



US011876279B2

(12) **United States Patent
Harper**

(10) **Patent No.: US 11,876,279 B2**
(45) **Date of Patent: Jan. 16, 2024**

- (54) **HYBRID CAVITY MODE ANTENNA**
- (71) Applicant: **Microsoft Technology Licensing, LLC**, Redmond, WA (US)
- (72) Inventor: **Marc Harper**, Snohomish, WA (US)
- (73) Assignee: **Microsoft Technology Licensing, LLC**, Redmond, WA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 558 days.

- (56) **References Cited**
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Primary Examiner — Graham P Smith
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(57) **ABSTRACT**

A communication device includes a metal chassis, a printed circuit board positioned within the metal chassis, and a hybrid cavity mode antenna. The hybrid cavity mode antenna includes a conductive wall defining at least a portion of a cavity, wherein the cavity is further defined by one or more surfaces of the metal chassis and the printed circuit board, and an electrically-fed antenna configured to radiate a first radiofrequency signal in a first frequency range. The electrically-fed antenna is electrically driven from the printed circuit board of the communication device. The electrically-fed antenna is positioned within the cavity to drive the cavity to radiate a second radiofrequency signal in a second frequency range.

24 Claims, 6 Drawing Sheets

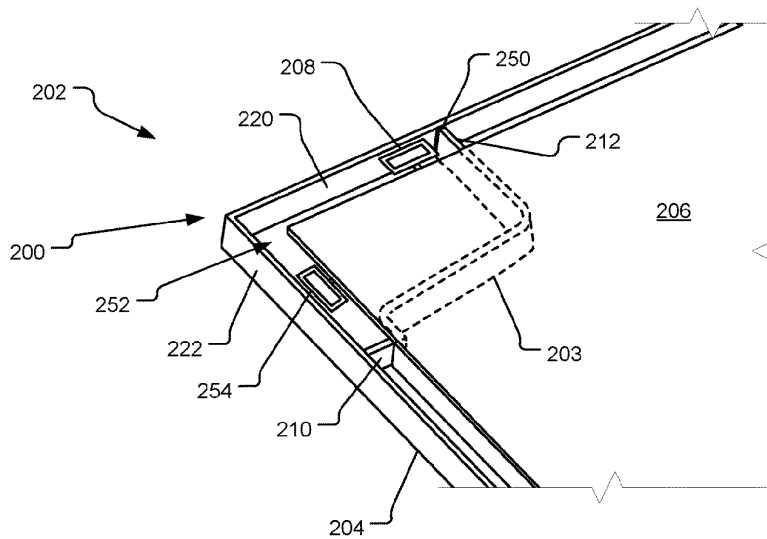
- (21) Appl. No.: **16/887,209**
- (22) Filed: **May 29, 2020**
- (65) **Prior Publication Data**
US 2021/0265735 A1 Aug. 26, 2021

Related U.S. Application Data

- (60) Provisional application No. 62/981,129, filed on Feb. 25, 2020.

- (51) **Int. Cl.**
H01Q 13/18 (2006.01)
H01Q 9/40 (2006.01)
H01Q 7/00 (2006.01)
H05K 1/02 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 13/18** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/40** (2013.01); **H05K 1/0243** (2013.01)

- (58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 9/40; H01Q 13/18; H05K 1/0243
See application file for complete search history.





US011876285B2

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

(10) **Patent No.:** **US 11,876,285 B2**
(45) **Date of Patent:** **Jan. 16, 2024**

(54) **ANTENNA APPARATUS AND TERMINAL**

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

(72) Inventors: **Le Chang**, Shenzhen (CN); **Kunpeng Wei**, Shenzhen (CN)

(73) Assignee: **HUAWEI TECHNOLOGIES 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 374 days.

(21) Appl. No.: **17/418,515**

(22) PCT Filed: **Dec. 27, 2018**

(86) PCT No.: **PCT/CN2018/124495**

§ 371 (c)(1),
(2) Date: **Jun. 25, 2021**

(87) PCT Pub. No.: **WO2020/133111**

PCT Pub. Date: **Jul. 2, 2020**

(65) **Prior Publication Data**

US 2022/0123456 A1 Apr. 21, 2022

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/40 (2015.01)
H01Q 13/10 (2006.01)
H01Q 21/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/40** (2015.01); **H01Q 13/10** (2013.01); **H01Q 21/24** (2013.01); **H01Q 21/28** (2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 1/38;
H01Q 21/28; H01Q 5/40; H01Q 21/24;
H01Q 9/40

See application file for complete search history.

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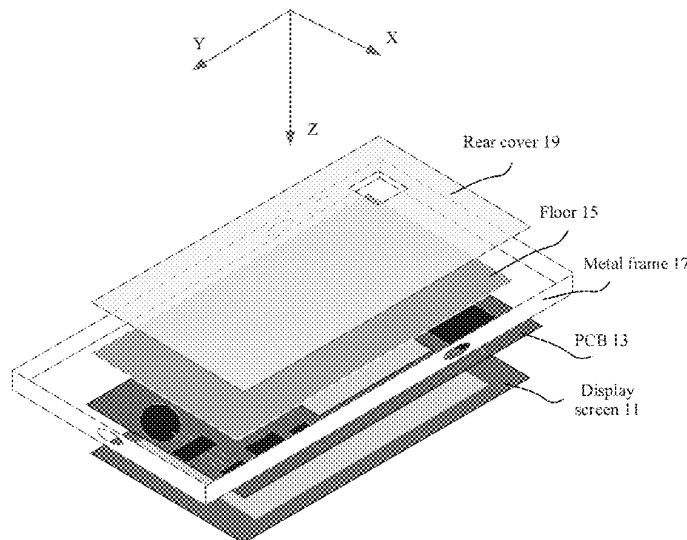
Primary Examiner — Joseph J Lauture

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

(57) **ABSTRACT**

A terminal comprises a printed circuit board (PCB), a PCB floor, and a rear cover. The metal frame is disposed at edges of the PCB floor. The PCB floor is disposed between the PCB and the rear cover, and the PCB floor is used to ground electronic components. The antenna apparatus may include a split antenna formed by a split provided on the metal frame, and a slot antenna formed by a slot connecting to the split. The slot may be connected to the split at a middle position on one side of the slot, and the slot may be provided on the metal frame of the terminal or on a PCB floor of the terminal.

20 Claims, 16 Drawing Sheets





US011881614B2

(12) **United States Patent**
Guan

(10) **Patent No.:** **US 11,881,614 B2**
(45) **Date of Patent:** **Jan. 23, 2024**

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

H01Q 1/50; H01Q 5/10; H01Q 5/307;
H01Q 5/314; H01Q 1/46; H01Q 1/00;
H04M 1/0274; H04M 1/0249; H04M
1/0277

(71) Applicant: **BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.**, Beijing (CN)

See application file for complete search history.

(72) Inventor: **Wenjie Guan**, Beijing (CN)

(56) **References Cited**

(73) Assignee: **Beijing Xiaomi Mobile Software 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 600 days.

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(21) Appl. No.: **16/681,783**

(22) Filed: **Nov. 12, 2019**

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(65) **Prior Publication Data**

US 2020/0343623 A1 Oct. 29, 2020

Intellectual property India, Office Action Issued in Application No. 201947047177, dated Dec. 6, 2021, (5p).

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(30) **Foreign Application Priority Data**

Apr. 26, 2019 (CN) 201910343400.5

Primary Examiner — Hai V Tran

Assistant Examiner — Bamidele A Immanuel

(74) *Attorney, Agent, or Firm* — Arch & Lake LLP

(51) **Int. Cl.**

H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/357 (2015.01)
H04M 1/02 (2006.01)

(57) **ABSTRACT**

A mobile terminal and an antenna radiation method of the mobile terminal are provided. The mobile terminal includes a frame employed as an antenna, the frame having a feed point; an antenna bracket positioned within the frame; a first metal sheet positioned on the antenna bracket, and coupled to the feed point; and a second metal sheet positioned on the antenna bracket, a gap being positioned between the second metal sheet and the first metal sheet, the second metal sheet being coupled to the first metal sheet via the gap for feeding.

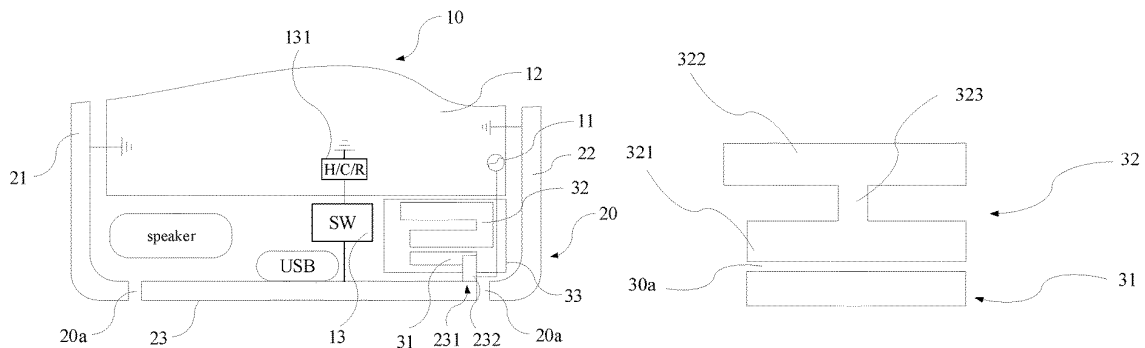
(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 5/357** (2015.01); **H04M 1/0274** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/357; H01Q 1/44;
H01Q 5/392; H01Q 1/36; H01Q 1/22;
H01Q 1/2258; H01Q 1/242; H01Q 1/38;

18 Claims, 3 Drawing Sheets





US011881630B2

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

(10) **Patent No.:** **US 11,881,630 B2**
(45) **Date of Patent:** **Jan. 23, 2024**

(54) **BEAM STEERING ANTENNA STRUCTURE AND ELECTRONIC DEVICE COMPRISING SAID STRUCTURE**

(52) **U.S. Cl.**
CPC **H01Q 3/26** (2013.01); **H04M 1/0266** (2013.01); **H01Q 1/288** (2013.01); **H01Q 3/00** (2013.01); **H01Q 3/24** (2013.01)

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

(58) **Field of Classification Search**
CPC .. **H01Q 3/26**; **H01Q 3/24**; **H01Q 3/00**; **H01Q 1/241**; **H01Q 1/288**; **H01Q 1/0266**
See application file for complete search history.

(72) Inventors: **Alexander Khripkov**, Helsinki (FI); **Janne Iivonen**, Helsinki (FI); **Ruiyuan Tian**, Helsinki (FI); **Jari Kristian Van Wonerghem**, Munich (DE); **Jian Ou**, Munich (DE); **Dongxing Tu**, Shenzhen (CN); **Zlatoljub Milosavljevic**, Helsinki (FI); **Hongting Luo**, Shanghai (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.

Primary Examiner — Joseph J Lature

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

(21) Appl. No.: **17/420,612**

(57) **ABSTRACT**

(22) PCT Filed: **Jan. 3, 2019**

A beam steering antenna structure comprises a stacked antenna module and a first conductive component. The antenna module comprises a first substrate and a second substrate arranged superjacent such that main planes of the substrates extend in parallel. The first substrate comprises a first antenna array transmitting and receiving a first radiation beam. The second substrate comprises a second antenna array transmitting and receiving a second radiation beam. The first conductive component extends adjacent to the antenna module and is at least partially separated from the antenna module in a first direction perpendicular to the main plane of the conductive component. The antenna module is coupled to the conductive component by means of at least one of a galvanic, capacitive, or inductive coupling. At least one of the first and the second radiation beams is at least partially steered away from the other one by the first conductive component.

(86) PCT No.: **PCT/EP2019/050095**

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(2) Date: **Jul. 2, 2021**

(87) PCT Pub. No.: **WO2020/141018**

PCT Pub. Date: **Jul. 9, 2020**

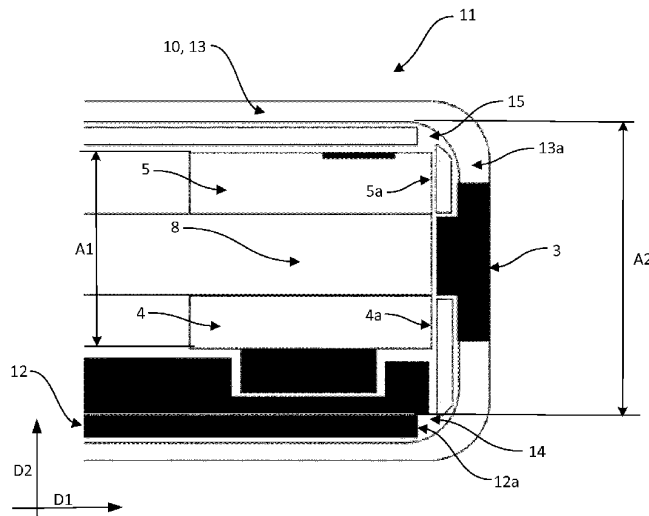
(65) **Prior Publication Data**

US 2022/0085497 A1 Mar. 17, 2022

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 3/26 (2006.01)

(Continued)

20 Claims, 4 Drawing Sheets





US011881636B2

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

(10) **Patent No.:** **US 11,881,636 B2**
(45) **Date of Patent:** **Jan. 23, 2024**

(54) **PRINTED CIRCUIT BOARD ANTENNA**

(58) **Field of Classification Search**

(71) Applicant: **BSH Hausgeraete GmbH**, Munich (DE)

CPC H05B 6/6444; H05B 6/70; H05B 6/72; H01Q 1/2291; H01Q 1/38; H01Q 1/48; (Continued)

(72) Inventors: **Josef Reitner**, Donaustauf (DE); **Ludwig Stoeckl**, Undorf (DE)

(56) **References Cited**

(73) Assignee: **BSH Hausgeraete GmbH**, Munich (DE)

U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 296 days.

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(21) Appl. No.: **17/441,548**

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

Primary Examiner — Monica C King
(74) *Attorney, Agent, or Firm* — Laurence A. Greenberg; Werner H. Stemer; Ralph E. Locher

(86) PCT No.: **PCT/EP2020/059388**
§ 371 (c)(1),
(2) Date: **Sep. 21, 2021**

(87) PCT Pub. No.: **WO2020/212153**
PCT Pub. Date: **Oct. 22, 2020**

(65) **Prior Publication Data**
US 2022/0181777 A1 Jun. 9, 2022

(30) **Foreign Application Priority Data**
Apr. 17, 2019 (DE) 102019205556.7

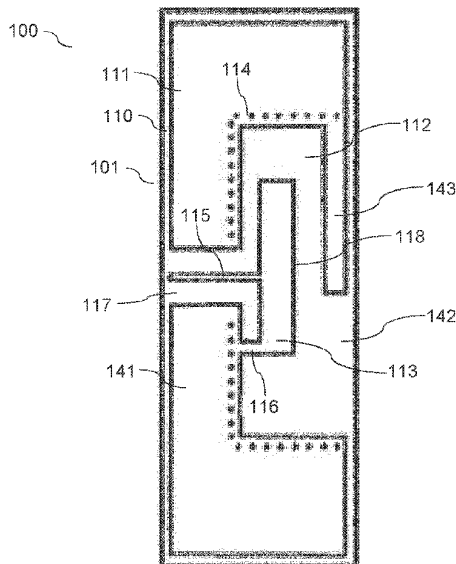
(51) **Int. Cl.**
H01Q 5/357 (2015.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01); **H01Q 1/38** (2013.01)

(57) **ABSTRACT**

A printed circuit board antenna contains an electrically conductive antenna structure on an outer layer of a printed circuit board, the antenna structure has a first resonance frequency. The printed circuit board antenna additionally contains an electrically conductive feed line to the antenna structure and an electrically conductive reference region on the outer layer. The reference region completely encloses the antenna structure with the exception of an insulating feed recess for the feed line and an insulating web recess. The web recess is arranged on the antenna structure face facing away from the feed line, and the reference region has a reference region web on the antenna structure face facing away from the feed line. The reference region web forms a resonator which is capacitively coupled to the antenna structure and has a second resonance frequency.

20 Claims, 5 Drawing Sheets





US011881638B2

(12) **United States Patent**
Canete Cabeza et al.

(10) **Patent No.:** **US 11,881,638 B2**
(45) **Date of Patent:** **Jan. 23, 2024**

(54) **ULTRA-LOW-PROFILE LOW FREQUENCY ANTENNA**

(58) **Field of Classification Search**
CPC H01Q 7/06; H01Q 1/40; H01Q 1/243;
H01Q 1/3241; H01Q 1/14; H01Q 1/2225;
(Continued)

(71) Applicant: **PREMO, SA**, Campanillas (ES)

(56) **References Cited**

(72) Inventors: **Claudio Canete Cabeza**, Benalmadena (ES); **Francisco Ezequiel Navarro Perez**, Barcelona (ES); **Jorge Rodriguez**, Malaga (ES); **Sergio Cobos Reyes**, Malaga (ES); **Antonio Rojas Cuevas**, Malaga (ES)

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(73) Assignee: **PREMO, SA**, Campanillas (ES)

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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 262 days.

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(21) Appl. No.: **17/606,348**

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(22) PCT Filed: **Feb. 20, 2020**

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(86) PCT No.: **PCT/EP2020/054502**

§ 371 (c)(1),
(2) Date: **Oct. 25, 2021**

Primary Examiner — David E Lotter

(74) *Attorney, Agent, or Firm* — Lucas & Mercanti, LLP

(87) PCT Pub. No.: **WO2020/216494**

PCT Pub. Date: **Oct. 29, 2020**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2022/0224011 A1 Jul. 14, 2022

An ultra-low-profile low frequency antenna including a magnetic core having coil winding channels in three intersecting axial directions orthogonal to each other, defining X-axis (X), Y-axis (Y) and Z-axis (Z), receiving respective X-coil (DX), Y-coil (DY), and Z-coil (DZ). A Z-coil winding channel surrounds the magnetic core around the Z-axis (Z), providing partial grooves confined between two parallel surfaces. The thickness of the magnetic core in the Z-axis (Z) is less than 1.2 mm. Each partial groove has a width in the Z-axis (Z) equal or less than 0.4 mm and its depth in a radial direction perpendicular to the Z-axis (Z) is at least two times of its width. The Z-coil (DZ) is wound within said groove and extends radially from 1/3 to 2/3 of the groove's depth. The outer edge of the Z-coil is at the entrance of the groove.

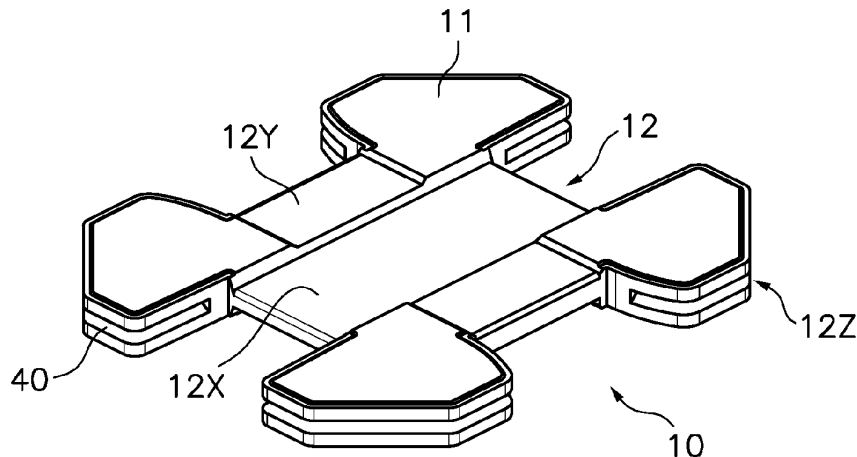
(30) **Foreign Application Priority Data**

Apr. 24, 2019 (EP) 19382311

12 Claims, 6 Drawing Sheets

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

(52) **U.S. Cl.**
CPC **H01Q 7/06** (2013.01); **H01Q 1/40** (2013.01); **H01Q 1/243** (2013.01)





US011881640B2

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

(10) **Patent No.:** **US 11,881,640 B2**
(45) **Date of Patent:** **Jan. 23, 2024**

(54) **ANTENNA ELEMENT, ANTENNA MODULE,
AND COMMUNICATION DEVICE**

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

(72) Inventors: **Kaoru Sudo, Kyoto (JP); Hirotsugu
Mori, Kyoto (JP); Kengo Onaka,
Kyoto (JP)**

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 451 days.

(21) Appl. No.: **17/169,726**

(22) Filed: **Feb. 8, 2021**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No.
PCT/JP2019/030419, filed on Aug. 2, 2019.

(30) **Foreign Application Priority Data**

Aug. 9, 2018 (JP) 2018-150512

(51) **Int. Cl.**

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H01Q 1/38 (2006.01)

H01Q 11/14 (2006.01)

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

CPC **H01Q 9/0407** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 11/14** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0407; H01Q 1/38; H01Q 11/14
See application file for complete search history.

(56) **References Cited**

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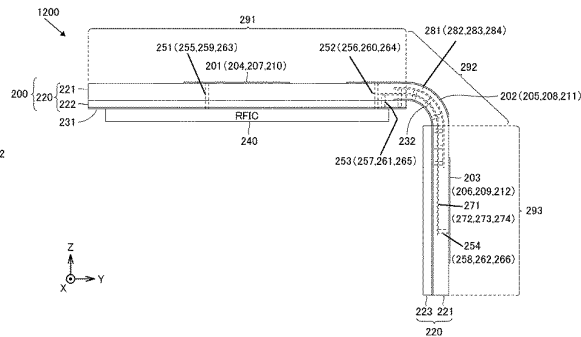
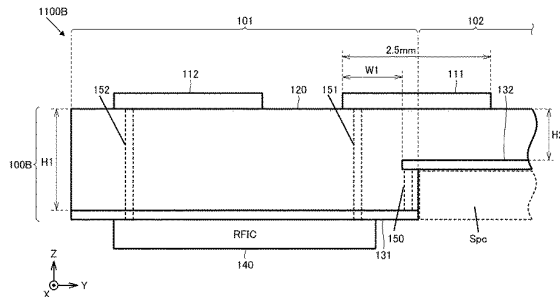
Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

(57) **ABSTRACT**

An antenna element includes a dielectric substrate, a first ground electrode, a second ground electrode, a via conductor, and a radiation electrode. The dielectric substrate includes a first portion shaped like a flat plate and a second portion thinner than the first portion. The first ground electrode is arranged in the first portion. The second ground electrode is arranged in the second portion. The via conductor couples the first ground electrode and the second ground electrode. A distance between the radiation electrode and the first ground electrode in a first thickness direction is more than a distance between the radiation electrode and the second ground electrode in a second thickness direction. Part of the radiation electrode lies opposite to the first ground electrode without lying opposite to the second ground electrode.

9 Claims, 13 Drawing Sheets





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

(10) **Patent No.:** **US 11,888,239 B2**
(45) **Date of Patent:** **Jan. 30, 2024**

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

(71) Applicant: **Huawei Technologies Co., Ltd.**,
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(72) Inventors: **Chih-Wei Hsu**, Taipei (CN); **Dong Yu**,
Shanghai (CN); **Hangfei Tang**,
Shanghai (CN); **Zhiyuan Xie**, Shanghai
(CN)

(73) Assignee: **HUAWEI TECHNOLOGIES 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 334 days.

(21) Appl. No.: **17/432,826**

(22) PCT Filed: **Feb. 7, 2020**

(86) PCT No.: **PCT/CN2020/074486**
§ 371 (c)(1),
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(87) PCT Pub. No.: **WO2020/168926**
PCT Pub. Date: **Aug. 27, 2020**

(65) **Prior Publication Data**
US 2022/0123469 A1 Apr. 21, 2022

(30) **Foreign Application Priority Data**
Feb. 22, 2019 (CN) 201910136437.0

(51) **Int. Cl.**
H01Q 5/392 (2015.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/392** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 1/36** (2013.01); **H01Q 1/44**
(2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 1/22;
H01Q 5/328; H01Q 13/10; H01Q 1/24;
(Continued)

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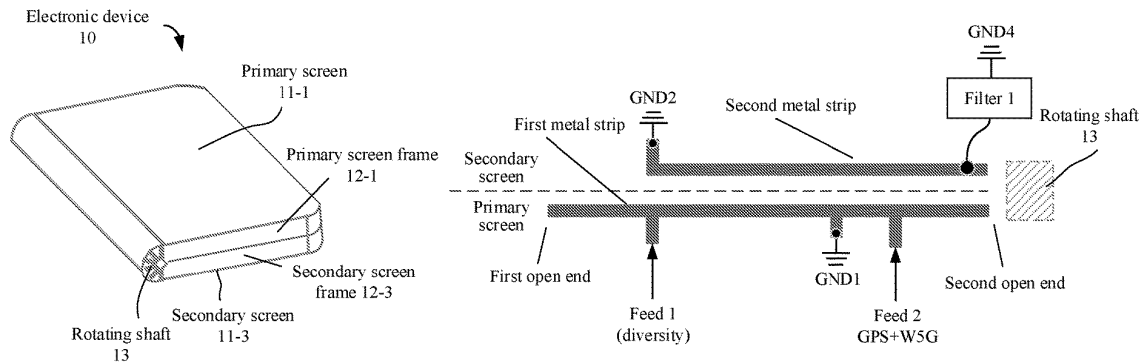
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Primary Examiner — Vibol Tan
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**
An antenna apparatus used in an electronic device having a
flexible display that can be bent at a rotating shaft and that
includes a primary screen and a secondary screen respec-
tively configured on two sides of the rotating shaft. The
antenna apparatus includes a first metal strip disposed on the
primary screen frame close to one end of the rotating shaft,
and a second metal strip disposed on the secondary screen
frame close to the same end of the rotating shaft. The first
metal strip is implemented as a plurality of antennas through
dual-feed design. When the flexible display is in a folded
state, the second metal strip is coupled to the first metal strip
to generate radiation and is used as a parasitic antenna of the
first metal strip.

20 Claims, 19 Drawing Sheets





US011899492B2

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

(10) **Patent No.:** **US 11,899,492 B2**
(45) **Date of Patent:** **Feb. 13, 2024**

(54) **ELECTRONIC DEVICE**
(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (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 448 days.

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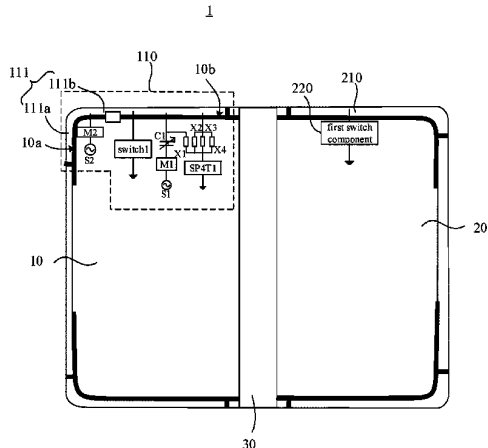
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(63) Continuation of application No. PCT/CN2019/125936, filed on Dec. 17, 2019.
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Dec. 29, 2018 (CN) 201811654714.9

(57) **ABSTRACT**
The present disclosure relates to an electronic device including a rotation shaft, a first body and a second body which are foldable or unfoldable in relation to each other around the rotation shaft. The first body has a first end surface facing away from the rotation shaft and a second end surface connected between the first end surface and the rotation shaft. A first metal member is provided on the first body, includes a first and second parts connected in such a manner that the first metal member has a bent form, and constitutes a radiator of a first antenna set. The first part is arranged on the first end surface. The second part is arranged on the second end surface. A second metal member is provided on the second body, is grounded via a first switch component configured to adjust an electrical length of the second metal member.

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G06F 1/16 (2006.01)
H01Q 5/328 (2015.01)
(Continued)
(52) **U.S. Cl.**
CPC **G06F 1/1616** (2013.01); **G06F 1/1686** (2013.01); **H01Q 1/22** (2013.01);
(Continued)
(58) **Field of Classification Search**
CPC G06F 1/1616; G06F 1/1686; H01Q 1/243; H01Q 1/36; H01Q 5/328; H01Q 5/335;
(Continued)

19 Claims, 9 Drawing Sheets





US011901641B2

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Vazquez et al.

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(45) **Date of Patent:** **Feb. 13, 2024**

(54) **ELECTRONIC DEVICES WITH MULTIPLE LOW BAND ANTENNAS**

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Primary Examiner — David E Lotter

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(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons

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(57) **ABSTRACT**

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An electronic device may include first and second antennas formed from respective first and second segments of a housing. The first antenna may have a first feed coupled to the first segment by a first switch and coupled to the first segment by a first conductive trace. The second antenna may have a second feed coupled to the second segment by a second switch and coupled to the second segment by a second conductive trace. The first segment may be separated from the second segment by a single gap, a data connector may pass through the second segment, and the antennas may selectively cover a low band. Alternatively, the first segment may be separated from the second segment by a third segment and two gaps, the data connector may pass through the third segment, and the first and second antennas may concurrently cover the low band.

(65) **Prior Publication Data**

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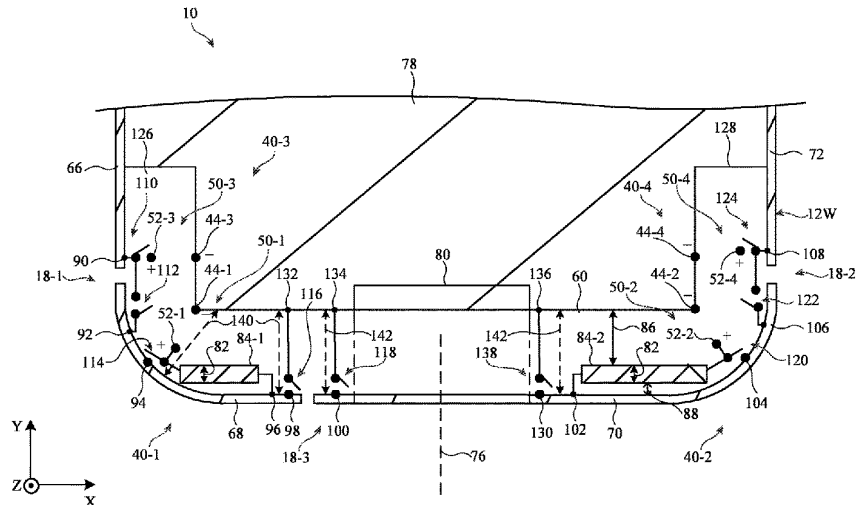
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/241** (2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/241; H01Q 1/38; H01Q 1/243; H01Q 13/10; H01Q 5/328; H01Q 1/521

See application file for complete search history.

20 Claims, 9 Drawing Sheets





US011901647B2

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

(10) **Patent No.:** **US 11,901,647 B2**
(45) **Date of Patent:** **Feb. 13, 2024**

(54) **ANTENNA DEVICE**
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(73) Assignee: **SONY GROUP CORPORATION**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 369 days.

(58) **Field of Classification Search**
CPC H01Q 5/35; H01Q 1/2291; H01Q 1/243; H01Q 9/42; H01Q 13/10; H01Q 1/48; H01Q 1/22; H01Q 1/24
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Primary Examiner — Hai V Tran
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§ 371 (c)(1),
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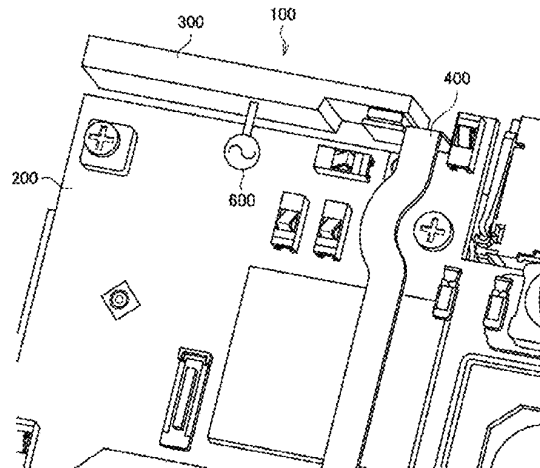
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H01Q 9/42 (2006.01)
(Continued)

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CPC **H01Q 5/35** (2015.01); **H01Q 1/22** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/24** (2013.01);
(Continued)

(57) **ABSTRACT**
To optimize space efficiency in mounting a plurality of antennas compatible with different frequencies. According to the present disclosure, provided is an antenna device including a first antenna that operates at a first frequency, and a second antenna that is provided adjacent to the first antenna, operates at a second frequency lower than the first frequency, and has a ground potential connected to a grounding wire provided at the first antenna.

18 Claims, 6 Drawing Sheets





US011901652B2

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

(10) **Patent No.:** **US 11,901,652 B2**
(45) **Date of Patent:** **Feb. 13, 2024**

(54) **ANTENNA WITH MULTIPLE FREQUENCY RANGES AND ELECTRONIC DEVICE**

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(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
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H01Q 1/52 (2006.01)
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H01Q 5/45 (2015.01)

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CPC **H01Q 9/42** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/45** (2015.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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Primary Examiner — Daniel Munoz
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**
An antenna with multi frequency ranges for communication in more bandwidths includes a dielectric substrate, a first subantenna, a second subantenna, a third subantenna, and first, second, and third isolators. The first to third subantennas are connected to the dielectric substrate and connect with signal sources. The first to third isolators are connected to the dielectric substrate and arranged to be between the first to third subantennas, to improve signal isolation between the subantennas. The application also provides an electronic device with the antenna having multiple frequency ranges. The antenna and the electronic device with the antenna enjoys reduced cross-interference between signals of the first subantenna, the second subantenna, and the third subantenna. The disclosure also provides an electronic device with the antenna.

17 Claims, 4 Drawing Sheets

