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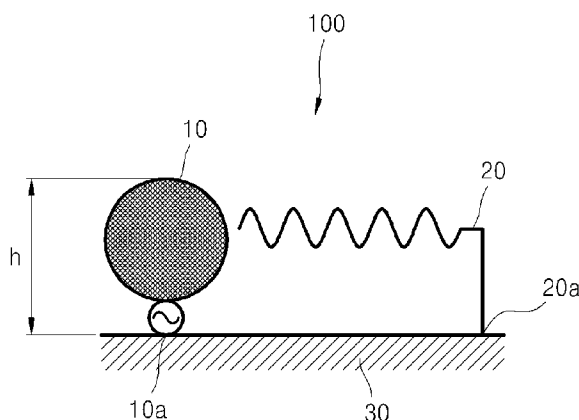
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FIG. 1



(57) **Abstract:** Provided is a multiband antenna device that can be easily designed and fabricated and is made small so as to be appropriately mounted on a mobile phone, or the like. The multiband antenna device includes a substrate comprising a feeding point and a short circuit point, a feeding element connected to the feeding point, and a parasitic element comprising a short circuit end connected to the short circuit point and an open end, wherein the feeding element and the parasitic element include a coupling portion that is closer to the open end than the short circuit end of the parasitic element, and the parasitic element operates in the coupling portion due to electronic coupling with the feeding element. In the antenna device, a low voltage standing wave ratio (VSWR) can be obtained in a relatively high frequency band due to the feeding element, and a low VSWR can be obtained in a low frequency band due to the parasitic element.

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Description

ANTENNA DEVICE

Technical Field

- [1] One or more embodiments relate to a small-sized multiband antenna device.

Background Art

- [2] Multiband antennas that are designed to operate on several bands have been developed in the field of mobile communication so as to solve lack of frequencies of mobile phones or high speed communication. Furthermore, complex wireless communication systems such as wireless local area network (WLAN), wireless metropolitan area network (WMAN), and wireless personal area network (WPAN), have been developed.
- [3] Related multiband antenna devices include several antenna elements having a length corresponding to each of a plurality of different frequencies. Multiband antenna devices have been used by feeding directly to each of the antenna elements, by using a parasitic element or by mixing these methods.
- [4] FIG. 14 illustrates a list of related wireless communication systems that are being used in (to be used in) a mobile phone. Several types of networks are shown in the list of FIG. 14. Here, referring to a frequency range of each of the wireless communication systems, near frequency bands can be realized by using one antenna element. For example, an antenna device 104 illustrated in FIG. 15 has been developed.
- [5] The antenna device 104 of FIG. 15 includes a first branch corresponding to GSM1900 and UMTS, a second branch corresponding to GSM1800, GSM1900, and UMTS, and a third branch corresponding to GSM900 and GSM1800. In this way, when a branch that is branched from a middle of an antenna element is counted as one antenna element, if each of the near frequency bands shown in the list of FIG. 14 is realized by using one element, an antenna that operates on four frequency bands of GSM850, GSM900, GSM1800, and GSM1900, and a frequency band of UMTS can be realized by using about two or three antenna elements.
- [6] However, for example, the number of antenna elements may be increased so as to additionally implement an antenna that operates on a frequency band for Mobile-Wimax. Interference occurs between antenna elements. Thus, due to an increase in the number of antenna elements, design of an antenna device is complicated.
- [7] Meanwhile, a ultra wide band (UWB) antenna may be used so as to operate the antenna device in many frequency bands, instead of increasing the number of antenna elements. As a small-sized UWB antenna, a disc monopole antenna is illustrated in each of FIGS. 16A and 16B. The disc monopole antenna is constituted by vertically arranging a circular plate 10 with respect to a substrate 30, as illustrated in the side

view of FIG. 16B.

- [8] In a frequency band which is higher than a frequency in which a diameter D of the circular plate 10 is nearly the same as $\lambda/4$, a voltage standing wave ratio (VSWR) of the disc monopole antenna is smaller than 2. Thus, for example, when the diameter D of the circular plate 10 is 25 mm, a VSWR that is smaller than 2 can be obtained in a frequency band of 3-20 GHz.

Disclosure of Invention

Technical Problem

- [9] However, when a multiband mobile antenna that can be used from GSM850(824-894 MHz) is constituted by simply making the disc monopole antenna large, the diameter D of the circular plate 10 is about 90 mm, which is not appropriate to mount the multiband mobile antenna on a mobile phone.
- [10] A small-sized disc monopole antenna is disclosed in Japanese Patent Laid-open Publication No. 2004-328062, for example. An antenna is made small by using the shape of antenna elements, a method of arranging the circular plate 10 with respect to the substrate 30, or a material such as a dielectric material so that a small-sized UWB antenna having a size of about $\lambda/10$ to about $\lambda/12$ can be developed. However, even when a multiband mobile phone antenna that can be used from GSM850(824-894 MHz) is constituted by using such technology, the height of the multiband mobile phone antenna is greater than 30 mm. Thus, it is not appropriate to mount the multiband mobile phone antenna on the mobile phone. In this way, a need for small-sized multiband antenna devices increases.

Technical Solution

- [11] One or more embodiments include a multiband antenna device which has a simple structure and can be easily designed and fabricated.
- [12] One or more embodiments include a multiband antenna device that is small-sized and has a simple structure in which a good antenna performance can be obtained in a wide frequency band .
- [13] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.
- [14] To achieve the above and/or other aspects, one or more embodiments may include a multiband antenna device including: a substrate comprising a feeding point and a short circuit point; a feeding element connected to the feeding point; and a parasitic element comprising a short circuit end connected to the short circuit point and an open end, wherein the feeding element and the parasitic element comprise a coupling portion that is closer to the open end than the short circuit end of the parasitic element, and the

parasitic element operates in the coupling portion due to electronic coupling with the feeding element.

- [15] The feeding element may be a ultra wide band (UWB) antenna or a monopole antenna.
- [16] The parasitic element may be an inverted-L antenna.
- [17] The feeding element may take charge of a relatively high frequency band, and the parasitic element may take charge of a relatively low frequency band.
- [18] The parasitic element may include a plurality of parasitic elements having the same electric field.
- [19] The plurality of parasitic elements may take charge of a frequency band of about 824 MHz to about 960 MHz and about 1710 MHz to about 2170 MHz, and the feeding element may take charge of a frequency band that is higher than about 2.3 GHz.
- [20] The parasitic element may include a plurality of parasitic elements having different electric fields.
- [21] The plurality of parasitic elements may take charge of a frequency band of about 824 MHz to about 960 MHz, about 1710 MHz to about 2170 MHz, and about 2305 MHz to about 2690 MHz, and the feeding element may take charge of a frequency band that is higher than about 3.1 GHz.
- [22] The feeding element may be disposed on one end of the substrate, and the parasitic element may be disposed on the other end of the substrate.
- [23] The feeding point of the feeding element may be disposed on one end of the substrate, and the short circuit point of the parasitic element may be disposed in a middle of the substrate.
- [24] The feeding point of the feeding element may be disposed in a middle of the substrate, and the short circuit point of the parasitic element may be disposed on an end of the substrate.
- [25] The feeding element may be formed of a dielectric material, and the parasitic element may be formed of a magnetic material.

Advantageous Effects

- [26] According to the one or more of the above embodiments, the multiband antenna device is small-sized and has a simple structure. Accordingly, the multiband antenna device can be easily designed and fabricated and can be appropriately mounted on a mobile phone, or the like.

Description of Drawings

- [27] These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

- [28] FIG. 1 schematically illustrates a structure of a multiband antenna device according to an embodiment ;
- [29] FIG. 2A schematically illustrates a ultra wide band (UWB) antenna according to an embodiment, and FIG. 2B schematically illustrates an inverted-L antenna according to an embodiment, and FIG. 2C is a graph showing a voltage standing wave ratio (VSWR) of each of a plurality of antennas, according to an embodiment;
- [30] FIGS. 3A and 3B illustrate combinations of a UWB antenna and an inverted-L antenna according to other embodiments, and FIG. 3C is a graph showing a VSWR of each of combinations of a UWB antenna and an inverted-L antenna according to an embodiment;
- [31] FIG. 4A illustrates a coupling portion of the multiband antenna device illustrated in FIG. 1, according to an embodiment, and FIG. 4B is a graph showing a change of a VSWR according to a distance between a feeding element and a parasitic element, according to an embodiment;
- [32] FIGS. 5A and 5B illustrate an arrangement location of a UWB antenna according to other embodiments, and FIG. 5C is a graph showing a VSWR versus the arrangement location according to an embodiment;
- [33] FIGS. 6A and 6B illustrate an arrangement location of a monopole antenna according to other embodiments, and FIG. 6C is a graph showing a VSWR according to arrangement locations according to an embodiment;
- [34] FIGS. 7A, 7B, and 7C illustrate an arrangement location of an antenna device according to other embodiments;
- [35] FIG. 8A is a perspective view of a multiband antenna device according to another embodiment, and FIG. 8B is an exploded view of FIG. 8A;
- [36] FIG. 9 is a graph showing a VSWR of the multiband antenna device illustrated in FIGS. 8A and 8B, according to an embodiment;
- [37] FIG. 10A is a perspective view of a multiband antenna device according to another embodiment, and FIG. 10B is an exploded view of FIG. 10A;
- [38] FIG. 11 is a graph showing a VSWR of the multiband antenna device illustrated in FIGS. 10A and 10B, according to an embodiment;
- [39] FIG. 12 illustrates the use of a dielectric or magnetic material when the antenna device according to one or more embodiments is made small, according to an embodiment;
- [40] FIGS. 13A and 13B schematically illustrate a multiband antenna device according to another embodiment;
- [41] FIG. 14 illustrates a related wireless communication system mounted on a mobile phone;
- [42] FIG. 15 illustrates a structure of a related multiband antenna device; and

[43] FIGS. 16A and 16B illustrate related disc monopole antennas, respectively.

Mode for Invention

[44] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present description.

[45] FIG. 1 schematically illustrates a structure of a multiband antenna device 100 according to an embodiment. Referring to FIG. 1, the multiband antenna device 100 includes a feeding element 10 and a parasitic element 20, which are installed on a substrate 30. The feeding element 10 may be a ultra wide band (UWB) antenna 10, for example, and the parasitic element 20 may be an inverted-L antenna. The substrate 30 includes a feeding point 10a and a short circuit point 20a, and the feeding element 10 is connected to the feeding point 10a, and the parasitic point 20 is connected to the short circuit point 20a.

[46] Hereinafter, reference numeral 10 denotes a feeding element or a UWB antenna as a feeding element, and reference numeral 20 denotes a parasitic element or an inverted-L antenna as the parasitic element. Each of the UWB antenna 10 and the inverted-L antenna 20 may be used as a single body, as illustrated in FIGS. 2A and 2B. When the UWB antenna 10 which is a feeding element as illustrated in FIG. 2A operates on a frequency band that is higher than DCS (1800 MHz) and an inverted-L antenna 21 illustrated in FIG. 2B operates on a frequency band of each of GSM8500 and GSM900 (824-894 MHz, 890-960 MHz), a voltage standing wave ratio (VSWR) when each of the UWB antenna 10 and the inverted-L antenna 21 is used as a single body, is shown in FIG. 2C. Here, the VSWR of the UWB antenna 10 is indicated by a solid line, and the VSWR of the inverted-L antenna is indicated by a dotted line.

[47] When the multiband antenna device 100 is constituted by combining the UWB antenna 10 and the inverted-L antenna 21, two configurations in which one part thereof is set as a feeding element and the other part is set as a parasitic element are possible. A first configuration is an antenna device 100 in which electricity is fed to a UWB antenna 10 and electricity is not fed to an inverted-L antenna 20, as illustrated in FIG. 3A. This is the same as in the embodiment of FIG. 1. In addition, a second configuration is an antenna device 101 in which electricity is not fed to a UWB antenna 12 and electricity is fed to an inverted-L antenna 21, as illustrated in FIG. 3B. In FIG. 3C, a VSWR of each of the antenna devices 100 and 101 is indicated by a solid line and a dotted line, respectively. (F) of FIG. 3C indicates a feeding state, and (P) of FIG. 3C indicates a parasitic state.

- [48] In general, when the antenna device is constituted by using a feeding element and a parasitic element, the main characteristic of the antenna device is determined by the feeding element, and the parasitic element causes a change of the characteristic of the feeding element. Thus, the most part of the VSWR that is obtained in the first configuration in which the UWB antenna is set as the feeding element as in FIG. 3C is similar to the VSWR of the UWB antenna shown in FIG. 2C. In addition, in the UWB antenna, the VSWR of the inverted-L antenna shown in FIG. 2C is reflected on a low frequency band in which a low VSWR may not be obtained. Thereby the antenna device 100 that is constituted by the first configuration shows a VSWR that is lower than 2 in a wide frequency band.
- [49] On the other hand, the most part of the VSWR that is obtained by the second configuration in which the inverted-L antenna is set as the feeding element as in FIG. 3B is the same as the VSWR of the inverted L-antenna shown in FIG. 2C, and a low VSWR may be obtained only in a very narrow frequency band.
- [50] Thus, according to one or more embodiments, the UWB antenna is set as the feeding element, and the inverted L-antenna is set as the parasitic element. As such, a good VSWR may be obtained in a wider frequency band.
- [51] Here, the arrangement of the UWB antenna and the inverted-L antenna is significant. The antenna device according to one or more embodiments does not affect the characteristic of the UWB antenna which is a feeding element and adds the characteristic of the inverted-L antenna which is the parasitic element. A distance between a feeding portion of the feeding element and a short circuit portion of the parasitic element need to be far away as far as the parasitic element operates, so as to implement such an antenna device.
- [52] In the antenna device 100, the feeding element 10 operates as a feeding probe with respect to the parasitic element 20, and the parasitic element 20 operates due to electronic coupling with the feeding element 10. Referring to FIG. 4A, electronic coupling may occur in a coupling portion in which the feeding element 10 and the parasitic element 20 are close to each other. For example, the coupling portion may include two coupling portions, i.e., a coupling portion A that is close to an open end of the parasitic element 20 and a coupling portion B that is close to a short circuit end of the parasitic element 20. Since coupling with respect to base resonance ($\lambda/4$) of the parasitic element 20 is dominant at the coupling portion A that is close to the open end of the parasitic element 20 and coupling with respect to high-order resonance of the parasitic element 20 is dominant at the coupling portion B that is close to the short circuit end of the parasitic element 20, electronic coupling may occur in the coupling portion A that is close to the open end of the parasitic element 20 so that base resonance coupling can be performed. In other words, a distance between the feeding

element 10 and the coupling portion A that is close to the open end of the parasitic element 20 may be smaller than a distance between the feeding element 10 and the coupling portion B that is close to the short circuit end of the parasitic element 20, and electronic coupling between the feeding element 10 and the parasitic element 20 may occur in the coupling portion B that is close to the open end of the parasitic element 20.

[53] FIG. 4B is a graph showing a VSWR when a distance d between the feeding element 10 and the coupling portion B that is close to the short circuit end of the parasitic element 20 is changed in the range of about 0.5 mm to about 22.5 mm, according to an embodiment. Referring to FIG. 4B, a good VSWR may be obtained when the distance d is about 22.5 mm. In other words, the amount of electronic coupling that occurs in the coupling portion B is reduced by increasing the distance d so that the UWB antenna as a feeding element can obtain a characteristic of a wide frequency band easily.

[54] However, when miniaturization of the antenna device 100 is further required even though the characteristic of the UWB antenna as a feeding element is deteriorated, the UWB antenna and the inverted-L antenna may be disposed to be closer to each other.

[55] Miniaturization of the antenna device 100 will now be described.

[56] The antenna device 100 includes the feeding element 10 and the parasitic element 20. Referring to FIG. 1, when the parasitic element 20 takes charge of a frequency band of GSM850 and GSM900 and the UWB antenna as the feeding element 10 takes charge of a frequency band that is higher than GSM1800, the height h of the antenna device 100 is about 44 mm (λ (1.71 GHz)/4). However, the height h of the antenna device 100 is too large to mount the antenna device 100 on a mobile phone.

[57] Thus, the antenna device 100 may be made small by using general methods of miniaturizing an antenna device, such as making of a three-dimensional shape of antenna elements, optimizing of a location in which an antenna is to be mounted on the mobile phone, or the like.

[58] For example, with regard to the making of the three-dimensional shape of antenna elements, the length of the antenna may be reduced by increasing the thickness of the antenna. In addition, with respect to the optimizing of the location in which the antenna is to be mounted on the mobile phone, the antenna may be mounted at a place in which an antenna signal is easily applied to a substrate. In this regard, the case where the antenna device 100 is mounted on a finite substrate such as a mobile phone or the like will now be described.

[59] FIGS. 5A and 5B illustrate an arrangement location of the UWB antenna 10 having a shape of a circular plate having a diameter of about 20 mm is disposed on the substrate 30 having a size of 100 mm x 50 mm and FIG. 5C is a graph showing a VSWR versus the arrangement location according to an embodiment. Different VSWR may be

obtained when the UWB antenna 10 is disposed at a relatively small side of the substrate 30, i.e., at an end portion of the substrate 30 as in FIG. 5A and in the middle of the substrate 30 as in FIG. 5B, respectively. FIG. 5C shows a VSWR in end portion arrangement and middle arrangement, respectively. In FIG. 5C, a VSWR of a place where the UWB antenna 10 is disposed at an end portion of the substrate 30 is lower than a VSWR of a place where the UWB antenna 10 is disposed in the middle of a side of the substrate 30 from a lower frequency band.

[60] Similarly, even when the monopole antenna 22 having a size of 20 mm x 2 mm is disposed on the substrate 30 having a size of 100 mm x 50 mm, a VSWR is changed according to the arrangement location of the monopole antenna 22. Different VSWR may be obtained when the monopole antenna 22 is disposed at an end portion of a relatively small side of the substrate 30 as in FIG. 6A and in the middle of the substrate 30 as in FIG. 6B, respectively. In other words, as in the case of the UWB antenna 10, a VSWR of a place where the monopole antenna 22 is disposed at an end portion of the substrate 30 is lower than a VSWR of a place where the monopole antenna 22 is disposed in the middle of a side of the substrate 30 from a lower frequency band. The inverted-L antenna 20 that is used in the antenna device 100 according to the current embodiment is a kind of monopole antenna and thus, the same result as the monopole antenna 22 may be obtained.

[61] In this way, all of the feeding element 10, the feeding point 10a, the parasitic element 20, and the short circuit point 20a are disposed near the end portion of the substrate 30 so that a high-performance and small-sized antenna device can be implemented. For example, as illustrated in FIG. 7A, the feeding point 10a of the feeding element 10 may be disposed at an end portion of the left side of the drawing, and the short circuit point 20a of the parasitic element 20 may be disposed at an end portion of the right side of the drawing. However, when the feeding point 10a and the short circuit point 20a are not easily disposed on both ends of the substrate 30 due to a large width of the substrate 30, the arrangement may be changed according to a priority of one performance of a high frequency band of which the feeding element 10 takes charge and a low frequency band of which the parasitic element 20 takes charge and miniaturization. For example, when high frequency band performance is prior to low frequency band performance and miniaturization, as illustrated in FIG. 7B, the feeding point 10a of the feeding element 10 may be disposed at the end portion of the substrate 30, and the short circuit point 20a of the parasitic element 20 may be disposed in the middle of the substrate 30. Alternatively, when low frequency band performance is prior to high frequency band performance and miniaturization, as illustrated in FIG. 7C, the short circuit point 20a of the parasitic element 20 may be disposed at the end portion of the substrate 30, and the feeding point 10a of the feeding element 10 may be

disposed in the middle of the substrate 30.

- [62] The UWB antenna 10 which is the feeding element when the antenna device 100 according to the current embodiment is implemented, is not limited to the above-described circular plate shape, and any monopole type UWB antenna may have the same effect regardless of the shape (oval, semicircular, polygonal, or the like) of a monopole type UWB antenna. Thus, as another embodiment together with the location in which the antenna device 100 is to be mounted as described previously, for example, an antenna device 100a or 100b illustrated in FIGS. 8A and 8B or FIG. 10 may be fabricated.
- [63] The antenna device 100a illustrated in FIGS. 8A and 8B includes a feeding element 10 and a parasitic element 20, which are installed at an end portion of a substrate 30 having a size of 80 mm x 45 mm. As illustrated in the exploded view of FIG. 8B, the feeding element 10 includes a feeding point 10a that is located at a contact point with the substrate 30, and the parasitic element 20 includes a short circuit point 20a that is located at a contact point with the substrate 30. The parasitic element 20 is electronically coupled with the feeding element 10 in a place where the parasitic element 20 is near the feeding element 10, i.e., where the parasitic element 20 is encompassed by a circle C. In addition, a distance between the feeding element 10 and the parasitic element 20 is adjusted at the circle C so that electronic coupling can be optimized.
- [64] FIG. 9 is a graph showing a VSWR of the antenna device 100a illustrated in FIGS. 8A and 8B, according to an embodiment. When it is assumed that a practical value is obtained if $VSWR < 3$, the antenna device 100a has a good characteristic over a wide frequency band.
- [65] An antenna device 100b illustrated in FIGS. 10A and 10B includes a feeding element 10 and a parasitic element 20, which are installed at an end portion of a substrate 30 having a size of 80 mm x 45 mm. As illustrated in FIG. 10B, the feeding element 10 includes a feeding point that is located at a contact point with the substrate 30, and the parasitic element 20 includes a short circuit point that is located at a contact point with the substrate 30. The parasitic element 20 is electronically coupled with the feeding element 10 in a place where the parasitic element 20 is near the feeding element 10, i.e., where the parasitic element 20 is encompassed by a circle D. In addition, a distance between the feeding element 10 and the parasitic element 20 is adjusted at the circle C so that electronic coupling can be optimized.
- [66] FIG. 11 is a graph showing a VSWR of the antenna device 100b illustrated in FIGS. 10A and 10B, according to an embodiment. In the drawing, a characteristic of a frequency band that is near 4 GHz is deteriorated. When it is assumed that the frequency band near 4 GHz is not used, a VSWR of the antenna device 100b is good.
- [67] In this way, the shape of the feeding element 10 and the shape of the parasitic

element 20 are changed in various ways so that the antenna devices 100, 100a, and 100b according to the one or more of the above embodiments can obtain difference VSWR. Meanwhile, as illustrated in FIGS. 8A and 10A, in the antenna devices 100a and 100b, the feeding element 10 and the parasitic element 20 may be patterned on the surface of a rectangular column-shaped portion 40 having a cross-section of 10 mm x 10 mm.

[68] Here, the rectangular column-shaped portion 40 is formed of a dielectric material so as to be made small, due to the characteristic of the dielectric material, as frequency increases, a dielectric loss increases gently, and radiation efficiency is lowered. Meanwhile, when the rectangular column-shaped portion 40 is made small by using a magnetic material, a rapid loss increase is expected other than in an applied frequency band. This is because there is no magnetic material having a good characteristic in a high frequency wide band and the magnetic material is developed and designed to be specially used in an applied frequency band. Thus, at the present, it is good to use miniaturization effect of the magnetic material for a magnetic material-applied frequency band than to make the entire antenna device small by using the magnetic material.

[69] In the antenna device 100 according to the one or more of the above embodiments, the inverted-L antenna which is the parasitic element 20 performs radiation limitedly in a low frequency band. Thus, as illustrated in FIG. 12, a dielectric material is used in a portion where a feeding element is disposed, and a magnetic material is used in a portion where a parasitic element is disposed. As such, an antenna device in which miniaturization can be achieved and simultaneously radiation efficiency of a high frequency wide band on which a UWB element operates is not lowered, can be implemented.

[70] The height h of the antenna device 100 according to the one or more of the above embodiments may be made small up to about 10 mm to about 15 mm (λ (1.71 GHz/12), for example.

[71] Meanwhile, in the multiband antenna device according to the one or more of the above embodiments, the number of the parasitic elements 20 is not limited to one. For example, a plurality of parasitic elements having nearly the same electric field are used, as illustrated in FIG. 13A, so that a wide frequency band antenna device can be implemented. For example, an antenna device 102 in which parasitic elements 20 and 23 operate on a low frequency band (about 824 MHz to about 960 MHz, about 1710 MHz to about 2170 MHz) and a feeding element 11 operates on a high frequency band (that is higher than about 2.3 GHz), can be implemented.

[72] In addition, a plurality of feeding elements having different electric fields are used, as illustrated in FIG. 13B, so that a multiband antenna device can be implemented. For

example, an antenna device 103 in which parasitic elements 20 and 23 operate on a low frequency band (about 824 MHz to about 960 MHz, about 1710 MHz to about 2170 MHz) and a feeding element 11 operates on a relatively high frequency band (about 2305 MHz to about 2690 MHz) than the low frequency band, can be implemented.

- [73] According to the one or more of the above embodiments, for example, a multiband antenna device that can be used in all of a five-band of WMAN, a three-band of WMAN, a three-band of WLAN, a two-band of WPAN, and a frequency band of IMT-Advanced can be provided. In addition, a portion of the UWB antenna is enlarged based on the basic configuration of FIG. 1 so that an antenna device corresponding to Japanese PAD or GPS can be implemented.
- [74] The multiband antenna device according to the one or more of the above embodiments does not need to correspond to all of communication methods illustrated in Table of FIG. 14. A good characteristic is selected based on several factors including an area in which a mobile phone on which the antenna device is mounted is used, or the like so that the antenna device can be more effectively designed.
- [75] As described above, according to the one or more of the above embodiments, the multiband antenna device is small-sized and has a simple structure. Accordingly, the multiband antenna device can be easily designed and fabricated and can be appropriately mounted on a mobile phone, or the like.
- [76] It should be understood that the exemplary embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

Claims

- [1] A multiband antenna device comprising:
a substrate comprising a feeding point and a short circuit point;
a feeding element connected to the feeding point; and
a parasitic element comprising a short circuit end connected to the short circuit point and an open end,
wherein the feeding element and the parasitic element comprise a coupling portion that is closer to the open end than the short circuit end of the parasitic element, and the parasitic element operates in the coupling portion due to electronic coupling with the feeding element.
- [2] The multiband antenna device of claim 1, wherein the feeding element is a ultra wide band (UWB) antenna or a monopole antenna.
- [3] The multiband antenna device of claim 1, wherein the parasitic element is an inverted-L antenna.
- [4] The multiband antenna device of one of claims 1 to 3, wherein the feeding element takes charge of a relatively high frequency band, and the parasitic element takes charge of a relatively low frequency band.
- [5] The multiband antenna device of one of claims 1 to 3, wherein the parasitic element comprises a plurality of parasitic elements having the same electric field.
- [6] The multiband antenna device of claim 5, wherein the plurality of parasitic elements take charge of a frequency band of about 824 MHz to about 960 MHz and about 1710 MHz to about 2170 MHz, and the feeding element takes charge of a frequency band that is higher than about 2.3 GHz.
- [7] The multiband antenna device of one of claims 1 to 3, wherein the parasitic element comprises a plurality of parasitic elements having different electric fields.
- [8] The multiband antenna device of claim 7, wherein the plurality of parasitic elements take charge of a frequency band of about 824 MHz to about 960 MHz, about 1710 MHz to about 2170 MHz, and about 2305 MHz to about 2690 MHz, and the feeding element takes charge of a frequency band that is higher than about 3.1 GHz.
- [9] The multiband antenna device of one of claims 1 to 3, wherein the feeding element is disposed on one end of the substrate, and the parasitic element is disposed on the other end of the substrate.
- [10] The multiband antenna device of one of claims 1 to 3, wherein the feeding point of the feeding element is disposed on one end of the substrate, and the short circuit point of the parasitic element is disposed in a middle of the substrate.

- [11] The multiband antenna device of one of claims 1 to 3, wherein the feeding point of the feeding element is disposed in a middle of the substrate, and the short circuit point of the parasitic element is disposed on an end of the substrate.
- [12] The multiband antenna device of one of claims 1 to 3, wherein the feeding element is formed of a dielectric material, and the parasitic element is formed of a magnetic material.

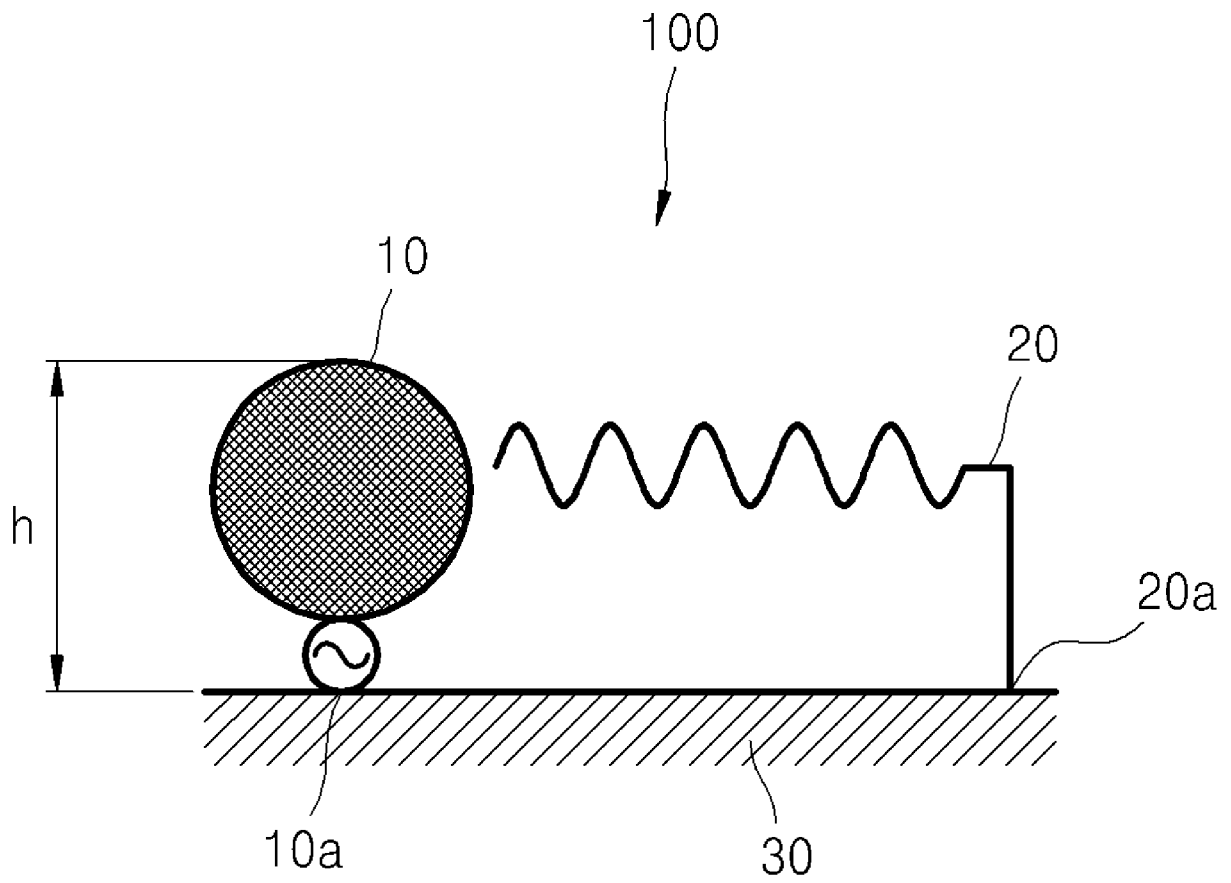
FIG. 1

FIG. 2A

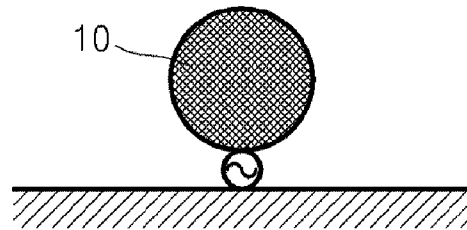


FIG. 2B

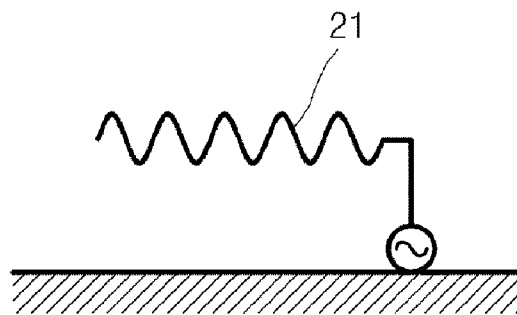


FIG. 2C

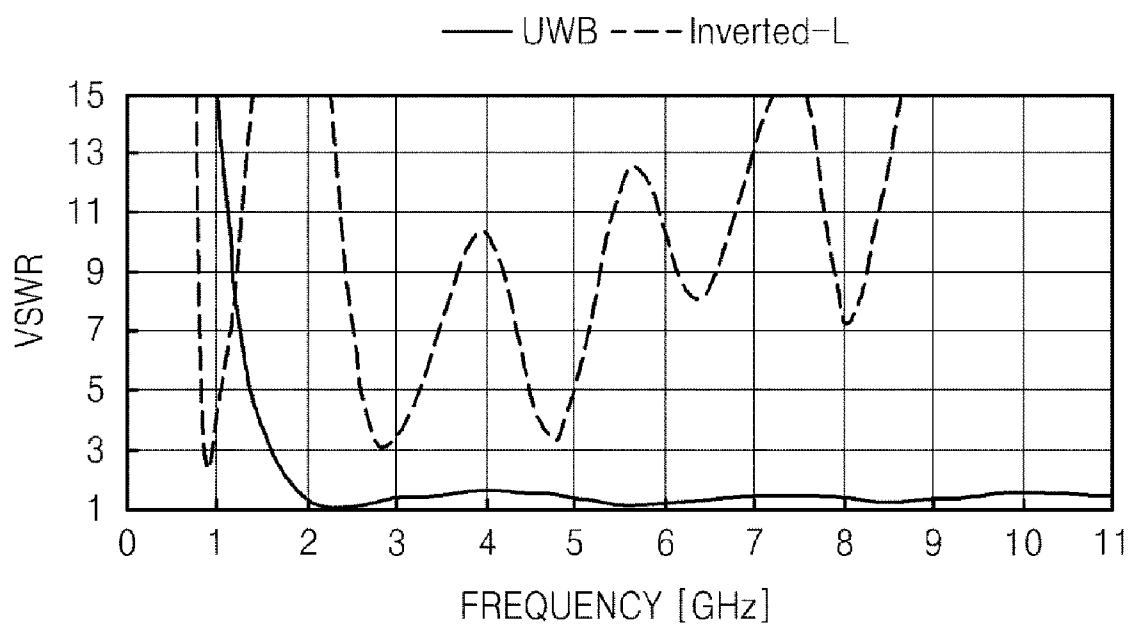


FIG. 3A

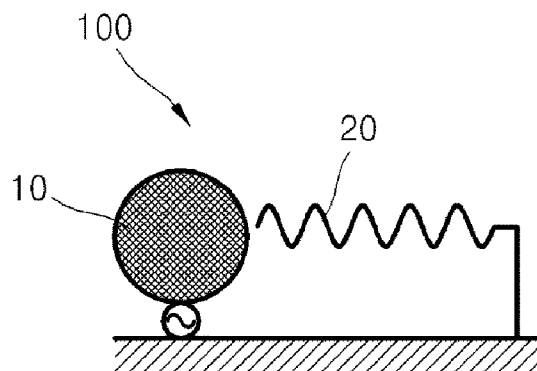


FIG. 3B

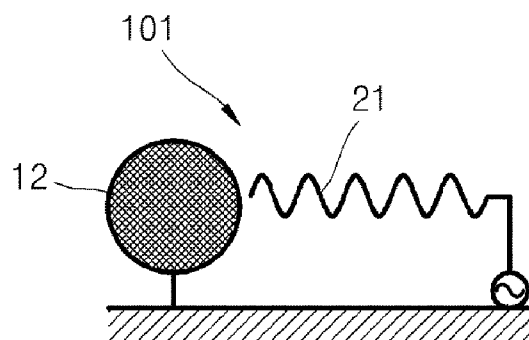


FIG. 3C

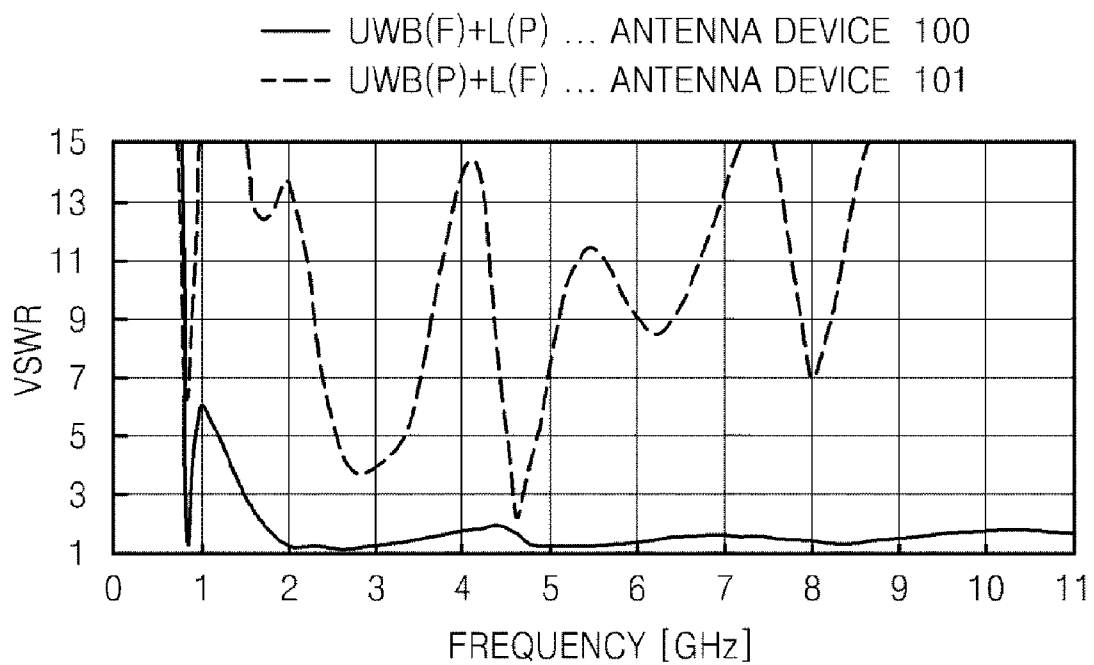


FIG. 4A

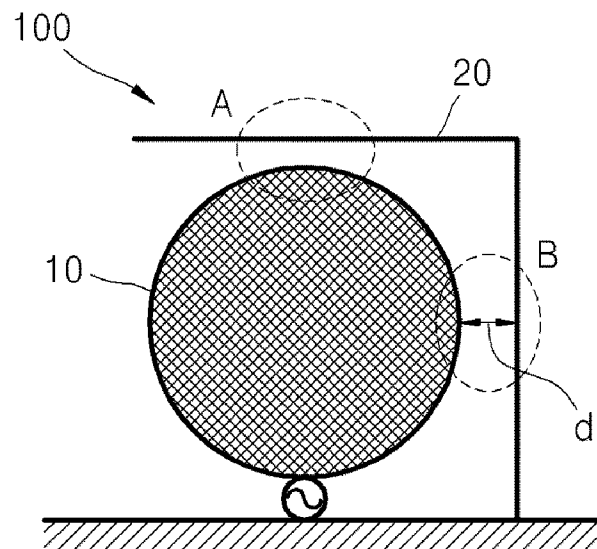


FIG. 4B

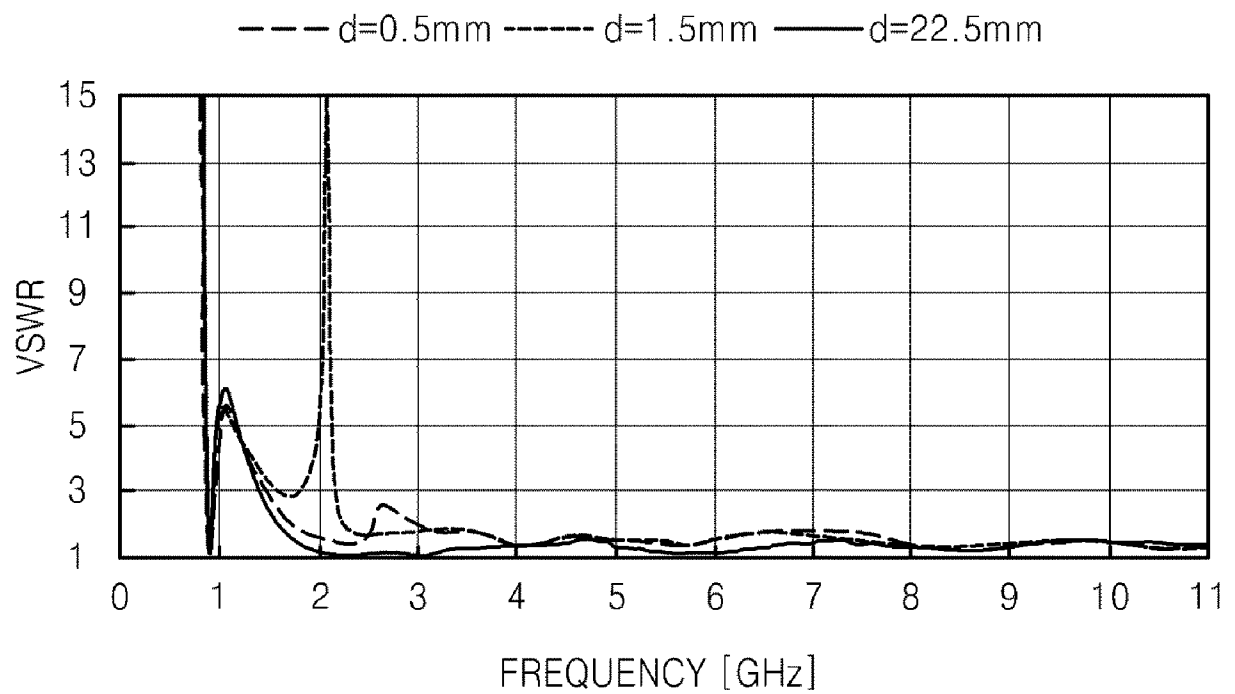


FIG. 5A

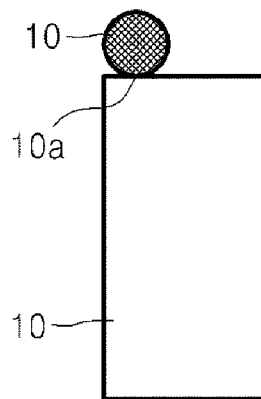


FIG. 5B

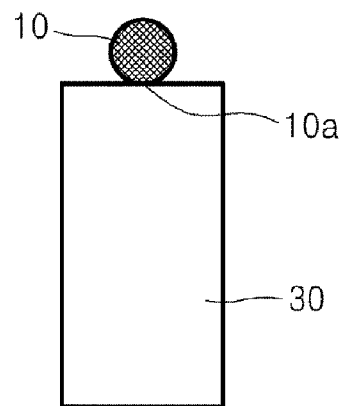


FIG. 5C

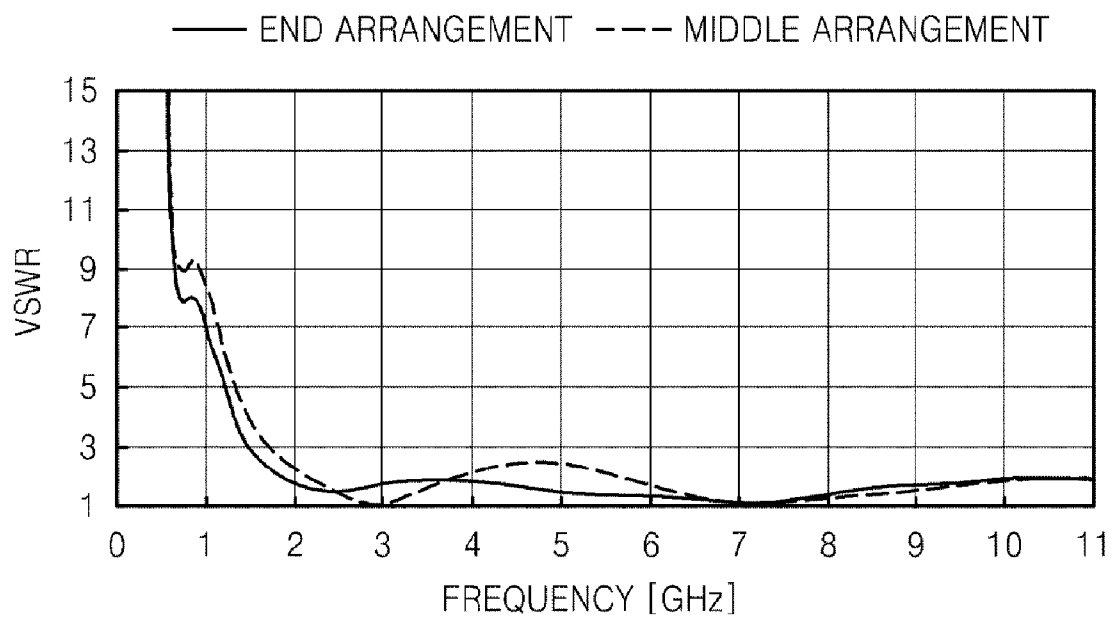


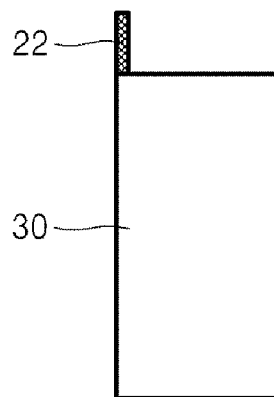
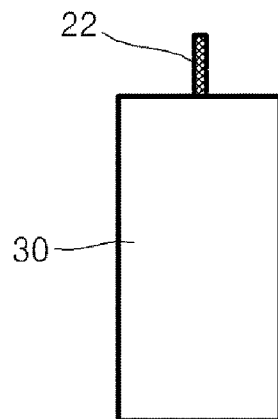
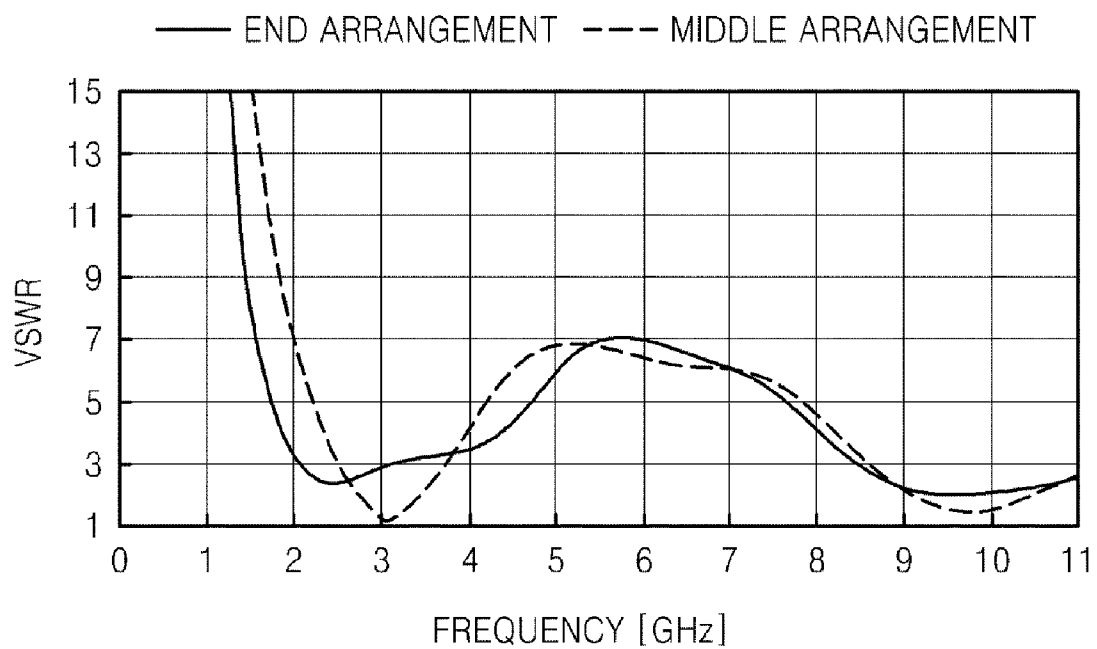
FIG. 6A**FIG. 6B****FIG. 6C**

FIG. 7A

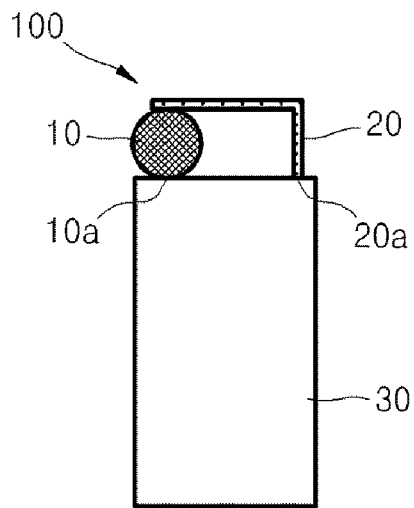


FIG. 7B

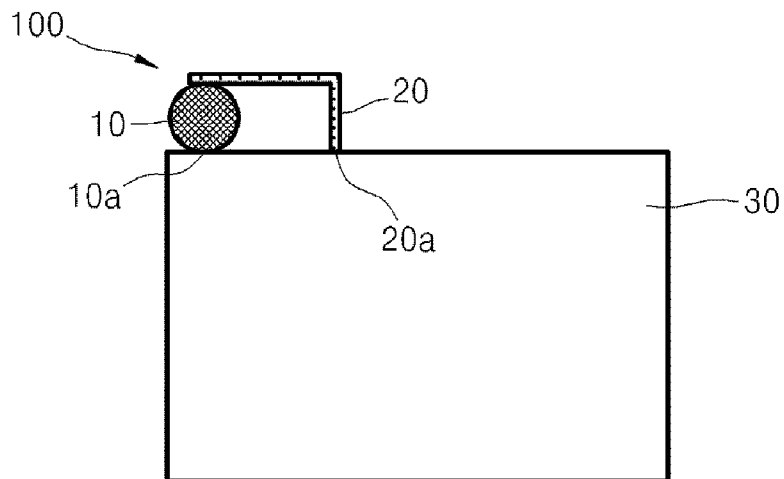


FIG. 7C

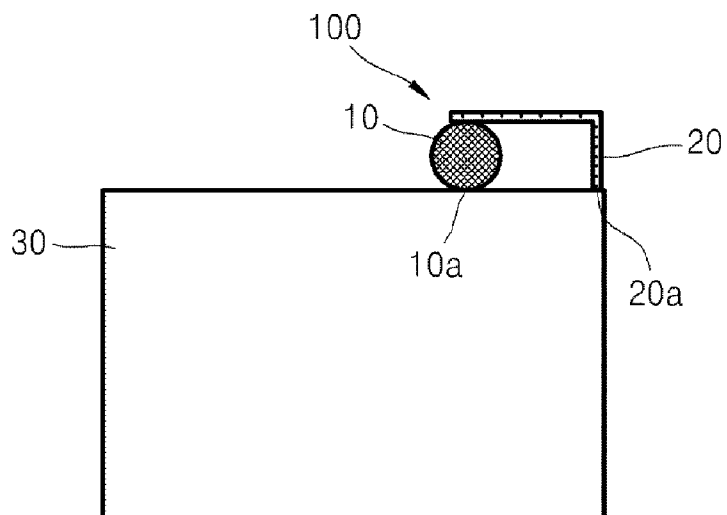


FIG. 8A

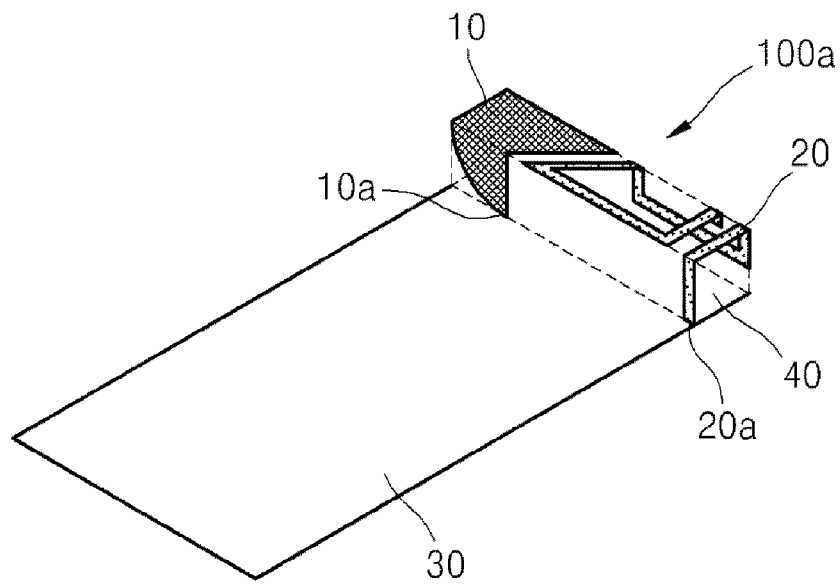


FIG. 8B

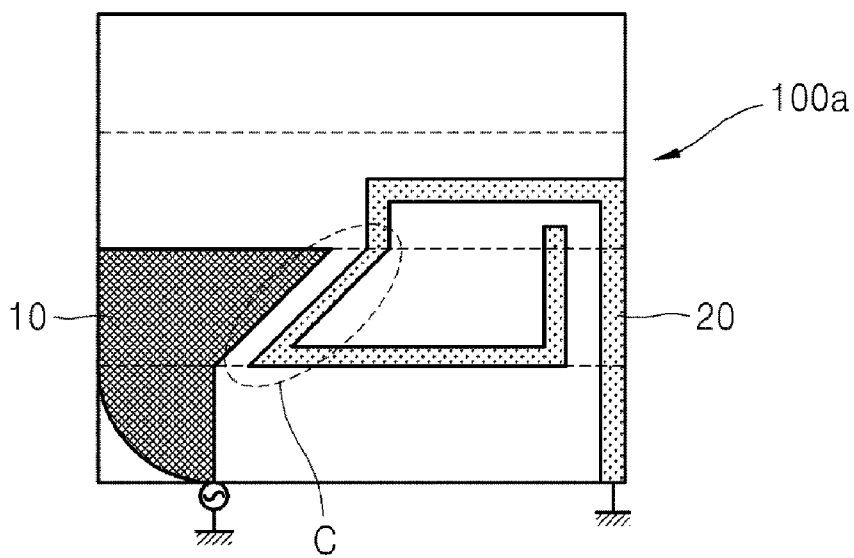


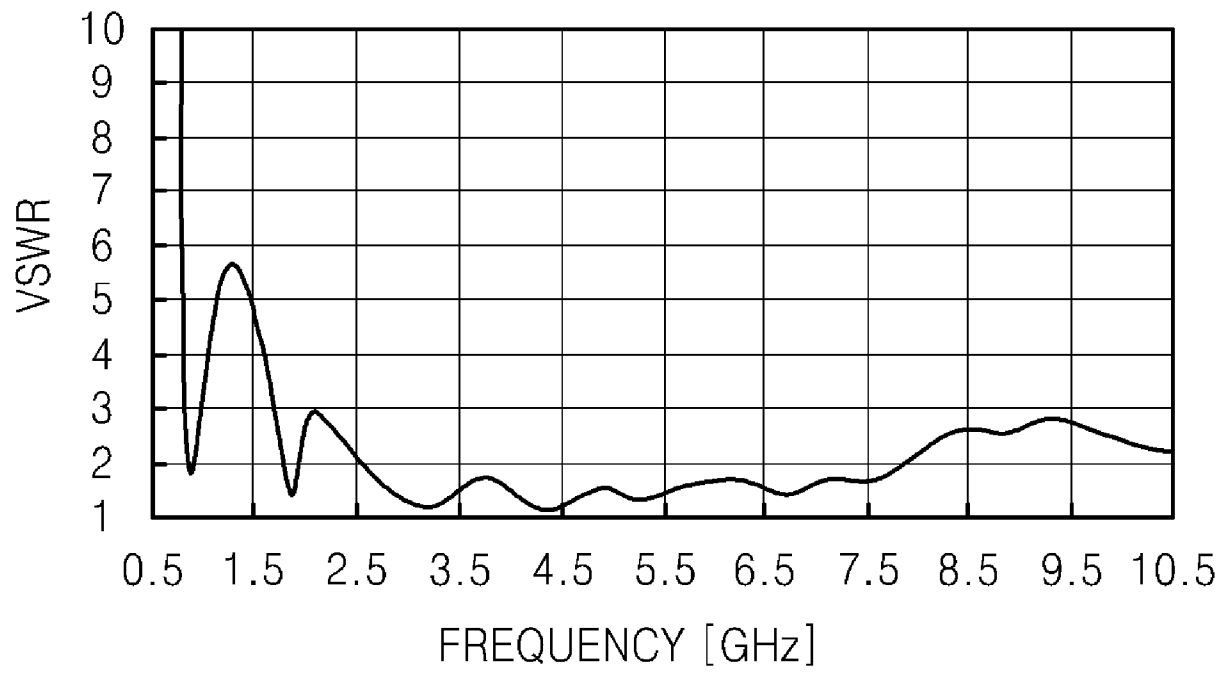
FIG. 9

FIG. 10A

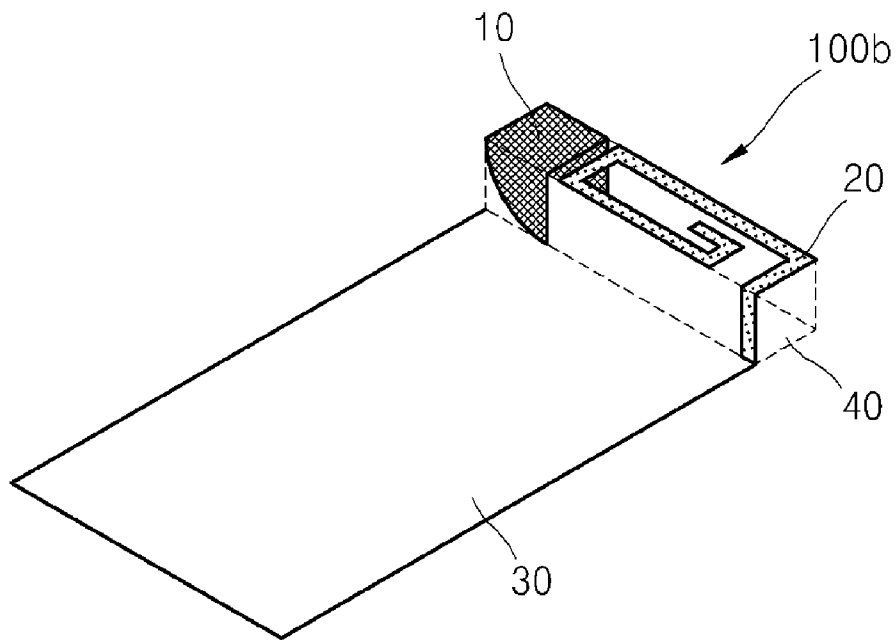


FIG. 10B

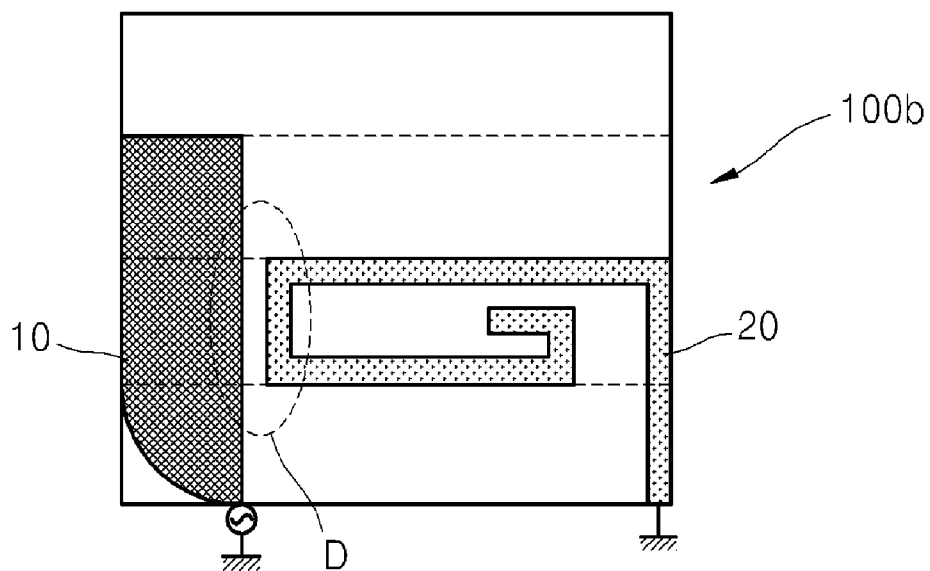


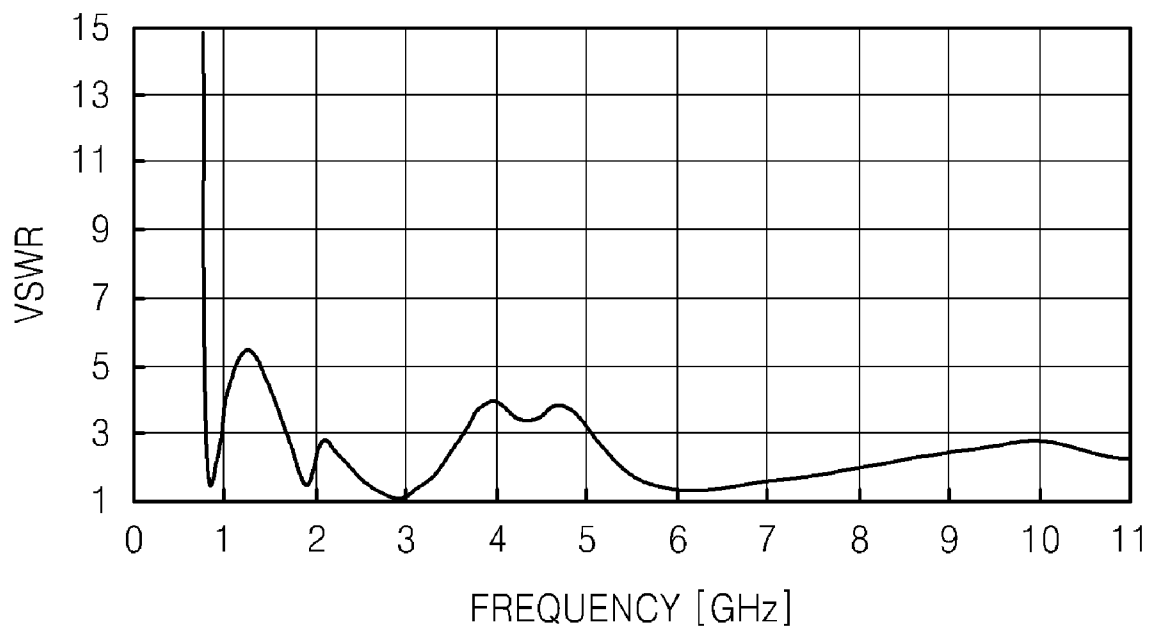
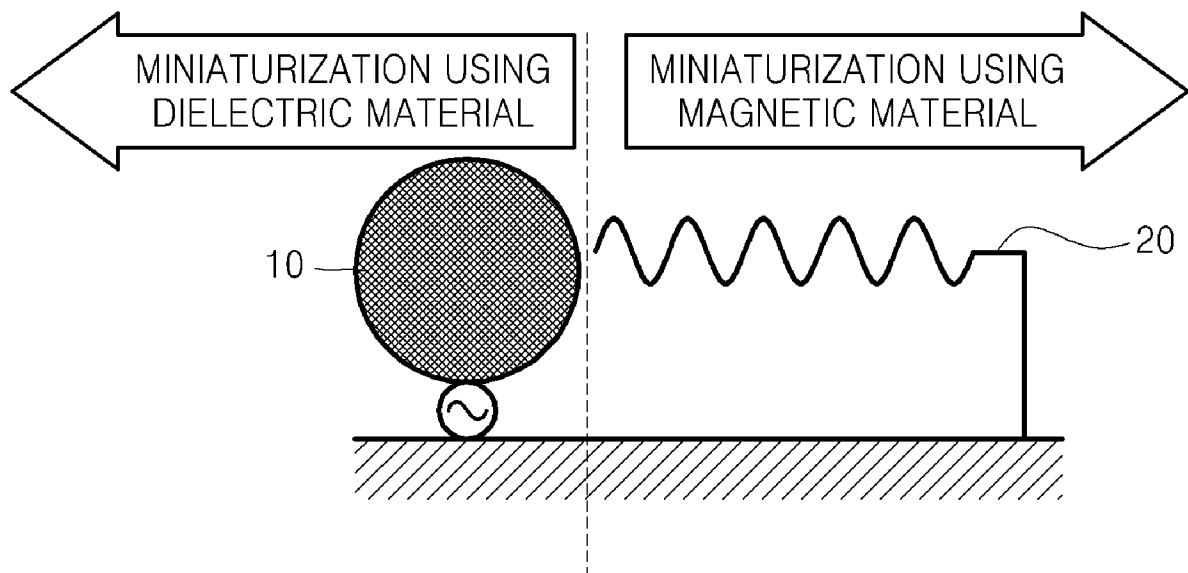
FIG. 11**FIG. 12**

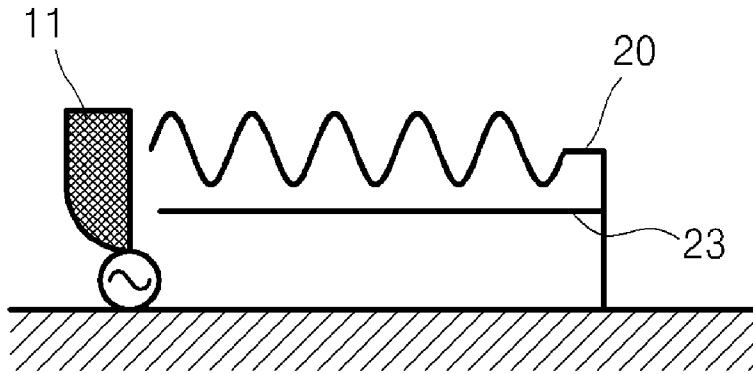
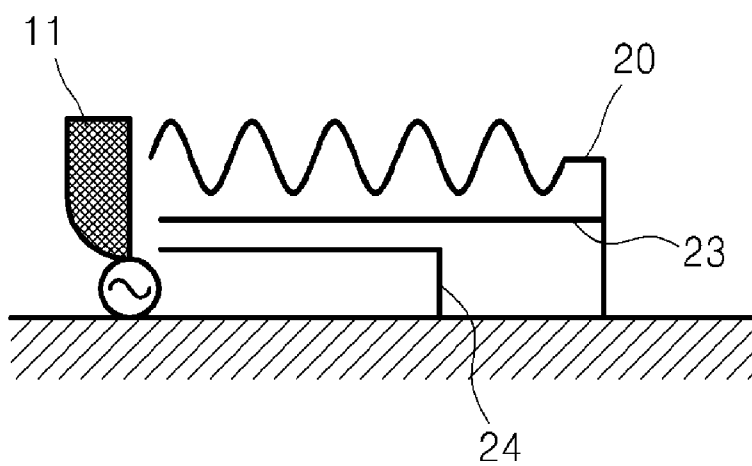
FIG. 13A**FIG. 13B**

FIG. 14

TYPE	FREQUENCY RANGE	SYSTEM
WWAN	824-894MHz	GSM850, ETC.
	890-960MHz	GSM900, ETC.
	1710-1880MHz	GSM1800, ETC.
	1850-1990MHz	GSM1900, ETC.
	1920-1980MHz 2110-2170MHz	UMTS, ETC.
WMAN	2305-2360MHz	mW2300, ETC.
	2496-2690MHz	mW2500, ETC.
	3300-3800MHz	mW3500, ETC.
WLAN	2400-2485MHz	IEEE802.11a/b/g/n
	5150-5350MHz	
	5470-5825MHz	
WPAN	2402-2480MHz	Bluetooth
	3100-10600MHz	UWB

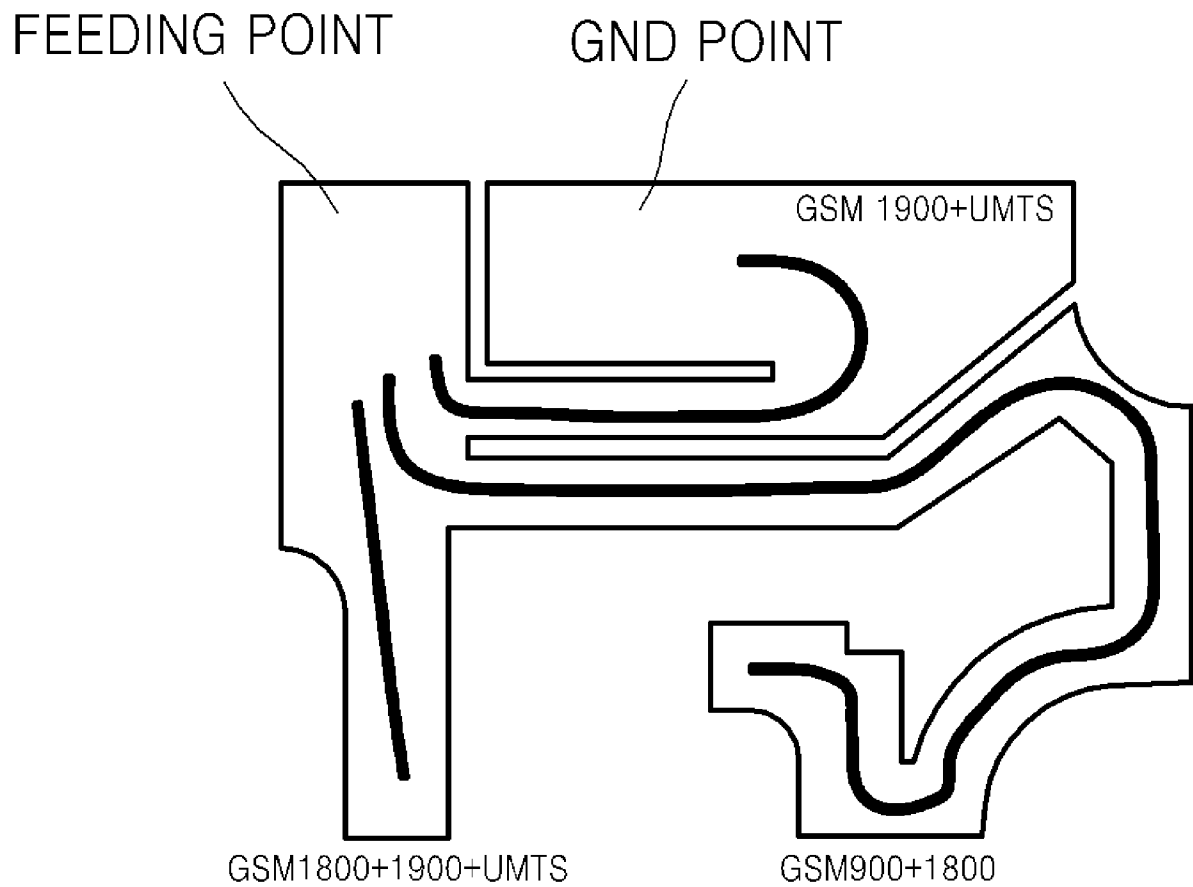
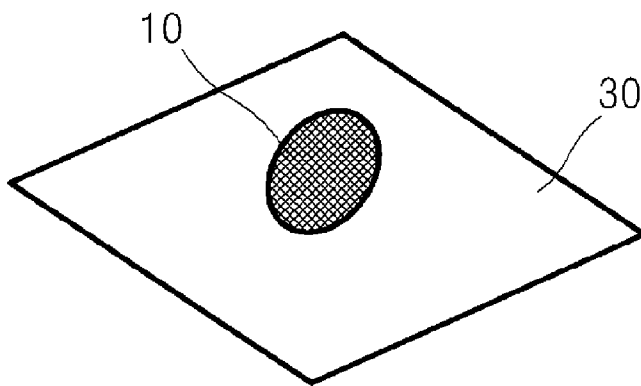
FIG. 15

FIG. 16A**FIG. 16B**