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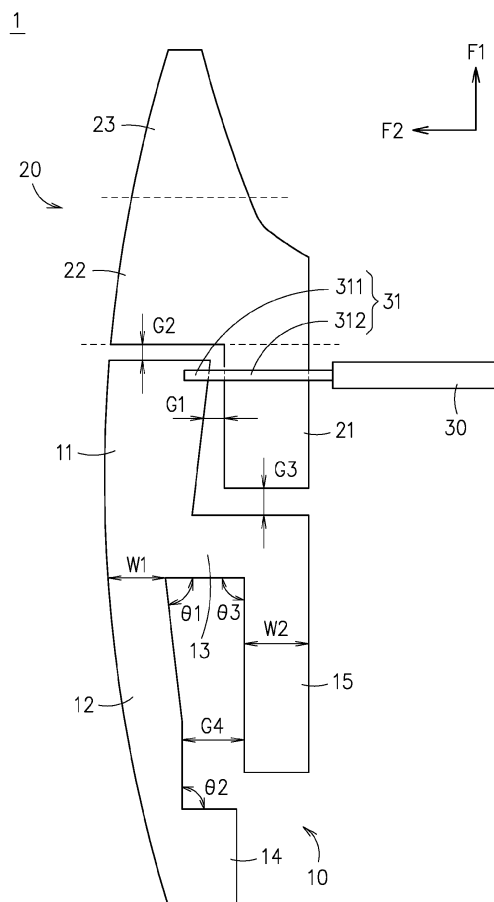
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(54) **DUAL-BAND ANTENNA**

(57) A dual-band antenna (1) includes a first radiation part (10) and a second radiation part (20). The first radiation part (10) as a unique piece includes a first main block (11), first and second extension parts (12), (13), and first and second bending parts (14), (15). The first extension part (12) is disposed between the first bending part (14) and the first main block (11). The second extension part (13) is disposed between the second bending part (15) and the first main block (11). The second radiation part (20) as a unique piece includes a second main block (12), a connecting block (22) and a matching part (23). The connecting block (22) is disposed between the second main block (12) and the matching part (23). The first main block (11) is spaced from the second main block (21) by a first gap (G1), the connecting block (22) is spaced from the first main block (11) by a second gap (G2), and the second main block (21) is spaced from the second extension part (13) by a third gap (G3).



Description**BACKGROUND OF THE INVENTION****(1) Field of the Invention**

[0001] The invention relates to a dual-band antenna, and more particularly to the dual-band antenna that is featured in a small size, less occupation, less cost and an independent design, that can be constructed on an insulated base plate such as a printed circuit board, whose frequency of resonance mode can be easily adjusted, and upon which a demanding frequency band of a wireless local network system can be obtained.

(2) Description of the Prior Art

[0002] With progress in technology, various types and sizes of antennas have been developed for handheld electronic devices (such as mobile phones or notebook computers) and wireless communication devices (such as USB Dongles, Wireless LAN Cards, or APs). For example, a printed antenna featured in lightweight, simple structure and well communicative efficiency, and already proved to be adequate to be constructed on an inner wall of an electronic device, has been widely applied to perform wireless communication for various handheld electronic devices or notebook computers.

[0003] Nevertheless, the conventional antenna does have some shortcomings anyway. By having a conventional dual-band antenna as an example, this type of antenna is featured in broader planar area, larger space occupation and higher cost, but needs a specific ground leg. With the limitation of having the ground leg to connect with a ground of the system, the dual-band antenna is not suitable to be used for a miniaturized electronic device.

[0004] Thus, the present invention provides a dual-band antenna featured in a small size, less cost, and independent design. This design can be disposed on an insulated base plate such as a printed circuit board, wherein a demanding frequency band of a wireless device can be achieved.

SUMMARY OF THE INVENTION

[0005] Accordingly, in one embodiment of the present invention, a dual-band antenna includes:

a first radiation part, made of a conductive material, including:

a first main block;

a first extension part, extending from one side of the first main block;

a second extension part, extending from the first ex-

tension part by opposing to the first main block with respect to the first extension part, extending in a direction different to another extending direction of the first extension part, a angle being formed between the second extension part and the first extension part;

a first bending part, extending from the first extension part by opposing to the first main block with respect to the first extension part, a longitudinal direction of the first bending part being different to that of the first extension part; and

a second bending part, extending from the second extension part by opposing to the first main block with respect to the the first extension part, a longitudinal direction of the second bending part being different to that of the second extension part; and

a second radiation part, made of another conductive material, including:

a second main block;

a connecting block, extending from the second main block; and

a matching part, extending from the connecting block by opposing to the second main block with respect to the connecting block;

wherein the first main block is spaced from the second main block by a first gap, the connecting block is spaced from the first main block by a second gap, the second main block is spaced from the second extension part by a third gap, one end of a soldering section of a signal line is soldered onto the first main block as a signal-feeding end, and another end of the soldering section of the signal line is soldered onto the second main block as a ground for feed signals.

[0006] All these objects are achieved by the dual-band antenna described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention will now be specified with reference to its preferred embodiment illustrated in the drawings, in which:

FIG.1 is a schematic view of an embodiment of the dual-band antenna in accordance with the present invention;

FIG.2 is a schematic top view of the dual-band antenna of FIG. 1 printed on a base plate;

FIG.3 shows schematically a plot of return loss for the dual-band antenna of FIG. 1; and

FIG.4 shows schematically a plot of radiation efficiency for the dual-band antenna of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] The invention disclosed herein is directed to a dual-band antenna. In the following description, numerous details are outlined to provide a thorough understanding of the present invention. It will be appreciated by one skilled in the art that variations of these specific details are possible while still achieving the results of the present invention. In other instances, well-known components are not described in detail as not to unnecessarily obscure the present invention.

[0009] Referring now to FIG. 1, an embodiment of the present invention is shown. The dual-band antenna 1 mainly includes a first radiation part 10 and a second radiation part 20, serving respectively two separate radiation divisions of the same dipole-antenna structure. Both the first radiation part 10 and the second radiation part 20 can be made of conductive materials, such as metal plates. Alternatively, the first radiation part 10 and the second radiation part 20 can be two separate metallic patterns printed on the same surface of a base plate such as a printed circuit board. The base plate may be an insulating material. In the embodiment shown in FIG. 1, the first radiation part 10 and the second radiation part 20 are two metal plates.

[0010] The first radiation part 10 as a unique piece includes a first main block 11, a first extension part 12, a second extension part 13, a first bending part 14 and a second bending part 15. The first extension part 12 extending from the first main block 11 is disposed at one side of the first main block 11. The second extension part 13, extending from the first main block 11, is disposed at the side of the first main block 11 having the first extension part 12 but extending in different directions from the first extension part 12 to form an angle θ_1 , which the angle θ_1 is approximately ninety degrees (90°). An arc-shaped side of the dual-band antenna 1 may be formed along the adjacent sides of the first extension part 12, the first main block 11, and the other adjacent parts on the same corresponding sides, so that the dual-band antenna 1 may be installed in a device which has an arc-shaped side; for example, a wireless device which has a curved shape. An angle formed between the second extension part 13 and the first extension part 12 may be in a range from more than 80 degrees to less than 90 degrees, not limited to ninety degrees (90°); so that the width difference between two ends of the first extension part 12 may maintain the desired range, to form the arc-shaped side of the dual-band antenna 1.

[0011] The first bending part 14, extending from the first extension part 12, is disposed at one end of the first extension part 12 opposing to the first main block 11. A

longitudinal direction of the first bending part 14 is intersected by another longitudinal direction of the first extension part 12. For example, an angle θ_2 formed by the two longitudinal directions of the first bending part 14 and the first extension part 12 is approximately ninety degrees (90°). The second bending part 15 extending from the second extension part 13 is disposed at one end of the second extension part 13 by opposing to the first main block 11 with respect to the second extension part 13. A longitudinal direction of the second bending part 15 is intersected by another longitudinal direction of the second extension part 13. For example, an angle θ_3 formed by the two longitudinal directions of the second bending part 15 and the second extension part 13 is approximately ninety degrees (90°).

[0012] The second radiation part 20 is configured for grounding and matching. The second radiation part 20 includes a second main block 21, a connecting block 22 and a matching part 23. The connecting block 22, extending from the second main block 21, is disposed at one side of the second main block 21. The matching part 23, extending from the connecting block 22, is disposed at one side of the connecting block 22 opposing to the second main block 21. The matching part 23 is to adjust the antenna impedance matching.

[0013] The first main block 11 is disposed adjacent to the second main block 21 by a first gap G1. The connecting block 22 is disposed adjacent to the first main block 11 by a second gap G2. The second main block 21 is disposed adjacent to the second extension part 13 by a third gap G3. A signal line 30 has a protrusive soldering section 31, and the soldering section 31 has one end 311 soldered onto the first main block 11 for feeding signals while another end 312 is soldered onto the second main block 21 for grounding the feed signals. The signal line 30 other than the soldering section 31 is led to connect with a signal module (not shown in the figure). A middle portion of the soldering section 31 that crosses the first gap G1 to bridge the end 311 for feeding signals and the end 312 for grounding the feed signals is formed as an intermediate isolation layer. In the present invention, determinations of the first gap G1, the second gap G2, and the third gap G3 are up to practical requirements.

[0014] The first main block 11, the first extension part 12, the second bending part 15 and the second main block 21 are all extended longitudinally in a first direction F1, while the second extension part 13 and the first bending part 14 are both extended longitudinally in a second direction F2.

[0015] The first main block 11 and the first extension part 12 are used for emitting and receiving signals with a first frequency. The signal of the first frequency has a first wavelength λ_1 . A total length from the first main block 11 (at the connection point with the end 311 of the soldering section 31 of the signal line 30) to the first extension part 12 is defined as a first length L1. Then, the first length L1 and the first wavelength λ_1 fulfill the following equation:

$$L1=(\lambda 1)/4;$$

[0016] in which both the first length L1 and the first wavelength $\lambda 1$ are measured in centimeters. For example, as the first frequency = 2450MHz and the first wavelength $\lambda 1 = 12.2\text{cm}$, then the total length (i.e., the first length L1) from the first main body 11 to the first extension part 12 is $12.2/4=3.05\text{cm}$.

[0017] The first main block 11 and the second extension part 13 are used for emitting and receiving signals with a second frequency. The signal of the second frequency has a second wavelength $\lambda 2$. A total length from the first main block 11 (at the connection point with the end 311 of the soldering section 31 of the signal line 30) to the second extension part 13 is defined as a second length L2. Then, the second length L2 and the second wavelength $\lambda 2$ fulfill the following equation:

$$L2=(\lambda 2)/4;$$

[0018] in which both the second length L2 and the second wavelength $\lambda 2$ are measured in centimeters. For example, as the second frequency = 5000MHz and the second wavelength $\lambda 2 = 6.0\text{cm}$, then the total length (i.e., the second length L2) from the first main body 11 to the second extension part 13 is $6.0/4=1.5\text{cm}$.

[0019] The first extension part 12 has a first width W1, the second bending part 15 has a second width W2, and the spacing between the first extension part 12 and the second bending part 15 is defined as a fourth width G4. Then, the first width W1, the second width W2, and the fourth width G4 fulfill the following equation:

$$G4>(W1+W2)/2;$$

[0020] in which the first width W1, the second width W2, and the fourth width G4 are all measured in the same unit. Upon such an arrangement, the dual-frequency structure can be established by a pair of the first main block 11 and the first extension part 12, and another pair of the first main block 11 and the second extension part 13.

[0021] It shall be explained that, in the embodiment of FIG. 1, the first extension part 12 is not absolutely parallel to the first direction F1, but forms an arc with the connecting block 22 and the matching part 23 (an arc-shaped side of the dual-band antenna 1 is formed along the adjacent sides of the first extension part 12, the first main block 11, the connecting block 22, and the matching part 23). However, it shall be understood as well that the aforesaid arc-shaped profile is simply one of many embodiments in accordance with the present invention, and will not limit the ranges of the aforesaid numbers. Namely, while in determining the first length L1, the second length L2, the first width W1, the second width W2 and/or the

fourth width G4, the foregoing three equations are the only limitations, and profiles of the first radiation part 10 and the second radiation part 20 is practically arbitrarily determined. Also, determination of lengths of the first bending part 14 and the second bending part 15 is not particularly limited, but up to the frequency in the application.

[0022] Referring now to FIG. 2, a schematic top view of the dual-band antenna 2 of FIG. 1 printed on a base plate is shown. As mentioned above, the first radiation part 10 and the second radiation part 20 can be printed on an insulated base plate 40. In addition, a first bare copper zone 111 can be furnished on the first main block 11, while a second bare copper zone 211 is furnished on the second main block 21. The first and second bare copper zones 111, 211 are to solder thereon the ends 311, 312 of the soldering section 31 of the signal line 30, for forming a signal-feeding end and a ground for feed signals, respectively.

[0023] Referring now to FIG. 3 and FIG. 4, the practical effect of a device equipped with the dual-band antenna having operational frequency bands 802.11b/g [2400MHz~2500MHz] + 802.11ac [4900MHz~5850MHz] is demonstrated. In FIG. 3, in two different operational frequency bands around 2.4GHz and 5GHz, the minimum return loss can be achieved. In FIG. 4, for all the operational frequency bands, the resulted radiation efficiency can be always kept at a stable level.

[0024] It shall be explained that the dual-band antenna provided by the present invention can be adjusted arbitrarily to meet system requirements. For example, the operational frequency band can be adjusted to 802.11a(5150~5850MHz), 802.11b(2400~2500MHz), 802.11g(2400~2500MHz), and 802.11n(2.4GHz or 5GHz Band), or can be further adjusted to meet a wider frequency-band requirement for the antenna of a wireless communication system.

[0025] In summary, the dual-band antenna provided by the present invention, featured in a small size, less occupation, less cost and an independent design, can be constructed on an insulated base plate such as a printed circuit board, and can have a frequency of resonance mode easily to be adjusted for obtaining an operational frequency band meeting requirements of a wireless local network system. In comparison with the conventional dual-band antenna, the dual-band antenna of the present invention can be produced with a reduced width (by removing at least 25-50% original width), and can save the cost significantly in materials for the printed antenna. In addition, in the circumstance of a reduced antenna surface area, the antenna efficiency is not sacrificed. Further, by introducing the present invention, expensive tooling and assembly cost for the conventional 3D antenna can be waived, and the risk in distorted products can be reduced. The dual-band antenna of the present invention can be furnished to any place in the system without considering the need for grounding.

[0026] While the present invention has been particu-

larly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be without departing from the spirit and scope of the present invention.

Claims

1. A dual-band antenna (1), comprising:

a first radiation part (10), made of conductive materials, including:

- a first main block (11);
- a first extension part (12), extending from one side of the first main block (11);
- a second extension part (13), extending from said side of the first main block (11) but in a different direction from the first extension part (12);
- a first bending part (14) extending from one end of the first extension part (12), opposing to the first main block (11), but in a different direction from a longitudinal direction of said first extension part (12); and
- a second bending part (15) disposed at one end of the second extension part (13), opposing to the first main block (11), wherein a longitudinal direction of the second bending part (15) is different to a longitudinal direction of said second extension part (13); and

a second radiation part (20), made of conductive materials, including:

- a second main block (21);
- a connecting block (22) extending from the second main block (21); and
- a matching part (23) disposed at one side of the connecting block (22) opposing to the second main block (21);

wherein the first main block (11) is spaced from the second main block (21) by a first gap (G1), the connecting block (22) is spaced from the first main block (11) by a second gap (G2), the second main block (21) is spaced from the second extension part (13) by a third gap (G3), one end of a soldering section (31) of a signal line (30) is soldered onto the first main block (11) as a signal-feeding end, and another end of the soldering section (31) of the signal line (30) is soldered onto the second main block (21) as a ground for feed signals;

wherein the first main block (11), the first extension part (12), the second bending part (15) and

the second main block (21) are all extended approximately in a first direction (F1), the second extension part (13) and the first bending part (14) are all extended in a second direction (F2), and an angle formed between the first direction (F1) and the second direction (F2) is approximately 90 degrees;

wherein an arc-shaped side of the dual-band antenna (1) is formed along adjacent sides of the first extension part (12), the first main block (11), the connecting block (22), and the matching part (23);

wherein the first extension part (12) has a first width W1, the second bending part (15) has a second width W2, the first extension part (12) and the second bending part (15) are spaced by a fourth width G4, and the first width W1, the second width W2 and the fourth width G4 fulfill the following equation:

$$G4 > (W1 + W2) / 2;$$

wherein the first width W1, the second width W2 and the fourth width G4 are all measured in the same unit.

2. The dual-band antenna (1) of claim 1, wherein the first main block (11) and the first extension part (12) are used for emitting and receiving signals with a first frequency, the signal of the first frequency has a first wavelength λ_1 , a total length from the first main block (11) to the first extension part (12) is defined as a first length L1, and the first length L1 and the first wavelength λ_1 fulfill the following equation:

$$L1 = (\lambda_1) / 4;$$

wherein the first main block (11) and the second extension part (13) are used for emitting and receiving signals with a second frequency, the signal of the second frequency has a second wavelength λ_2 , a total length from the first main block (11) to the second extension part (13) is defined as a second length L2, and the second length L2 and the second wavelength λ_2 fulfill the following equation:

$$L2 = (\lambda_2) / 4;$$

wherein the first length L1, the first wavelength λ_1 , the second length L2 and the second wavelength λ_2 are all measured in centimeters.

3. The dual-band antenna (1) of claim 1, wherein the longitudinal direction of the first bending part (14) intersects that of the first extension part (12) by an

angle which is approximately 90 degrees.

4. The dual-band antenna (1) of claim 1, wherein the longitudinal direction of the second bending part (15) intersects that of the second extension part (13) by an angle which is approximately 90 degrees. 5
5. The dual-band antenna (1) of claim 1, wherein an angle formed between the second extension part (13) and the first extension part (12) is in a range from more than 80 degrees to less than 90 degrees. 10

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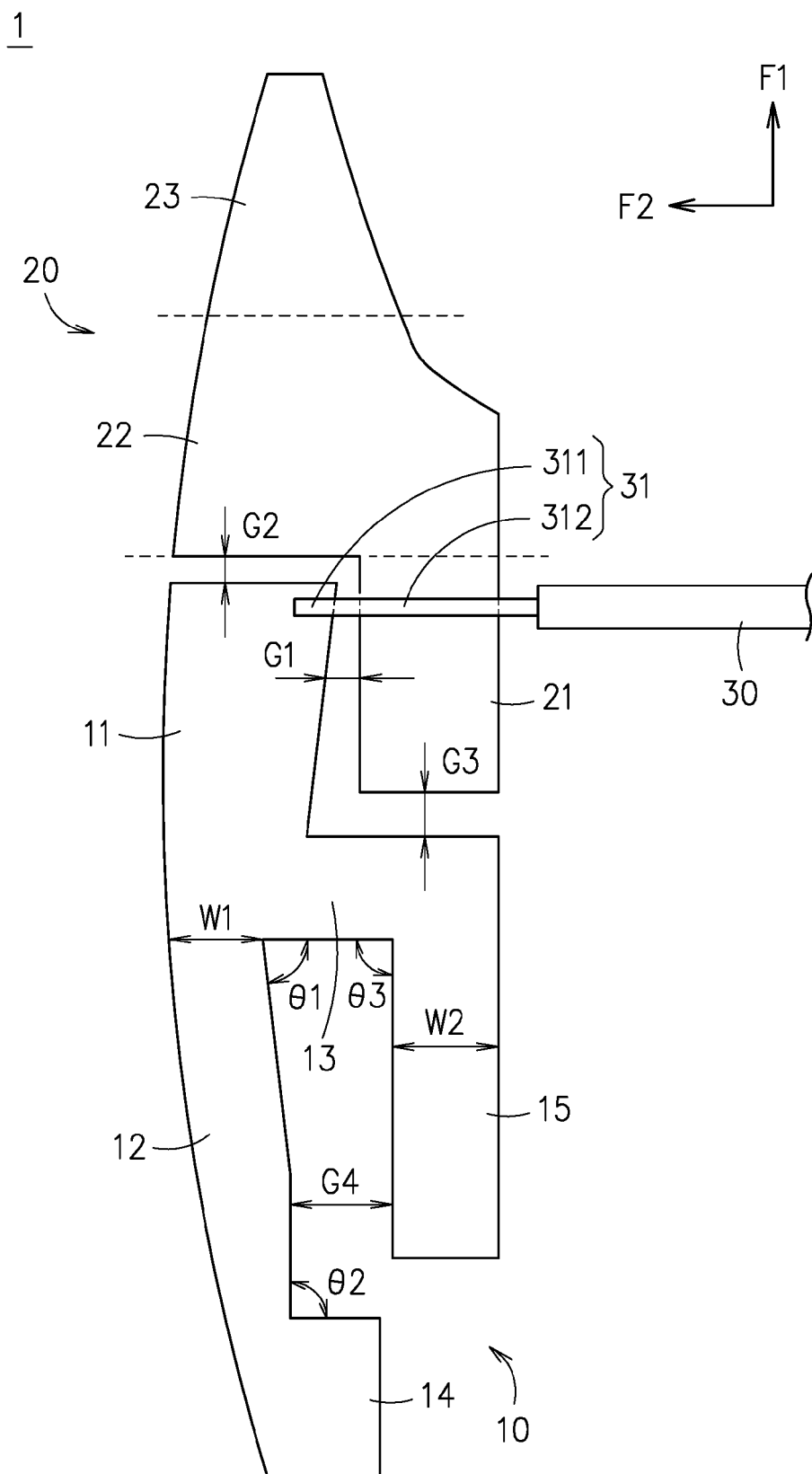


FIG. 1

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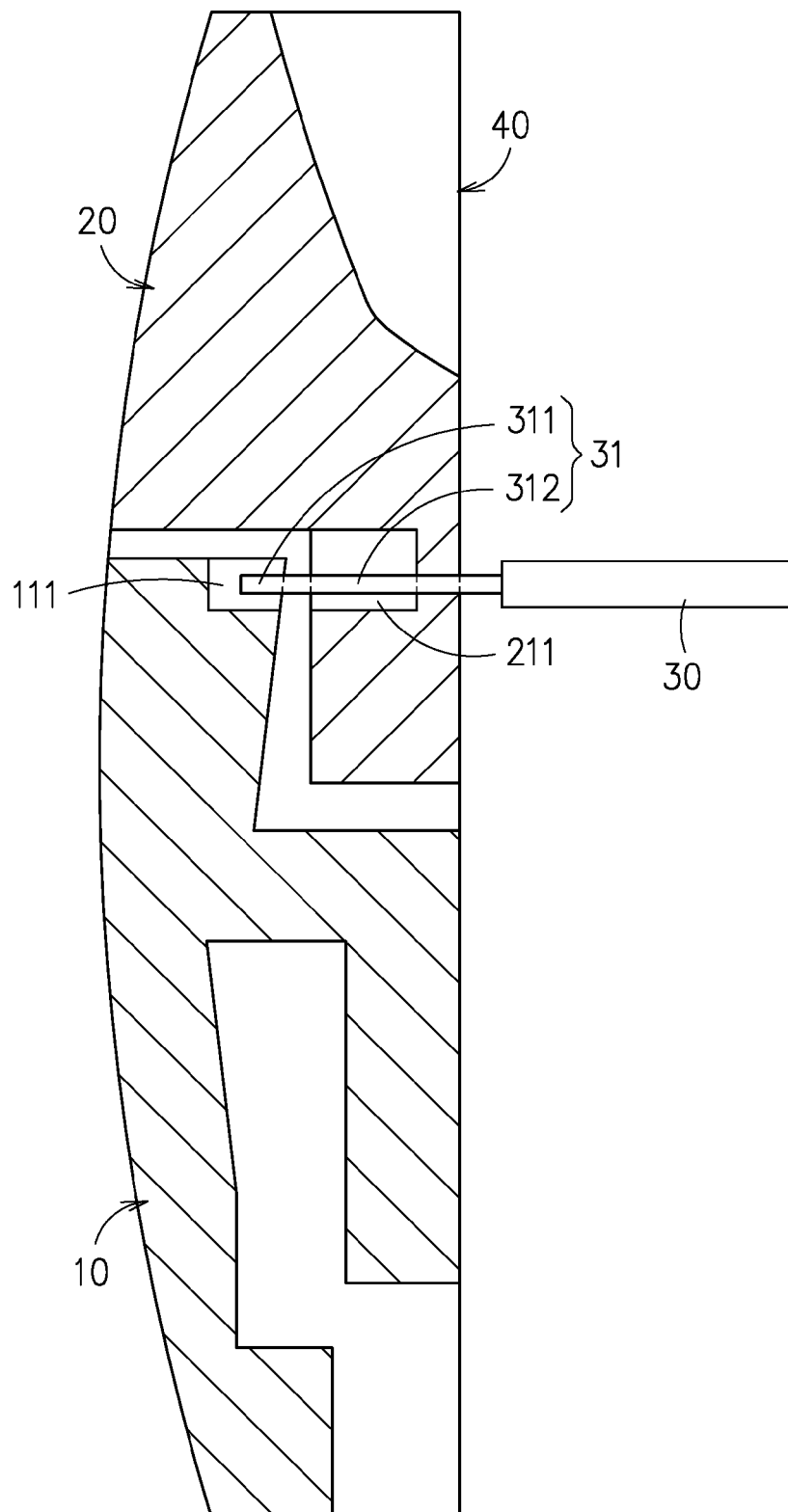


FIG. 2

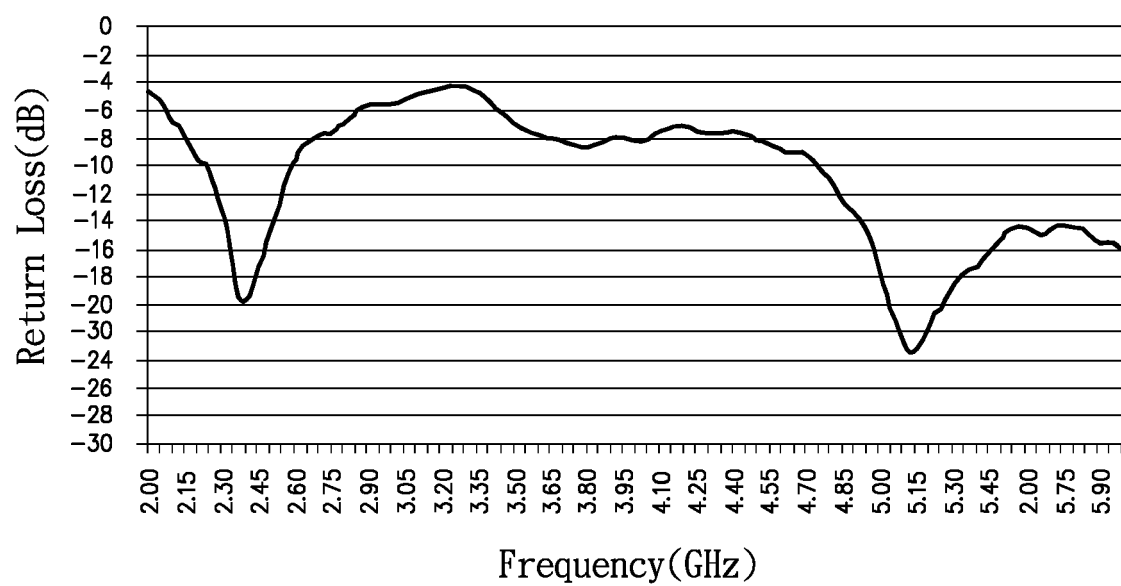


FIG. 3

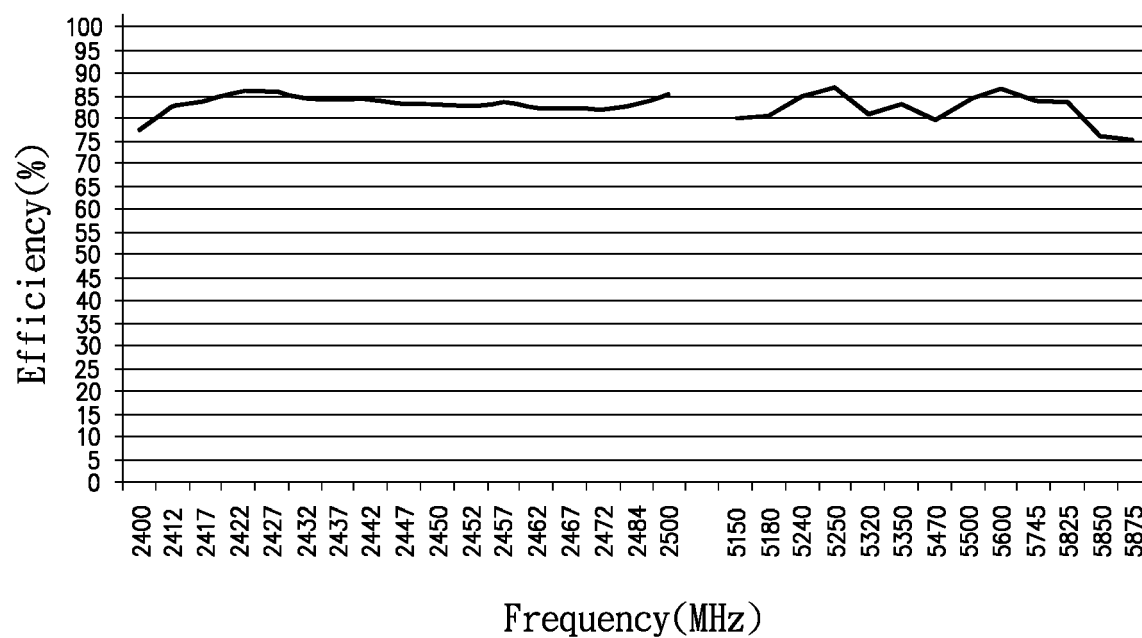


FIG. 4



EUROPEAN SEARCH REPORT

 Application Number
 EP 19 19 5074

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/085145 A1 (CHEN HSI-CHIEH [TW]) 27 March 2014 (2014-03-27) * paragraph [0010] - paragraph [0020]; figure 1 *	1-5	INV. H01Q5/371 H01Q9/28
X	US 2014/132469 A1 (WANG CHIH-MING [TW] ET AL) 15 May 2014 (2014-05-15) * paragraph [0021] - paragraph [0030]; figures 2, 3 *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01Q
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 January 2020	Examiner Keyrouz, Shady
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	

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**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.
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