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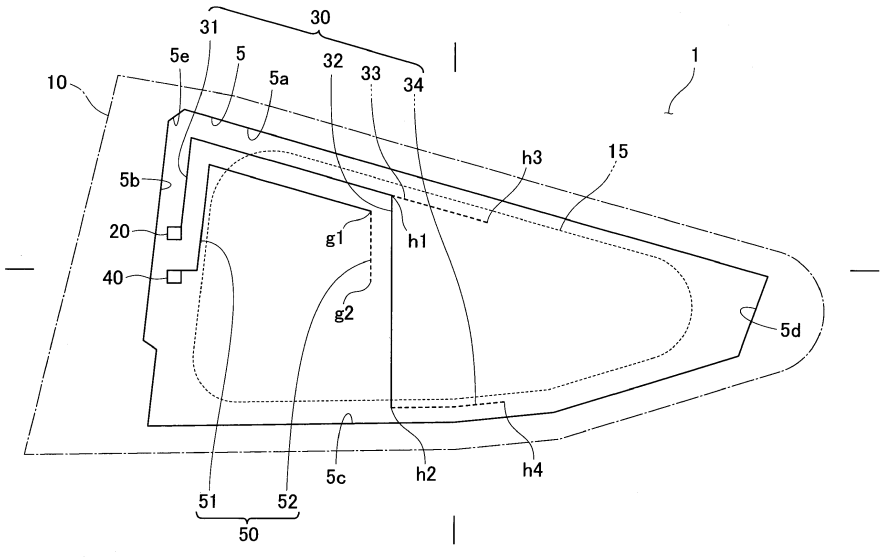
(54) VEHICULAR GLASS ANTENNA

(57) A vehicular glass antenna includes a core wire-side power supplying section (20), a core wire-side antenna element (30) electrically connected to the core wire-side power supplying section, a ground-side power supplying section (40), and a ground-side antenna element (50) electrically connected to the ground-side power supplying section. The core wire-side antenna element includes a core wire-side first element (31) and a core wire-side second element (32). The core wire-side first element extends from the core-side power supplying section as a starting point along an edge of a window opening (5) of a vehicle body (1) in such a manner as to keep a first predetermined distance relative to a closest part of the edge of the window opening. The core wire-side second element extends from the core wire-side first element in a substantially vertical direction at a position (h1) separated by more than a prescribed distance from each of left and right edges (5b, 5d) of the window opening. The ground-side antenna element has a ground-side first element (51) extending from the ground-side power supplying section as a starting point along the core wire-side first element in such a manner as to keep a second predetermined distance relative to the core wire-side first element.

FIG.1



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Description

[0001] The present invention relates generally to an antenna for a vehicular glass, and more particularly to such a vehicular glass antenna capable of securing a sufficient reception sensitivity without being limited by the position of a power supplying section of the vehicle.

[0002] Japanese Patent Application Laid-open Publication (JP-A) No. 2011-193381 shows a planar antenna (antenna for a vehicular glass) designed for the reception of vertically polarized radio waves, especially terrestrial DAB (digital audio broadcasting) waves. The planar antenna disclosed in JP 2011-193381A includes a core wire-side element (core wire-side antenna element) and a ground-side element (ground-side antenna element). The ground-side element extends from a ground-side power supplying section in a horizontal direction and is disposed in proximity to an upper edge or a lower edge of a window opening of the vehicle body over the entire length of the ground-side element. The core wire-side element includes a first element extending in a vertical direction from a core wire-side power supplying section located in proximity to the ground-side power supplying section. The first element of the core wire-side element extends in a direction separating away from the upper or lower edge of the window opening along which the ground-side element is disposed in proximity thereto.

[0003] Since the ground-side element extends in the horizontal direction in such a manner as to be in proximity to the upper edge or the lower edge of the window opening over the entire length thereof, the planar antenna shown in JP 2011-193381 can only be installed in a vehicle having a power supplying position located in proximity to the upper edge or the lower edge of the window opening. In other words, the planar antenna shown in JP 2011-193381 cannot be installed in such a vehicle which has a power supplying position located in proximity to a left edge or a right edge of the window opening.

[0004] Japanese Patent Application Laid-open Publication (JP-A) No. 2011-160236 shows a glass antenna (antenna for a vehicular glass) capable of receiving vertically polarized radio waves, especially DAB waves. As re-illustrated here in Fig. 1, the glass antenna 100 disclosed in JP 2011-160236A includes a first L-shaped element 101 formed by a first element section 103 extending from a core wire-side power supplying section 107 and a second element section 104 extending from a terminal end of the first element section 103, and a second L-shaped element 102 formed by a first element section 105 extending from a ground-side power supplying section 108 and a second element section 106 extending from a terminal end of the first element section 105. The core wire-side power supplying section 107 and the ground-side power supplying section 108 are disposed in proximity to a left edge 109a of a window opening 109 of the vehicle body. The glass antenna 100 shown in JP 2011-160236A can thus be installed in a vehicle having a power supplying position located in proximity to the left edge 109a of the window opening 109 of the vehicle body.

[0005] According to JP 2011-160236A, the second element section 106 of the second L-shaped element 102 is adjusted to have a conductor length of more than 150 mm, preferably 200 mm or more in order to improve the antenna gain (reception sensitivity). For the purpose of improving the antenna gain, the glass antenna 100 is required to be installed in such a vehicle which has a ground-side power supplying position located in proximity to the left edge 109a of the window opening 109 and separated from a lower edge 109b of the window opening 109 by at least more than 150 mm. In other words, when the glass antenna 100 disclosed in JP 2011-160236A is installed in a vehicle having a ground-side power supplying position located in proximity to the left edge 109a of the window opening 109 and separated by less than 150 mm from the lower edge 109b of the window opening 109, a sufficient antenna gain cannot be obtained.

[0006] The present inventors have acknowledged that depending on the position of a power supplying section of a vehicle, the vehicular glass antennas shown in JP 2011-193381A and JP 2011-160236A become impossible to install in the vehicle; and even when they can be installed in the vehicle, a sufficient antenna gain cannot be obtained. More specifically, the present inventors have recognized that there is room for improvement in the shape and configuration of a core wire-side element and/or a ground-side element of a vehicular glass antenna when the antenna is installed in either a vehicle having a power supplying position located at a left lower corner portion or a right lower corner portion of a window opening of the vehicle body, or a vehicle with a window opening having a small size in a vertical direction (e.g., less than 200 mm).

[0007] It is therefore an object of the present invention to provide a vehicular glass antenna which is capable of securing a sufficient reception sensitivity without being limited by the position of a power supplying section of the vehicle.

[0008] According to the present invention, there is provided an antenna for a vehicular glass, comprising: a core wire-side power supplying section; a core wire-side antenna element electrically connected to the core wire-side power supplying section; a ground-side power supplying section; and a ground-side antenna element electrically connected to the ground-side power supplying section, wherein the core wire-side antenna element includes: a core wire-side first element extending from the core-side power supplying section as a starting point along an edge of a window opening of a vehicle body in such a manner as to keep a first predetermined distance relative to a part of the edge of the window opening closest to the core wire-side first element; and a core wire-side second element extending from the core wire-side first element in a substantially vertical direction at a position separated by more than a prescribed distance from each of left and right edges of the window opening, and wherein the ground-side antenna element has a portion

extending from the ground-side power supplying section as a starting point along the core wire-side first element in such a manner as to keep a second predetermined distance relative to the core wire-side first element.

[0009] With this arrangement, the core wire-side first element and the ground-side first element are allowed to be arranged in proximity to the vehicle body serving as a grounding potential, thereby reducing their influences on performance of the antenna. As a result, the core wire-side second element is allowed to be disposed at a prescribed distance to each of the left and right edges of the window opening without being limited by the position of the core wire-side power supplying section, wherein the prescribed distance is set to be a value sufficient to reduce the influence of the vehicle body upon the core wire-side second element.

[0010] The starting point of the core wire-side second element can be provided at an upper part of the window opening without being limited by the position of the core wire-side power supplying section. This arrangement will ensure that a length of the core wire-side second element, which is suited for frequency bands of vertically polarized radio waves to be received by the vehicular glass antenna, can be secured. A sufficient reception sensitivity can thus be obtained without being limited by the power supplying position of the vehicle.

[0011] Some vehicle is unable to provide a power supplying position located in an upper part or a lower part of the window opening due to the presence of another device such as an air-bag device. Even in an application to such vehicle, the vehicular glass antenna can also secure a sufficient reception sensitivity because it is able to secure the same level of reception sensitivity without being limited by the power supplying position of the vehicle.

[0012] Preferably, the prescribed distance by which the core wire-side second element is separated from each of the left and right edges of the window opening is more than 50 mm. With this arrangement, the influence of the vehicle body upon the core wire-side second element can be reduced, and the reception sensitivity is increased correspondingly.

[0013] It is preferable that the core wire-side second element has a length more than 140 mm. In the case where the vertically polarized radio waves to be received by the vehicular glass antenna include radio waves of BAND III DAB frequencies, the core wire-side second element can secure a sufficient length long enough to improve the reception sensitivity.

[0014] Preferably, the first predetermined distance is less than 40. With this arrangement, because the core wire-side antenna element and the ground-side antenna element can only give little influence to performance of the vehicular glass antenna, a further improvement in the reception sensitivity is possible.

[0015] Preferably, the second predetermined distance is in a range of from 5 to 20 mm. With this arrangement, because the core wire-side antenna element and the ground-side antenna element are arranged in proximity to the vehicle body serving as a grounding potential, the influence of the core wire-side antenna element and the ground-side antenna element exerted upon performance of the antenna can be reduced, which will lead to a further improvement in the reception sensitivity.

[0016] It is preferable that the core wire-side antenna element and the ground-side antenna element at least partially include a looped shape. The loop-shaped part of the wire-side antenna element and the ground-side antenna element has the same effect as a thickened part of the antenna element and hence is effective to improve the reception sensitivity. Furthermore, the antenna element having a looped shape is inconspicuous as compared to an antenna element having an enlarged line width or diameter and, hence, the antenna reception sensitivity and the appearance of the entire vehicle can be compatibly achieved.

[0017] The vehicular glass antenna may further include a glass provided with the core wire-side power supplying section, the core wire-side antenna element, the ground-side power supplying section, and the ground-side antenna element. The core wire-side antenna element and the ground-side antenna element are formed, for example, by screen-printing on a surface of the glass to thereby complete a vehicular glass antenna.

Fig. 1 is a view diagrammatically showing a basic structure of an antenna for vehicular glasses according to the present invention;

Fig. 2 is a view diagrammatically showing a structure of an antenna for vehicular glasses according to a first embodiment of the present invention;

Fig. 3 is a view diagrammatically showing a structure of an antenna for vehicular glasses according to a second embodiment of the present invention;

Fig. 4 is a graph showing a performance evaluation of the vehicular glass antennas according to the first and second embodiments;

Figs. 5(A) and 5(B) are views diagrammatically showing vehicular glass antennas according to further embodiments of the present invention;

Figs. 6(A) and 6(B) are views diagrammatically showing vehicular glass antennas according to still further embodiments of the present invention; and

Fig. 7 is a view diagrammatically showing the structure of a vehicular glass antenna according to the prior art.

[0018] Certain preferred structural embodiments of the present invention will be described in greater details below, by way of example only, with reference to the accompanying sheets of drawings.

1. Basic Structure

[0019] Fig. 1 shows a glass 10 having power supplying sections, antenna elements, etc. formed thereon, which constitutes a structural example of a vehicular glass an-

tenna 10 according to the present invention. The vehicular glass antenna 10 shown in Fig. 1 is configured to receive digital audio broadcasting (DAB) waves as an example of vertical polarization radio waves.

[0020] As shown in Fig. 1, the vehicular glass antenna 10 includes a core wire-side power supplying section 20, a core wire-side antenna element 30 electrically connected to the core wire-side power supplying section 20, a ground-side power supplying section 40, and a ground-side antenna element 50 electrically connected to the ground-side power supplying section 40. In the illustrated example, the vehicular glass antenna 10 is arranged in a vehicle body 1 such that a combination of the core wire-side power supplying section 20 and the core wire-side antenna element 30 and a combination of the ground-side power supplying section 40 and the ground-side antenna element 50 are located inside a window opening 5 of the vehicle body 1. In Fig. 1, the shape of the vehicle body 1 is omitted from illustration.

[0021] The core wire-side power supplying section 20 and the ground-side power supplying section 40 shown in Fig. 1 are configured to be electrically connectable with a transmitting path such as a coaxial cable (not shown). The coaxial cable is connected to a signal processing device such as a receiver (not shown) installed in the vehicle in connection with DAB. The core wire-side power supplying section 20 is connected, for example, with a central conductor of the coaxial cable. The ground-side power supply section 40 is connected, for example, with an outer conductor of the coaxial cable. The core wire-side power supplying section 20 and the ground-side power supplying section 40 are provided in the proximity of a power supplying position of the vehicle, which is a position connectable to the coaxial cable. The power supplying position of the vehicle is different according to the type, model, etc. of the vehicle so that the core wire-side power supplying section 20 and the ground-side power supplying section 40 need to be provided in accordance with the power supplying position of the vehicle.

[0022] The core wire-side antenna element 30 and the ground-side antenna element 50 are made of an electrically conductive material. For example, the core wire-side antenna element 30 and the ground-side antenna element 50 may be formed by preparing a conductive paste composed of fine particles of silver, a powder of low melting point glass, etc. made into a pasty state by an organic solvent, screen-printing the conductive paste on a surface of the glass 10, and baking the printed conductive paste. Alternatively, the core wire-side antenna element 30 and the ground-side antenna element 50 may be formed on a surface of the glass 10 via a sheet (not shown), in which instance the sheet may be a transparent insulating film sheet fixedly attached to a surface of the glass located inside the window opening 5, and the core wire-side power supplying section 20, the core wire-side antenna element 30, the ground-side power supplying section 40, and the ground-side antenna element 50 may be formed directly on the sheet. The sheet provided with the core wire-side power supplying section 20, the core wire-side antenna element 30, the ground-side power supplying section 40, and the ground-side antenna element 50 also constitutes an antenna for a vehicular glass.

[0023] The core wire-side antenna element 30 includes, at least, a core wire-side first element 31 and a core wire-side second element 32. The core wire-side first element 31 extends from the core wire-side power supplying section 20 as a starting point to a terminal end h1. The core wire-side second element 32 extends from the terminal end h1 of the core wire-side first element 31 as a starting point to a terminal end h2. The core wire-side antenna element 30 may further include a core wire-side third element 33 extending from the terminal end h1 of the core wire-side first element 31 as a starting point to a terminal end h3, an a core wire-side fourth element 34 extending from the terminal end h2 of the core wire-side second element 32 as a starting point to a terminal end h4.

[0024] The ground-side antenna element 50 includes at least a ground-side first element 51. The ground-side first element 51 extends from the ground-side power supplying section 40 as a starting point to a terminal end g1. The ground-side antenna element 50 may further include a ground-side second element 52 extending from the terminal end g1 of the ground-side first element 51 as a starting point to a terminal end g2.

[0025] In the example shown in Fig. 1, the core wire-side power supplying section 20 and the ground-side power supplying section 40 are disposed in proximity to a left edge 5b of the window opening 1 and arranged in vertical juxtaposition with each other. The core wire-side first element 31 extends along that part of the edge of the window opening 5 closest to the core wire-side first element 31 in such a manner as to keep a first predetermined distance relative to the closest edge part of the window opening 5. The first predetermined distance between the core wire-side first element 31 and the closest edge part of the window opening 5 will be sometimes referred to as "edge distance". The edge distance measured at a first part of the core wire-side first element 31 located closest to the left edge 5b of the window opening 5 may be made equal to or made different from an edge distance measured at a second part of the core wire-side first element 31 located closest to an upper edge 5a of the window opening 5. Preferably, the core wire-side first element 31 extends along the closest edge part of the window opening 5 in such a manner that more than 50% of the entire length of the core wire-side first element 31 (extending from the core wire-side power supplying section 20 to the terminal end h1) can keep the first predetermined distance (edge distance) relative to the closest edge part of the window opening 5. More preferably, the core wire-side first element 31 extends along the closest edge part of the window opening 5 in such a manner that more than 70% of the entire length of the core wire-side first element 31 (extending from the core wire-side power supplying section 20 to the terminal end h1) can keep

the first predetermined distance (edge distance) relative to the closest edge part of the window opening 5.

[0026] As shown in Fig, 1, in the case where there is a left upper corner edge 5e provided between the upper edge 5a and the left edge 5b of the window opening 5 of the vehicle body 1, the core wire-side first element 31 may be arranged to extend without consideration of the element-to-edge distance between relative to the left upper corner edge 5e. Alternatively, the core wire-side first element 31 may be arrange to extend along the left upper corner edge 5e of the window opening 5 in such a manner that the first predetermined distance (edge distance) is kept between that part of the core wire-side first element closest to the left upper corner edge 5e and the left upper corner edge 5e. The same shall apply when a corner edge is located at another position.

[0027] In the example shown in Fig. 1, the ground-side first element 51 extends from the ground-side power supplying section 40 as the starting point to the terminal end g1 along the core wire-side first element 31 in such a manner as to keep a second predetermined distance relative to the core wire-side first element 31. The second predetermined distance between the core wire-side first element 31 and the ground-side first element 51 may be sometimes referred to as "first element distance". The first element distance measured at first parts of the core wire-side first element 31 and the ground-side first element 51 extending along the left edge 5b of the window opening 5 may be made equal to or made different from a first element distance measured at second parts of the core wire-side first element 31 and the ground-side first element 51 extending along the upper edge 5a of the window opening 5. A first element distance measured at third parts of the core wire-side first element 31 and the ground-side first element 51 extending along the left upper corner edge 5e of the window opening 5 may be made equal to the aforesaid two first element distances or alternatively made different from at least one of the aforesaid two first element distances.

[0028] The starting point h1 of the core wire-side second element 32 is located at a position separated from each of the left edge 5b and a right edge 5d by a prescribed distance or more. In other words, the core wire-side first element 31 is extended to a position separated from each of the left and right edges 5b, 5d of the window opening 5 by the prescribed distance or more.

[0029] In the example shown in Fig. 1, the terminal end h2 of the core wire-side second element 32 is located at a position separated in a vertical direction from the starting point h1 of the core wire-side second element 32 by a third predetermined distance or more. In other words, the core wire-side second element 32 extends in the substantially vertical direction from the position h1 (as a starting point separated from each of the left and right edges 5b, 5d of the window opening 5 by the prescribed distance or more) to the terminal end h2 separated from the starting point h1 by the third predetermined distance or more.

[0030] The core wire-side third element 33 extends from the terminal end h1 as a starting point to the terminal end h3 along a direction in which the core wire-side first element 31 is extending to the terminal end h1. The core wire-side fourth element 34 extends from the terminal end h2 of the core wire-side second element 32 as a starting point along a lower edge 5c of the window opening 5 to the terminal end h4 in such a manner as to keep a fourth predetermined distance relative to the lower edge 5c of the window opening 5. The fourth predetermined distance between the core wire-side fourth element 34 and the lower edge 5c of the window opening 5 may be equal to the first predetermined distance (edge distance).

[0031] In the example shown in Fig. 1, the ground-side second element 52 extends from the terminal end g1 of the ground-side first element 52 as a starting point in a substantially vertical direction to the terminal end g2. A distance between the ground-side second element 52 and the core wire-side second element 32 may be equal to the first element distance between the aforesaid first parts of the core wire-side first element 31 and the ground-side first element 51 extending along the left edge 5b of the window opening 5. The core wire-side third element 33, the core wire-side fourth element 34, and the ground-side second element 52 will be sometimes referred to as "adjusting elements". The adjusting elements will be described later on.

[0032] In general, the antenna has a high sensitivity reception radio wave frequency band which is determined by a total length of antenna elements formed by conductive material. More specifically, the reception sensitivity is improved when the total length of the antenna elements is determined such that the respective antenna elements resonate at approximately an intermediate frequency of a reception radio wave frequency band. Normally, in order to improve the reception sensitivity, the total length of the antenna elements is increased as the reception radio wave frequency band becomes low, and conversely, when the reception radio wave frequency band becomes high, the total length of the antenna elements is reduced.

[0033] The vehicular glass antenna 10 shown in Fig. 1 is configured such that a reception radio wave frequency band for the vehicular glass antenna 10 is determined mainly by a length of the core wire-side second element 32. In other words, the vehicular glass antenna 10 shown in Fig. 1 is configured such that antenna elements other than the core wire-side second element 32, and more particularly, the core wire-side first element 31 and the ground-side first element 51 can only give little or limited influence on performance of the vehicular glass antenna 10, such as reception sensitivity, frequency characteristic, etc. Ideally, the vehicular glass antenna 10 is configured such that the core wire-side first element 31 and the ground-side first element 51 function as transmission paths and not as antennas.

[0034] To this end, it is preferable for the vehicular glass antenna 10 that the edge distance (i.e., the first

predetermined distance between the core wire-side first element 31 and that part of the edge of the window opening 5 closest to the core wire-side first element 31) is less than 40 mm. Furthermore, the first element distance (i.e., the second predetermined distance between the core wire-side first element 31 and the ground-side first element 51) is preferably in a range of 5 to 20 mm. Specific optimum values for the edge distance and the first element distance are determined by simulation or measurement performed in accordance with the size of the vehicular glass antenna 10 and/or the window opening 5 such that the effects of the core wire-side first antenna 31 and the ground-side first antenna 51 upon performance of the vehicular glass antennal 10 become small.

[0035] In order to improve the reception sensitivity, it is preferable that adverse effects of the vehicle body (such as loss of antenna function of the core wire-side second element 32), which may occur when the core wire-side second element 32 is disposed in proximity to the vehicle body as a grounding potential, should be minimized. Preferably, the starting point h1 and the terminal end h2 of the core wire-side second element 32 are separated from each of the left and right edges 5b, 5d of the window opening 5 by at least 50 mm or more.

[0036] Additionally, since the vehicular glass antenna 10 shown in Fig. 1 is designed for reception of vertically polarized radio waves such as DAB radio waves, it is preferable to arrange the vehicular glass antenna 10 in the vehicle body 1 such that the core wire-side second element 32 extends in a direction substantially perpendicular to a horizontal plane (i.e., a substantially vertical direction). Furthermore, in the case where the vertically polarized radio waves to be received by the vehicular glass antenna 10 shown in Fig. 1 include, for example, those in DAB BAND III (i.e., a frequency band of 174 MHz to 240 MHz), a length of the core wire-side second element 32 as measured from the starting point h1 to the terminal end h2 is preferably more than 140 mm.

[0037] Thus, the vehicular glass antenna 10 shown in Fig. 1 ensures that the core wire-side first element 31 and the ground-side first element 51 can be arranged in proximity to the vehicle body serving as the grounding potential to the extent that they can give only a small or limited influence on performance of the vehicular glass antenna 10. As a result, the core wire-side second element 32 is allowed to be arranged, without being subjected to a limitation by the position of the core wire-side power supplying section 20, in such a manner as to keep an appropriate distance from the left and right edges 5b, 5d of the window opening 5 which can sufficiently reduce the effect of the vehicle body 1 on the core wire-side second element 32.

[0038] Furthermore, since the starting point of the core wire-side second element 32 is disposed at an upper part of the window opening 5 without being limited by the position of the power supplying sections and particularly the core wire-side power supplying section 20, it is possible to secure a length of the core wire-side second element 32 which is suited for a frequency band of the vertically polarized radio waves to be received by the vehicular glass antenna 10. More particularly, when the vertically polarized radio waves to be received by the vehicular glass antenna 10 include the DAB BAND III, which is lower than L-BAND (i.e., a frequency band of 1452 MHz to 1492 MHz), the length of the core wire-side second element 32 can be adjusted within a range more than 140 mm. The vehicular glass antenna 10 shown in Fig. 1 can secure desired reception sensitivity without being subjected to a limitation by a power supplying position of the vehicle.

[0039] The core wire-side third element 33, the core wire-side fourth element 34 and the ground-side second element 52, which are provided as adjusting elements, may be added singly or in combination. In the vehicular glass antenna 10 shown in Fig. 1, antenna elements other than the core wire-side second element 32 give little influence to performance of the vehicular glass antenna 10. It is not to be said that these antenna elements give no effect on the performance of the vehicular glass antenna 10.

[0040] For instance, it may occur that the vehicular glass antenna 10 cannot secure sufficient reception sensitivity for radio waves to be received only by adjustment of the length of the core wire-side second element 32. Under such condition, at least one of the core wire-side third element 33, the core wire-side fourth element 34 and the ground-side second element 52 may be added, and through an adjustment of the length of the added one or more of the antenna elements 33, 34, 52, the vehicular glass antenna 10 can secure a desired level of reception sensitivity for the radio waves to be received. As an alternative, at least one of the core wire-side third element 33, the core wire-side fourth element 34, and the ground-side second element 52 may be added and, through an adjustment of the length of the added one or more of the antenna elements 33, 34, 52, reception sensitivity can be secured for radio waves in a frequency band (e.g., DAB L-BAND) which is different from a frequency band of radio waves to be received mainly by the core wire-side second element 32.

[0041] In the case where the length of the core wire-side second element 32 has a fixed value, an adjustment of the lengths of the core wire-side third element 33 and the core wire-side fourth element 34 is preferably be achieved such that one of the third and fourth elements 33, 34 is increased and, at the same time, the other of the third and fourth elements 33, 34 is decreased. Similarly, an adjustment of the lengths of the core wire-side fourth element 34 and the ground-side second element 52 is preferably achieved such that one of these elements 34, 52 is increased and, at the same time, the other of these elements 34, 52 is decreased.

2. First Embodiment

[0042] Fig. 2 shows a first embodiment of the vehicular

glass antenna 10. The first embodiment shown in Fig. 2 is comprised of a vehicular glass antenna 10 which is configured for installation in a window opening for a rear quarter glass for the purpose of reception of radio waves of BAND III and L-BAND DAB frequencies. In the vehicular glass antenna 10 according to the first embodiment shown in Fig. 2, these parts which are designated by reference characters identical to those used in Fig. 1 are the same as or corresponding to those of the vehicular glass antenna according to the basic structure shown in Fig. 1. In Fig. 2, those parts provided outside the window opening 5 are omitted from illustration. Additionally, a shielding film which is identical to the one 15 shown in Fig. 1 is not shown in Fig. 2.

[0043] The vehicular glass antenna 10 according to the first embodiment shown in Fig. 2 includes a core wire-side power supplying section 20, a core wire-side first element 31, a core wire-side second element 32, a core wire-side third embodiment 33, a core wire-side fourth element 34, a ground-side power supplying section 40, and a ground-side first element 51. In the first embodiment, the core wire-side power supplying section 20 and the ground-side power supplying section 40 are arranged in vertical juxtaposition with each other at a position which is in proximity to a left edge 5b of the window opening 5 and which is substantially intermediate between an upper edge 5a and a lower edge 5c of the window opening 5. The first embodiment is therefore directed to such a vehicular glass antenna 10 which is applicable to a vehicle having a power supplying position which is located in proximity to the left edge 5b of the window opening 5 and substantially intermediate between the upper edge 5a and the lower edge 5c of the window opening 5.

[0044] According to the first embodiment, the core wire-side first element 31 includes a core wire-side first element main wire 31a extending from a left side edge of the core wire-side power supplying section 20 as a starting point, and a core wire-side first element subsidiary wire 31b extending from a right side edge of the core wire-side power supplying section 20 as a starting point. It is to be noted, however, that the terms "main wire" and "subsidiary wire" are used herein for the purpose of convenience only and they do not mean that the core wire-side first element main wire 31a is an essential or indispensable wire while the core wire-side first element subsidiary wire 31b is a subsidiary or auxiliary wire. This also applies to other antenna elements as well as to other embodiments. Although in the embodiment shown in Fig. 2, the core wire-side first element main wire 31a and the core wire-side first element subsidiary wire 31b are arranged to extend from different positions on the core wire-side power supplying section 20, it is possible for another embodiment or another antenna element to arrange the core wire-side first element main wire 31a and the core wire-side first element subsidiary wire 31b in such a manner as to extend from the same position on the core wire-side power supplying section 20.

[0045] The core wire-side first element main wire 31 extends from the left side edge of the core wire-side power supplying section 20 along the left edge 5b of the window opening 5 while keeping a predetermined edge distance relative to the left edge 5b until it approaches the upper edge 5a. After arrival at a position proximate to the upper edge 5a of the window opening 5, the core wire-side first element main wire 31a is arranged to extend along the upper edge 5a while keeping the predetermined edge distance relative to the upper edge 5a until it arrives at a terminal end h1. The core wire-side first element main wire 31a is arranged only in consideration of the edge distance relative to the left edge 5b and the edge distance relative to the upper edge 5a without taking into consideration of an edge distance relative to a left upper corner edge 5e formed between the upper edge 5a and the left edge 5b of the window opening 5. The core wire-side first element subsidiary wire 31b is arranged such that at least more than 70% of the entire length of the core wire-side first element subsidiary wire 31b extends along the core wire-side first element main wire 31a while keeping a predetermined element distance relative to the core wire-side first element main wire 31a.

[0046] The core wire-side first element 31 as a whole is arranged such that at least more than 70% of the entire length extending from the core wire-sider power supplying section 20 as a starting point to the terminal point h1 extends along a closest edge part of the window opening 5 while keeping a predetermined distance (edge distance) relative to the closest edge part. In the first embodiment, the edge distance between the left and upper edges 5b, 5a of the window opening 5 and the core wire-side first element main wire 31a is less than 10 mm. More specifically, in the first embodiment, the edge distance between the core wire-side first element main wire 31a and the closest edge part of the window opening 5 is smaller at a first longitudinal part of the core wire-side first element main wire 31a extending alongside the left edge 5b than at a second longitudinal part of the core wire-side first element main wire 31a extending alongside the upper edge 5a.

[0047] The core wire-side first element 31 in the first embodiment has a looped shape as the core wire-side first element main wire 31a and the core wire-side first element subsidiary wire 31b are closed by the core wire-side second element 32 which extends from the terminal end h1 of the core wire-side first element 31 or the core wire-side first element main wire 31a. The antenna element (e.g., the core wire-side first element 31) having such looped shape is able to achieve a similar effect to that attained when the length width or diameter of an antenna element is increased. In general, the resistance value of an antenna element reduces with an increase in the line width or diameter, which will lead to an improvement of the reception sensitivity of the vehicular glass antenna 10. The antenna element having a looped shape is inconspicuous as compared to an antenna element having an enlarged line width or diameter and,

hence, the antenna reception sensitivity and the appearance of the entire vehicle can be compatibly achieved. In the first embodiment, the element distance between the core wire-side first element main wire 31a and the core wire-side first element subsidiary wire 31b is approximately 20 mm. The same shall apply to other antenna elements as long as they have a looped shape.

[0048] In the first embodiment, the core wire-side second element 32 extends from the terminal end h1 of the core wire-side first element 31 or the core wire-side first element main wire 31 as a starting point to a terminal end h2 in a substantially vertical direction and, more precisely, in parallel to the left edge 5b of the window opening 5. Since a lower edge 5c of the window opening 5 curves upward as it approaches a right edge 5d, the arrangement of the core wire-side second element 32 in parallel to the left edge 5b allows the core wire-side second element 32 to have a larger length than a length obtain when it extends exactly in a vertical direction from the terminal end h1 of the core wire-side first element 31 or the core wire-side first element main wire 31a. In the first element, the length of the core wire-side second element 32 is more than 190 mm. The reception sensitivity of the antenna tends to deteriorate as its orientation deviates from the vertical direction. It is therefore preferable that the core wire-side second element 32 is arranged to extend in a direction close to the vertical direction as much as possible. In the first embodiment, the terminal end h1 of the core wire-side first element 31 or the core wire-side first element main wire 31a, which is a starting point of the core wire-side second element 32, and the terminal end h2 of the core wire-side second element 32 are separated by at least more than 100 mm from each of the left edge 5b and the right edge 5d of the window opening 5.

[0049] The core wire-side third element 33 in the first embodiment includes a core wire-side third element main wire 33a extended to a terminal end h3 along a direction in which the core wire-side first element main wire 31a, and a core wire-side third element subsidiary wire 33b extended along a direction in which the core wire-side first element subsidiary wire 31b extends. The core wire-side third element subsidiary wire 33b is joined with the core wire-side third element main wire 33a at the terminal end h3. Thus, the core wire-side third element 33 has a looped shape.

[0050] The core wire-side fourth element 34 in the first embodiment extends from the terminal end h2 of the core wire-side second element 32 as a starting point to a terminal end h4 along the lower edge 5c of the window opening 5 in such a manner as to keep a predetermined edge distance relative to the lower edge 5c. The edge distance for the core wire-side fourth element 34 is equal to the edge distance defined between the upper edge 5a of the window opening 5 and the core wire-side first element main wire 31a of the core wire-side first element 31.

[0051] In the first embodiment, the ground-side antenna element only have a ground-side first element 51. The ground-side first element 51 extends from the ground-side power supplying section 40 as a starting point to a terminal end g1 along the core wire-side first element 31 (more specifically, the core wire-side first element subsidiary wire 31b) while keeping a predetermined first element distance relative to the core wire-side first element 31 (the core wire-side first element subsidiary wire 31b). The first element distance in the first embodiment is approximately 10 mm or less. However, the first element distance is set to be smaller at a part extending along the left edge 5b of the window opening 5 than at a part extending along the upper edge 5a of the window opening 5. The ground-side first element 51 in the first embodiment has a ground-side first element subsidiary wire 51b by which that part of the ground-side first element 51 extending along the left edge 5b of the window opening 5 is made to form a looped shape. The remaining part of the ground-side first element 51, which extends along that part of the core-side first element 31 extending along the upper edge 5a of the window opening 5, may be made to have a looped shape.

[0052] As thus far described, the vehicular glass antenna 10 according to the first embodiment can secure a more than 190-mm-length of the core wire-side second element 32 even though it is installed in the window opening 5 having a relatively small size in a vertical direction (e.g., less than 200 mm).

3. Second Embodiment

[0053] Fig. 3 shows a second embodiment of the vehicular glass antenna 10. The second embodiment shown in Fig. 3 is comprised of a vehicular glass antenna 10 configured to be installed in a window opening 5 for a rear quarter glass in a same manner as the first embodiment for the purpose of reception of radio waves of BAND III and L-BAND DAB frequencies. The vehicular glass antenna according to the second embodiment shown in Fig. 3 is therefore a modified form of the vehicular glass antenna according to the first embodiment. Following description will be limited to these parts of the vehicular glass antenna 10 of the second embodiment which are different from those described in conjunction with the first embodiment. As will be discussed under the heading "Performance Evaluation of First and Second Embodiments", the vehicle glass antenna 10 of the second embodiment is designed to have a same level of reception sensitivity as the vehicular glass antenna 10 of the first embodiment.

[0054] The vehicular glass antenna 10 of the second embodiment shown in Fig. 3 includes a core wire-side power supplying section 20, a core wire-side first element 31, a core wire-side second element 32, a core wire-side third element 33, a core wire-side fourth element 34, a ground-side power supplying section 40, a ground-side first element 51, and a ground-side second element 52. In the second embodiment, the core wire-side power supplying section 20 and the ground-side power supplying

section 40 are disposed in vertical juxtaposition at a position located in proximity to a left upper corner edge 5e of the window opening 5. The vehicular glass antenna 10 of the second embodiment is therefore is suitable for application in a vehicle having a power supplying position located in proximity to the left upper corner edge 5e of the window opening 5.

[0055] In the second embodiment, a core wire-side first element main wire 31a and a core wire-side first element subsidiary wire 31b extend from a same position on the core wire-side power supplying section 20. The core wire-side first element main wire 31a extends from the core wire-side power supplying section 20 as a starting point in such a manner as to first approach an upper edge 5a of the window opening 5 then run rightward along the upper edge 5a while keeping a predetermined edge distance relative to the upper edge 5 unit it arrives at a terminal end h1. The edge distance between the core wire-side first element main wire 31a and the upper edge 5a of the window opening 5 is equal to the edge distance in the first embodiment, which is defined between the upper edge 5a of the window opening 5 and a corresponding longitudinal part of the core wire-side first element main wire 31a.

[0056] In the second embodiment, the terminal end h1 of the core wire-side first element 31 is located more closely to a right edge 5d of the window opening 5 than the terminal end h1 of the core wire-side first element 31 in the first embodiment. The core wire-side second element 32 has a length more than 180 mm, which is smaller than the length of the core wire-side second element 32 in the first embodiment. Furthermore, lengths of the core wire-side first element 31 and the ground-side first element 51 are set to be smaller in the second embodiment than in the first embodiment.

[0057] In order to secure a reception sensitivity similar to that in the first embodiment, lengths of the core wire-side third element 33 and the core wire-side fourth element 34 in the second embodiment are set to be larger than lengths of the core wire-side third element 33 and the core wire-side fourths elements 33, 34, respectively, in the first embodiment. Furthermore, in the second embodiment, the ground-side second element 52 is also provided. Additionally, the entire ground-side first element 51 in the second embodiment has a looped shape. A first element distance defined between the ground-side first element 51 and the core wire-side first element 31 (more precisely between the core wire-side first element subsidiary wire 31b and a ground-side first element main wire 51a) is set to be larger than the first element distance in the first embodiment which is defined at a part extending along the left edge 5b of the widow opening 5.

[0058] In the first and second embodiments, a total length of antenna elements is designed to be substantially equal regardless of whether the total length is obtained when only main wires of looped portions are taken into consideration, or obtained when both of the main and subsidiary wires of the looped portions are taken into consideration.

4. Performance Evaluation of First and Second Embodiments

[0059] Fig. 4 is a graph showing reception sensitivities of the vehicular glass antennas according to the first and second embodiments of the present invention. In the graph shown in Fig. 4, a horizontal axis represents the frequency (MHz), and a vertical axis represents the sensitivity (dBd). A range of the frequency shown on the horizontal axis of the graph of Fig. 4 is from 174 to 240 MHz, which corresponds to a frequency band assigned to BAND III OAB frequencies.

[0060] In the graph shown in Fig. 4, a solid line 60 represents a frequency characteristic of the vehicular glass antenna 10 according to the first embodiment, and a broken line 70 represents a frequency characteristic of the vehicular glass antenna 10 according to the first embodiment. As is evident from the frequency characteristics, in both the first and second embodiments, a reception sensitivity exceeding -10.0 dBd is achieved over the substantially entire frequency range shown in Fig. 4 excepting that the reception sensitivity in the second embodiment is lowered to be close to -12.0 dBd at a frequency around 180 MHz. This means that not only in an application to a vehicle having a power supplying position located in proximity to the left edge 5b of the window opening 5 and intermediate between the upper and lower edges 5a, 5c of the window opening 5, but also in an application to a vehicle having a power supplying position located in proximity to a left upper corner edge 5e of the window opening 5, the vehicular glass antennas 10 of the present invention can exhibit a sufficient reception sensitivity.

[0061] Furthermore, the frequency characteristics of the first and second embodiments have substantially the same reception sensitivity over the substantially entire frequency range shown in Fig. 4 except for a frequency around 180 MHz. This also means that the vehicular glass antennas 10 of the present invention can possess substantially the same frequency characteristic regardless of whether the power supplying position of the vehicle is located in proximity to the left edge 5b of the window opening 5 and intermediate between the upper and lower edges 5a, 5c of the window opening 5, or located in proximity to the left upper corner edge 5e of the window opening 5.

[0062] Additionally, the vehicular glass antennas 10 according to the first and second embodiments of the invention are able to secure a sufficient reception sensitivity even when they are installed in a window opening 5 having a relatively small size in a vertical direction (e.g., less than 200 mm).

5. Other Embodiments

[0063] The present invention should by no means be

limited to the first and second embodiments described above. Rather, various antenna patterns other than those of the first and second embodiments can be realized by adjusting the antenna elements in terms of the length, arrangement, and presence/absence of a looped shape. Needless to say, the position of the power supplying sections and the pattern of antenna elements can be reversed left and right or up and down.

[0064] Fig. 5(A) shows a structural example of the vehicular glass antenna in which a core wire-side antenna element 30 and a ground-side antenna element 50 do not have a looped shape. In the vehicular glass antenna 10 shown in Fig. 5(A), a core wire-side second element 32 extends in a substantially vertical direction. In the case where the vehicular glass antenna 10 can possess a sufficient reception sensitivity for radio waves in the required frequency bands without providing a looped shape, a fine adjustment of e.g., the length of antenna elements can be achieved easily as compared to the case where the vehicular glass antenna does not have a looped shape.

[0065] Fig. 5(B) shows a structural example of the vehicular glass antenna in which only a core wire-side antenna element 30 has a looped shape, and a core wire-side third element 33 is not present. The vehicular glass antenna 10 exemplified in Fig. 5(A) and the vehicular glass antenna 10 exemplified in Fig. 5(B) are designed for use in the same radio-wave frequency band to be received and possess the same reception sensitivity. The vehicular glass antenna 10 shown in Fig. 5(B) differs from that of Fig. 5(A) in that a core wire-side first element 31 has a looped shape provided in place of the core wire-side third element 33, and an edge distance of the core wire-side first element 31 and an edge distance of the core wire-side fourth element 34 are set to be smaller than those shown in Fig. 5(A). Due to the absence of the core wire-side third element 33, the vehicular glass antenna 10 shown in Fig. 5(B) has a reduced number of antenna elements to be adjusted in length, which will facilitate fine adjustment of the vehicular glass antenna.

[0066] Fig. 6(A) shows an example of the vehicular glass antenna 10, which is installed in a vehicle having a window opening 5 having a curved left upper corner edge 5e between an upper edge 5a and a left edge 5b. In the example shown in Fig. 6(A), a core wire-side first element 31 is arranged to extend to a terminal end h1 while an edge distance relative to the left edge 5b of the window opening 5, an edge distance relative to the curved left upper corner edge 5e, and an edge distance relative to the upper edge 5a are taken into account. The core wire-side first element 31 has a longitudinal portion closest to the left upper corner edge 5e of the window opening 5, which extends along the left upper corner edge 5e in such a manner as to draw a curved line while keeping the edge distance relative to the left upper corner edge 5e. A ground-side first element 51 has a longitudinal portion extending along the curved longitudinal portion of the core wire-side first element 31, the longitudinal portion extending in such a manner to draw a curved line.

[0067] Fig. 6(B) shows an example of the vehicular glass antenna 10, which is installed in a vehicle having a window opening 5 having a rounded shape as a whole. A core wire-side first element 31 extends along an edge of the window opening 5 and a ground-side first element 51 extends along the core wire-side first element 31, so that in the example shown in Fig. 6(B), the core wire-side first element 31 and the ground-side first element 51 extend with roundness. A core wire-side fourth element 34 shown in Fig. 6(B) extends to draw a straight line. However, if a part of the edge of the window opening 5 closest to the core wire-side fourth element 34 is formed by a curved line, the core wire-side fourth element 34 may extend in a manner to draw a curved line. It is preferable however that a core wire-side second element 32 extends to draw a straight line as it give a great influence to performance of the vehicular glass antenna 10. Preferably, a ground-side second element 52 extending along the core wire-side second element 32 extends to draw a straight line. Except for the core wire-side second element 32 and the ground-side second element 52, the antenna elements may be extended to draw a curved line according to the shape of an edge of the window opening 5 closest to each of the antenna elements.

[0068] Though not shown in the embodiments discussed above, the core wire-side second element 32 and/or the ground-side second element 52 may have a looped shape. However, since the length of the core wire-side second element 32 gives a great influence to performance, such as reception sensitivity, of the antenna, it is assumed that the frequency of fine adjustments of the length of the core wire-side second element is high. If the core wire-side second element 32 has a looped shape, a fine length adjustment should be performed for two wires. To facilitate the fine adjustment, it is preferable that the core wire-side second element 32 does not have a looped shape.

[0069] It is readily appreciated that various examples or embodiments other than those discussed above can be realized according to the invention. According to the invention, by adjusting the length and arrangement of antenna elements, it is possible to provide a vehicular glass antenna which has a sufficient reception sensitivity without being limited by a power supplying position of the vehicle. In other words, the vehicular glass antenna of the present invention does not limit the type of vehicle to which it is applicable.

Claims

1. An antenna for a vehicular glass, comprising:

a core wire-side power supplying section (20);
a core wire-side antenna element (30) electrically connected to the core wire-side power supplying section (20);
a ground-side power supplying section (40); and

a ground-side antenna element (50) electrically connected to the ground-side power supplying section (40),
wherein the core wire-side antenna element (30) includes:

a core wire-side first element (31) extending from the core-side power supplying section (20) as a starting point along an edge of a window opening (5) of a vehicle body (1) in such a manner as to keep a first predetermined distance relative to a part of the edge of the window opening (5) closest to the core wire-side first element (31); and
a core wire-side second element (32) extending from the core wire-side first element (31) in a substantially vertical direction at a position (h1) separated by more than a prescribed distance from each of left and right edges (5b, 5d) of the window opening (5), and
wherein the ground-side antenna element (50) has a portion (51) extending from the ground-side power supplying section (40) as a starting point along the core wire-side first element (31) in such a manner as to keep a second predetermined distance relative to the core wire-side first element (31).

2. The antenna for a vehicular glass according to claim 1, wherein the prescribed distance by which the core wire-side second element (32) is separated from each of the left and right edges (5b, 5d) of the window opening (5) is more than 50 mm.

3. The antenna for a vehicular glass according to claim 1 or 2, wherein the core wire-side second element (32) has a length more than 140 mm.

4. The antenna for a vehicular glass according to any one of claims 1 to 3, wherein the first predetermined distance is less than 40.

5. The antenna for a vehicular glass according to any one of claims 1 to 4, wherein the second predetermined distance is from 5 to 20 mm.

6. The antenna for a vehicular glass according to any one of claims 1 to 5, wherein the core wire-side antenna element (30) and the ground-side antenna element (50) at least partially include a looped shape.

7. The antenna for a vehicular glass according to any one of claims 1 to 6, further comprising: a glass provided with the core wire-side power supplying section (20), the core wire-side antenna element (30), the ground-side power supplying section (40), and the ground-side antenna element (50).

FIG.1

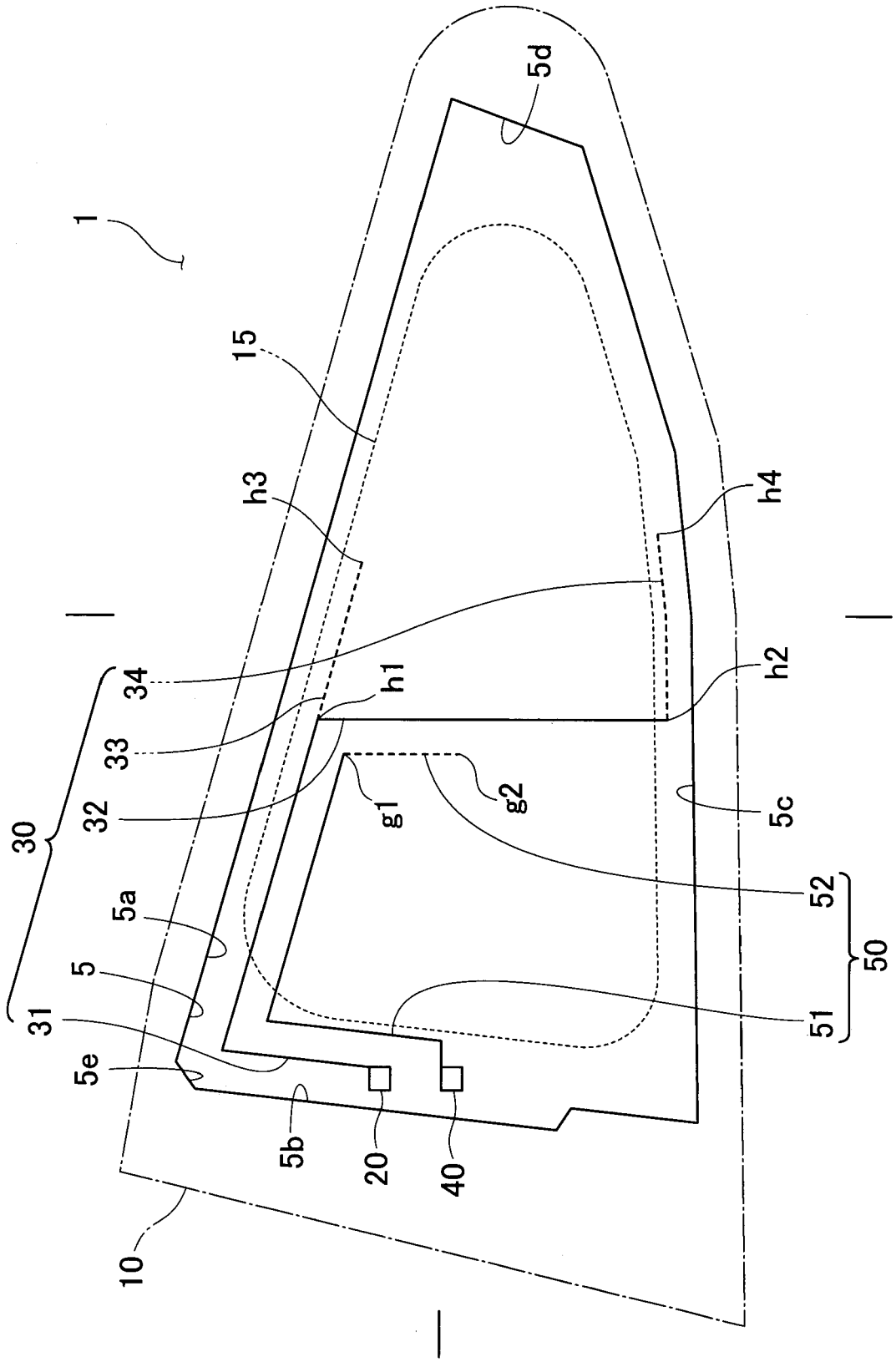
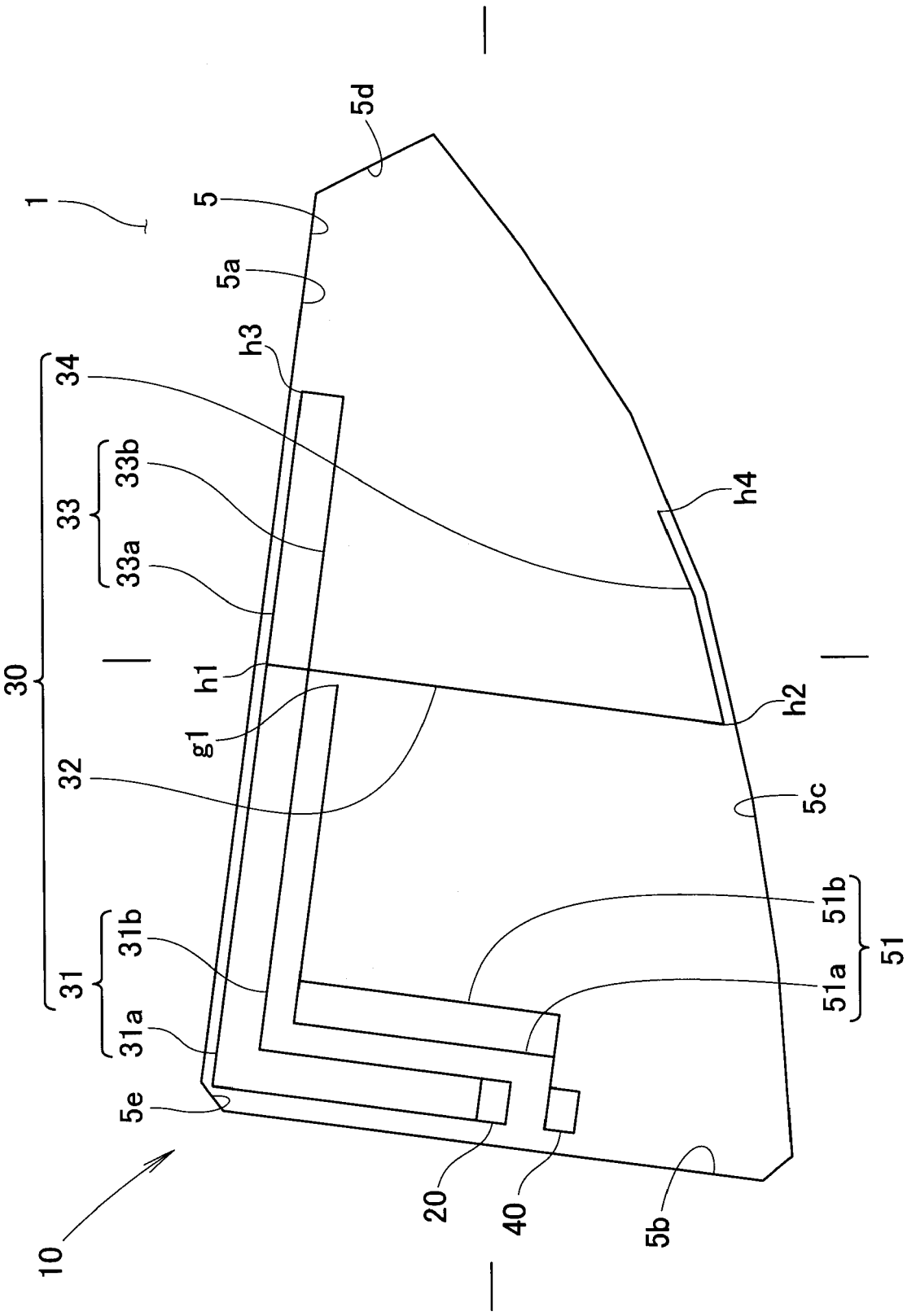


FIG.2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h3
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33b
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30
h1
g1
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h4
h2
5c
51b
51a
51

FIG.3

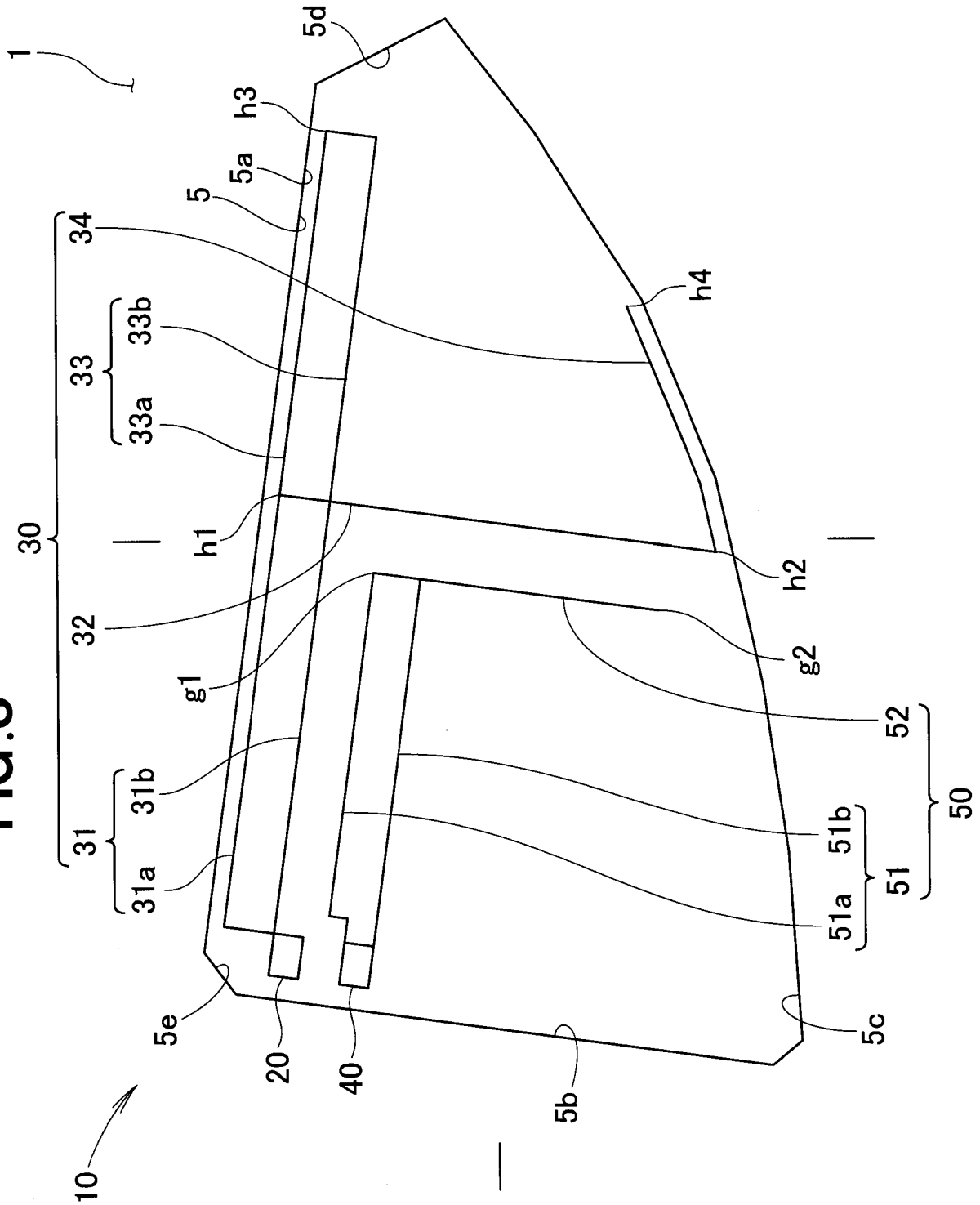
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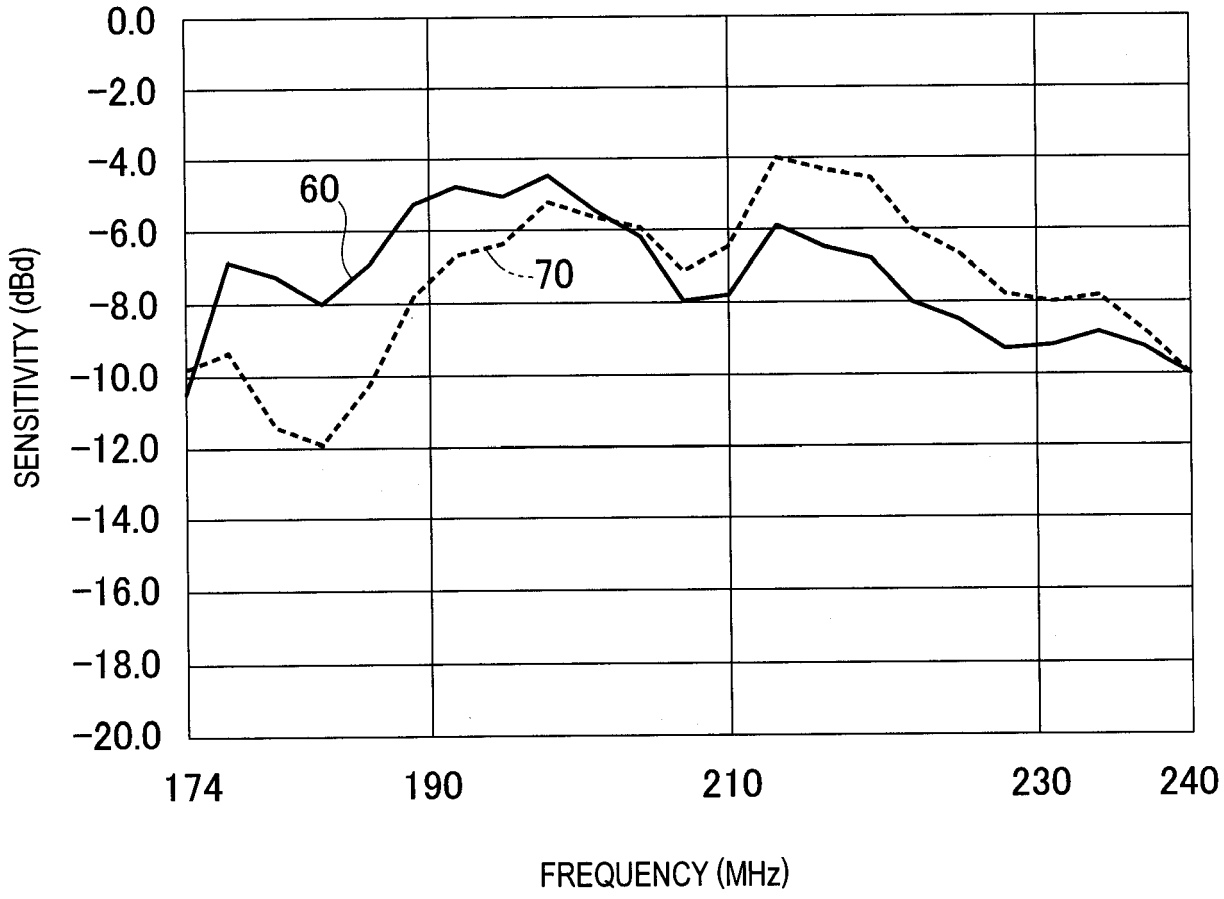
FIG.4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SENSITIVITY (dBd)
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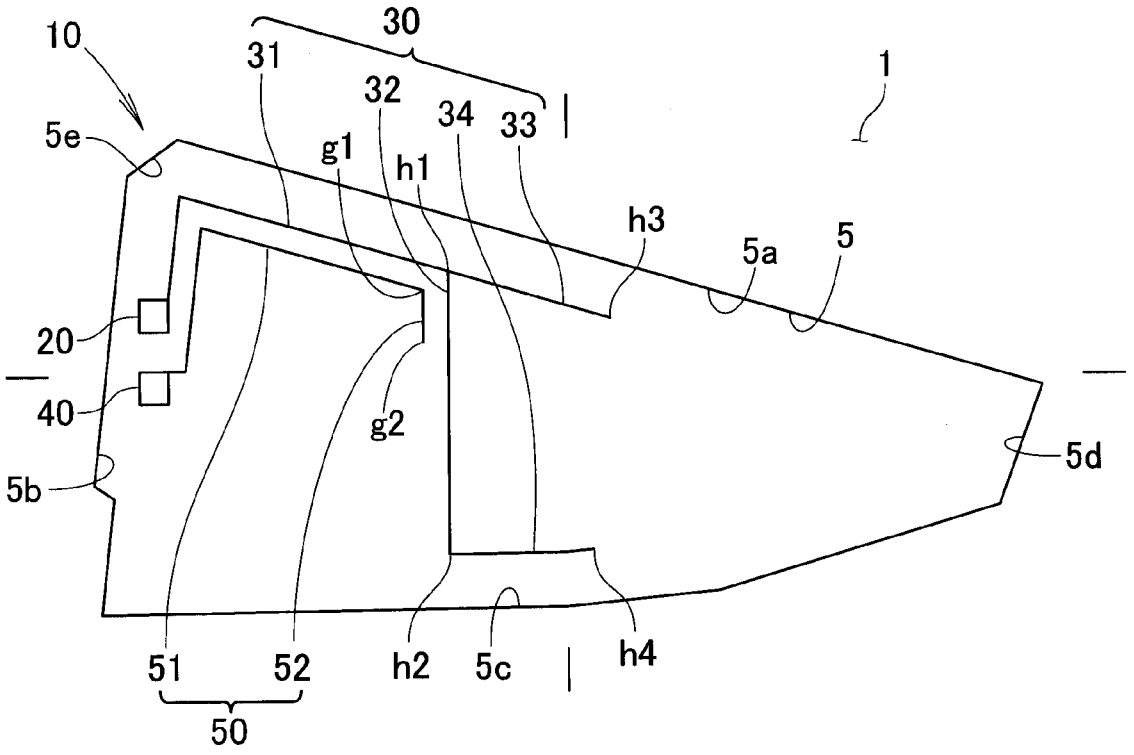
70
174
190
210
230
240
FREQUENCY (MHz)

FIG.5(A)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5b
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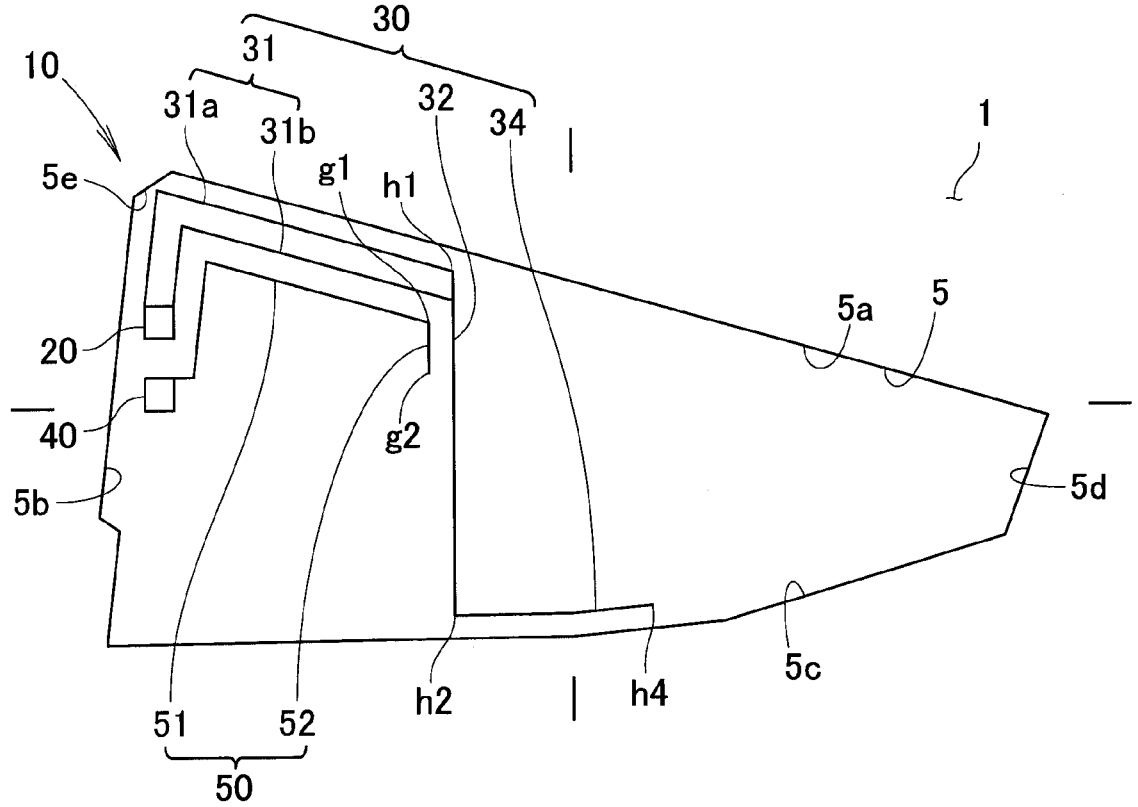
52
h2
5c
h4
50

FIG.5(B)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h1
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40
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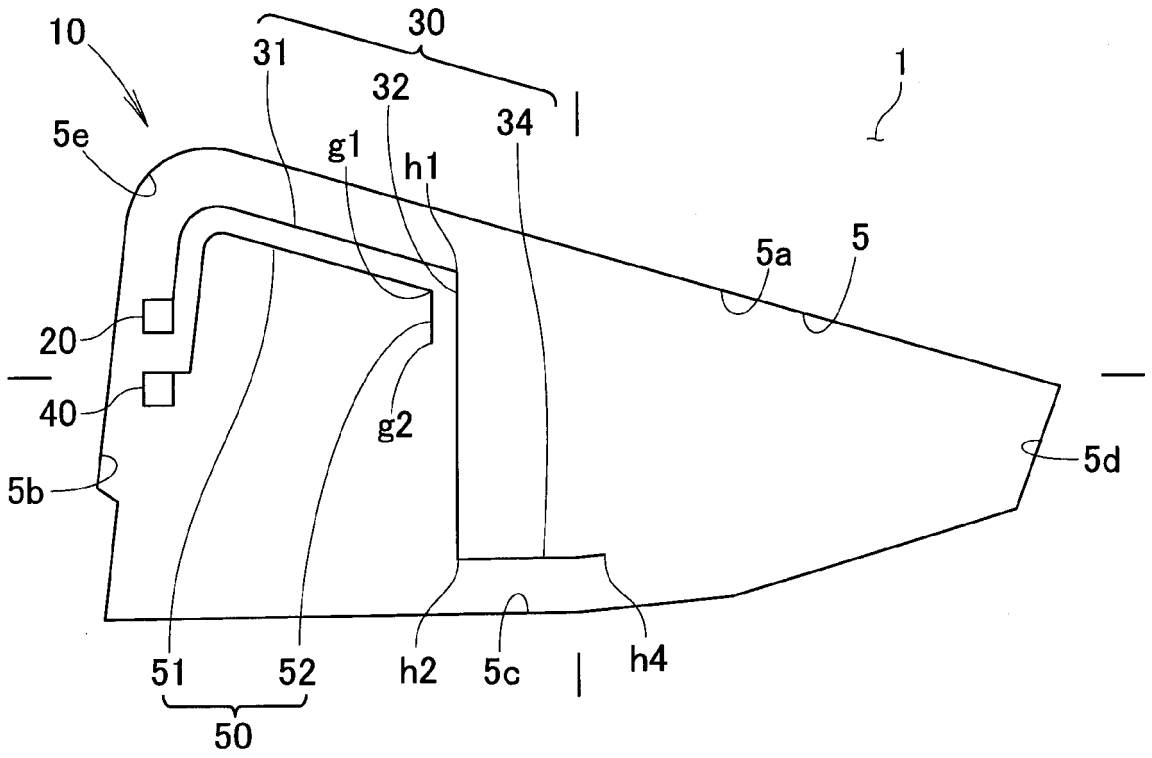
5b
5c
51
52
h2
h4
50

FIG.6(A)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40
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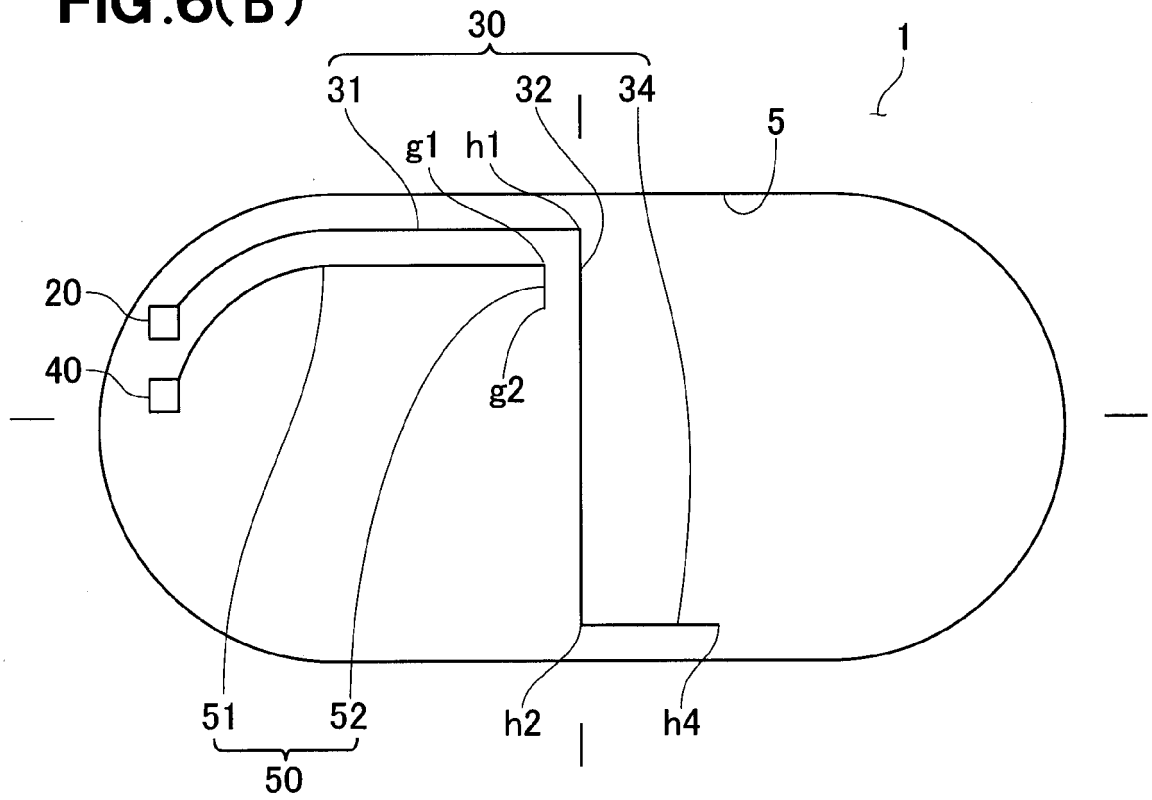
5d
5b
51
52
h2
5c
h4
50

FIG.6(B)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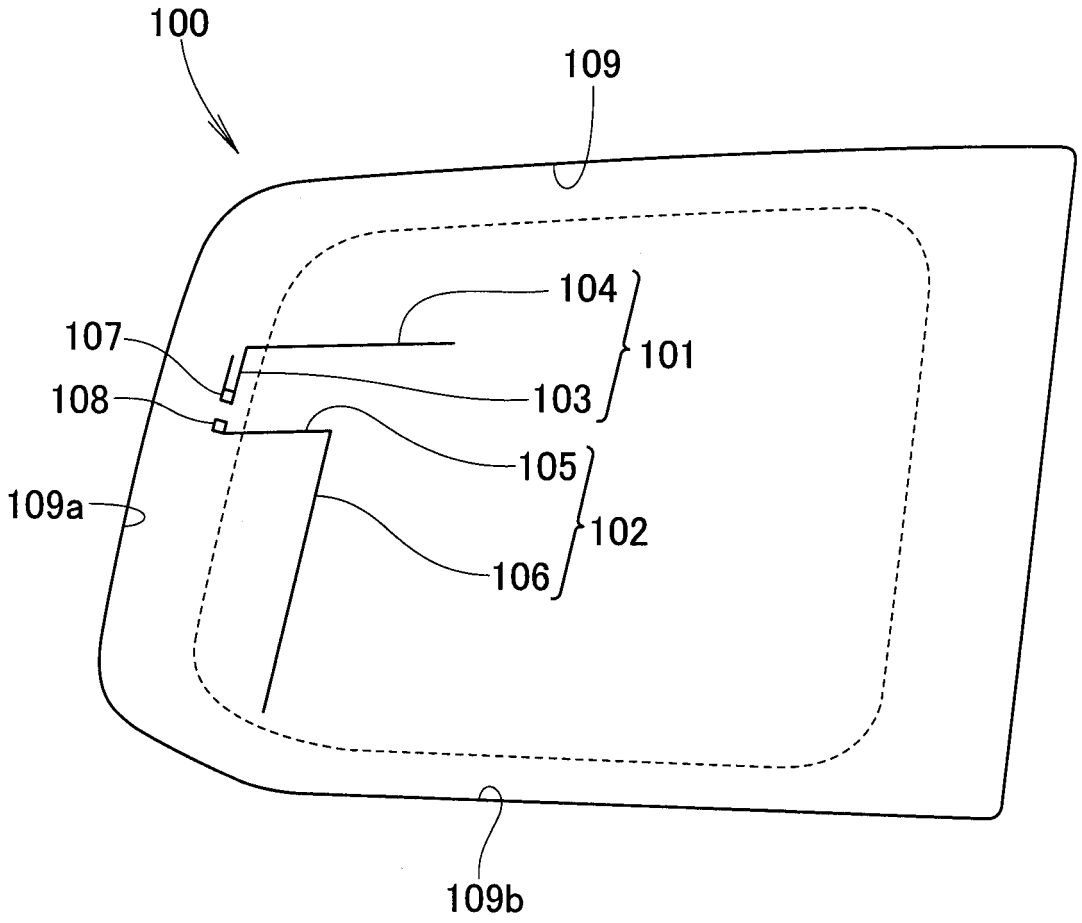
g1
h1
20
40
g2
51
52
h2
h4
50

FIG.7



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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 8343

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	JP 2002 299932 A (CENTRAL GLASS CO LTD) 11 October 2002 (2002-10-11) * abstract; figures 1,7 *	1,3,7	INV. H01Q1/12 H01Q21/28 H01Q9/30
X	JP 2002 064317 A (NIPPON SHEET GLASS CO LTD) 28 February 2002 (2002-02-28) * abstract; figures 1,6,11,12 *	1,2,6	
X	EP 2 787 573 A1 (CENTRAL GLASS CO LTD [JP]) 8 October 2014 (2014-10-08)	1	
A	* paragraph [0020] - paragraph [0023]; figures 1,4,6 * * paragraph [0028] - paragraph [0029] * * paragraph [0033] - paragraph [0034] *	2-7	
X	US 2004/008144 A1 (KUBOTA MASATO [JP]) 15 January 2004 (2004-01-15)	1	
A	* paragraph [0030] - paragraph [0036]; figure 1 *	2-7	
X	EP 2 503 638 A1 (CENTRAL GLASS CO LTD [JP]) 26 September 2012 (2012-09-26)	1	TECHNICAL FIELDS SEARCHED (IPC)
A	* paragraph [0017] - paragraph [0023]; figure 1 * * paragraph [0041] - paragraph [0044] *	2-7	H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 April 2016	Pastor Jiménez, J

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22-04-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2002299932 A	11-10-2002	NONE	
JP 2002064317 A	28-02-2002	NONE	
EP 2787573 A1	08-10-2014	AU 2014201814 A1	16-10-2014
		EP 2787573 A1	08-10-2014
		JP 2014204190 A	27-10-2014
US 2004008144 A1	15-01-2004	NONE	
EP 2503638 A1	26-09-2012	CN 102612788 A	25-07-2012
		EP 2503638 A1	26-09-2012
		JP 5428790 B2	26-02-2014
		JP 2011109330 A	02-06-2011
		KR 20120080642 A	17-07-2012
		US 2012229353 A1	13-09-2012
		WO 2011058878 A1	19-05-2011

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Patent documents cited in the description

- JP 2011193381 A **[0002] [0003] [0006]**
- JP 2011160236 A **[0004] [0005] [0006]**