



(19) **United States**

(12) **Patent Application Publication**  
**HUANG et al.**

(10) **Pub. No.: US 2020/0028265 A1**

(43) **Pub. Date: Jan. 23, 2020**

(54) **ANTENNA DEVICE AND CONTROL METHOD THEREOF**

*H01Q 19/00* (2006.01)

*H01Q 1/24* (2006.01)

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(52) **U.S. Cl.**  
CPC ..... *H01Q 9/045* (2013.01); *H01Q 1/36* (2013.01); *H01Q 1/24* (2013.01); *H01Q 19/005* (2013.01); *H01Q 1/50* (2013.01)

(72) Inventors: **Pei-Chuan HUANG**, TAIPEI (TW);  
**Shao-Kai LIU**, TAIPEI (TW)

(57) **ABSTRACT**

(21) Appl. No.: **16/510,073**

An antenna device and its control method is provided. The antenna device includes: a ground layer; a feeding element, connecting to the ground layer; a first radiating element, extending along a first direction and connected to the ground layer; a second radiating element, extending along a second direction which is orthogonal to the first direction, and connected the ground layer; a first switching element, coupled between the feeding element and the first radiating element, and configured to electrically connect or disconnect the feeding element and the first radiating element; and a second switching element disposed between the feeding element and the second radiating element, and configured to electrically connect or disconnect the feeding element and the second radiating element.

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

(30) **Foreign Application Priority Data**

Jul. 19, 2018 (CN) ..... 201810794869.6

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 9/04* (2006.01)  
*H01Q 1/36* (2006.01)  
*H01Q 1/50* (2006.01)

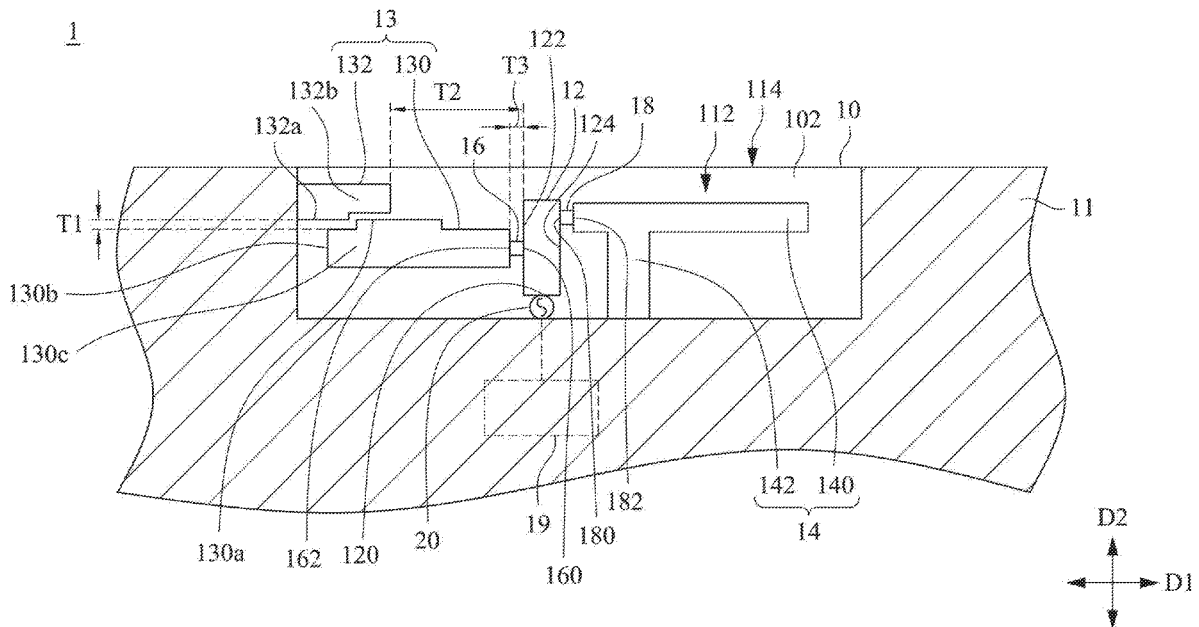


FIG. 2A



(19) **United States**

(12) **Patent Application Publication**  
**Watson**

(10) **Pub. No.: US 2020/0028276 A1**

(43) **Pub. Date: Jan. 23, 2020**

(54) **ANTENNA WITH SELECTIVELY ENABLED  
INVERTED-F ANTENNA ELEMENTS**

*21/0025* (2013.01); *H01Q 1/2291* (2013.01);  
*H01Q 9/0421* (2013.01)

(71) Applicant: **Paul Robert Watson**, Ottawa (CA)

(57) **ABSTRACT**

(72) Inventor: **Paul Robert Watson**, Ottawa (CA)

(21) Appl. No.: **16/041,249**

(22) Filed: **Jul. 20, 2018**

**Publication Classification**

(51) **Int. Cl.**

*H01Q 21/06* (2006.01)

*H01Q 1/48* (2006.01)

*H01Q 9/04* (2006.01)

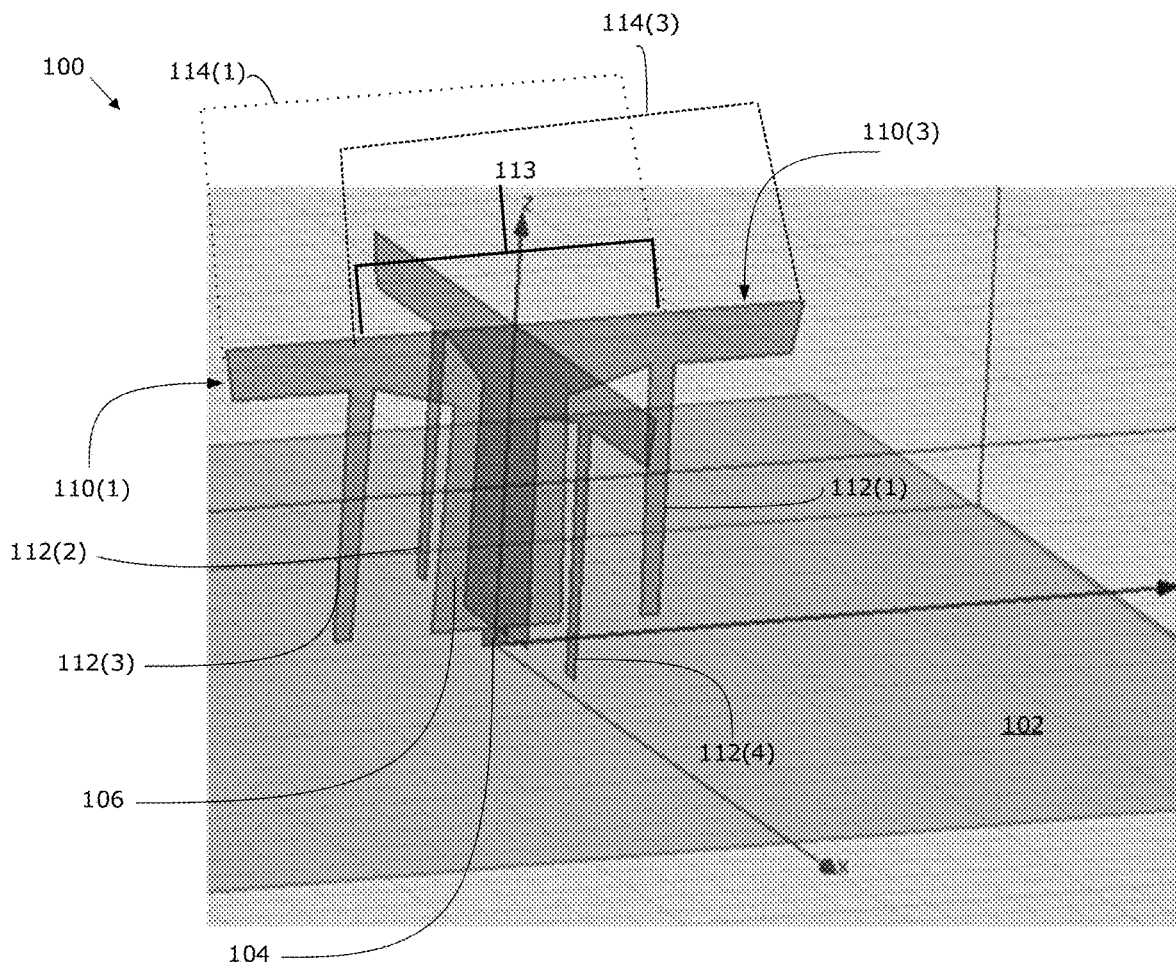
*H01Q 21/00* (2006.01)

*H01Q 1/22* (2006.01)

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

CPC ..... *H01Q 21/065* (2013.01); *H01Q 1/48*  
(2013.01); *H01Q 5/307* (2015.01); *H01Q*

A radio frequency (RF) antenna unit is described. The RF antenna unit includes a feed portion, at least first and second selective grounding portions each configured to selectively enable or disable an electrical coupling to a substrate, and at least first and second conductive arms. The first conductive arm provides electrical conduction between the feed portion and the first grounding portion, extending from the first grounding portion towards and beyond the feed portion. The second conductive arm provides electrical conduction between the feed portion and the second grounding portion, extending from the second grounding portion towards and beyond the feed portion. First and second inverted F antenna (IFA) elements are defined by the feed portion, the respective first or second grounding portion and the respective first or second conductive arm. The feed portion is common to both the first and second IFA elements.





US 20200036084A1

(19) **United States**

(12) **Patent Application Publication**

**Her et al.**

(10) **Pub. No.: US 2020/0036084 A1**

(43) **Pub. Date: Jan. 30, 2020**

(54) **ANTENNA APPARATUS AND WIRELESS COMMUNICATION DEVICE USING SAME**

**Publication Classification**

(71) Applicant: **Chiun Mai Communication Systems, Inc., New Taipei (TW)**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H04M 1/02* (2006.01)  
*H01Q 1/48* (2006.01)

(52) **U.S. Cl.**  
 CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/48* (2013.01); *H04M 1/026* (2013.01)

(72) Inventors: **Yih-Shyang Her, New Taipei (TW); Yun-Jian Chang, Tu-Cheng (TW); Chien-Hua Li, New Taipei (TW); Wei-En Hsieh, New Taipei (TW)**

(57) **ABSTRACT**

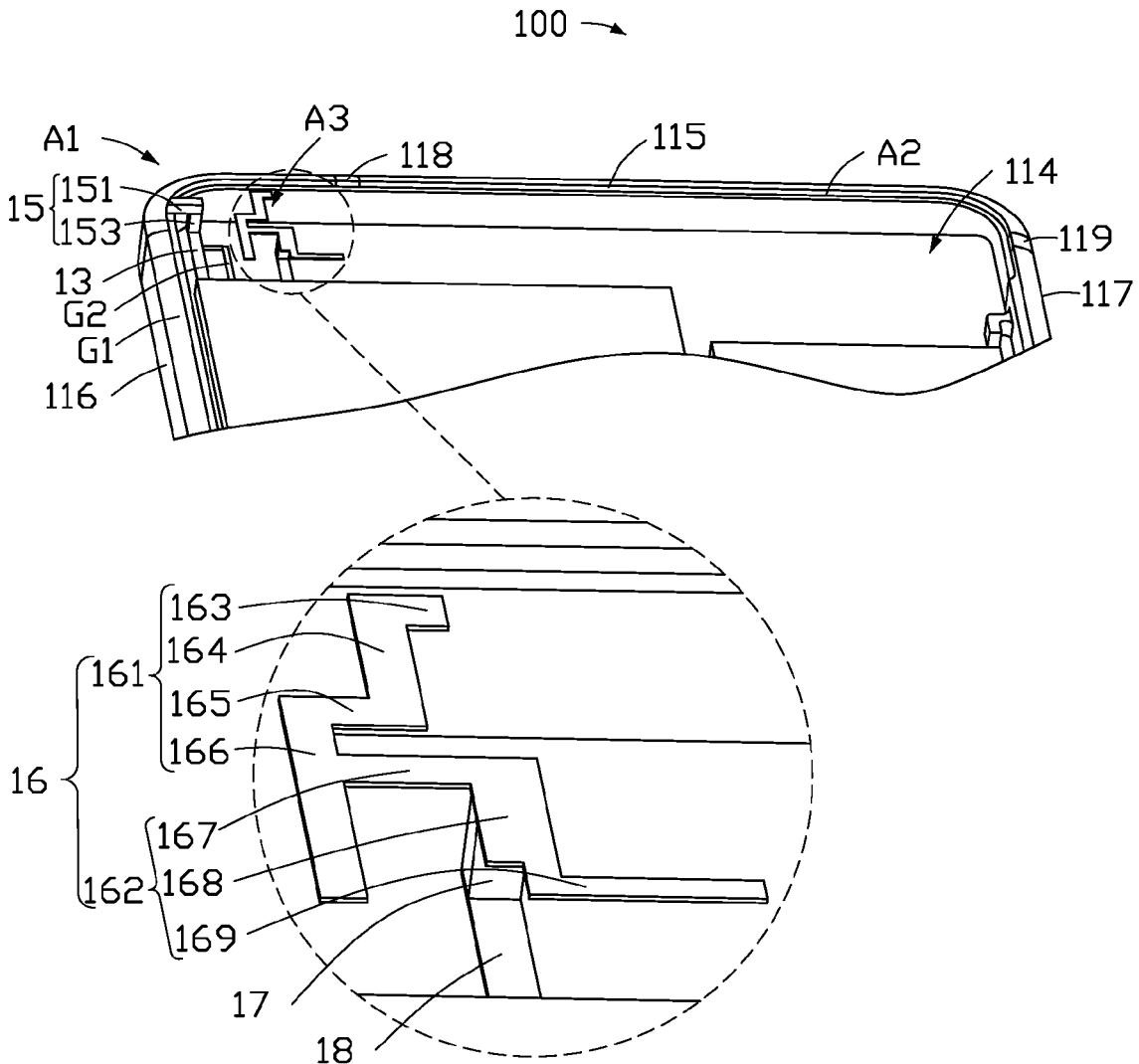
An antenna apparatus sited within a metal housing with improved frequency isolation between individual antennas includes the housing, a first ground portion, a first feed portion, and a second ground portion. A side frame of the housing defines at least one gap, the gap separates a first antenna and a second antenna. The first ground portion is formed by extending an end of the first antenna away from the gap. One end of the second ground portion is connected to the first feed portion, other end of the second ground portion is connected to ground. A first feed point feeds power and signal to the first antenna. A wireless communication device using the antenna apparatus is also provided.

(21) Appl. No.: **16/522,776**

(22) Filed: **Jul. 26, 2019**

(30) **Foreign Application Priority Data**

Jul. 27, 2018 (CN) ..... 201810846445.X





US 20200036820A1

(19) **United States**

(12) **Patent Application Publication**

**LEE et al.**

(10) **Pub. No.: US 2020/0036820 A1**

(43) **Pub. Date: Jan. 30, 2020**

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

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

(72) Inventors: **Hyung Joo LEE**, Seongnam-si (KR); **Gyu Sub KIM**, Seoul (KR); **Dong Yeon KIM**, Suwon-si (KR); **Chae Up YOO**, Seoul (KR)

(21) Appl. No.: **16/589,734**

(22) Filed: **Oct. 1, 2019**

**Related U.S. Application Data**

(63) Continuation of application No. 15/991,568, filed on May 29, 2018, which is a continuation of application No. 15/673,097, filed on Aug. 9, 2017, now Pat. No. 10,015,294, which is a continuation of application No. 15/234,547, filed on Aug. 11, 2016, now Pat. No. 9,762,710.

**Foreign Application Priority Data**

Aug. 13, 2015 (KR) ..... 10-2015-0114638

**Publication Classification**

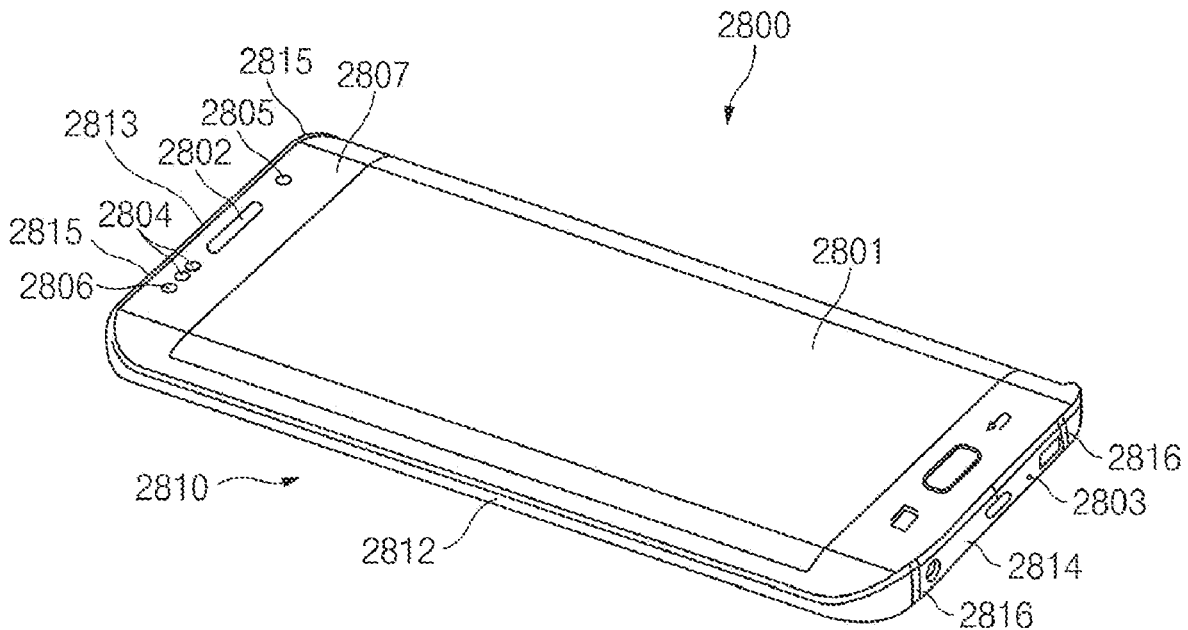
(51) **Int. Cl.**  
**H04M 1/02** (2006.01)  
**H01Q 1/24** (2006.01)

**H01Q 1/48** (2006.01)  
**H01Q 1/52** (2006.01)  
**H01Q 5/314** (2006.01)  
**H01Q 5/328** (2006.01)  
**H01Q 5/35** (2006.01)  
**H04B 1/3827** (2006.01)  
**H04B 1/48** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H04M 1/0202** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/521** (2013.01); **H04W 4/80** (2018.02); **H01Q 5/328** (2015.01); **H01Q 5/35** (2015.01); **H04B 1/3833** (2013.01); **H04B 1/48** (2013.01); **H01Q 5/314** (2015.01)

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a first surface, a second surface disposed facing an opposite side of the first surface, and a side surface configured to surround at least a portion of a space between the first surface and the second surface, a first elongated metal member configured to form a first portion of the side surface and including a first end and a second end, at least one communication circuit electrically connected to a first point of the first elongated metal member through a capacitive element, at least one ground member disposed in an interior of the housing, and a first conductive member configured to electrically connect a second point of the first elongated metal member to the ground member. The second point of the first elongated metal member is disposed closer to the second end than to the first point.





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(19) **United States**

(12) **Patent Application Publication**  
**TORNATTA, Jr. et al.**

(10) **Pub. No.: US 2020/0044309 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **MULTI-RESONANT ANTENNA STRUCTURE**

**Publication Classification**

(71) Applicant: **CAVENDISH KINETICS, INC.**, San Jose, CA (US)

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/30** (2006.01)

(72) Inventors: **Paul Anthony TORNATTA, Jr.**, Melbourne, FL (US); **Young Joong LEE**, Gyeonggi-do (KR); **Hak Ryol KIM, Jr.**, Seoul (KR)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/30** (2015.01)

(21) Appl. No.: **16/342,935**

(57) **ABSTRACT**

(22) PCT Filed: **Oct. 18, 2017**

The present disclosure generally relates to any device capable of wireless communication, such as a mobile telephone or wearable device, having one or more antennas. The antenna has a structure with multiple resonances to cover all commercial wireless communications bands from a single antenna with one feed connection to the main radio system. The antenna is usable where there are two highly efficient, closely spaced resonances in the lower part of the frequency band. One of those resonances can be adjusted in real time by using a variable reactance attached to the radiator while the other resonance is fixed.

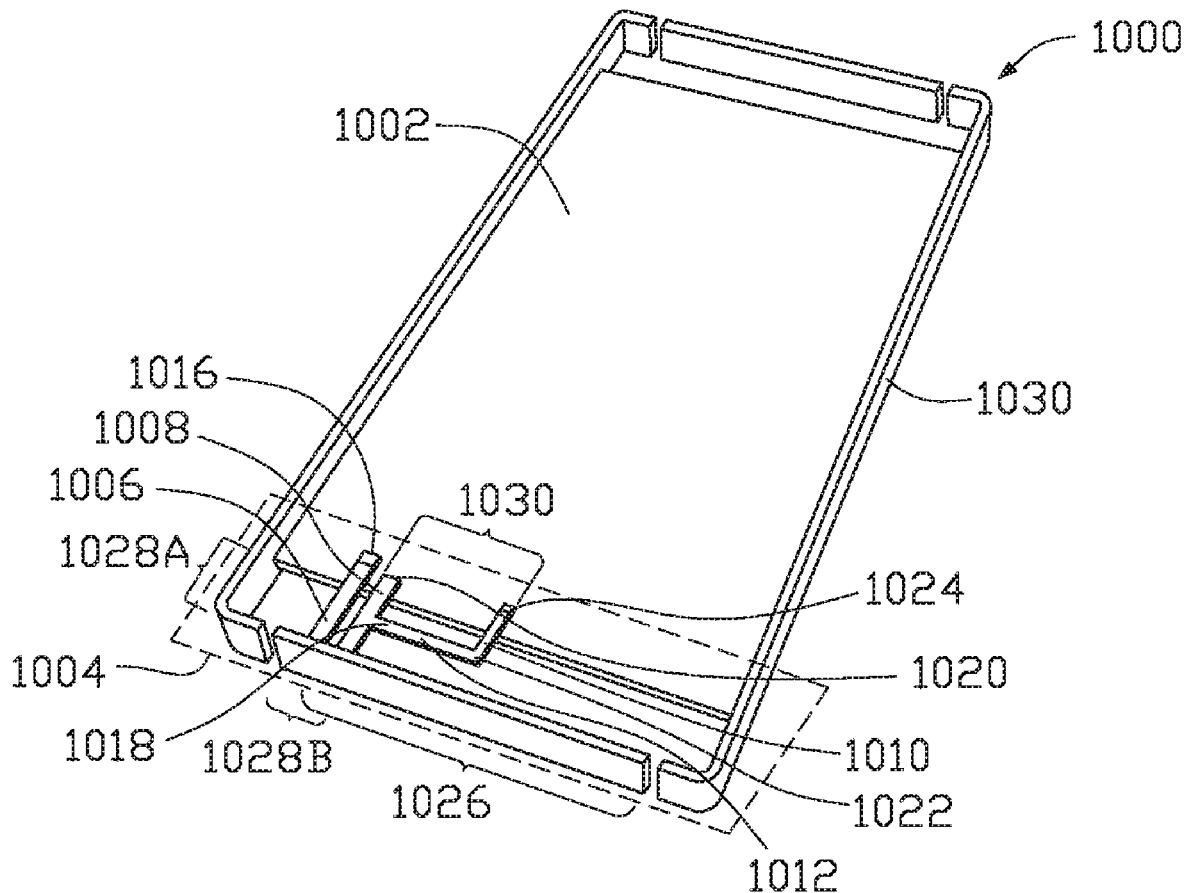
(86) PCT No.: **PCT/US2017/057084**

§ 371 (c)(1),

(2) Date: **Apr. 17, 2019**

**Related U.S. Application Data**

(60) Provisional application No. 62/410,933, filed on Oct. 21, 2016.





US 20200044311A1

(19) **United States**

(12) **Patent Application Publication**

**Gu et al.**

(10) **Pub. No.: US 2020/0044311 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/48* (2013.01); *H01Q 1/50* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore City (SG)

(72) Inventors: **Haichuan Gu**, Shenzhen (CN);  
**Jianchun Mai**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,045**

(22) Filed: **Jul. 27, 2019**

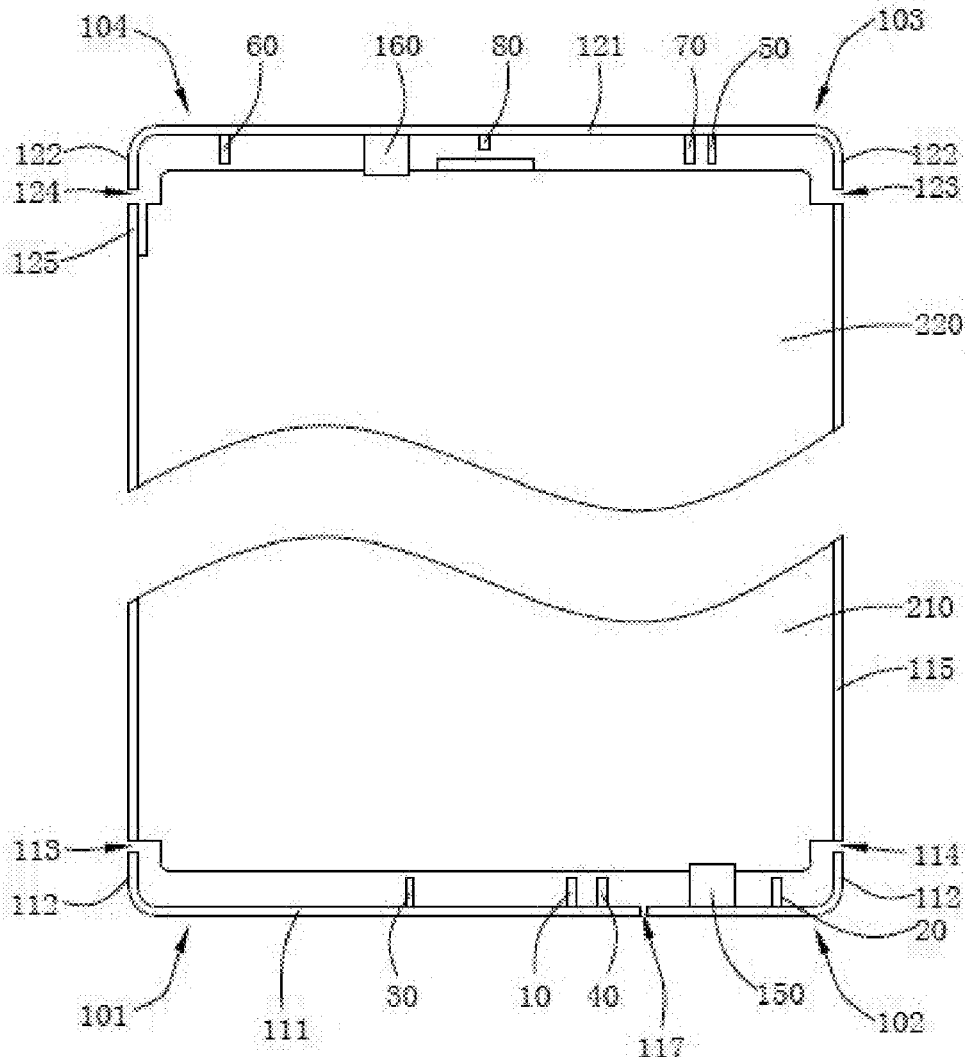
The present invention provides an antenna system and a mobile terminal. The antenna system comprises a metal frame, a main board received in the metal frame, and a first feeding point, a second feeding point, a first grounding point, a second grounding point, a third feeding point, a fourth feeding point, a third grounding point, a fourth grounding point, a first tuning switch, a second tuning switch, a first matching network, a variable capacitor, a third tuning switch, a fourth tuning switch, and a second matching network disposed at the main board. The metal frame is divided into a first radiating portion and a second radiating portion at the bottom and a third radiating portion and a fourth radiating portion at the top.

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810876521.1

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 1/50* (2006.01)  
*H01Q 1/48* (2006.01)





(19) **United States**

(12) **Patent Application Publication**  
**Wang**

(10) **Pub. No.: US 2020/0044312 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/2258** (2013.01); **G06F 2213/3814** (2013.01); **H01Q 9/0442** (2013.01); **G06F 13/387** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(72) Inventor: **Aqi Wang**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,048**

(22) Filed: **Jul. 27, 2019**

An antenna system and a mobile terminal are provided. The antenna system includes a metal frame including a bottom frame located at the bottom thereof; a main board received in the metal frame, the main board including a system ground and a feeding point; a tuning switch arranged on the main board; a USB interface provided on the main board and having a metal shell; and a metal part arranged across one side of the USB interface facing away from the main board. A clearance region is formed by the bottom frame and the mainboard. The USB interface and the metal part are coupled to the bottom frame to form an antenna radiator, and the USB interface, the metal part, the bottom frame, the feeding point, the tuning switch and the system ground together constitute an antenna unit.

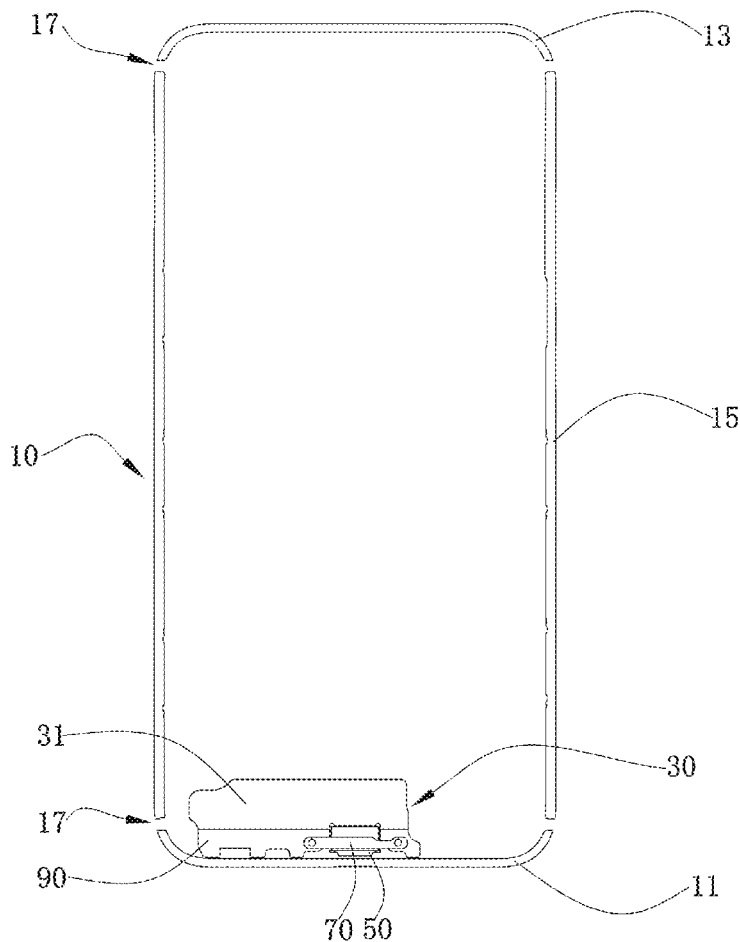
(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201821255117.4

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/22** (2006.01)  
**G06F 13/38** (2006.01)  
**H01Q 9/04** (2006.01)

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US 20200044313A1

(19) **United States**

(12) **Patent Application Publication**  
**Liu**

(10) **Pub. No.: US 2020/0044313 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **LOOP ANTENNA SYSTEM AND MOBILE TERMINAL**

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 7/00* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore City (SG)

(57) **ABSTRACT**

(72) Inventor: **Feng Liu**, Shenzhen (CN)

The present disclosure provides a loop antenna system, including a back cover, a main board, a plastic back shell, and a loop antenna. The loop antenna including a first loop radiating unit, a second loop radiating unit, and a connecting member connecting the first loop radiating unit and the second loop radiating unit. Compared with the related technologies, the loop antenna system provided in the present disclosure has the following advantageous effects: by disposing a connecting member over an earphone base, the problem is solved that limitation to the thickness of a conventional entire structure results in that no bracket may be disposed over an earphone base, thereby eliminating the limitation to layout of an antenna by an earphone base. The present disclosure also provides a mobile terminal.

(21) Appl. No.: **16/524,083**

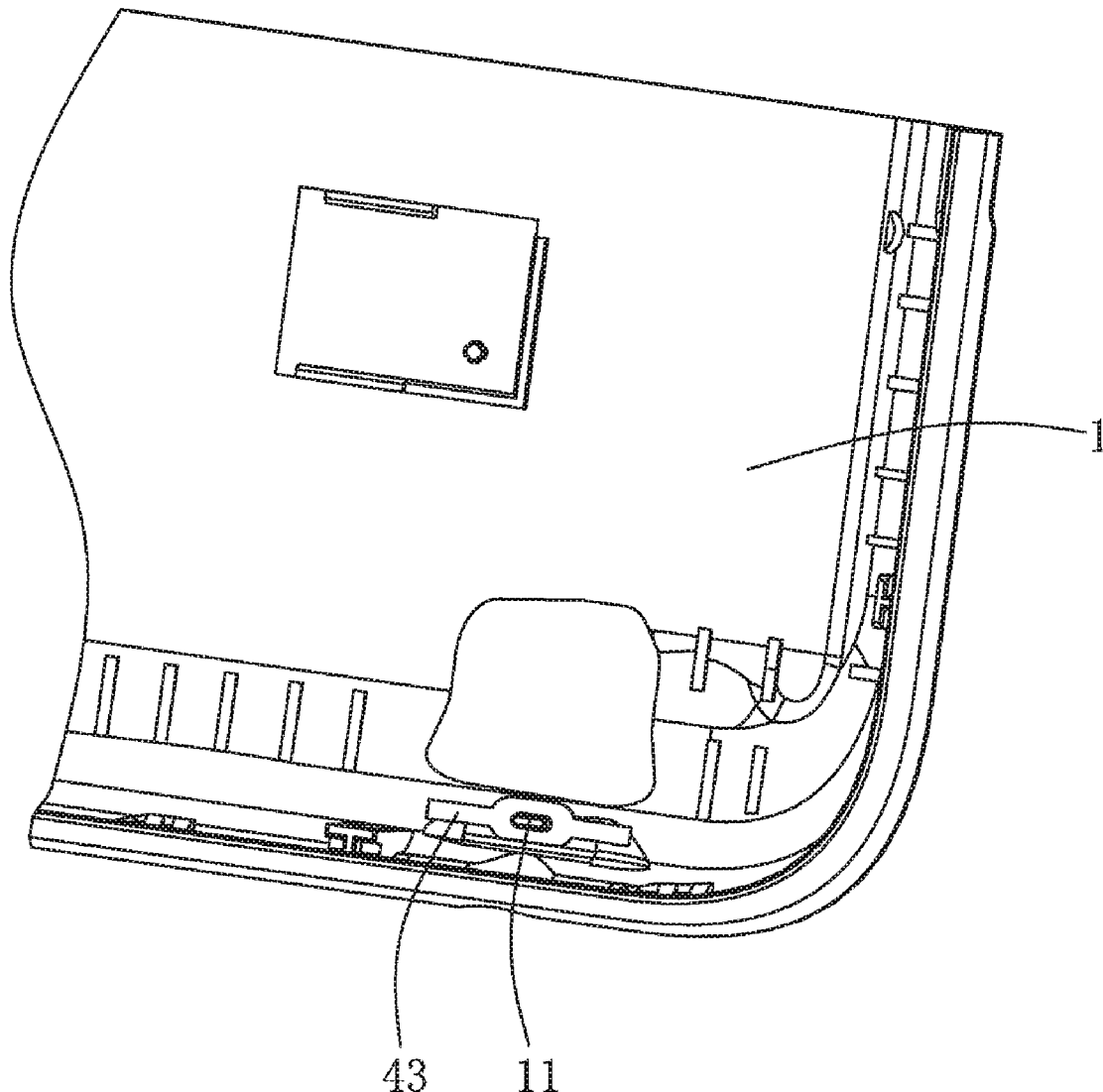
(22) Filed: **Jul. 28, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810878313.5

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 7/00* (2006.01)







US 20200044315A1

(19) **United States**

(12) **Patent Application Publication**  
**Gu**

(10) **Pub. No.: US 2020/0044315 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 9/42* (2013.01); *H04B 7/0413* (2013.01); *H01Q 21/28* (2013.01); *H01Q 9/26* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(72) Inventor: **Haichuan Gu**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/527,074**

(22) Filed: **Jul. 31, 2019**

(30) **Foreign Application Priority Data**

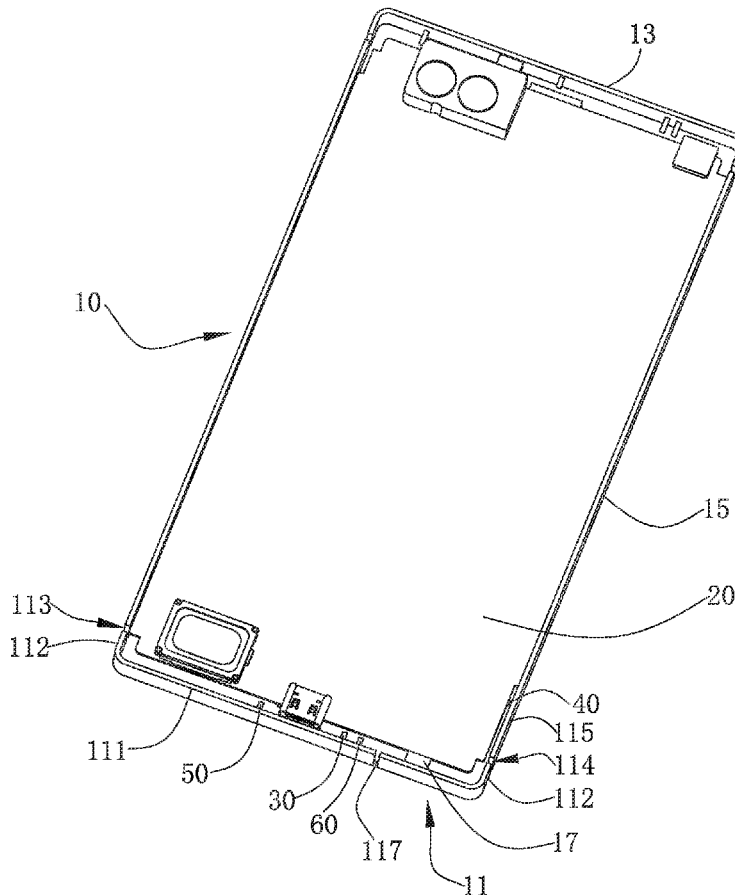
Aug. 3, 2018 (CN) ..... 201810876533.4

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 9/42* (2006.01)  
*H01Q 9/26* (2006.01)  
*H01Q 21/28* (2006.01)  
*H04B 7/0413* (2006.01)

An antenna system and a mobile terminal are provided. The antenna system includes a metal frame, a mainboard received inside the metal frame, and a first feeding point, a second feeding point, a first grounding point and a second grounding point provided on the mainboard. The metal frame includes a bottom frame separated by the breach into a first radiation portion located at the bottom left corner and a second radiation portion located at the bottom right corner. A first antenna is formed by feeding of the first feeding point, a second antenna is formed by feeding of the second feeding point, a working frequency of the first antenna covers LTE low frequency, and the working frequencies of the first antenna and the second antenna cover LTE intermediate frequency and high frequency & 3.4-3.8 GHz & C frequency band.

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US 20200044319A1

(19) **United States**

(12) **Patent Application Publication**  
**Shen**

(10) **Pub. No.: US 2020/0044319 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/245* (2013.01); *H01Q 5/50* (2015.01); *H01Q 5/328* (2015.01); *H01Q 1/243* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore City (SG)

(72) Inventor: **Yachuan Shen**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,080**

An antenna module and a mobile device are provided. The antenna module includes a radiator formed on a surface of the plastic rear housing facing the back cover, and a feed point, a first ground point, and a second ground point that are disposed on the motherboard. The antenna module further includes a matching network, a first tuning switch, and a second tuning switch. The feed point is connected to the radiator through the matching network. The first ground point is connected to the radiator through the first tuning switch. The second ground point is connected to the radiator through the second tuning switch. The surface of the plastic rear housing facing the back cover includes a first shaping zone for shaping the radiator and a second zone other than the first shaping zone, and the radiator completely covers the first shaping zone.

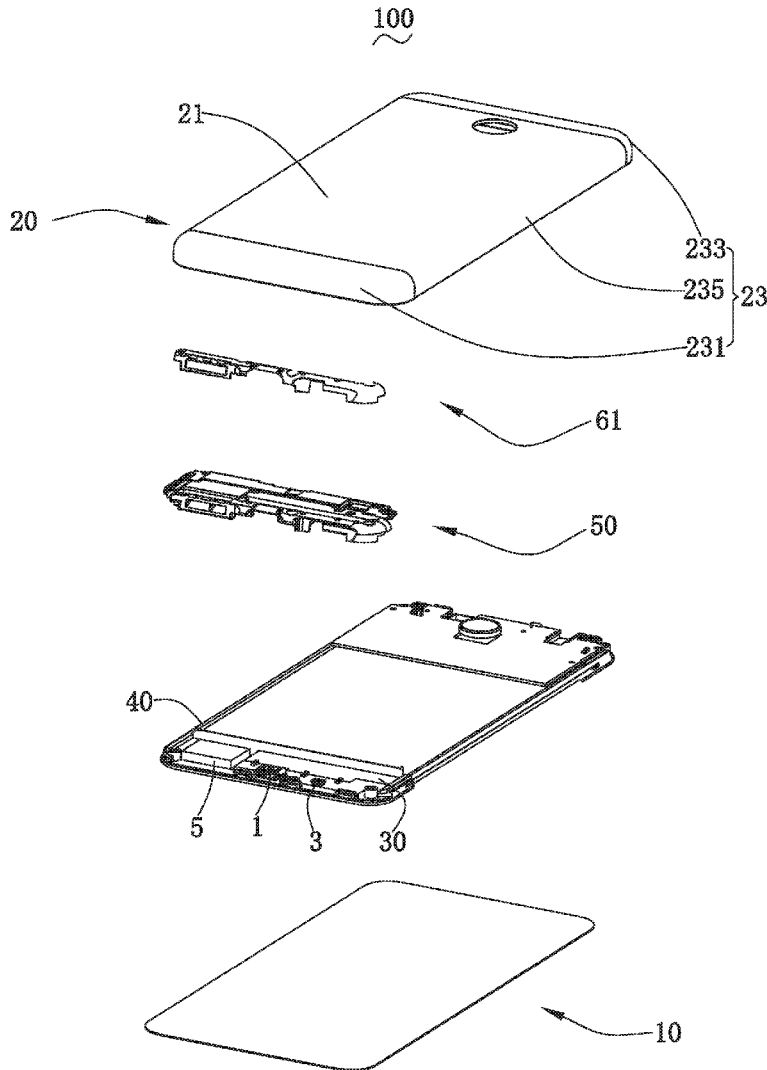
(22) Filed: **Jul. 28, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201821267573.0

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 5/328* (2006.01)  
*H01Q 5/50* (2006.01)





US 20200044322A1

(19) **United States**

(12) **Patent Application Publication**

Lee et al.

(10) **Pub. No.: US 2020/0044322 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

*H01Q 13/10* (2006.01)

*H01Q 9/04* (2006.01)

*H01Q 9/42* (2006.01)

*H01Q 5/364* (2006.01)

(71) Applicant: **E Ink Holdings Inc.**, Hsinchu (TW)

(72) Inventors: **Yu-Ming Lee**, Hsinchu (TW);  
**Chuen-Jen Liu**, Hsinchu (TW)

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

CPC ..... *H01Q 1/248* (2013.01); *H01Q 5/30*

(2015.01); *H01Q 5/364* (2015.01); *H01Q*

*9/0457* (2013.01); *H01Q 9/42* (2013.01);

*H01Q 13/10* (2013.01)

(73) Assignee: **E Ink Holdings Inc.**, Hsinchu (TW)

(21) Appl. No.: **16/596,772**

(22) Filed: **Oct. 9, 2019**

(57)

**ABSTRACT**

**Related U.S. Application Data**

(63) Continuation of application No. 15/904,448, filed on Feb. 26, 2018, now Pat. No. 10,490,885.

**Foreign Application Priority Data**

Aug. 17, 2017 (CN) ..... 201710705390.6

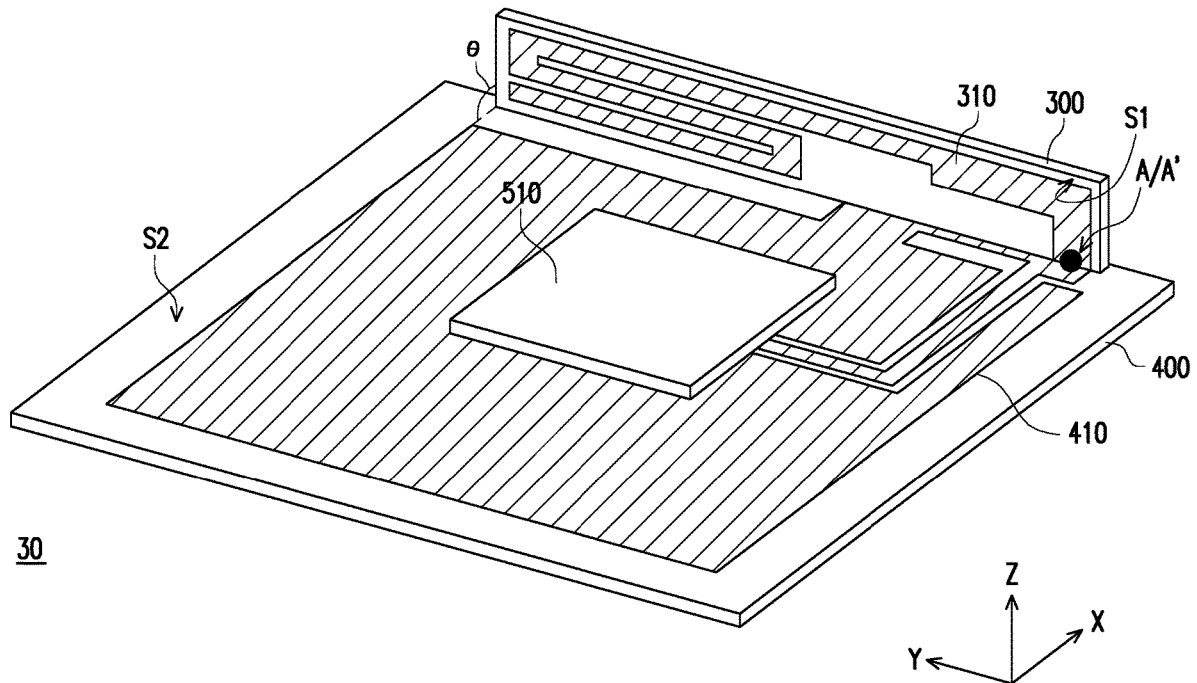
**Publication Classification**

(51) **Int. Cl.**

*H01Q 1/24* (2006.01)

*H01Q 5/30* (2006.01)

An antenna device including an antenna radiator and a feed line layer is provided. The antenna radiator is disposed on a first surface of a detachable substrate. The antenna radiator receives a microwave signal of at least one frequency band. The feed line layer is disposed on a second surface of a control circuit board. The feed line layer includes a signal feed line. The signal feed line is coupled to the antenna radiator through a connection point. The connection point is located on one side of the control circuit board. The detachable substrate and the control circuit board are arranged to have an angle between the first surface and the second surface. In addition, an electronic apparatus is also provided.





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(19) **United States**

(12) **Patent Application Publication**  
**WU et al.**

(10) **Pub. No.: US 2020/0044329 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **DEVICE AND METHOD OF REDUCING MUTUAL COUPLING OF TWO ANTENNAS BY ADDING CAPACITORS ON GROUND**

*H01Q 1/24* (2006.01)

*H01Q 9/04* (2006.01)

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

CPC ..... *H01Q 1/48* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 1/243* (2013.01); *H01Q 1/521* (2013.01)

(71) Applicant: **The Chinese University of Hong Kong, Shatin (CN)**

(72) Inventors: **Ke-Li WU, Shatin (CN); Jiangwei Sui, Henan (CN); Dacheng Wei, Guangzhou (CN)**

(57)

**ABSTRACT**

Radio frequency antennas sharing a ground plane are largely decoupled using one or more lumped capacitive elements set into holes within the ground plane. The holes, which are precisely placed, can extend to a side of the ground plane. A stub extends from a fringe of the hole either straight or bending in an L shape, and a capacitor connects between an end of the stub and another side of the hole. Capacitive elements can also be supported on raised solder pads above a ground plane or off to one side of the ground plane. Methods for manufacturing the decoupling apparatus are described.

(73) Assignee: **The Chinese University of Hong Kong, Shatin (CN)**

(21) Appl. No.: **16/054,288**

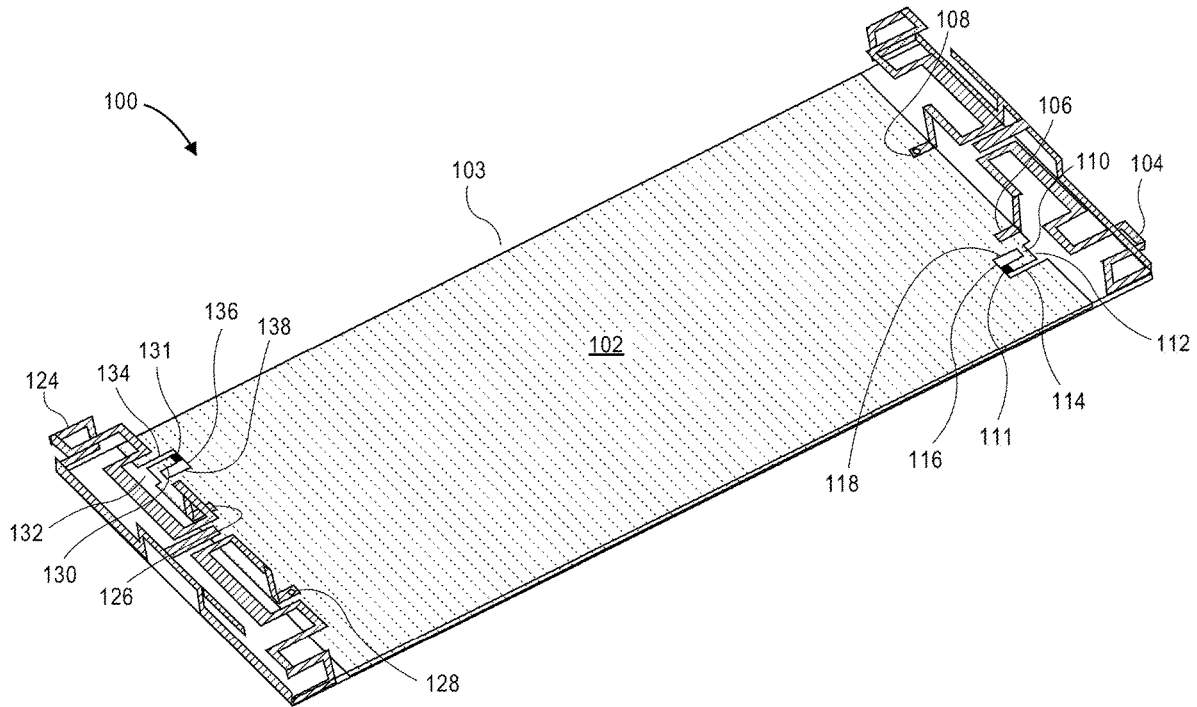
(22) Filed: **Aug. 3, 2018**

**Publication Classification**

(51) **Int. Cl.**

*H01Q 1/48* (2006.01)

*H01Q 1/52* (2006.01)





(19) **United States**

(12) **Patent Application Publication**

**Liu et al.**

(10) **Pub. No.: US 2020/0044331 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **MULTI-ANTENNA SYSTEM AND MOBILE TERMINAL**

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/523* (2013.01); *H01Q 21/06* (2013.01); *H01Q 1/243* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(72) Inventors: **Shijie Liu**, Shenzhen (CN); **Ge Zhang**,  
Shenzhen (CN); **Yue Liang**, Shenzhen  
(CN)

(57) **ABSTRACT**

The present disclosure provides a multi-antenna system comprising at least two antenna units and a neutralization line for connecting two adjacent antenna units, and the neutralization line is provided with an inductor element. The invention also provides a mobile terminal. The multi-antenna system and the mobile terminal provided by the present disclosure could significantly increase the isolation degree between the antenna units by providing a neutralization line between the two adjacent antenna units for connecting the same and providing an inductor element on the neutralization line, thereby reducing the mutual coupling interference between antenna units and improving the antenna performance.

(21) Appl. No.: **16/524,053**

(22) Filed: **Jul. 27, 2019**

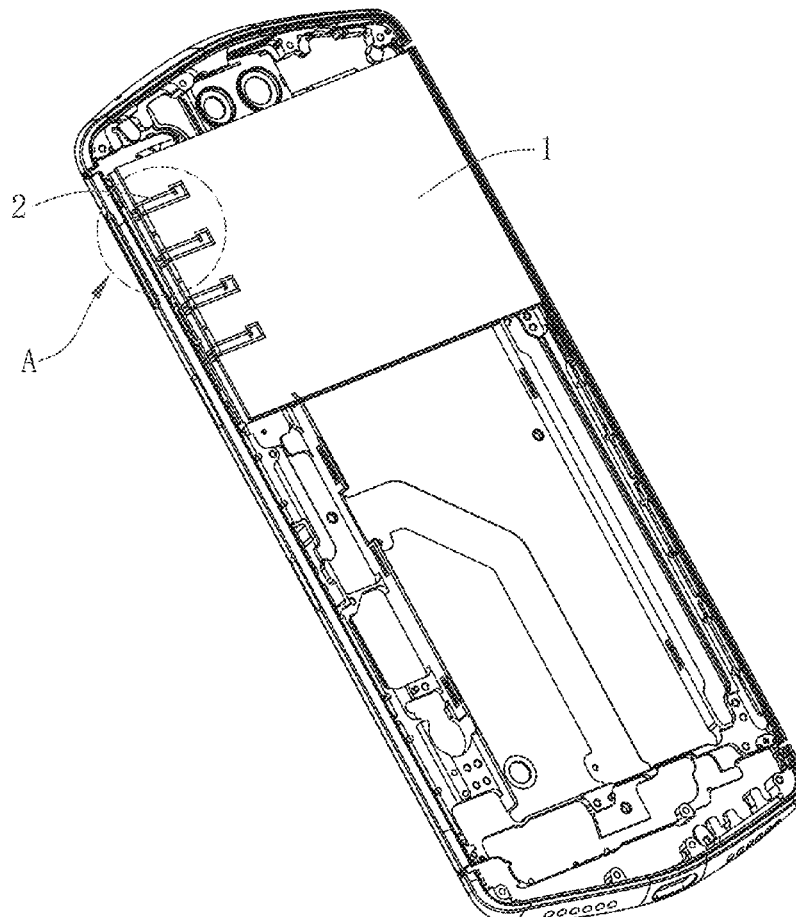
(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810879378.1

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/52* (2006.01)  
*H01Q 1/24* (2006.01)  
*H01Q 21/06* (2006.01)

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(19) **United States**

(12) **Patent Application Publication**

Zhu et al.

(10) **Pub. No.: US 2020/0044339 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 5/30* (2015.01); *H01Q 21/30* (2013.01); *H01Q 1/243* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(72) Inventors: **Yufei Zhu**, Shenzhen (CN); **Yongsheng Peng**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,084**

(22) Filed: **Jul. 28, 2019**

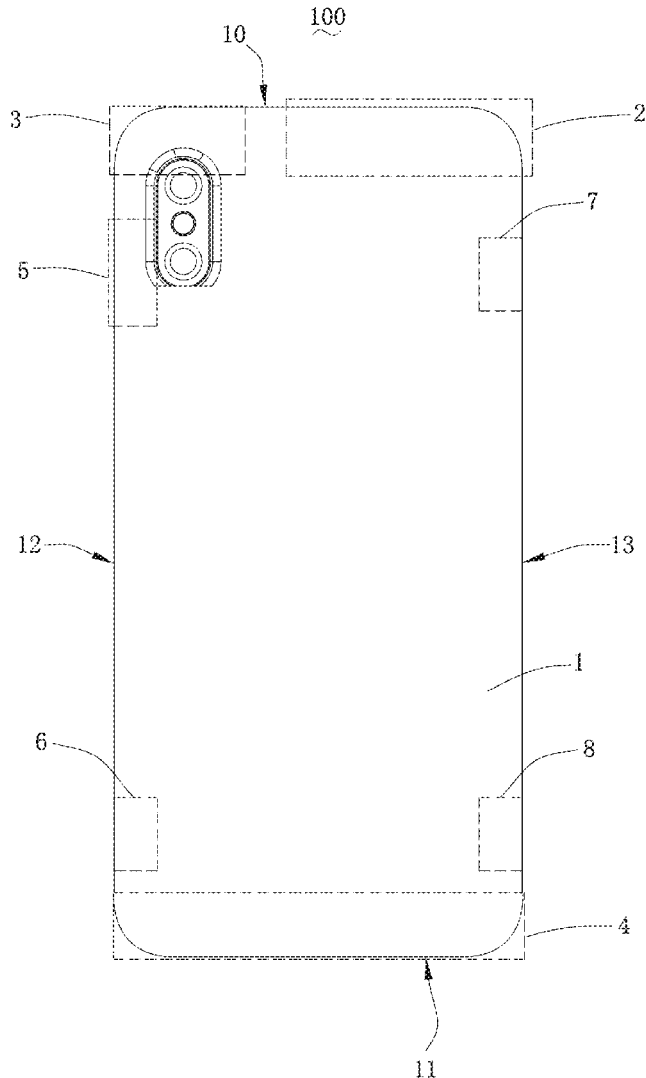
The present disclosure provides an antenna system including a non-metallic housing. The non-metallic housing includes a top edge portion, a bottom edge portion provided correspondingly to the top edge portion, and a first long side edge portion and a second long side edge portion that connect the top edge portion with the bottom edge portion. The antenna system further includes seven antenna units provided on a periphery of the non-metallic housing. Compared with the related art, the antenna system provided by the present disclosure, by providing seven antenna units on the periphery of the non-metallic housing, achieves 3.3-3.6 GHz-4x4 MIMO, WIFI-2x2 MIMO, GPS, and 2G, 3G and 4G mobile communications.

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810880128.X

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 5/30* (2006.01)  
*H01Q 1/24* (2006.01)  
*H01Q 21/30* (2006.01)





US 20200044340A1

(19) **United States**

(12) **Patent Application Publication**  
**Zhu**

(10) **Pub. No.: US 2020/0044340 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

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

CPC ..... **H01Q 5/328** (2015.01); **H01Q 1/48** (2013.01); **H01Q 1/241** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(57)

**ABSTRACT**

(72) Inventor: **Yufei Zhu**, Shenzhen (CN)

The present disclosure provides an antenna system, including: a metal housing including a radiation frame and a grounded back shell; a circuit board located in the metal housing and including a radio frequency feeding source and a tunable capacitor; and an antenna unit connected to the radio frequency feeding source and configured to be coupled to the radiation frame. A fracture is formed between each of two ends of the radiation frame and the grounded back shell. The tunable capacitor is connected to the radiation frame so as to change an electrical length of the antenna system by switching to different capacitances. Compared with the related art, the antenna system provided by present disclosure, by providing the tunable capacitor as a tuner of the antenna system, not only can achieve that the radiation frequency of the antenna system covers 790-960 MHz and 1710-2690 MHz, but also has good radiation performance.

(21) Appl. No.: **16/524,217**

(22) Filed: **Jul. 29, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810875750.1

**Publication Classification**

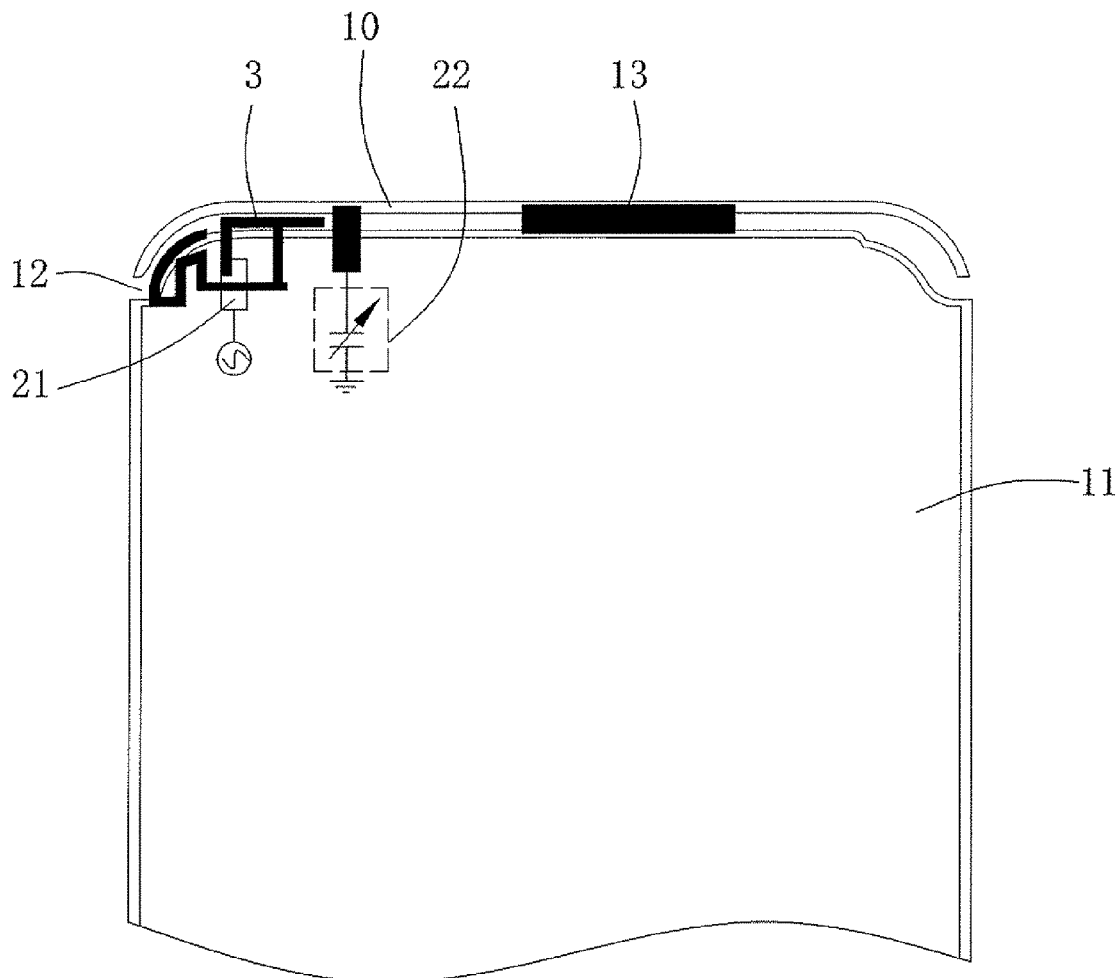
(51) **Int. Cl.**

**H01Q 5/328** (2006.01)

**H01Q 1/24** (2006.01)

**H01Q 1/48** (2006.01)

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US 20200044341A1

(19) **United States**

(12) **Patent Application Publication**  
**Shen**

(10) **Pub. No.: US 2020/0044341 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **ANTENNA SYSTEM OF MOBILE TERMINAL AND MOBILE TERMINAL**

(52) **U.S. Cl.**  
CPC ..... *H01Q 5/335* (2015.01); *H01Q 9/0414* (2013.01); *H01Q 1/242* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(57) **ABSTRACT**

(72) Inventor: **Yachuan Shen**, Shenzhen (CN)

The present disclosure provides an antenna system of a mobile terminal. The mobile terminal includes a housing, a mainboard accommodated in the housing, a plastic holder covering the mainboard, and a USB interface installed on the mainboard. The antenna system includes a radiator formed on a surface of the plastic holder facing the housing, and a feed end, a first ground point and a second ground point that are disposed on the mainboard. The radiator includes a feed end and a ground feed end spaced apart from each other, a connection end connecting the feed end and the ground feed end, a first stub connected to the ground feed end, and a second stub and a third stub connected to the feed end. The antenna system provided by the present disclosure is more space-saving, and reduces the impact of the USB interface on the antenna.

(21) Appl. No.: **16/524,215**

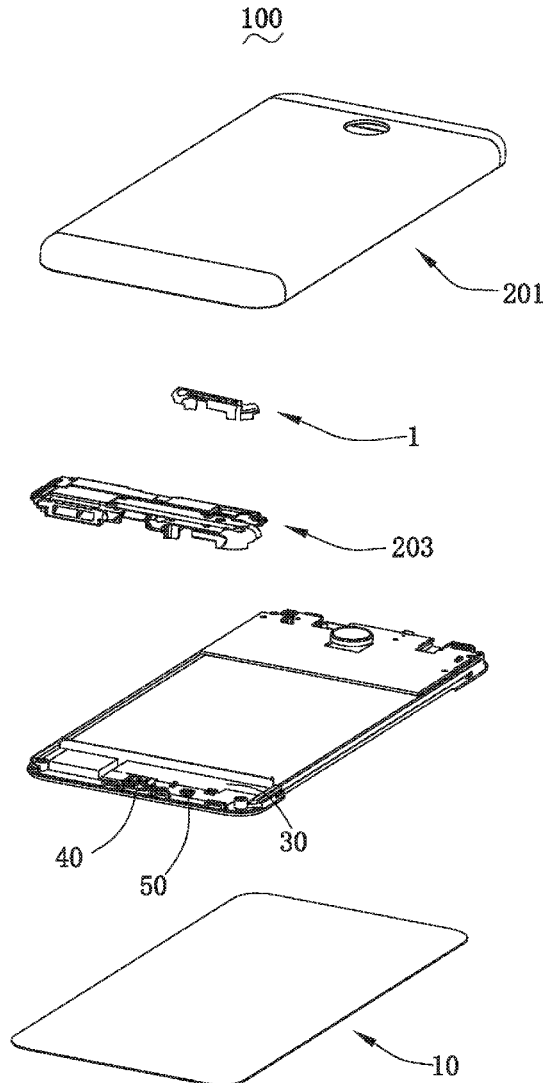
(22) Filed: **Jul. 29, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201821245508.8

**Publication Classification**

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









US 20200044346A1

(19) **United States**

(12) **Patent Application Publication**  
**Gu**

(10) **Pub. No.: US 2020/0044346 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

*H01Q 5/328* (2006.01)

*H04B 7/0413* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(52) **U.S. Cl.**  
CPC ..... *H01Q 5/50* (2015.01); *H04B 7/0413*  
(2013.01); *H01Q 5/328* (2015.01); *H01Q*  
*1/241* (2013.01)

(72) Inventor: **Haichuan Gu**, Shenzhen (CN)

(21) Appl. No.: **16/524,041**

(22) Filed: **Jul. 27, 2019**

(30) **Foreign Application Priority Data**

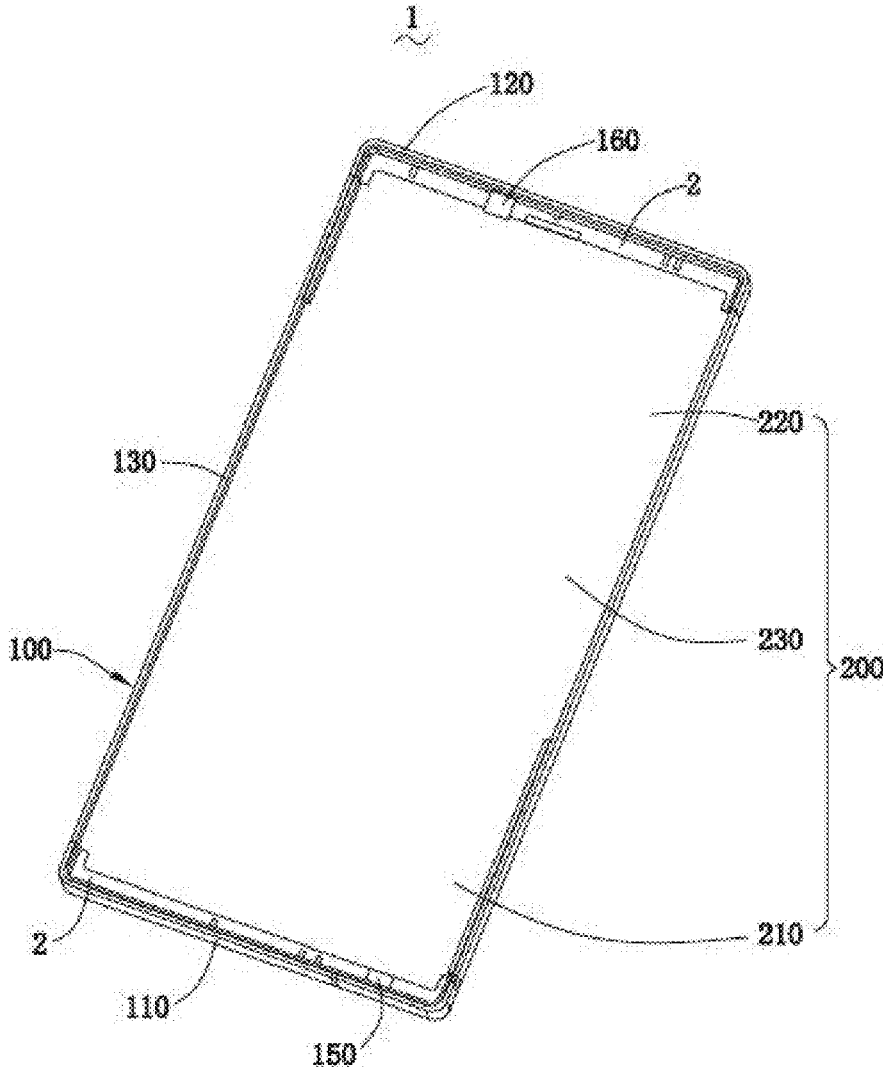
Aug. 3, 2018 (CN) ..... 201810876500.X

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 5/50* (2006.01)  
*H01Q 1/24* (2006.01)

(57) **ABSTRACT**

The present disclosure provides an antenna system and a mobile terminal. The antenna system comprises a metal frame, a main board received in the metal frame, and a first feeding point, a second feeding point, a first grounding point, a second grounding point, a third feeding point, a fourth feeding point, a third grounding point, a fourth grounding point, a first tuning switch, a second tuning switch, a first matching network, a variable capacitor, a third tuning switch, a fourth tuning switch, and a second matching network disposed at the main board. The metal frame is partitioned into a first radiating portion and a second radiating portion at the bottom and a third radiating portion and a fourth radiating portion at the top.





US 20200044347A1

(19) **United States**

(12) **Patent Application Publication**

**Hang et al.**

(10) **Pub. No.: US 2020/0044347 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **LOOP ANTENNA SYSTEM AND MOBILE TERMINAL**

*H01Q 5/328* (2006.01)

*H04B 7/0413* (2006.01)

*H01Q 5/50* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

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

CPC ..... *H01Q 7/00* (2013.01); *H01Q 1/241*  
(2013.01); *H01Q 5/50* (2015.01); *H04B*  
*7/0413* (2013.01); *H01Q 5/328* (2015.01)

(72) Inventors: **Mingjun Hang**, Shenzhen (CN); **Yufei Zhu**, Shenzhen (CN); **Dawei Shi**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN)

(57)

**ABSTRACT**

(21) Appl. No.: **16/524,044**

(22) Filed: **Jul. 27, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201821251442.3

**Publication Classification**

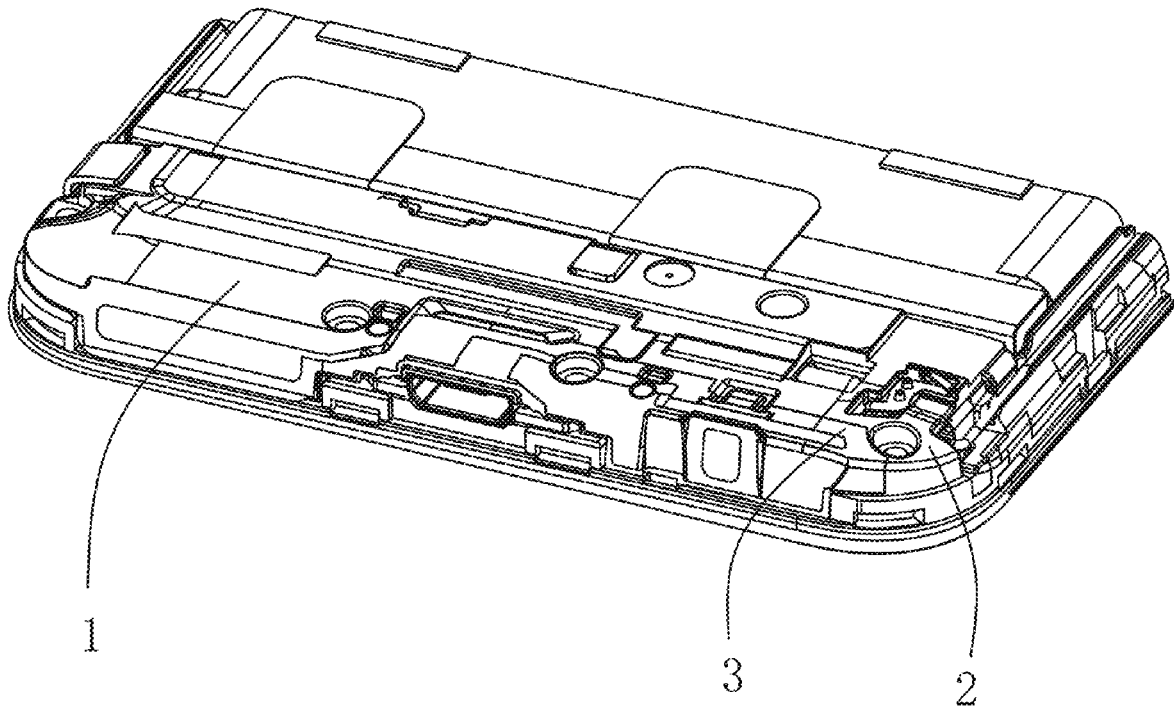
(51) **Int. Cl.**

*H01Q 7/00* (2006.01)

*H01Q 1/24* (2006.01)

A loop antenna system, comprising a plastic back shell and a main board accommodated in the plastic back shell, wherein the loop antenna system comprises a loop antenna disposed on a surface of the plastic back shell, the main board is disposed with a ground switch and a feed point which are connected to the loop antenna. The loop antenna at least has two operation states by adjusting the ground switch, wherein one state is that the loop antenna operates at a GSM900 TX frequency band, and the other state is that the loop antenna operates at a GSM900 RX frequency band.

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US 20200044348A1

(19) **United States**

(12) **Patent Application Publication**  
**Xu**

(10) **Pub. No.: US 2020/0044348 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

*H01Q 5/328* (2006.01)

*H01Q 5/50* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(52) **U.S. Cl.**  
CPC ..... *H01Q 9/0414* (2013.01); *H01Q 1/245*  
(2013.01); *H01Q 5/50* (2015.01); *H01Q 5/328*  
(2015.01); *H01Q 1/243* (2013.01)

(72) Inventor: **Xinying Xu**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,082**

The present disclosure provides an antenna system, including a mainboard having a system ground, a metal frame disposed around the mainboard and being closed-loop without any breakpoints, a first wire, a second wire, a third wire, a feed terminal, and a ground terminal. The system ground is electrically connected to the metal frame. The first wire is connected to the feed terminal and is opposite to and spaced apart from the metal frame, so that the first wire forms a first antenna unit. The second wire is connected to the ground terminal and is spaced apart from the first wire, and the second wire and the first wire are at least partially opposite, so that the second wire and the first wire are coupled with each other, to form a second antenna unit.

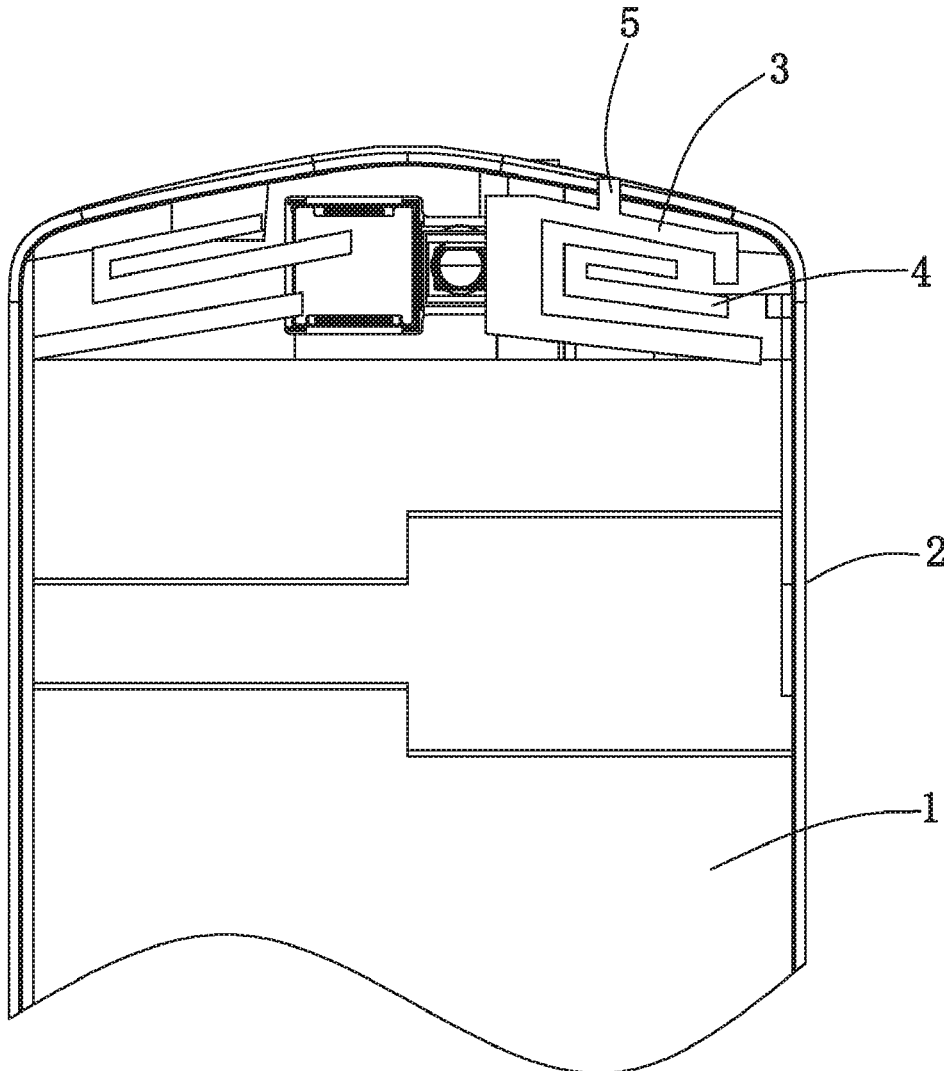
(22) Filed: **Jul. 28, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201821252395.4

**Publication Classification**

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





US 20200044364A1

(19) **United States**

(12) **Patent Application Publication**

Zhu et al.

(10) **Pub. No.: US 2020/0044364 A1**

(43) **Pub. Date: Feb. 6, 2020**

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

*H01Q 5/328* (2006.01)

*H01Q 5/50* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(52) **U.S. Cl.**  
CPC ..... *H01Q 21/28* (2013.01); *H01Q 5/50*  
(2015.01); *H01Q 5/328* (2015.01); *H01Q*  
*1/241* (2013.01)

(72) Inventors: **Yufei Zhu**, Shenzhen (CN); **Mingjun Hang**, Shenzhen (CN); **Dawei Shi**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN)

(57) **ABSTRACT**

A mobile communication device is provided. The mobile communication device includes: a metal housing, a diversity antenna unit, an integrated antenna unit, a first main antenna unit, a second main antenna unit, and a main board. Compared with the related art, with the antenna system provided by the present disclosure, the diversity antenna unit, the integrated antenna unit, the first main antenna unit, and the second main antenna unit constitute 4x4 MIMO of an LTE Band3 and an LTE Band7, so that performance of the medium frequency and high frequency is improved; and the integrated antenna unit and the second main antenna unit constitute 2x2 MIMO of the Wi-Fi5G, so that performance of the Wi-Fi5G is improved.

(21) Appl. No.: **16/524,054**

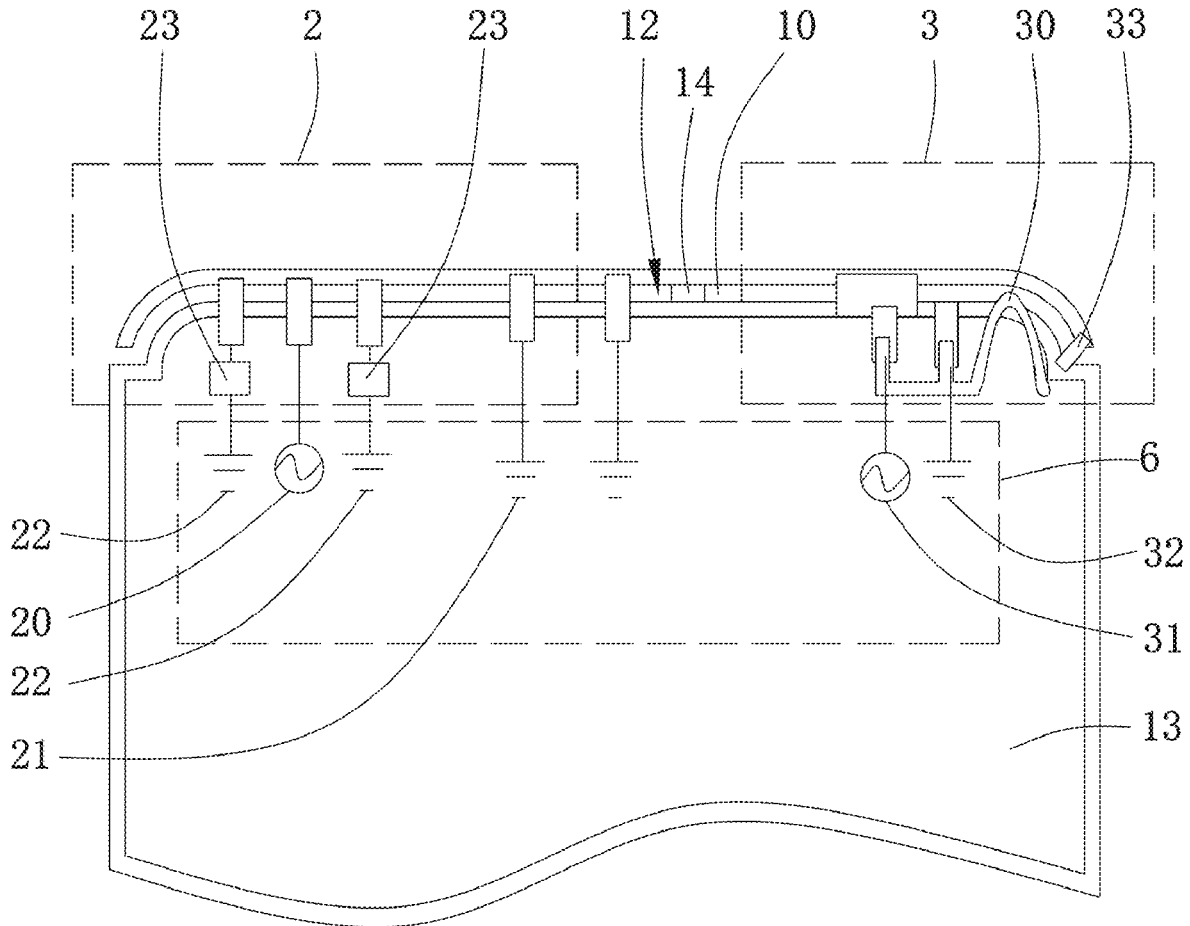
(22) Filed: **Jul. 27, 2019**

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) ..... 201810878294.6

**Publication Classification**

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





US 20200044484A1

(19) **United States**

(12) **Patent Application Publication**

**LEE et al.**

(10) **Pub. No.: US 2020/0044484 A1**

(43) **Pub. Date: Feb. 6, 2020**

(54) **ELECTRONIC DEVICE HAVING A PLURALITY OF STACKED COIL ANTENNAS**

*H02J 50/70* (2006.01)

*H01Q 7/00* (2006.01)

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

(52) **U.S. Cl.**  
CPC ..... *H02J 50/10* (2016.02); *H01Q 7/005*  
(2013.01); *H02J 50/70* (2016.02); *H02J 50/40*  
(2016.02)

(72) Inventors: **Sungmin LEE**, Gyeonggi-do (KR);  
**Seongyeol KIM**, Gyeonggi-do (KR);  
**Jaewoong LEE**, Gyeonggi-do (KR);  
**Yujin JEONG**, Gyeonggi-do (KR)

(57) **ABSTRACT**

(73) Assignee: **Samsung Electronics Co., Ltd.**

An electronic device is provided. The electronic device includes a housing including a first surface facing in a first direction, a second surface facing in a second direction opposite to the first direction, and a side surface enclosing a space between the first surface and the second surface, a display exposed at least partially through the first surface, a first conductive coil positioned inside the housing, positioned above the display when viewed from above the second surface, and having an axis substantially perpendicular to the first direction or the second direction, and a second conductive coil and a third conductive coil positioned inside the housing, positioned above the first conductive coil when viewed from above the second surface, and having an axis substantially horizontal to the first direction or the second direction.

(21) Appl. No.: **16/527,853**

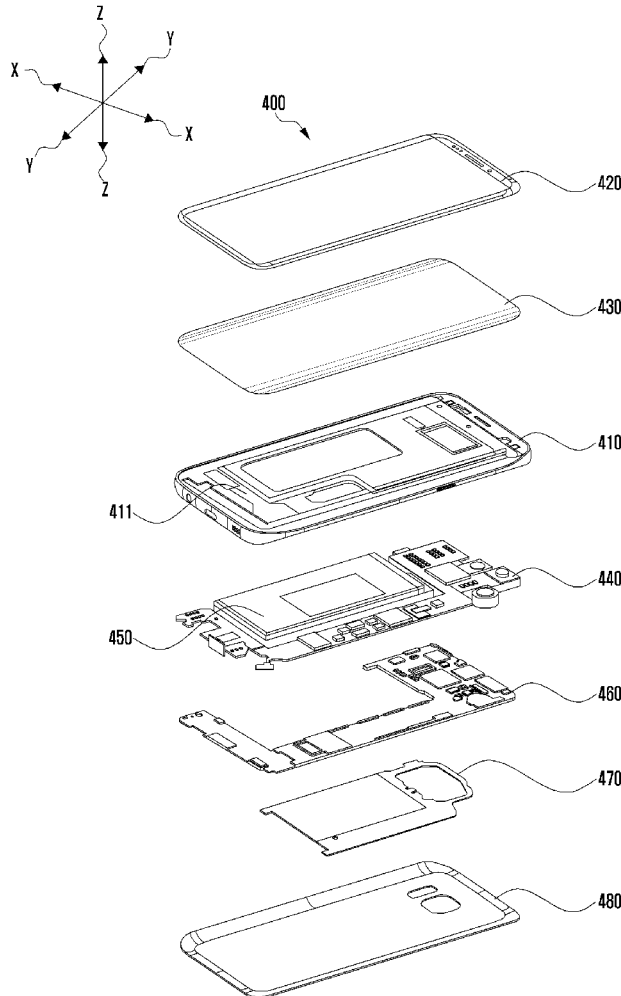
(22) Filed: **Jul. 31, 2019**

(30) **Foreign Application Priority Data**

Jul. 31, 2018 (KR) ..... 10-2018-0089604

**Publication Classification**

(51) **Int. Cl.**  
*H02J 50/10* (2006.01)  
*H02J 50/40* (2006.01)





(19) **United States**

(12) **Patent Application Publication**  
**JUNG et al.**

(10) **Pub. No.: US 2020/0051468 A1**

(43) **Pub. Date: Feb. 13, 2020**

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

**Publication Classification**

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

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

(72) Inventors: **Hojin JUNG**, Suwon-si (KR); **Boochul BAE**, Suwon-si (KR); **Jongoh LIM**, Suwon-si (KR)

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

(21) Appl. No.: **16/536,558**

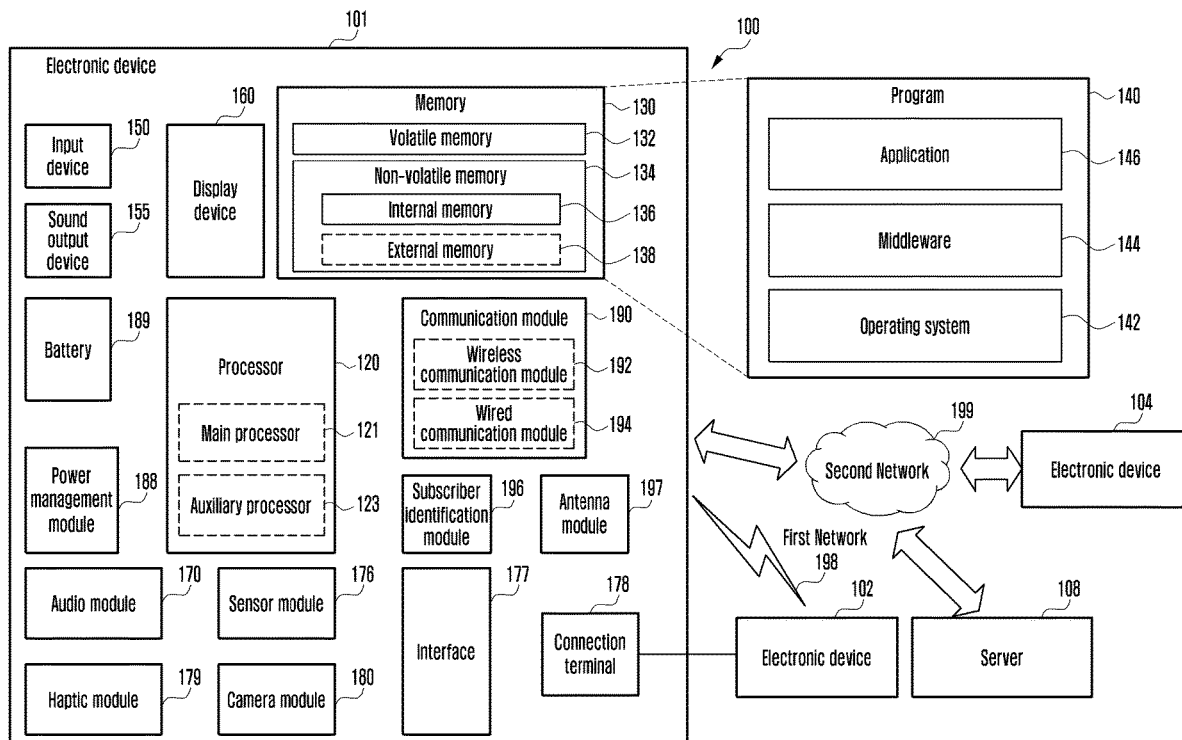
(57) **ABSTRACT**

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

(22) Filed: **Aug. 9, 2019**

(30) **Foreign Application Priority Data**

Aug. 10, 2018 (KR) ..... 10-2018-0093954  
Aug. 2, 2019 (KR) ..... 10-2019-0094397





US 20200052380A1

(19) **United States**

(12) **Patent Application Publication**  
**Shi et al.**

(10) **Pub. No.: US 2020/0052380 A1**

(43) **Pub. Date: Feb. 13, 2020**

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

*H01Q 21/00* (2006.01)

*H01Q 21/30* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/36*  
(2013.01); *H01Q 21/30* (2013.01); *H01Q*  
*9/0414* (2013.01); *H01Q 21/0006* (2013.01);  
*H01Q 9/0442* (2013.01)

(72) Inventors: **Dawei Shi**, Shenzhen (CN); **Kai Dong**,  
Shenzhen (CN); **Mingjun Hang**,  
Shenzhen (CN); **Yufei Zhu**, Shenzhen  
(CN)

(57) **ABSTRACT**

An antenna system applied to a mobile terminal. The mobile terminal comprises a back shell, a main board received in the back shell, a bracket arranged between the back shell and the main board, and a metal wiring arranged on the surface of the bracket. A clearance area is arranged at one end of the main board; an orthographic projection of the metal wiring on the main board is located in the clearance area. The main board is provided with a grounding switch and a feeding point. The metal wiring comprises a body part, a first branch for generating low-frequency resonance, a second branch for generating high-frequency resonance and a third branch for generating medium-frequency resonance. The first branch, the second branch and the third branch respectively extend from the body part to two sides. The grounding switch and the feeding point are connected with the body part.

(21) Appl. No.: **16/524,088**

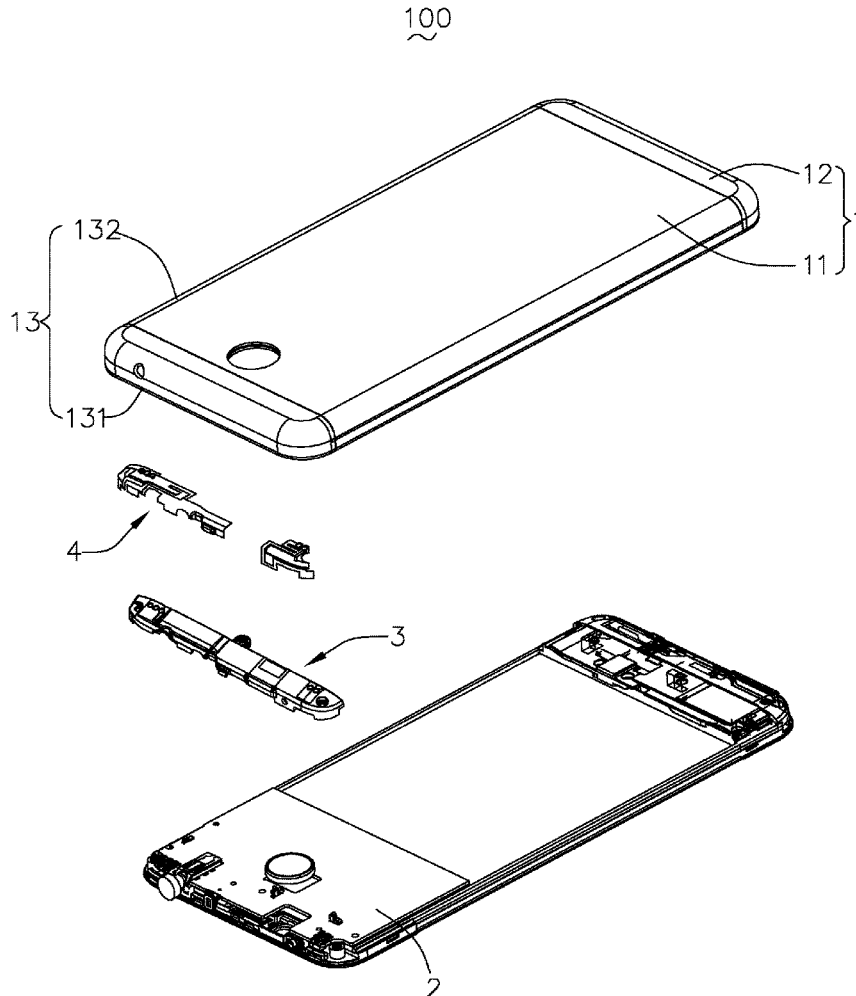
(22) Filed: **Jul. 28, 2019**

(30) **Foreign Application Priority Data**

Aug. 12, 2018 (CN) ..... 201821294952.9

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 1/36* (2006.01)  
*H01Q 9/04* (2006.01)







(19) **United States**

(12) **Patent Application Publication**  
**Luo**

(10) **Pub. No.: US 2020/0052381 A1**

(43) **Pub. Date: Feb. 13, 2020**

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 7/005** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(72) Inventor: **Jingqiang Luo**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/524,219**

(22) Filed: **Jul. 29, 2019**

(30) **Foreign Application Priority Data**

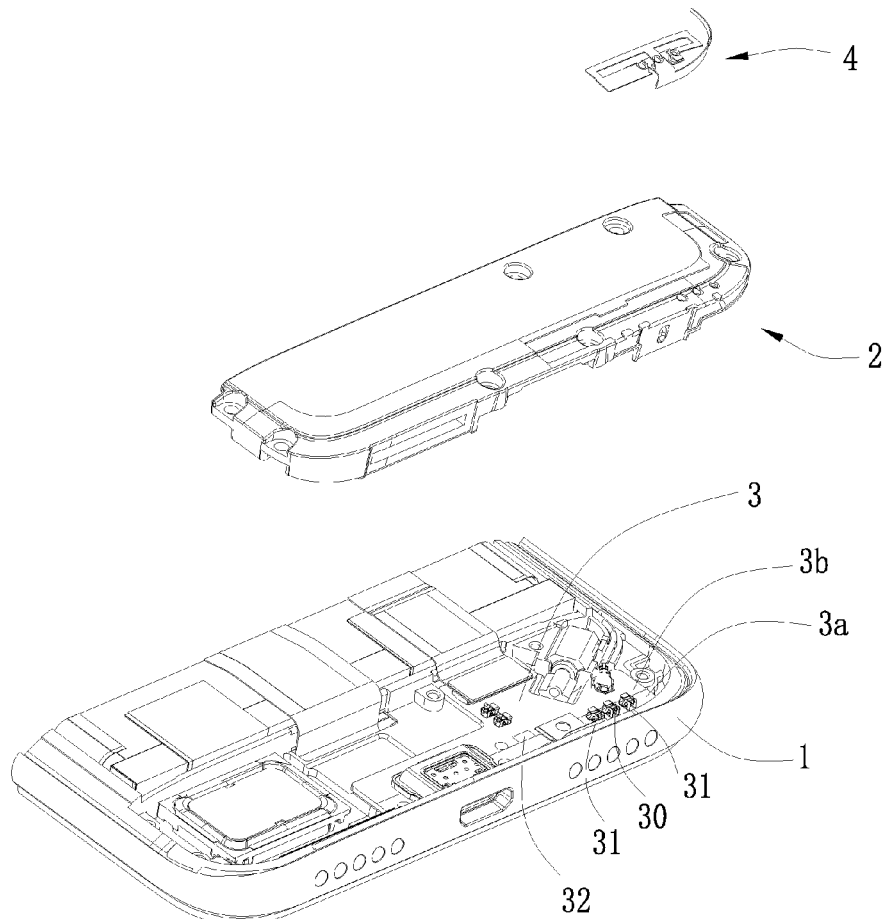
Aug. 7, 2018 (CN) ..... 201810893334.4

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 7/00** (2006.01)  
**H01Q 21/00** (2006.01)

The present invention provides an antenna system applied to a mobile terminal. The mobile terminal includes a metal bezel, a plastic back shell and a main board. The antenna system includes a metal trace. The metal trace includes a feed section, a radiating section, a first loop unit and a second loop unit. The main board is provided with one feed point connected to both the feed section and the metal bezel, two ground points respectively connected to an end, away from the feed section, of the first loop unit and an end, away from the feed section, of the second loop unit, and a tuning switch connected to the metal bezel.

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US 20200052383A1

(19) **United States**

(12) **Patent Application Publication**  
**Qiu**

(10) **Pub. No.: US 2020/0052383 A1**

(43) **Pub. Date: Feb. 13, 2020**

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 9/26* (2013.01); *H01Q 1/38* (2013.01); *H01Q 5/328* (2015.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore City (SG)

(72) Inventor: **Xiaojun Qiu**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/525,589**

Provided is an antenna system applied to a mobile terminal and including a back shell having a metal frame, a main board received in the back shell, an antenna unit provided between the back shell and the main board. The main board includes a front surface facing towards the antenna unit and a back surface arranged opposite to and spaced apart from the front surface. The mobile terminal includes a first metal ground layer and a first electrode plate provided on the front surface, a second metal ground layer and a second electrode plate provided on the back surface. The first electrode plate and the second electrode plate are spaced apart from the first and second metal ground layer, and connected to the antenna unit and the metal frame. The first and second electrode plates are arranged opposite to and spaced apart from each other to form a capacitor structure.

(22) Filed: **Jul. 30, 2019**

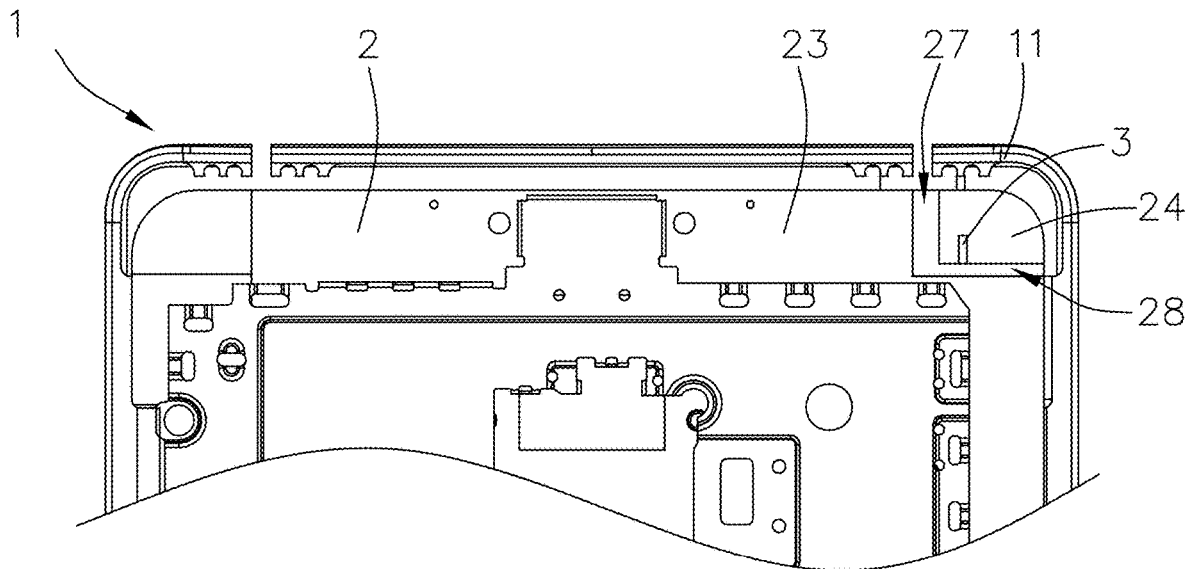
(30) **Foreign Application Priority Data**

Aug. 13, 2018 (CN) ..... 201810915707.3

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 5/328* (2006.01)  
*H01Q 1/38* (2006.01)  
*H01Q 9/26* (2006.01)

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US 20200052406A1

(19) **United States**

(12) **Patent Application Publication**  
**ZHINONG et al.**

(10) **Pub. No.: US 2020/0052406 A1**

(43) **Pub. Date: Feb. 13, 2020**

(54) **MILLIMETER WAVE ANTENNA**

*H01Q 1/48* (2006.01)

(71) Applicant: **SONY CORPORATION**, Tokyo (JP)

(52) *H01Q 5/50* (2006.01)

(72) Inventors: **Ying ZHINONG**, Lund (SE); **Kun ZHAO**, Lund (SE)

(57) **U.S. Cl.**  
CPC ..... *H01Q 9/285* (2013.01); *H01Q 5/50* (2015.01); *H01Q 1/48* (2013.01); *H01Q 1/243* (2013.01)

(21) Appl. No.: **16/490,426**

(22) PCT Filed: **Apr. 26, 2017**

(57) **ABSTRACT**

(86) PCT No.: **PCT/US2017/029650**

§ 371 (c)(1),

(2) Date: **Aug. 30, 2019**

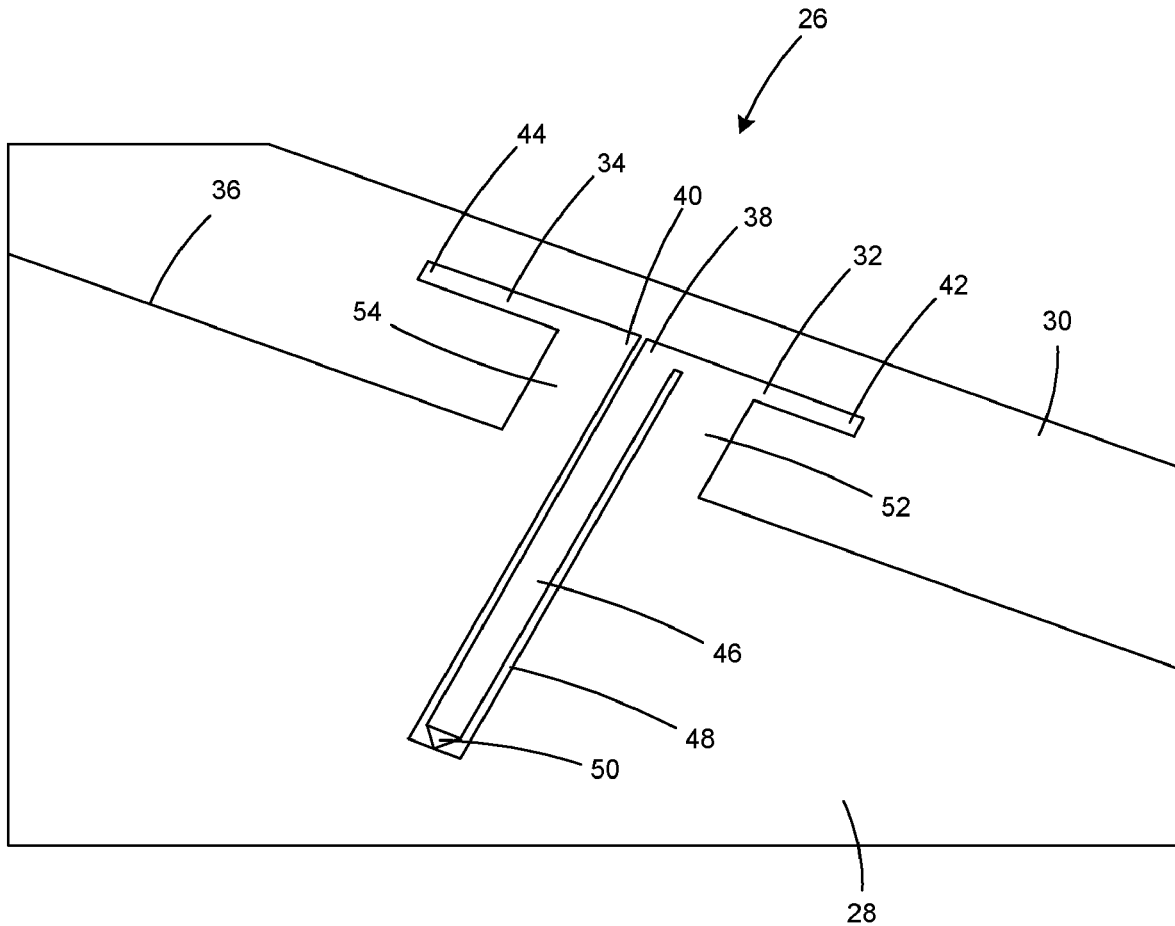
**Publication Classification**

(51) **Int. Cl.**

*H01Q 9/28* (2006.01)

*H01Q 1/24* (2006.01)

A balanced planar antenna having at least one mmWave resonant frequency includes a ground plane, first and second antenna elements, an arm that connects the second antenna element to the ground plane, a feed line connected to the first antenna element and for feeding a radio frequency signal to the first antenna element, and a balun that connects the first antenna element to the ground plane. The ground plane, first antenna element, second antenna element, arm, feed line and balun each are disposed on a substrate and are coplanar.





US 20200052415A1

(19) **United States**

(12) **Patent Application Publication**  
**Choon et al.**

(10) **Pub. No.: US 2020/0052415 A1**

(43) **Pub. Date: Feb. 13, 2020**

(54) **MILLIMETER WAVE ARRAY ANTENNA AND MOBILE TERMINAL**

*H01Q 1/48* (2006.01)

*H01Q 1/24* (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,  
Singapore city (SG)

(52) **U.S. Cl.**  
CPC ..... *H01Q 21/064* (2013.01); *H01Q 13/10*  
(2013.01); *H01Q 1/243* (2013.01); *H01Q 1/48*  
(2013.01); *H01Q 21/22* (2013.01)

(72) Inventors: **Tan Yew Choon**, Singapore (SG); **Ng Guan Hong**, Singapore (SG); **Tay Yew Siow**, Singapore (SG)

(57) **ABSTRACT**

The present invention provides a millimeter wave array antenna including: two metal grounding layers and a sandwich metal layer between the two metal grounding layers. The sandwich metal layer includes a top surface, a bottom surface and a plurality of antenna slots. The top surface is connected with the two metal grounding layers along a long axis direction, the bottom surface is opposite to and in parallel with the top surface, the antenna slots space the array along the long axis direction, penetrate the top surface and bottom surface and are connected with the two metal grounding layers. The metal grounding layers are provided with feed parts at positions corresponding to each antenna slot, and, each of the antenna slots, the metal grounding layers and the sandwich metal layer forms a slot antenna unit.

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