**, Anhui (CN)

(72) Inventors: **Lixia Yang**, Hefei (CN); **Haoran Yu**, Hefei (CN); **Aidi Ren**, Hefei (CN); **Zhanhao Zhang**, Hefei (CN)

(73) Assignee: **Anhui University**, Hefei (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 321 days.

(21) Appl. No.: **17/686,868**

(22) Filed: **Mar. 4, 2022**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Nov. 9, 2021 (CN) 202111319486.1

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 5/371 (2015.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 7/00** (2013.01); **H01Q 21/065** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 7/00; H01Q 21/065; H01Q 5/364; H01Q 21/28; H01Q 1/243; H01Q 1/38; H01Q 1/242; Y02D 30/70; H01P 7/08

See application file for complete search history.

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Primary Examiner — Hai V Tran

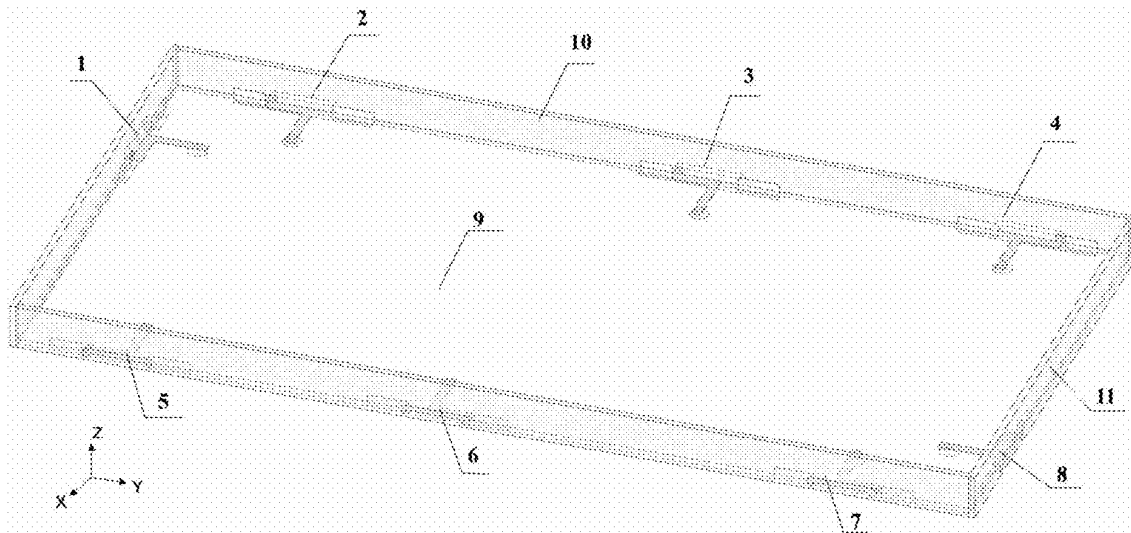
Assistant Examiner — Michael M Bouizza

(74) *Attorney, Agent, or Firm* — Kirk A. Wilson; Joseph T. Guy; Patent Filing Specialist Inc.

(57) **ABSTRACT**

A multi-loop resonance structure and a multiple-input and multiple-output (MIMO) antenna communication system. The multi-loop resonance structure includes a metal floor, a first feed branch plate, and a first metal patch, where the metal floor is disposed on a lower surface of the first dielectric substrate, and the metal floor is provided with a resonant-tank set; the first feed branch plate is disposed in parallel on an upper surface of the first dielectric substrate, and a first straight plate in the first feed branch plate is disposed opposite to the resonant-tank set along a substrate line; an end, in the first feed branch plate, far away from the substrate line is connected to the metal floor; and the first metal patch is connected to the metal floor through the first dielectric substrate along a first surface, in the second dielectric substrate, perpendicular to the first dielectric substrate.

20 Claims, 7 Drawing Sheets





US012034202B2

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

(10) **Patent No.:** **US 12,034,202 B2**
(45) **Date of Patent:** **Jul. 9, 2024**

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

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

(72) Inventors: **Sinhyung Jeon**, Suwon-si (KR);
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(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 329 days.

(21) Appl. No.: **17/531,452**

(22) Filed: **Nov. 19, 2021**

(65) **Prior Publication Data**
US 2022/0158331 A1 May 19, 2022

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2021/016991, filed on Nov. 18, 2021.

(30) **Foreign Application Priority Data**
Nov. 19, 2020 (KR) 10-2020-0155520
Apr. 19, 2021 (KR) 10-2021-0050710

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 5/307** (2015.01); **H04M 1/0268** (2013.01); **H05K 9/005** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/2266; H01Q 1/243; H01Q 1/38; H01Q 1/52;
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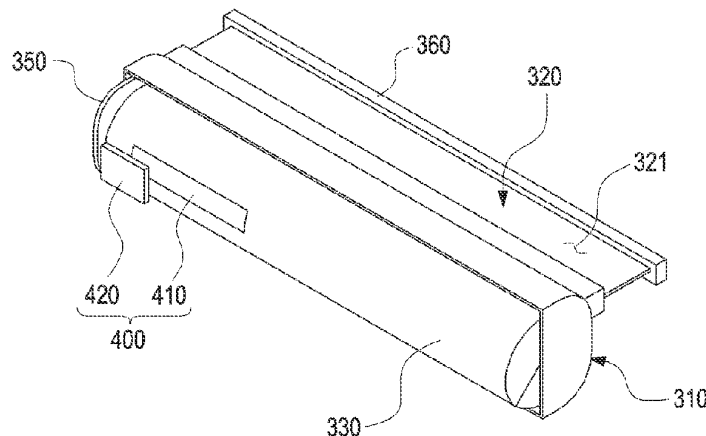
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Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**
According to various embodiments of the disclosure, an electronic device may include: a housing, a rollable display, a shielding case disposed inside the housing and surrounding at least a part of the rollable display, and including a first opening accommodating the rollable display, and a first antenna structure including at least one antenna disposed in an area outside the shielding case.

15 Claims, 11 Drawing Sheets

101





US012034224B2

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

(10) **Patent No.:** **US 12,034,224 B2**
(45) **Date of Patent:** **Jul. 9, 2024**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Donghun Shin**, Suwon-si (KR);
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Hongpyo Bae, Suwon-si (KR);
Youngjun Cho, Suwon-si (KR);
Gyubok Park, Suwon-si (KR); **Jinkyu Bang**, 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 124 days.

(21) Appl. No.: **17/885,429**

(22) Filed: **Aug. 10, 2022**

(65) **Prior Publication Data**
US 2022/0384953 A1 Dec. 1, 2022

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2021/001823, filed on Feb. 10, 2021.

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

(52) **U.S. Cl.**
CPC **H01Q 5/364** (2015.01); **H01Q 1/241** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/364; H01Q 1/241; H01Q 7/00; H01Q 9/42; H01Q 13/10; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

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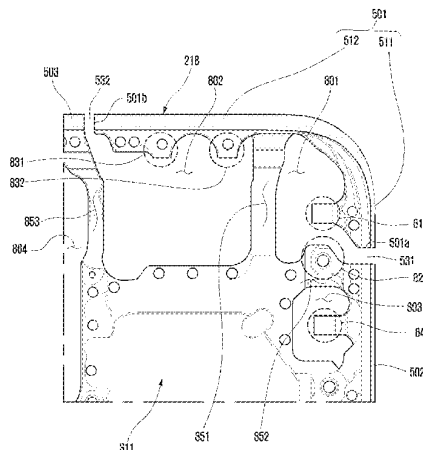
Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

According to an embodiment of the disclosure, an electronic device comprises: a housing including a front plate, a rear plate positioned on the opposite side from the front plate, and a side bezel surrounding at least part of the space between the front plate and the rear plate, and including a first conduction unit comprising a conductor, a second conduction unit comprising a conductor positioned such that a first segment is between the second conduction unit and one end of the first conduction unit, and a third conduction unit comprising a conductor positioned such that a second segment is between the third conduction unit and an other end of the first conduction unit; a support positioned inside the space and connected to the first conduction unit, the second conduction unit, and the third conduction unit, and which includes a first opening extending from the first segment and positioned within a specified proximity of the first conduction unit; a printed circuit board positioned inside the space between the support and the rear plate, and including first and second terminals electrically connected to at least part of the support surrounding the first opening, a ground plane, a first electrical path electrically connecting

(Continued)





US012034225B2

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

(10) **Patent No.:** **US 12,034,225 B2**
(45) **Date of Patent:** **Jul. 9, 2024**

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

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

(72) Inventors: **Sooyoung Jang**, Suwon-si (KR);
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Gyubok Park, Suwon-si (KR);
Donghun Shin, Suwon-si (KR);
Minkyung Lee, 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 34 days.

(21) Appl. No.: **17/901,100**

(22) Filed: **Sep. 1, 2022**

(65) **Prior Publication Data**
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Related U.S. Application Data
(63) Continuation of application No. PCT/KR2022/011936, filed on Aug. 10, 2022.

(30) **Foreign Application Priority Data**
Aug. 10, 2021 (KR) 10-2021-0105046
Jan. 11, 2022 (KR) 10-2022-0004039

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

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

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 1/38; H01Q 1/50; H01Q 5/328; H01Q 9/42; H01Q 1/243
See application file for complete search history.

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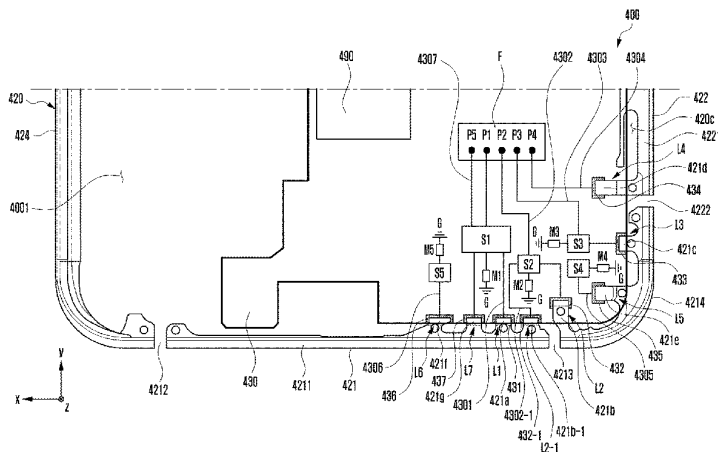
Primary Examiner — Seung H Lee

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

An example electronic device may include: a side member including a first conductive portion disposed through a first non-conductive portion and a second non-conductive portion and a second conductive portion disposed through the second non-conductive portion and a third non-conductive portion; a substrate disposed in the internal space of the housing and including a ground; at least one wireless communication circuit disposed on the substrate; a first switching circuit disposed in a first electrical path connecting the wireless communication circuit and a first point of the first conductive portion; a second switching circuit disposed in a second electrical path connecting the wireless communication circuit and a second point of the second conductive portion; a third switching circuit disposed in a third electrical path connecting the wireless communication circuit and a third point of the second conductive portion between the second point and the third non-conductive portion; and at least one processor configured to control at least one switching circuit among the first, second, and third switching circuits, wherein the second switching circuit is

(Continued)





US012041191B2

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

(10) **Patent No.:** **US 12,041,191 B2**
(45) **Date of Patent:** **Jul. 16, 2024**

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

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

(72) Inventors: **Yongyoun Kim**, Suwon-si (KR);
Jaesung Shim, Suwon-si (KR);
Myeongsu Oh, Suwon-si (KR); **Hojin Jung**,
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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 340 days.

(21) Appl. No.: **17/426,892**

(22) PCT Filed: **Jan. 2, 2020**

(86) PCT No.: **PCT/KR2020/000028**
§ 371 (c)(1),
(2) Date: **Jul. 29, 2021**

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(65) **Prior Publication Data**
US 2022/0103668 A1 Mar. 31, 2022

(30) **Foreign Application Priority Data**
Feb. 13, 2019 (KR) 10-2019-0016491

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H05K 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04M 1/0214** (2013.01); **H04M 1/0268**
(2013.01); **H05K 1/0213** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/243; H01Q 1/44;
H01Q 5/335; H01Q 5/371; H01Q 9/42;
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Application No. 10-2019-0016491.
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Primary Examiner — Tan H Trinh
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**
An electronic apparatus is provided. The electronic apparatus includes a housing which comprises a front surface plate, a rear surface plate oriented in the opposite direction to the front surface plate, and a side surface member surrounding the space between the front surface plate and the rear surface plate, at least a portion of the side surface member including at least one conductive section positioned between a first non-conductive section and a second non-conductive section which are spaced apart from each other, a conductive extended portion part extending from at least a partial area of the conductive section to the space, a printed circuit board disposed in the space, and a wireless communication circuit disposed on the printed circuit board and electrically con-
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