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

(57) An antenna assembly and an electronic device are provided in the present disclosure. The antenna assembly includes a first antenna and a second antenna. The first antenna includes a first radiator, a first signal-source, and a first frequency-selective filter circuit. The second antenna includes a second radiator, a second signal-source, and a second frequency-selective filter circuit. The first radiator is spaced apart and coupled with the second radiator. The first signal-source is electrically connected to the first radiator through the first frequency-selective filter circuit. The second signal-source is electrically connected to the second radiator through the second frequency-selective filter circuit. The first antenna is configured to generate at least one resonant mode. The second antenna is configured to generate at least two resonant modes. The at least two resonant modes of the second antenna are configured to cover reception and transmission of an electromagnetic wave signal in a first band, an electromagnetic wave signal in a second band, and an electromagnetic wave signal in a third band. At least one of the at least two resonant modes of resonant modes of the second antenna is excited by a capacitive coupling feed between the first antenna and the second antenna. The antenna as-

sembly in the present disclosure has a relatively great communication effect.

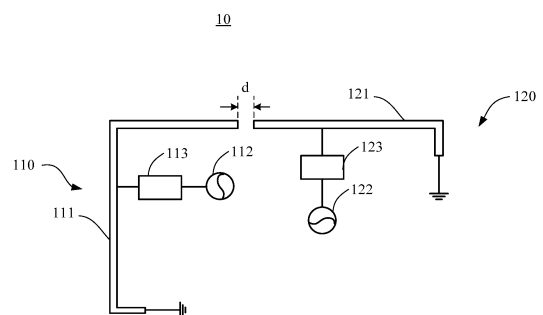


FIG. 1

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Description

TECHNICAL FIELD

[0001] This disclosure relates to the field of communication technology, and in particular to an antenna assembly and an electronic device.

BACKGROUND

[0002] With development of technologies, electronic devices such as mobile phones that have communication functions become more and more popular, and functions of the electronic devices become more and more powerful. An electronic device generally includes an antenna assembly to realize a communication function of the electronic device. However, in the related art, a communication performance of the antenna assembly in the electronic device is not good enough, and there is still a space for improvement.

SUMMARY

[0003] In a first aspect, an antenna assembly is provided in the present disclosure. The antenna assembly includes a first antenna and a second antenna. The first antenna includes a first radiator, a first signal-source, and a first frequency-selective filter circuit. The second antenna includes a second radiator, a second signal-source, and a second frequency-selective filter circuit. The first radiator is spaced apart from and coupled with the second radiator. One end of the first radiator away from the second radiator is grounded. The first signal-source is electrically connected to the first radiator through the first frequency-selective filter circuit. One end of the second radiator away from the first radiator is grounded. The second signal-source is electrically connected to the second radiator through the second frequency-selective filter circuit. The first antenna is configured to generate at least one resonant mode. The second antenna is configured to generate at least two resonant modes. The at least two resonant modes of the second antenna are configured to cover reception and transmission of an electromagnetic wave signal in a first band, an electromagnetic wave signal in a second band, and an electromagnetic wave signal in a third band. At least one of the at least two resonant modes of the second antenna is excited by a capacitive coupling feed between the first antenna and the second antenna.

[0004] In a second aspect, an electronic device is further provided in the present disclosure. The electronic device includes the antenna assembly in the first aspect.

[0005] The second antenna in the antenna assembly provided in the present disclosure cannot only receive and transmit the electromagnetic wave signal in the first band, but also receive and transmit at least one of the electromagnetic wave signal in the second band and the electromagnetic wave signal in the third band, such that

the antenna assembly has a relatively great communication effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In order to explain technical solutions in implementations of the present disclosure more clearly, the following will give a brief introduction to the accompanying drawings required for describing the implementations. Apparently, the accompanying drawings in the following description illustrate some implementations of the present disclosure. For those of ordinary skill in the art, other accompanying drawings can be obtained according to these accompanying drawings without creative efforts.

FIG. 1 is a schematic diagram of an antenna assembly provided in an implementation of the present disclosure.

FIG. 2 is a schematic diagram of an antenna assembly provided in an implementation corresponding to FIG. 1.

FIG. 3-FIG. 10 are schematic diagrams of frequency-selective filter sub-circuits provided in various implementations.

FIG. 11 is a schematic diagram of an antenna assembly provided in another implementation of the present disclosure.

FIG. 12 is a schematic diagram of an antenna assembly provided in yet another implementation of the present disclosure.

FIG. 13 is a schematic diagram of an antenna assembly provided in yet another implementation of the present disclosure.

FIG. 14 is a schematic diagram of a return loss (RL) curve of a first antenna and a RL curve of a second antenna in an antenna assembly in an implementation.

FIG. 15 is a schematic diagram illustrating a main distribution of a current in mode a.

FIG. 16 is a schematic diagram illustrating a main distribution of a current in mode b.

FIG. 17 is a schematic diagram illustrating a main distribution of a current in mode c.

FIG. 18 is a schematic diagram illustrating a main distribution of a current in mode d.

FIG. 19 is a schematic diagram illustrating a main distribution of a current in mode e.

FIG. 20 is a schematic diagram illustrating a main distribution of a current in mode f.

FIG. 21 is a structural perspective diagram of an electronic device provided in an implementation of the present disclosure.

FIG. 22 is a cross-sectional diagram of the electronic device of FIG. 21 provided in an implementation, taken along line I-I.

FIG. 23 is a top diagram of a metal frame in an implementation of the present disclosure.

FIG. 24 is a top diagram of a metal frame in another implementation of the present disclosure.

FIG. 25 is a schematic diagram of a position of a first radiator and a position of a second radiator in an electronic device in an implementation.

FIG. 26 is a schematic diagram of a position of a first radiator and a position of a second radiator in an electronic device in another implementation.

DETAILED DESCRIPTION

[0007] In a first aspect, an antenna assembly is provided in implementations of the present disclosure. The antenna assembly includes a first antenna and a second antenna. The first antenna includes a first radiator, a first signal-source, and a first frequency-selective filter circuit. The second antenna includes a second radiator, a second signal-source, and a second frequency-selective filter circuit. The first radiator is spaced apart from and coupled with the second radiator. One end of the first radiator away from the second radiator is grounded. The first signal-source is electrically connected to the first radiator through the first frequency-selective filter circuit. One end of the second radiator away from the first radiator is grounded. The second signal-source is electrically connected to the second radiator through the second frequency-selective filter circuit. The first antenna is configured to generate at least one resonant mode. The second antenna is configured to generate at least two resonant modes. The at least two resonant modes of the second antenna are configured to cover reception and transmission of an electromagnetic wave signal in a first band, an electromagnetic wave signal in a second band, and an electromagnetic wave signal in a third band. At least one of the at least two resonant modes of the second antenna is excited by a capacitive coupling feed between the first antenna and the second antenna.

[0008] In implementations, the first antenna is operable in a first resonant mode, a second resonant mode, and a third resonant mode. The second antenna is operable in a fourth resonant mode, a fifth resonant mode, and a sixth resonant mode. The first resonant mode, the second resonant mode, the third resonant mode, the fourth resonant mode, the fifth resonant mode, and the sixth resonant mode are configured to cover reception and transmission of an electromagnetic wave signal in a middle high band (MHB) and an electromagnetic wave signal in an ultra high band (UHB).

[0009] In implementations, the first frequency-selective filter circuit and the second frequency-selective filter circuit are configured to adjust a resonant frequency of the first antenna according to a first preset frequency-selective parameter, to make the first antenna resonate in the first resonant mode, the second resonant mode, or the third resonant mode. The first antenna is configured to receive and transmit an electromagnetic wave signal in a fourth band in the first resonant mode, receive and transmit an electromagnetic wave signal in a fifth

band in the second resonant mode, and receive and transmit an electromagnetic wave signal in a sixth band and an electromagnetic wave signal in a seventh band in the third resonant mode.

[0010] In implementations, the first radiator includes a first sub-radiator, a second sub-radiator, and a third sub-radiator that are bent and connected sequentially. The first sub-radiator and the third sub-radiator are located at a same side of the second sub-radiator. The first sub-radiator has a first ground end that is away from the second sub-radiator and grounded. The second sub-radiator has a first feeding point electrically connected with the first frequency-selective filter circuit. The third sub-radiator has a first free end that is away from the second sub-radiator and adjacent to the second radiator.

[0011] In implementations, when the first antenna resonates in the first resonant mode, a current in the first radiator flows from the first ground end to the first feeding point and the first free end in sequence. When the first antenna resonates in the second resonant mode, the current in the first radiator flows from the first feeding point to a connection point of the second sub-radiator and the third sub-radiator and the first free end in sequence. When the first antenna resonates in the third resonant mode, the current in the first antenna includes a first sub-current and a second sub-current, the first sub-current flows from the first ground end to the first feeding point, and the second sub-current flows from the first free end to the first feeding point.

[0012] In implementations, the fourth band includes a global positioning system L1 (GPS-L1) band, the fifth band includes a long-term evolution (LTE) MHB, the sixth band includes a wireless fidelity (WIFI) 2.4G band, and the seventh band includes a N41 band.

[0013] In implementations, the first frequency-selective filter circuit and the second frequency-selective filter circuit are configured to adjust a resonant frequency of the second antenna according to a second preset frequency-selective parameter, to make the second antenna resonate in the fourth resonant mode, the fifth resonant mode, or the sixth resonant mode. The second antenna is configured to receive and transmit an electromagnetic wave signal in the first band in the fourth resonant mode, receive and transmit an electromagnetic wave signal in the second band and an electromagnetic wave signal in the third band in the fifth resonant mode, and receive and transmit an electromagnetic wave signal in an eighth band in the sixth resonant mode.

[0014] In implementations, the second radiator includes a fourth sub-radiator and a fifth sub-radiator that are bent and connected. The fourth sub-radiator has a second free end that is away from the fifth sub-radiator and is spaced apart from the first antenna. The fifth sub-radiator has a second feeding point electrically connected with the second frequency-selective filter circuit. The fifth sub-radiator has a second ground end that is away from the fourth sub-radiator and grounded.

[0015] In implementations, when the second antenna

resonates in the fourth resonant mode, a current in the second radiator flows from the second free end to the second ground end, and further flows from the second feeding point to the second ground end. When the second antenna resonates in the fifth resonant mode, the current in the second radiator flows from the second ground end to the second free end. When the second antenna resonates in the sixth resonant mode, the current in the second radiator flows from the second feeding point to the second free end.

[0016] In implementations, the first band includes a N78 band, the second band includes a N77 band, the third band includes a N79 band, and the eighth band includes a WIFI 5G band.

[0017] In implementations, the first radiator includes a first sub-radiator and a second sub-radiator that are bent and connected. The first sub-radiator has a first ground end that is away from the second sub-radiator and grounded. The second sub-radiator has a first free end that is away from the first sub-radiator and adjacent to the second radiator. The second sub-radiator has a first feeding point electrically connected with the first frequency-selective filter circuit. The second radiator includes a third sub-radiator and a fourth sub-radiator that are bent and connected. The third sub-radiator has a second free end that is away from the fourth sub-radiator and spaced apart from the first free end. The third sub-radiator has a second feeding point electrically connected with the second frequency-selective filter circuit. The fourth sub-radiator has a second ground end that is away from the third sub-radiator and grounded.

[0018] In implementations, a dimension d of a gap between the first radiator and the second radiator meets: $0.5\text{mm} \leq d \leq 1.5\text{mm}$.

[0019] In implementations, the first frequency-selective filter circuit includes one or more frequency-selective filter sub-circuits. The second frequency-selective filter circuit includes one or more frequency-selective filter sub-circuits. The one or more frequency-selective filter sub-circuits are further configured to isolate the first antenna from the second antenna.

[0020] In implementations, the one or more frequency-selective filter sub-circuits each include one or more of following circuits. A band-pass circuit includes an inductor and a capacitor which are connected in series. A band-stop circuit includes an inductor and a capacitor which are connected in parallel. A circuit includes an inductor, a first capacitor, and a second capacitor, where the inductor is connected with the first capacitor in parallel, and the second capacitor is electrically connected with a node where the inductor is electrically connected with the first capacitor. A circuit includes a capacitor, a first inductor, and a second inductor, where the capacitor is connected with the first inductor in parallel, and the second inductor is electrically connected with a node where the capacitor is electrically connected with the first inductor. A circuit includes an inductor, a first capacitor, and a second capacitor, where the inductor is connected with the first ca-

pacitor in series, one end of the second capacitor is electrically connected with a first end of the inductor that is not connected with the first capacitor, and another end of the second capacitor is electrically connected with one end of the first capacitor which is not connected with the inductor. A circuit includes a capacitor, a first inductor, and a second inductor, where the capacitor is connected with the first inductor in series, one end of the second inductor is electrically connected with one end of the capacitor which is not connected with the first inductor, and another end of the second inductor is electrically connected with one end of the first inductor which is not connected with the capacitor. A circuit includes a first capacitor, a second capacitor, a first inductor, and a second inductor, where the first capacitor is connected with the first inductor in parallel, the second capacitor is connected with the second inductor in parallel, and one end of the second capacitor and the second inductor that are connected in parallel is electrically connected with one end of the first capacitor and the first inductor that are connected in parallel. A circuit includes a first capacitor, a second capacitor, a first inductor, and a second inductor, where the first capacitor and the first inductor are connected in series to define a first unit, the second capacitor and the second inductor are connected in series to define a second unit, and the first unit is connected with the second unit in parallel.

[0021] In implementations, an excitation signal generated by the second signal-source passes through the second frequency-selective filter circuit and is fed to the second radiator through capacitive coupling.

[0022] In a second aspect, an electronic device is provided in implementations of the present disclosure. The electronic device includes the antenna assembly of any of implementations in the first aspect.

[0023] In implementations, the electronic device further includes a metal frame. The metal frame includes a frame body, a first metal section, and a second metal section. The first metal section is spaced apart from the second metal section. A gap is defined between the first metal section and the frame body. A gap is defined between the second metal section and the frame body. One end of the first metal section away from the second metal section is connected with the frame body. One end of the second metal section away from the first metal section is connected with the frame body. The first radiator includes the first metal section. The second radiator includes the second metal section.

[0024] In implementations, the metal frame includes an edge frame. The edge frame is connected around a periphery of the frame body in a bent manner. The first metal section and the second metal section are formed on the edge frame.

[0025] In implementations, the electronic device further includes a ground system. The ground system includes one or more of a middle frame, a circuit board, and a display screen. One end of the first radiator away from the second radiator is electrically connected with

the ground system to be grounded. One end of the second radiator away from the first radiator is electrically connected with the ground system to be grounded.

[0026] In implementations, the electronic device has a top and a bottom. The first radiator and the second radiator are disposed on the top.

[0027] The following will describe technical solutions in implementations of the present disclosure clearly and completely with reference to the accompanying drawings in implementations of the present disclosure. Apparently, implementations described herein are merely some implementations, rather than all implementations, of the present disclosure. Based on implementations described herein, all other implementations obtained by those of ordinary skill in the art without creative effort shall fall within the protection scope of the present disclosure.

[0028] The term "implementation" referred to herein means that a particular feature, structure, or characteristic described in conjunction with the embodiment or implementation may be contained in at least one implementation of the present disclosure. The phrase "implementation" appearing in various places in the specification does not necessarily refer to the same implementation, nor does it refer to an independent or alternative embodiment that is mutually exclusive with other implementations. It is expressly and implicitly understood by those skilled in the art that implementations described herein may be combined with other implementations.

[0029] An antenna assembly 10 is provided in the present disclosure. The antenna assembly 10 can be applied to an electronic device 1. The electronic device 1 includes, but not limited to, electronic devices 1 having communication functions, such as a mobile phone, a mobile internet device (MID), an electronic book, a play station portable (PSP), or a personal digital assistant (PDA).

[0030] Reference can be made to FIG. 1, which is a schematic diagram of an antenna assembly provided in an implementation of the present disclosure. The antenna assembly 10 includes a first antenna 110 and a second antenna 120. The first antenna 110 includes a first radiator 111, a first signal-source 112, and a first frequency-selective filter circuit 113. The second antenna 120 includes a second radiator 121, a second signal-source 122, and a second frequency-selective filter circuit 123. The first radiator 111 is spaced apart from and coupled with the second radiator 121. One end of the first radiator 111 away from the second radiator 121 is grounded. The first signal-source 112 is electrically connected to the first radiator 111 through the first frequency-selective filter circuit 113. One end of the second radiator 121 away from the first radiator 111 is grounded. The second signal-source 122 is electrically connected to the second radiator 121 through the second frequency-selective filter circuit 123. The first antenna 110 is configured to generate at least one resonant mode. The second antenna 120 is configured to generate at least two resonant modes. The at least two resonant modes of the second antenna 120 are configured to cover reception and transmission of an

electromagnetic wave signal in a first band, an electromagnetic wave signal in a second band, and an electromagnetic wave signal in a third band. At least one of the at least two resonant modes of the second antenna 120 is excited by a capacitive coupling feed between the first antenna 110 and the second antenna 120.

[0031] In addition, it should be noted that the terms such as "first", "second", etc., in the specification, the claims, and the above accompanying drawings of the present disclosure are used to distinguish different objects, rather than describing a particular order. Furthermore, the terms "including", "comprising", and "having" as well as variations thereof are intended to cover non-exclusive inclusion.

[0032] Resonant modes of the first antenna 110 and the second antenna 120 will be described below with reference to FIG. 14 and FIG. 15-FIG. 20. The first antenna 110 is operable in a first resonant mode, a second resonant mode, and a third resonant mode. The second antenna 120 is operable in a fourth resonant mode, a fifth resonant mode, and a sixth resonant mode. The first resonant mode, the second resonant mode, the third resonant mode, the fourth resonant mode, the fifth resonant mode, and the sixth resonant mode are configured cover reception and transmission of an electromagnetic wave signal in a MHB and an electromagnetic wave signal in an UHB. The resonant modes here are also called a resonant mode. The MHB ranges from 1000MHz to 3000MHz. The UHB ranges from 3000MHz to 6000MHz.

[0033] The first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 are configured to adjust a resonant frequency of the first antenna 110 according to a first preset frequency-selective parameter, to make the first antenna 110 resonate in the first resonant mode, the second resonant mode, or the third resonant mode. The first antenna 110 is configured to receive and transmit an electromagnetic wave signal in a fourth band in the first resonant mode. The first antenna 110 is configured to receive and transmit an electromagnetic wave signal in a fifth band in the second resonant mode. The first antenna 110 is configured to receive and transmit an electromagnetic wave signal in a sixth band and an electromagnetic wave signal in a seventh band in the third resonant mode.

[0034] In an implementation, the first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 are configured to adjust a resonant frequency of the second antenna 120 according to a second preset frequency-selective parameter, to make the second antenna 120 resonate in the fourth resonant mode, the fifth resonant mode, or the sixth resonant mode. The second antenna 120 is configured to receive and transmit an electromagnetic wave signal in the first band in the fourth resonant mode. The second antenna 120 is configured to receive and transmit an electromagnetic wave signal in the second band and an electromagnetic wave signal in the third band in the fifth resonant mode. The second antenna 120 is configured to receive and transmit

an electromagnetic wave signal in an eighth band in the sixth resonant mode.

[0035] In this implementation, the first band includes a N78 band (3.3GHz~3.8GHz), the second band includes a N77 band (3.3GHz~4.2GHz), the third band includes a N79 band (4.4GHz~5.0GHz), and the eighth band includes a WIFI 5G band (5.725GHz~5.825GHz). The fourth band includes a GPS-L1 band, the fifth band includes an LTE MHB, the sixth band includes a WIFI 2.4G band, and the seventh band includes a N41 band (2496MHz-2690MHz).

[0036] The first radiator 111 is a flexible circuit board (FPC) antenna radiator, a laser direct structuring (LDS) antenna radiator, a print direct structuring (PDS) antenna radiator, or a metal branch. The second radiator 121 is the FPC antenna radiator, the LDS antenna radiator, the PDS antenna radiator, or the metal branch.

[0037] When the first signal-source 112 is directly electrically connected with the first radiator 111, and the second signal-source 122 is directly electrically connected with the second radiator 121, the second antenna 120 is able to receive and transmit the electromagnetic wave signal in the first band, but is unable to receive and transmit the electromagnetic wave signal in the second band and the electromagnetic wave signal in the third band. When the first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 are disposed additionally, the first signal-source 112 is electrically connected to the first radiator 111 through the first frequency-selective filter circuit 113, and the second signal-source 122 is electrically connected to the second radiator 121 through the second frequency-selective filter circuit 123. By setting frequency-selective parameters (including a resistance, an inductance, and a capacitance) of the first frequency-selective filter circuit 113 and frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the second frequency-selective filter circuit 123, the second antenna 120 is able to receive and transmit the electromagnetic wave signal in the first band, and is able to receive and transmit an electromagnetic wave signal in at least one of the second band and the third band. A specific circuit form of the first frequency-selective filter circuit 113 and a specific circuit form of the second frequency-selective filter circuit 123 will be introduced later. The first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 may also be called matching circuits.

[0038] As mentioned above, the first signal-source 112 is electrically connected to the first radiator 111 through the first frequency-selective filter circuit 113, which means that the first signal-source 112 is electrically connected with an input end of the first frequency-selective filter circuit 113 and an output end of the first frequency-selective filter circuit 113 is electrically connected with the first radiator 111. The second signal-source 122 is electrically connected to the second radiator 121 through the second frequency-selective filter circuit 123, which

means that the second signal-source 122 is electrically connected with an input end of the second frequency-selective filter circuit 123 and an output end of the second frequency-selective filter circuit 123 is electrically connected with the second radiator 121.

[0039] The first signal-source 112 is configured to generate a first excitation signal. The first excitation signal is loaded on the first radiator 111 through the first frequency-selective filter circuit 113, such that the first radiator 111 is configured to radiate an electromagnetic wave signal. The second signal-source 122 is configured to generate a second excitation signal. The second excitation signal is loaded on the second radiator 121 through the second frequency-selective filter circuit 123, such that the second radiator 121 is configured to radiate an electromagnetic wave signal. The first radiator 111 is spaced apart from and coupled with the second radiator 121, that is, the first radiator 111 and the second radiator 121 have the same aperture. When the antenna assembly 10 operates, the second excitation signal generated by the second signal-source 122 can be coupled to the first radiator 111 through the second radiator 121. In other words, when the second antenna 120 operates, not only can the second radiator 121 be used to receive and transmit an electromagnetic wave signal, but also the first radiator 111 of the first antenna 110 can be used to receive and transmit an electromagnetic wave signal, such that the second antenna 120 can operate in a relatively wide band. In the same way, the first radiator 111 is spaced apart from and coupled with the second radiator 121, and when the antenna assembly 10 operates, the first excitation signal generated by the first signal-source 112 can also be coupled to the second radiator 121 via the first radiator 111. In other words, when the first antenna 110 operates, not only can the first radiator 111 be used to receive and transmit the electromagnetic wave signal, but also the second radiator 121 of the second antenna 120 can be used to receive and transmit the electromagnetic wave signal, such that the first antenna 110 can operate in a relatively wide band. Not only can the first radiator 111 be used but also the second radiator 121 can be used when the first antenna 110 operates, and not only can the second radiator 121 be used but also the first radiator 111 can be used when the second antenna 120 operates, such that reuse of radiators and reuse of space can be realized, which is beneficial to reducing a size of the antenna assembly 10.

[0040] In the related art, the second antenna 120 is only able to receive and transmit the electromagnetic wave signal in the first band, but is unable to receive and transmit the electromagnetic wave signal in the second band or the electromagnetic wave signal in the third band. If reception and transmission of the electromagnetic wave signal in the second band need to be supported, an antenna needs to be disposed additionally to support the reception and transmission of the electromagnetic wave signal in the second band. If reception and transmission of the electromagnetic wave signal in the third

band need to be supported, an antenna needs to be disposed additionally to support the reception and transmission of the electromagnetic wave signal in the third band. It can be seen that in the related art, more antennas need to be disposed to support reception and transmission of the electromagnetic wave signal in the first band, the electromagnetic wave signal in the second band, and the electromagnetic wave signal in the third band, thereby resulting in a relatively large volume of the antenna assembly 10. In implementations, the antenna assembly 10 does not need to be additionally provided with antennas to support reception and transmission of the electromagnetic wave signal in the second band and the electromagnetic wave signal in the third band, such that the antenna assembly 10 has a relatively small volume. Costs of the antenna assembly 10 may also be relatively high by additionally disposing the antenna to support the reception and transmission of the electromagnetic wave signal in the second band and additionally disposing the antenna to support the reception and transmission of the electromagnetic wave signal in the third band. When the antenna assembly 10 is applied to the electronic device 1, a stacking difficulty of the antenna assembly 10 and other components is increased. In implementations, the antenna assembly does not need to be provided with the additional antennas to support the reception and transmission of the electromagnetic wave signal in the second band and the electromagnetic wave signal in the third band, such that the costs of the antenna assembly 10 are relatively low, and when the antenna assembly is applied to the electronic device 1, the stacking difficulty is relatively low. In addition, insertion loss of radio frequency links of the antenna assembly 10 may also be increased by additionally disposing the antenna to support the reception and transmission of the electromagnetic wave signal in the second band and additionally providing the antenna to support the reception and transmission of the electromagnetic wave signal in the third band. In the present disclosure, the second antenna 120 is able to receive and transmit the electromagnetic wave signal in the first band, and the electromagnetic wave signal in at least one of the second band and the third band, such that the insertion loss of the radio frequency links can be reduced.

[0041] When the antenna assembly 10 is applied to the electronic device 1 (reference can be made to FIG. 21 and FIG. 22), the first signal-source 112 may be disposed on a circuit board 50 (reference can be made to FIG. 21 and FIG. 22) in the electronic device 1. The second signal-source 122 may also be disposed on the circuit board 50 in the electronic device 1. The first frequency-selective filter circuit 113 may be disposed on the circuit board 50 in the electronic device 1. The second frequency-selective filter circuit 123 may be disposed on the circuit board 50 in the electronic device 1.

[0042] In implementations, the first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 can help the second antenna 120 to fur-

ther receive and transmit the electromagnetic wave signal in the second band and the electromagnetic wave signal in the third band besides the electromagnetic wave signal in the first band. Further, the first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 are configured to isolate the first antenna 110 from the second antenna 120. In other words, the first frequency-selective filter circuit 113 and the second frequency-selective filter circuit 123 are further able to isolate an electromagnetic wave signal received and transmitted by the first antenna 110 and an electromagnetic wave signal received and transmitted by the second antenna 120 from each other without interference.

[0043] Reference can be made to FIG. 2, which is a schematic diagram of an antenna assembly provided in an implementation corresponding to FIG. 1. In this implementation, the first frequency-selective filter circuit 113 includes one or more frequency-selective filter sub-circuits 113a. The second frequency-selective filter circuit 123 includes one or more frequency-selective filter sub-circuits 113a. The one or more frequency-selective filter sub-circuits are further configured to isolate the first antenna 110 from the second antenna 120. In the schematic diagram of this implementation, for example, the first frequency-selective filter circuit 113 includes two frequency-selective filter sub-circuits 113a which are connected in parallel, and the second frequency-selective filter circuit 123 includes two frequency-selective filter sub-circuits 113a which are connected in series. Each frequency-selective filter sub-circuit 113a in the first frequency-selective filter circuit 113 and each frequency-selective filter sub-circuit 113a in the second frequency-selective filter circuit 123 are able to isolate the first antenna 110 from the second antenna 120. In other words, said each frequency-selective filter sub-circuit 113a in the first frequency-selective filter circuit 113 and said each frequency-selective filter sub-circuit 113a in the second frequency-selective filter circuit 123 are able to make the electromagnetic wave signal received and transmitted by the first antenna 110 and the electromagnetic wave signal received and transmitted by the second antenna 120 not interfere with each other. It should be noted that the frequency-selective filter sub-circuit 113a in the first frequency-selective filter circuit 113 may be the same as or different from the frequency-selective filter sub-circuit 113a in the second frequency-selective filter circuit 123. When the first frequency-selective filter circuit 113 includes multiple frequency-selective filter sub-circuits 113a, the multiple frequency-selective filter sub-circuits 113a may be connected with one another in series, in parallel, etc. When the second frequency-selective filter circuit 123 includes multiple frequency-selective filter sub-circuits 113a, the multiple frequency-selective filter sub-circuits 113a may be connected with one another in series, in parallel, etc. Each frequency-selective filter sub-circuit 113a is introduced in detail as follows.

[0044] Reference can be made to FIG. 3 to FIG. 10 together, where FIG. 3-FIG. 10 are schematic diagrams

of frequency-selective filter sub-circuits provided in various implementations. A frequency-selective filter sub-circuit 113a includes one or more of following circuits.

[0045] Reference can be made to FIG. 3. In FIG. 3, the frequency-selective filter sub-circuit 113a includes a band-pass circuit. The band-pass circuit includes an inductor L0 and a capacitor C0 which are connected in series.

[0046] Reference can be made to FIG. 4. In FIG. 4, the frequency-selective filter sub-circuit 113a includes a band-stop circuit. The band-stop circuit includes an inductor L0 and a capacitor C0 which are connected in parallel.

[0047] Reference can be made to FIG. 5. In FIG. 5, the frequency-selective filter sub-circuit 113a includes an inductor L0, a first capacitor C1, and a second capacitor C2. The inductor L0 is connected with the first capacitor C1 in parallel, and the second capacitor C2 is electrically connected with a node where the inductor L0 is electrically connected with the first capacitor C1.

[0048] Reference can be made to FIG. 6. In FIG. 6, the frequency-selective filter sub-circuit 113a includes a capacitor C0, a first inductor L1, and a second inductor L2. The capacitor C0 is connected with the first inductor L1 in parallel, and the second inductor L2 is electrically connected with a node where the capacitor C0 is electrically connected with the first inductor L1.

[0049] Reference can be made to FIG. 7. In FIG. 7, the frequency-selective filter sub-circuit 113a includes an inductor L0, a first capacitor C1, and a second capacitor C2. The inductor L0 is connected with the first capacitor C1 in series. One end of the second capacitor C2 is electrically connected with a first end of the inductor L0 that is not connected with the first capacitor C1, and another end of the second capacitor C2 is electrically connected with one end of the first capacitor C1 which is not connected with the inductor L0.

[0050] Reference can be made to FIG. 8. In FIG. 8, the frequency-selective filter sub-circuit 113a includes a capacitor C0, a first inductor L1, and a second inductor L2. The capacitor C0 is connected with the first inductor L1 in series. One end of the second inductor L2 is electrically connected with one end of the capacitor C0 which is not connected with the first inductor L1, and another end of the second inductor L2 is electrically connected with one end of the first inductor L1 which is not connected with the capacitor C0.

[0051] Reference can be made to FIG. 9. In FIG. 9, the frequency-selective filter sub-circuit 113a includes a first capacitor C1, a second capacitor C2, a first inductor L1, and a second inductor L2. The first capacitor C1 is connected with the first inductor L1 in parallel, and the second capacitor C2 is connected with the second inductor L2 in parallel. One end of the second capacitor C2 and the second inductor L2 that are connected in parallel is electrically connected with one end of the first capacitor C1 and the first inductor L1 that are connected in parallel.

[0052] Reference can be made to FIG. 10. In FIG. 10,

the frequency-selective filter sub-circuit 113a includes a first capacitor C1, a second capacitor C2, a first inductor L1, and a second inductor L2. The first capacitor C1 is connected with the first inductor L1 in series to define a first unit 113b, the second capacitor C2 is connected with the second inductor L2 in series to define a second unit 113c, and the first unit 113b is connected with the second unit 113c in parallel.

[0053] Reference can be made to FIG. 11, which is a schematic diagram of an antenna assembly provided in another implementation of the present disclosure. In this implementation, an excitation signal generated by the second signal-source 122 passes through the second frequency-selective filter circuit 123 and is fed to the second radiator 121 through capacitive coupling.

[0054] In an implementation, an output end of the second frequency-selective filter circuit 123 is electrically connected with one end of a coupling capacitor C3, and another end of the coupling capacitor C3 is electrically connected with the second radiator 121. The excitation signal (i.e., the second excitation signal) generated by the second signal-source 122 is fed to the second radiator 121 through the coupling capacitor C3 after passing through the second frequency-selective filter circuit 123. In another implementation, a coupling capacitor C3 is formed between the output end of the second frequency-selective filter circuit 123 and the second radiator 121, and the excitation signal (i.e., the second excitation signal) generated by the second signal-source 122 is fed to the second radiator 121 through the coupling capacitor C3 after passing through the second frequency-selective filter circuit 123.

[0055] The excitation signal generated by the second signal-source 122 is fed to the second radiator 121 through capacitive coupling via the second frequency-selective filter circuit 123, such that the electromagnetic wave signal received and transmitted by the second antenna 120 has a relatively high efficiency bandwidth.

[0056] It can be understood that in other implementations, the excitation signal generated by the second excitation source is directly coupled to the second radiator 121 via the second frequency-selective filter circuit 123. Specifically, the second excitation source is electrically connected with the input end of the second frequency-selective filter circuit 123, and the output end of the second frequency-selective filter circuit 123 is directly electrically connected with the second radiator 121.

[0057] Reference can be made to FIG. 12, which is a schematic diagram of an antenna assembly provided in yet another implementation of the present disclosure. The first radiator 111 includes a first sub-radiator 1111, a second sub-radiator 1112, and a third sub-radiator 1113 that are bent and connected sequentially. The first sub-radiator 1111 and the third sub-radiator 1113 are located on the same side of the second sub-radiator 1112. The first sub-radiator 1111 has a first ground end G1 that is away from the second sub-radiator 1112 and grounded. The second sub-radiator 1112 has a first feed-

ing point P1 electrically connected with the first frequency-selective filter circuit 112. The third sub-radiator 1113 has a first free end F1 that is away from the second sub-radiator 1112 and adjacent to the second radiator 121.

[0058] The second radiator 121 includes a fourth sub-radiator 1211 and a fifth sub-radiator 1212 that are bent and connected. The fourth sub-radiator 1211 has a second free end F2 that is away from the fifth sub-radiator 1212 and is spaced apart from the first radiator 111. In this implementation, the second free end F2 is spaced apart from one end of the third sub-radiator 1113 of the first radiator 111 away from the second sub-radiator 1112. The fifth sub-radiator 1212 has a second feeding point P2 electrically connected with the second frequency-selective filter circuit 123. The fifth sub-radiator 1212 has a second ground end G2 that is away from the fourth sub-radiator 1211 and grounded.

[0059] This structural arrangement of the first radiator 111 and the second radiator 121 can facilitate an arrangement of the antenna assembly 10 corresponding to a corner of the electronic device 1. When the antenna assembly 10 is disposed corresponding to the corner of the electronic device 1, and the electronic device 1 is used by a user, the antenna assembly 10 is not prone to be held by the user, such that the electronic device 1 to which the antenna assembly 10 is applied can have a good communication effect.

[0060] In this implementation, for example, the first sub-radiator 1111, the second sub-radiator 1112, and the third sub-radiator 1113 each are rectangular. In other implementations, the first sub-radiator 1111, the second sub-radiator 1112, and the third sub-radiator 1113 may also have other shapes. Accordingly, in this implementation, the fourth sub-radiator 1211 and the fifth sub-radiator 1212 each are rectangular. In other implementations, the fourth sub-radiator 1211 and the fifth sub-radiator 1212 may have other shapes.

[0061] In this implementation, the first sub-radiator 1111 and the third sub-radiator 1113 each extend in a first direction D1, the second sub-radiator 1112 extends in a second direction D2, and the first direction D1 is perpendicular to the second direction D2. In this implementation, the fourth sub-radiator 1211 is disposed opposite to the third sub-radiator 1113. The fourth sub-radiator 1211 extends in the first direction D1. The fifth sub-radiator 1212 extends in the second direction D2. It can be understood that in other implementations, the first direction D1 may not be perpendicular to the second direction D2, and the first sub-radiator 1111 may not be parallel to the third sub-radiator 1113. A shape and an extension direction of the first sub-radiator 1111, a shape and an extension direction of the second sub-radiator 1112, and a shape and an extension direction of the third sub-radiator 1113 can be adjusted according to environment to which the antenna assembly 10 is applied. Accordingly, in other implementations, a shape and an extension direction of the fourth sub-radiator 1211 and a shape and an extension direction of the fifth sub-radiator

1212 can also be adjusted according to environment to which the antenna element is applied.

[0062] Reference can be made to FIG. 12. The first frequency-selective filter circuit 113 is electrically connected to the first feeding point P1. The first feeding point P1 of the first radiator 111 is located at the second sub-radiator 1112 or the third sub-radiator 1113. When the first feeding point P1 of the first radiator 111 is located at different positions, current distributions in the first radiator 111 are different.

[0063] Reference can be made to FIG. 13, which is a schematic diagram of an antenna assembly provided in yet another implementation of the present disclosure. In this implementation, the first radiator 111 includes a first sub-radiator 1111 and a second sub-radiator 1112 that are bent and connected. The first sub-radiator 1111 has a first ground end G1 that is away from the second sub-radiator 1112 and grounded. The second sub-radiator 1112 has a first free end F1 that is away from the first sub-radiator 1111 and adjacent to the second radiator 121. The second sub-radiator 1112 has a first feeding point P1 electrically connected with the first frequency-selective filter circuit 113. The second radiator 121 includes a third sub-radiator 1113 and a fourth sub-radiator 1211 that are bent and connected. The third sub-radiator 1113 has a second free end F2 that is away from the fourth sub-radiator 1211 and spaced apart from the first free end F1. In other words, the second free end F2 is spaced apart from one end of the second sub-radiator 1112 away from the first sub-radiator 1111. The third sub-radiator 1113 has a second feeding point P2 electrically connected with the second frequency-selective filter circuit 123. The fourth sub-radiator 1211 has a second ground end G2 that is away from the third sub-radiator 1113 and grounded.

[0064] This structural arrangement of the first radiator 111 and the second radiator 121 can facilitate an arrangement of the antenna assembly 10 corresponding to an edge of the electronic device 1. When the antenna assembly 10 is disposed corresponding to the edge (e.g., a top edge) of the electronic device 1, since the user holds a side edge of the electronic device 1 while using the electronic device 1, the antenna assembly 10 is not prone to be held by the user, such that the electronic device 1 to which the antenna assembly 10 is applied can have a relatively great communication effect.

[0065] In an implementation, the second antenna 120 is further configured to receive and transmit an electromagnetic wave signal in the WIFI 5G band (5.725GHz~5.825GHz). Specifically, by setting frequency-selective parameters (including a resistance, an inductance, and a capacitance) of the first frequency-selective filter circuit 113 and frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the second frequency-selective filter circuit 123, the second antenna 120 is able to receive and transmit the electromagnetic wave signal in the first band, the electromagnetic wave signal in the at least one of the

second band and the third band, and the electromagnetic wave signal in the WIFI 5G band. It should be noted that the second antenna 120 is able to receive and transmit the electromagnetic wave signal in the first band, the electromagnetic wave signal in the at least one of the second band and the third band, and the electromagnetic wave signal in the WIFI 5G band, which means that the second antenna 120 is able to simultaneously receive and transmit the electromagnetic wave signal in the first band, the electromagnetic wave signal in the at least one of the second band and the third band, and the electromagnetic wave signal in the WIFI 5G band.

[0066] With reference to the above implementations, a length of the first radiator 111 is larger than a length of the second radiator 121, and a band of the electromagnetic wave signal received and transmitted by the first antenna 110 is lower than a band of the electromagnetic wave signal received and transmitted by the second antenna 120.

[0067] When the first radiator 111 includes multiple sub-radiators and the second radiator 121 includes multiple sub-radiators, the length of the first radiator 111 is larger than the length of the second radiator 121, which means that the sum of lengths of the multiple sub-radiators of the first radiator 111 is greater than the sum of lengths of the multiple sub-radiators of the second radiator 121. As illustrated in FIG. 12, for example, the first radiator 111 includes the first sub-radiator 1111, the second sub-radiator 1112, and the third sub-radiator 1113, and the second radiator 121 includes the fourth sub-radiator 1211 and the fifth sub-radiator 1212. For convenience of description, a length of the first radiator 111 is denoted as L1, a length of the second radiator 121 is denoted as L2, a length of the first sub-radiator 1111 is denoted as L11, a length of the second sub-radiator 1112 is denoted as L12, a length of the third sub-radiator 1113 is denoted as L13, a length of the fourth sub-radiator 1211 is denoted as L21, and a length of the fifth sub-radiator 1212 is denoted as L22. Then, $L1=L11+L12+L13$; and $L2=L21+L22$. The length of the first radiator 111 is larger than the length of the second radiator 121, that is, $L1>L2$. In this implementation, the length of the first radiator 111 is larger than the length of the second radiator 121, and the band of the electromagnetic wave signal received and transmitted by the first antenna 110 is lower than the band of the electromagnetic wave signal received and transmitted by the second antenna 120, such that more bands can be covered when the antenna assembly 10 operates, and the communication effect of the antenna assembly 10 is improved.

[0068] It can be understood that in this implementation, for example, the first radiator 111 is located at a left side of the second radiator 121. In other implementations, the first radiator 111 and the second radiator 121 may also be located at other positions. For example, the first radiator 111 is located at a right side of the second radiator 121; or the first radiator 111 and the second radiator 121 are arranged in an up-down direction and the first radiator

111 is located above the second radiator 121; or the first radiator 111 and the second radiator 121 are arranged in an up-down direction and the first radiator 111 is located below the second radiator 121. In summary, the first radiator 111 and the second radiator 121 can be flexibly arranged according to environment to which the antenna assembly 10 is applied. Compared with the first radiator 111 being located at the left side of the second radiator 121, when the first radiator 111 is located at the right side of the second radiator 121, both the length and the feeding position of the first radiator 111 are changed, and an operating band of the first radiator 111 and an operating band of the second radiator 121 are also exchanged.

[0069] Specifically, by setting the frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the first frequency-selective filter circuit 113 and the frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the second frequency-selective filter circuit 123, the first antenna 110 is able to receive and transmit an electromagnetic wave signal in the GPS-L1 band, an electromagnetic wave signal in the WiFi 2.4G band, an electromagnetic wave signal in the LTE MHB, and an electromagnetic wave signal in the N41 band (2496MHz-2690MHz).

[0070] It should be noted that GPS mentioned herein means positioning, including but not limited to global positioning system (GPS) positioning, BeiDou positioning, GLONASS positioning, GALILEO positioning, etc. The WiFi 2.4G band ranges from 2.4GHz to 2.5 GHz. The LTE MHB refers to middle high band and ranges from 1000MHz to 3000MHz.

[0071] Specifically, by setting the frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the first frequency-selective filter circuit 113 and the frequency-selective parameters (including the resistance, the inductance, and the capacitance) of the second frequency-selective filter circuit 123, the first antenna 110 is able to receive and transmit the electromagnetic wave signal in the GPS-L1 band, the electromagnetic wave signal in the WiFi 2.4G band, the electromagnetic wave signal in the LTE MHB, and the electromagnetic wave signal in the N41 band, such that the first antenna 110 is able to support more bands. It should be noted that when the first antenna 110 is able to receive and transmit the electromagnetic wave signal in the GPS-L1 band, the electromagnetic wave signal in the WiFi 2.4G band, the electromagnetic wave signal in the LTE MHB, and the electromagnetic wave signal in the N41 band, the first antenna 110 is able to simultaneously receive and transmit the electromagnetic wave signal in the GPS-L1 band, the electromagnetic wave signal in the WiFi 2.4G band, the electromagnetic wave signal in the LTE MHB, and the electromagnetic wave signal in the N41 band.

[0072] With reference to the antenna assembly 10 in the above implementations, a dimension d of a gap be-

tween the first radiator 111 and the second radiator 121 meets: $0.5\text{ mm} \leq d \leq 2.0\text{ mm}$. Specifically, reference can be made to FIG. 1, which illustrates the dimension d. The dimension d of the gap between the first radiator 111 and the second radiator 121 is selected from the above range, such that a good coupling effect between the first radiator 111 and the second radiator 121 can be ensured. Further optionally, the dimension d of the gap between the first radiator 111 and the second radiator 121 meets: $0.5\text{ mm} \leq d \leq 1.5\text{ mm}$, such that coupling between the first radiator 111 and the second radiator 121 is better.

[0073] Next, for example, the first antenna 110 is configured to receive and transmit the electromagnetic wave signal in the GPS-L1 band, the electromagnetic wave signal in the WIFI 2.4G band, the electromagnetic wave signal in the LTE MHB, and the electromagnetic wave signal in the N41 band. The second antenna 120 is configured to receive and transmit the electromagnetic wave signal in the WIFI 5G band, an electromagnetic wave in the N78 band, an electromagnetic wave in the N77 band, and an electromagnetic wave in the N79 band.

[0074] Reference can be made to FIG. 14, which is a schematic diagram of a return loss (RL) curve of a first antenna and a RL curve of a second antenna in an antenna assembly in an implementation. The RL curve refers to a return loss curve, where RL is an abbreviation for "return loss". In FIG. 14, an abscissa represents a frequency in units of MHz, and an ordinate represents RL in units of decibel (dB). In FIG. 14, curve ① (i.e., a solid curve in FIG. 14) is a RL curve of the first antenna 110, and curve ② (i.e., a dashed curve in FIG. 14) is a RL curve of the second antenna 120. It can be seen from curve ① that the first antenna 110 has three modes, which are first resonant mode a, second resonant mode b, and third resonant mode c. The operating band of the first antenna 110 covers 1500MHz~3000MHz, that is, the first antenna 110 supports reception and transmission of the electromagnetic wave signal in the GPS-L1 band, the electromagnetic wave signal in the LTE MHB, the electromagnetic wave signal in the WIFI 2.4G band, and the electromagnetic wave signal in the N41 band. Mode a supports the GPS-L1 band, mode b supports the LTE MHB, and mode c supports the WIFI 2.4G band and the N41 band. It can be seen from curve ② that the second antenna 120 has three modes, which are fourth resonant mode d, fifth resonant mode e, and sixth resonant mode f. The operating band of the second antenna 120 covers 3300MHz~6000MHz, that is, the second antenna 120 supports reception and transmission of the electromagnetic wave signal in the N78 band, the electromagnetic wave signal in the N77 band, the electromagnetic wave signal in the N79 band, and the electromagnetic wave signal in the WIFI 5G band. Mode d supports the N78 band, mode e supports the N77 band and the N79 band, and mode f supports the WIFI 5G band. Mode d is generated by a capacitive coupling feed. It can be seen from FIG. 14 that mode a to mode f each have a relatively high efficiency bandwidth. Positions of feeding points of the

first radiator 111 of the first antenna 110 are different, such that orders of occurrence of various modes are different. For example, when a feeding point of the first radiator 111 of the first antenna 110 is at the position illustrated above, the RL curve of the first antenna 110 is illustrated in FIG. 14. When the feeding position of the first radiator 111 moves towards the gap between the first radiator 111 and the second radiator 121, mode c appears before mode b, and a band supported by mode c and a band supported by mode b also change, for example, mode b supports the WiFi 2.4G band and the N41 band, and mode c supports the LTE MHB. In addition, it can be seen from the schematic diagram that the antenna assembly 10 is able to cover the Sub 6G band, the MHB, and the UHB. Since the antenna assembly 10 has a relatively small volume, a space utilization rate of the electronic device 1 to which the antenna assembly 10 is applied can be improved.

[0075] In order to facilitate understanding of the aforementioned modes, a main distribution of a current in the first radiator 111 and a main distribution of a current in the second radiator 121 in various modes will be described in detail below with reference to the various modes. Reference can be made to FIG. 15 to FIG. 20 together, where FIG. 15 is a schematic diagram illustrating a current distribution of a current in mode a, FIG. 16 is a schematic diagram illustrating a main distribution of a current in mode b, FIG. 17 is a schematic diagram illustrating a main distribution of a current in mode c, FIG. 18 is a schematic diagram illustrating a main distribution of a current in mode d, FIG. 19 is a schematic diagram illustrating a main distribution of a current in mode e, and FIG. 20 is a schematic diagram illustrating a main distribution of a current in mode f. In order to enable the first antenna 110 and the second antenna 120 to support the various modes described above, a first feeding point P1 of the first radiator 111 is located adjacent to a midpoint of the first radiator 111 and at a part of the first radiator 111 close to the second radiator 121, and a second feeding point P2 of the second radiator 121 is disposed adjacent to the gap between the second radiator 121 and the first radiator 111.

[0076] Reference can be made to FIG. 15, and when the first antenna 110 resonates in the first resonant mode (mode a), a current in the first radiator 111 flows through the first feeding point P1 and the free end F1 in sequence from the first ground end G1.

[0077] Reference can be made to FIG. 16, and when the first antenna 110 resonates in the second resonant mode (mode b), the current in the first radiator 111 flows from the first feeding point P1 to a connection point of the second sub-radiator 1112 and the third sub-radiator 1113 and the first free end F1 in sequence.

[0078] Reference can be made to FIG. 17, and when the first antenna 110 resonates in the third resonant mode (mode c), the current in the first radiator 111 includes a first sub-current I_x and a second sub-current I_y. The first sub-current I_x flows from the first ground end G1 to the

first feeding point P1, and the second sub-current I_2 flows from the first free end F1 to the first feeding point P1.

[0079] Reference can be made to FIG. 18, and when the second antenna 120 resonates in the fourth resonant mode, a current in the second radiator 121 flows from the second free end F2 to the second ground end G2, and further flows from the second feeding point P2 to the second ground end G2.

[0080] Reference can be made to FIG. 19, and when the second antenna 120 resonates in the fifth resonant mode, the current in the second radiator 121 flows from the second ground end G2 to the second free end F2.

[0081] Reference can be made to FIG. 20, and when the second antenna 120 resonates in the sixth resonant mode, the current in the second radiator 121 flows from the second feeding point P2 to the second free end G2.

[0082] It should be noted that FIG. 15 to FIG. 20 illustrate main distributions of currents in the various modes, and do not represent all current distributions in the various modes. Due to the coupling between the first radiator 111 and the second radiator 121, a current is coupled from the third sub-radiator 1113 to the fourth sub-radiator 1211 of the second radiator 121, and is ground via the fourth sub-radiator 1211 and the fifth sub-radiator 1212. For example, in mode b and mode c, a current is also distributed in the second radiator 121. However, in mode b and mode c, the current is mainly distributed in the first radiator 111 but is not mainly distributed in the second radiator 121, so the current distribution in the second radiator 121 is not illustrated. In the same way, in mode d to mode f, the current is mainly distributed in the second radiator 121, and a current is also distributed in the first radiator 111 due to the coupling between the first radiator 111 and the second radiator 121.

[0083] Reference can be made to FIG. 21 and FIG. 22 together, where FIG. 21 is a structural perspective diagram of an electronic device provided in an implementation of the present disclosure, and FIG. 22 is a cross-sectional diagram of the electronic device of FIG. 21 provided in an implementation, taken along line I-I. The electronic device 1 includes the antenna assembly 10 of any of the above implementations.

[0084] Reference can be made to FIG. 23 and FIG. 24 together, where FIG. 23 is a top diagram of a metal frame in an implementation of the present disclosure, and FIG. 24 is a top diagram of a metal frame in another implementation of the present disclosure. The electronic device 1 further includes a metal frame 20. The metal frame 20 includes a frame body 210, a first metal section 220, and a second metal section 230. The first metal section 220 is spaced apart from the second metal section 230. A gap is defined between the first metal section 220 and the frame body 210. A gap is defined between the second metal section 230 and the frame body 210. One end of the first metal section 220 away from the second metal section 230 is connected with the frame body 210. One end of the second metal section 230 away from the first metal section 220 is connected with the frame body 210.

The first radiator 111 includes the first metal section 220. The second radiator 121 includes the second metal section 230. In FIG. 23, for example, the first metal section 220 and the second metal section 230 correspond to a corner of the frame body 210. In FIG. 24, for example, the first metal section 220 and the second metal section 230 correspond to an edge of the frame body 210.

[0085] Since a relatively large piece of metal may constitute a ground electrode, the frame body 210 may constitute the ground electrode. The end of the first metal section 220 away from the second metal section 230 is connected with the frame body 210, such that the first metal section 220 is grounded. The end of the second metal section 230 away from the second metal section 230 is connected with the frame body 210, such that the second metal section 230 is grounded.

[0086] Reference can be made to FIG. 22 again, and the metal frame 20 includes an edge frame 240. The edge frame 240 is connected around a periphery of the frame body 210 in a bent manner. The first metal section 220 and the second metal section 230 are formed on the edge frame 240.

[0087] In this implementation, the metal frame 20 is the middle frame 30 of the electronic device 1.

[0088] The middle frame 30 is made of metal, such as aluminum-magnesium alloy. The middle frame 30 generally constitutes ground of the electronic device 1. When electronic components in the electronic device 1 need to be grounded, the electronic components can be connected with the middle frame to be grounded. In addition to the middle frame 30, a ground system of the electronic device 1 further includes ground of the circuit board 50 and ground of a screen 40.

[0089] In this implementation, the electronic device 1 further includes the screen 40, the circuit board 50, and a battery cover 60. The screen 40 may be a display screen with a display function or a screen 40 integrated with a display function and a touch function. The screen 40 is configured to display texts, images, videos, and other information. The screen 40 is carried on the middle frame 30 and is located at one side of the middle frame 30. The circuit board 50 is also generally carried on the middle frame 30. The circuit board 50 and the screen 40 are carried at two opposite sides of the middle frame 30. In the antenna assembly 10 described above, at least one or more of the first signal-source 112, the second signal-source 122, the first frequency-selective filter circuit 113, and the second frequency-selective filter circuit 123 may be disposed on the circuit board 50. The battery cover 60 is disposed at one side of the circuit board 50 away from the middle frame 30. The battery cover 60, the middle frame 30, the circuit board 50, and the screen 40 cooperatively constitute a complete electronic device 1. It can be understood that a structural description of the electronic device 1 is only a description of one form of a structure of the electronic device 1, and should not be understood as a limitation to the electronic device 1 or the antenna assembly 10.

[0090] In other implementations, the metal frame 20 is also called the middle frame 30, and only one metal frame 20 is disposed inside the electronic device 1.

[0091] In other implementations, the first radiator 111 is an FPC antenna radiator, an LDS antenna radiator, a PDS antenna radiator, or a metal branch. The second radiator 121 is the FPC antenna radiator, the LDS antenna radiator, the PDS antenna radiator, or the metal branch. The first radiator 111 may be disposed at an edge of the middle frame 30 and electrically connected with the middle frame 30. It can be understood that in other implementations, the first radiator 111 and the second radiator 121 may also be disposed at other positions and electrically connected with the ground system of the electronic device 1. The ground system of the electronic device 1 includes a middle frame 30, a screen 40, and a circuit board 50. The first radiator 111 and the second radiator 121 are electrically connected with the ground system of the electronic device 1, which means that the first radiator 111 and the second radiator 121 are electrically connected with any one or more of the middle frame 30, the screen 40, and the circuit board 50.

[0092] In an implementation, the first radiator 111 and the second radiator 121 are antenna radiators of the same type and are disposed on the same substrate. The first radiator 111 and the second radiator 121 have the same type and are disposed on the same substrate, thereby facilitating manufacturing of the first radiator 111 and the second radiator 121, and assemblies of the first radiator 111 and the second radiator 121 with other components in the electronic device 1. In this implementation, the electronic device 1 further includes a ground system. The ground system includes one or more of a middle frame 30, a circuit board 50, and a display screen. One end of the first radiator 111 away from the second radiator 121 is electrically connected with the ground system to be grounded. One end of the second radiator 121 away from the first radiator 111 is electrically connected with the ground system to be grounded. In this implementation, the first radiator 111 is an FPC antenna radiator, an LDS antenna radiator, a PDS antenna radiator, or a metal branch. The second radiator 121 is the FPC antenna radiator, the LDS antenna radiator, the PDS antenna radiator, or the metal branch. However, when the first radiator 111 and the second radiator 121 are not directly formed on the middle frame 30, the first radiator 111 and the second radiator 121 need to be electrically connected with the ground system of the electronic device 1.

[0093] When the first radiator 111 is electrically connected with ground of the middle frame 30, the first radiator 111 may be connected with the ground of the middle frame 30 through a connecting rib, or the first radiator 111 may be electrically connected with the ground of the middle frame 30 through a conductive elastic piece. In the same way, when the second radiator 121 is electrically connected with the ground of the middle frame 30, the second radiator 121 may be connected with the ground of the middle frame 30 through the connecting

rib, or the second radiator 121 may be electrically connected with the ground of the middle frame 30 through the conductive elastic piece.

[0094] Reference can be made to FIG. 25, which is a schematic diagram of a position of a first radiator and a position of a second radiator in an electronic device in an implementation. In this implementation, an electronic device 1 has a top 1a and a bottom 1b. The first radiator 111 and the second radiator 121 are disposed on the top.

[0095] The top 1a refers to a part located at an upper side of the electronic device 1 when the electronic device 1 is used, and the bottom 1b refers to a region located at a lower side of the electronic device 1 opposite to the top 1a.

[0096] The top 1a includes three situations as follows. The first radiator 111 and the second radiator 121 are disposed at a top-left corner of the electronic device 1; or the first radiator 111 and the second radiator 121 are disposed at a top edge of the electronic device 1; or the first radiator 111 and the second radiator 121 are disposed at a top-right corner of the electronic device 1.

[0097] When the first radiator 111 and the second radiator 121 are disposed at the top-left corner of the electronic device 1, following cases are included. Part of the first radiator 111 is located at a left side-edge, rest of the first radiator 111 is located at the top edge, and the second radiator 121 is completely located at the top edge; or part of the second radiator 121 is located at the top edge, rest of the second radiator 121 is located at the left side-edge, and the first radiator 111 is located at the left side-edge.

[0098] When the first radiator 111 and the second radiator 121 are disposed at the top-right corner of the electronic device 1, following cases are included. Part of the first radiator 111 is located at the top edge, rest of the first radiator 111 is located at a right side-edge, and the second radiator 121 is located at the right side-edge; or part of the second radiator 121 is located at the right side-edge, rest of the second radiator 121 is located at the top edge, and part of the first radiator 111 is located at the top edge.

[0099] When the electronic device 1 is placed vertically, the top 1a of the electronic device 1 is generally away from the floor and the bottom 1b of the electronic device 1 is generally close to the floor. When the first radiator 111 and the second radiator 121 are disposed on the top 1a, the first antenna 110 and the second antenna 120 have a relatively great upper hemisphere radiation efficiency, such that the first antenna 110 and the second antenna 120 have a relatively great communication efficiency. In other implementations, the first radiator 111 and the second radiator 121 may also be disposed corresponding to the bottom 1b of the electronic device 1. When the first radiator 111 and the second radiator 121 are disposed corresponding to the bottom 1b of the electronic device 1, the upper hemisphere radiation efficiency of the first antenna 110 and the second antenna 120 is not so good, but the communication effect can also be

good as long as the upper hemisphere radiation efficiency is greater than or equal to a preset efficiency.

[0100] Reference can be made to FIG. 26, which is a schematic diagram of a position of a first radiator and a position of a second radiator in an electronic device in another implementation. In this implementation, an electronic device 1 includes a first edge 11, a second edge 12, a third edge 13, and a fourth edge 14 that are sequentially connected end to end. The first edge 11 and the third edge 13 are short edges of the electronic device 1, and the second edge 12 and the fourth edge 14 are long edges of the electronic device 1. The first edge 11 is opposite to and spaced apart from the third edge 13, the second edge 12 is opposite to and spaced apart from the fourth edge 14. The second edge 12 is connected with the first edge 11 in a bent manner, and the second edge 12 is connected with the third edge 13 in a bent manner. The fourth edge 14 is connected with the first edge 11 in a bent manner, and the fourth edge 14 is connected with the third edge 13 in a bent manner. A corner of the electronic device 1 is formed at a joint between the first edge 11 and the second edge 12, a corner of the electronic device 1 is formed at a joint between the second edge 12 and the third edge 13, a corner of the electronic device 1 is formed at a joint between the third edge 13 and the fourth edge 14, and a corner of the electronic device 1 is formed at a joint between the fourth edge 14 and the first edge 11. The first radiator 111 and the second radiator 121 may be disposed corresponding to any corner of the electronic device 1. It should be noted that the first radiator 111 and the second radiator 121 are disposed corresponding to the same corner of the electronic device 1. When the first radiator 111 and the second radiator 121 are disposed corresponding to the corner of the electronic device 1, the first antenna 110 and the second antenna 120 have a relatively high efficiency. It can be understood that in this implementation, for example, the first edge 11 and the third edge are the short edges of the electronic device 1, and the second edge 12 and the fourth edge 14 are the long edges of the electronic device 1. In other implementations, the first edge 11, the second edge 12, the third edge 13 and the fourth edge 14 are equal in length.

[0101] Although implementations of the present disclosure have been illustrated and described above, it can be understood that the above implementations are exemplary and cannot be understood as limitations to the present disclosure. Those of ordinary skill in the art can change, amend, replace, and modify the above implementations within the scope of the present disclosure, and these modifications and improvements are also regarded as the protection scope of the present disclosure.

Claims

1. An antenna assembly, comprising:

a first antenna and a second antenna, wherein the first antenna comprises a first radiator, a first signal-source, and a first frequency-selective filter circuit, and the second antenna comprises a second radiator, a second signal-source, and a second frequency-selective filter circuit, wherein

the first radiator is spaced apart from and coupled with the second radiator, one end of the first radiator away from the second radiator is grounded, the first signal-source is electrically connected to the first radiator through the first frequency-selective filter circuit, one end of the second radiator away from the first radiator is grounded, and the second signal-source is electrically connected to the second radiator through the second frequency-selective filter circuit; and the first antenna is configured to generate at least one resonant mode, the second antenna is configured to generate at least two resonant modes, the at least two resonant modes of the second antenna are configured to cover reception and transmission of an electromagnetic wave signal in a first band, an electromagnetic wave signal in a second band, and an electromagnetic wave signal in a third band, and at least one of the at least two resonant modes of the second antenna is excited by a capacitive coupling feed between the first antenna and the second antenna.

2. The antenna assembly of claim 1, wherein the first antenna is operable in a first resonant mode, a second resonant mode, and a third resonant mode, and the second antenna is operable in a fourth resonant mode, a fifth resonant mode, and a sixth resonant mode; and wherein the first resonant mode, the second resonant mode, the third resonant mode, the fourth resonant mode, the fifth resonant mode, and the sixth resonant mode are configured to cover reception and transmission of an electromagnetic wave signal in a middle high band (MHB) and an electromagnetic wave signal in an ultra high band (UHB).
3. The antenna assembly of claim 2, wherein the first frequency-selective filter circuit and the second frequency-selective filter circuit are configured to adjust a resonant frequency of the first antenna according to a first preset frequency-selective parameter, to make the first antenna resonate in the first resonant mode, the second resonant mode, or the third resonant mode; and wherein the first antenna is configured to receive and transmit an electromagnetic wave signal in a fourth band in the first resonant mode, receive and transmit an electromagnetic wave signal in a fifth band in the second resonant mode, and receive and transmit an electromagnetic wave signal in a sixth band in the third resonant mode.

wave signal in a sixth band and an electromagnetic wave signal in a seventh band in the third resonant mode.

4. The antenna assembly of claim 3, wherein the first radiator comprises a first sub-radiator, a second sub-radiator, and a third sub-radiator that are bent and connected sequentially, the first sub-radiator and the third sub-radiator are located at a same side of the second sub-radiator, the first sub-radiator has a first ground end that is away from the second sub-radiator and grounded, the second sub-radiator has a first feeding point electrically connected with the first frequency-selective filter circuit, and the third sub-radiator has a first free end that is away from the second sub-radiator and adjacent to the second radiator.

5. The antenna assembly of claim 4, wherein

when the first antenna resonates in the first resonant mode, a current in the first radiator flows through the first feeding point and the first free end in sequence from the first ground end;

when the first antenna resonates in the second resonant mode, the current in the first radiator flows from the first feeding point to a connection point of the second sub-radiator and the third sub-radiator and the first free end in sequence; and

when the first antenna resonates in the third resonant mode, the current in the first antenna comprises a first sub-current and a second sub-current, the first sub-current flows from the first ground end to the first feeding point, and the second sub-current flows from the first free end to the first feeding point.

6. The antenna assembly of claim 3, wherein the fourth band comprises a global positioning system L1 (GPS-L1) band, the fifth band comprises a long-term evolution (LTE) MHB, the sixth band comprises a wireless fidelity (WIFI) 2.4G band, and the seventh band comprises a N41 band.

7. The antenna assembly of any of claims 2 to 6, wherein the first frequency-selective filter circuit and the second frequency-selective filter circuit are configured to adjust a resonant frequency of the second antenna according to a second preset frequency-selective parameter, to make the second antenna resonate in the fourth resonant mode, the fifth resonant mode, or the sixth resonant mode; and wherein the second antenna is configured to receive and transmit an electromagnetic wave signal in the first band in the fourth resonant mode, receive and transmit an electromagnetic wave signal in the second band and an electromagnetic wave signal in the third

band in the fifth resonant mode, and receive and transmit an electromagnetic wave signal in an eighth band in the sixth resonant mode.

8. The antenna assembly of claim 7, wherein the second radiator comprises a fourth sub-radiator and a fifth sub-radiator that are bent and connected, the fourth sub-radiator has a second free end that is away from the fifth sub-radiator and is spaced apart from the first antenna, the fifth sub-radiator has a second feeding point electrically connected with the second frequency-selective filter circuit, and the fifth sub-radiator has a second ground end that is away from the fourth sub-radiator and grounded.

9. The antenna assembly of claim 8, wherein

when the second antenna resonates in the fourth resonant mode, a current in the second radiator flows from the second free end to the second ground end, and further flows from the second feeding point to the second ground end; when the second antenna resonates in the fifth resonant mode, the current in the second radiator flows from the second ground end to the second free end; and

when the second antenna resonates in the sixth resonant mode, the current in the second radiator flows from the second feeding point to the second free end.

10. The antenna assembly of claim 7, wherein the first band comprises a N78 band, the second band comprises a N77 band, the third band comprises a N79 band, and the eighth band comprises a WIFI 5G band.

11. The antenna assembly of claim 1, wherein the first radiator comprises a first sub-radiator and a second sub-radiator that are bent and connected, the first sub-radiator has a first ground end that is away from the second sub-radiator and grounded, the second sub-radiator has a first free end that is away from the first sub-radiator and adjacent to the second radiator, and the second sub-radiator has a first feeding point electrically connected with the first frequency-selective filter circuit; and the second radiator comprises a third sub-radiator and a fourth sub-radiator that are bent and connected, the third sub-radiator has a second free end that is away from the fourth sub-radiator and spaced apart from the first free end, the third sub-radiator has a second feeding point electrically connected with the second frequency-selective filter circuit, and the fourth sub-radiator has a second ground end that is away from the third sub-radiator and grounded.

12. The antenna assembly of claim 1, wherein a dimen-

sion d of a gap between the first radiator and the second radiator meets: $0.5\text{mm} \leq d \leq 1.5\text{mm}$.

13. The antenna assembly of claim 1, wherein the first frequency-selective filter circuit comprises one or more frequency-selective filter sub-circuits, the second frequency-selective filter circuit comprises one or more frequency-selective filter sub-circuits, and the one or more frequency-selective filter sub-circuits are further configured to isolate the first antenna from the second antenna.

14. The antenna assembly of claim 13, wherein the one or more frequency-selective filter sub-circuits each comprise one or more of following circuits:

a band-pass circuit comprising an inductor and a capacitor which are connected in series;
 a band-stop circuit comprising an inductor and a capacitor which are connected in parallel;
 a circuit comprising an inductor, a first capacitor, and a second capacitor, wherein the inductor is connected with the first capacitor in parallel, and the second capacitor is electrically connected with a node where the inductor is electrically connected with the first capacitor;
 a circuit comprising a capacitor, a first inductor, and a second inductor, wherein the capacitor is connected with the first inductor in parallel, and the second inductor is electrically connected with a node where the capacitor is electrically connected with the first inductor;
 a circuit comprising an inductor, a first capacitor, and a second capacitor, wherein the inductor is connected with the first capacitor in series, one end of the second capacitor is electrically connected with a first end of the inductor that is not connected with the first capacitor, and another end of the second capacitor is electrically connected with one end of the first capacitor which is not connected with the inductor;
 a circuit comprising a capacitor, a first inductor, and a second inductor, wherein the capacitor is connected with the first inductor in series, one end of the second inductor is electrically connected with one end of the capacitor which is not connected with the first inductor, and another end of the second inductor is electrically connected with one end of the first inductor that is not connected with the capacitor;
 a circuit comprising a first capacitor, a second capacitor, a first inductor, and a second inductor, wherein the first capacitor is connected with the first inductor in parallel, the second capacitor is connected with the second inductor in parallel, and one end of the second capacitor and the second inductor that are connected in parallel is electrically connected with one end of the first

capacitor and the first inductor that are connected in parallel; and

a circuit comprising a first capacitor, a second capacitor, a first inductor, and a second inductor, wherein the first capacitor and the first inductor are connected in series to define a first unit, the second capacitor and the second inductor are connected in series to define a second unit, and the first unit is connected with the second unit in parallel.

15. The antenna assembly of claim 1, wherein an excitation signal generated by the second signal-source passes through the second frequency-selective filter circuit and is fed to the second radiator through capacitive coupling.

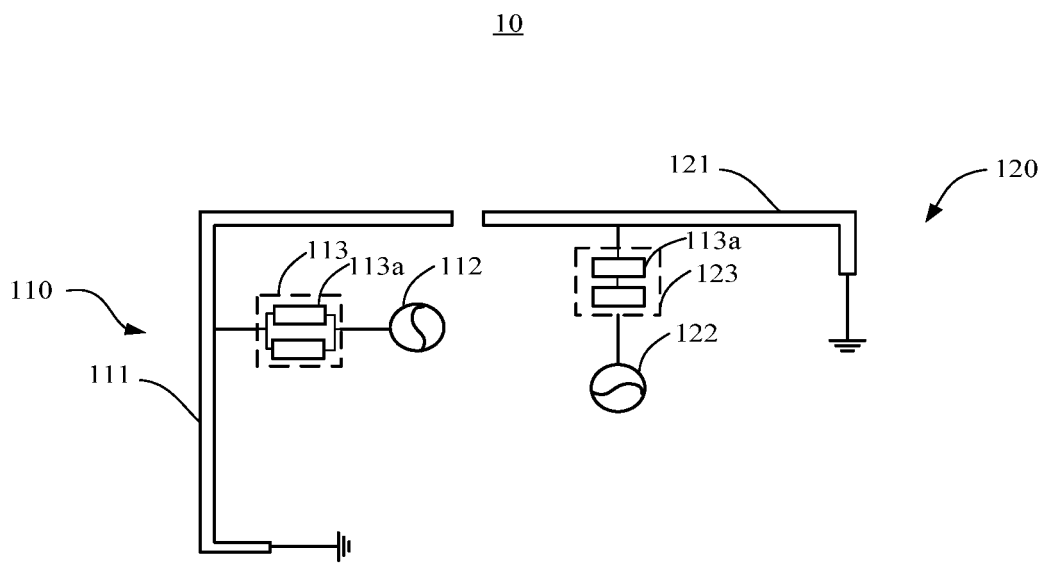
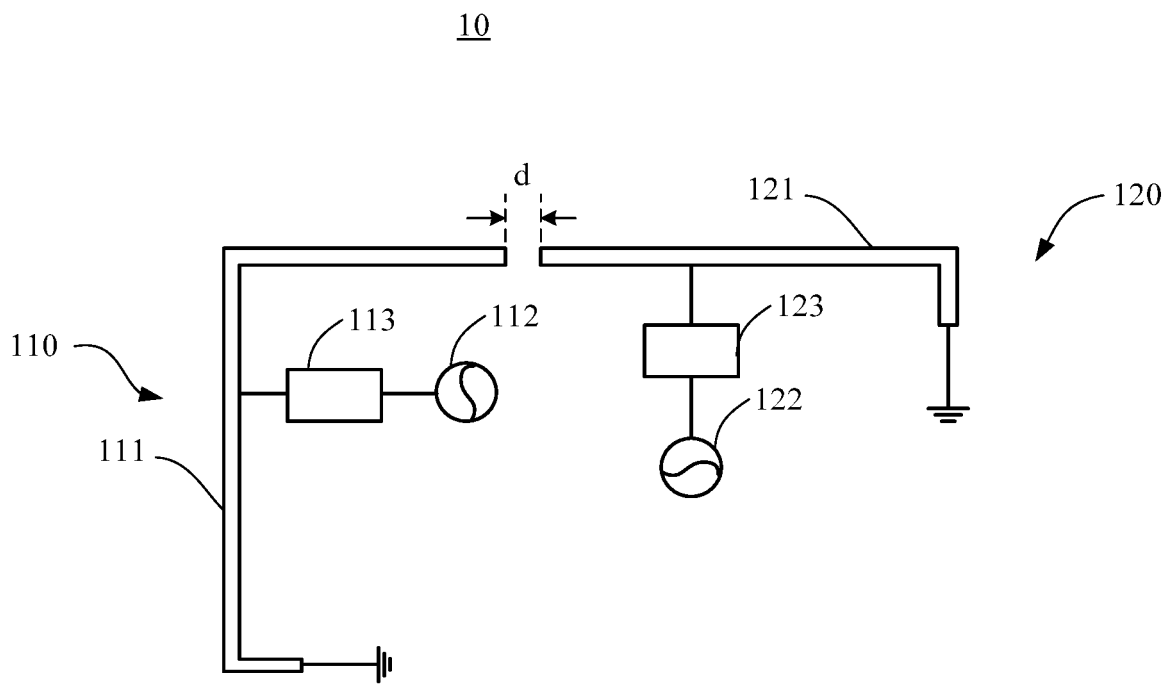
16. An electronic device, comprising the antenna assembly of any of claims 1 to 15.

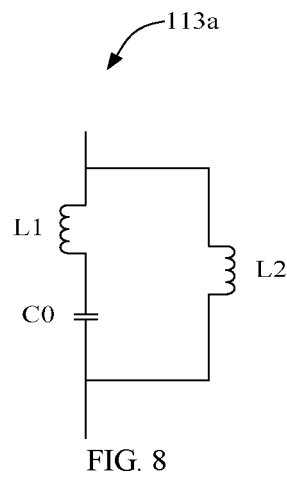
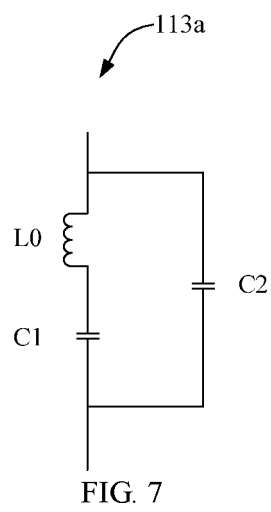
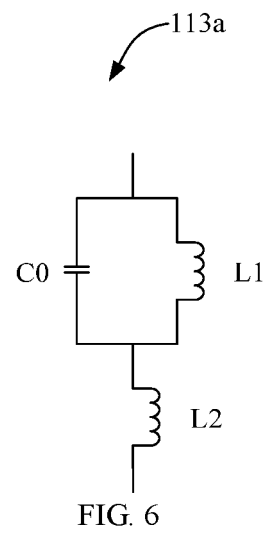
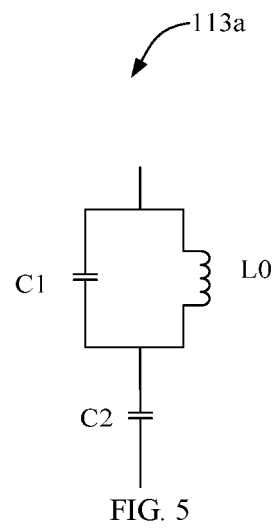
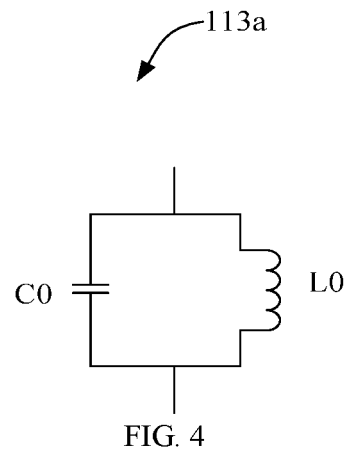
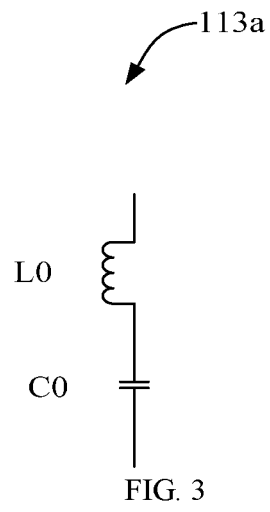
17. The electronic device of claim 16, further comprising a metal frame, wherein the metal frame comprises a frame body, a first metal section, and a second metal section, the first metal section is spaced apart from the second metal section, a gap is defined between the first metal section and the frame body, a gap is defined between the second metal section and the frame body, one end of the first metal section away from the second metal section is connected with the frame body, and one end of the second metal section away from the first metal section is connected with the frame body; and wherein the first radiator comprises the first metal section, and the second radiator comprises the second metal section.

18. The electronic device of claim 17, wherein the metal frame comprises an edge frame, the edge frame is connected around a periphery of the frame body in a bent manner, and the first metal section and the second metal section are formed on the edge frame.

19. The electronic device of claim 16, further comprising a ground system, wherein the ground system comprises one or more of a middle frame, a circuit board, and a display screen, one end of the first radiator away from the second radiator is electrically connected with the ground system to be grounded, and one end of the second radiator away from the first radiator is electrically connected with the ground system to be grounded.

20. The electronic device of claim 16, having a top and a bottom, wherein the first radiator and the second radiator are disposed on the top.





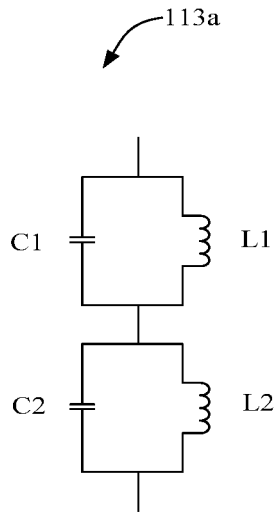


FIG. 9

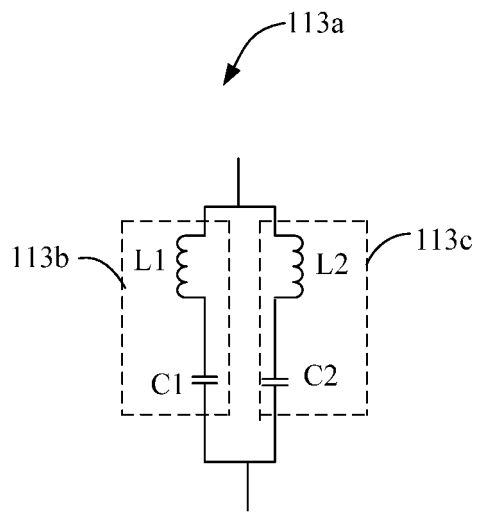


FIG. 10

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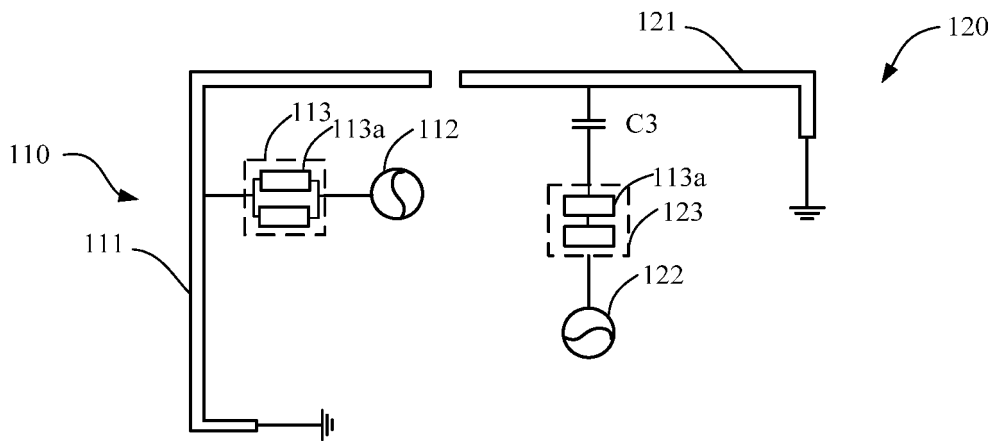


FIG. 11

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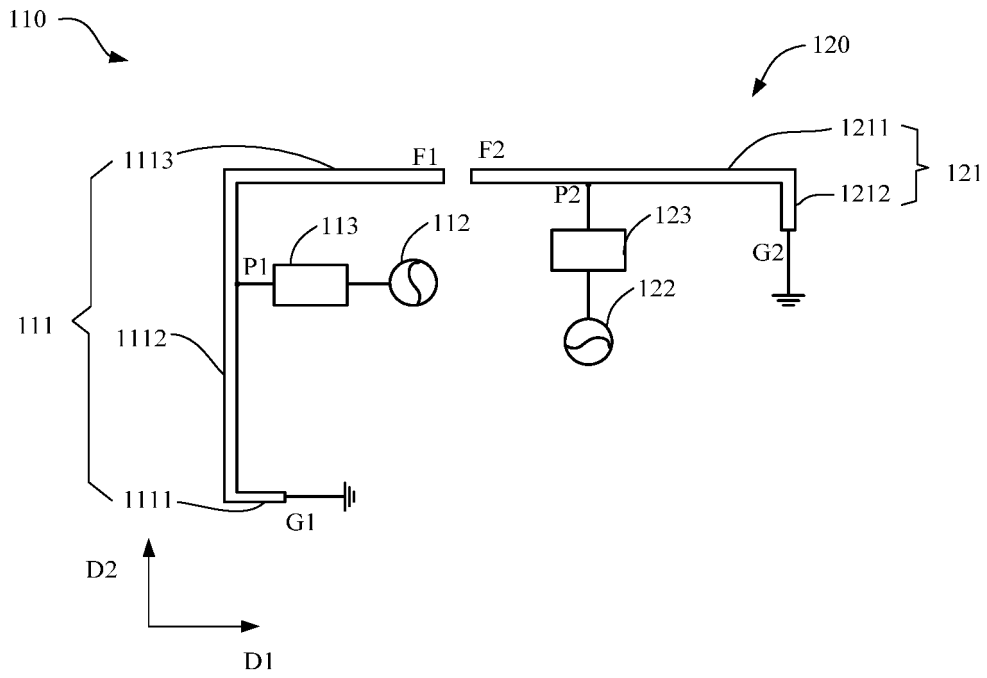


FIG. 12

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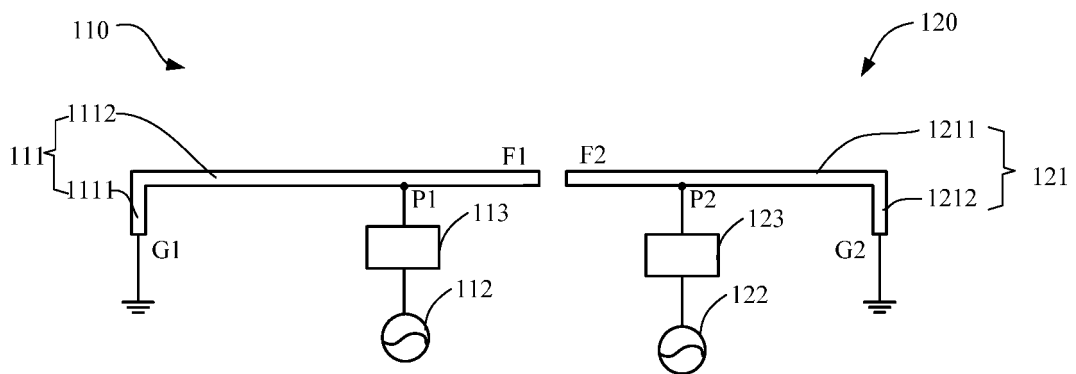


FIG. 13

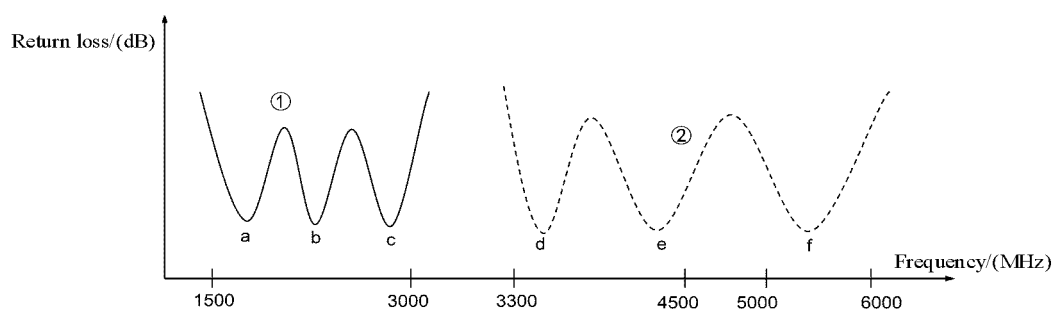


FIG. 14

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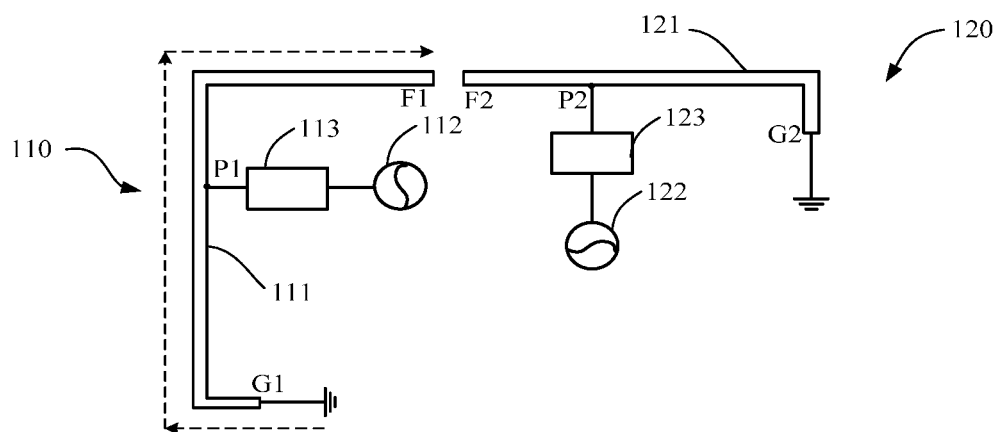


FIG. 15

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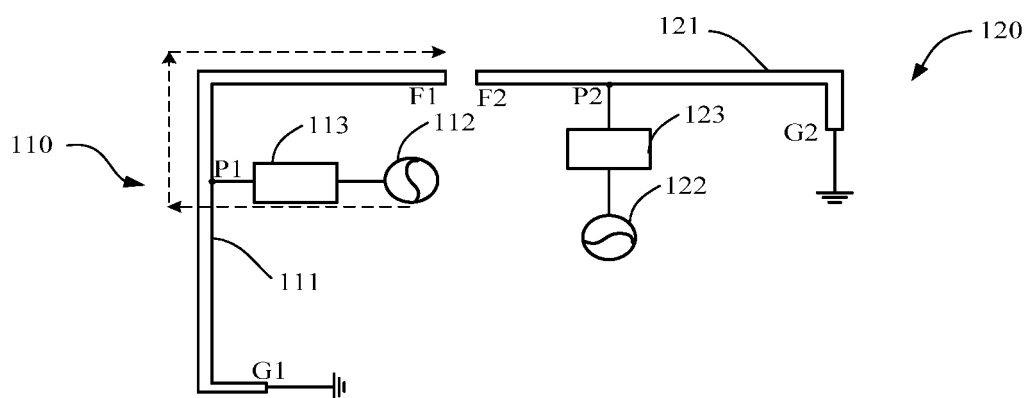


FIG. 16

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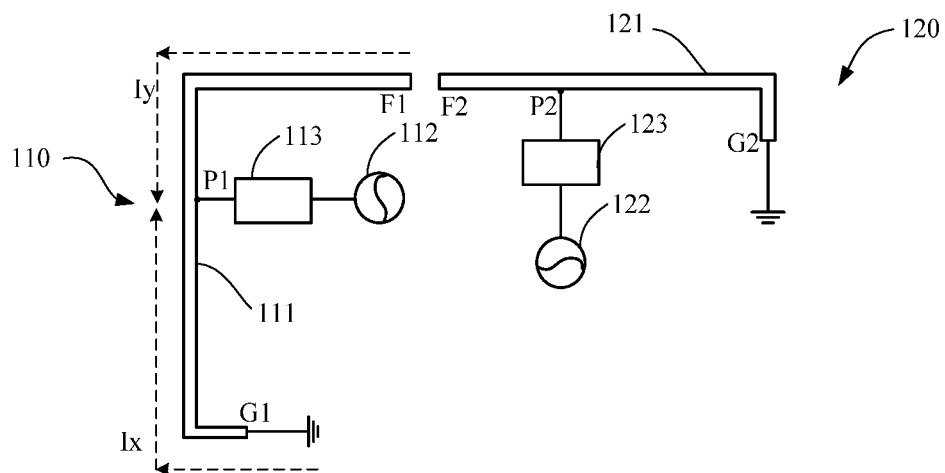


FIG. 17

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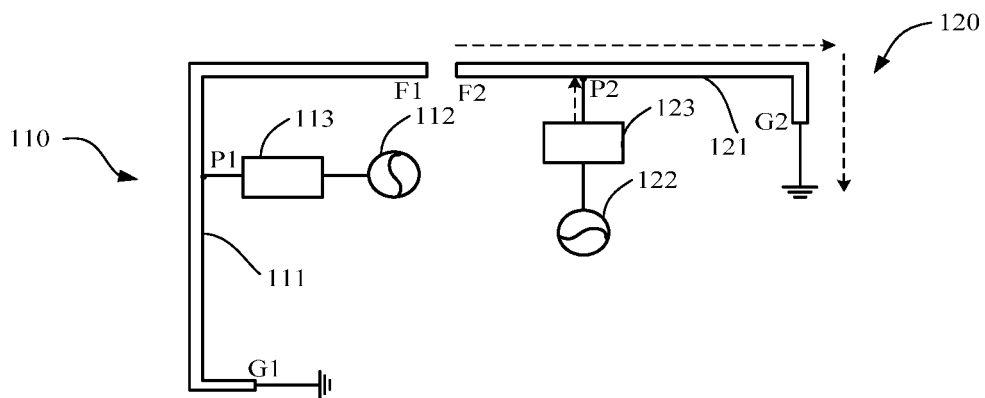


FIG. 18

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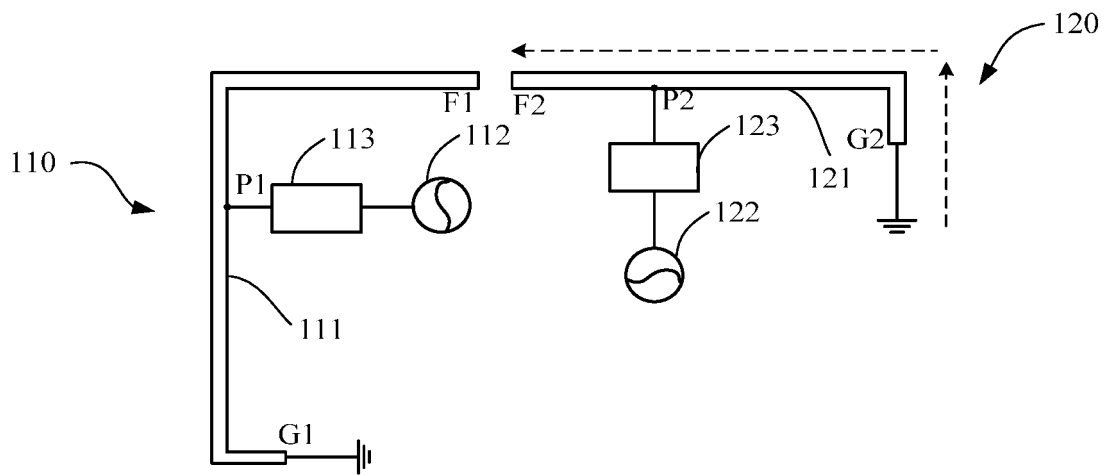


FIG. 19

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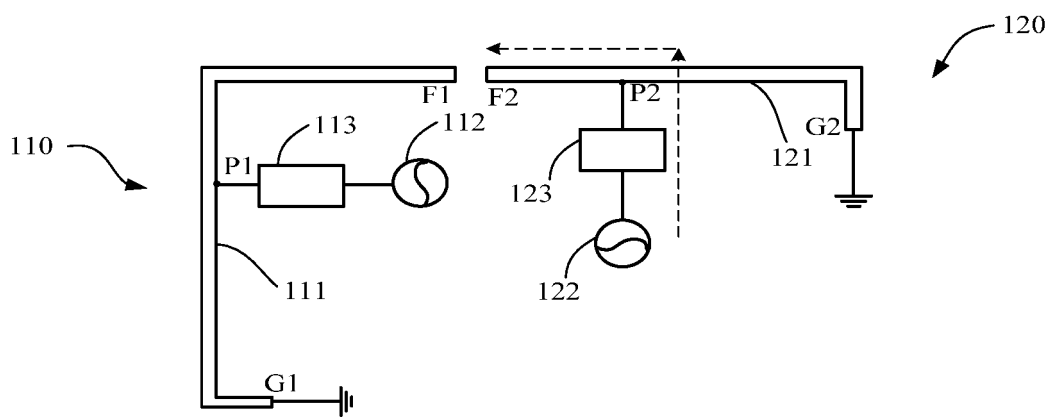


FIG. 20

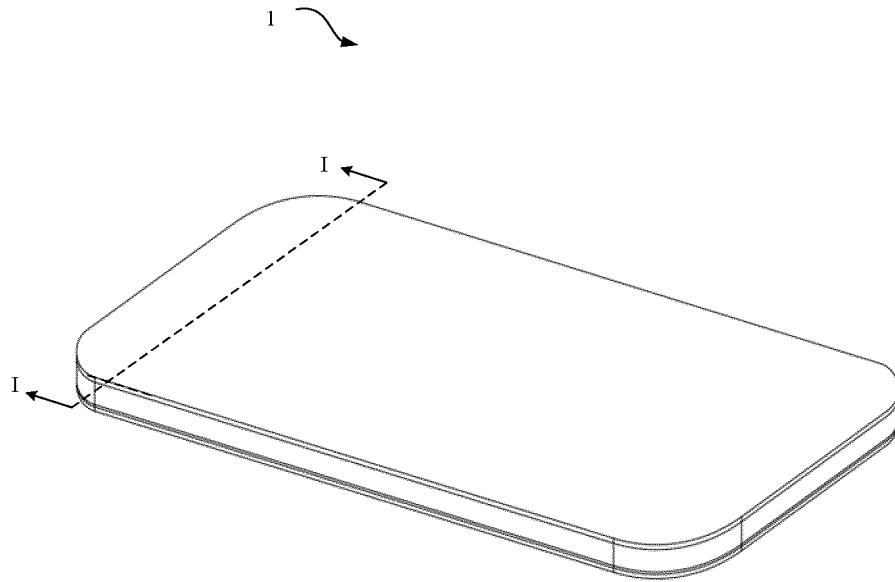


FIG. 21

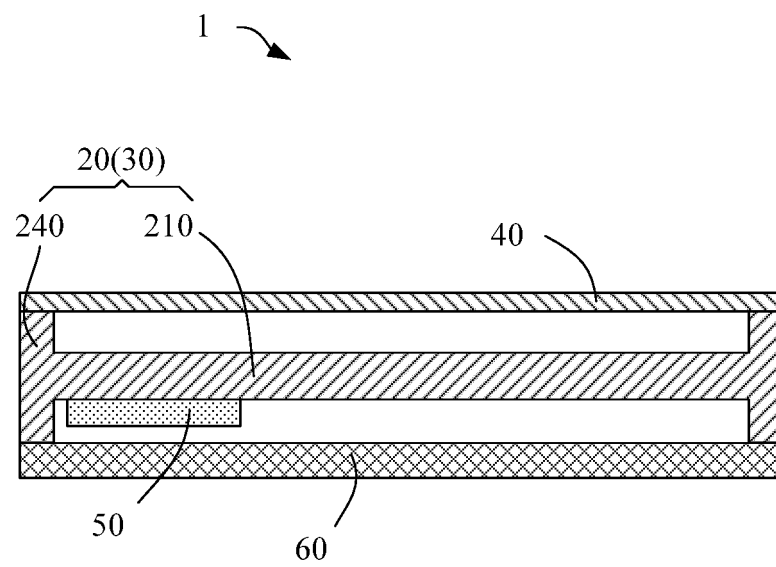


FIG. 22

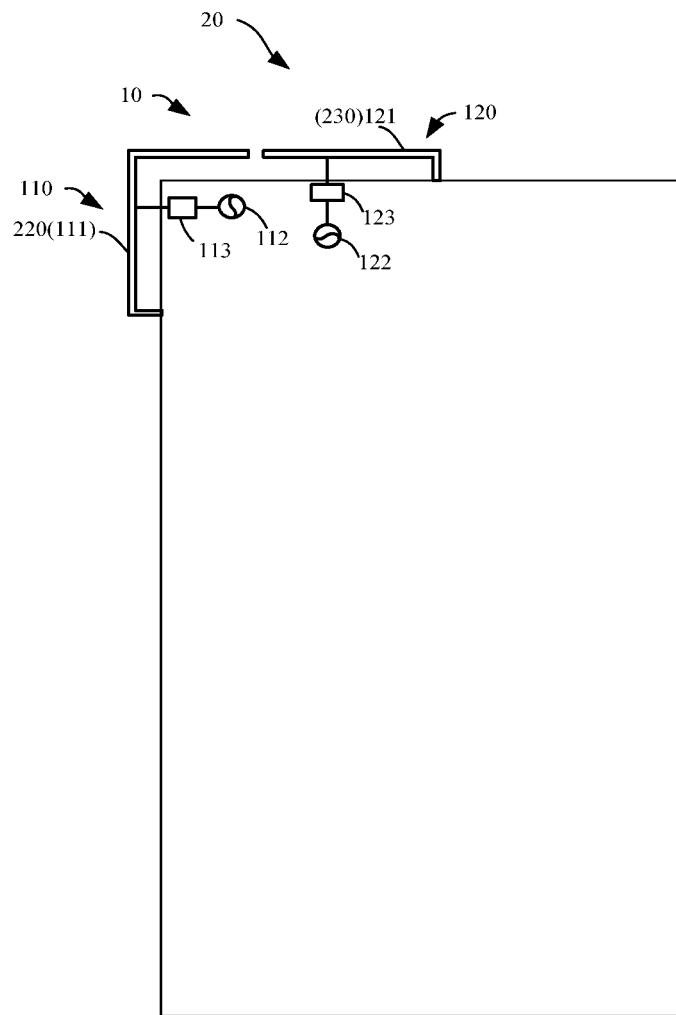


FIG. 23

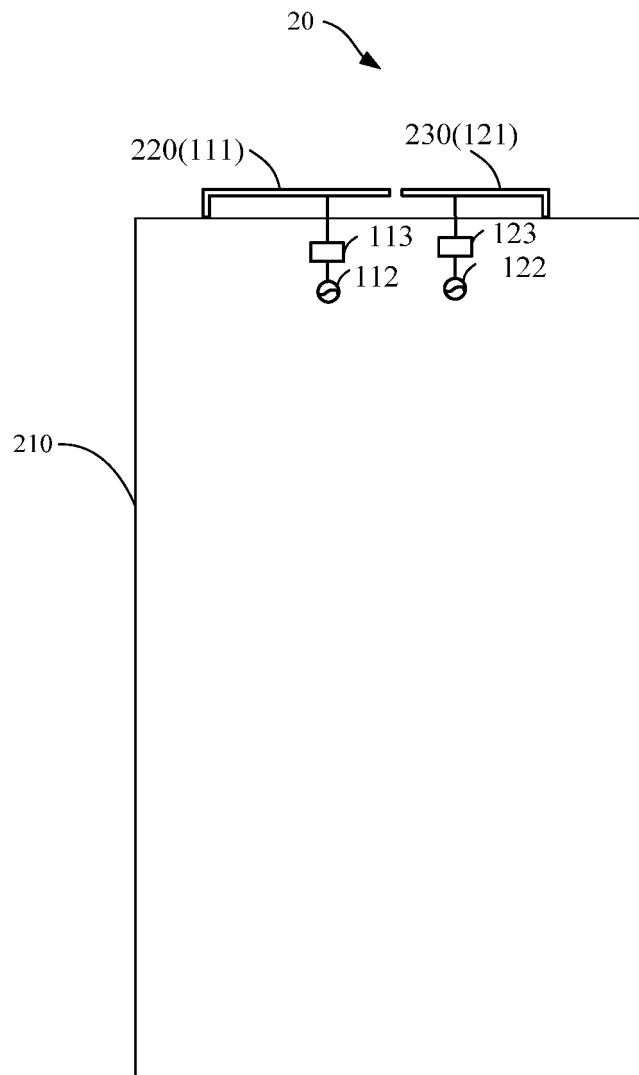


FIG. 24

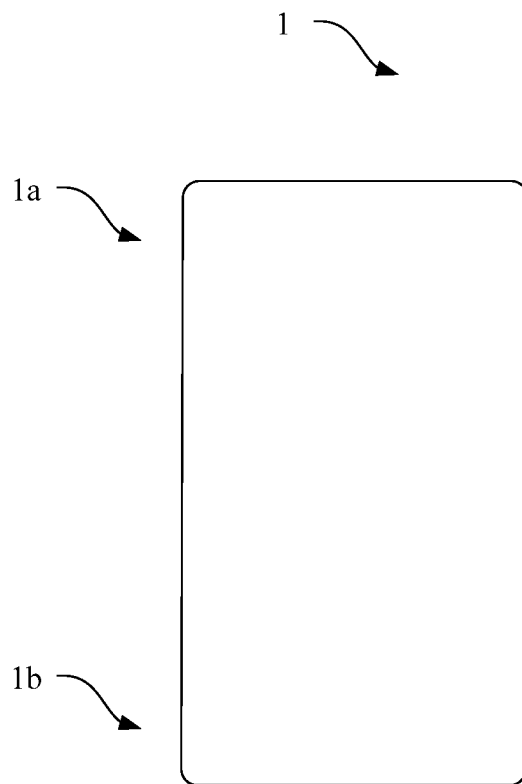


FIG. 25

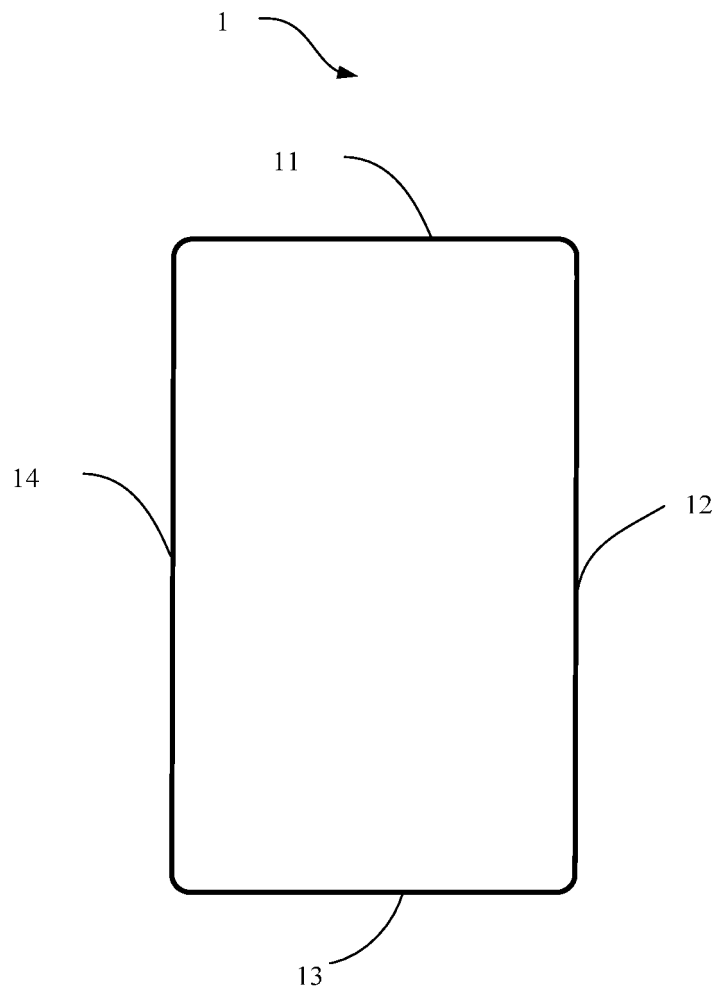


FIG. 26

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/109935

A. CLASSIFICATION OF SUBJECT MATTER H01Q 5/10(2015.01)i; H01Q 5/314(2015.01)i; H01Q 5/335(2015.01)i; H01Q 1/22(2006.01)i; H01Q 1/36(2006.01)i; H01Q 1/44(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC																					
B. FIELDS SEARCHED																					
Minimum documentation searched (classification system followed by classification symbols) H01Q Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																					
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) VEN; CNTXT; CNABS; CNKI; USTXT; EPTXT; WOTXT; IEEE: 天线, 终端, 便携, 谐振, 耦合, 框, 壳体, 缝, 槽, 切口, 开口, antenna, terminal, portable, resonant, couple, housing, shell, frame, slot, slit, groove, gap																					
C. DOCUMENTS CONSIDERED TO BE RELEVANT																					
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>CN 110931956 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 27 March 2020 (2020-03-27) description paragraphs 0022-0051; figures 1, 4-6</td> <td>1,13-16,19,20</td> </tr> <tr> <td>Y</td> <td>CN 110931956 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 27 March 2020 (2020-03-27) description paragraphs 0022-0051; figures 1, 4-6</td> <td>11,12,17,18</td> </tr> <tr> <td>Y</td> <td>CN 108631041 A (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.) 09 October 2018 (2018-10-09) description, paragraphs 0014-0034, figures 1-5</td> <td>11,12,17,18</td> </tr> <tr> <td>A</td> <td>CN 109546311 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 29 March 2019 (2019-03-29) entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 10297906 B2 (LG ELECTRONICS INC.) 21 May 2019 (2019-05-21) entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>EP 2528165 B1 (APPY APPLE INC et al.) 27 May 2020 (2020-05-27) entire document</td> <td>1-20</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	CN 110931956 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 27 March 2020 (2020-03-27) description paragraphs 0022-0051; figures 1, 4-6	1,13-16,19,20	Y	CN 110931956 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 27 March 2020 (2020-03-27) description paragraphs 0022-0051; figures 1, 4-6	11,12,17,18	Y	CN 108631041 A (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.) 09 October 2018 (2018-10-09) description, paragraphs 0014-0034, figures 1-5	11,12,17,18	A	CN 109546311 A (VIVO COMMUNICATION TECHNOLOGY CO., LTD.) 29 March 2019 (2019-03-29) entire document	1-20	A	US 10297906 B2 (LG ELECTRONICS INC.) 21 May 2019 (2019-05-21) entire document	1-20	A	EP 2528165 B1 (APPY APPLE INC et al.) 27 May 2020 (2020-05-27) entire document	1-20
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																					
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Date of the actual completion of the international search 14 October 2021	Date of mailing of the international search report 21 October 2021																				
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451	Authorized officer Telephone No.																				

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International application No.

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 112086753 A (OPPO GUANGDONG MOBILE COMMUNICATIONS CO., LTD.) 15 December 2020 (2020-12-15) entire document	1-20
PX	CN 212277399 U (OPPO GUANGDONG MOBILE COMMUNICATIONS CO., LTD.) 01 January 2021 (2021-01-01) entire document	1-20

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