



US 20150338523A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0338523 A1**

(43) **Pub. Date: Nov. 26, 2015**

(54) **ELECTRONIC DEVICE HAVING ARRAY OF SATELLITE NAVIGATION SYSTEM ANTENNAS**

(52) **U.S. Cl.**
CPC *G01S 19/37* (2013.01)

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

(57) **ABSTRACT**

(72) Inventors: **Harish Rajagopalan**, Cupertino, CA (US); **Jiang Zhu**, Sunnyvale, CA (US); **Qingxiang Li**, Mountain View, CA (US); **Robert W. Schlub**, Cupertino, CA (US); **Rodney A. Gomez Angulo**, Sunnyvale, CA (US)

An electronic device may be provided with wireless circuitry. The wireless circuitry may include a pair of antennas. The antennas may be formed from inverted-F antenna resonating elements located along one of the peripheral edges of a device housing. The housing may be formed of metal and may serve as an antenna ground for the antennas. The antennas may be used to receive satellite navigation system signals that are processed by a satellite navigation system receiver. An orientation sensor may be used to gather information on the orientation of the electronic device relative to the Earth. Information on received signal strength may be obtained from the satellite navigation system receiver. Based on orientation information or received signal strength information or other information, switching circuitry may be adjusted to switch an optimum one of the antennas into use or phase shifter circuitry may be adjusted to optimize signal reception.

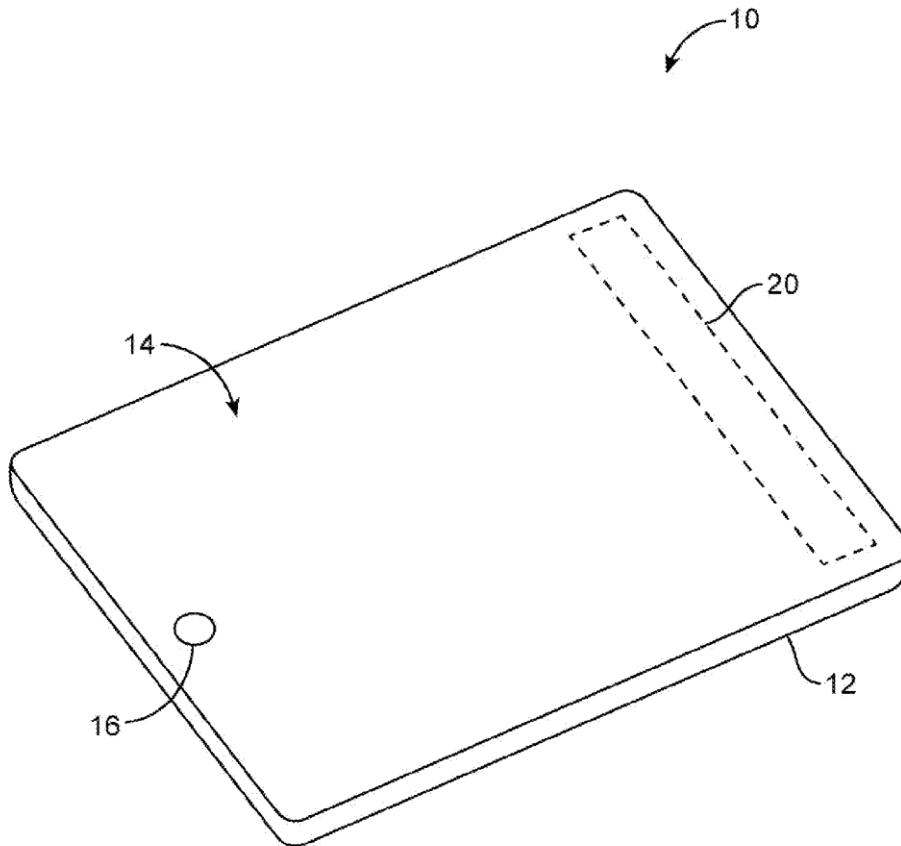
(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(21) Appl. No.: **14/285,321**

(22) Filed: **May 22, 2014**

Publication Classification

(51) **Int. Cl.**
G01S 19/37 (2006.01)





US 20150340756A1

(19) **United States**

(12) **Patent Application Publication**
Huang

(10) **Pub. No.: US 2015/0340756 A1**

(43) **Pub. Date: Nov. 26, 2015**

(54) **APPARATUS HAVING A CONDUCTIVE HOUSING AND AN ANTENNA WITH TUNABLE RESONANCE**

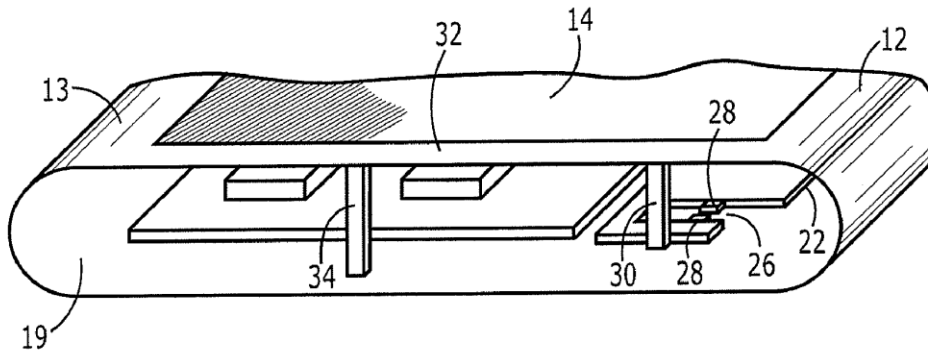
(52) **U.S. Cl.**
CPC *H01Q 1/24* (2013.01)

(71) Applicant: **Nokia Corporation**, Espoo (FI)
(72) Inventor: **Wei Huang**, San Diego, CA (US)
(73) Assignee: **Nokia Corporation**, Espoo (FI)
(21) Appl. No.: **14/286,365**
(22) Filed: **May 23, 2014**

(57) **ABSTRACT**
An apparatus and a portable electronic device are provided to facilitate tuning of the resonance of an antenna at least partially disposed within a conductive housing. As such, an apparatus is provided that includes a conductive housing having a first conductive portion. The first conductive portion defines a non-conductive aperture. The apparatus also includes a second conductive portion disposed at least partially within the conductive housing. The second conductive portion defines an open-ended non-conductive slot. The slot is configured to couple to radio frequency circuitry. The apparatus further includes a conductive element extending between and conductively coupling the first and second conductive portions. A personal electronic device that embodies the apparatus is also provided.

Publication Classification

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





US 20150340757A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0340757 A1**

(43) **Pub. Date: Nov. 26, 2015**

(54) **ANTENNA DEVICE AND MOBILE
TERMINAL HAVING SAME**

(30) **Foreign Application Priority Data**

Aug. 6, 2013 (KR) 10-2013-0093223

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

Publication Classification

(72) Inventors: **Sungjung RHO**, Seoul (KR);
Byungwoon JUNG, Seoul (KR);
Youngbae KWON, Seoul (KR);
Hanphil RHYU, Seoul (KR);
Changwon YUN, Seoul (KR); **Duckyun
KIM**, Seoul (KR); **Deuksu CHOI**, Seoul
(KR); **Jaewoo LEE**, Seoul (KR);
Sungjoon HONG, Seoul (KR)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/342 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/342**
(2015.01); **H01Q 9/42** (2013.01)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(57) **ABSTRACT**

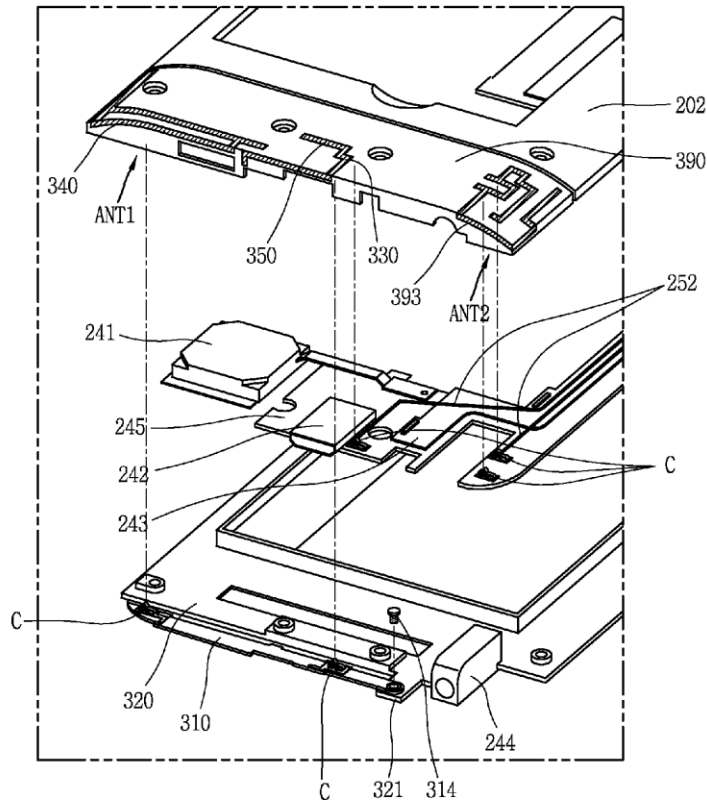
(21) Appl. No.: **14/648,850**

An antenna apparatus according to one exemplary embodiment disclosed herein includes a first member and a second member limiting a slot, a feeding unit provided on one surface of a carrier covering the slot and configured to feed the slot, and a first radiator formed on the one surface of the carrier with being spaced apart from the feeding unit, and electrically connected to the first member, the first radiator configured to resonate together with the slot at a first frequency band and a second frequency band.

(22) PCT Filed: **Aug. 6, 2013**

(86) PCT No.: **PCT/KR2013/007101**

§ 371 (c)(1),
(2) Date: **Jun. 1, 2015**





US 20150340761A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0340761 A1**

(43) **Pub. Date: Nov. 26, 2015**

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

Publication Classification

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

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 7/00 (2006.01)

(72) Inventors: **Chao Feng**, Beijing (CN); **Tiezhu Liang**, Beijing (CN)

(52) **U.S. Cl.**
CPC ... **H01Q 1/38** (2013.01); **H01Q 7/00** (2013.01)

(21) Appl. No.: **14/816,190**

(57) **ABSTRACT**

(22) Filed: **Aug. 3, 2015**

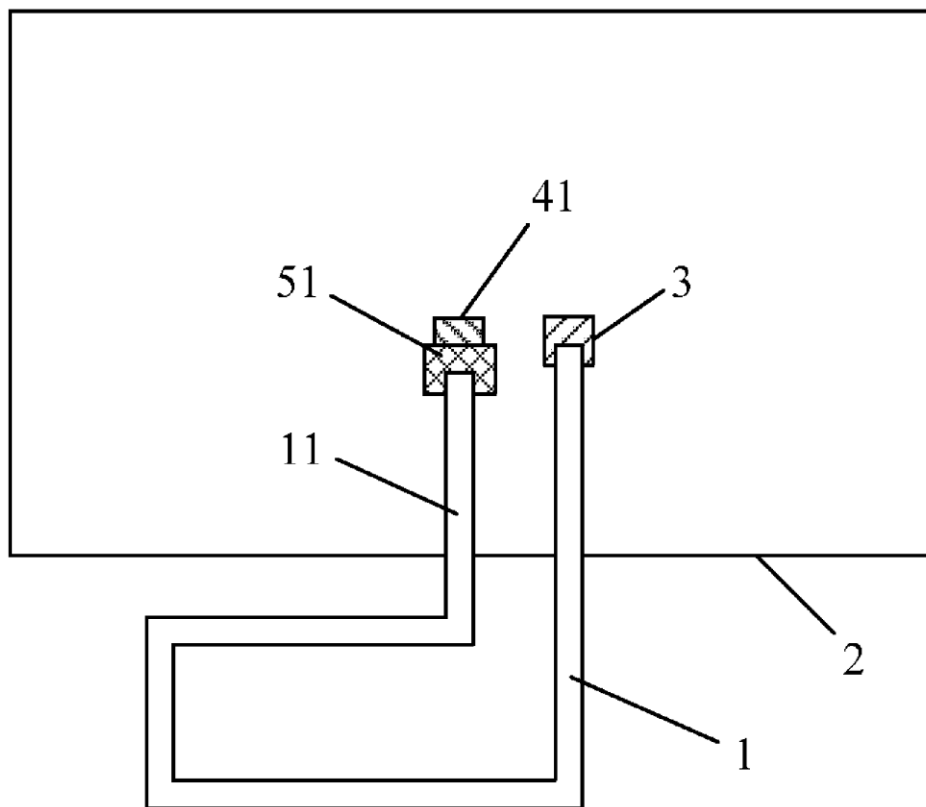
An antenna apparatus and a terminal device are provided, which relate to the field of communications technologies. A switch disposed at an end of an antenna arm controls an antenna to switch to different resonance frequencies, therefore reduced antenna efficiency caused by switch loss is avoided and space occupied by the antenna is not increased. The antenna apparatus includes an antenna and a printed circuit board, where a feedpoint and a first grounding point are disposed on the printed circuit board, the antenna is connected to the feedpoint, and the antenna includes a first arm.

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2014/071740, filed on Jan. 29, 2014.

Foreign Application Priority Data

(30) Feb. 4, 2013 (CN) 201310043758.9





US 20150341476A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0341476 A1**

(43) **Pub. Date: Nov. 26, 2015**

(54) **BAND WITH AN ANTENNA FOR USE WITH A WIRELESS ELECTRONIC DEVICE**

(21) Appl. No.: **14/758,993**

(22) PCT Filed: **Jan. 4, 2013**

(86) PCT No.: **PCT/US2013/020326**

§ 371 (c)(1),

(2) Date: **Jul. 2, 2015**

Publication Classification

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H04B 1/3827 (2006.01)

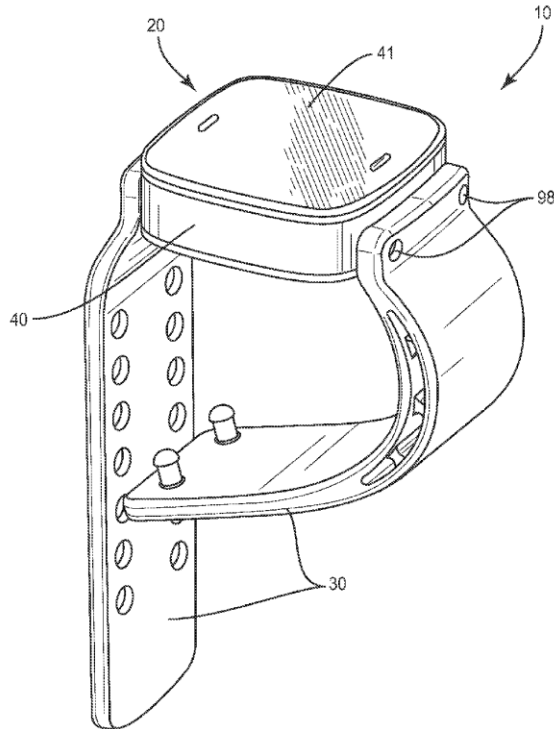
(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **H04B 1/385**
(2013.01); **H04B 2001/3861** (2013.01)

(71) Applicants: **Kenneth HOGUE**, Chapel Hill, NC (US); **Owen Lewis JOYCE**, Cary, NC (US); **Timothy NARCHUK**, Raleigh, NC (US); **Jeffrey LICK**, Raleigh, NC (US); **Torbjørn ANDERSSEN**, Oslo (NO); **Sten KIRKBAK**, Trondheim (NO); **Pål SELNÆS**, Morrisville, NC (US); **Anders BROMS**, Nacka Stockholm (SE); **Espen VOLL**, Oslo (NO); **William Herbert DARDEN, IV**, Cary, NC (US); **EVADO FILIP HOLDING LTD.**, London (GB)

(72) Inventors: **Kenneth Hogue**, Chapel Hill, NC (US); **Owen Lewis Joyce**, Cary, NC (US); **Timothy Bodnarchuk**, Raleigh, NC (US); **Jeffrey Lick**, Raleigh, NC (US); **Torbjørn Anderssen**, Oslo (NO); **Sten Kirkbak**, Trondheim (NO); **Pål Selnaes**, Morrisville, NC (US); **Anders Broms**, Nacka Stockholm (SE); **Espen Voll**, Oslo (NO); **William Herbert Darden, IV**, Cary, NC (US)

(57) **ABSTRACT**

An electronic device having a unique interface between the electronic circuitry of the device and an antenna that is external to the device and located in a band. The antenna functionality is achieved externally in the band and includes a conductive path from one or more components of the device to the antenna in the band. The conductive path may extend through an exterior housing of the device to electrically connect the one or more components and the antenna.





US 20150357703A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0357703 A1**

(43) **Pub. Date: Dec. 10, 2015**

(54) **MULTIBAND ANTENNAS FORMED FROM BEZEL BANDS WITH GAPS**

Publication Classification

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

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

(72) Inventors: **Joshua G. Nickel**, San Jose, CA (US);
Juan Zavala, Watsonville, CA (US);
Yijun Zhou, Sunnyvale, CA (US);
Mattia Pascolini, San Francisco, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Ruben Caballero, San Jose, CA (US)

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

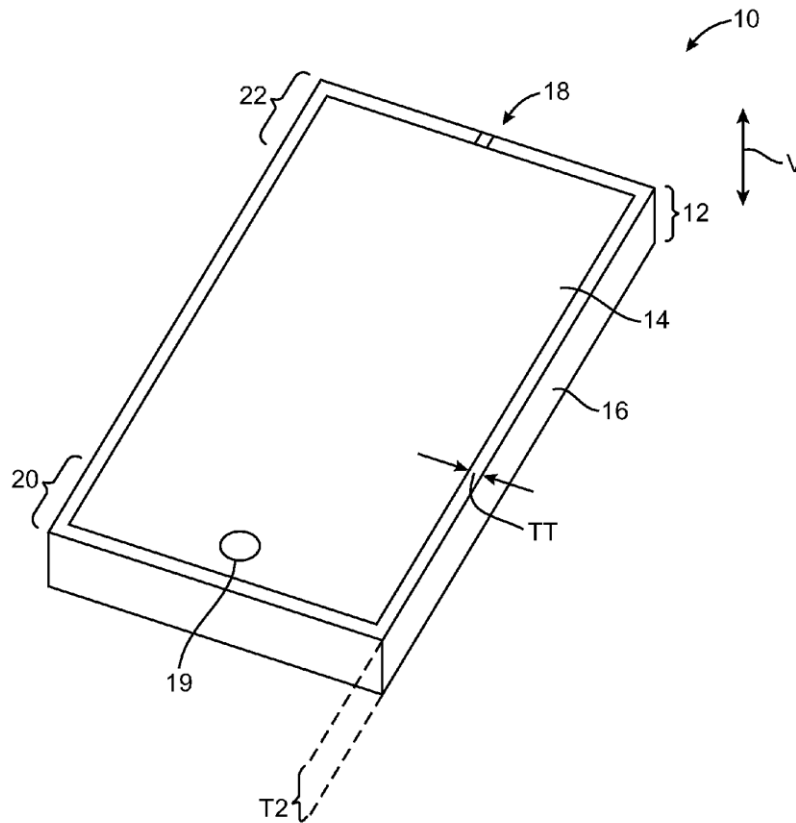
(57) **ABSTRACT**
Electronic devices are provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and antenna structures. An inverted-F antenna may have first and second short circuit legs and a feed leg. The first and second short circuit legs and the feed leg may be connected to a folded antenna resonating element arm. The antenna resonating element arm and the first short circuit leg may be formed from portions of a conductive electronic device bezel. The folded antenna resonating element arm may have a bend. The bezel may have a gap that is located at the bend. Part of the folded resonating element arm may be formed from a conductive trace on a dielectric member. A spring may be used in connecting the conductive trace to the electronic device bezel portion of the antenna resonating element arm.

(21) Appl. No.: **14/830,227**

(22) Filed: **Aug. 19, 2015**

Related U.S. Application Data

(63) Continuation of application No. 12/752,966, filed on Apr. 1, 2010, now Pat. No. 9,160,056.





US 20150357717A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0357717 A1**

(43) **Pub. Date: Dec. 10, 2015**

(54) **FLEXIBLE PLANAR INVERTED F ANTENNA**

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

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

(71) Applicant: **L.S. Research, LLC**, Cedarburg, WI (US)

(57) **ABSTRACT**

(72) Inventors: **Brian E. Petted**, Cedarburg, WI (US);
Mark R. Wolski, Mequon, WI (US)

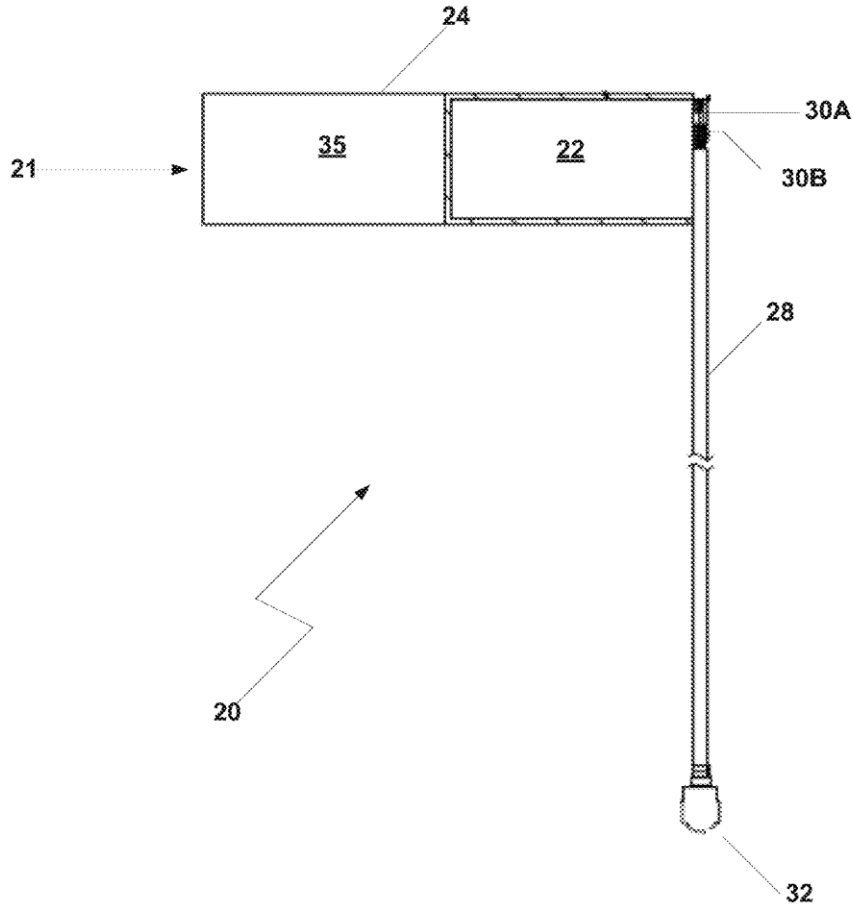
A flexible inverted "F" antenna (PIFA) is shown. The flexible PIFA is not only applicable to flat surfaces, but it can be applied to curved surfaces, both convex and concave, without degrading performance. The flexible PIFA can also be used close to living bodies or to a metal surface without detuning. The flexible PIFA is formed from a flexible printed circuit board (PCB) having a metal layer on one side and over which a cover layer is positioned. The flexible PCB is folded, on its reverse side, around a flexible dielectric element with the covered metal layer facing outward to form a metal conducting service, an impedance matching stub and a ground plate. An adhesive layer forms a portion of the ground plate that is not in contact with the dielectric element. This adhesive layer is applied against the desired surface. A coaxial cable is electrically coupled to corresponding feed and ground tabs at the short circuit plate portion of the flexible PIFA.

(21) Appl. No.: **14/298,200**

(22) Filed: **Jun. 6, 2014**

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)





US 20150364810A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0364810 A1**

(43) **Pub. Date: Dec. 17, 2015**

(54) **ANTENNA AND ELECTRONIC EQUIPMENT USING SAME**

(30) **Foreign Application Priority Data**

Jun. 11, 2014 (CN) 201410256780.6

(71) Applicant: **Xiaomi Inc.**, Beijing (CN)

Publication Classification

(72) Inventors: **Anna Xing Yan**, Beijing (CN);
Xiaodong Zhu, Beijing (CN);
Shengxiang Cheng, Beijing (CN)

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

(21) Appl. No.: **14/587,050**

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

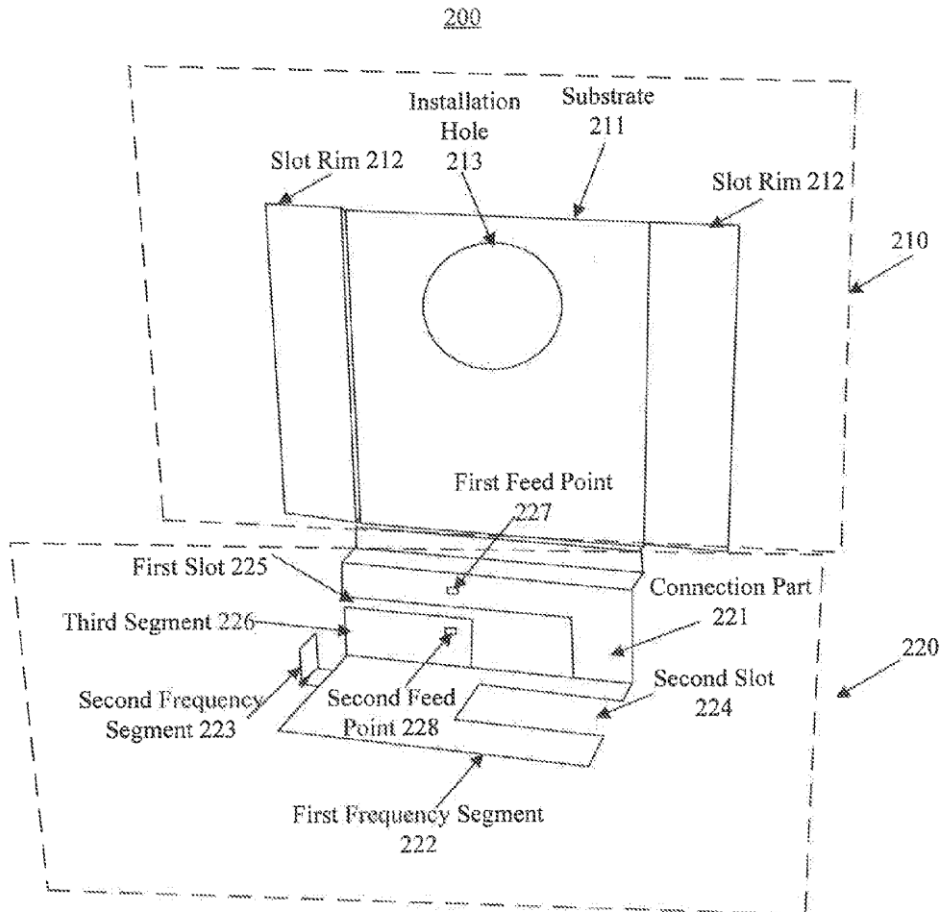
(22) Filed: **Dec. 31, 2014**

(57) **ABSTRACT**

An antenna component for use in an antenna of electronic equipment, includes: a fastening part configured to connect with a metal plate in the electronic equipment, to make the metal plate serve as a part of the antenna component; and a radiator part connected to the fastening part and configured to generate antenna resonances in at least one frequency band.

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2014/089295, filed on Oct. 23, 2014.





US 20150364812A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0364812 A1**

(43) **Pub. Date: Dec. 17, 2015**

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

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

(71) Applicant: **KING SLIDE TECHNOLOGY CO., LTD.**, Kaohsiung City (TW)

(57) **ABSTRACT**

(72) Inventors: **Hsin-Cheng Su**, Kaohsiung City (TW);
Chun-Ta Liu, Kaohsiung City (TW);
Shu-Chen Lin, Kaohsiung City (TW)

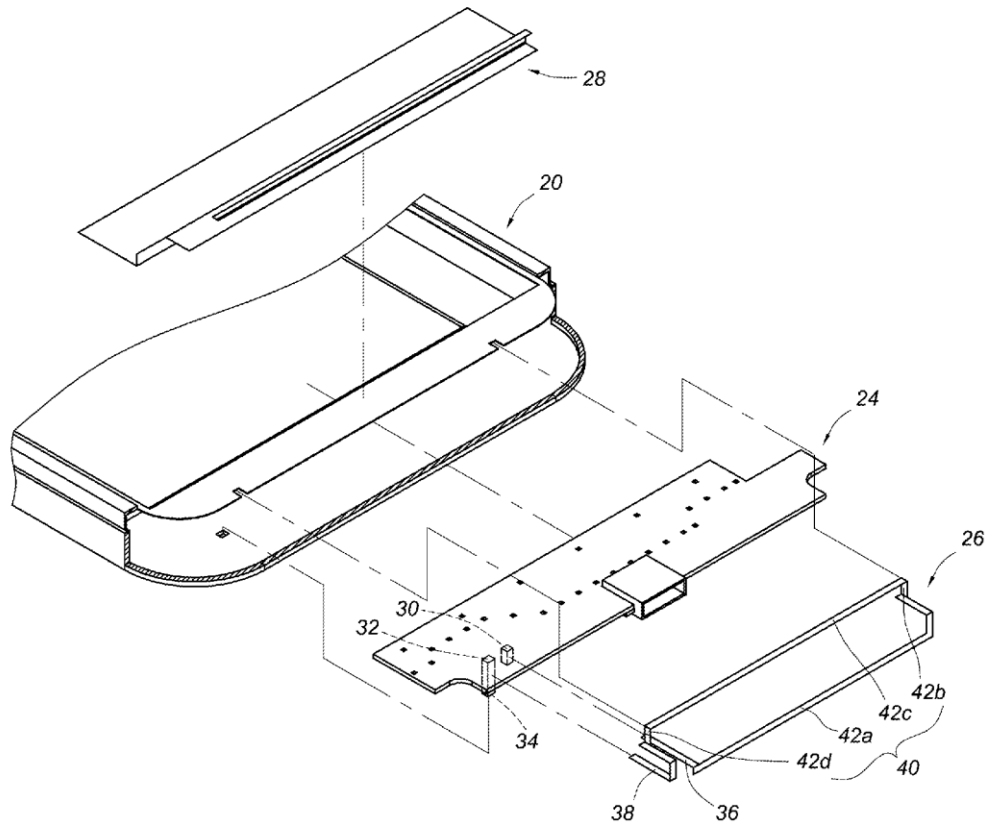
A communication device comprises a front housing, a back cover, a main body, a display panel, a signal feed point, a ground point, an antenna and a conductor. The main body is located between the front housing and the back cover. The antenna is installed on the main body and corresponding to an adjacent edge of the display panel. The antenna comprises a first metal part and a second metal part. The first metal part is coupled to the signal feed point, and the second metal part is coupled to the ground point. A coupling gap is defined between the conductor and the antenna, and at least one part of the conductor corresponds to the display panel.

(21) Appl. No.: **14/302,418**

(22) Filed: **Jun. 11, 2014**

Publication Classification

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





US 20150364813A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0364813 A1**

(43) **Pub. Date: Dec. 17, 2015**

(54) **ANTENNA HAVING FLEXIBLE FEED STRUCTURE WITH COMPONENTS**

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

CPC *H01Q 1/243* (2013.01); *H01Q 9/045* (2013.01); *H05K 1/028* (2013.01)

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

(72) Inventors: **Dean F. Darnell**, San Jose, CA (US);
William J. Noellert, Sunnyvale, CA (US);
Mattia Pascolini, San Francisco, CA (US)

(57) **ABSTRACT**

(21) Appl. No.: **14/825,011**

(22) Filed: **Aug. 12, 2015**

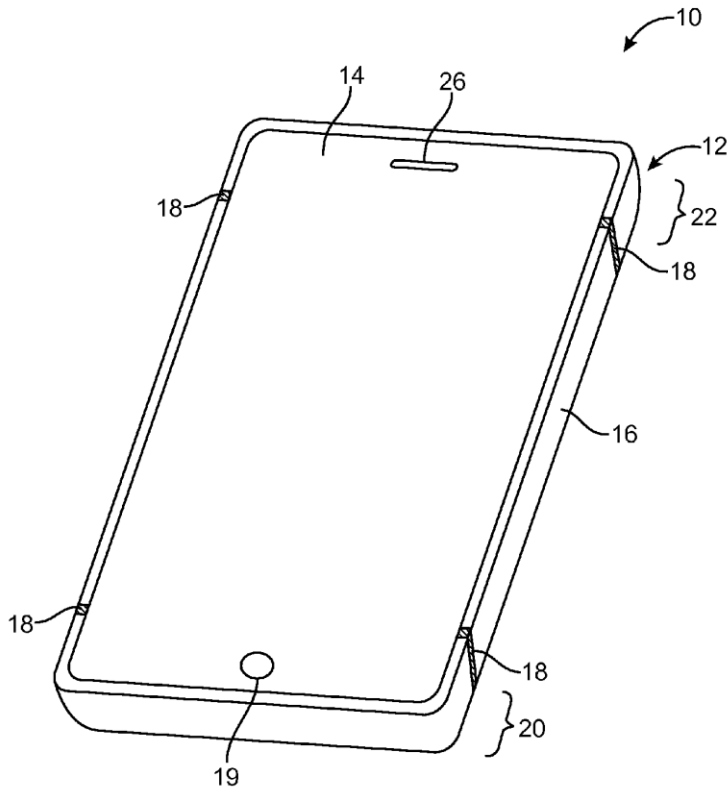
Related U.S. Application Data

(63) Continuation of application No. 14/486,602, filed on Sep. 15, 2014, which is a continuation of application No. 13/435,351, filed on Mar. 30, 2012, now Pat. No. 8,836,587.

Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H05K 1/02 (2006.01)
H01Q 9/04 (2006.01)

Electronic devices may include antenna structures. The antenna structures may form an antenna having first and second feeds at different locations. Transceiver circuitry for transmitting and receiving radio-frequency antenna signals may be mounted on one end of a printed circuit board. Transmission line structures may be used to convey signals between an opposing end of the printed circuit board and the transceiver circuitry. The printed circuit board may be coupled to an antenna feed structure formed from a flexible printed circuit using solder connections. The flexible printed circuit may have a bend and may be screwed to conductive electronic device housing structures using one or more screws at one or more respective antenna feed terminals. Electrical components such as an amplifier circuit and filter circuitry may be mounted on the flexible printed circuit.





US 20150364820A1

(19) **United States**

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

(10) **Pub. No.: US 2015/0364820 A1**

(43) **Pub. Date: Dec. 17, 2015**

(54) **MULTIBAND ANTENNA APPARATUS AND METHODS**

(52) **U.S. Cl.**
CPC . *H01Q 5/30* (2015.01); *H01Q 5/20* (2015.01);
H01Q 5/10 (2015.01)

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

(72) Inventors: **Yuandan Dong**, San Diego, CA (US);
Jatupum Jenwatanavet, San Diego, CA (US);
Allen Minh-Triet Tran, San Diego, CA (US)

(57) **ABSTRACT**

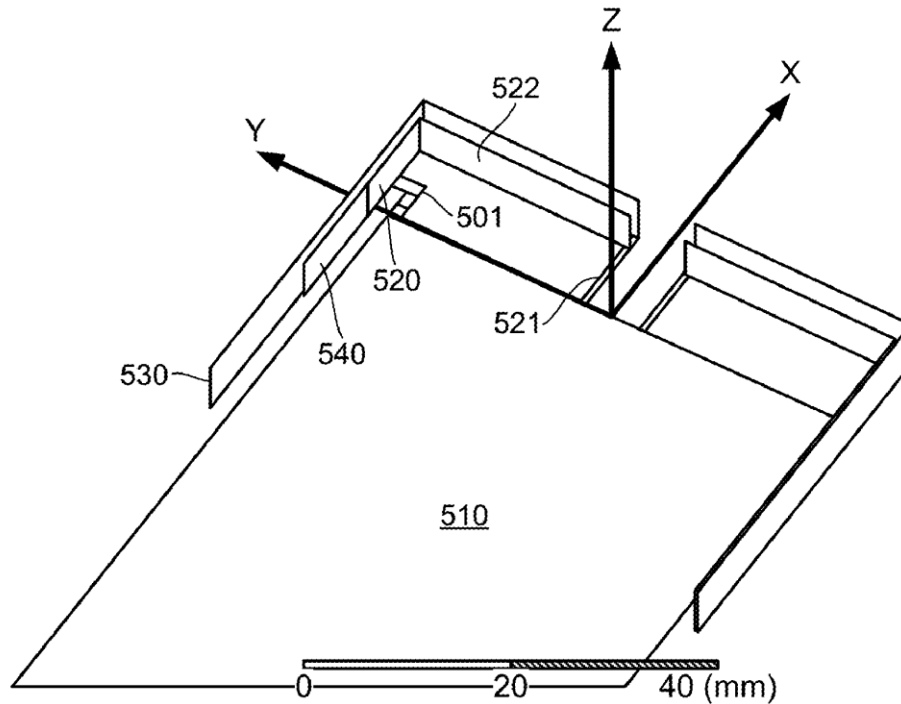
The present disclosure includes multiband antenna apparatus and methods. In one embodiment, an antenna includes a loop antenna having a first corner between a first side and a second side and a second corner between the second side and a third side, a loop fed inverted F antenna comprising the loop antenna and a first arm extending from the second corner of the loop antenna, the first arm configured in parallel with the first and second sides of the loop antenna and forming a corner proximate to the first corner of the loop antenna, and a monopole antenna coupled to the first side of the loop antenna.

(21) Appl. No.: **14/303,840**

(22) Filed: **Jun. 13, 2014**

Publication Classification

(51) **Int. Cl.**
H01Q 5/30 (2006.01)
H01Q 5/10 (2006.01)
H01Q 5/20 (2006.01)





US 20150364825A1

(19) **United States**

(12) **Patent Application Publication**
CHANG

(10) **Pub. No.: US 2015/0364825 A1**

(43) **Pub. Date: Dec. 17, 2015**

(54) **DUAL-BAND THREE-DIMENSIONAL ANTENNA**

Publication Classification

(71) Applicant: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu City (TW)

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

(72) Inventor: **JING-TENG CHANG**, Hsinchu County (TW)

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 5/371** (2015.01)

(21) Appl. No.: **14/325,819**

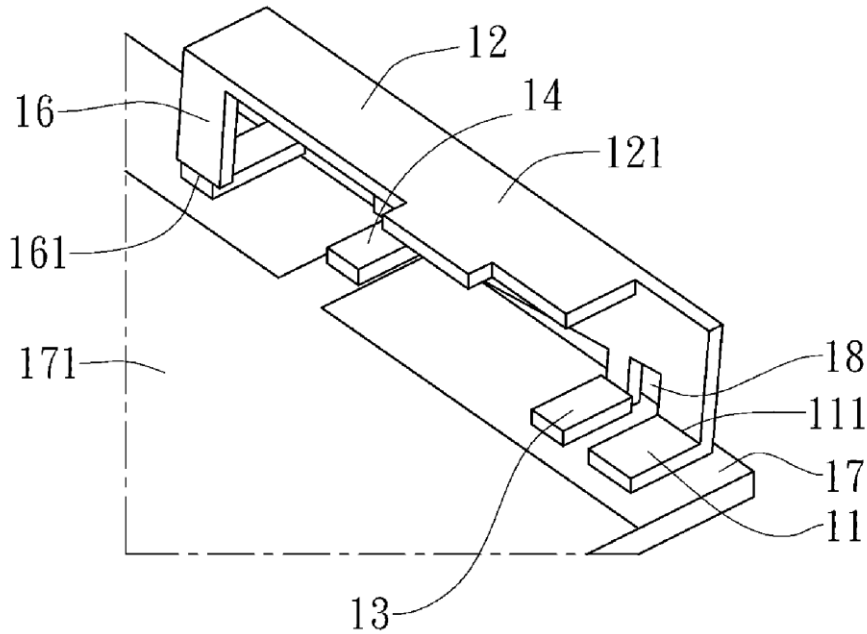
(57) **ABSTRACT**

(22) Filed: **Jul. 8, 2014**

A dual-band three-dimensional (3D) antenna is disclosed, which comprises: a first radiation unit; a resonant extension unit, being disposed not on the same plane with the first radiation unit; a feeder unit, coupled to the first radiation unit while allowing an opening to be formed at a position between the feeder unit and the first radiation unit; a connection unit, coupled to a substrate and the feeder unit while allowing an obliquely extending unit to be formed at a position between the connection unit and the feeder unit; and a second radiation unit, coupled to the resonant extension unit.

(30) **Foreign Application Priority Data**

Jun. 16, 2014 (TW) 103120748





US 20150366002A1

(19) **United States**

(12) **Patent Application Publication**
CHIU

(10) **Pub. No.: US 2015/0366002 A1**

(43) **Pub. Date: Dec. 17, 2015**

(54) **ANTENNA STRUCTURE, COMMUNICATION APPARATUS AND ELECTRONIC EQUIPMENT**

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

CPC *H04W 88/06* (2013.01); *H04B 1/40* (2013.01); *H01Q 9/04* (2013.01)

(71) Applicant: **Sony Corporation**, Toyko (JP)

(57) **ABSTRACT**

(72) Inventor: **Chi-Yuk CHIU**, Hong Kong (HK)

Embodiments of the present application provide an antenna structure, communication apparatus and electronic equipment. The antenna structure includes a first antenna and a second antenna configured to perform first network communication; wherein the antenna structure further includes a third antenna located between the first antenna and the second antenna and configured to perform second network communication, the third antenna being connected to a communication module of the second network. By providing the third antenna configured to perform the second network communication between the first antenna and the second antenna configured to perform the first network communication, the correlation between the first antenna and the second antenna may be reduced, and the second network communication may be performed.

(21) Appl. No.: **14/585,284**

(22) Filed: **Dec. 30, 2014**

(30) **Foreign Application Priority Data**

Jun. 12, 2014 (CN) 201410260704.2

Publication Classification

(51) **Int. Cl.**

H04W 88/06 (2006.01)
H01Q 9/04 (2006.01)
H04B 1/40 (2006.01)

