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

(57) The disclosure is related to a dual-band dipole antenna and an electronic device. The main body of the dual-band dipole antenna is a U-shaped or L-shaped first antenna member (31), and a square-shaped second antenna member (32). The first antenna member (31) is a printed radiator having at least one turning portion. The first antenna member (31) has a first electrical connection member (311), and the second antenna member (32) has a second electrical connection member (321). When a current source feeds signals to the antenna via the

connection members (311, 321) respectively, the currents flowing through the first antenna member (31) and the second antenna member (32) have the same directions. The first antenna member (31) induces a first band electromagnetic wave, and the second antenna member (32) induces a second band electromagnetic wave with optimized induced frequency response when a coupling effect is formed between the first and the second antenna members (32).

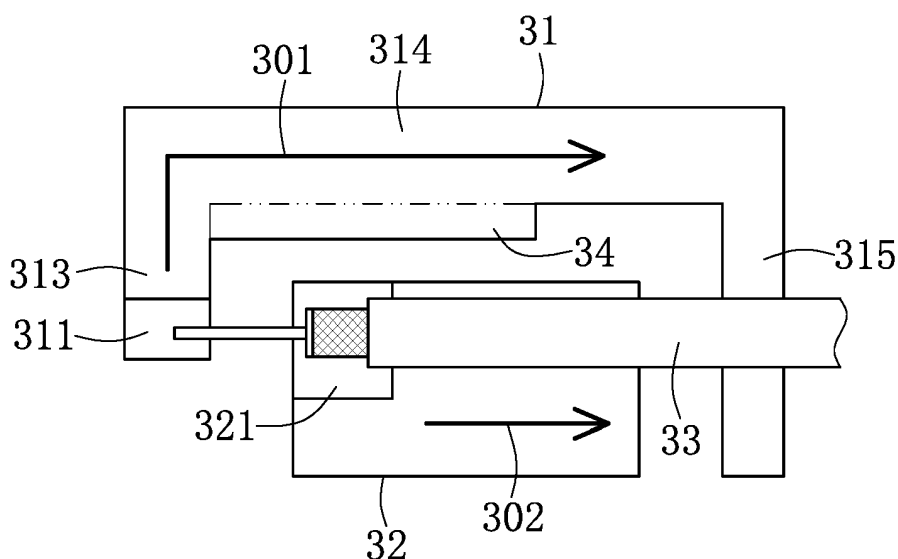


FIG. 3

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention is generally related to a dipole antenna and a system, and in particular to a compact-sized dual-band dipole antenna having a radiator with an isotropic current flow, and an electronic system using the antenna.

2. Description of Related Art

[0002] With the rapid development of modern technology, the computation power and signal processing capability of an electronic device increase by the day. The evolution of broadband network and multimedia service has also caused transmission rate of an electronic device to become one of the greatest demands.

[0003] Current development of electronic devices aims toward a light, thin, short and small-sized design. The current trend for achieving the same is to minimize the components of the electronic device. For example, an antenna inside the electronic device is required to support the use of multiple frequencies while also having a compact design.

[0004] In a conventional technology, a dipole antenna includes two radiators having two directions of current flow. A total length of the two radiators is around a half wavelength. References are made to Fig. 1 and Fig. 2. Fig. 1 shows the two radiators 11 and 12 at two sides of an antenna. The feeding signals are fed to the antenna via a wire 13, and form two opposite directions of currents that are indicated by two arrows in the diagram. Fig. 2 shows an antenna having two symmetric radiators 21 and 22. The currents are fed to the radiators 21 and 22 of the antenna via a wire 23. The arrows in the diagram indicate two opposite current directions over the radiators 21 and 22. The radiators at the two sides of the dipole antenna render a wider radiation field.

SUMMARY OF THE INVENTION

[0005] The disclosure in accordance with the present disclosure is related to a dual-band dipole antenna, and an electronic system adopting the dual-band dipole antenna. The dual-band dipole antenna includes a first antenna member that has a turning portion and forms an L-shaped printed radiator, or a U-shaped printed radiator having two turning portions. The dual-band dipole antenna further includes a second antenna member that is a square-shaped printed radiator with four lateral sides. A coupling effect is induced at the portion between at least two adjacent sides and the first antenna member. A current source is electrically connected with a first electrical connection member of the first antenna member and a second electrical connection member of the first electrical

connection member via a conductor. The arrangement forms a current with the same signal direction over the first antenna member and the second antenna member respectively, and a coupling effect is induced at two adjacent sides of the first antenna member and the second antenna member.

[0006] In one embodiment, the first electrical connection member and the second electrical connection member are disposed at adjacent positions for respectively connecting to a current end and a ground end of a wire in the same direction.

[0007] In one aspect of the disclosure, the first antenna member is used to induce a first band electromagnetic wave; the coupling effect induced at the side of the second antenna member adjacent to the first antenna member causes the second antenna member to induce a second band electromagnetic wave with an optimized frequency response.

[0008] The disclosure is also related to an electronic system that is such as wireless network equipment adopting the aforementioned dual-band dipole antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 shows a schematic diagram depicting a conventional dipole antenna;

Fig. 2 shows another conventional dipole antenna;

Fig. 3 shows a schematic diagram depicting a dual-band dipole antenna according to one embodiment of the present disclosure;

Fig. 4 shows another schematic diagram depicting the dual-band dipole antenna according to another embodiment of the present disclosure;

Fig. 5 shows a schematic diagram depicting the dual-band dipole antenna in one further embodiment of the present disclosure;

Fig. 6 shows another schematic diagram depicting the dual-band dipole antenna according to another embodiment of the present disclosure;

Fig. 7 shows the VSWR of the antenna in one embodiment of the present disclosure; and

Fig. 8 shows a schematic diagram depicting the main circuit components of an electronic system using the dual-band dipole antenna in one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the disclosure are shown. This disclosure may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this dis-

closure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art.

[0011] The disclosure is related to a dual-band dipole antenna and an electronic system adopting the dual-band dipole antenna in accordance with the present disclosure. One of the objectives of the present disclosure is to provide a compact-sized printed antenna, e.g. a dual-band dipole antenna, having a band applied to the antenna that is easily adjustable. It should be noted that the area of the compact-sized antenna is smaller than the conventional dipole antenna. In one example, the size of the compact-sized antenna is reduced by more than 50-70% of the size of the conventional dipole antenna. In this manner, the compact-sized dual-band dipole antenna can be applicable to two frequency bands, e.g. 2G and 5G bands. Further, this compact-sized printed antenna can save material cost of the printed antenna, and can be used for more applications. For example, the dual-band dipole antenna can be used in an electronic system, e.g. a wireless transmission device.

[0012] The dual-band dipole antenna can be adjusted and corrected on as desired for reaching a specific application. The dual-band dipole antenna is configured to have an independent ground, but not any additional ground for a common antenna. This configuration of the antenna allows the dual-band dipole antenna to be disposed in any position inside the electronic system without being limited by the requirement of being connected to the ground of the system. The signals for the dual-band dipole antenna can be fed to a feeding point of the antenna via a wire. For example, the wire is such as a 50Ω coaxial cable soldered to the feeding point of the antenna. The other end of the wire can be extended to an RF module of the electronic system. Further, according to one embodiment, the dual-band dipole antenna can be printed on a circuit board. Compared with the conventional three-dimensional antenna, the printed dual-band dipole antenna can reduce mold cost and assembly cost, and prevent the risk of deformation.

[0013] Reference is made to Fig. 3 showing a schematic diagram of the dual-band dipole antenna in one embodiment of the present disclosure. The antenna has a U-shaped or inverted U-shaped radiator that forms a first antenna member 31 of the antenna, and a square-shaped or near square-shaped second antenna member 32.

[0014] The radiator of the dual-band dipole antenna has at least one turning portion. The first antenna member 31 is a printed radiator with two turning portions that form a first radiation member 313, a second radiation member 314, and a third radiation member 315 of the first antenna member 31. The first radiation member 313 at the left side of the diagram, which is similar with the first radiation member 413 shown in Fig. 4, has a first electrical connection member 311. The second antenna member 32 is a near-square shaped printed radiator. The printed second antenna member 32 is surrounded by the U-shaped first antenna member 31. The radiator at the

upper-left corner of the second antenna member 32 has a second electrical connection member 321.

[0015] In one embodiment, the first antenna member 31 is configured to have a first radiation member 313, a second radiation member 314, and a third radiation member 315 that form two turning portions of the U-shaped antenna. It should be noted that a length of the second radiation member 314 and the third radiation member 315 is larger than one half of a total length of the dual-band dipole antenna.

[0016] In one example, the currents flowing through the first antenna member 31 and the second antenna member 32 form a same signal direction. For forming the same signal direction the first and second antenna members 31 and 32, the first electrical connection member 311 and the second electrical connection member 321 may be disposed at two adjacent positions that correspond to each other. In one embodiment, the first electrical connection member 311 acts as a signal-feeding over the first radiation member 313 for the first antenna member 31. The second electrical connection member 321 of the second antenna member 32 is at the opposite position adjacent to the first radiation member 313 of the first antenna member 31. The second electrical connection member 321 acts as a grounding area for the second antenna member 32. This configuration of the antenna mentioned above is for the wire 33 connected with a current end and a grounding end over the same direction since the first electrical connection member 311 forms a signal-feeding area for the first antenna member 31, and the second electrical connection member 321 forms a grounding area for the second antenna member 32. In this example, the wire 33 is arranged in a horizontal direction from left to right.

[0017] According to one of the embodiments of the present disclosure, the wire 33 acts as a conductor that can be a coaxial cable. The coaxial cable is a type of cable that has an inner conductor acting as the current end surrounded by a tubular insulating layer conducting a shield, and an outer shield acting as the grounding end sharing a geometric axis. The current end and the grounding end are connected with the first electrical connection member 311 and the second electrical connection member 321 respectively. A current source is electrically connected to the first electrical connection member 311 and the second electrical connection member 321 over the wire 33. The current along the wire 33 forms a first signal direction 301 over the first antenna member 31 and a second signal direction 302 over the second antenna member 32. It is preferable that the configuration of the antenna forms a current with the same signal direction over the first antenna member and the second antenna member respectively. A coupling effect is particularly induced at the two adjacent sides of the first antenna member and the second antenna member.

[0018] In one embodiment of the present disclosure, the first antenna member 31 is used to induce a first band electromagnetic wave; the coupling effect induced at the

side of the second antenna member 32 adjacent to the first antenna member 31 causes the second antenna member 32 to induce a second band electromagnetic wave with an optimized frequency response. In this embodiment, the first band electromagnetic wave is exemplified as being around 2GHz, and the second band electromagnetic wave is exemplified as being around 5GHz.

[0019] Further, in a structural arrangement, the first antenna member 31 has a conductor structure 34 formed at a turning portion. The conductor structure 34 acts as a function of impedance matching. It should be noted that the structure of impedance matching is not limited to the current embodiment.

[0020] Still further, the wire 33 electrically connects to the first antenna member 31 or the second antenna member 32 using the joining method such as, but not limited to, welding, brazing, soldering, swaging, riveting, or a screw.

[0021] In addition to the U-shaped first antenna member of the dual-band dipole antenna, an L-shaped printed radiator having only one turning portion can be used. Reference is made to Fig. 4 showing an L-shaped radiator of the first antenna member of the antenna according to one embodiment of the present disclosure.

[0022] An L-shaped first antenna member 41 can be divided into a first radiation member 413 and a second radiation member 414 by the turning portion. A first electrical connection member 411 is formed at one end of the first radiation member 413. An additional conductor structure 415 formed at the turning portion of the L-shaped first antenna member 41 can be used to tune an operating frequency of the antenna. The conductor structure 415 is exemplified as a square-shaped conductor. It should be noted that, in the L-shaped antenna, a length of the second radiation member 414 is larger than one half of a total length of the dual-band dipole antenna.

[0023] In this embodiment, the second antenna member 42 of the dual-band dipole antenna is still a near-square shaped printed radiator. The position of the second electrical connection member 421 is opposite to the first electrical connection member 411. A wire 43 is connected to the first electrical connection member 411, which acts as a signal-feeding area, and the second electrical connection member 421, which acts as a grounding area, along the same direction.

[0024] A coupling effect can also be induced between the first antenna member 41 and the second antenna member 42. When a current is fed to the antenna via the first electrical connection member 411 and the second electrical connection member 421 respectively, the same signaling direction is formed over the first antenna member 41 and the second antenna member 42. The coupling effect is induced to generate an additional operating frequency of the antenna.

[0025] As shown in Fig. 5, according to one of the embodiments of the present disclosure, an antenna mainly includes a first antenna member 51 and a second antenna member 52. The first antenna member 51 can be di-

vided into a first radiation member 513 and a second radiation member 514 by a turning portion. A first electrical connection member 511 is formed on the first radiation member 513 of the first antenna member 51, and a second electrical connection member 521 is formed on the second antenna member 52.

[0026] According to the structural arrangement of the antenna, a first conductor structure 515 formed at the turning portion of the first antenna member 51 is used to conduct an impedance matching. Further, an extended portion of the first radiation member 513 forms a second conductor structure 516. In one example, the second conductor structure 516 is a structural portion extending downwardly from the first electrical connection member 511. It should be noted that the first electrical connection member 511 and the second electrical connection member 521 are still maintained at the two opposite positions allowing the current to flow through the first antenna member 51 and the second antenna member 52 along the same direction.

[0027] It is also worth noting that the configuration of the impedance matching structure may not be excluded for other applications that have two turning portions of the antenna.

[0028] The dual-band dipole antenna exemplarily shown in Fig. 6 describes the configuration of scales of a first antenna member 61 and a second antenna member 62 thereof. A turning portion of the dual-band dipole antenna is provided in this example.

[0029] Structurally, a first electrical connection member 611 of the first antenna member 61 and a second electrical connection member 621 of the second antenna member 62 are formed at two opposite positions that can facilitate a wire connected to the antenna along a predetermined direction. In one example, the radiator of the first antenna member 61 is used to induce a first band electromagnetic wave; the radiator of the second antenna member 62 is used to induce a second band electromagnetic wave. Further, the coupling effect induced at the side of the second antenna member adjacent to the first antenna member causes the second antenna member to induce the second band electromagnetic wave with an optimized frequency response.

[0030] Reference is made to Fig. 6, illustrating the configuration of the antenna according to one of the embodiments of the present disclosure. A proportional relationship is shown to exist structurally between a radiator length L of first antenna member and a radiator length A of second antenna member.

[0031] For example, the length of the first antenna member is 'L', but its maximum length can be 'L'; the length of the second antenna member is 'a' or its maximum length 'A'. The change of the length 'a' of the second antenna member can be 'a' plus a first length ' Δa_1 ', 'a' plus a second length ' Δa_2 ', and 'a' plus a third length ' Δa_3 '.

[0032] For inducing the first band electromagnetic wave, the length 'L' of the first antenna member may

have a certain proportional relationship with the wavelength of the first band electromagnetic wave. Similarly, the length 'a' of the second antenna member should reach a certain length for inducing the second band electromagnetic wave. Further, the coupling effect induced between the first antenna member 61 and second antenna member 62 may also be taken into account for reaching the second band electromagnetic wave. For example, both a first coupling distance d1 and a second coupling distance d2 should be taken into account for reaching a certain band of electromagnetic wave when the length 'L' of the first antenna member and the length 'a' of the second antenna member are defined.

[0033] In one example, a proportion 'L/a' of the length 'L' of the first antenna member and the length 'a' of the second antenna member is provided. This proportion 'L/a' changes with the change of length of the second antenna member 62. The proportion 'L/a' has a maximum value that may be limited within a certain range. The limitation of the proportion 'L/a' allows the dual-band dipole antenna to function under a certain range of the electromagnetic wave as demanded by the electronic system. °

[0034] Reference is made to Fig. 7, illustrating the performance of the VSWR of the dual-band dipole antenna in accordance with the present disclosure.

[0035] In the diagram, a horizontal axis of the histogram represents frequency (GHz), and a vertical axis of the histogram indicates return loss (dB). The experimental data of the return loss shows several operating frequencies being applicable to the dual-band dipole antenna. For example, a first mark 1 on the curve indicates a return loss 1.8716 around the frequency 2.4GHz; a second mark 2 indicates a return loss 1.6695 around the frequency 2.45GHz; and a third mark 3 indicates a return loss 1.7719 around the frequency 2.5GHz. Accordingly, the dual-band dipole antenna can apply to the operating frequency around 2400MHz to 2500MHz, which is applicable to IEEE802.11 b/g based wireless communication protocol. It should be noted that a fourth mark 4 indicates a return loss 1.6173 around the frequency 4.9GHz and a fifth mark 5 indicates a return loss 1.3467 around 5.85GHz that allow the dual-band dipole antenna to be applied to the operating frequency 4900MHz to 5850MHz and that meets IEEE802.11 ac based wireless communication protocol. Therefore, the dual-band dipole antenna achieves the dual-band applications.

[0036] The disclosure is also directed to an electronic system, e.g. a wireless network device, which adopts the aforementioned dual-band dipole antenna in accordance with the present disclosure. Reference is made to Fig. 8 showing a schematic diagram depicting the main electronic components of the electronic system. A dual-band dipole antenna 81 formed on a circuit board 80 of the electronic system is shown. The main components of the electronic system include a ground plane 84, an RF module 83, a baseband module 85, and a member unit 87.

[0037] The RF module 83 is the circuit for processing

the wireless signals that is electrically connected with the dual-band dipole antenna 81. The RF module 83 is used to convert the signals received by the antenna 81, or convert the signals to the electromagnetic wave to be transmitted. The signals reaching the dual-band dipole antenna 81 are received by the RF module 83, and processed by the baseband module 85. The signals can be buffered to the member unit 87 and then provided to the electronic system. Alternatively, the signals generated by the electronic system are processed by the baseband module 85, and converted to the electromagnetic wave by the RF module 83. The dual-band dipole antenna 81 then sends out the electromagnetic wave.

[0038] Thus, rather than having two opposite directions of current flow as in the conventional dipole antenna, the dual-band dipole antenna of the present disclosure has an isotropic current flow through its two radiators. Further, the dual-band dipole antenna has an independent ground so as to achieve the benefits of miniaturization and wide application.

[0039] It is intended that the specification and depicted embodiment be considered exemplary only, with a true scope of the invention being determined by the broad meaning of the following claims.

Claims

1. A dual-band dipole antenna, **characterized by:**

a first antenna member (31) having a printed radiator with at least one turning portion and a first electrical connection member (311);
a second antenna member (32) being a square-shaped printed radiator having a second electrical connection member (321);
wherein, a current source is electrically connected with the first electrical connection member (311) and the second electrical connection member (321) via a conductor, and forms a current with the same signal direction over the first antenna member (31) and the second antenna member (32) respectively, and a coupling effect is induced at two adjacent sides of the first antenna member (31) and the second antenna member (32).

2. The antenna as recited in claim 1, **characterized in that** the first antenna member (31) includes one turning portion that forms an L-shaped radiator.

3. The antenna as recited in claim 2, **characterized in that** the L-shaped radiator includes a first radiation member (413) and a second radiation member (414) that form the turning portion of the first antenna member (31).

4. The antenna as recited in claim 3, **characterized in**

that, a length of the second radiation member (414) is larger than one half of a total length of the dual-band dipole antenna.

5. The antenna as recited in claim 1, **characterized in that** the first antenna member (31) includes two turning portions that form a U-shaped radiator. 5
6. The antenna as recited in claim 5, **characterized in that** the U-shaped radiator includes a first radiation member (313), a second radiation member (314), and a third radiation member (315) that form the two turning portions of the first antenna member (31). 10
7. The antenna as recited in claim 6, **characterized in that**, a length of the second radiation member (314) and the third radiation member (315) is larger than one half of a total length of the dual-band dipole antenna. 15
8. The antenna as recited in any of claims 1 to 7, **characterized in that** the first electrical connection member (311) is disposed on the first radiation member (313) of the first antenna member (31) and forms a signal-feeding area; the second electrical connection member (321) is disposed at one side of the second antenna member (32) where the side is adjacent to the first radiation member (313) of the first antenna member (31), and the second electrical connection member (321) forms a grounding area. 20
9. The antenna as recited in claim 8, **characterized in that** the first antenna member (31) is used to induce a first band electromagnetic wave; the coupling effect induced at the side of the second antenna member (32) adjacent to the first antenna member (31) causes the second antenna member (32) to induce a second band electromagnetic wave with an optimized frequency response. 25
10. The antenna as recited in claim 9, **characterized in that** the first electrical connection member (311) and the second electrical connection member (321) are disposed at the adjacent portion for respectively connecting to a current end and a ground end of a wire along the same direction. 30
11. The antenna as recited in claim 10, **characterized in that** the first antenna member (31) includes a conductor structure that is used to tune up an impedance matching of the antenna, and the conductor structure includes an extended structure of the first radiation member (313). 35
12. The antenna as recited in claim 11, **characterized in that** the conductor structure includes a turning portion between the first radiation member (313) and the second radiation member (314) of the first antenna member (31). 40

tenna member (31).

13. An electronic system including a dual-band dipole antenna, **characterized in that** the dual-band dipole antenna comprises: 5

a first antenna member (31) having a printed radiator with at least one turning portion and a first electrical connection member (311);
a second antenna member (32) being a square-shaped printed radiator having a second electrical connection member (321);
wherein, a current source is electrically connected with the first electrical connection member (311) and the second electrical connection member (321) via a conductor, and forms a current with the same signal direction over the first antenna member (31) and the second antenna member (32) respectively, and a coupling effect is induced at two adjacent sides of the first antenna member (31) and the second antenna member (32). 10

14. The system as recited in claim 13, **characterized in that** the first antenna member (31) of the dual-band dipole antenna includes a first radiation member (413) and a second radiation member (414) that form an L-shaped radiator and a turning portion; in which a length of the second radiation member (414) is larger than one half of a total length of the dual-band dipole antenna. 15

15. The system as recited in claim 13, **characterized in that** the first antenna member (31) of the dual-band dipole antenna includes a first radiation member (313), a second radiation member (314), and a third radiation member (315) that form a U-shaped radiator and two turning portions; in which a length of the second radiation member (314) and the third radiation member (315) is larger than one half of a total length of the dual-band dipole antenna. 20

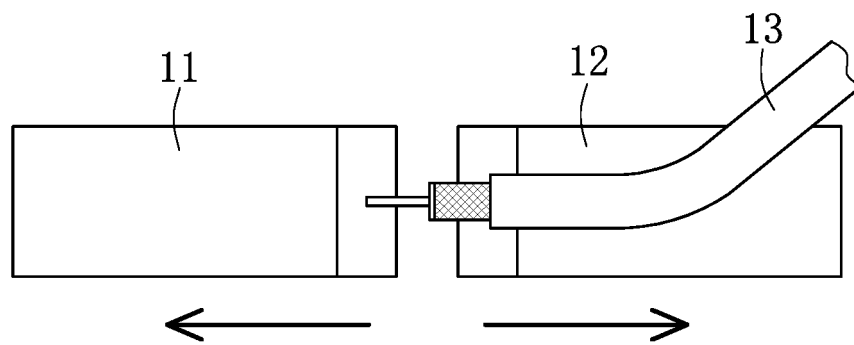


FIG. 1
PRIOR ART

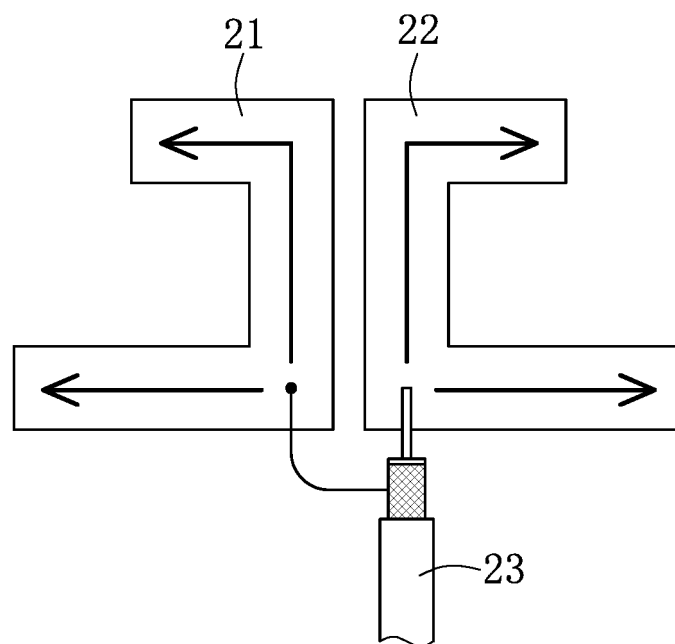


FIG. 2
PRIOR ART

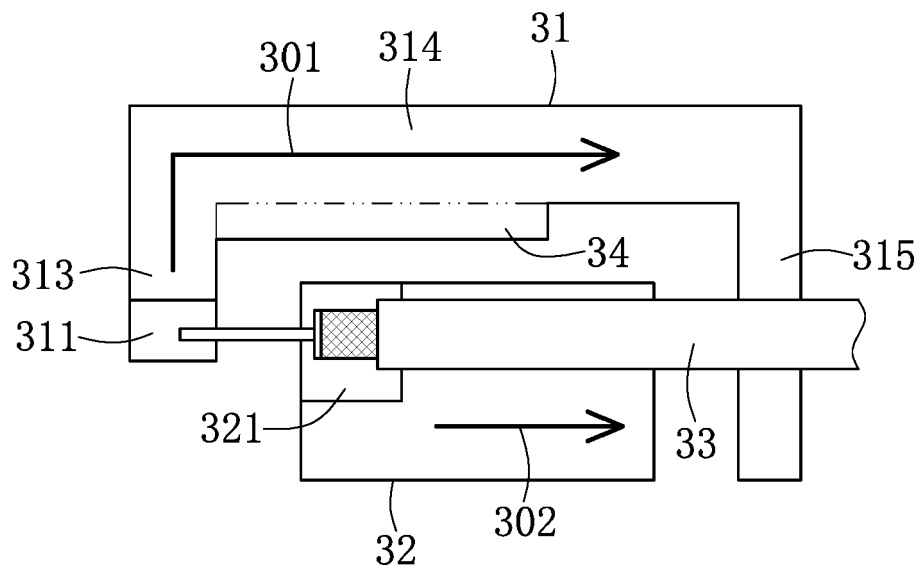


FIG. 3

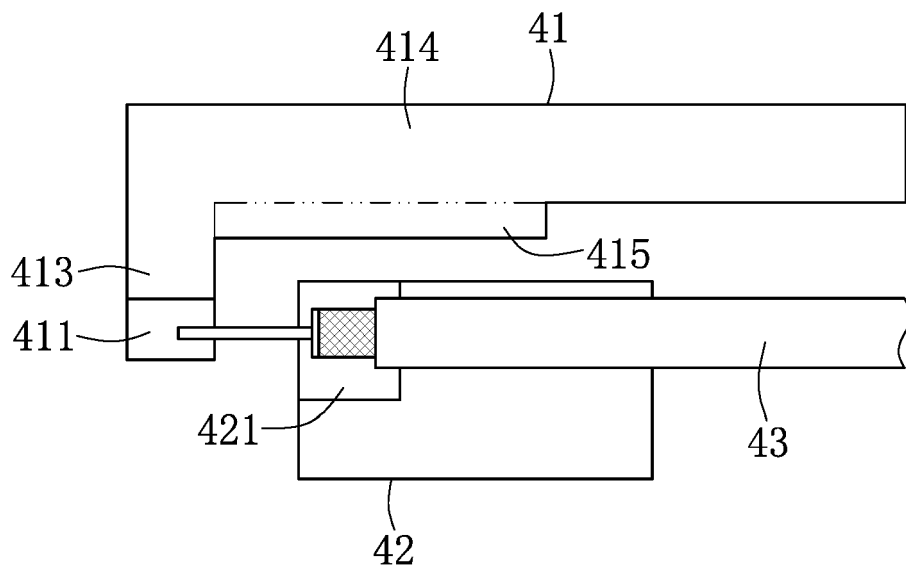


FIG. 4

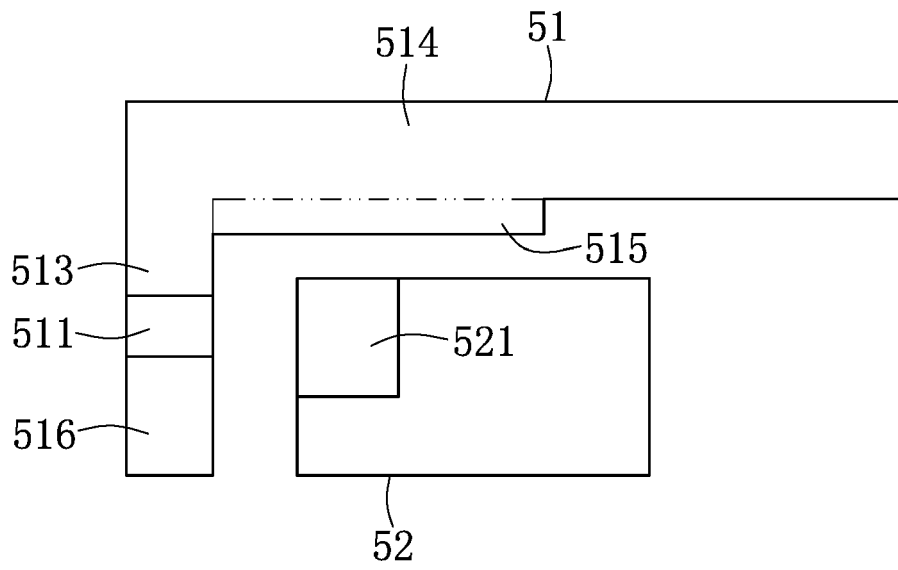


FIG. 5

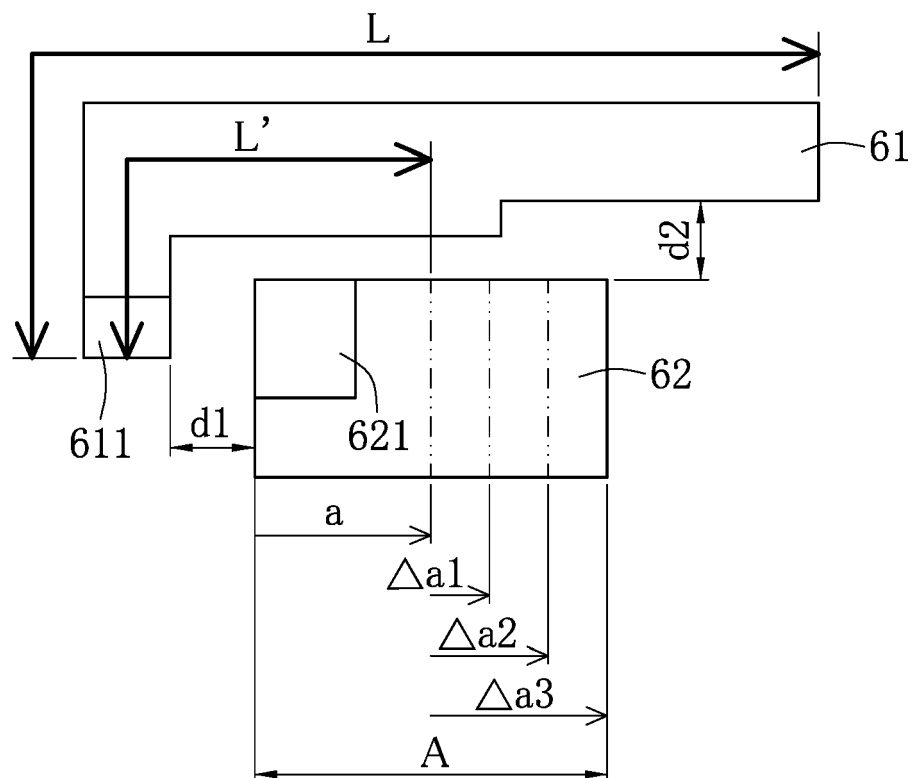


FIG. 6

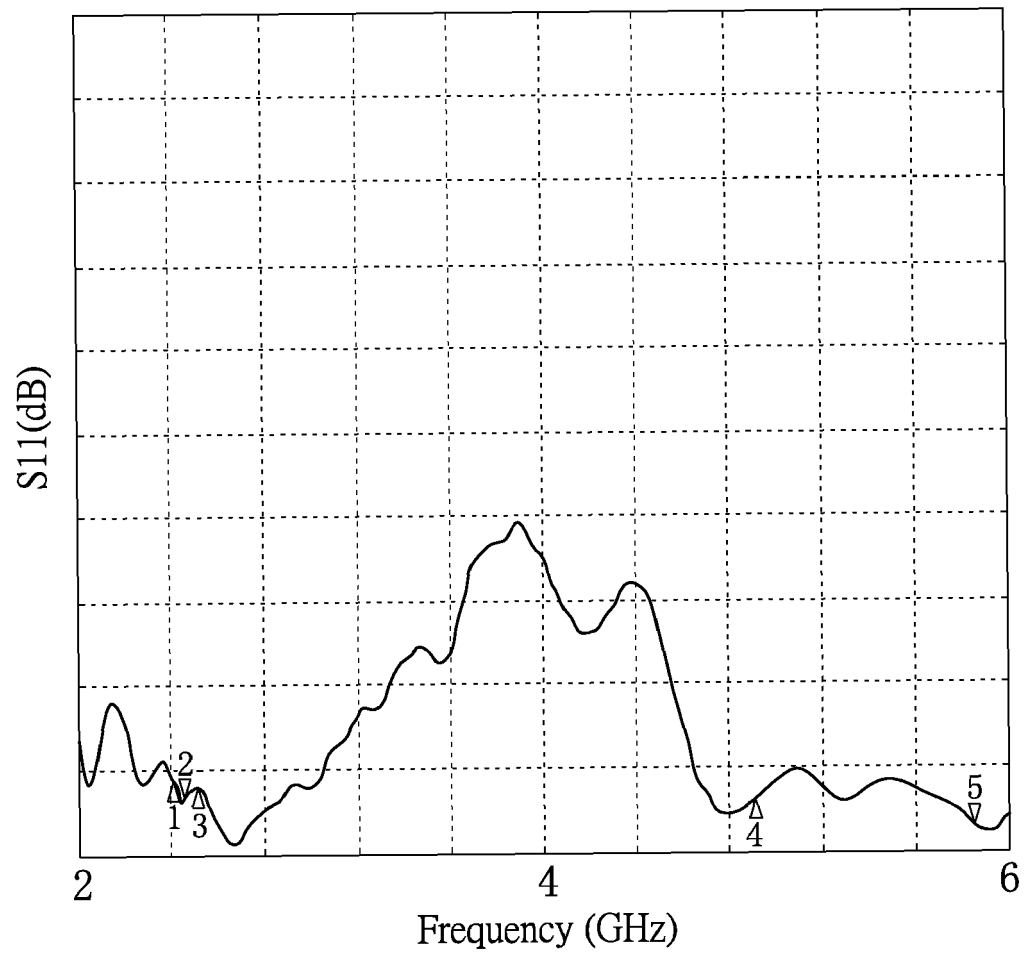


FIG. 7

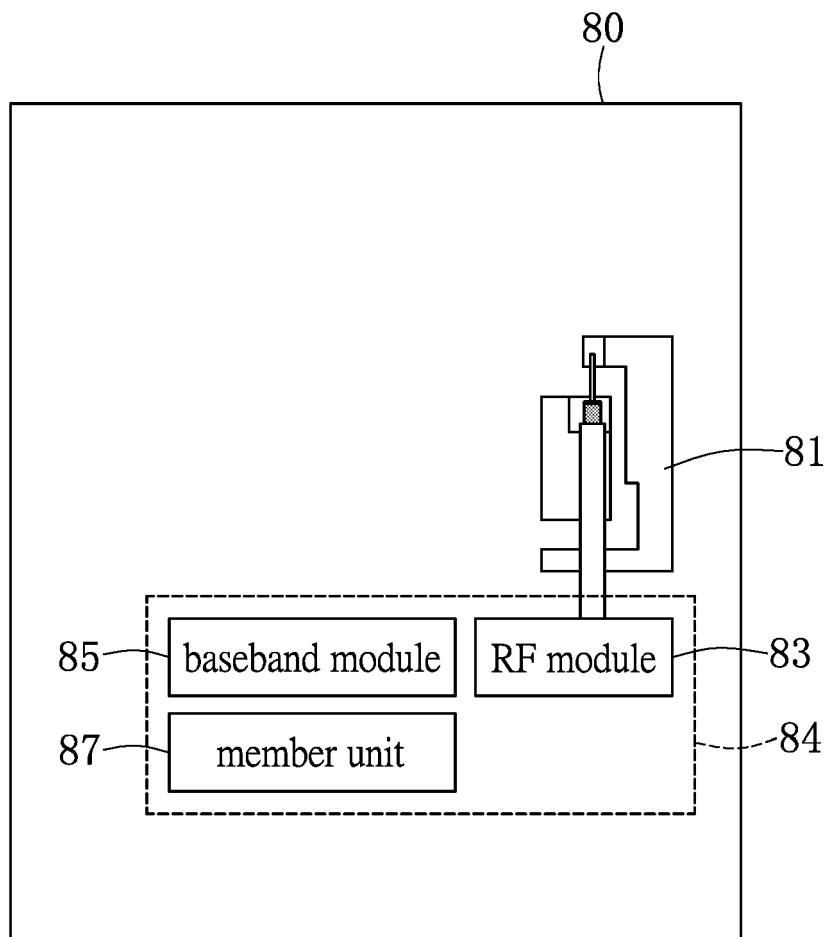


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 0110

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 November 2017	Examiner Hüschelrath, Jens
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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