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(72) Inventors:
• **HAYASHI, Takuji**
Tokyo, 100-8405 (JP)
• **TOKUNAGA, Satoshi**
Japan, 100-8405 (JP)

(74) Representative: **Müller-Boré & Partner**
Patentanwälte PartG mbB
Friedenheimer Brücke 21
80639 München (DE)

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(71) Applicant: **AGC INC.**
Chiyoda-ku,
Tokyo 1008405 (JP)

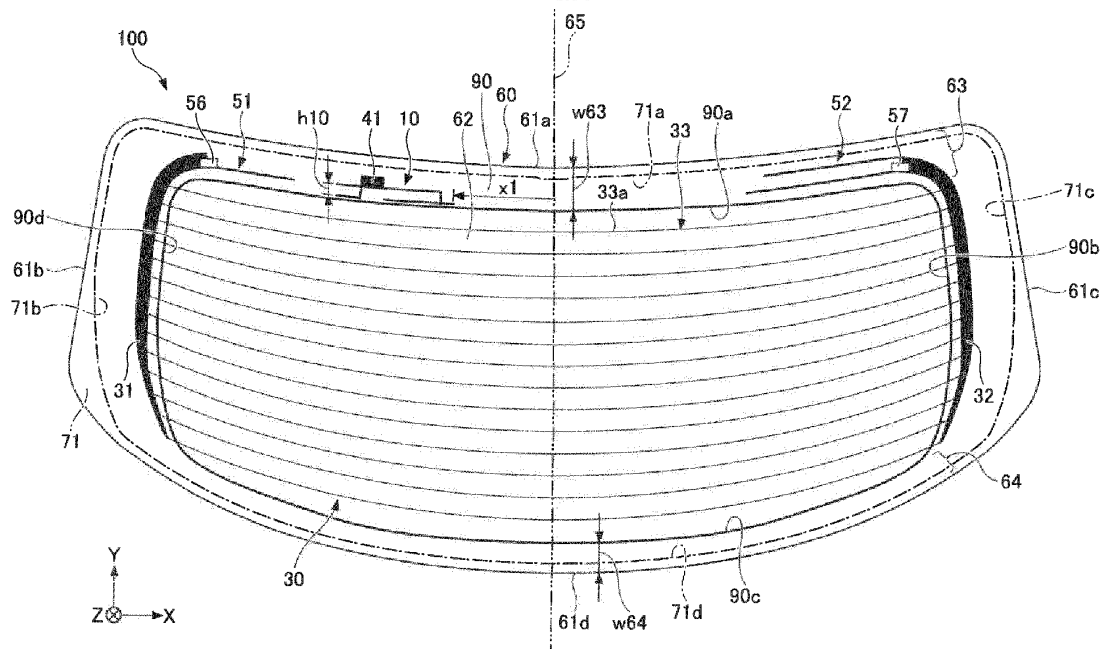
(54) REAR GLASS FOR VEHICLE WITH ANTENNA

(57) A rear glass for vehicle with an antenna, includes an opening portion; and a light shielding film arranged around the opening portion.

The light shielding film includes a belt-like light shielding region extending in a horizontal direction of the rear glass for vehicle.

The width of the light shielding region in the vertical direction of the rear glass for vehicle is 20 mm or more and 50 mm or less.

An antenna including a plurality of elements formed so as to be able to receive vertically polarized electromagnetic waves is arranged in the light shielding region.

FIG.1**EP 3 477 766 A1**

Description**BACKGROUND OF THE INVENTION**

1. Field of the Invention

[0001] The disclosure herein generally relates to a rear glass for vehicle with antenna.

2. Description of the Related Art

[0002] An opening (transparent) portion of a rear glass for vehicle is provided with various function portions, such as a defogger or an antenna, subject to securing visibility in the opening portion. The function portions provided in the opening portion have an effect of providing added value to the vehicle, but there is a problem in that a complicated configuration of the function portions is noticeable, and appearance is not good (See for example, Japanese Unexamined Patent Application Publication No. 2016-72910 and Japanese Unexamined Patent Application Publication No. 2017-50892). Then, for example, WO 2017/18323 discloses a configuration in which an antenna pattern for LTE (Long Term Evolution) is overlaid on a region of a light shielding film arranged around the opening portion, and thereby a size of patterns viewed in the opening portion is reduced.

SUMMARY OF THE INVENTION

[Technical Problem]

[0003] However, for example, in a vehicle in which a size (area) of a rear glass itself is relatively small (e.g. a compact car or a hatch back vehicle), a size (area) of the opening portion also tends to be relatively small. In order to secure a predetermined size of the opening portion from a viewpoint of safety or the like, a height of a belt-like light shielding region arranged around the opening portion (width in the vertical direction on the rear glass) is also small. When an antenna for receiving vertically polarized electromagnetic waves is arranged in such a narrow light shielding region, a part of the antenna is exposed in the opening portion, and it is difficult to receive vertically polarized electromagnetic waves while securing a good appearance.

[0004] Thus, the disclosure of the present application provides a rear glass for vehicle with an antenna that can receive vertically polarized waves while securing a good appearance.

[Solution to Problem]

[0005] According to an aspect of the present application, a rear glass for vehicle with an antenna, including an opening portion; and a light shielding film arranged around the opening portion,

the light shielding film including a belt-like light shielding region extending in a horizontal direction of the rear glass for vehicle,

a width of the light shielding region in a vertical direction of the rear glass for vehicle being 20 mm or more and 50 mm or less, and

an antenna including a plurality of elements formed so as to be able to receive vertically polarized electromagnetic waves being arranged in the light shielding region, is provided.

[Effect of Invention]

[0006] According to an aspect of the present invention, a rear glass for vehicle with antenna that can receive vertically polarized electromagnetic wave while securing a good appearance can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS**[0007]**

FIG. 1 is a plan view depicting an example of a configuration of a rear glass for vehicle with an antenna according to an embodiment viewed from a viewpoint inside a vehicle;

FIG. 2 is a diagram depicting an example of a shape of a first antenna of the rear glass for vehicle and a power feeding structure;

FIG. 3 is a diagram showing an example of a result of measurement for an antenna gain in Band III of 174 MHz to 240 MHz;

FIG. 4 is a diagram showing an example of a result of measurement for an antenna gain in L Band of 1452 MHz to 1492 MHz; and

FIG. 5 is a cross-sectional diagram depicting an example of the rear glass for vehicle according to the embodiment installed in a window frame.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] In the following, with reference to drawings, embodiments for implementing the present invention will be described. Note that in each embodiment, a direction, such as parallel, a right angle, orthogonal, horizontal, vertical, up-down, right-left, or the like, allows a deviation enough to keep the effect of the present invention. Moreover, a shape of a corner portion of an antenna element is not limited to a right angle, but may be arcuate and rounded. Moreover, each plan view is a diagram when a glass surface of a glass plate for a vehicle window (in the following, also referred to as a "window glass") is viewed facing the glass surface, and the window glass installed in the vehicle viewed from a viewpoint inside the vehicle will be shown (vehicle interior view). Moreover, when the window glass is a rear glass installed in a rear part of the vehicle, a vertical direction in each plan view corresponds

to a vertical direction of the vehicle, and a right-left direction in each drawing is equivalent to a vehicle width direction.

[0009] Moreover, in each plan view, a direction parallel to an X-axis (X-axis direction), a direction parallel to a Y-axis (Y-axis direction), and a direction parallel to a Z-axis (Z-axis direction) indicate the right-left direction of the glass plate (horizontal direction), the up-down direction of the glass plate (vertical direction), and a direction orthogonal to a surface of the glass plate (also referred to as a normal direction), respectively. The X-axis direction, the Y-axis direction and the Z-axis direction are orthogonal to each other.

[0010] FIG. 1 is a plan view (X-Y) depicting an example of a configuration of a vehicle window glass according to an embodiment viewed from a viewpoint inside a vehicle. The rear glass 100, illustrated in FIG. 1, is an example of a rear glass for vehicle with an antenna mounted in a rear part of a vehicle. The rear glass 100 is a vehicle window glass including a glass plate for a vehicle window 60, a defogger 30 arranged on the glass plate 60, and an antenna 10 arranged in an upper left area of the glass plate 60.

[0011] The glass plate 60 is an example of a glass plate for a vehicle window. An outer shape of the glass plate 60 is approximately a quadrangle. An upper edge 61a is a glass edge on an upper side of the glass plate 60. A lower edge 61d is a glass edge on a lower side (opposite to the upper edge 61a) of the glass plate 60. A left edge 61b is a glass edge on a left side of the glass plate 60 viewed from a viewpoint inside a vehicle. A right edge 61c is a right side (opposite to the left edge 61b) of the glass plate 60 viewed from a viewpoint inside a vehicle. The left edge 61b is a glass edge adjacent to left ends of the upper edge 61a and the lower edge 61d. The right edge 61c is a glass edge adjacent to right ends of the upper edge 61a and the lower edge 61d.

[0012] The glass plate 60 has a pair of side edges. The left edge 61b is an example of a first side edge that is one of the pair of side edges. The right edge 61c is an example of a second side edge that is the other of the pair of side edges. At a connection portion of the upper edge 61a and the left edge 61b, the upper edge 61a and the left edge 61b are connected to each other with a curvature, but may be connected without a curvature. The same applies to shapes of the other connection portions of edges.

[0013] The defogger 30 is an electric heating conductor pattern that removes fogging on the glass plate 60. The defogger 30 includes a plurality of heater wires extending in the right-left direction in the glass plate 60, and a plurality of bus bars for feeding power to the plurality of heater wires. In the embodiment, a plurality of heater wires 33 extending in the right-left direction in the glass plate 60 so as to extend parallel to each other, and a pair of bus bars 31 and 32 connected to the plurality of heater wires 33 are arranged on the glass plate 60. When an electric voltage is applied between the pair of bus bars

31 and 32, the plurality of heater wires 33 conduct and produce heat, and thereby fogging on the glass plate 60 is removed.

[0014] The plurality of heater wires 33 are conductor patterns connected to the left bus bar 31 and the right bus bar 32 and arranged between the left bus bar 31 and the right bus bar 32. The left bus bar 31 is an example of a first bus bar, and is a conductor pattern that extends in the vertical direction of the glass plate 60 along the left edge 61b. The right bus bar 32 is an example of a second bus bar, and is a conductor pattern that extends in the vertical direction of the glass plate 60 along the right edge 61c.

[0015] The rear glass 100 is mounted to a window frame 71 formed in a metallic body of the vehicle. The window frame 71 includes frame edges for forming a window (an upper frame edge 71a, a left frame edge 71b, a right frame edge 71c, and a lower frame edge 71d).

[0016] The antenna 10 is arranged in a region above the defogger 30. In the embodiment, the antenna 10 is arranged in a region between the heater wire 33a, that is located at the uppermost position from among the plurality of heater wires 33, and an upper edge 61a of the glass plate 60. In the state where the rear glass 100 is mounted to the window frame 71, the antenna 10 is located near the upper frame edge 71a of the window frame 71. In the embodiment, the antenna 10 is located between the upper frame edge 71a of the window frame 71 and the heater wire 33a at the uppermost position of the plurality of heater wires 33.

[0017] The glass plate 60 includes an opening portion 62, and a light shielding film 90. The opening portion 62 is a glass plate region that transmits a visible light. In the embodiment, heating wire parts of the respective heating wires, other than both ends of wires, of the plurality of heat wires 33 are arranged in the opening portion 62. The light shielding film 90 is a member that shields a visible light. The light shielding film 90 is arranged around the opening portion 62. In the embodiment, the light shielding film 90 has an upper film edge 90a and a lower film edge 90c that are opposite each other in a Y-axis direction, and a right film edge 90b and a left film edge 90d that are opposite each other in an X-axis direction which is orthogonal to the Y-axis direction.

[0018] For example, at least a part of a function portion, such as a bus bar, a heating wire, a feeding portion and an antenna, are arranged so as to overlap with the light shielding film 90 formed in a peripheral region of the glass plate 60. The light shielding film 90 includes, for example, a ceramic such as a black ceramic film. In the case where a part of the function portion is arranged so as to overlap with the light shielding film 90 in this way, when the rear glass 100 is viewed from outside the vehicle, the part arranged so as to overlap with the light shielding film 90 cannot be seen from outside the vehicle because of the light shielding film 90. Thus, a design property of the rear glass 100 or the vehicle is enhanced.

[0019] In the embodiment, the antenna 10 is arranged

in a belt-like light shielding region 63, between the upper film edge 90a at the upper part of the light shielding film 90 and the upper edge 61a of the glass plate 60. The light shielding region is a part of the light shielding film 90, which extends in the horizontal direction of the rear glass 100 above the opening portion 62. Because all of the plurality of elements with which the antenna 10 is provided become not visible from outside the vehicle by being arranged in the light shielding region 63, the design property of the rear glass 100 or the vehicle is further enhanced. Thus, the antenna 10 according to the embodiment is formed along the upper film edge 90a, so that a horizontal element located on a lower edge of the antenna 10 is not exposed from the light shielding region 63.

[0020] The rear glass 100 is preferably used in a vehicle in which a size (area) of the rear glass itself is relatively narrow in the specification (e.g. a compact car or a hatch back vehicle). When the size of the rear glass 100 becomes small, the size (area) of the opening portion 62 also tends to be small.

In order to secure a predetermined size of the opening portion 62 from a viewpoint of safety or the like, a width of the belt-like light shielding region arranged in the rear glass 100 becomes also small. For example, the rear glass 100 is preferably used in a vehicle, in which a width w63 of the light shielding region 63 in the vertical direction of the rear glass 100 is 20 mm or more and 50 mm or less, in the specification. On the other hand, in a vehicle, in which the size of the rear glass itself is relatively wide in the specification, the width of the belt-like light shielding region arranged in the rear glass often exceeds 50 mm.

[0021] The rear glass 100 according to the embodiment includes the antenna 10 having a plurality of elements that can receive vertically polarized electromagnetic waves in the light shielding region 63. Thus, because the antenna 10 is not visible from outside the vehicle because of the light shielding region 63, the rear glass 100 with an antenna that can receive vertically polarized electromagnetic waves while securing a good appearance can be provided.

[0022] Note that the antenna 10 having the plurality of elements that can receive vertically polarized electromagnetic waves may be arranged in a light shielding region 64 below the opening portion 62. Also in this case, because the antenna 10 is not visible from outside the vehicle because of the light shielding region 64, vertically polarized electromagnetic waves can be received while securing a good appearance. The light shielding region 64 is a part of the light shielding film 90 that extends in the horizontal direction of the rear glass 100 below the opening portion 62. For example, the rear glass 100 is preferably used in a vehicle in which a width w64 of the light shielding region 64 in the vertical direction of the rear glass 100 is 20 mm or more and 50 mm or less, in the specification.

[0023] Moreover, FIG. 5 is a cross-sectional view schematically depicting an example of the rear glass 100

mounted to the window frame 71 by an adhesive agent 72. When a glass surface of the rear glass 100 is viewed, opposite to the glass surface, in a state where the rear glass 100 is mounted to the window frame 71, the antenna 10 is located in a boundary region 63a of the light shielding region 63 that is a boundary part between the light shielding region 63 and the opening portion 62. When a glass surface of the rear glass 100 is viewed, opposite to the glass surface, in a state where the rear glass 100 is mounted to the window frame 71, the boundary region 63a indicates a light shielding region between the upper frame edge 71a of the window frame 71 and the upper film edge 90a of the light shielding film 90. Because the antenna 10 is located in the boundary region 63a and will not be hidden by the upper frame edge 71a, a directivity of the antenna 10 is more enhanced, and an antenna gain for vertically polarized electromagnetic wave is more enhanced. The same applies to the case where the antenna 10 is arranged in the light shielding region 64 in the lower part of the light shielding film 90.

[0024] Moreover, in order to enhance a sensitivity of receiving vertically polarized electromagnetic waves (antenna gain for vertically polarized electromagnetic waves), the plurality of elements in the antenna 10 include, for example, at least one vertical element that extends in the vertical direction of the rear glass 100. The antenna 10 according to the embodiment has two vertical elements 15 and 16, illustrated in FIG. 2, which will be described later in detail. In FIG. 1, a maximum length h10 of at least one vertical element extending in the vertical direction of the rear glass 100 is preferably 0.25 or more and 0.80 or less, with the width of the light shielding region w63 being taken as unity, from the viewpoint of enhancing the antenna gain for vertically polarized electromagnetic waves. The maximum length h10 is more preferably 0.30 or more and 0.75 or less. When the maximum length h10 is less than 0.25, it becomes difficult to secure the antenna gain for the vertically polarized electromagnetic waves. When the maximum length h10 is greater than 0.80, it becomes difficult to secure an arrangement region for the feeding portion 41. The same applies to the case where the antenna 10 is arranged in the light shielding region 64.

[0025] Moreover, with reference to a center line 65 extending in the vertical direction of the rear glass 100, let the shortest distance from the center line 65 to the left film edge 90d of the light shielding film 90 be taken as +1, and let the shortest distance from the center line 65 to the right film edge 90b of the light shielding film 90 be taken as -1. In this case, the shortest distance x1 from the center line 65 to the antenna 10 with reference to the center line 65 is preferably -0.8 or more (i.e. towards 0) and 0.8 or less from the viewpoint of enhancing the antenna gain of the antenna 10 for vertically polarized electromagnetic waves, and more preferably -0.5 or more and 0.5 or less. The shortest distance from the center line 65 to the left edge 61b and the shortest distance from the center line 65 to the right edge 61c are almost the

same. Note that the shortest distance x_1 indicates a length along the glass surface of the rear glass 100.

[0026] Note that when the shortest distance x_1 exceeds +0.8, because the antenna 10 is too close to the left frame edge 71b, the antenna 10 is hidden by the left frame edge 71b, and the directivity of the antenna 10 degrades. As a result, the antenna gain of the antenna 10 for vertically polarized electromagnetic waves is reduced. When the shortest distance x_1 is less than -0.8 (i.e. away from 0), because the antenna 10 is too close to the right frame edge 71c, the antenna 10 is hidden by the right frame edge 71c, and the directivity of the antenna 10 degrades. As a result, the antenna gain of the antenna 10 for vertically polarized electromagnetic waves is reduced.

[0027] Particularly, when the shortest distance x_1 is +0.2 or more and +0.8 or less, it is preferable from a viewpoint that a power feeding cable, wired along the upper frame edge 71a of the window frame from the left frame edge 71b side of the window frame 71, and connected directly or indirectly to the feeding portion 41, can be shortened. FIG. 1 is a diagram depicting a case where the shortest distance x_1 is +0.2 or more and +0.8 or less. When the shortest distance x_1 is zero or more and less than +0.2, because the length of the power feeding cable from the left frame edge 71b side to the feeding portion 41 becomes longer than necessary, a cost and a weight of the power feeding cable wired along the upper frame edge 71a from the left frame edge 71b increase.

[0028] Similarly, when the shortest distance x_1 is -0.8 or more and -0.2 or less, it is preferable from a viewpoint that a power feeding cable, wired along the upper frame edge 71a of the window frame from the right frame edge 71c side of the window frame 71, and connected directly or indirectly to the feeding portion 41, can be shortened. When the shortest distance x_1 exceeds -0.2 and is less than zero, because the length of the power feeding cable from the right frame edge 71c side to the feeding portion 41 becomes longer than necessary, a cost and a weight of the power feeding cable wired along the upper frame edge 71a from the right frame edge 71c increase.

[0029] Note that the power feeding cable connected directly or indirectly to the feeding portion 41 include, as a specific example, a coaxial cable or a feeder line.

[0030] In FIG. 1, a maximum length h_{10} of at least one vertical element extending in the vertical direction of the rear glass 100 is preferably 10 mm or more and 45 mm or less from a viewpoint that the antenna gain for vertically polarized electromagnetic waves can be enhanced. The maximum length h_{10} is more preferably 12 mm or more and 40 mm or less. When the maximum length h_{10} is less than 10 mm, it becomes difficult to secure the antenna gain for vertically polarized electromagnetic waves. When the maximum length h_{10} is greater than 45 mm, it is difficult to secure an arrangement region for the feeding portion 41. The same applies to the case where the antenna 10 is arranged in the light shielding region 64.

[0031] Moreover, the glass plate 60 may include at least one connection element connected to at least one of the pair of bus bars 31 and 32, in the light shielding region 63. In the embodiment, an example, where one linear connection element 51 extending from an upper part of the left bus bar 31 is arranged, and two linear connection elements 52 extending from an upper part of the right bus bar 32 are arranged, is depicted. Note that when the antenna 10 and the heater wire 33a are arranged with an interval such that the antenna 10 and the heater wire 33a can be capacitively coupled with each other (e.g. an interval of 30 mm), by including the connection element extending in the light shielding region 63, an impedance between the antenna 10 and the defogger 30 can be controlled.

[0032] Moreover, in order to control the impedance between the antenna 10 and the defogger 30, a reactance element 56 may be inserted between the connection element 51 and the left bus bar 31, and a reactance element 57 may be inserted between the connection element 52 and the right bus bar 32.

[0033] The connection element in the light shielding region 63 is, for example, in a state where the rear glass 100 is mounted to the window frame 71, located between the heater wire 33a and the upper frame edge 71a. Because the connection element in the light shielding region 63 and the heater wire 33a or the upper frame edge 71a are arranged at the interval with which the connection element and the heater wire 33a or the upper frame edge 71a can be capacitively coupled with each other, the impedance between the antenna 10 and the defogger 30 can be controlled by the connection element.

[0034] Note that a length of the interval with which the connection element and the heater wire or the upper-frame edge can be capacitively coupled with each other is, for example, 5 mm or more and 50 mm or less.

[0035] As described above, at least one connection element, such as the connection elements 51 and 52 extending from upper parts of the pair of bus bars 31 and 32, are provided. Thus, it becomes unnecessary to arrange at least one vertical line crossing the plurality of heater wires 33 in the vertical direction in order to control the impedance between the antenna 10 and the defogger 30. Thus, it becomes possible to avoid degradation in appearance due to vertical lines. Moreover, because the connection element is located in the light shielding region 63, it is possible to avoid degradation in appearance due to an exposure to the opening portion 62.

[0036] The vertically polarized electromagnetic waves that can be received by the antenna 10 include, as a specific example, electromagnetic waves of Band III (174 MHz to 240 MHz) under the DAB (Digital Audio Broadcast) standard. Moreover, the plurality of elements included in the antenna 10 can be formed so as to be suitable for transmitting/receiving vertically polarized electromagnetic waves used in a high-speed communication system. The high-speed communication system includes a telematics service in which information is transmit-

ted/received between a communication device mounted on a vehicle and an outside of the vehicle.

[0037] FIG. 2 is a planar view depicting an example of a configuration of the antenna 10. The antenna 10 illustrated in FIG. 2 is preferably used as a DAB antenna that receives vertically polarized electromagnetic waves under DAB standard. The antenna 10 has a relatively higher antenna gain in frequency bands of Band III (174 MHz to 240 MHz) and of L band (1452 MHz to 1492 MHz) under DAB standard.

[0038] The antenna 10 is a monopole type antenna provided with a feeding portion 41 as a feeding point. The feeding portion 41 is a conductor pattern having a predetermined shape of a rectangle or the like. To the feeding portion 41, one end of the power feeding cable is directly or indirectly connected. The other end of the power feeding cable is connected to a reception unit to which a signal according to electromagnetic waves received by the antenna 10 is input.

[0039] The antenna 10 has horizontal elements 11 to 14 and vertical elements 15 and 16. The horizontal elements 11 to 14 and the vertical elements 15 and 16 are a linear conductor pattern formed so as to receive vertically polarized electromagnetic waves under DAB standard.

[0040] The horizontal element 11 is an example of a first horizontal element. In the embodiment, the horizontal element 11 is a linear conductor extending in the horizontal direction of the rear glass 100. One end portion 11a of the horizontal element 11 is connected to the feeding portion 41. The horizontal element 11 has the one end portion 11a and the other end portion 11b, and extends in the X-axis direction between the one end portion 11a and the other end portion 11b.

[0041] The horizontal element 12 is an example of a second horizontal element. In the embodiment, the horizontal element 12 is a linear conductor extending in the horizontal direction of the rear glass 100. One end portion 12a of the horizontal element 12 is connected to the feeding portion 41. The horizontal element 12 has the one end portion 12a and the other end portion 12b, and extends in the X-axis direction between the one end portion 12a and the other end portion 12b.

[0042] The vertical element 15 is an example of a first vertical element. In the embodiment, the vertical element 15 is a linear conductor extending in the vertical direction of the rear glass 100. One end portion 15a of the vertical element 15 is connected to the feeding portion 41. The vertical element 15 has the one end portion 15a and the other end portion 15b, and extends in the Y-axis direction between the one end portion 15a and the other end portion 15b. Note that the end portion 15a may be connected to an intermediate portion of the horizontal element 11, i.e. at any position between the end portion 11a and the end portion 11b. Moreover, the end portion 15b may be connected to an intermediate portion of the horizontal element 13, which will be described later, i.e. at any position between an end portion 13a and an end portion

14b. Furthermore, the vertical element 15 preferably has a configuration of being connected to the horizontal element 11 without protruding (in the +Y-axis direction) from the horizontal element 11, because a capacitive coupling with the upper frame edge 71a is enhanced. Similarly, the vertical element 15 preferably has a configuration of being connected to the horizontal element 13 without protruding (in the -Y-axis direction) from the horizontal element 13, because the capacitive coupling with the heater wire 33 is enhanced.

[0043] The vertical element 16 is an example of a second vertical element. In the embodiment, the vertical element 16 is a linear conductor extending in the vertical direction of the rear glass 100, on a side where the vertical element 15 extends toward the horizontal element 12. One end portion 16a of the vertical element 16 is connected to the end portion 12b of the horizontal element 12. The vertical element 16 has the one end portion 16a and the other end portion 16b, and extends in the Y-axis direction between the one end portion 16a and the other end portion 16b. Note that the end portion 16a may be connected to an intermediate portion of the horizontal element 12, i.e. at any position between the end portion 12a and the end portion 12b. Moreover, the end portion 16b may be connected to an end portion 14b of the horizontal element 14, which will be described later. Furthermore, the vertical element 16 preferably has a configuration of being connected to the horizontal element 12 without protruding (in the +Y-axis direction) from the horizontal element 12, because a capacitive coupling with the upper frame edge 71a is enhanced. Similarly, the vertical element 16 preferably has a configuration of being connected to the horizontal element 14 without protruding (in the -Y-axis direction) from the horizontal element 14, because the capacitive coupling with the heater wire 33 is enhanced.

[0044] The horizontal element 13 is an example of a third horizontal element. In the embodiment, the horizontal element 13 is a linear conductor extending in the horizontal direction of the rear glass 100. One end portion 13a is connected to the end portion 15b of the vertical element 15. The horizontal element 13 has the one end portion 13a and the other end portion 13b, and extends in the X-axis direction between the one end portion 13a and the other end portion 13b.

[0045] The horizontal element 14 is an example of a fourth horizontal element. In the embodiment, the horizontal element 14 is a linear conductor extending in the horizontal direction of the rear glass 100. An intermediate portion of the horizontal element 14 is connected to the end portion 16b of the vertical element 16. The horizontal element 14 has the one end portion 14a and the other end portion 14b, and extends in the X-axis direction between the one end portion 14a and the other end portion 14b.

[0046] Moreover, the horizontal element 13 and the horizontal element 14 are located at a position where the horizontal elements 13 and 14 cannot be connected to

each other. In the embodiment, a gap is provided between the end portion 13a and the end portion 14a. The horizontal element 14 has a part that extends, in the horizontal direction of the rear glass 100, on the same side at which the horizontal element 13 extends with respect to the vertical element 16 (in the embodiment, a part between the end portion 16b and the end portion 14a).

[0047] Because the antenna 10 includes the horizontal elements 11 to 14 and the vertical elements 15 and 16, as described above, the antenna 10 has a relatively high antenna gain in the frequency bands of Band III and of L Band under the DAB standard.

[0048] From the viewpoint of enhancing the antenna gain in the frequency bands of Band III and of L Band under the DAB standard, as illustrated in FIG. 2, the horizontal element 12 is preferably longer than the horizontal element 11, and the horizontal element 14 is preferably longer than the horizontal element 13. Alternatively, from the viewpoint of enhancing the antenna gain in the frequency bands of Band III and of L Band under the DAB standard, the horizontal element 11 may be longer than the horizontal element 12, and the horizontal element 13 may be longer than the horizontal element 14.

[0049] Moreover, from the viewpoint of enhancing the antenna gain in the frequency bands of Band III and of L Band under the DAB standard, as illustrated in FIG. 2, the end portion 13a of the horizontal element 13 is preferably connected to the end portion 15b of the vertical element 15.

[0050] Moreover, from the viewpoint of enhancing the antenna gain in the frequency bands of Band III and of L Band under the DAB standard, as illustrated in FIG. 2, the end portion 16b of the vertical element 16 is preferably connected to a portion of the horizontal element 14 other than the end portions 14a and 14b (an intermediate portion between the end portion 14a and the end portion 14b).

[0051] Furthermore, from the viewpoint of enhancing the antenna gain in the frequency bands of Band III and of L Band under the DAB standard, as illustrated in FIG. 2, the vertical element 15 and the vertical element 16 preferably have the same length (e.g. 15 mm).

[0052] FIG. 3 is a diagram depicting an example of a result of measurement for antenna gains for the frequency band of Band III of 174 MHz to 240 MHz. FIG. 3 shows the antenna gain of the antenna 10 (See FIG. 2). Values in the vertical axis indicate average values of antenna gains which were measured for each prescribed angle in a horizontal plane within a half-circumferential range around the rear side of the vehicle. A value obtained by further averaging the average values measured at the respective frequencies, was -5.6 dBd. Thus, a high reception sensitivity (antenna gain) of the antenna 10 for the frequency band of Band III was realized.

[0053] FIG. 4 is a diagram depicting an example of a result of measurement for antenna gains for the frequency band of L Band of 1452 MHz to 1492 MHz. FIG. 4 shows the antenna gain of the antenna 10 (See FIG. 2).

Values in the vertical axis indicate average values of antenna gains which were measured for each prescribed angle in a horizontal plane within a half-circumferential range around the rear side of the vehicle. A value obtained by further averaging the average values measured at the respective frequencies, was -10.4 dBd. Thus, a high reception sensitivity (antenna gain) of the antenna 10 for the frequency band of L Band was realized.

[0054] Note that in the measurements illustrated in FIGS. 3 and 4, the respective dimensions of the antenna 10 were as follows:

Length of the horizontal element 11: 32 mm,
Length of the horizontal element 12: 80 mm,
Length of the horizontal element 13: 28 mm;
Length of the horizontal element 14: 93 mm;
Length of the vertical element 15: 15 mm;
Length of the vertical element 16: 15 mm;
Distance between the end portion 14a and the end portion 16b: 75 mm;
Distance between the end portion 16b and the end portion 14b: 18 mm; and
Distance between the end portion 13a and the end portion 14a: 32 mm.

[0055] As described above, the rear glass for vehicle with an antenna has been described using the embodiment. However, the present invention is not limited to the above-described specific embodiment. Various variations and modifications, such as combinations with a part or a whole of another embodiment or replacement, may be made without departing from the scope of the present invention.

[0056] For example, an "end portion" of an element may be a starting point or an end point of an extension of the element, or may be a starting point vicinity or an end point vicinity that is a conductor part in front of the starting point or the end point of the element. Moreover, in a connection portion of elements, the elements may be connected to each other, with a curvature.

[0057] Moreover, the bus bar, the antenna element, and the feeding portion are formed by printing a paste containing an electrically conductive metal (e.g. a silver paste) on a vehicle inner surface of a window glass and baking the paste. However, the formation method of the bus bar, the antenna element, and the feeding portion is not limited to this. For example, the bus bar, the antenna element, or the feeding portion may be formed by arranging a linear body or a foil type body containing a conductive material such as copper on a vehicle inner surface or a vehicle outer surface of the window glass. Alternatively, the bus bar, the antenna element or the feeding portion may be adhered onto the window glass via an adhesive agent, or may be arranged inside the window glass.

[0058] A shape of the feeding portion may be, for example, a polygonal shape such as a square, or a circular shape, such as a circle or an ellipse.

[0059] Moreover, a configuration in which a conductive layer forming at least any one of the bus bar, the antenna element and the feeding portion is arranged inside or on a surface of a synthetic resin film, and the synthetic resin film with the conductive layer is arranged on the vehicle inner surface or the vehicle outer surface of the window glass, may be employed. Furthermore, a configuration in which a flexible circuit substrate, on which an antenna element is formed, is arranged on the vehicle inner surface or the vehicle outer surface of the window glass may be employed.

[0060] The present application is based on and claims the benefit of priority of Japanese Priority Application No. 2017-207736 filed on October 27, 2017, the entire contents of which are hereby incorporated by reference.

REFERENCE SIGNS LIST

[0061]

10	antenna
11,12,13,14	horizontal element
15,16	vertical element
30	defogger
31	left bus bar
32	right bus bar
33	heater wire
41	feeding portion
51,52	connection element
60	glass plate
62	opening portion
63,64	light shielding region
65	center line
71	window frame
90	light shielding film
100	rear glass

Claims

1. A rear glass for vehicle with an antenna, comprising:

an opening portion; and
a light shielding film arranged around the opening portion,
wherein the light shielding film includes a belt-like light shielding region extending in a horizontal direction of the rear glass for vehicle,
wherein a width of the light shielding region in a vertical direction of the rear glass for vehicle is 20 mm or more and 50 mm or less, and
wherein an antenna including a plurality of elements formed so as to be able to receive vertically polarized electromagnetic waves is arranged in the light shielding region.

2. The rear glass for vehicle with an antenna according to claim 1,

wherein the antenna is arranged in the light shielding region above the opening portion.

3. The rear glass for vehicle with an antenna according to claim 1 or 2,
wherein the plurality of elements include at least one vertical element that extends in the vertical direction, and
wherein a maximum length of the at least one vertical element is 0.25 or more and 0.80 or less, with respect to the width of the light shielding region being taken as unity.

4. The rear glass for vehicle with an antenna according to any one of claims 1 to 3,
wherein when, with reference to a center line extending in the vertical direction of the rear glass, a shortest distance from the center line to a left film edge of the light shielding film is taken as +1, and a shortest distance from the center line to a right film edge of the light shielding film is taken as -1,
a shortest distance from the center line to the antenna is -0.8 or more and +0.8 or less.

5. The rear glass for vehicle with an antenna according to claim 4,
wherein the shortest distance from the center line to the antenna is +0.2 or more and +0.8 or less, or -0.8 or more and -0.2 or less.

6. The rear glass for vehicle with an antenna according to any one of claims 1 to 5,
wherein the plurality of elements include at least one vertical element extending in the vertical direction, and
wherein a maximum length of the vertical elements is 10 mm or more and 45 mm or less.

7. The rear glass for vehicle with an antenna according to any one of claims 1 to 6 further comprising:

a defogger including a plurality of heater wires arranged at an interval from the antenna, and a pair of bus bars for feeding power to the heater wires; and
at least one connection element arranged in the light shielding region and connected to at least one of the pair of bus bars.

8. The rear glass for vehicle with an antenna according to any one of claims 1 to 7,
wherein the antenna is a DAB (Digital Audio Broadcast) antenna.

9. The rear glass for vehicle with an antenna according to any one of claims 1 to 8,
wherein the antenna includes a feeding portion;

a first horizontal element extending in the horizontal direction, one end portion of the first horizontal element being connected to the feeding portion;
 a second horizontal element extending in the horizontal direction on an opposite side to a side, where the first horizontal element extends, with respect to the feeding portion, one end portion of the second horizontal element being connected to the feeding portion;
 a first vertical element extending in the vertical direction, one end portion of the first vertical element being connected to the feeding portion or the first horizontal element;
 a second vertical element extending in the vertical direction on a side, where the first vertical element extends, with respect to the second horizontal element, one end portion of the second vertical element being connected to the second horizontal element;
 a third horizontal element extending in the horizontal direction and being connected to the first vertical element; and
 a fourth horizontal element extending in the horizontal direction and being connected to the second vertical element,
 wherein the third horizontal element and the fourth horizontal element are located at positions where the third horizontal element and the fourth horizontal element are not connected to each other.

10. The rear glass for vehicle with an antenna according to claim 9,
 wherein the second horizontal element is longer than the first horizontal element, and the fourth horizontal element is longer than the third horizontal element, or the first horizontal element is longer than the second horizontal element, and the third horizontal element is longer than the fourth horizontal element.
11. The rear glass for vehicle with an antenna according to claim 9 or 10,
 wherein an end portion of the third horizontal element is connected to another end of the first vertical element.
12. The rear glass for vehicle with an antenna according to any one of claims 9 to 11,
 wherein another end portion of the second vertical element is connected to a portion of the fourth horizontal element other than end portions of the fourth horizontal element.
13. The rear glass for vehicle with an antenna according to any one of claims 9 to 12,
 wherein the first vertical element and the second vertical element have a same length.
14. The rear glass for vehicle with an antenna according to any one of claims 1 to 13,

wherein when a glass surface of the rear glass is viewed facing to the glass surface, in a state where the rear glass is mounted to a window frame, the antenna is located between a frame edge of the window frame and a film edge of the light shielding film.

FIG.1

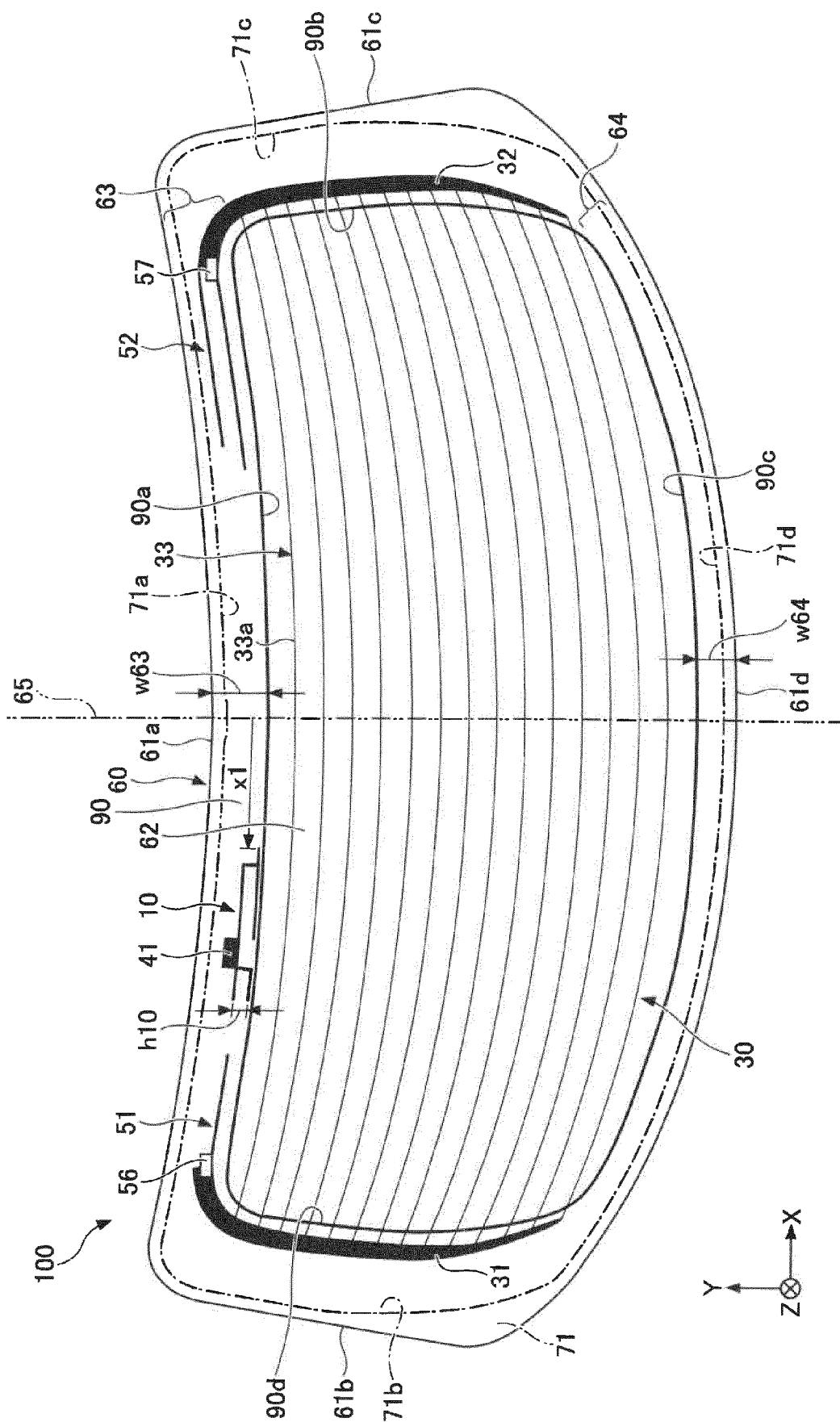


FIG.2

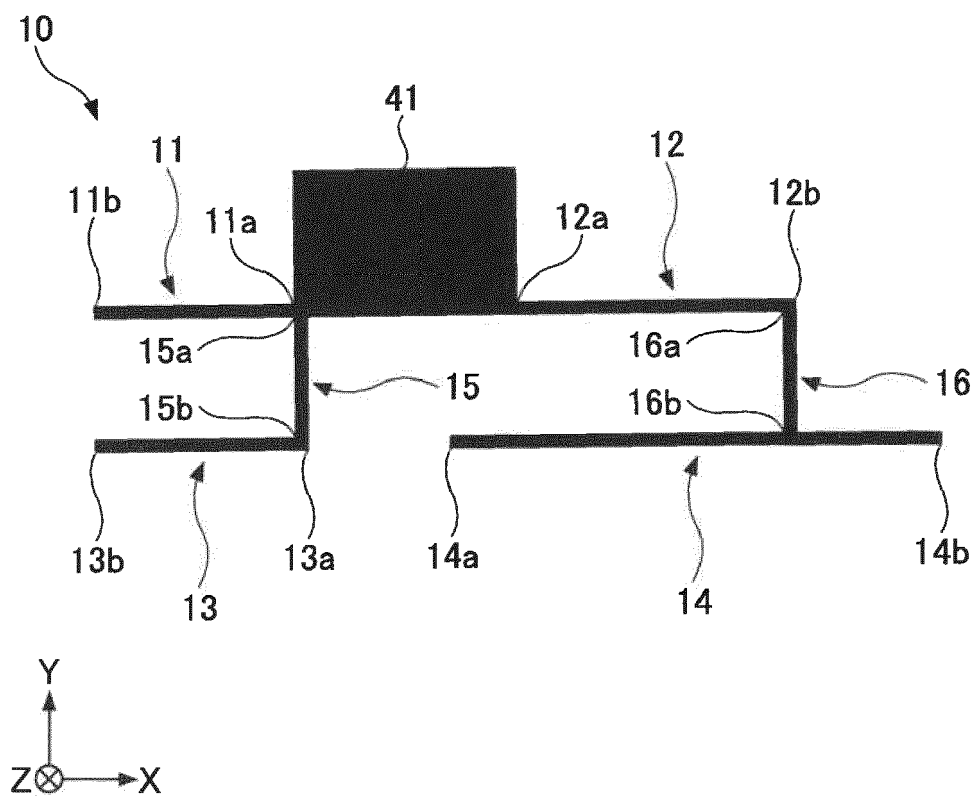


FIG.3

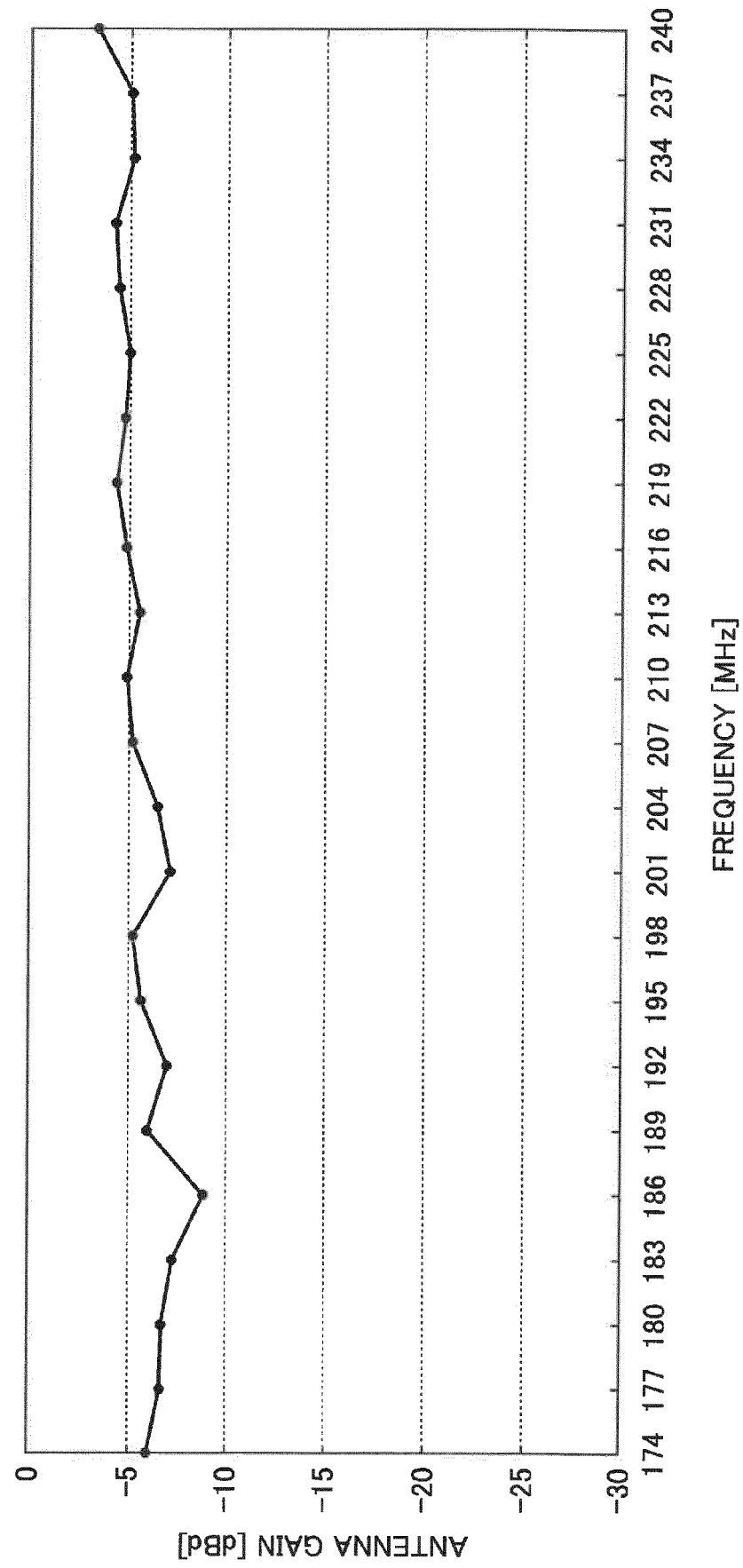


FIG.4

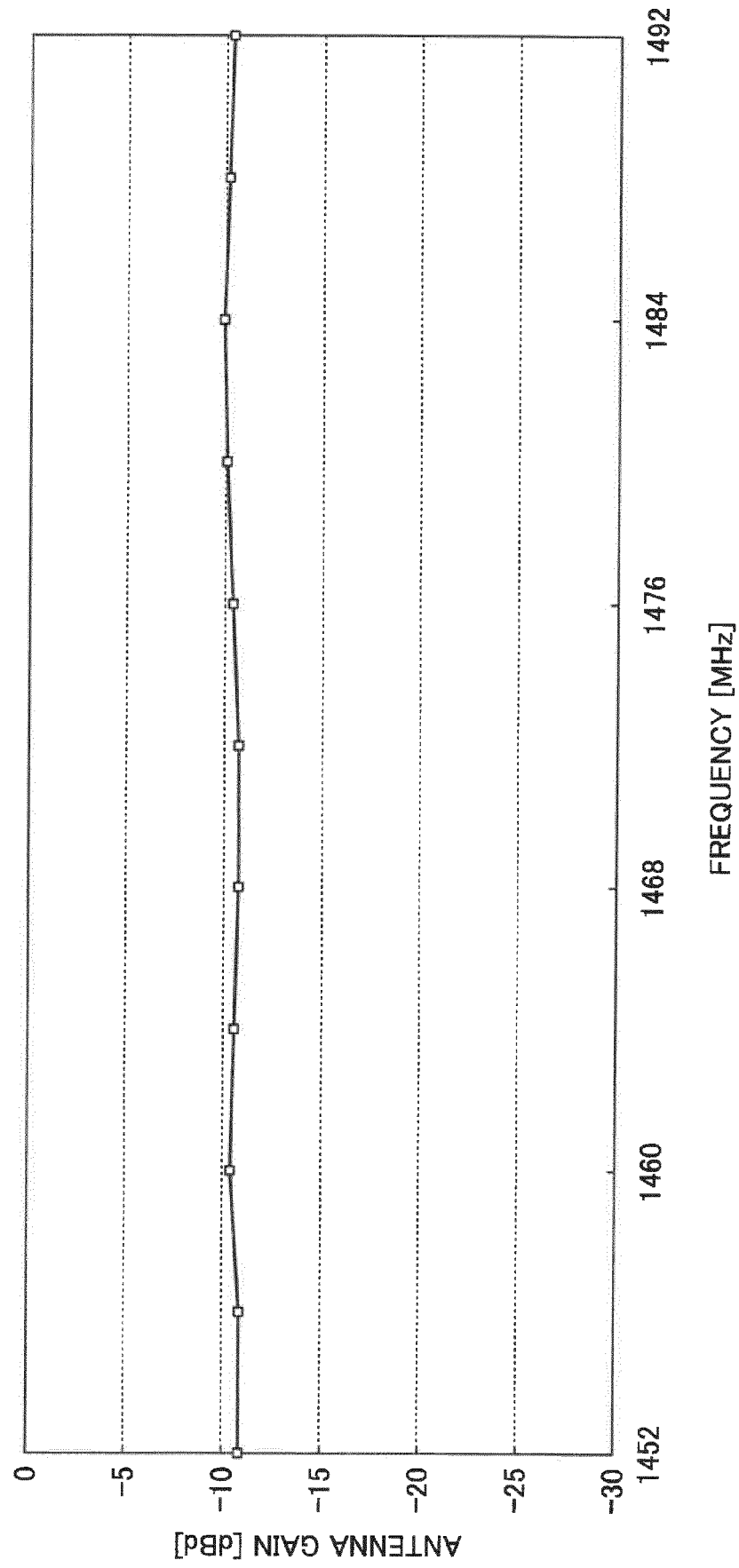
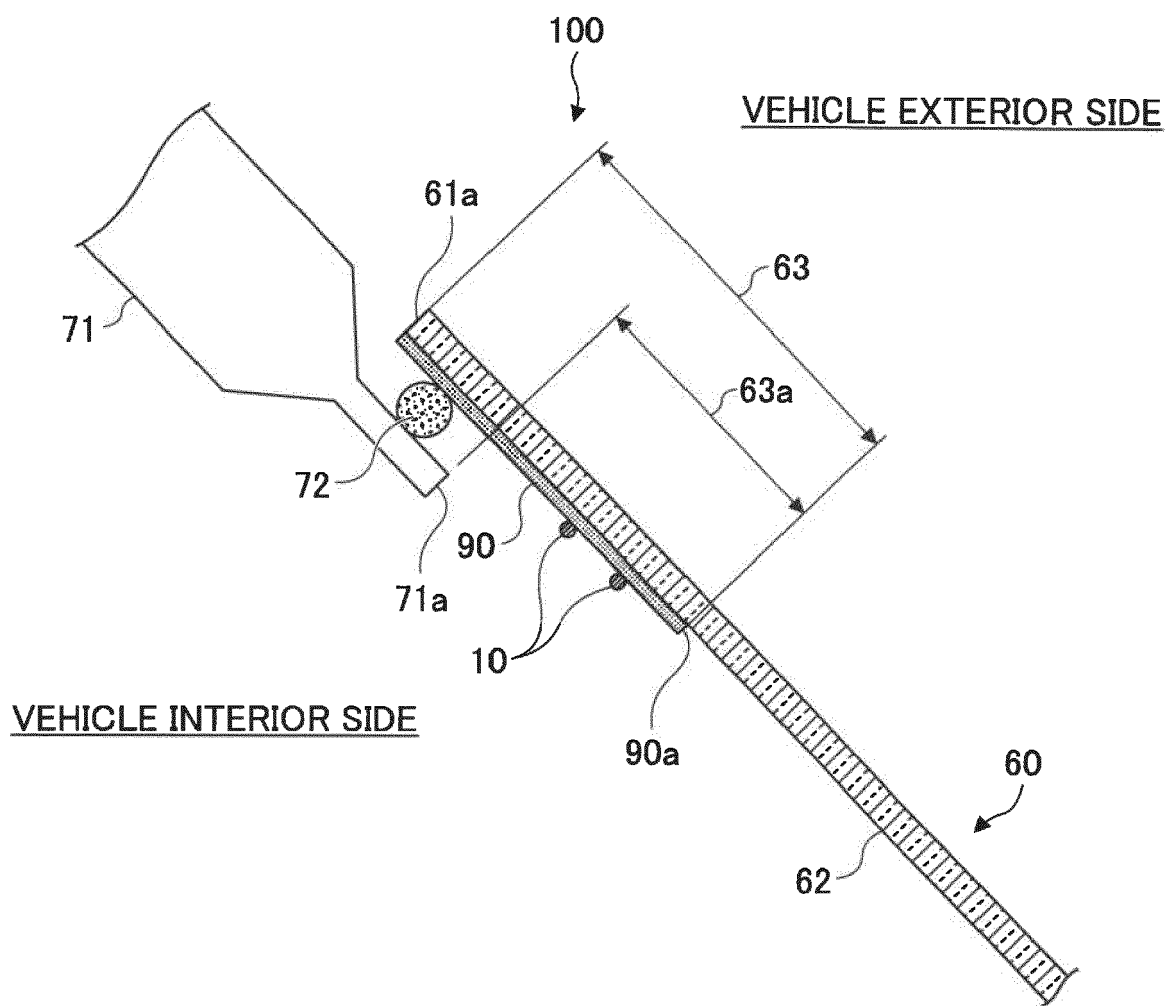


FIG.5





EUROPEAN SEARCH REPORT

 Application Number
 EP 18 20 2181

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Place of search The Hague		Date of completion of the search 22 March 2019	Examiner Wattiaux, Véronique
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