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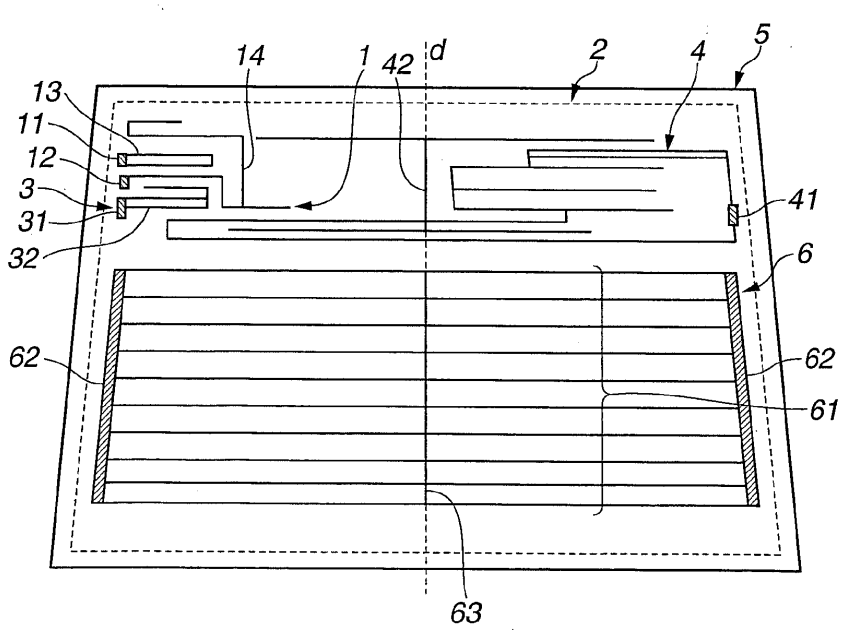
(54) Vehicular glass antenna

(57) A vehicular glass antenna disposed on a window glass of an automotive vehicle and which comprises: a core wire side feed point (11); an earth side feed point (12) which is separate from the core wire side feed point (11); a core wire side antenna element (13) connected to the core wire side feed point (11) and extended in a direction far away from the core wire side feed point (11); and a loop shaped strip (141) connected to the earth side feed point (12), the loop shaped strip (141) being extended in the direction far away from the core wire side feed point (11) and the earth side feed point (12) and bent to enclose the core wire side antenna element (13) and a tip section of the loop shaped strip (141) providing an opening end.

FIG.11



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Description

BACKGROUND OF THE INVENTION

(1) **Field of the Invention**

[0001] The present invention relates to a vehicular glass antenna mounted on a window glass of an automotive (vehicle) and which is capable of receiving appropriately an electric wave of a terrestrial digital radio broadcasting, viz., DAB (DAB: Digital Audio Broadcasting).

(2) **Description of related art**

[0002] Recently, in a radio broadcasting, digital radios having various types of digital modulation systems of low noise and high quality as compared with those having conventional analog modulation systems have been developed. In each country of the world, digital radio broadcastings of various types of broadcasting standards have been put into practice. The various types of broadcasting standards include DAB (Digital Audio Broadcasting), DRM (Digital Radio Mondiale), DMB (Digital Multimedia Broadcasting), ISDB (Integrated Services Digital Broadcasting), and so forth.

[0003] From among these various types of digital radio broadcasting standards, a standard which has almost been used in each country of the world is DAB standard. A first frequency bandwidth of DAB standard is a band III having a frequency bandwidth of 174 through 240MHz and a second frequency bandwidth of DAB standard is an L band of DAB standard having the frequency bandwidth of 1452 through 1492 MHz. These separate frequency bandwidths have been used.

[0004] The frequency bandwidth of band III of DAB standard is wide. Hence, it is necessary for the vehicular glass antenna which receives this electric wave to be able to receive the electric wave with an equally high sensitivity at a desired wide frequency bandwidth. A Japanese Patent Application First Publication (tokkai) No. 2005-2291140 published on August 25, 2005 exemplifies a first previously proposed vehicular glass antenna which is capable of receiving the electric wave at a wide frequency bandwidth. The previously proposed vehicular glass antenna described in the above-described Japanese Patent Application First Publication includes: a first antenna element connected to a first feed point; and a second antenna element connected to a second feed point and which constitutes a closed loop enclosing the first antenna element.

[0005] In addition, another Japanese Patent Application First Publication (tokkai) No. 2012-029032 published on February 9, 2012 exemplifies a second previously proposed vehicular glass antenna. The second previously proposed vehicular glass antenna includes: a hot side antenna element connected to a hot side feed point; an earth side feed point mounted so as to be separate from the hot side feed point; and earth side first antenna element and earth side second antenna element extended in the mutually opposite directions from the earth side feed point, the earth side first antenna element and the earth side antenna second element being disposed so as to enclose the hot side antenna element from both of the left and right sides, and respective tip sections of the earth side first antenna element and the earth side second antenna element being mutually placed in proximity to each other and being overlapped on each other and a capacitive coupling being carried out between the earth side first and second antenna elements.

SUMMARY OF THE INVENTION

[0006] The second antenna element in the first previously proposed vehicular glass antenna is structured in the closed loop shape. In a case where this vehicular glass antenna is applied to a window glass of the vehicle having various forms, large difficulties are involved in an antenna tuning of adjusting a length and a form of each antenna element to obtain a desired antenna sensitivity at a desired bandwidth.

[0007] On the other hand, in the second previously proposed vehicular glass antenna, the respective tip sections of the earth side first element and the earth side second element are overlapped on each other so that their lengths and an interval of overlapped sections can be adjusted. Hence, as compared with the first previously proposed vehicular glass antenna, in a case where the second previously proposed vehicular glass antenna is applied to the window glass of the vehicle having various shapes, the adjustment to obtain the desired antenna sensitivity at the desired frequency bandwidth becomes facilitated. However, large difficulties are involved in finding an optimum antenna pattern when overlapped lengths of the respective tip sections of the earth side first antenna element and the earth side second antenna element and an arrangement of these respective antenna elements are adjusted.

[0008] It is, therefore, an object of the present invention to provide a vehicular glass antenna which can solve the above-described problems, namely, which is capable of appropriately receiving the electric wave of band III of DAB over a whole frequency bandwidth of band III of DAB, whose antenna configuration is simple, and which is easy in adjustments to obtain a desired antenna sensitivity in band III of DAB when applied to various vehicular window glasses.

[0009] According to the present invention, there is provided a vehicular glass antenna disposed on a window glass of an automotive vehicle, comprising: a core wire side feed point; an earth side feed point which is separate from the core wire side feed point; a core wire side antenna element connected to the core wire side feed point and extended in a direction far away from the core wire side feed point; and a loop shaped strip connected to the earth side feed point, the loop shaped strip being extended in the direction far away from the core wire side feed

point and the earth side feed point and bent to enclose the core wire side antenna element and a tip section of the loop shaped strip providing an opening end.

[0010] In the vehicular glass antenna according to the present invention, the tip section of the loop shaped strip provides the opening end, as described above. Thus, the antenna tuning of adjusting the length of the loop shaped strip and/or adjusting the shape of the loop shaped strip to obtain the desired antenna sensitivity at the desired frequency bandwidth becomes easy when the vehicular antenna according to the present invention is applied to various types of the vehicle.

[0011] In addition, in the vehicular glass antenna according to the present invention, when the vehicular glass antenna according to the present invention is attached to a vehicle body, the vehicular glass antenna may be disposed on the window glass in order for a part of the loop shaped strip to be placed in the proximity of an end edge of a body flange of the vehicle body.

[0012] In the vehicular glass antenna according to the present invention, a part of the loop shaped strip is placed in proximity of the end edge of the body flange to achieve a capacitive coupling between the loop shaped strip and the end edge of the body flange so that it becomes easy for the vehicular glass antenna according to the present invention to obtain the desired antenna sensitivity at the desired frequency bandwidth.

[0013] Furthermore, in the vehicular glass antenna according to the present invention, the tip section of the loop shaped strip can be folded back.

[0014] In the vehicular glass antenna according to the present invention, by folding the tip section of the loop shaped strip as described above, an area enclosed by the loop shaped strip can be made small while maintaining the length of the loop shaped strip in order to obtain the desired antenna sensitivity at the desired frequency bandwidth. In addition, in the vehicular glass antenna shown in Fig. 5, the tip section of the loop shaped strip folded back toward an upper side of the end edge of the body flange is placed in proximity of the end edge of the body flange so that adjustments of a length of the tip section of the loop shaped strip and an interval between the tip section and the upper side of the end edge of the body flange become easy. Hence, the antenna tuning of the vehicular glass antenna according to the present invention to obtain the desired antenna sensitivity at the desired frequency bandwidth becomes easier.

[0015] In addition, in the vehicular glass antenna according to the present invention, an auxiliary antenna element may be connected to the loop shaped strip or the auxiliary antenna element may be disposed so as to be placed in the proximity of the loop shaped strip at an outside of the loop shaped strip to achieve the capacitive coupling between the auxiliary antenna element and the loop shaped strip. By providing such an auxiliary antenna element as described above, an input impedance of the vehicular glass antenna according to the present invention is adjusted. Hence, the adjustment for obtaining the desired antenna sensitivity at the desired frequency bandwidth becomes easy.

[0016] In the vehicular glass antenna according to the present invention, a whole length of the loop shaped antenna may be set to $0.7\ \alpha\ \lambda$ (α: a shortening coefficient of wavelength in a glass plate and λ : a center frequency in a desired frequency bandwidth). By setting the length of the loop shaped strip as described above, the desired antenna sensitivity at the desired bandwidth can be obtained.

[0017] In the vehicular glass antenna according to the present invention, the tip section of the loop shaped strip provides the opening end. Hence, when the vehicular glass antenna is applied to various types of the vehicle, the antenna tuning of adjusting the length of the loop shaped strip and adjusting the shape of the loop shaped strip to obtain the desired antenna sensitivity at the desired frequency bandwidth can be facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a front elevation view of a vehicular glass antenna related to a first preferred embodiment as viewed from an inside of a vehicle.

Fig. 2 is a front elevation view of the vehicular glass antenna related to a second preferred embodiment as viewed from the inside of the vehicle.

Fig. 3 is a front elevation view of the vehicular glass antenna related to a third preferred embodiment as viewed from the inside of the vehicle.

Fig. 4 is a front elevation view of the vehicular glass antenna related to a fourth preferred embodiment as viewed from the inside of the vehicle.

Fig. 5 is a front elevation view of the vehicular glass antenna related to a fifth preferred embodiment as viewed from the inside of the vehicle.

Fig. 6 is a front elevation view of the vehicular glass antenna related to a sixth preferred embodiment as viewed from the inside of the vehicle.

Fig. 7 is a front elevation view of the vehicular glass antenna related to a seventh preferred embodiment as viewed from the inside of the vehicle.

Fig. 8 is a front elevation view of the vehicular glass antenna related to an eighth preferred embodiment as viewed from the inside of the vehicle.

Fig. 9 is a front elevation view of the vehicular glass antenna related to a ninth preferred embodiment as viewed from the inside of the vehicle.

Fig. 10 is a front elevation view of the vehicular glass antenna related to a tenth preferred embodiment as viewed from the inside of the vehicle.

Fig. 11 is a front elevation view of a whole rear glass as viewed from the inside of the vehicle when the vehicular glass antenna related to the tenth preferred embodiment is attached onto a (blank) space section of an upper part of a defogger of a rear glass of the

vehicle.

Fig. 12 is a graph representing a result of measurement of an antenna sensitivity in band III of DAB when the vehicular glass antenna related to the tenth embodiment is attached onto the blank space section of the upper part of the defogger of the rear glass.

Fig. 13 is a front elevation view of a whole front glass as viewed from the inside of the vehicle when the vehicular glass antenna related to the second embodiment is attached to an upper side of a front glass of the vehicle.

Fig. 14 is a front elevation view of a whole side glass as viewed from the inside of the vehicle when a vehicular glass antenna related to the first embodiment is attached to the side glass of the vehicle.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Hereinafter, a structure of the vehicular glass antenna of the preferred embodiments according to the present invention will be described. It should be noted that terms of upper and lower and left and right are used for the accompanied drawings and they are not prescribe a direction of actual products (articles).

[First embodiment]

[0020] Fig. 1 shows a front elevation view of the antenna related to a first preferred embodiment according to the present invention as viewed from an inside of a vehicle (automotive vehicle).

[0021] The vehicular glass antenna in the first embodiment includes: a core wire side feed point 11 and an earth side feed point 12. Earth side feed point 12 is disposed at a lower position of core wire side feed point 11 with a blank space from core wire side feed point 11 provided.

[0022] One end of a horizontal strip 131 constituting a core wire side antenna element 13 is connected to core wire side feed point 11 and horizontal strip 131 is extended toward a direction away from core wire side feed point 11. In addition, one end of a loop shaped strip 141 constituting an earth side antenna element 14 is connected to earth side feed point 12. The other end of loop shaped strip 141 is disposed to enclose horizontal strip 131 in a rectangular shape to provide an opening end.

[0023] In the vehicular glass antenna in the first embodiment is, as described above, a tip (section) of loop shaped strip 141 is formed to be the opening end. Thus, an antenna tuning such that a length of loop shaped strip 141 is adjusted or a shape thereof is adjusted can become facilitated to obtain a desired sensitivity at a desired frequency bandwidth when the vehicular antenna according to the present invention is applied to various types of vehicles.

[Second embodiment]

[0024] Fig. 2 shows a front elevation view of the vehicular glass antenna related to the second embodiment according to the present invention as viewed from the inside of the vehicle. A difference point of the second embodiment from the first embodiment is that the opening end of loop shaped strip 141 is formed with a proximity section 14a to a body flange of the vehicle so that the opening end of loop shaped strip 141 comes close to an end edge 2 of the body flange and a capacitive coupling is formed between the vehicular antenna (loop shaped strip 141) and the body flange (end edge 2 of the body flange).

[0025] As described above, in the vehicular antenna in the second embodiment, proximity section 14a to the body flange is formed so that the desired sensitivity of the antenna at the desired frequency bandwidth can easily be obtained.

[Third embodiment]

[0026] Fig. 3 shows a front elevation view of the vehicular glass antenna related to a third preferred embodiment according to the present invention as viewed from the inside of the vehicle.

[0027] The difference point of the vehicular glass antenna in the third embodiment from that of the second embodiment is that earth side feed point 12 is spaced apart from core wire side feed point 11 at an upper side of core wire side feed point 11, proximity section 14a to the body flange is formed at the other end section of loop shaped strip 141 to which earth side feed point 12 is connected and is close to end edge 2 of the body flange and the capacitive coupling is formed between proximity section 14a and end edge 2 of the body flange. Even in the above-described structure, by forming proximity section 14a to the body flange, the desired sensitivity can easily be obtained at the desired frequency bandwidth.

[Fourth embodiment]

[0028] Fig. 4 shows the vehicular glass antenna related to a fourth embodiment according to the present invention as viewed from the inside of the vehicle.

[0029] The difference point of the vehicular antenna in the fourth embodiment from that of the second embodiment is that core wire side feed point 11 and earth side feed point 12 are laterally spaced apart from each other and core wire side antenna element 13 is constituted by letter L shaped strip, this letter L shaped strip being constituted by; a vertical strip 132 whose one end is connected to core wire side feed point 11 and which is extended toward a lower direction; and horizontal strip 131 which is connected to a lower end of vertical strip 132 and extended toward a rightward direction. The vehicular glass antenna, even in the fourth embodiment, can easily obtain the desired sensitivity of the antenna at the desired

frequency bandwidth even in such a structure as described above.

[Fifth embodiment]

[0030] Fig. 5 shows a front elevation view of the vehicular glass antenna related to a fifth preferred embodiment according to the present invention as viewed from the inside of the vehicle.

[0031] The difference point of the vehicular antenna in the fifth embodiment from that in the second embodiment is that a tip section of loop shaped strip 141 is folded back toward an upper part of loop shaped strip 141 to form a folded back section 141a in the loop shaped strip, the tip section of folded back section 141a is placed in proximity of end edge 2 of the body flange to form proximity section 14a and the capacitive coupling is formed between proximity section 14a and end edge 2 of the body flange.

[0032] The vehicular antenna in the fifth embodiment according to the present invention can, as described above, reduce an area enclosed by loop shaped strip 141 while maintaining a length of the loop shaped strip so as to obtain the desired sensitivity of the antenna at the desired frequency bandwidth by folding the tip section of loop shaped strip 141.

In addition, since the tip section of folded back section 141a of the loop shaped strip is placed in proximity of end edge 2 of the body flange of the vehicle to form proximity section 14a to the body flange so that the adjustment of the length of proximity section 14a to the body flange and the adjustment of an interval of proximity section 14a from end edge 2 of the body flange becomes facilitated. Consequently, the antenna tuning to obtain the desired sensitivity of the antenna at the desired frequency bandwidth can become easier.

[Sixth embodiment]

[0033] Fig. 6 shows a front elevation view of the vehicular antenna in a sixth preferred embodiment according to the present invention as viewed from the inside of the vehicle. The difference of the vehicular antenna in the sixth embodiment from that in the second embodiment is that core wire side antenna element 13 has two horizontal strips 131 whose one ends are connected to core wire side feed point 11 and extended in the same direction. The lengths of the two horizontal strips may have the same length or may be different from each other to obtain the desired sensitivity of the antenna at the desired frequency bandwidth.

[0034] In addition, in a case where core wire side antenna element 13 is constituted by a plurality of strips, the positional relationship of their respective strips may not limited to the configuration of the fourth embodiment such that mutual ends of horizontal strip 131 and vertical strip 132 are connected together or to the configuration of the sixth embodiment such that the respective ends of the plurality of strips are connected to the core wire side feed point and extended in the same direction.

For example, in a case where the core wire side antenna element is constituted by the two strips, one end of one of the two strips may be connected to core wire side feed point 11 and one end of the other of the two strips may be connected to a midway section of the one strip to which core wire side feed point 11 is connected.

[Seventh embodiment]

[0035] Fig. 7 is a front elevation view of the vehicular glass antenna related to a seventh embodiment according to the present invention as viewed from the inside of the vehicle.

[0036] The difference point of the vehicular antenna in the seventh embodiment from that in the second embodiment is that the shape of loop shaped strip 141 is not the rectangular.

[0037] The vehicular glass antenna according to the present invention may not only the rectangular but at least core wire side strip 141 may be enclosed by loop shaped strip 141. The shape of loop shaped strip 141 does not matter.

[Eighth embodiment]

[0038] Fig. 8 shows a front elevation view of the vehicular glass antenna related to an eighth preferred embodiment according to the present invention as viewed from the inside of the vehicle.

[0039] The difference point of the vehicular glass antenna in the eighth embodiment from that in the seventh embodiment is that one end of an auxiliary strip 142 as an auxiliary antenna element is connected to loop shaped strip 141. In this way, by connecting auxiliary strip 142 to loop shaped strip 141, an input impedance of the vehicular glass antenna according to the present invention can be adjusted to meet a characteristic impedance of a coaxial cable connected to the vehicular glass antenna according to the present invention. Thus, auxiliary strip 142 can serve to obtain the desired sensitivity of the antenna at the desired frequency bandwidth.

[Ninth embodiment]

[0040] Fig. 9 shows a front elevation view of the vehicular glass antenna related to a ninth preferred embodiment according to the present invention as viewed from the inside of the vehicle.

[0041] The difference point of the vehicular glass antenna in the ninth embodiment from that in the eighth embodiment is that the auxiliary strip is a non-feed strip 15, non-feed strip 15 is placed in proximity of loop shaped strip 141, a proximity section 14b to this auxiliary antenna element is formed on loop shaped strip 141, and loop shaped strip 141 is placed in proximity of non-feed strip 15 at proximity section 14b to the non-feed strip and the capacitive coupling between loop shaped strip 141 and

non-feed strip 15 is made. Even in a case where the auxiliary antenna element is constituted by non-feed strip 15, the auxiliary antenna element can help of obtaining the desired antenna sensitivity at the desired frequency bandwidth.

[Tenth embodiment]

[0042] Fig. 10 shows a front elevation view of the vehicular glass antenna related to a tenth preferred embodiment according to the present invention as viewed from the inside of the vehicle.

[0043] The difference point of the vehicular glass antenna in the tenth embodiment from that in the eighth embodiment is that the tip section of loop shaped strip 141 is folded back and, as the auxiliary antenna element, in addition to auxiliary strip 142, an antenna element 32 constituting an FM (Frequency Modulation) second antenna is used.

[0044] In addition, loop shaped strip 141 is placed in proximity of a part of the element of FM second antenna 32 and a proximity section 14c to the FM second antenna is formed and capacitive coupling between loop shaped strip 141 and FM second antenna is formed. It should be noted that a connection strip 133 to connect between upper horizontal strip 131 and lower horizontal strip 131 is disposed in core wire side antenna element 13. Even in a case where, as the auxiliary antenna element, the antenna element constituting another purpose antenna from the vehicular glass antenna is used, this auxiliary antenna element can help of obtaining the desired sensitivity of the antenna at the desired frequency bandwidth.

[Connection of the vehicular glass antenna according to the present invention to a receiver]

[0045] In the vehicular glass antenna according to the present invention, a coaxial cable is used as a feeder line to transmit a signal received by the vehicular glass antenna to a receiver. A feed terminal is connected to a tip of the coaxial cable (not shown) and is soldered to core wire side feed point 11 of the vehicular glass antenna according to the present invention and to earth side feed point 12 according to the present invention. The core wire side of the feed terminal is connected to a core wire of the coaxial cable and a ground side of the feed terminal is connected to an outer sheath conductor of the coaxial cable.

[Method of forming the vehicular glass antenna according to the present invention]

[0046] The vehicular glass antenna according to the present invention can use a generally available conductive ceramic paste which is the same as forming the defogger of the rear glass, can be printed in the same method as the defogger, and can be baked through a heat furnace.

[Example 1]

[0047] Vehicular glass antenna 1 in the tenth embodiment shown in Fig. 10 was disposed on a blank space section formed between an FM first antenna 4 at an upper part of defogger 6 of a rear glass 5 and an FM second antenna 3, as shown in Fig. 11. Furthermore, a dimension and a positional relationship of each antenna constituent and a positional relationship thereof to FM second antenna 3 were adjusted for the vehicular glass antenna to be favorable in the frequency bandwidth of DAB band III of 174 through 240 MHz.

[0048] Then, rear glass 5 shown in Fig. 11 was attached onto the vehicle and a measurement of an antenna performance of vehicular antenna 1 in the tenth embodiment at the frequency bandwidth of band III of DAB in the tenth embodiment was carried out.

[Positional relationship of each antenna on the rear glass]

[0049] Fig. 11 shows rear glass 5 as viewed from the inside of the vehicle. Defogger 6, FM first antenna 4, FM second antenna 3, and vehicular glass antenna 1 according to the present invention which was adjusted for receiving band III of DAB were disposed on rear glass 5.

[0050] A pair of bus bars 62 were disposed on both ends of rear glass 5 along left and right ends of rear glass 5 and a plurality of heating strips 61 were disposed in a horizontal direction, and both ends of heating strips 61 were connected to bus bars 62, in the case of defogger 6. An orthogonal strip 63 was disposed from an uppermost heating strip 61 to a lowermost heating strip 61 along a center line **d** of leftward and rightward (horizontal) directions of rear glass 5. Orthogonal strip 63 was connected to all heating strips 61 which were overlapped on one another.

[0051] FM first antenna 4 was disposed on an upper part of defogger 6 of rear glass 5. FM first antenna 4 has feed point 41 of FM first antenna disposed at the right side end section of rear glass 5 at the upper part of defogger 6. An antenna element 42 of FM first antenna was extended from feed point 41 of FM first antenna 4 so that a blank space section was formed at a left side of the upper part of defogger 6 of rear glass 5.

[0052] FM second antenna 3 was disposed at a blank space section at the upper part of left side of defogger 6 of rear glass 5 in which no element 42 of FM first antenna was disposed. FM second antenna 3 has feed point 31 thereof disposed at a right side section of rear glass 5 at the upper part of defogger 6. Antenna element 32 of FM second antenna 3 was extended from feed point 31 of FM second antenna 3.

[0053] One end of a strip constituting antenna element 32 of FM second antenna 3 was connected to feed point 31 of FM second antenna 3, this strip being extended in the rightward direction of rear glass 5, being folded back at a middle point of the extended strip, and being formed as a folded back section 3c.

Furthermore, antenna element 32 of FM second antenna 3 was constituted by double strips in which one strip was extended from feed point 31 of FM second antenna 3 toward folded back section 3c of the above-described strip so as to be parallel to the above-described strip.

[0054] Vehicular glass antenna 1 according to the present invention was disposed at the blank space section on which antenna element 42 of FM first antenna 4 is not disposed at the left side of the upper part of defogger 6 of rear glass 5 and at the upper part of FM second antenna 3.

[0055] In vehicular glass antenna 1 according to the present invention, core wire side feed point 11 and earth side feed point 12 were disposed so as to be spaced apart from each other in the vertical direction along a left side section of rear glass 5. Core wire side feed point 11 was disposed at a more upper part than earth side feed point 12.

[0056] One end of loop shaped strip 141 constituting earth side antenna element 14 was connected to earth side feed point 12 and a lower side of this strip 141 was extended toward the right side of rear glass 5. Loop shaped strip 141 is placed in proximity of folded back section 3c of the strip constituting antenna element 32 of FM second antenna 3 and a proximity section 14c between loop shaped strip 141 described above and FM second antenna 3 was formed and the capacitive coupling between proximity section 14c and FM second antenna 3 was carried out.

In such a configuration as described above, in order for the lower part of loop shaped strip 141 to be placed in the proximity of the folded back section (3c) of the strip constituting antenna element 32 at a constant interval, the lower part of loop shaped strip extended from earth side feed point 12 was extended toward the rightward direction and, thereafter, once bent toward the lower side, and, thereafter, was folded back in the upper direction.

[0057] In addition, one end of auxiliary strip 142 of the earth side antenna element was connected to a bending point located at a lower part of loop shaped strip 141 and from which the loop shaped strip was folded back toward the upper direction and auxiliary strip 142 was extended in the horizontal (rightward) direction. Furthermore, folded back section 141a of loop shaped strip 141 was placed in the proximity of end edge 2 of the body flange when rear glass 5 was attached to the vehicle.

[Dimensions of the vehicular glass antenna according to the present invention and the FM second antenna and interval between respective antennae]

[0058] Dimensions are hereinbelow described using symbols shown in Fig. 10.

[Dimension of the vehicular glass antenna according to the present invention]

[0059]

Dimensions of core wire side feed point and earth side feed point = 10mm x 10mm
An interval 1k between core wire side feed point 11 and earth side feed point 12 = 30mm
A length 1a of horizontal strip 131 of core wire side antenna element = 110mm
An interval 1b between horizontal strips 131 of the two core wire side antenna elements = 15mm
A whole length of loop shaped strip 141 = 670mm A length of a part 1c of loop shaped strip 141 = 175mm
A length of a part 1d of loop shaped strip 141 = 40mm
A length of a part 1e of loop shaped strip 141 = 45mm
A length of a part 1f of loop shaped strip 141 = 115mm
A length of a part 1g of loop shaped strip 141 = 220mm
A whole length of folded back section 141a of the loop shaped strip 141a = 75mm
A length of a part 1h of folded back section 141a of the loop shaped strip = 15mm
A length of a part 1i of folded back section 141a of the loop shaped strip = 60mm
A length of auxiliary strip 142 of the earth side element = 110mm
A length of proximity section 14a between the loop shaped element and the end edge of the body flange = 60mm
A length of proximity section 14c between the loop shaped element and the FM second antenna 3 = 205mm
A whole length of loop shaped strip 141 can be expressed as about 0.7 α λ when a wavelength of a center frequency (207MHz) of the frequency bandwidth of band III of DAB is λ and a shortening coefficient α of wavelength of a glass (plate) on which the vehicular glass antenna according to the present invention is disposed is α =0.7.

[Dimension of FM second antenna]

[0060]

A length of a part 3a of FM second antenna = 170mm
A length of a part 3b of FM second antenna = 25mm
A length of a part 3c of FM second antenna = 160mm
A length of a part 3d of FM second antenna = 10mm

[Intervals among the vehicular glass antenna according to the present invention, the FM second antenna, and the end edge of the body flange]

[0061]

An interval **a** between end edge 2 of the flange and folded back section 14a = 5mm
An interval **b** between a lower horizontal section of loop shaped strip 141 and folded back section 3c of FM second antenna 3 = 5mm
An interval **c** between a bending section of loop

shaped strip 141 toward the lower section lower side and folded back section 3c of FM second antenna 3= 5mm

An interval **d** between earth side feed point 12 and feed point 31 of FM second antenna 3 = 20mm

[Method for forming the respective antennae]

[0062] A generally available conductive ceramic paste can be used for forming vehicular glass antenna 1 according to the present invention, FM second antenna 3, and FM first antenna 4 in the same way as the formation of the defogger of the rear glass of the vehicle. These antennae were printed in the same method as the defogger and baked by means of the heating furnace. In addition, a width of each strip constituting all of the antennae was 3mm.

[Method for connecting each antenna to the receiver]

[Method for connecting FM first antenna and FM second antenna to the receiver]

[0063] FM first antenna 4 was connected to an amplifier (not shown) installed on a vehicle body in proximity of feed point 41 of FM first antenna via an AV (Low-voltage cables for Automobile and Vinyl) cable and a coaxial cable extended from a receiver was connected to the amplifier. An outer sheath side of the coaxial cable is grounded to the vehicle body via the amplifier. In addition, FM second antenna 3 was not connected to the amplifier. Therefore, for FM second antenna 3, a coaxial cable was connected from the receiver (not shown) to a ground point (not shown) placed on the vehicle body placed in proximity of feed point 31 of FM second antenna 31, the outer sheath side of the coaxial cable was grounded, a core wire side of the coaxial cable was connected to the AV cable (not shown) and was connected to feed point 31 of FM second antenna.

[Connection method of the vehicular glass antenna according to the present invention to the receiver]

[0064] The coaxial cable was used as the feed (or feeder) line to transmit the signal received by the antenna to the receiver in vehicular glass antenna 1. One tip of the coaxial cable was connected to a feed terminal (not shown) and an earth side of the feed terminal was connected to earth side feed point 12 and a hot side (core wire side) of the feed terminal was connected to a hot side (core wire side) feed point 11.

[0065] The feed terminal and each feed point were soldered.

[0066] In addition, the hot side of the feed terminal was connected to the core wire of the coaxial cable and the earth side of the feed terminal was connected to an outer sheath conductor of the coaxial cable. Then, the other tip of the coaxial cable was connected to the receiver.

[Measurement result of the vehicular antenna according to the present invention]

[0067] Fig.12 shows an average value of the antenna sensitivities in all directions at each of frequencies in the frequency bandwidth of 174 through 240MHz which is the band III of DAB in the vehicular glass antenna according to the present invention.

[0068] A scale of a lateral axis of Fig. 12 is the frequency and a unit of each scale in the lateral axis is MHz. A longitudinal axis of Fig. 12 indicates the antenna sensitivities and one scale thereof corresponds to 10dB.

[0069] As shown in Fig. 12, it was appreciated that uniform high antenna sensitivities were obtained over the frequency bandwidth of 174 through 240 MHz which are band III of DAB.

[Example 2]

[0070] Vehicular glass antenna 1 in the second embodiment was disposed on a left side upper part of front glass 7 as shown in Fig. 13 (viewed from the inside of the vehicle). The dimensions and positional relationship of the respective antenna elements and feed points were adjusted so that the sensitivities become favorable in the frequency bandwidth of 174 through 240 MHz of band III of DAB. Then, the measurement of the antenna performance of the vehicular glass antenna in the second embodiment in the frequency bandwidth of band III of DAB was carried out.

[0071] For vehicular antenna 1 according to the present invention, the coaxial cable was used as the feed (or feeder) line to transmit the signal received by antenna 1 to the receiver. One tip of the coaxial cable was connected to the feed terminal (not shown), the earth side of the feed terminal being connected to earth side feed point 12 and the hot side (core wire side) of the feed terminal being connected to hot side (core wire side) feed point 11. Then, the feed terminal and the respective feed points are soldered (connected to each other by means of a soldering).

[0072] The hot side (core wire side) of the feed terminal was connected to the core wire of the coaxial cable and the earth side of the feed terminal was connected to the outer sheath conductor of the coaxial cable. Then, the other tip of the coaxial cable was connected to the receiver. Then, as the result of measurement, it was appreciated that the uniform high sensitivities of the antenna were obtained in the frequency band of 174 through 240 MHz which is the band III of DAB in the same way as first example 1.

[Example 3]

[0073] Vehicular glass antenna 1 in the first embodiment according to the present invention was disposed at a left side section of a side glass 8 as shown in Fig. 14.

[0074] The dimensions and positional relationships

were adjusted so that the antenna sensitivities were favorable in 174 through 240 MHz which is the frequency bandwidth of band III of DAB. Then, with side glass 8 attached to the vehicle, the measurement of the antennal performance in the frequency bandwidth of band III of DAB was carried out.

[0075] For vehicular glass antenna 1 according to the present invention, the coaxial cable was used as the feed line to transmit the signal received by the antenna to the receiver.

[0076] One tip of the coaxial cable is connected to the feed terminal (not shown), the earth side of the feed terminal being connected to earth side feed point 12 and the hot side (core wire side) of the feed terminal being connected to hot side (core wire side) feed point 11.

[0077] Then, the feed terminal and respective feed points were soldered (connected to each other by means of soldering). The hot side of the feed terminal was connected to the core wire of the coaxial cable and the earth side of the feed terminal was connected to the outer sheath conductor of the coaxial cable. The other tip of the coaxial cable was connected to the receiver.

[0078] Then, as the result of measurement, it was appreciated that the uniform high sensitivities of the antenna were obtained at the frequency bandwidth of 174 through 240 MHz which is band III of DAB in the same way as example 1.

Claims

1. A vehicular glass antenna disposed on a window glass of an automotive vehicle, comprising:

   a core wire side feed point (11);
   an earth side feed point (12) which is separate from the core wire side feed point (11);
   a core wire side antenna element (13) connected to the core wire side feed point (11) and extended in a direction far away from the core wire side feed point (11); and
   a loop shaped strip (141) connected to the earth side feed point (12), the loop shaped strip (141) being extended in the direction far away from the core wire side feed point (11) and the earth side feed point (12) and bent to enclose the core wire side antenna element (13) and a tip section of the loop shaped strip (141) providing an opening end.

2. The vehicular glass antenna as claimed in claim 1, wherein the loop shaped strip (141) is placed in the proximity of an end edge (2) of a body flange of a vehicle body when the vehicular glass antenna is attached to the vehicle body.

3. The vehicular glass antenna as claimed in either claim 1 or 2, wherein the tip section of the loop shaped strip (141) is folded back.

4. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 3, wherein an auxiliary antenna element (142) is connected to the loop shaped strip (141).

5. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 3, wherein an auxiliary antenna element (15, 32) is placed in the proximity of the loop shaped strip (141) at an outside of the loop shaped strip (141).

6. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 5, wherein a whole length of the loop shaped strip is set to 0.7 $\alpha\lambda$ (α : a shortening coefficient of wavelength in a glass plate and λ : a center frequency in a desired frequency bandwidth).

7. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 6, wherein the core wire side antenna element (13) is constituted by a horizontal strip (131) and the loop shaped strip (141) constitutes an earth side antenna element (14), one end of the loop shaped strip (141) being connected to the earth side feed point (12) and the other end of the loop shaped strip (141) being disposed in a rectangular shape to enclose the horizontal strip (131) to provide the opening end.

8. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 7, wherein the opening end of the loop shaped strip (141) forms a proximity section (14a) to the end edge (2) of the body flange.

9. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 8, wherein the core wire side antenna element (13) is constituted by two horizontal strips (131), one end of each of the horizontal strips (131) being connected to the core wire side feed point (11) and the horizontal strips (131) being extended in the same direction.

10. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 9, wherein one end of an auxiliary strip (142) is connected to the loop shaped strip (141) and the other end of the auxiliary strip (142) provides another opening end.

11. The vehicular glass antenna as claimed in any one of the preceding claims 1 through 10, wherein an auxiliary antenna element constituted by a non-feed strip (15) is placed in the proximity of the loop shaped strip (141) or in addition to the auxiliary strip (142), another antenna element (32) constituting the auxiliary antenna element is placed in the proximity of

the loop shaped strip at an outside of the loop shaped strip (141).

FIG.1

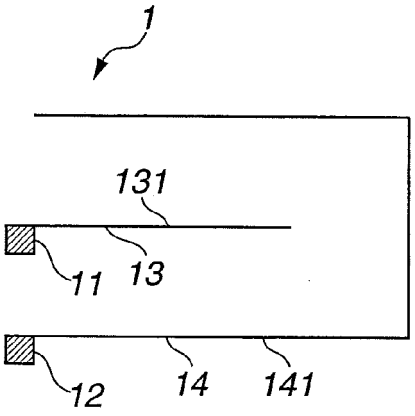


FIG.2

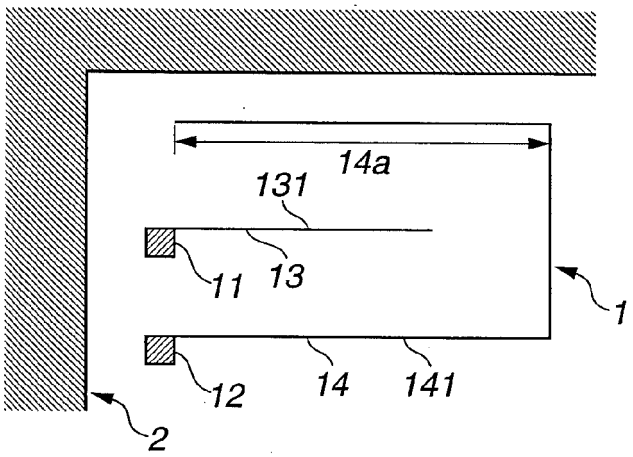


FIG.3

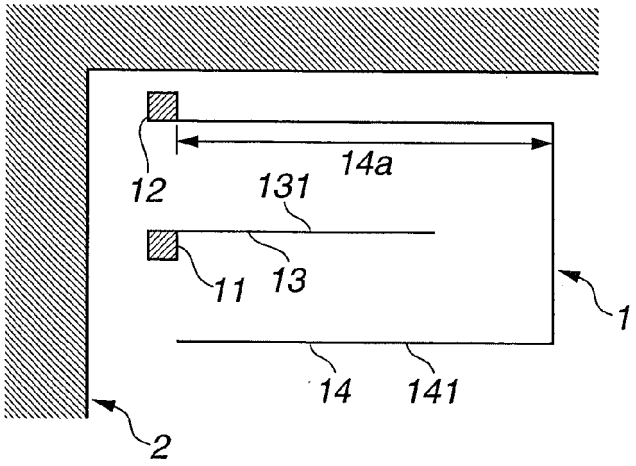


FIG.4

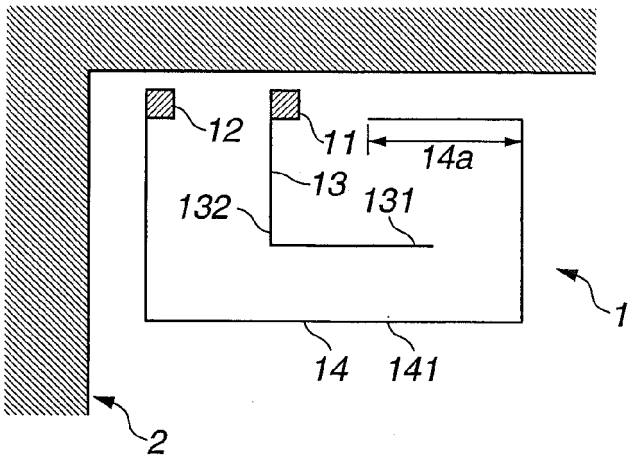


FIG.5

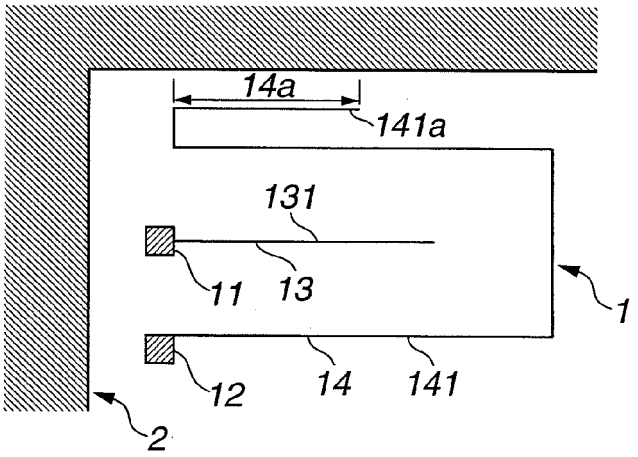


FIG.6

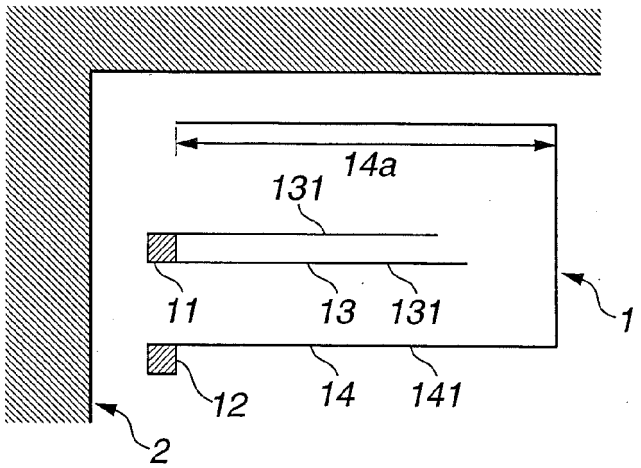


FIG.7

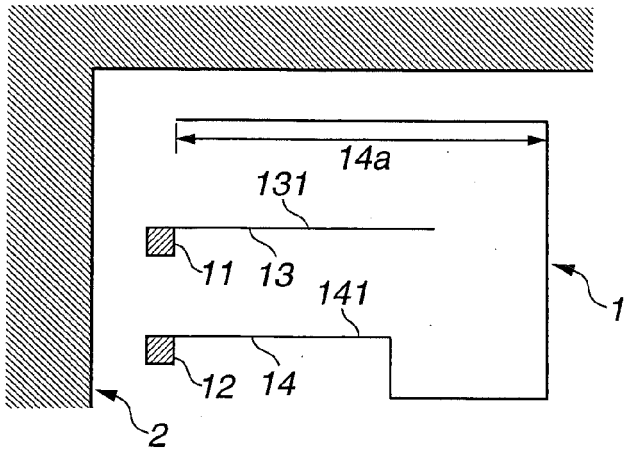


FIG.8

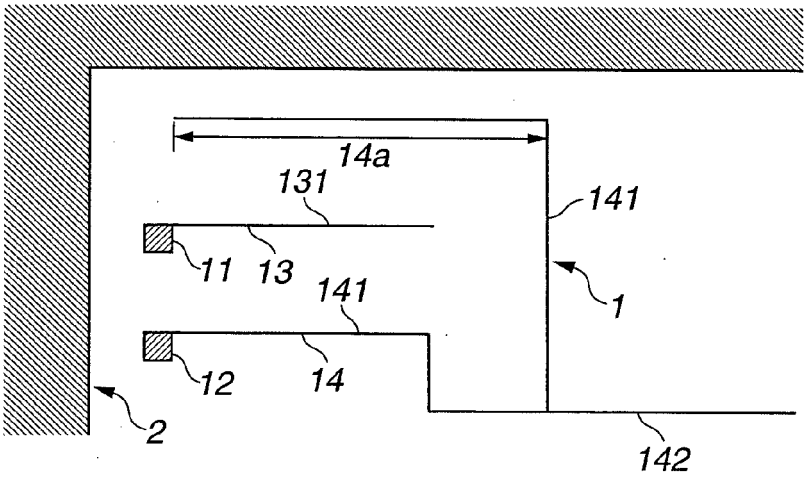


FIG.9

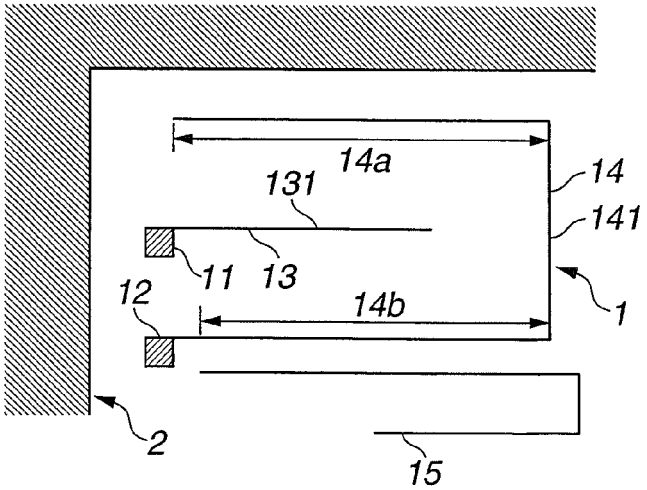
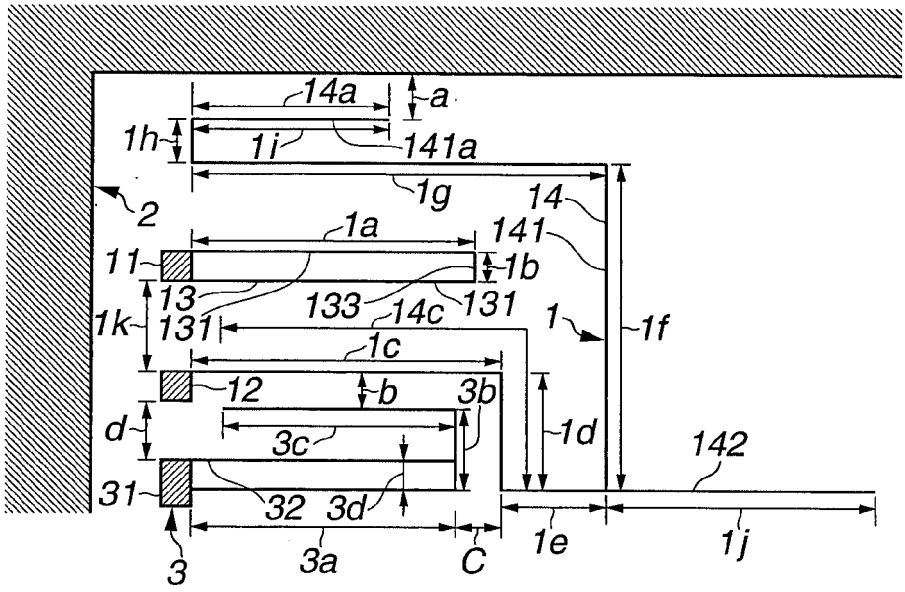


FIG.10


14a
a
1h
1i
141a
1g
14
2
1a
141
11
1b
13
133
14c
131
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131
1
1f
1c
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d
3c
1d
142
31
32
3d
3
3a
C
1e
1j

FIG.11

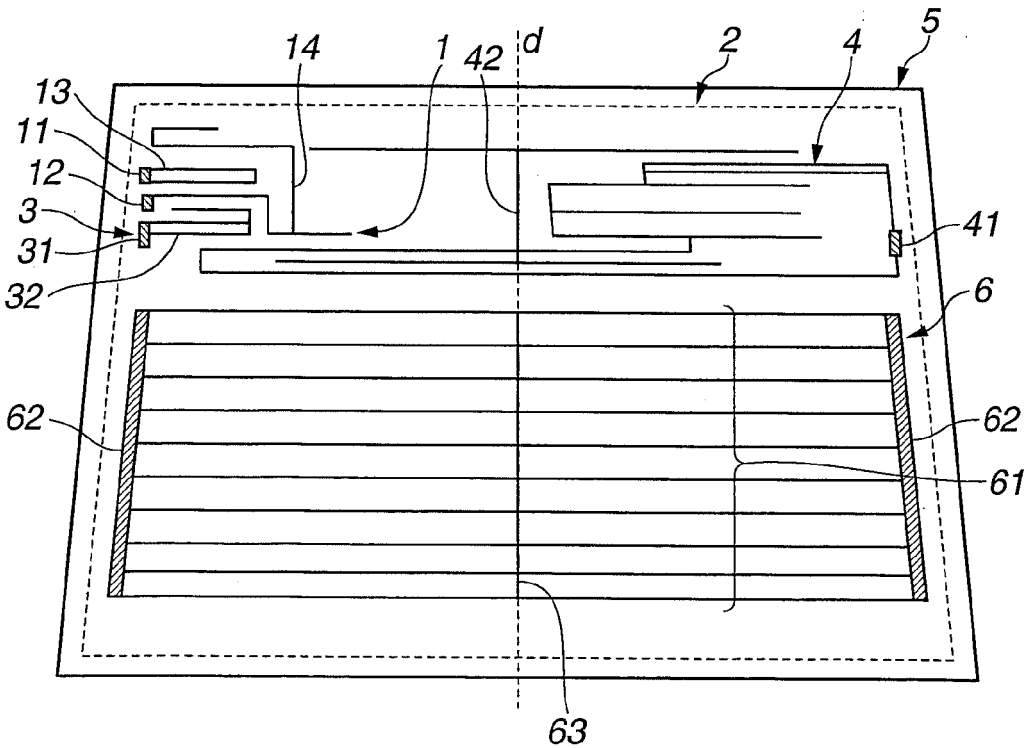

14
1
42
d
2
4
5
13
11
12
3
31
32
41
6
62
62
61
63

FIG.12

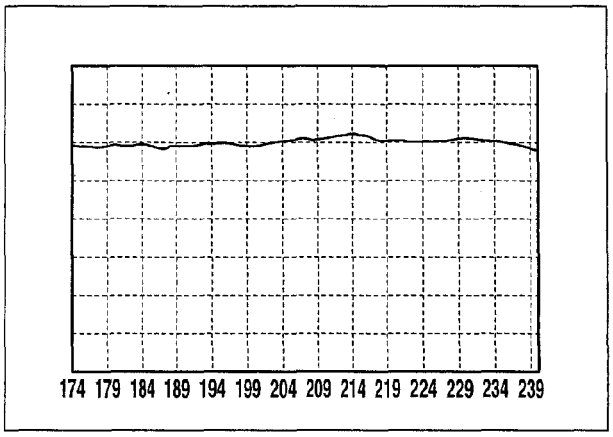


FIG.13

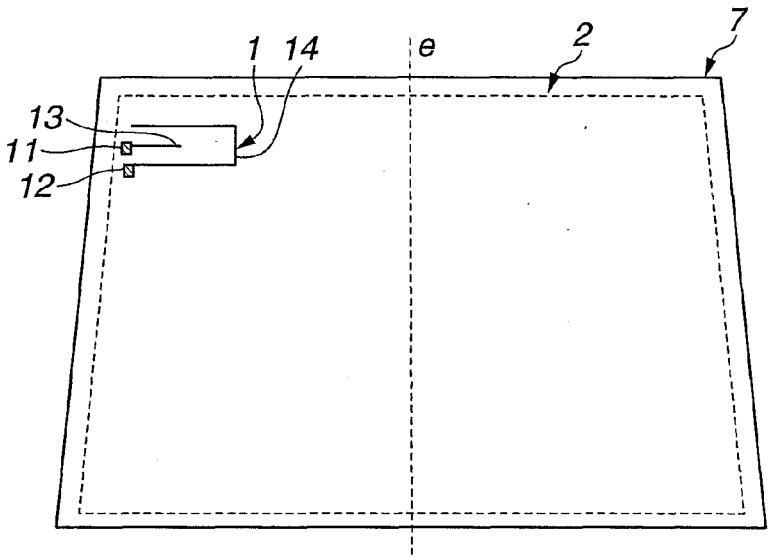
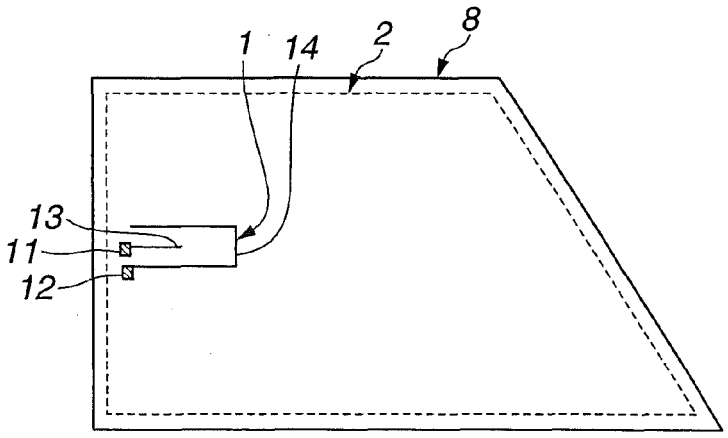


FIG.14



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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 1055

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D Y	JP 2012 029032 A (CENTRAL GLASS CO LTD) 9 February 2012 (2012-02-09) * paragraph [0001] * * paragraph [0008] * * paragraph [0024] * * paragraph [0025] * * figures 1, 5, 8 *	1-6,8, 10,11 7,9	INV. H01Q1/12
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X,P	WO 2013/094470 A1 (CENTRAL GLASS CO LTD [JP]) 27 June 2013 (2013-06-27) * the whole document *	1-11	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 July 2014	Yvonnet, Yannick

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18-07-2014

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