



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.09.2015 Bulletin 2015/40

(51) Int Cl.:
H01Q 1/12 (2006.01) H01R 24/44 (2011.01)

(21) Application number: **15159789.5**

(22) Date of filing: **19.03.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

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(30) Priority: **26.03.2014 JP 2014062907**
26.02.2015 JP 2015036454

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(54) **Vehicular glass antenna**

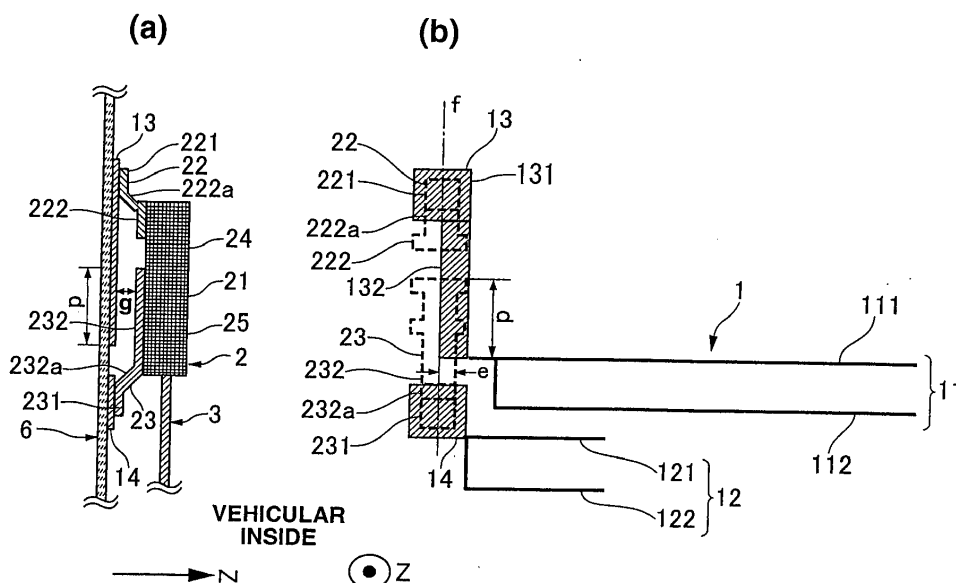
(57) It is an object of the present invention to provide a vehicular glass antenna which can be expected to be a larger improvement of an antenna sensitivity.

[Means for solving task]

There is provided with a vehicular glass antenna in which a coaxial cable is disposed between an antenna element and a receiver, characterized in that the antenna

element is constituted by a positive pole side conductor section and a negative pole side conductor section; a part of the positive pole side conductor section and a part of the negative pole side conductor are separated from each other and overlapped on each other with an overlap gap g in a vertical direction of a glass surface to constitute an overlap part.

[FIG.3]



Description

First Publication (tokkai) No. 2003-273625.

[Technical field]

[0001] The present invention relates to a vehicular glass antenna disposed on a window glass of an automotive vehicle.

[Background of the invention]

[0002] A vehicular glass antenna has been used for receiving electric waves in an FM band through an UHF band such as an FM broadcasting, an DAB (Digital Audio Broadcasting: a digital terrestrial radio broadcasting), and a digital terrestrial television broadcasting or for receiving the electric waves of a microwave band such as GPS. In such a vehicular glass antenna as described above, a dimension and a shape of a window glass are different depending upon a vehicle to be attached and a position of the window glass. Hence, it is often difficult to obtain a favorable antenna sensitivity.

[0003] For example, a patent document 1 describes the vehicular glass antenna which obtains a sufficient antenna gain even in a narrow area. As a feeding terminal of such a glass antenna as described above, for example, a feeding terminal constituted by a catcher as described in a patent document 2 and a connector as described in a patent document 3 is used, the catcher being equipped with a signal connection terminal section and a ground connection terminal section. Then, the signal connection terminal section is connected to an antenna side feeding section and the ground connection terminal section is connected to an earth side feeding section.

[0004] Furthermore, a patent document 4 describes the vehicular glass antenna in which a part of a conductive wire strip extended from a positive feeding point and constituted by a horizontal component and a vertical component is extended so as to close to one side of a negative feeding point and this part is closed to a second conductive wire extended from the negative feeding point so that a phase between the horizontal component and the vertical component is made different, thus electric waves of a circularly polarized wave can favorably be received.

[Pre-published document]**[Patent document]****[0005]**

[Patent document 1] A Japanese Patent Application First Publication (tokkai) No. 2010-114782.

[Patent document 2] A Japanese Patent Application First Publication (tokkai) No. 2008-300267.

[Patent document 3] A Japanese Patent Application First Publication (tokkai) No. 2008-035479.

[Patent document 4] A Japanese Patent Application

[Summary of the invention]**[Task to be solved by the invention]**

[0006] Conventionally, such a method has been used in which, in a case where the vehicular glass antenna is formed using the antenna feeding terminal as described in patent documents 2 and 3, a size of an earth side feeding section is as large as possible so that an outer conductor of a coaxial cable connected to the antenna feeding terminal is favorably grounded and a favorable antenna sensitivity can be achieved as described in patent document 1. However, such a method as described above does not positively adjust an input impedance of the antenna by changing the shape of the earth side feeding section.

[0007] In the vehicular glass antenna described in patent document 4, the phase adjustment can be carried out by approaching the conductor wire strip extended from the feeding point of the positive pole side to the negative side feeding point and to the second conductive wire strip extended from the negative pole side. Hence, the circularly polarized wave can favorably be received. However, in a case where a reception performance with respect to the electric wave of a certain polarized plane wave is increased, a large effect cannot be obtained.

[0008] In a case where, in the vehicular glass antenna, the coaxial cable is connected to an antenna element, an electric current is caused to flow through an outside of the outer conductor of the coaxial cable so that the outer conductor is operated as a part of antenna and an impedance of the antenna is varied. To avoid this, it is a general practice that the outer conductor of the coaxial cable is grounded at a proximity section of the antenna element so that the variation of the impedance is suppressed.

[0009] However, when the digital terrestrial television broadcasting glass antenna is mounted in the vehicle, for a design convenience, the outer conductor of the coaxial cable is needed to be grounded at a location which is remote from the antenna element. Consequently, a distance between the antenna element and the grounded location becomes long as compared with a wavelength and an impedance of a proximity section of the antenna element becomes high.

[0010] It is, therefore, an object of the present invention to provide a vehicular glass antenna which can assure a large improvement of the antenna sensitivity by easily matching an input impedance of the vehicular glass antenna with a characteristic impedance of the coaxial cable to be connected to the vehicular glass antenna, even in a case where the outer conductor of the coaxial cable is grounded at the location remote from the antenna element.

[Means for solving the task]

[0011] According to the present invention, there is provided with a vehicular glass antenna in which a coaxial cable is disposed between an antenna element and a receiver, characterized in that the antenna element is constituted by a positive pole side conductor section and a negative pole side conductor section; a part of the positive pole side conductor section and a part of the negative pole side conductor are separated from each other and overlapped on each other with an overlap gap g in a vertical direction of a glass surface to constitute an overlap part.

[0012] In addition, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that, at the overlap part between the positive pole side conductor section and the negative pole side conductor section, the negative pole side conductor section is located at an upper part of the positive pole side conductor section in the vertical direction on the glass surface.

[0013] Furthermore, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that the positive pole side conductor section includes a positive pole side feeding section and a positive pole side element; the negative pole side conductor section includes the negative pole side feeding section.

[0014] Furthermore, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that the negative pole side conductor section further includes a negative pole side element extended from the negative pole side feeding section.

[0015] Furthermore, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that a part of the positive pole side element and a part of the negative pole side element are separated from each other with an overlap gap g to form an overlap part between the positive pole side conductor section and the negative pole side conductor section.

[0016] Furthermore, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that the antenna element further includes a feeding terminal, the positive pole side conductor section includes a positive pole purpose metal fitting of the feeding terminal and the negative pole side conductor section further includes a negative pole purpose metal fitting of the feeding terminal, the positive pole purpose metal fitting or the negative pole purpose metal fitting is separated from the negative pole side feeding section or the positive pole side feeding section with an overlap gap g to form an overlap part between the positive pole side conductor section and the negative pole side conductor section.

[0017] Then, according to the present invention, there is provided with the vehicular glass antenna described

above, characterized in that the overlap part between the positive pole side conductor section and the negative pole side conductor section is inserted between a connection point to the coaxial cable and the positive pole side element when the antenna element is connected to the coaxial cable.

[0018] The glass antenna according to the present invention is provided with an overlap part in which a part of the positive pole side conductor section and a part of the negative pole side conductor section, the positive pole side conductor section and the negative pole side conductor section constituting an antenna element, are separated from each other and overlapped in a vertical direction on a glass surface. Hereinafter, this separated gap is called "overlap gap g ". This overlap part forms a conductance in an equivalent circuit. Hence, the conductance can be adjusted by adjusting this overlap gap g and/or an area (length d x width e) of the overlap part.

[0019] Then, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that the overlap gap g is from 0.5mm to 1.5mm.

[0020] In addition, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that an area of the overlap part between the positive pole side conductor section and the negative pole side conductor section is 10mm^2 through 300mm^2 .

[0021] In addition, according to the present invention, there is provided with the vehicular glass antenna described above, characterized in that the glass antenna is a glass antenna for receiving a terrestrial digital television broadcasting.

[Effect of the invention]

[0022] Since, according to the present invention, the input impedance of the antenna can largely be adjusted by adjusting the overlap gap g and/or the area of the overlap part (length d x width e), the input impedance of the antenna easily matches with the characteristic impedance of the coaxial cable connected to the vehicular glass antenna according to the present invention. Thus, a large improvement of an antenna sensitivity could be achieved.

[Brief description of the drawings]

[0023]

Fig. 1(a) is a longitudinal cross sectional view cut away along a center line f shown in Fig. 1(b) and Fig. 1(b) is a view of a vehicular glass antenna in a first preferred embodiment according to the present invention as viewed from a vehicular inside.

Fig. 2(a) is a longitudinal cross sectional view cut away along center line f shown in Fig. 2(b) and Fig. 2(b) is a view of the vehicular glass antenna in a

second preferred embodiment according to the present invention as viewed from the vehicular inside.

Fig. 3(a) is a longitudinal cross sectional view cut away along center line f shown in Fig. 3(b) and Fig. 3(b) is a view of the vehicular glass antenna in a third preferred embodiment according to the present invention as viewed from the vehicular inside.

Fig. 4(a) is a view representing a structure of a catcher and a connector of a feeding terminal used in the first through third preferred embodiments, particularly a view viewed from a lower side of the catcher and the connector,

Fig. 4(b) is a view representing the structure of the catcher and the connector of the feeding terminal used in the first through third preferred embodiments, particularly a view viewed from an upper side of the catcher and the connector, and Fig. 4(c) is a view representing the structure of the catcher and the connector of the feeding terminal used in the first through third preferred embodiments, particularly a view viewed from a side of the catcher and the connector.

Fig. 5 is an equivalent circuit diagram of the vehicular glass antenna according to the present invention.

Fig. 6 is a view as viewed from the vehicular inside when the antenna in the third preferred embodiment is disposed on a front windshield (a front window glass) of the vehicle.

Fig. 7 is a view as viewed from the vehicular inside when the antenna in the third preferred embodiment is disposed on a rear windshield (a rear window glass) of the vehicle.

Fig. 8 is a view as viewed from the vehicular inside when the antenna in the third preferred embodiment is disposed on a side windshield (side window glass) of the vehicle.

Fig. 9 is a plan view of the vehicular glass antenna in a reference example 1 according to the present invention for which a simulation is carried out.

Fig. 10 is a plan view of the vehicular glass antenna in a reference example 2 according to the present invention for which a simulation is carried out.

Fig. 11 is a plan view of the vehicular glass antenna in a reference example 3 according to the present invention for which a simulation is carried out.

Fig. 12 is a graph representing a simulation result related to the vehicular glass antenna of reference example 1 according to the present invention.

Fig. 13 is a graph representing a simulation result of a condition 1 related to the vehicular glass antenna of reference example 2 according to the present invention.

Fig. 14 is a graph representing a simulation result of a condition 2 related to the vehicular glass antenna of reference example 2 according to the present invention.

Fig. 15 is a graph representing a simulation result

related to the vehicular glass antenna of reference example 3 according to the present invention.

[Preferred embodiments for carrying out the invention]

[0024] Figs. 1(a) through 3(b) are views of a vehicular glass antenna in each of various preferred embodiments viewed from a vehicular inside. In the following explanation, when it is said that it is a vertical direction with respect to a glass surface, it is a direction directed from the glass surface on which the vehicular glass antenna according to the present invention is disposed toward the vehicular inside, viz., a direction denoted by an arrow mark Z in Figs. 1(a) through 3(b). In addition, when "upper", "lower", "left", and "right" are said in the specification, unless otherwise specified, in the drawings, they indicate that an upper side is present with respect to a certain criterion, a lower side is present, a leftward is present, and a rightward is present.

<First preferred embodiment>

<A structure in which a negative pole side conductor section and a positive pole side conductor section are remotely disposed on the window glass: an embodiment in which a negative pole side feeding section which is a part of the negative pole side conductor section and a positive pole purpose metal fitting which is a part of the positive pole side conductor section are remotely disposed on the window glass and overlapped on each other>

[0025] The glass antenna according to the present invention can take a structure as in a first preferred embodiment shown in Figs. 1(a) and 1(b). Fig. 1(b) is a view of the glass antenna in the first embodiment viewed from the vehicular inside. The glass antenna in the preferred embodiment is formed on a vehicular inside surface side of the window glass. In addition, Fig. 1(a) is a view representing a longitudinal cross section cut away along a center line f of a feeding terminal 2 in Fig. 1(b).

[0026] The glass antenna according to the present invention takes the following structure as the positive pole side conductor section and the negative pole side conductor section constituting an antenna element 1. That is to say, as the positive pole side conductor section, a positive pole side feeding section 13 and a positive pole side element 11 are disposed on window glass 6. Positive pole side element 11 is further constituted by, for example, a positive pole side element first wire strip 111 extended from positive pole side feeding section 13 and a positive pole side element second wire strip 112 branched from positive pole side element first wire strip 111, remote from positive pole side element first wire strip 111, and extended in parallel to positive pole side element first wire strip 111 on the same glass surface as the positive pole side element first wire strip 111.

[0027] In addition, the negative pole side conductor section includes: a negative pole side feeding section 14 disposed remotely, for example, longitudinally on the window glass from positive pole side feeding section 13; and a negative pole side element 12.

Negative pole side element 12 is further constituted by: for example, a negative pole side element first wire strip 121 extended from negative pole side feeding section 14; and a negative pole side element second wire strip 122 extended similarly from negative pole side feeding section 14, remotely disposed from negative pole side element first wire strip 121, and extended in parallel to negative pole side element first strip 121 on the same glass surface.

[0028] In the glass antenna in the first preferred embodiment, feeding terminal 2 is used to connect a coaxial cable 3 to connect between a receiver (not shown) and antenna element 1 of the vehicular glass antenna in this embodiment. The structure of feeding terminal 2 will be described later. It should be noted that, in the vehicular glass antenna in this embodiment, a distance between antenna element 1 and a ground location of an outer contact of coaxial cable 3 is 20cm and, in an ordinary case, the distance is equal to or shorter than 25cm. If the distance becomes longer than 25cm, a high frequency wave current flowing through the outer conductor of the coaxial cable is often resonated. Thus, this is not preferable.

[0029] Feeding terminal 2 used in the glass antenna in this embodiment includes: a catcher 21 previously connected to the vehicular inside surface of a window glass 6 as shown in Fig. 1(a); and a connector 25 connected to catcher 21. One end of coaxial cable 3 is connected to connector 25 and the other end of coaxial cable 3 is connected to the receiver. When feeding terminal 2 is connected to the window glass, a positive pole purpose metal fitting 22 and a negative pole purpose metal fitting 23 are remotely disposed and faced against each other with an overlap gap g from window glass 6.

[0030] Positive pole purpose metal fitting 22 includes: a positive pole side contact 221; and a positive pole purpose metal fitting housing section 222 connected from positive pole side contact 221 and arranged on a rear surface of catcher 21. Positive pole side contact 221 is connected to positive pole side feeding section 13 by means of a soldering and/or a conductive adhesive.

In addition, positive pole side metal fitting housing section 222 includes an inclination section 222a at the connection location with positive pole side contact 221. When feeding terminal 2 is attached onto window glass 6, gap g can be formed between a part of positive pole purpose metal fitting housing section 222 and window glass 6.

[0031] Negative pole purpose metal fitting 23 includes: a negative pole side contact 231; and a negative pole purpose metal fitting housing section 232 connected from negative pole side contact 231 and arranged onto the rear surface of catcher 21. Negative pole side contact 231 is connected to negative pole side feeding section

13 by means of the soldering and/or conductive adhesive. In addition, negative pole side metal fitting housing section 232 includes an inclination section 232a at the connection location with positive pole side contact 231. When feeding terminal 2 is attached onto window glass 6, gap g can be formed between a part of negative pole purpose metal fitting housing section 232 and window glass 6.

[0032] Then, positive pole purpose metal fitting 22 constitutes a part of the positive pole side conductor section and negative pole purpose metal fitting 23 constitutes a part of the negative pole side conductor section. In other words, in the glass antenna in the first embodiment, the positive pole side conductor section is constituted by positive pole side feeding section 13, positive pole side element 11, and positive pole purpose metal fitting 22. Negative pole side conductor section is constituted by negative pole side feeding section 14, negative pole side element 12, and negative pole purpose metal fitting 23.

[0033] In the glass antenna in this preferred embodiment, negative pole side feeding section 14 includes: a negative pole side feeding section first section 141 to be connected to negative pole side contact 231; and a negative pole side feeding section second section 142 formed to be extended from negative pole side feeding section first section 141 toward a direction of positive pole side feeding section 13. In the first embodiment, a width of negative pole side feeding first section 141 and a width of negative pole side feeding section second section 142 are the same. However, the width of negative pole side feeding section second section 142 can be varied regardless of the width of negative pole side feeding section first section 141.

[Structure of the overlap part]

[0034] Furthermore, positive pole purpose metal fitting housing section 222 is formed to be extended from positive pole side feeding section 13 toward the direction of negative pole side feeding section 14. Then, a part of a lower end side of positive pole purpose metal fitting housing section 222 and a part of an upper end side of negative pole side feeding section second section 142 form an overlap part between the positive pole side conductor section and the negative pole side conductor section with a width e, a length d, and an overlap gap g. In this way, negative pole side feeding section second section 142 is disposed to be overlapped on positive pole purpose metal fitting housing section 222 with a gap in an upward direction. In Fig. 1(b), positive pole side feeding section 13 and negative pole side feeding section 14 are denoted by oblique lines and positive pole purpose metal fitting 22 and negative pole purpose metal fitting 23 are denoted by dot lines. In the glass antenna in the first embodiment, width e, length d, and a length of overlap gap g are 6mm, 15mm, and 1mm, respectively, and an area (length d x width e) of the overlap part is 90mm².

[0035] In the glass antenna according to the present

invention, there are many cases where antenna element 1 formed on window glass 6 is connected to coaxial cable 3 via feeding terminal 2. As in the case of the glass antenna in the first preferred embodiment, positive pole purpose metal fitting housing section 222 which is a part of positive pole side metal fitting 22 of feeding terminal 2 can be overlapped on the negative pole side conductor section which is upwardly remote from positive pole purpose metal fitting housing section 222 as the positive pole side conductor section. Hence, it is not necessary to dispose a special structure in order to provide an overlap part between the positive pole side conductor section and the negative pole side conductor section and the structure of the glass antenna according to the present invention can be simplified.

[Explanation of an operation of the glass antenna in the first preferred embodiment]

[0036] Since, in the glass antenna in the first embodiment, the overlap part between the positive pole side conductor section and the negative pole side conductor section is formed so that a circuit as shown in an equivalent circuit diagram shown in Fig. 5 is formed.

[0037] In Fig. 5, an impedance denoted by Z_1 represents an input impedance in a case where the glass antenna is not provided with the overlap part between the positive pole side conductor section and the negative pole side conductor section as in the case of the first preferred embodiment according to the present invention. R_1 denotes a radiation resistance representing a consumption of an electric wave radiated toward a space, L_1 and C_1 denote an inductance of the antenna and a conductance of the antenna, respectively, and Z_1 can be expressed in the following equation 1.

[Equation 1]

$$Z_1 = j\omega \left(L_1 - \frac{1}{C_1} \right) + R_1$$

[0038] In a case where antenna element 1 is provided with the overlap part between the positive pole side conductor section and the negative pole side conductor section as in the case of the glass antenna in the first embodiment, this overlap part forms a conductance C_2 . Then, since such a location of the overlap part as described above is provided, an impedance Z_2 in parallel to impedance Z_1 is provided. Impedance Z_2 is expressed by conductance C_2 in the following equation 2.

[Equation 2]

$$Z_2 = \frac{1}{j\omega C_2}$$

[0039] The glass antenna in the first preferred embodiment provides a parallel circuit between Z_1 and Z_2 . Input impedance Z_i can be expressed in the following equation 3.

[Equation 3]

$$\frac{1}{Z_i} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

[0040] In the glass antenna in this embodiment, a magnitude of Z_2 can be adjusted by adjusting overlap gap g of the overlap part between the positive pole side conductor section and the negative pole side conductor section, the area ($d \times e$) of the overlap part, and so forth. The input impedance of the glass antenna in this embodiment can be closed to the characteristic impedance of coaxial cable 3 to which the glass antenna in the first embodiment is connected. Hence, a transmission loss can be reduced and it becomes possible to improve the antenna sensitivity.

[0041] In the glass antenna in the first embodiment, it is preferable that overlap gap g is 0.5 ~ 1.5mm. It is more preferable that overlap gap g is 0.7 ~ 1.3mm. As overlap gap g is made narrower, an electric capacitance becomes larger and the impedance can be reduced. However, there is a tendency that a manufacturing of the terminal structure becomes difficult.

[0042] In the glass antenna in the first preferred embodiment, it is preferable that the area ($d \times e$) of the overlap part is 10 ~ 300mm² although it depends upon the impedance of the antenna to be matched. It is more preferable that the area is 30 ~ 150mm². If the area of the overlap part is wider, the electrical capacitance is made larger and the impedance can be reduced.

[0043] In the equivalent circuit shown in Fig. 5, only conductance C_2 is described as Z_2 . Not only conductance C_2 but also the element is added and the shape of the feeding section is varied due to the provision of the overlap part between the positive pole side conductor section and the negative pole side conductor section. Hence, ordinarily, not only conductance C_2 but also the radiation resistance and the inductance are added. In this way, newly additions of radiation resistance and the inductance contributes on the improvement of the antenna sensitivity of the glass antenna in this embodiment.

<Second embodiment>

<Embodiment in which the negative pole purpose metal fitting which is a part of the negative pole side conductor section and the positive pole side feeding section which is a part of the positive pole side conductor section are remotely disposed on the window glass and are overlapped on each other>

[0044] The glass antenna according to the present invention can take the structure as a second preferred embodiment shown in Figs. 2(a) and 2(b).

[0045] Fig. 2(b) is a view of the vehicular glass antenna in the second preferred embodiment viewed from the vehicular inside and the vehicular antenna in this embodiment is formed on a vehicular inside surface of the window glass. In addition, Fig. 2(a) is a view of the vehicular window glass antenna representing a longitudinally cross section cut away along center line f of feeding terminal 2 in Fig. 2(b).

[0046] In the vehicular glass antenna in the second preferred embodiment, in the same way as the vehicular glass antenna in the first embodiment, feeding terminal 2 is used to connect coaxial cable 3 which connects between the receiver and the antenna element of the window glass antenna in this embodiment.

[0047] In the vehicular glass antenna in the second preferred embodiment, a part of the positive pole side conductor section is located at an upper part in a vertical direction of the glass surface with respect to a part of the negative pole side conductor section to constitute an overlap part between the positive pole side conductor section and the negative pole side conductor section. This is a difference point from the first embodiment.

[0048] That is to say, in the window glass antenna in the first embodiment, negative pole side feeding section 14 includes: negative pole side feeding section first section 141 to which negative pole side contact 231 of feeding terminal 2 is connected; and negative pole side feeding section second section 142 connected to negative pole side feeding section first section 141 and extended toward the direction of positive pole side feeding section 13. On the other hand, in the window glass antenna in the second preferred embodiment, positive pole side feeding section 13 includes: a positive pole side feeding section first section 131 to which the positive pole side contact of feeding terminal 2 is connected; and a positive pole side feeding section second section 132 connected to positive pole side feeding section first section 131 and extended toward the direction of negative pole side feeding section 14 from a lower side of positive pole side feeding section first section 131 by a length j.

[0049] Then, in the glass antenna in the first embodiment, positive pole purpose metal fitting housing section 222 constituting feeding terminal 2 is extended toward the direction of negative pole purpose metal fitting housing section 232 and is formed to be an overlap part to overlap on negative pole side feeding section second

section 142 with overlap gap g. However, in the glass antenna in the second preferred embodiment, negative pole purpose metal fitting housing section 232 constituting feeding terminal 2 is extended toward the direction of positive pole side metal fitting housing section 222 and forms the overlap part with positive pole side feeding section second section 132 with width e, length d, and overlap gap g to constitute the overlap part between the positive pole side conductor section and the negative pole side conductor section. In this way, in the glass antenna in the second embodiment, positive pole side feeding section second section 132 is used to overlap negative pole side metal fitting housing section 232, space apart from negative pole purpose metal fitting housing section 232 by overlap gap g. Since, in many of feeding terminal 2, the length of negative pole purpose metal fitting housing section 232 is longer than that of positive pole purpose metal fitting housing section 222, in a case where feeding terminal 2 is used to form the overlap part between the positive pole side conductor section and the negative pole side conductor section, it is desirable to form the structure of the glass antenna in the second embodiment.

[0050] Then, one end of positive pole side element first wire strip 111 constituting positive pole side element 11 is connected to positive pole side feeding section first section 131.

[0051] The other parts of the glass antenna in the second embodiment are the same as the structure of the glass antenna in the first embodiment.

[0052] In the glass antenna in this preferred embodiment, a width of positive pole side feeding section second section 132 is narrower than a lateral width of positive pole side feeding section first section 131 constituting positive pole side feeding section 13.

[0053] In addition, positive pole side feeding section second section 132 is connected to positive pole side feeding section first section 131 so that a right side of positive pole side feeding section second section 132 is connected to a right side of positive pole side feeding section first section 131.

[Structure of the overlap part]

[0054] Ordinarily, it is difficult to modify a dimension of positive pole purpose metal fitting 22 of the feeding terminal and the dimension of negative pole purpose metal fitting 23 since the modifications of the dimensions of positive pole purpose metal fitting 22 and negative pole purpose metal fitting 23 largely affect a performance of the feeding terminal. Therefore, in a case where a part of negative pole purpose metal fitting 23 and a part of positive pole side feeding section 13 are separated and overlapped with overlap gap g to form the overlap part so as to constitute the overlap part between the positive pole side conductor section and the negative pole side conductor section, it is preferable that the width, the length, and the position of positive pole purpose feeding section second section 132 constituting positive pole side

feeding section 13 are adjusted to adjust the dimension of the overlap part and an input impedance at a desired frequency band of the glass antenna in the second preferred embodiment is adjusted to match with the characteristic impedance of coaxial cable 3 to be connected. In Fig. 2(b), positive pole side feeding section 13 and negative pole side feeding section 14 are denoted by oblique lines and positive pole purpose metal fitting 22 and negative pole purpose metal fitting 23 are denoted by dot lines.

[0055] In the window glass antenna in the second preferred embodiment, width e , length d , and the length of overlap gap g are 3mm, 15mm, and 1mm, respectively, and area (length d x width e) of the overlap part is 45mm^2 .

[Operation characteristic of the window glass antenna in the second preferred embodiment]

[0056] Since an explanation of the operation of the overlap part between the positive pole side conductor section and the negative pole side conductor section is the same as the first preferred embodiment, the explanation thereof will herein be omitted.

<Third preferred embodiment>

<An embodiment in which the negative pole purpose metal fitting which is a part of the negative pole side conductor section and the positive pole side feeding section which is a part of the positive pole side conductor section are separated from each other on the window glass and overlapped and a case where the overlap part between the positive pole side conductor section and the negative pole side conductor section is disposed on a terminal section of the coaxial cable and the positive pole side element>

[0057] The window glass antenna according to the present invention can take the third preferred embodiment shown in Figs. 3(a) and 3(b). Fig. 3(b) is a view of the window glass antenna in the third preferred embodiment viewed from the vehicular inside. The glass antenna in the third preferred embodiment is formed on the vehicular inside surface of the window glass. In addition, Fig. 3(a) is a view representing a longitudinally cross section cut away along center line f of feeding terminal 2 shown in Fig. 3(b).

[0058] In the glass antenna in the third preferred embodiment, feeding terminal 2 is used to connect coaxial cable 3 which connects between the receiver and the glass antenna in this embodiment in the same way as the glass antenna in the second preferred embodiment. Feeding terminal 2 is denoted by the dot line in Fig. 3(b) in the same way as the second preferred embodiment in Fig. 2(b).

[0059] In the glass antenna in the third preferred embodiment, a location at which positive pole side element first wire strip 111 is connected to positive pole side feed-

ing section second section 132 is a terminal section of negative pole side feeding section 14 side. This is a difference point from glass antenna 1 in the second preferred embodiment and the other structures of the window glass antenna in the third embodiment are the same as that in the second embodiment.

[Structure of the overlap part]

[0060] In the glass antenna in the third preferred embodiment, the overlap part between the positive pole side conductor section and the negative pole side conductor section is interposed between positive pole side element first wire strip 111 and coaxial cable 3 connected to the receiver. In the third preferred embodiment, the above-described structure is taken so that width e and length d of the overlap part between the positive pole side conductor section and the negative pole side conductor section are variably adjusted. Thus, the input impedance in the desired frequency band of the glass antenna in the third preferred embodiment is easier to be varied than the glass antenna in the second preferred embodiment. Thus, the input impedance is easily matched with the characteristic impedance of coaxial cable 3. In the glass antenna in the third preferred embodiment, width e , length d , and the length of overlap gap g are 3mm, 15mm, and 1 mm, respectively, and area (length d x width e) of the overlap part is 45mm^2 .

[Operational characteristic of the window glass antenna in the third preferred embodiment]

[0061] An explanation of the operation of the overlap part between the positive pole side conductor section and the negative pole side conductor section is basically the same as those of the first and second preferred embodiments. Hence, the explanation thereon will herein be omitted.

[0062] However, in the glass antenna in the third preferred embodiment, positive pole side element first wire strip 111 is structured so that the overlap part between a part of the positive pole conductor section and a part of the negative pole conductor section with overlap gap g is interposed between positive pole side element first wire strip 111 and a core wire of coaxial cable 3 connected to the receiver. Hence, a larger influence due to the variation of the length, the width, and the gap of the overlap part is received than glass antenna 1 in the second preferred embodiment.

[0063] Therefore, in the glass antenna in the third preferred embodiment, the adjustment of the input impedance of window glass antenna 1 is easier to be carried out than the glass antenna in the second preferred embodiment.

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<Preparing method of the glass antenna according to the present invention>

[0064] A generally available conductive ceramic paste can be used for positive pole side element 11, negative pole side element 12, positive pole side feeding section 13, and negative pole side feeding section 14 from among antenna element 1 of the glass antenna according to the present invention in the same way as forming a defogger of the rear window glass (rear windshield), can be printed in the same method as the defogger, and can be baked through a heating furnace.

[0065] In addition, concerning the overlap part between the positive pole side conductor section and the negative pole side conductor section, a hard conductive plate material, for example, a copper plate or an aluminum plate is bent, or an insulating characteristic spacer is inserted, the conductive ceramic paste is coated along the spacer, or copper foil is adhered, or use of a feeding terminal as will be described later can be formed so that one of the positive pole side feeding section and the negative pole side feeding section which is upper than the other can be separated by the overlap gap g from the lower side feeding section.

[0066] Furthermore, in a case where the overlap part between the positive pole side conductor section and the negative pole side conductor section is formed by feeding terminal 2, a commercially available good is generally used for feeding terminal 2. Thus, overlap gap g between positive pole side contact 221 of positive pole side contact 221 of positive pole purpose metal fitting 22 and positive pole purpose metal fitting housing section 222 and overlap gap g between negative pole side contact 231 of the negative pole purpose metal fitting 23 and negative pole purpose metal fitting housing section 232 are constant and cannot be altered.

[0067] Therefore, for example, in a case where feeding terminal 2 is used in the window glass antenna in the third preferred embodiment and positive pole purpose metal fitting housing section 222 of feeding terminal 2 or negative pole purpose metal fitting housing section 232 is used for a part constituting the overlap section, thicknesses of positive pole side feeding section 13 and negative pole side feeding section 14 connected, respectively, to positive pole side contact 221 and negative pole side contact 231 are provided so that overlap gap g of the overlap part between the positive pole side conductor section and the negative pole side conductor section can be adjusted.

It should be noted that, as positive pole purpose metal fitting 22 and negative pole purpose metal fitting 23, a metallic plate is generally used and, as the metallic plate, for example, a brass or copper alloy is used and a tin-plating is treated on the surface to facilitate the soldering.

<Connection of the antenna according to the present invention with the receiver>

[0068] In addition, the first preferred embodiment through the third preferred embodiment indicate the glass antenna in which positive pole side feeding section 13 and negative pole side feeding section 14 are provided on the window glass. In such a window glass antenna as described above, the core wire and the outer conductor of coaxial cable 3 extended from the receiver (not shown) are directly or via feeding terminal 2 connected to positive pole side feeding section 13 and negative pole side feeding section 14, respectively.

< Mounting position of the glass antenna according to the present invention on the window glass>

[0069] The vehicular glass antenna according to the present invention is mounted at a location of the vehicular window glass which is inconspicuous from a vehicular occupant. For example, as shown in Fig. 6, the feeding section of the glass antenna according to the present invention is provided on left or right side of the upper side of the front window glass as shown in Fig. 6, on an upper part margin section of a defogger 7 of the rear window glass as shown in Fig. 7, and on a proximity of a side of the side glass as shown in Fig. 8.

< Feeding terminal used in the window glass antenna according to the present invention >

[0070] The structure of feeding terminal 2 used in the first through third preferred embodiments are shown in Figs. 4(a), 4(b), and 4(c). Fig. 4(a) is a view of feeding terminal 2 viewed from a lower side of feeding terminal, Fig. 4(b) is a view of feeding terminal 2 viewed from an upper side of feeding terminal 2, and Fig. 4(c) is a view of feeding terminal 2 viewed from a side of feeding terminal 2. In each of the drawings of Figs. 4(a) through 4(c), at the upper part, a catcher 21 is depicted and, at the lower part, connector 25 is depicted.

[0071] Catcher 21 includes: a box-shaped housing 24 having an opening at an upper side to fit connector 25 thereto to fix the connector at a predetermined position; positive pole purpose metal fitting 22; and negative pole purpose metal fitting 23.

[0072] Positive pole purpose metal fitting 22 includes: a positive pole side contact 221 connected to positive pole side feeding section 13 disposed on the window glass; and a positive pole purpose metal fitting housing section 222 arranged on a lower side of housing 24. Then, positive pole purpose metal fitting housing section 222 is provided with an inclination section 222a faced against the positive pole side contact 221. Therefore, when catcher 21 is disposed on the window glass, an upward gap is provided between a surface of the window glass and housing 24 as shown in Fig. 4(c).

[0073] Negative pole purpose metal fitting 23 includes:

a negative pole side contact 231 connected to negative pole side feeding section 14 disposed on the window glass; and a negative pole purpose metal fitting housing section 232 disposed on a lower surface of housing 24, in the same way as positive pole side metal fitting 22.

[0074] Then, negative pole purpose housing section 232 is provided with an inclination section 232a against negative pole side contact 231. Therefore, when catcher 21 is disposed on the window glass, an upward gap is provided between the surface of the window glass and housing 24 when catcher 21 is disposed on the window glass.

[0075] Positive pole purpose metal fitting housing section 222 is provided with a positive pole purpose catcher side engagement section 223 of a pin shape and penetrated through a lower surface of housing 24 along a center line f in a forward-and-rearward direction of the housing as shown in Fig. 4(b). In addition, negative pole side metal fitting housing section 232 is provided with a negative pole purpose catcher side engagement section 233 penetrated through a lower surface of housing 24 and disposed along an inner wall of the side surface of the housing.

[0076] Connector 25 is of a box shape which matches with an upper opening of housing 24. Connector 25 includes: a positive pole purpose connector side engagement section 251 in which positive pole purpose catcher side engagement section 223 of catcher 21 is inserted to connect with a core wire side of coaxial cable 3 when connector 25 is fitted into catcher 21, as shown in Fig. 4(a); and a negative pole purpose connector side engagement section 252 contacted on negative pole purpose catcher section engagement section 233 provided on an inside side surface of housing 24 of catcher 22 to connect to the outer conductor of coaxial cable 3 when connector 25 is fitted into catcher 21, as shown in Figs. 4(a) and 4(b).

[0077] Connector 25 is connected to coaxial cable 3. The core wire of coaxial cable 3 is connected to positive pole purpose connector side engagement section 251 and the outer conductor of coaxial cable 3 is connected to negative pole purpose connector side engagement section 252.

[0078] Positive pole purpose connector side engagement section 251 is of a cylindrical conductor into which pin shaped positive pole purpose catcher side engagement section 223 is inserted to be contacted and a conduction is obtained.

[0079] Negative pole purpose connector side engagement section 252 is a plate-like conductor disposed on an outer side surface of connector 25 and a conduction is obtained when it is contacted on negative pole side catcher side engagement section 233.

[Execution example]

[0080] The glass antenna in an execution example is the glass antenna in the third preferred embodiment

shown in Figs. 3(a) and 3(b).

[0081] In the glass antenna in the execution example, feeding terminal 2 is used to connect to coaxial cable 3 which connects between antenna element 1 of the glass antenna in the third preferred embodiment and the receiver.

[0082] In window glass 6, positive pole side feeding section 13, negative pole side feeding section 14, positive pole side element 11 extended from positive pole side feeding section 13, and negative pole side element 12 extended from negative pole side feeding section 14 are provided.

[0083] Positive pole side feeding section 13 includes: a positive pole side feeding section first section 131 connected to positive pole side contact 221 of feeding terminal 2; and positive pole side feeding section second section 132 connected to positive pole side feeding section 131 and extended toward the direction of negative pole side feeding section 14.

A right side of positive pole side feeding section second section 132 is connected to the right side of positive pole side feeding section first section 131 so as to coincide with the right side of the positive pole side feeding section first section 131.

[0084] Positive pole side element 11 includes positive pole side element first wire strip 111 and positive pole side element second wire strip 112. One end of positive pole side element first strip 111 is connected to a terminal section of positive pole side feeding section second section 132 away from the positive pole side feeding section first section 131. Positive pole side element first wire strip 111 is extended toward the direction separate from positive pole side feeding section 13. Then, positive pole side element second wire strip 112 is connected to a midway section of positive pole side element first wire strip 111 and extended in parallel to positive pole side element first strip 111 in a plane direction of the window glass.

[0085] Negative pole side element 12 includes a negative pole side element first wire strip 121 and a negative pole side element second wire strip 122. One end of negative pole side element first strip 121 is connected to negative pole side feeding section 14 and extended in a direction separate from negative pole side feeding section 14. In addition, negative pole side element second wire strip 122 is connected to negative pole side feeding section 14 and extended so as to be parallel to negative pole side element first wire strip 121.

[0086] Positive pole side feeding section 13 and negative pole side feeding section 14 are connected to positive pole side contact 221 of positive pole purpose metal fitting 22 of feeding terminal 2 and negative pole side contact 231 of negative pole purpose metal fitting 23, respectively, by means of soldering.

[0087] In feeding terminal 2, the core wire and the outer conductor of coaxial cable 3 are connected to positive pole side feeding section 13 and negative pole side feeding section 14 via positive pole purpose metal fitting 22

and negative pole purpose metal fitting 23, respectively.

[0088] Positive pole purpose metal fitting 22 includes positive pole side contact 221 and positive pole purpose metal fitting housing section 222. An inclination section 222a is provided between positive pole side contact 221 and positive pole purpose metal fitting housing section 222. Negative pole side metal fitting 23 is constituted by negative pole side contact 231 and negative pole purpose metal fitting housing section 232. Inclination section 232a is provided between negative pole side contact 231 and negative pole purpose metal fitting housing section 232. Then, when feeding terminal 2 is attached onto the window glass, inclination sections 222a and 232a provide an upward gap among the surface of the window glass, positive pole purpose metal fitting housing section 222, and negative pole purpose metal fitting housing section 232.

[0089] Negative pole purpose metal fitting housing section 232 is extended toward the direction of positive pole purpose metal fitting housing section 222. Positive pole side feeding second section 132 is extended toward the direction of negative pole side feeding section 14 so that a part of negative pole purpose metal fitting housing section 232 and a part of positive pole side feeding section second section 132 are separated and overlapped with overlap gap g to form the overlap part.

[0090] Negative pole purpose metal fitting housing section 232 becomes slim with respect to the width of the bottom surface of housing 24 and a part of negative pole purpose metal fitting housing section 232 is approximately the same width of the bottom surface of housing 24. This is because a fastener is formed to fix negative pole purpose metal fitting 23 to housing 24.

[0091] Feeding terminal 2 is installed in such a way that its center line f is coincident with center lines in width directions of positive pole side feeding section first section 131 and negative pole side feeding section 14.

[0092] The following describes dimensions of respective constituents of the glass antenna in the execution example.

Positive pole side feeding section first section 131 = width 12mm x length 12mm.

Positive pole side feeding section second section 132 = width 6mm x length 26mm.

Negative pole side feeding section 14 = width 12mm x length 12mm

An interval between a lower side of positive pole side feeding section second section 132 and an upper side of negative pole side feeding section 14 = 5mm.

Positive pole side element first wire strip 111 = 125mm

Positive pole side element second wire strip 112 = 130 mm (a dimension of a location at which positive pole side element second wire strip 112 is parallel to positive pole side element first wire strip 111 = 120mm).

An interval between positive pole side element first strip 111 and positive pole side element second wire strip 112 = 10mm.

A connection point of positive pole side element second

wire strip 112 to positive pole side element first wire strip 111 = a location of 120mm from a tip of positive pole side element first wire strip 111.

Negative pole side element first strip 121 = 40mm. Negative pole side element second strip 122 = 50mm.

An interval between negative pole side element first wire strip 121 and negative pole side element second wire strip 122 = 10mm.

An interval between positive pole side element second wire strip 112 and negative pole side element first wire strip 121 = 5mm.

A length d of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 with overlap gap g separated from each other = 15mm

A width e of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 with overlap gap g separated from each other = 3mm.

Overlap gap g of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 with overlap gap g separated from each other = 1mm.

It should be noted that a width of each wire strip is 0.7 mm.

[0093] In the glass antenna in this execution example, in the way described above, not only positive pole side element 11 and negative pole side element 12 but also a part of positive pole side feeding section second section 132 and a part of negative pole purpose metal fitting housing section 232 are spaced apart from each other with overlap gap g and the length and width of the overlap part are adjusted so that an input impedance of the glass antenna 1 in this execution example can be adjusted to match with the characteristic impedance 50 Ω of the coaxial cable connected to glass antenna 1 between 470MHz and 770MHz which is the frequency band of the terrestrial digital broadcasting. Thus, a favorable antenna sensitivity in the above-described frequency band of the terrestrial digital broadcasting band could be obtained.

[0094] The following reference examples show how the input impedance of the glass antenna is varied when the width and length of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting 23 are varied by changing variously the magnitude of positive pole side feeding section second section 132 in the antenna shape of the execution example using a simulation.

From the following reference examples, it is appreciated that the width and the length of the above-described overlap part have optimum values to match with the characteristic impedance of coaxial cable 3.

< Reference example 1 >

[0095] A reference example 1 indicates a simulation result. The glass antenna in reference example 1 is structured as shown in Fig. 9.

[0096] The structure and dimension of the glass an-

tenna in reference example 1 are the same as the glass antenna in the execution example except the lengths of positive pole side feeding section second section 132 and positive pole side element first wire strip 111.

[0097] In addition, in the execution example, positive pole side contact 221 and negative pole side contact 231 are connected to positive pole side feeding section first section 131 and negative pole side feeding section 14. However, since this reference example is the simulation result, positive pole purpose metal fitting 22 and negative pole purpose metal fitting 23 are line contacted on positive pole side feeding section first section 131 and negative pole side feeding section 14, respectively, to provide a positive pole side contact point 224 and negative pole side contact point 234.

[0098] In the simulation of reference example 1, a variation of the input impedance in the frequency band of the terrestrial digital broadcasting is checked when positive pole side feeding section 132 is moved in the leftward direction with positive pole side feeding section second section 132 unchanged from a position at which the right side of positive pole side feeding section second section 132 is coincident with the right side of positive pole side feeding first section 131.

[0099] The width of positive pole side feeding section second section 132 is 1mm and constant and the length of positive pole side element first wire strip 111 is extended by a leftward movement of positive pole side feeding section second section 132.

[0100] Conditions of the simulation in reference example 1 are as follows:

Method of simulation : Finite element method Supposing that a conductive film was formed by copper on a glass plate

Physical property of the glass plate: relative permittivity: $\epsilon = 7.2$, dielectric tangent: $\tan\Delta = 0.005$

Physical property of copper: electrical conductivity: $5.8 \times 10^7 \text{ S/m}$

The antenna is arranged in a proximity of the center of the glass plate.

[0101] A result of the input impedance of the glass antenna in this execution example obtained by the simulation in reference example 1 is shown in Fig. 12.

[0102] A longitudinal axis in Fig. 12 denotes the input impedance of glass antenna 1 of this reference example at the calculated frequencies and a lateral axis denotes the leftward movement of the right side of positive pole side feeding section 132 up to 10mm, when the right side of positive pole side feeding section second section 132 is coincident with the right side of positive pole side feeding section first section 131, viz., with (point a) as 0mm. A solid line denotes the variation of the input impedance at 600MHz, a dot line denotes the variation of the input impedance at 700MHz, and a dot-and-dash line denotes the variation of the input impedance at 500MHz.

[0103] As appreciated from Fig. 12, when, at each of

the frequencies, positive pole side feeding section second section 132 is moved by 0mm through 10mm, the variation of the input impedance of about 20Ω can be obtained. In this way, since the input impedance can be varied largely, the favorable antenna sensitivity can easily be obtained.

<reference example 2>

[0104] Reference example 2 also indicates the simulation result. Glass antenna 1 in reference example 2 is shown in Fig. 10. The dimension and the structure of reference example 2 are the same as the glass antenna in the execution example except the lengths of positive pole side feeding section second section 132 and positive pole side element first wire strip 111. The conditions of the simulation are the same as those of reference example 1.

[0105] In this reference example, the following cases are checked. That is to say, the width of positive pole side feeding section second section 132 is, at first, 1mm and the length of positive pole side feeding section second section 132 is constant, condition 1: a case where, in a state where the right side of positive pole side feeding section second section 132 is made coincident with the right side of positive pole side feeding section first section 131 (point a), the width of positive pole side feeding section second section 132 is widened toward the leftward direction: and condition 2: a case where, in a state (point b) where the center line in the lengthwise direction of positive pole side feeding section second section 132 is fixed at a position at which the center line of the lengthwise direction of positive pole side feeding section second section 132 matches with the lengthwise center line of positive pole side feeding first section 131, the width of positive pole side feeding section second section 132 is widened in the leftward and rightward directions.

[0106] From among the results of the input impedance of the glass antenna in this reference example obtained by the simulation of reference example 2, condition 1 is shown in Fig. 13 and condition 2 is shown in Fig. 14.

[0107] In Fig. 13 representing the result of condition 1, a longitudinal axis of Fig. 13 denotes the input impedance of the glass antenna in condition 1 of reference example 2 at the calculated frequencies and a lateral axis of Fig. 13 denotes a width of positive pole side feeding section second section 132. Then, a solid line denotes the variation of the input impedance at 600MHz, a dot line denotes the variation of the input impedance at 700MHz, and a dot-and-dash line denotes the variation of the input impedance at 500MHz.

[0108] In a case of condition 1, the width of feeding terminal 2 is 6mm and center line f of feeding terminal 2 in a lengthwise direction of feeding terminal 2 is overlapped on the center line of positive pole side feeding section first section 131. Thus, when the width of positive pole side feeding section second section 132 is larger than 3mm, the overlap part is formed between positive

pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232. Then, as shown in Fig. 13, the width of overlap of the overlap part is 6mm or larger, namely, the overlap value of the overlap part corresponds to 9mm or larger in Fig. 13. It is appreciated that when negative pole purpose metal fitting housing 232 is overlapped on positive pole side feeding section second section 132 in the width direction, the input impedance is not largely varied. It is appreciated from this that, concerning the overlap part in which negative pole purpose metal fitting housing section 232 and positive pole side power fitting section second section 132 are separated from each other with overlap gap g and overlapped on each other, if only the width of the overlap part is widened, the large variation in the input impedance cannot be obtained.

[0109] In such a state as described above, in a case where the input impedance of the glass antenna according to the present invention is furthermore desired to be reduced, the width is not widened but the length of the overlap part may be varied and overlap gap g may be varied.

[0110] In Fig. 14 representing the result of condition 2, a viewpoint is the same as Fig. 13. In Fig. 14, when the width of positive pole side feeding section second section 132 becomes equal to or larger than 6mm which is the same as the width of negative pole purpose metal fitting housing section 232, the value of the input impedance is not largely varied.

[0111] From the results of condition 1 and condition 2, when the width of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 with overlap gap g is widened up to the width of one of positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 which is wider than the other, the large variation of the input impedance cannot be obtained if the width described above is more widened.

[0112] Therefore, when the input impedance is actually varied to obtain the favorable antenna sensitivity, the width of the overlap part between positive pole side feeding section second section 132 and negative pole purpose metal fitting housing 232 with overlap gap g is previously matched with the width of one of positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 which is wider than the other and it is efficient to vary the length of the overlap part.

[0113] It should be noted that, in condition 1, as appreciated from Fig. 13, when the width of positive pole side feeding section second section 132 is 6mm, the input impedance is close to the characteristic impedance 50Ω of the coaxial cable at each of 500MHz, 600MHz, and 700MHz.

[0114] It should be noted that, in condition 2, as appreciated from Fig. 14, when the width of positive pole side feeding section second section 132 is 6mm, the input

impedance is close to the characteristic impedance 50Ω of the coaxial cable at each of 500MHz, 600MHz, and 700MHz.

5 <Reference example 3>

[0115] A reference example 3 indicates the simulation result. Glass antenna 1 in reference example 3 has the structure shown in Fig. 11.

10 **[0116]** The dimension and structure of glass antenna in reference example 3 are the same as those of reference examples 1 and 2. The condition of the simulation is the same as reference examples of 1 and 2. However, the difference point is that, in reference example 3, the width of positive pole side feeding section second section 132 is constant but the length of positive pole side feeding section second section 132 is varied. Since, in reference example 3, the length of positive pole side feeding section 132 is only varied, the length of positive pole side element first wire strip 111 is constant.

15 **[0117]** In reference example 3, the width of positive pole side feeding section second section 132 is 12mm and constant but the length of positive pole side feeding section second section 132 is varied from 10mm to 25mm. When the length of positive pole side feeding section second section 132 is larger than 11mm, positive pole side feeding section second section 132 and negative pole purpose metal fitting housing section 232 are overlapped on each other with overlap gap g to form the overlap part.

20 **[0118]** The result of the input impedance of the glass antenna in reference example 3 obtained in the simulation of this reference example is shown in Fig. 15. In Fig. 15, the longitudinal axis denotes the input impedance of glass antenna 1 in the execution example at the calculated frequencies and the lateral axis denotes the length of positive pole side feeding section second section 132. In addition, the solid line denotes the variation of the input impedance at 600MHz, the dot line denotes the variation of the input impedance at 700MHz, and the dot-and-dash line denotes the variation of the input impedance at 500MHz.

25 **[0119]** As appreciated from Fig. 15, as the length of positive pole side feeding section second section 132 becomes longer, namely, length d of the overlap part becomes longer, the input impedance of the antenna in this reference example becomes smaller.

30 **[0120]** It should be noted that when, in glass antenna 1 in this reference example, the length of positive pole side feeding section second section 132 is approximately 20mm, namely, length d of the overlap part is approximately 9mm, the value of the input impedance of glass antenna in this reference example at each of 600MHz, 700MHz, and 500MHz which is close to characteristic impedance 50Ω of the coaxial cable connected to glass antenna in this reference example is obtained and, thus, the favorable antenna sensitivity is obtained.

[Explanation of signs]

[0121]

1	antenna element	5
11	positive pole side element	
111	positive pole side element first wire strip	
112	positive pole side element second wire strip	
12	negative pole side element	
121	negative pole side element first wire strip	10
122	negative pole side element second wire strip	
13	positive pole side feeding section	
131	positive pole side feeding section first section	
132	positive pole side feeding section second section	15
14	negative pole side feeding section	
141	negative pole side feeding section first section	
142	negative pole side feeding section second section	
2	feeding terminal	20
21	catcher	
22	positive pole purpose metal fitting	
221	positive pole side contact	
222	positive pole purpose metal fitting housing section	25
222a	inclination section	
223	positive pole purpose catcher side engagement section	
224	positive pole side contact point	
23	negative pole purpose metal fitting	30
231	negative pole side contact	
232	negative pole purpose metal fitting housing section	
232a	inclination section	
233	negative pole purpose catcher side engagement section	35
234	negative pole side contact point	
24	housing	
25	connector	
251	positive pole purpose connector side engagement section	40
252	negative pole purpose connector side engagement section	
3	coaxial cable	
6	window glass	45
61	black edge	
7	defogger	
71	bus bar	
72	heating element	50

Claims

1. A vehicular glass antenna in which a coaxial cable (3) is disposed between an antenna element (1) and a receiver, **characterized in that** the antenna element (1) is constituted by a positive pole side conductor section and a negative pole side conductor

section; a part of the positive pole side conductor section and a part of the negative pole side conductor are separated from each other and overlapped on each other with an overlap gap g in a vertical direction of a glass surface to constitute an overlap part.

2. The vehicular glass antenna as claimed in claim 1, **characterized in that**, at the overlap part between the positive pole side conductor section and the negative pole side conductor section, the negative pole side conductor section is located at an upper part of the positive pole side conductor section in the vertical direction on the glass surface.
3. The vehicular glass antenna as claimed in either claim 1 or 2, **characterized in that** the positive pole side conductor section includes a positive pole side feeding section (13) and a positive pole side element (11); the negative pole side conductor section includes a negative pole side feeding section (14).
4. The vehicular glass antenna as claimed in claim 3, **characterized in that** the negative pole side conductor section further includes a negative pole side element (12) extended from the negative pole side feeding section (14).
5. The vehicular glass antenna as claimed in claim 3, **characterized in that** a part of the positive pole side element (11) and a part of the negative pole side element (12) are separated from each other with an overlap gap g to form an overlap part between the positive pole side conductor section and the negative pole side conductor section.
6. The vehicular glass antenna as claimed in either claim 3 or 4, **characterized in that** the antenna element (1) further includes a feeding terminal (2), the positive pole side conductor section includes a positive pole purpose metal fitting (22) of the feeding terminal (2) and the negative pole side conductor section further includes a negative pole purpose metal fitting (23) of the feeding terminal (2), the positive pole purpose metal fitting (22) or the negative pole purpose metal fitting (23) is separated from the negative pole side feeding section (14) or the positive pole side feeding section (13) with an overlap gap g to form an overlap part between the positive pole side conductor section and the negative pole side conductor section.
7. The vehicular glass antenna as claimed in any one of the preceding claims 3 through 5, **characterized in that** the overlap part between the positive pole side conductor section and the negative pole side conductor section is inserted between a connection point to the coaxial cable (3) and the positive pole side element (11) when the antenna element (1) is

connected to the coaxial cable (3).

8. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 7, **characterized in that** the overlap gap g is from 0.5mm to 1.5mm. 5
9. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 8, **characterized in that** an area of the overlap part between the positive pole side conductor section and the negative pole side conductor section is 10mm² through 300mm². 10
10. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 9, **characterized in that** the glass antenna is a glass antenna for receiving a terrestrial digital television broadcasting. 15

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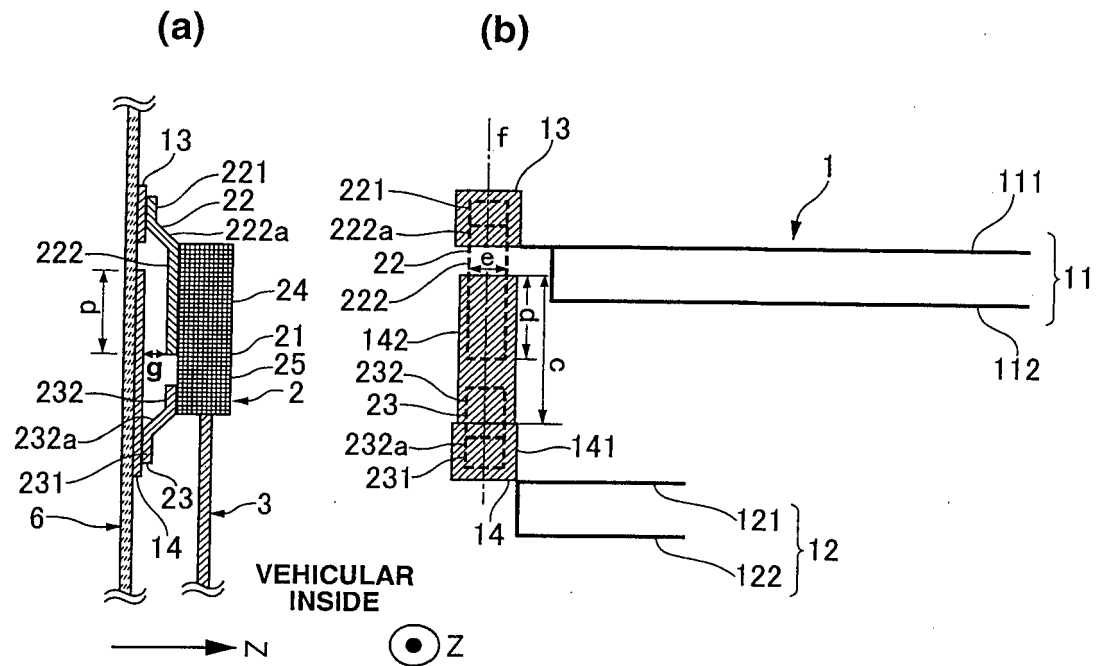
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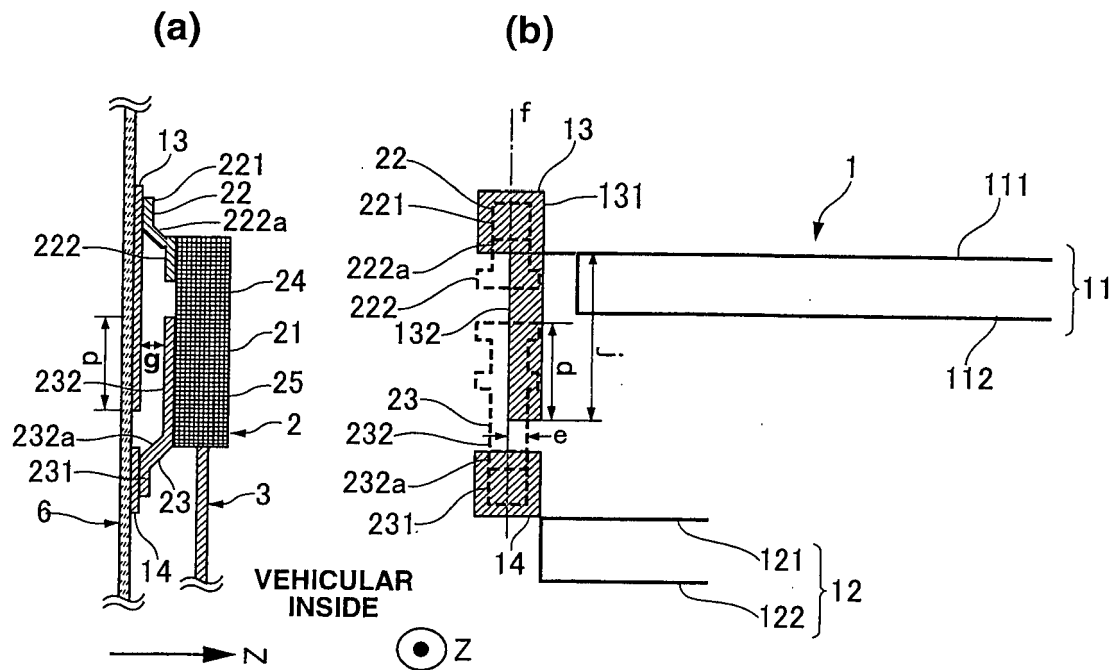
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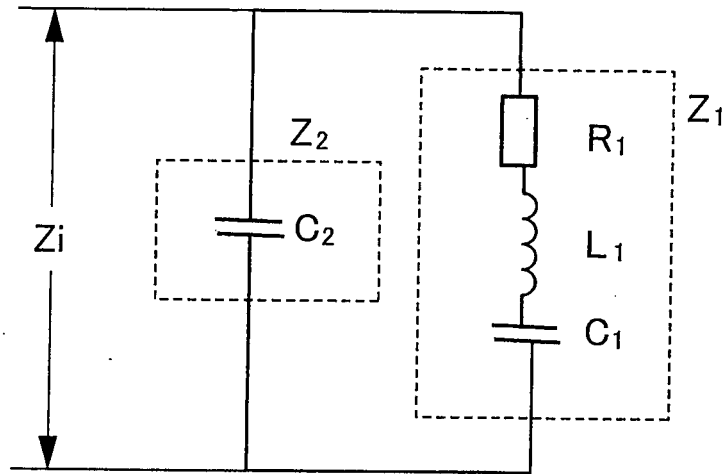
[FIG.1]



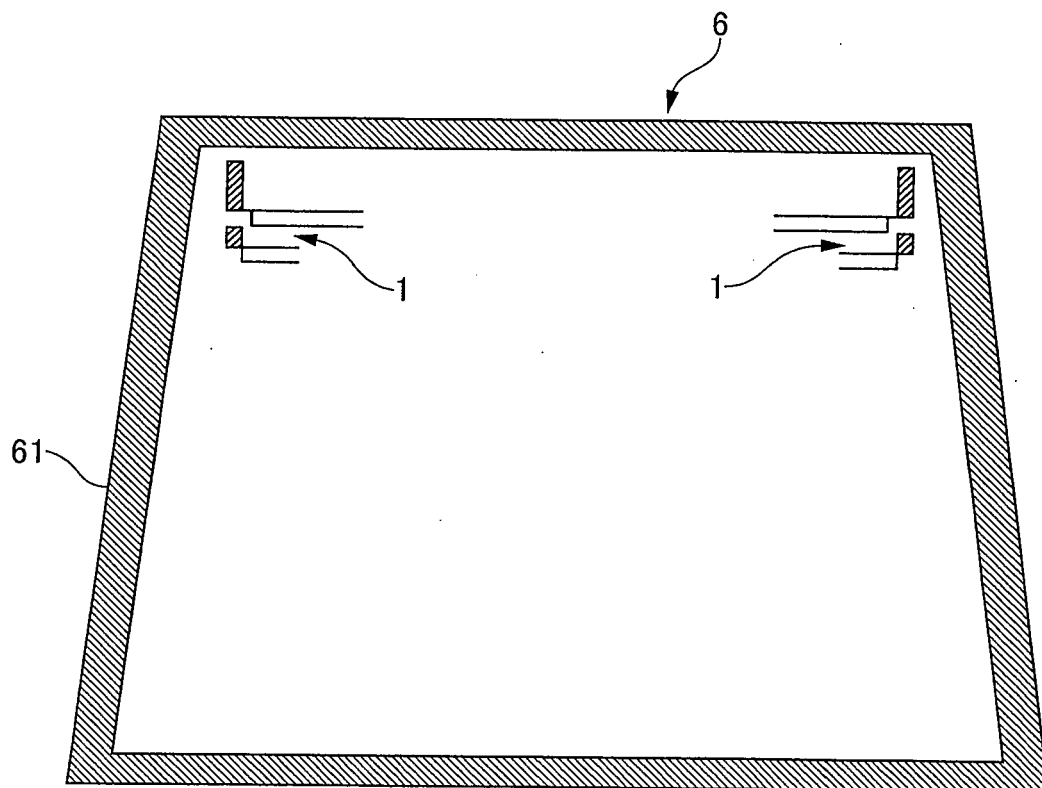
[FIG.2]



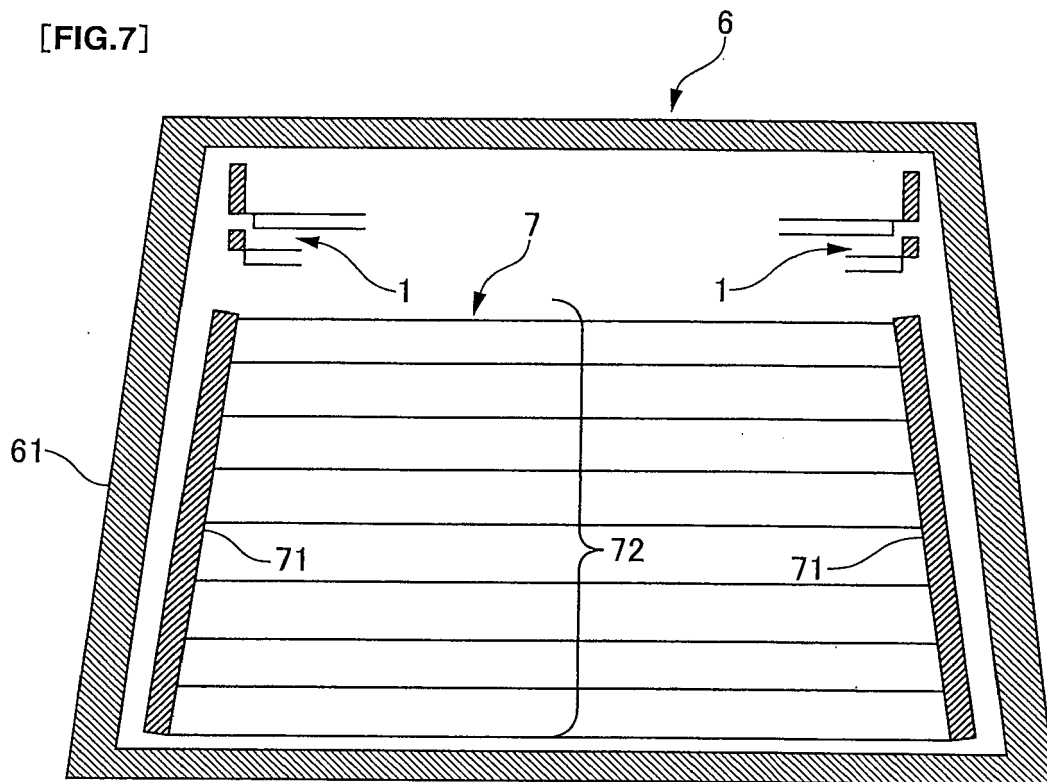
[FIG.5]



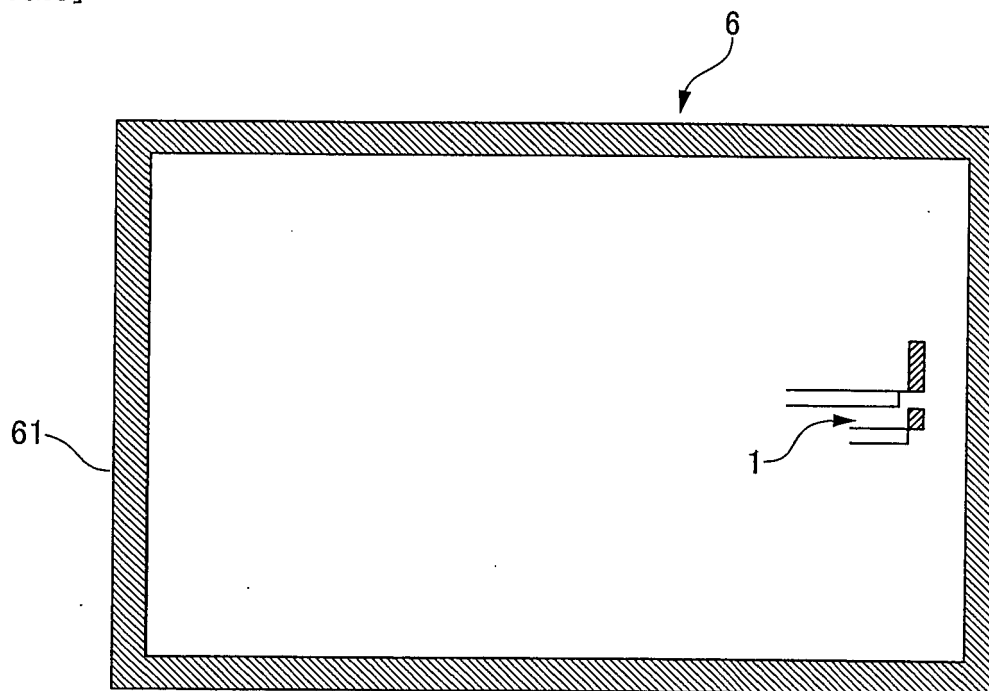
[FIG.6]



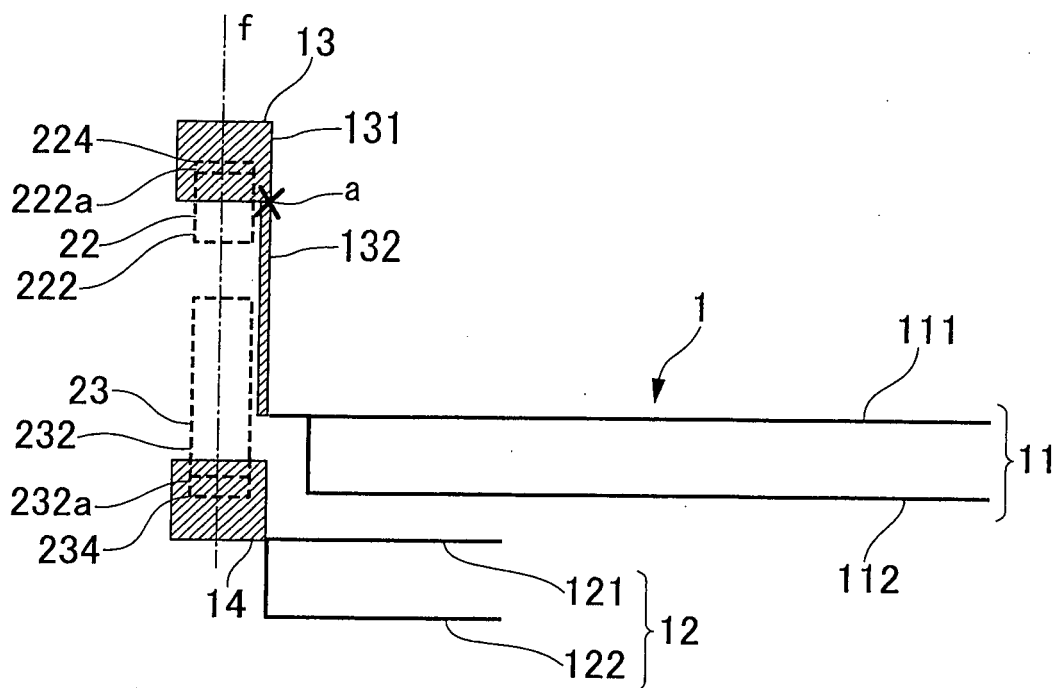
[FIG.7]



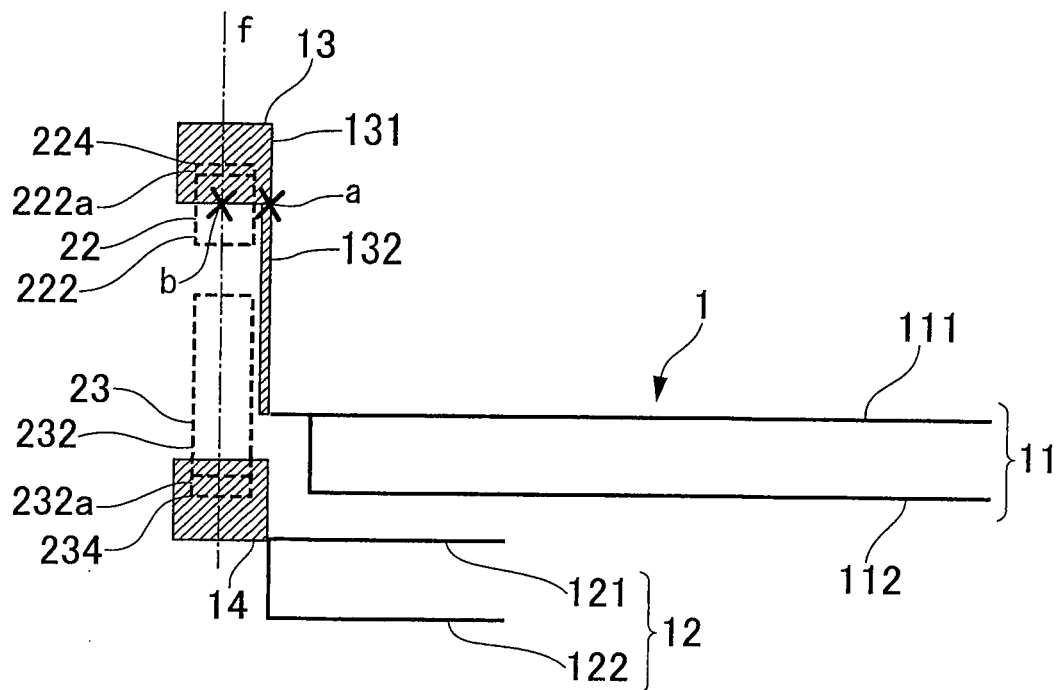
[FIG.8]



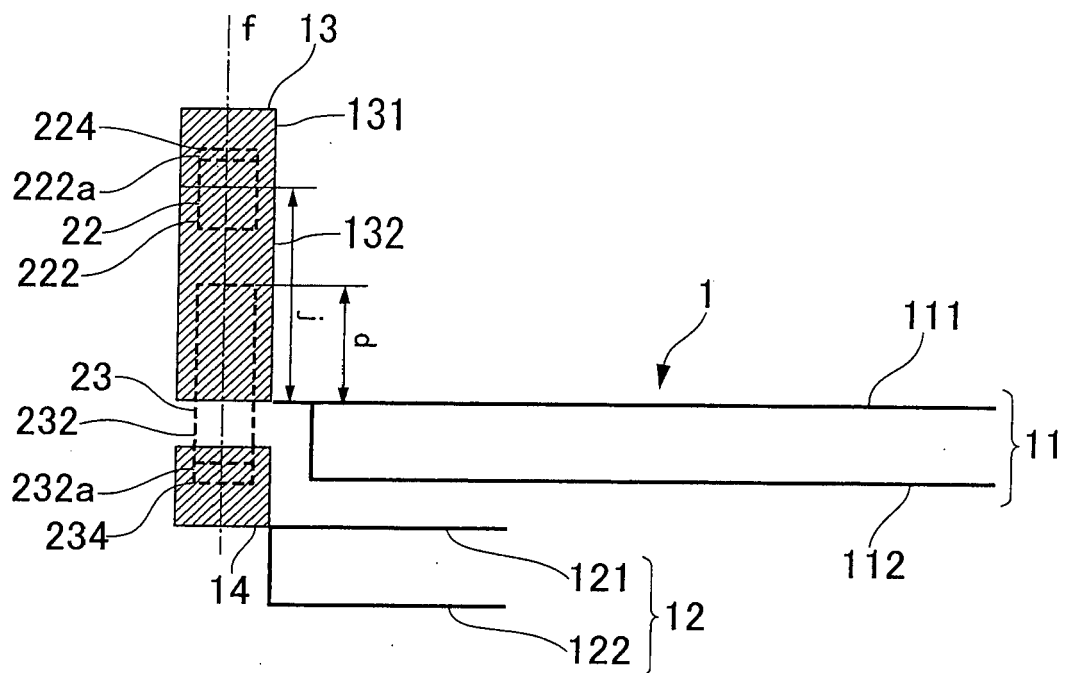
[FIG.9]



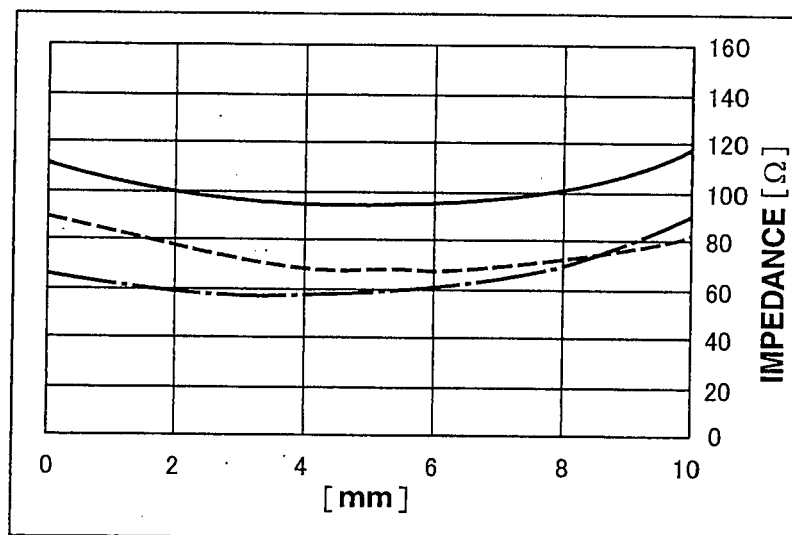
[FIG.10]



[FIG.11]

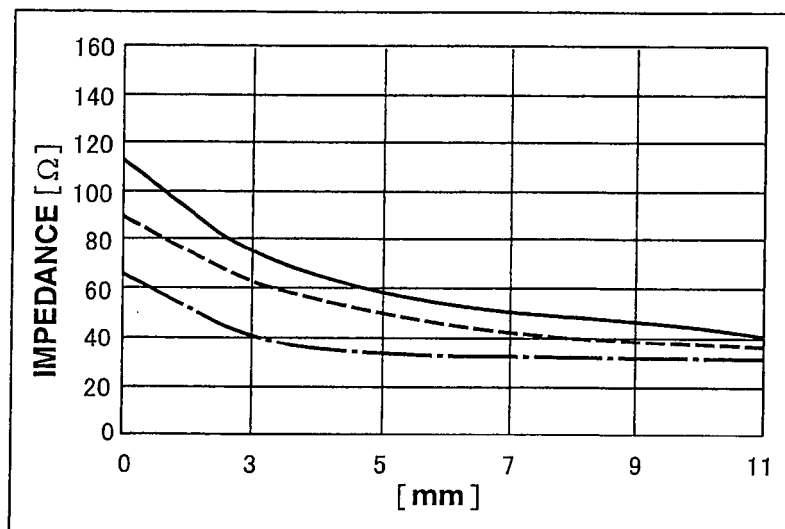


[FIG.12]



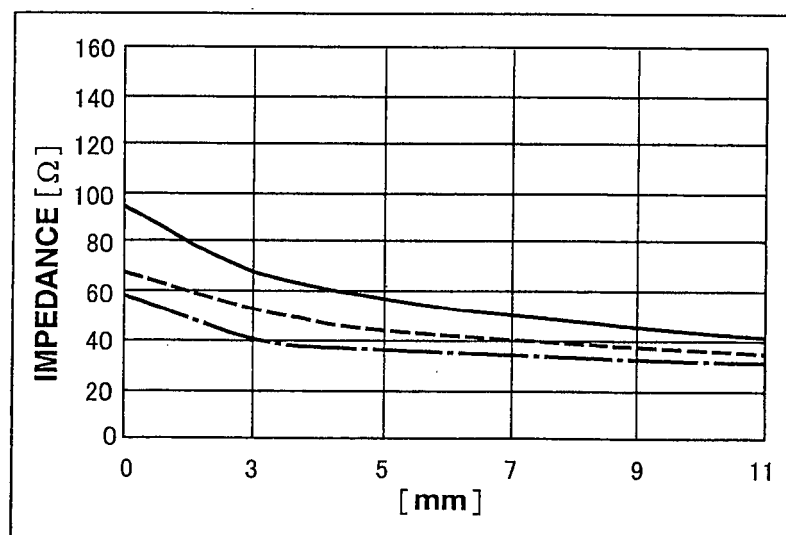
SOLID LINE : 600MHz
DOT LINE : 700MHz
DOT-AND-DASH LINE : 500MHz

[FIG.13]



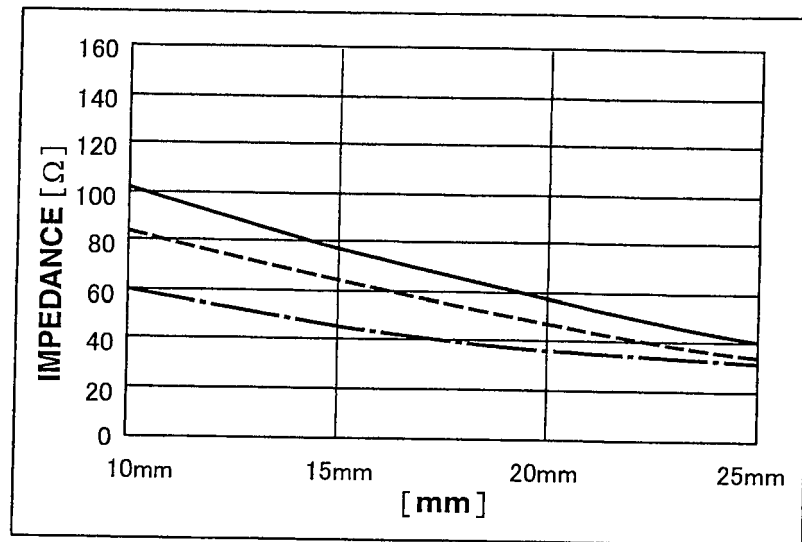
SOLID LINE : 600MHz
DOT LINE : 700MHz
DOT-AND
-DASH LINE : 500MHz

[FIG.14]



SOLID LINE : 600MHz
DOT LINE : 700MHz
DOT-AND
-DASH LINE : 500MHz

[FIG.15]



SOLID LINE : 600MHz
 DOT LINE : 700MHz
 DOT-AND
 -DASH LINE : 500MHz



EUROPEAN SEARCH REPORT

Application Number
EP 15 15 9789

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	EP 2 475 045 A1 (HONDA TSUSHIN KOGYO CO LTD [JP]) 11 July 2012 (2012-07-11)	1-5,7-10	INV.
A	* figures 1,5,9A,10,13A *	6	H01Q1/12
	* paragraphs [0001] - [0002] *		H01R24/44
	* paragraphs [0015] - [0018] *		
	* paragraphs [0025] - [0026] *		

X	US 2009/207086 A1 (SHINKAWA TOMOHIRO [JP] ET AL) 20 August 2009 (2009-08-20)	1,3,4,10	
	* figures 3,5,6 *		
	* paragraphs [0053] - [0055] *		
	* paragraphs [0068] - [0077] *		

The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		7 August 2015	Niemeijer, Reint
CATEGORY OF CITED DOCUMENTS		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	
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			

EPO FORM 1503 03/82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 15 15 9789

5

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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07-08-2015

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2475045 A1	11-07-2012	EP 2475045 A1	11-07-2012
		JP 2012142220 A	26-07-2012

US 2009207086 A1	20-08-2009	JP 5278673 B2	04-09-2013
		JP 2009225429 A	01-10-2009
		US 2009207086 A1	20-08-2009

15

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35

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

- JP 2010114782 A [0005]
- JP 2008300267 A [0005]
- JP 2008035479 A [0005]
- JP 2003273625 A [0005]