



US012573749B2

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

(10) **Patent No.:** **US 12,573,749 B2**
(45) **Date of Patent:** **Mar. 10, 2026**

(54) **ANTENNA COMBINATION SYSTEM AND
TERMINAL DEVICE**

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(73) Assignee: **HONOR DEVICE CO., LTD.**,
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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 399 days.

(21) Appl. No.: **18/547,455**

(22) PCT Filed: **May 6, 2022**

(86) PCT No.: **PCT/CN2022/091177**

§ 371 (c)(1),

(2) Date: **Aug. 22, 2023**

(87) PCT Pub. No.: **WO2023/015979**

PCT Pub. Date: **Feb. 16, 2023**

(65) **Prior Publication Data**

US 2024/0145910 A1 May 2, 2024

(30) **Foreign Application Priority Data**

Aug. 9, 2021 (CN) 202110909423.5

(51) **Int. Cl.**

H04B 7/02 (2018.01)

H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 1/523** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/48** (2013.01); **H04B**
1/0064 (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/523; H01Q 1/243; H01Q 1/48;
H01Q 1/245; H01Q 1/521; H01Q 5/335;

(Continued)

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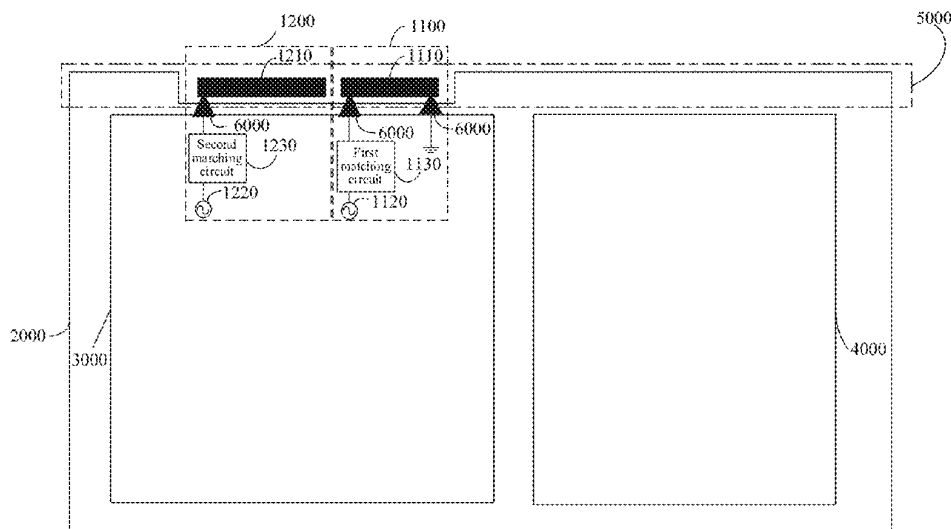
Primary Examiner — Andrew Wendell

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

(57) **ABSTRACT**

An antenna combination system and a terminal device. The antenna combination system includes a first antenna and a second antenna having a distance less than a first preset threshold. The first antenna includes a first radiation branch and a first feed point, a feed point of the second antenna is arranged on a side away from the first feed point, and a side of the first radiation branch away from the first feed point is grounded. The first feed point is arranged on a side close to the second antenna, and the length of the first radiation branch is an odd multiple of $(\frac{1}{2})\lambda$. In a case that the second antenna transmits a signal in a first frequency band, a first signal and a second signal that cancel each other are coupled from the second antenna to the first antenna.

20 Claims, 13 Drawing Sheets





US012562480B2

(12) **United States Patent**
Hamabe

(10) **Patent No.:** **US 12,562,480 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

(54) **ANTENNA DEVICE AND COMMUNICATION DEVICE**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

(72) Inventor: **Taichi Hamabe**, Osaka (JP)

(73) Assignee: **PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 229 days.

(21) Appl. No.: **18/207,867**

(22) Filed: **Jun. 9, 2023**

(65) **Prior Publication Data**

US 2023/0402752 A1 Dec. 14, 2023

(30) **Foreign Application Priority Data**

Jun. 10, 2022 (JP) 2022-094690

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/50 (2006.01)
H01Q 5/35 (2015.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/35** (2015.01); **H01Q 1/50** (2013.01); **H01Q 7/00** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 5/35; H01Q 1/50; H01Q 7/00; H01Q 5/371; H01Q 21/28

See application file for complete search history.

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Primary Examiner — Dimary S Lopez Cruz

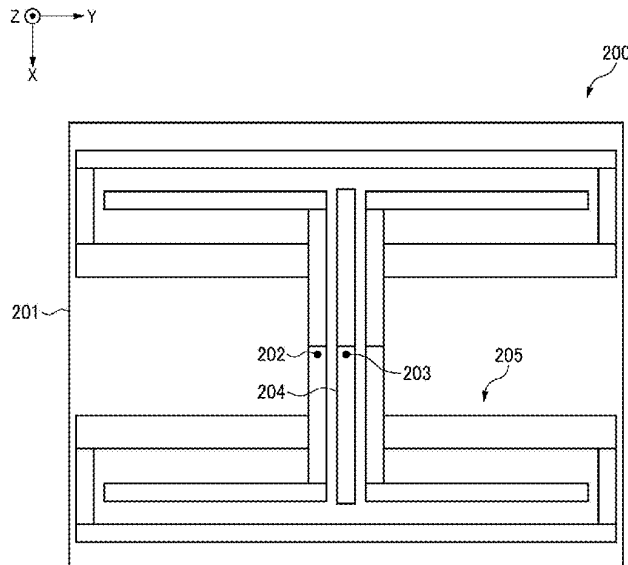
Assistant Examiner — Bamidele A Immanuel

(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**

There are provided an antenna device and a communication device including: a feed antenna connected to a feed point; a loop antenna connected to ground and arranged to surround the feed antenna; and two resonators provided inside the loop antenna and on both sides of the feed antenna in a short direction of the feed antenna. Each of the two resonators is connected to the loop antenna and has an L shape.

6 Claims, 8 Drawing Sheets





US012562483B2

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

(10) **Patent No.:** **US 12,562,483 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

(54) **ANTENNA AND ELECTRONIC DEVICE
COMPRISING SAME**

(71) Applicant: **SAMSUNG ELECTRONICS CO.,
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(73) Assignee: **SAMSUNG ELECTRONICS CO.,
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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 114 days.

(21) Appl. No.: **18/514,723**

(22) Filed: **Nov. 20, 2023**

(65) **Prior Publication Data**
US 2024/0106125 A1 Mar. 28, 2024

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/004853, filed on Apr. 5, 2022.

(30) **Foreign Application Priority Data**
May 20, 2021 (KR) 10-2021-0064740

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 5/10**
(2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 1/243; H01Q 1/48;
H01Q 5/10; H01Q 9/0428; H01Q 21/065;
H01Q 9/0414
See application file for complete search history.

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tional Searching Authority on Jul. 13, 2022 in corresponding
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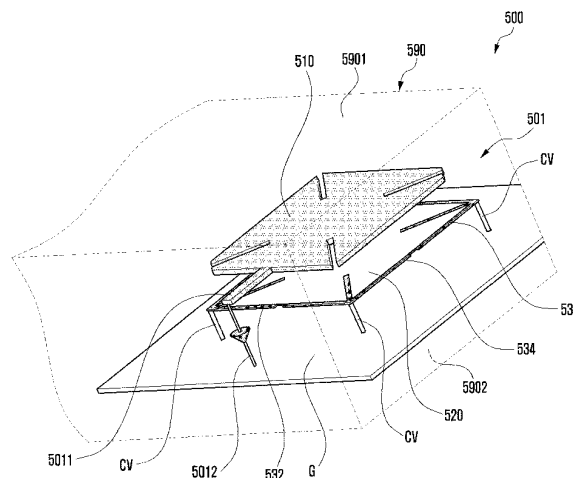
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device includes a substrate including a ground
layer; and a plurality of antenna structures space apart from
each other on the substrate. Each of the plurality of antenna
structures may include, on the substrate: a rectangular first
conductive patch including a pair of cutting portions in
which diagonally opposite corners are cut; a rectangular
second conductive patch disposed so as to be coupled to the
first conductive patch; and a plurality of conductive pads
which are disposed along the periphery of the second
conductive patch so as to be spaced apart from each other at
a specified interval, and are electrically connected to the
ground layer.

20 Claims, 27 Drawing Sheets





US012562493B2

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

(10) **Patent No.:** **US 12,562,493 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

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

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(72) Inventors: **Ta Wei Kuo**, Hsinchu (TW); **I Yuan Lu**, Hsinchu (TW); **Yen Ming Hong**, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 78 days.

(21) Appl. No.: **18/591,086**

(22) Filed: **Feb. 29, 2024**

(65) **Prior Publication Data**
US 2024/0297441 A1 Sep. 5, 2024

Related U.S. Application Data

(60) Provisional application No. 63/488,208, filed on Mar. 3, 2023.

(30) **Foreign Application Priority Data**

Feb. 6, 2024 (TW) 113104759

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 13/10 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 21/28** (2013.01); **H01Q 1/2291** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 21/28; H01Q 1/2291; H01Q 5/371

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

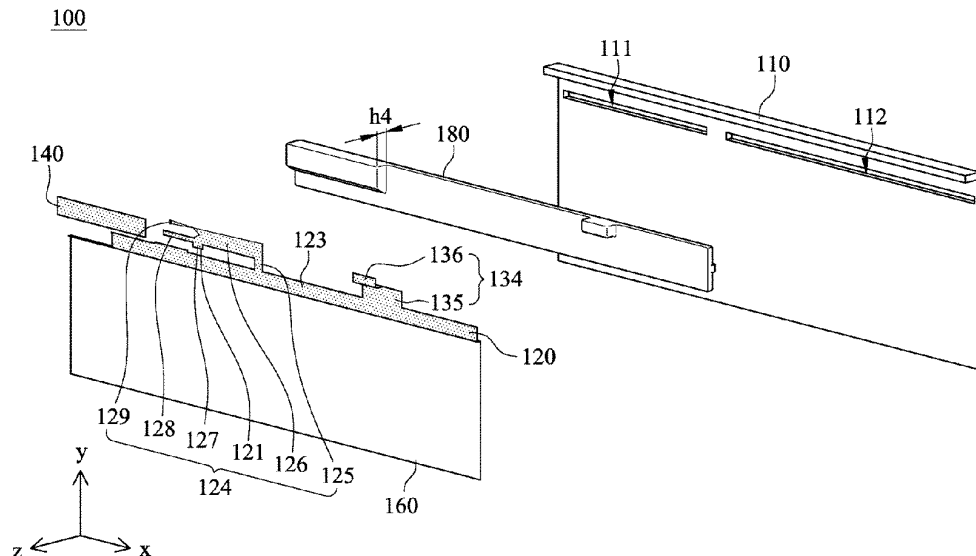
Assistant Examiner — Michael M Bouizza

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

(57) **ABSTRACT**

An antenna structure is provided. The antenna structure includes a first metal element and a second metal element. The first metal element includes a first slot that extends along a first direction to form an elongated shape. The second metal element includes a first branch portion including a first open section and a part section. The first open section extends along the first direction to form an open end, and the part section extends along a second direction to form an open end. A projection of the part section and a projection of the first slot are partially overlapped when being observed along a third direction. The first direction, the second direction, and the third direction are perpendicular to one another.

18 Claims, 7 Drawing Sheets





US012562494B2

(12) **United States Patent**
Chu

(10) **Patent No.:** **US 12,562,494 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

(54) **SLOT ANTENNA DEVICE AND SLOT
ANTENNA COMBINATION SYSTEM**

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei
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(72) Inventor: **Fang-Hsien Chu**, Taipei (TW)

(73) Assignee: **ASUSTEK COMPUTER INC.**, Taipei
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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 252 days.

(21) Appl. No.: **17/957,255**

(22) Filed: **Sep. 30, 2022**

(65) **Prior Publication Data**

US 2023/0246341 A1 Aug. 3, 2023

(30) **Foreign Application Priority Data**

Jan. 28, 2022 (TW) 111104099

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01); **H01Q 13/10**
(2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/106; H01Q 13/16
See application file for complete search history.

(56) **References Cited**

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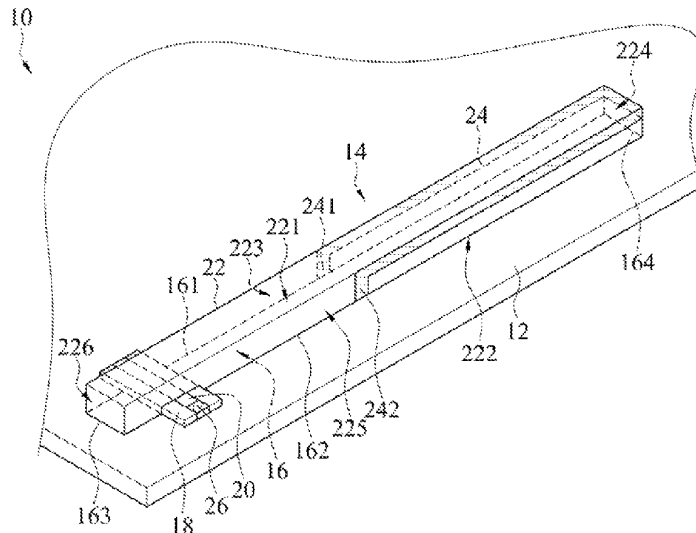
Primary Examiner — Amal Patel

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

(57) **ABSTRACT**

A slot antenna device is disposed on a metal case and includes a slot, a first dielectric substrate, a feeding metal branch, a coupling metal branch, and a signal source. The slot is in the metal case and includes a first long side, a second long side, a first short side and a second short side. The first dielectric substrate is on the metal case adjacent to the first short side of the slot and located above the slot. The feeding metal branch is on the first dielectric substrate and above the slot. A first end of the coupling metal branch is connected to the metal case of the first long side, and a second end of the coupling metal branch extends along the first long side and toward the second short side. The signal source is electrically connected to the feeding metal branch and the metal case.

14 Claims, 9 Drawing Sheets





US012562505B2

(12) **United States Patent**
Jiang

(10) **Patent No.:** **US 12,562,505 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

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

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

(72) Inventor: **Wenyu Jiang**, Guangdong (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., 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 216 days.

(21) Appl. No.: **18/505,357**

(22) Filed: **Nov. 9, 2023**

(65) **Prior Publication Data**
US 2024/0079796 A1 Mar. 7, 2024

Related U.S. Application Data
(63) Continuation of application No. PCT/CN2022/083091, filed on Mar. 25, 2022.

(30) **Foreign Application Priority Data**
May 11, 2021 (CN) 202110513133.9

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 1/50 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 21/30** (2013.01); **H01Q 1/50** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/50; H01Q 1/521; H01Q 21/28; H01Q 21/30; H01Q 5/20; H01Q 5/30
See application file for complete search history.

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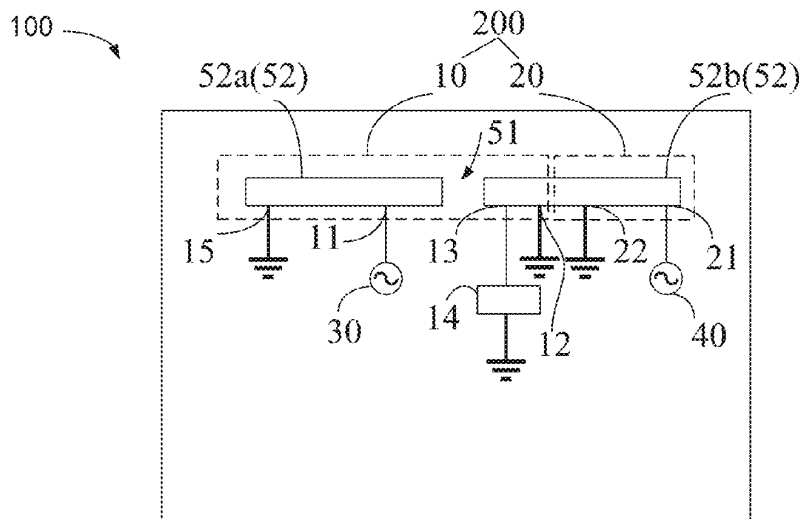
Primary Examiner — Jason M Crawford

(74) *Attorney, Agent, or Firm* — Hodgson Russ LLP

(57) **ABSTRACT**

An electronic device includes a first antenna radiator, a second antenna radiator, a first feed source, and a second feed source. The first antenna radiator includes a first feed point and a first ground point. The second antenna radiator includes a second feed point and a second ground point. The first feed point is disposed at a side of the first ground point away from the second ground point, and the second feed point is disposed at a side of the second ground point away from the first ground point. The first feed source is electrically connected to the first feed point and is configured to provide a feed signal for the first antenna radiator. The second feed source is electrically connected to the second feed point and is configured to provide a feed signal for the second antenna radiator.

19 Claims, 7 Drawing Sheets





US012573748B2

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

(10) **Patent No.:** **US 12,573,748 B2**
(45) **Date of Patent:** **Mar. 10, 2026**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
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(72) Inventors: **Hojung Nam**, Suwon-si (KR);
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Jaeho Lim, Suwon-si (KR);
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Soonho Hwang, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**,
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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 42 days.

(21) Appl. No.: **18/781,686**

(22) Filed: **Jul. 23, 2024**

(65) **Prior Publication Data**
US 2024/0380103 A1 Nov. 14, 2024

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2023/000175, filed on Jan. 4, 2023.

(30) **Foreign Application Priority Data**

Jan. 28, 2022 (KR) 10-2022-0013359

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

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 13/10** (2013.01); **H01R**
13/2407 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/30; H01Q 13/10;
H04M 1/026; H04M 1/0277
See application file for complete search history.

(56) **References Cited**

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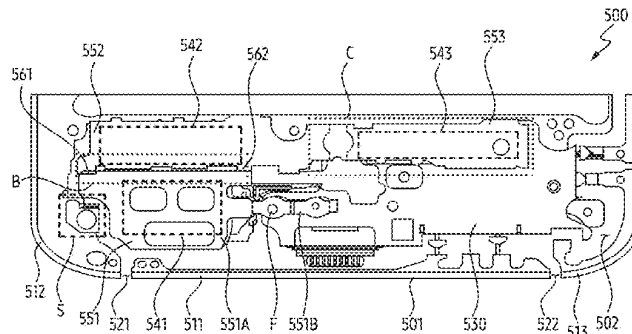
Primary Examiner — Jason M Crawford

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

(57) **ABSTRACT**

An electronic device according to an embodiment comprises: a printed circuit board; a first electronic component electrically connected to the printed circuit board; a second electronic component electrically connected to the printed circuit board and facing one side surface of the first electronic component; a first conductive plate including a feeding point supporting the first electronic component and electrically connected to the printed circuit board; a second conductive plate spaced apart from the first conductive plate and supporting the second electronic component; and a plurality of bridges connecting the first conductive plate with the second conductive plate to form a slot, wherein a wireless communication circuit may be configured to communicate with an external electronic device through at least

(Continued)



S10: 511, 512, 513
S20: 521, 522
A1: 551, 552, 553



US012573753B2

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

(10) **Patent No.:** **US 12,573,753 B2**
(45) **Date of Patent:** **Mar. 10, 2026**

(54) **MINIATURE LOW PROFILE HARSH ENVIRONMENT WIRELESS SENSOR WITH TUNABLE ANTENNA**

(71) Applicant: **Applied Materials, Inc.**, Santa Clara, CA (US)

(72) Inventors: **Qianyi Xie**, Sunnyvale, CA (US);
Chuang-Chia Lin, San Ramon, CA (US)

(73) Assignee: **Applied Materials, Inc.**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 146 days.

(21) Appl. No.: **18/388,492**

(22) Filed: **Nov. 9, 2023**

(65) **Prior Publication Data**

US 2025/0158279 A1 May 15, 2025

(51) **Int. Cl.**
H01Q 5/10 (2015.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/10** (2015.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/10; H01Q 1/38; H01Q 5/314
See application file for complete search history.

(56) **References Cited**

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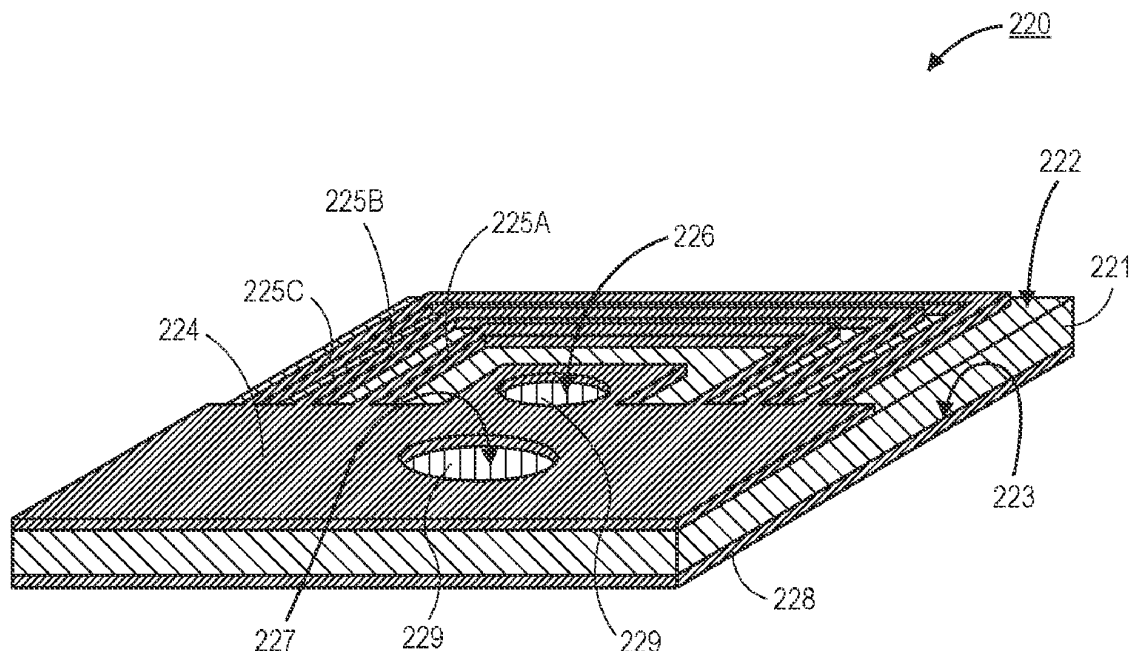
Primary Examiner — David E Lotter

(74) *Attorney, Agent, or Firm* — Schwabe, Williamson & Wyatt, P.C.

(57) **ABSTRACT**

Embodiments disclosed herein include an antenna with a dielectric substrate with a first surface and a second surface. An electrically conductive first pad is on the first surface, and a plurality of traces are on the first surface. In an embodiment, lengths of the plurality of traces are non-uniform. An electrically conductive second pad is on the second surface, and a first hole is through the first pad, the substrate, and the second pad. A first liner is along sidewalls of the first hole and electrically couples the first pad to the second pad. A second hole is through the first pad and the substrate, and a second liner is along sidewalls of the second hole to electrically couple the first pad to an electrically conductive third pad on the second surface. In an embodiment, an electrically insulating ring is between the second pad and the third pad.

9 Claims, 10 Drawing Sheets





US012573755B2

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

(10) **Patent No.:** **US 12,573,755 B2**
(45) **Date of Patent:** **Mar. 10, 2026**

(54) **DUAL-BAND DIPOLE ANTENNA AND ELECTRONIC DEVICE**

(56) **References Cited**

(71) Applicant: **LUXSHARE PRECISION INDUSTRY COMPANY LIMITED**,
Shenzhen (CN)

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(72) Inventors: **Yao-Yuan Chang**, Taipei (TW);
Yu-Tsung Wang, Taipei (TW);
Wei-Hsin Chen, Taipei (TW)

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(73) Assignee: **LUXSHARE PRECISION INDUSTRY COMPANY LIMITED**,
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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 39 days.

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(21) Appl. No.: **18/829,851**

Primary Examiner — Wei (Victor) Y Chan

(22) Filed: **Sep. 10, 2024**

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

(65) **Prior Publication Data**

US 2025/0219292 A1 Jul. 3, 2025

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Dec. 27, 2023 (CN) 202311836081.4

Disclosed is a dual-band dipole antenna including a dielectric carrier with a first surface, a first radiator, a second radiator, a coupled radiator, a coaxial cable and a balun line. The first radiator and the second radiator in opposite areas of the first surface have different structural shapes. The coupled radiator on the first surface extends from the second radiator toward the first radiator. There is a coupling slot between the coupled radiator and the first radiator. An inner conductor and an outer conductor of the coaxial cable are electrically connected to the second radiator and the first radiator respectively. The balun line disposed on the first surface has a serpentine structure, and is connected to the first radiator and the second radiator. The first radiator, the second radiator and the coupled radiator are configured to generate a first resonance mode, a second resonance mode and a third resonance mode.

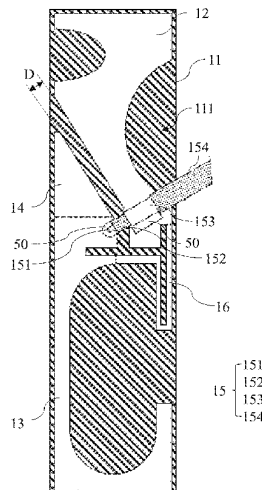
(51) **Int. Cl.**
H01Q 5/48 (2015.01)
H01Q 5/50 (2015.01)
(Continued)

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 21/28; H01Q 9/42;
H01Q 21/24; H01Q 13/085; H01Q 1/521;
(Continued)

20 Claims, 17 Drawing Sheets

1





US012573759B2

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

(10) **Patent No.:** **US 12,573,759 B2**
(45) **Date of Patent:** **Mar. 10, 2026**

(54) **ANTENNA STRUCTURE**

(56)

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

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(72) Inventors: **Hung-Ying Lin**, Hsinchu (TW);
Kuo-Jen Lai, Hsinchu (TW); **Wen-Tai Tseng**, Hsinchu (TW)

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2024/0030615 A1 * 1/2024 Cheng H01Q 5/378

(73) Assignee: **WISTRON NEWEB CORP.**, 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 78 days.

Xie et al. CN202759017U (Year: 2012).*

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(21) Appl. No.: **18/594,383**

Primary Examiner — Dameon E Levi

Assistant Examiner — Michael M Bouizza

(22) Filed: **Mar. 4, 2024**

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

(65) **Prior Publication Data**

US 2024/0313407 A1 Sep. 19, 2024

(57)

ABSTRACT

(30) **Foreign Application Priority Data**

Mar. 16, 2023 (TW) 112109745

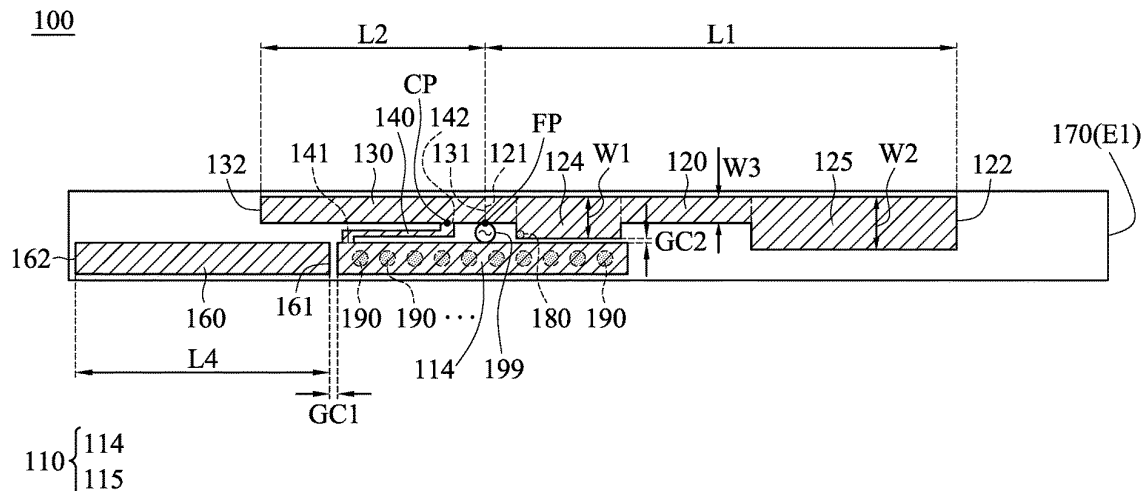
An antenna structure includes a grounding element, a first, a second and a third radiation portion, a shorting radiation portion, a grounding radiation portion, a dielectric substrate, and a first conductive via element. The first radiation portion and the second radiation portion are coupled to a feeding point. The second radiation portion is coupled to the grounding element through the shorting radiation element. The third radiation portion is coupled to the grounding element. A first coupling gap is formed between the grounding radiation element and the grounding element. The dielectric substrate has a first surface and a second surface which are opposite to each other. The first radiation portion is disposed on the first surface. The third radiation portion is disposed on the second surface. The third radiation portion is coupled to the first radiation portion through the first conductive via element.

(51) **Int. Cl.**
H01Q 21/22 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 21/22** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0421; H01Q 21/22; H01Q 1/48; H01Q 9/40; H01Q 1/22; H01Q 1/38; H01Q 5/371; H01Q 5/378; H01Q 9/42
See application file for complete search history.

20 Claims, 4 Drawing Sheets





US012580304B2

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

(10) **Patent No.:** **US 12,580,304 B2**
(45) **Date of Patent:** **Mar. 17, 2026**

(54) **LIQUID CRYSTAL ANTENNA**

(71) Applicants: **BEIJING BOE TECHNOLOGY DEVELOPMENT CO., LTD.**, Beijing (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Guoqiang Tang**, Beijing (CN); **Jia Fang**, Beijing (CN); **Yang Zheng**, Beijing (CN); **Yali Wang**, Beijing (CN); **Zongmin Liu**, Beijing (CN); **Feng Qu**, Beijing (CN); **Biqi Li**, Beijing (CN)

(73) Assignee: **BEIJING BOE TECHNOLOGY DEVELOPMENT 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 359 days.

(21) Appl. No.: **17/923,757**

(22) PCT Filed: **Dec. 23, 2021**

(86) PCT No.: **PCT/CN2021/140931**

§ 371 (c)(1),

(2) Date: **Nov. 7, 2022**

(87) PCT Pub. No.: **WO2023/115475**

PCT Pub. Date: **Jun. 29, 2023**

(65) **Prior Publication Data**

US 2024/0222856 A1 Jul. 4, 2024

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01P 1/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/364** (2013.01); **H01P 1/10** (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 21/0075; H01Q 1/48; H01Q 21/0087; H01Q 3/36

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

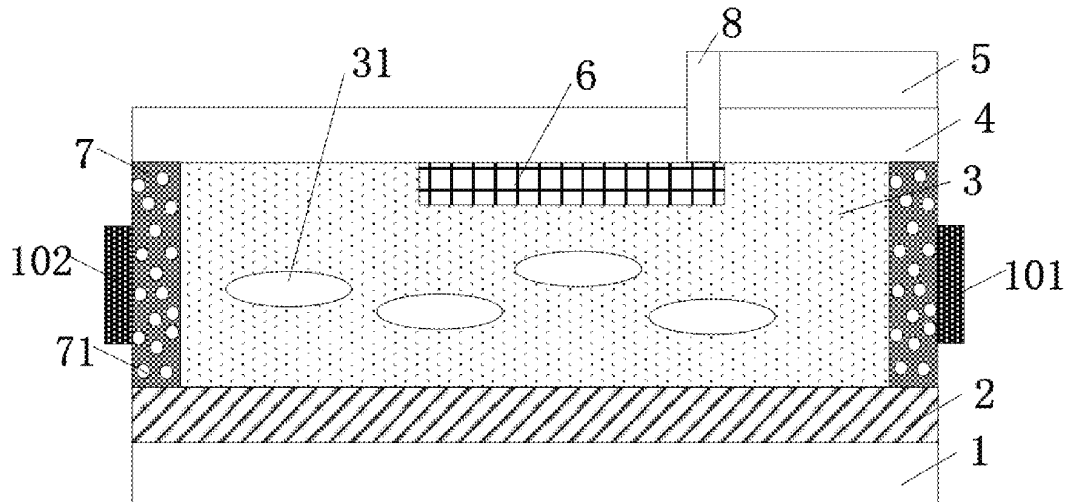
Assistant Examiner — Aladdin Abdulbaki

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

(57) **ABSTRACT**

Provided is a liquid crystal antenna, which includes a first substrate and a second substrate which are oppositely arranged; a liquid crystal layer located between the first substrate and the second substrate; a first electrode located on one side of the first substrate close to the liquid crystal layer; a second electrode located on one side of the second substrate close to the liquid crystal layer; a feeder line located on one side of the second substrate far away from the second electrode and electrically connected with the second electrode; an encapsulation layer located between the first substrate and the second substrate and surrounding the liquid crystal layer; and a side electrode assembly including a plurality of side electrodes.

7 Claims, 5 Drawing Sheets





US012580314B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 12,580,314 B2**
(45) **Date of Patent:** **Mar. 17, 2026**

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

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

(72) Inventor: **Wuxin Huang**, Dongguan (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 524 days.

(21) Appl. No.: **18/148,488**

(22) Filed: **Dec. 30, 2022**

(65) **Prior Publication Data**

US 2023/0170617 A1 Jun. 1, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/096769, filed on May 28, 2021.

(30) **Foreign Application Priority Data**

Aug. 14, 2020 (CN) 202010821435.8

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/48** (2013.01); **H04B 5/24** (2024.01); **H04B 5/43** (2024.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/24; H01Q 9/0407
See application file for complete search history.

(56) **References Cited**

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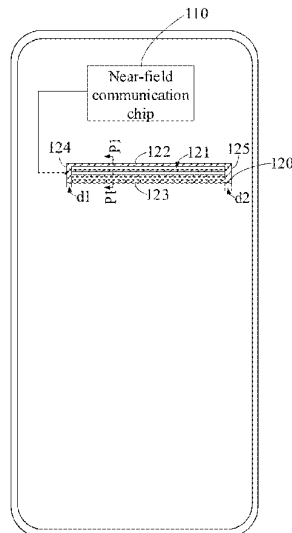
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — Hodgson Russ LLP

(57) **ABSTRACT**

Embodiments of the present application provide an antenna assembly and an electronic device. The antenna assembly comprises a near field communication chip and a first conductive structure; the first conductive structure is electrically connected to the near field communication chip to transmit near field communication excitation current supplied by the near field communication chip; the first conductive structure is provided with one or more first gaps; when the first conductive structure transmits the near field communication excitation current, the first conductive structure can generate a magnetic field, and the magnetic field generated by the first conductive structure can radiate to the outside by means of the first gaps.

18 Claims, 13 Drawing Sheets





US012580317B2

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

(10) **Patent No.:** **US 12,580,317 B2**
(45) **Date of Patent:** **Mar. 17, 2026**

(54) **DIPOLE ANTENNA**

(56)

References Cited

(71) Applicant: **LUXSHARE PRECISION**
INDUSTRY COMPANY LIMITED,
Shenzhen (CN)

U.S. PATENT DOCUMENTS

(72) Inventors: **Yao-Yuan Chang**, Taipei City (TW);
Yu-Tsung Wang, Taipei City (TW);
Wei-Hsin Chen, Taipei City (TW)

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343/795
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(73) Assignee: **LUXSHARE PRECISION**
INDUSTRY COMPANY LIMITED,
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 96 days.

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TW I474560 B 2/2015

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(21) Appl. No.: **18/806,905**

Primary Examiner — Dimary S Lopez Cruz

(22) Filed: **Aug. 16, 2024**

Assistant Examiner — Brandon Sean Woods

(65) **Prior Publication Data**

US 2025/0357673 A1 Nov. 20, 2025

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

(30) **Foreign Application Priority Data**

May 14, 2024 (CN) 202421045077.6

(57) **ABSTRACT**

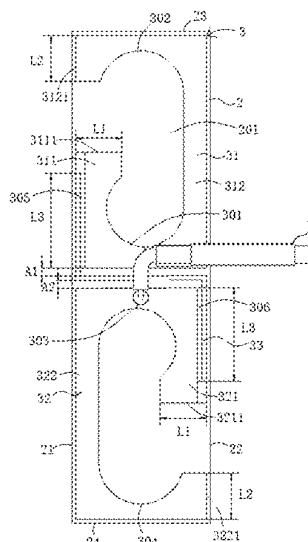
(51) **Int. Cl.**
H01Q 9/28 (2006.01)
H01Q 1/38 (2006.01)

A dipole antenna comprising a dielectric carrier board, a radiating structure, and a coaxial cable is disclosed. The dielectric carrier board includes a carrier board surface. The radiating structure is arranged on the carrier board surface and includes a first radiator, a second radiator, and a Balun line. The first radiator includes a first short segment and a first long segment, arranged side by side on one side of the Balun line, with the first long segment extending away from it. The second radiator includes a second short segment and a second long segment, arranged side by side on the other side of the Balun line, with the second long segment extending away from it. The Balun line connects the first and second short segments. The inner conductor of the coaxial cable connects to the second radiator.

(52) **U.S. Cl.**
CPC **H01Q 9/285** (2013.01); **H01Q 1/38**
(2013.01)

(58) **Field of Classification Search**
USPC 343/795
See application file for complete search history.

23 Claims, 10 Drawing Sheets





US012580326B2

(12) **United States Patent**
Coelho De Souza

(10) **Patent No.:** **US 12,580,326 B2**
(45) **Date of Patent:** **Mar. 17, 2026**

(54) **DESIGNS FOR IMPROVED ANTENNA
ARRAY ELEMENT ISOLATION**

(71) Applicant: **QUALCOMM Incorporated**, San
Diego, CA (US)

(72) Inventor: **Aline Coelho De Souza**, Cambridge
(GB)

(73) Assignee: **QUALCOMM Incorporated**, San
Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 119 days.

(21) Appl. No.: **18/507,199**

(22) Filed: **Nov. 13, 2023**

(65) **Prior Publication Data**

US 2025/0158290 A1 May 15, 2025

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/00 (2006.01)
H01Q 21/06 (2006.01)
H01Q 21/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/523**
(2013.01); **H01Q 21/0087** (2013.01); **H01Q**
21/08 (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/38; H01Q 1/50; H01Q 1/52; H01Q
1/523; H01Q 21/00; H01Q 21/0087;
H01Q 21/06; H01Q 21/061; H01Q
21/065; H01Q 21/08; H01Q 21/24; H01Q
9/04; H01Q 9/0407

See application file for complete search history.

(56) **References Cited**

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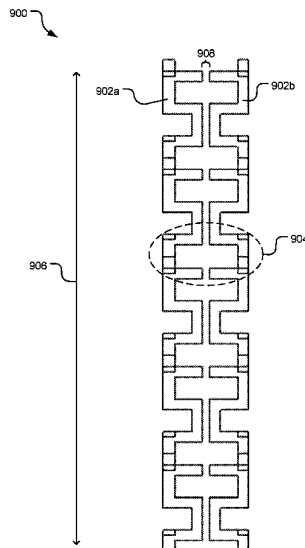
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Holland & Hart
LLP/Qualcomm Incorporated

(57) **ABSTRACT**

Techniques are provided for improving antenna isolation
and angle-of-arrival (AoA) performance of an antenna array.
An example antenna array includes a plurality of patch
antenna elements disposed on a planar substrate, and one or
more resonator elements disposed on the planar substrate
and between each of the plurality of patch antenna elements,
wherein each of the one or more resonator elements includes
a first repeating S-shaped conductor in a first orientation, and
a second repeating S-shaped conductor in a second orien-
tation that is rotated 180 degrees relative to the first orien-
tation.

21 Claims, 13 Drawing Sheets





US012581007B2

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

(10) **Patent No.:** **US 12,581,007 B2**
(45) **Date of Patent:** **Mar. 17, 2026**

(54) **ELECTRONIC DEVICE INCLUDING
MULTIPLE PCBS AND ANTENNAS PRINTED
ON PCBS**

(58) **Field of Classification Search**
CPC H04M 1/0277; H04M 2201/38; H01Q
1/243; H01Q 7/06; H01Q 5/40;
(Continued)

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

(56) **References Cited**

(72) Inventors: **Taejin Kang**, Suwon-si (KR); **Hyoseok Na**, Suwon-si (KR); **Jongdoo Kim**,
Suwon-si (KR); **Kyungdae Son**,
Suwon-si (KR); **Jiyoung Jung**,
Suwon-si (KR); **Wanjae Ju**, Suwon-si
(KR)

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

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 358 days.

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European Patent Application No. 22756562.9.

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Primary Examiner — Ping Y Hsieh

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(21) Appl. No.: **18/338,854**

(22) Filed: **Jun. 21, 2023**

(65) **Prior Publication Data**

US 2023/0336652 A1 Oct. 19, 2023

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/002448, filed on Feb. 18, 2022.

(30) **Foreign Application Priority Data**

Feb. 18, 2021 (KR) 10-2021-0021914

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/24 (2006.01)

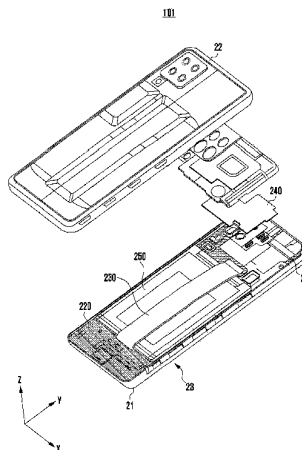
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(52) **U.S. Cl.**
CPC **H04M 1/0277** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 7/06** (2013.01);
(Continued)

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a first plate facing a first direction and a second plate facing a second direction opposite to the first direction, and forming a space between the first plate and the second plate, a display disposed inside the housing and exposed through the first plate, a first printed circuit board disposed between the display and the second plate, a second printed circuit board disposed between the display and the second plate, a third printed circuit board which is disposed between the display and the second plate and electrically connects the first printed circuit board and the second printed circuit board, and a first antenna coupled to the first printed circuit board, wherein the third printed circuit board may include a second antenna electrically connected to the first antenna.

20 Claims, 11 Drawing Sheets





US012560813B2

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

(10) **Patent No.:** **US 12,560,813 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

(54) **ELECTRONIC DEVICES WITH FRAME ANTENNAS**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Lijun Zhang**, Los Gatos, CA (US); **Jiangfeng Wu**, San Jose, CA (US); **Lu Zhang**, Shanghai (CN); **Mattia Pascolini**, San Francisco, CA (US); **Siwen Yong**, San Francisco, CA (US); **Yi Jiang**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 344 days.

(21) Appl. No.: **18/171,067**

(22) Filed: **Feb. 17, 2023**

(65) **Prior Publication Data**

US 2023/0305302 A1 Sep. 28, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/US2021/046925, filed on Aug. 20, 2021.
(Continued)

(51) **Int. Cl.**
G02B 27/01 (2006.01)
G02C 1/06 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **G02B 27/017** (2013.01); **G02C 1/06** (2013.01); **G02C 5/008** (2013.01); **G02C 5/14** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC G02B 27/017; G02B 2027/0178; G02C 1/06; G02C 5/008; G02C 5/14; G02C 11/10

(Continued)

(56) **References Cited**

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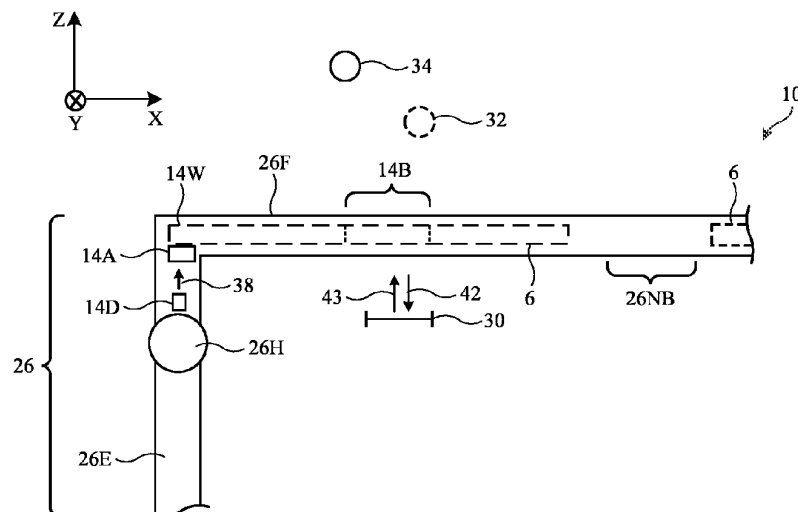
Primary Examiner — William R Alexander

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Tianyi He

(57) **ABSTRACT**

A head-mounted device such as a pair of glasses may have display systems. The display systems may present images to eye boxes for viewing by a user. The glasses may have clear lenses through which real-world objects may be viewed from the eye boxes. The glasses may have a metal frame that surrounds the lenses and may have temples that are coupled to the frame using hinges. Radio-frequency transceiver circuitry such as cellular telephone transceiver circuitry may be coupled to one or more antennas in the head-mounted device. The antennas may have antenna resonating elements formed by placing dielectric-filled gaps in the metal frame to divide the frame into segments. Antenna resonating elements formed from segments of the metal frame may be coupled to the radio-frequency transceiver circuitry using transmission lines.

20 Claims, 10 Drawing Sheets





US012562504B2

(12) **United States Patent**
Wu

(10) **Patent No.:** **US 12,562,504 B2**
(45) **Date of Patent:** **Feb. 24, 2026**

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

(71) Applicant: **Nokia Technologies Oy**, Espoo (FI)

(72) Inventor: **Xiaopu Wu**, Dongguan (CN)

(73) Assignee: **NOKIA TECHNOLOGIES OY**,
Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 235 days.

(21) Appl. No.: **18/340,284**

(22) Filed: **Jun. 23, 2023**

(65) **Prior Publication Data**

US 2023/0352852 A1 Nov. 2, 2023

Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2021/131236, filed on Nov. 17, 2021.

(30) **Foreign Application Priority Data**

Dec. 29, 2020 (CN) 202011608740.5

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/243**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/241; H01Q 21/28; H01Q 21/30;
H01Q 5/30; H01Q 1/22; H01Q 1/243;
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IP.com search history (Year: 2025).*

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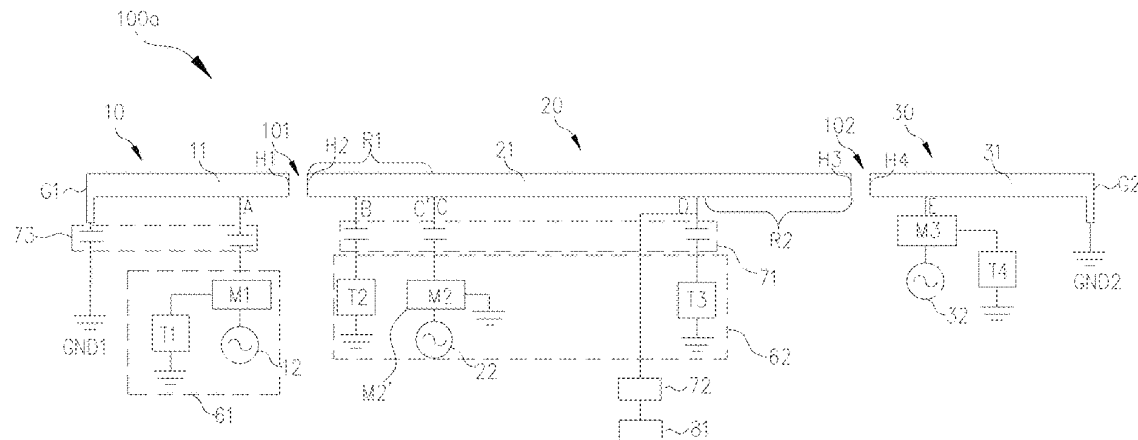
Primary Examiner — Moustapha Diaby

(74) *Attorney, Agent, or Firm* — ALSTON & BIRD LLP

(57) **ABSTRACT**

An antenna system includes multiple antenna modules. Each antenna module includes a first lower band (LB) antenna element, a second LB antenna element, a third LB antenna element, and a fourth LB antenna element. The first LB antenna element, the second LB antenna element, the third LB antenna element, and the fourth LB antenna element are all configured to support at least one of a long term evolution (LTE)-LB (LTE-LB) and a new radio (NR)-LB (NR-LB). The first controller is configured to control at least one of the first LB antenna element, the second LB antenna element, the third LB antenna element, or the fourth LB antenna element to support the LTE-LB, and at least one other among the first LB antenna element, the second LB antenna element, the third LB antenna element, and the fourth LB antenna element unit to support the NR-LB.

20 Claims, 14 Drawing Sheets





US012567663B2

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

(10) **Patent No.:** **US 12,567,663 B2**
(45) **Date of Patent:** **Mar. 3, 2026**

(54) **MILLIMETER-WAVE OPTICAL FIBER
ANTENNA MODULE AND METHOD FOR
MANUFACTURING THE SAME**

(71) Applicant: **UNIVERSAL SCIENTIFIC
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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 93 days.

(21) Appl. No.: **18/626,259**

(22) Filed: **Apr. 3, 2024**

(65) **Prior Publication Data**
US 2025/0246796 A1 Jul. 31, 2025

(30) **Foreign Application Priority Data**
Jan. 30, 2024 (CN) 202410130684.0

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H05K 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2283** (2013.01); **H05K 1/0243**
(2013.01); **H05K 3/284** (2013.01); **H05K 3/34**
(2013.01); **H05K 2201/10098** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2283; H05K 1/0243; H05K
2201/10098; H05K 3/284; H05K 3/34
See application file for complete search history.

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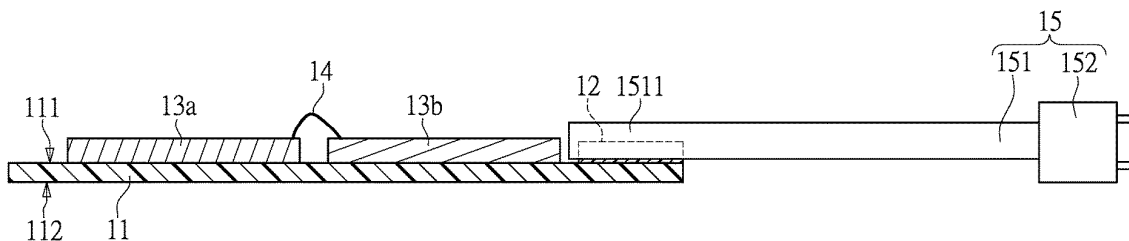
Primary Examiner — Thien M Le

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

(57) **ABSTRACT**

A millimeter-wave optical fiber antenna module and a method for manufacturing the same are provided. The millimeter-wave optical fiber antenna module includes a packaging module, an antenna member, and a second encapsulant. The packaging module includes a first circuit substrate, a first placement member, a first chip assembly, a second chip assembly, an optical fiber connector, and a first encapsulant. The first circuit substrate has a top surface and a bottom surface. The first placement member is disposed on the top surface. The first placement member has first grooves, and the first grooves are linear and parallel to one another. The first chip assembly and the second chip assembly are located on the top surface. The first chip assembly is electrically connected to the second chip assembly. The first chip assembly and the second chip assembly respectively include an integrated circuit chip and an integrated optical circuit chip.

10 Claims, 9 Drawing Sheets





US012567667B2

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

(10) **Patent No.:** **US 12,567,667 B2**
(45) **Date of Patent:** **Mar. 3, 2026**

(54) **ANTENNA STRUCTURE**

(56)

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

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(72) Inventors: **De-Shao Yao**, Hsinchu (TW);
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(73) Assignee: **WISTRON NEWEB CORP.**, 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 420 days.

Primary Examiner — Henry Luong

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

(21) Appl. No.: **18/480,648**

(22) Filed: **Oct. 4, 2023**

(57)

ABSTRACT

(65) **Prior Publication Data**

US 2024/0145918 A1 May 2, 2024

An antenna structure includes a metal mechanism element, a ground element, a feeding radiation element, a connection radiation element, a shorting radiation element, a parasitic radiation element, and a dielectric substrate. The metal mechanism element has a slot. The feeding radiation element has a feeding point. The connection radiation element is coupled to the feeding radiation element. The connection radiation element is further coupled through the shorting radiation element to the ground element. The parasitic radiation element is coupled to the ground element. The parasitic radiation element is disposed between the feeding radiation element and the shorting radiation element. The dielectric substrate is adjacent to the slot of the metal mechanism element. The feeding radiation element, the connection radiation element, the shorting radiation element, and the parasitic radiation element are all disposed on the dielectric substrate.

(30) **Foreign Application Priority Data**

Oct. 26, 2022 (TW) 111140540

(51) **Int. Cl.**

H01Q 5/378 (2015.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

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

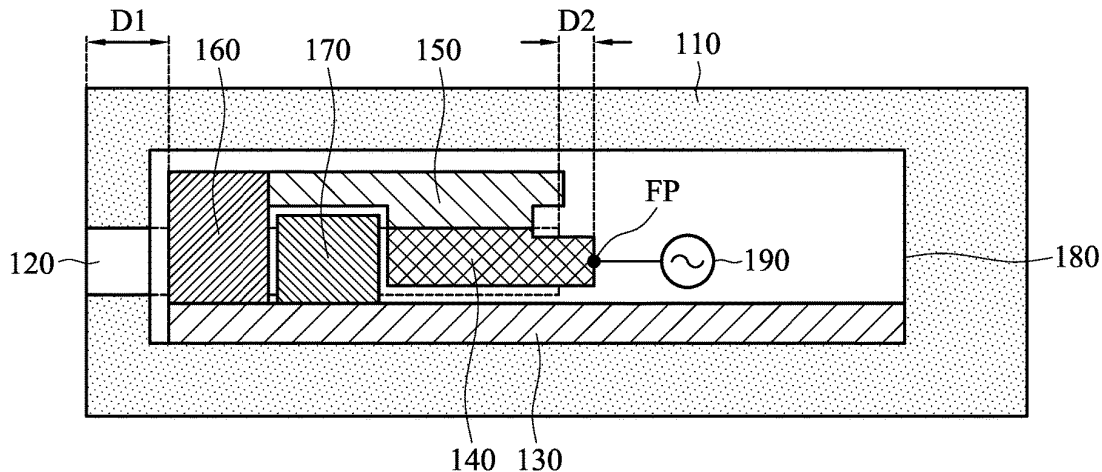
CPC **H01Q 5/378** (2015.01); **H01Q 1/48** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/378; H01Q 1/48; H01Q 9/0421
See application file for complete search history.

20 Claims, 5 Drawing Sheets

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US012567674B2

(12) **United States Patent**
Jo

(10) **Patent No.:** **US 12,567,674 B2**
(45) **Date of Patent:** **Mar. 3, 2026**

(54) **MULTI-LAYER COUPLING-CONTROLLED
ULTRA COMPACT ANTENNA SYSTEM**

(71) Applicant: **SkyMirr, Inc.**, Melbourne, FL (US)

(72) Inventor: **Youngmin Jo**, Melbourne, FL (US)

(73) Assignee: **SkyMirr, Inc.**, Melbourne, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 125 days.

(21) Appl. No.: **18/747,795**

(22) Filed: **Jun. 19, 2024**

(65) **Prior Publication Data**

US 2025/0055198 A1 Feb. 13, 2025

Related U.S. Application Data

(60) Provisional application No. 63/552,755, filed on Feb. 13, 2024, provisional application No. 63/552,769, filed on Feb. 13, 2024, provisional application No. 63/531,547, filed on Aug. 8, 2023.

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/38 (2006.01)
H01Q 7/06 (2006.01)
H01Q 11/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/38** (2013.01); **H01Q 7/06** (2013.01); **H01Q 11/08** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/36; H01Q 1/38;
H01Q 7/06; H01Q 11/08; H01Q 1/362;
H01Q 21/067

See application file for complete search history.

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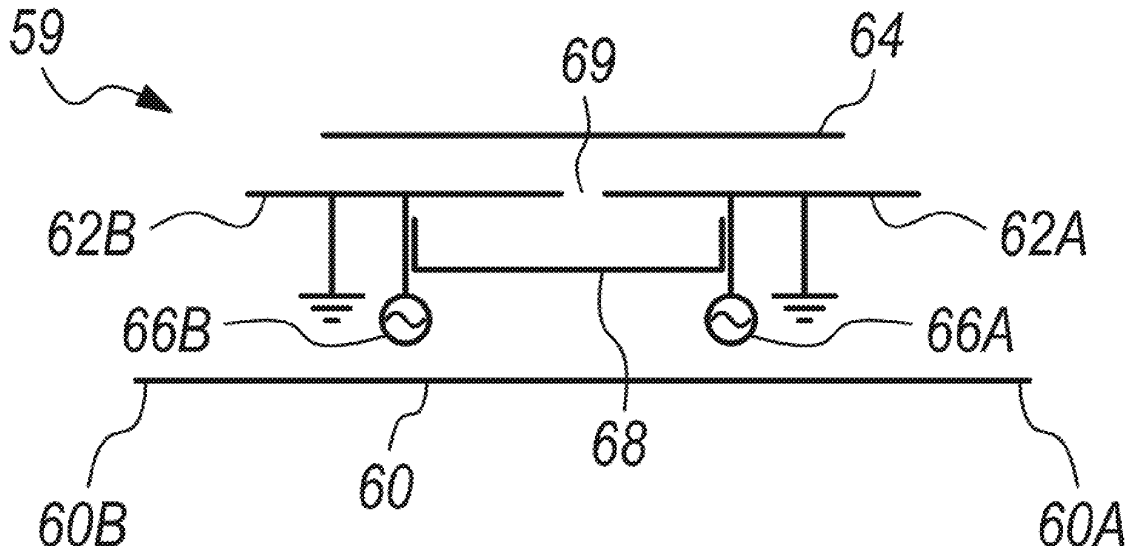
Primary Examiner — Seung H Lee

(74) *Attorney, Agent, or Firm* — John L. DeAngelis;
Wolter Van Dyke Davis, PLLC

(57) **ABSTRACT**

A multi-layer coupling-controlled antenna. A first and second spaced-apart radiating elements define a gap therebetween and each is responsive to a source signal. A third conductive element is disposed below and spaced apart from the first and second radiating elements and located to bridge the gap. An upper conductive element is disposed above and spaced apart from the first and second radiating elements. The upper conductive element comprises a single element or a plurality of spaced-apart conductive elements. A lower conductive element is disposed below and spaced apart from the third conductive element.

13 Claims, 7 Drawing Sheets





US012567675B2

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

(10) **Patent No.:** **US 12,567,675 B2**
(45) **Date of Patent:** **Mar. 3, 2026**

(54) **ANTENNA STRUCTURE**

(56) **References Cited**

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

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(72) Inventors: **Yen-Ming Hong**, Hsinchu (TW);
Chin-Tang Huang, Hsinchu (TW);
Wei-Shin Chen, Hsinchu (TW)

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2022/0223996 A1 * 7/2022 Chen H01Q 1/38

(73) Assignee: **WISTRON NEWEB CORP.**, 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 37 days.

CN 115241646 A 10/2022

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(21) Appl. No.: **18/754,843**

Primary Examiner — Amal Patel

(22) Filed: **Jun. 26, 2024**

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

(65) **Prior Publication Data**

US 2025/0038407 A1 Jan. 30, 2025

(30) **Foreign Application Priority Data**

Jul. 28, 2023 (TW) 112128374

(51) **Int. Cl.**

H01Q 13/18 (2006.01)
H01Q 5/357 (2015.01)
H01Q 5/378 (2015.01)

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

CPC **H01Q 13/18** (2013.01); **H01Q 5/357** (2015.01); **H01Q 5/378** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/357; H01Q 5/364; H01Q 5/371;
H01Q 5/378; H01Q 5/385; H01Q 5/392;
H01Q 13/18

See application file for complete search history.

(57) **ABSTRACT**

An antenna structure includes a metal cavity, a first radiation element, a second radiation element, a third radiation element, and a dielectric substrate. The metal cavity has an opening region. The first radiation element has a first feeding point. The first radiation element is coupled to the metal cavity. The second radiation element has a second feeding point. The second radiation element is coupled to the metal cavity. The third radiation element is adjacent to the first radiation element and the second radiation element. The third radiation element is coupled to the metal cavity. The dielectric substrate is adjacent to the opening region of the metal cavity. The first radiation element, the second radiation element, and the third radiation element are disposed on the dielectric substrate.

17 Claims, 5 Drawing Sheets

