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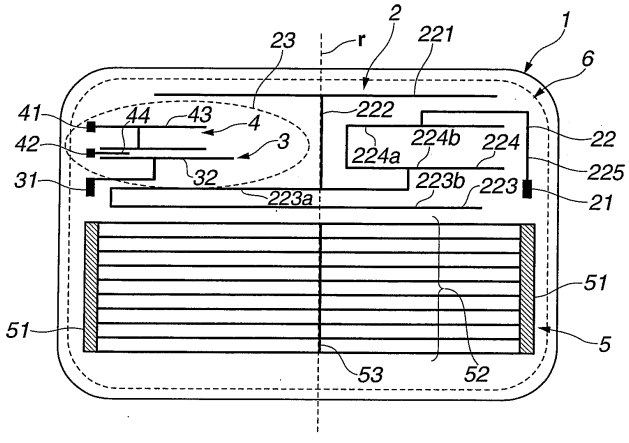
(54) **Automotive glass antenna**

(57) In a glass antenna disposed at an upper section of a defogger (5) of a rear window glass (1) of an automotive vehicle, an FM first antenna (2) receives an FM broadcasting wave or both of the FM broadcasting wave and an AM broadcasting wave, an FM second antenna (3) performs a diversity reception of the FM broadcasting wave together with the first FM antenna, and a DAB purpose antenna receiving a DAB broadcasting wave. The FM first antenna (2) is disposed in such a way that a blank space (23) formed by an FM first antenna element (22) and a flange end edge (6) of the automotive vehicle is disposed at an upper part of the defogger when the rear window glass is attached to the automotive vehicle, the FM second antenna (3) and the DAB purpose antenna (4) are disposed on the blank space (23), the FM second antenna (3) includes: an FM second antenna feed point (31) disposed at a side section of the rear window glass (1); and an FM second antenna element (32), the FM second antenna element (32) includes: an FM second antenna first strip (321); and an FM second antenna second strip (322), and FM second antenna first strip (321) has one end connected to the FM second antenna feed point (31), is extended in a direction away from the FM second antenna feed point (31), and has the other end connected to a tip or to a midway section through the FM second antenna second strip (322).

FIG.1



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Description

BACKGROUND OF THE INVENTION

(1) **Field of the Invention**

[0001] The present invention relates to a vehicular glass antenna (or an automotive glass antenna) in which two FM (Frequency Modulation) purpose antennae for performing a diversity reception of FM broadcasting waves and a DAB (Digital Audio Broadcasting) purpose antenna for receiving a DAB broadcasting wave are coexistent on a blank space located at an upper section of a defogger provided on a rear window glass of an automotive vehicle.

(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] Two FM wave receiving antennae for receiving FM broadcasting waves (the frequency bandwidth in Japan is 76MHz ~ 90MHz and the frequency bandwidth out of Japan is 88MHz ~ 108MHz) are provided on the blank space of the defogger of the rear window glass of the automotive vehicle to perform the diversity reception of the FM broadcasting wave. Conventionally, one of two FM receiving antennae is provided on the blank space at the upper part of the defogger and the other of the receiving antennae is provided on the blank space at a lower part of the defogger.

[0005] However, recently, two FM purpose antennae are provided on the blank space at the upper part of the defogger as described in a Japanese Patent Application First Publication (tokkai) No. 2011-135405 published on July 7, 2011 (which corresponds to EP 2 485 325 A1). In details, the above-described Japanese Patent Application First Publication describes that an FM radio receiving main antenna is provided on an upper part blank space of the defogger and an FM radio receiving sub antenna is provided on a blank space of the FM radio receiving main antenna.

SUMMARY OF THE INVENTION

[0006] In a case where the above-described DAB purpose antenna is disposed on the blank space of the upper part of the rear window glass, the DAB purpose antenna and FM radio wave sub antenna are disposed on the blank space of the FM radio receiving main antenna.

[0007] If the DAB purpose antenna and FM radio wave sub antenna are disposed as described above, DAB purpose antenna and FM radio receiving sub antenna are disposed in a short distance between these antennae so that a mutual electromagnetic interference occurs and an antenna sensitivity at the band III of the DAB purpose antenna is often reduced.

[0008] With the above-described problem in mind, it is an object of the present invention to provide an automotive glass antenna in which the FM radio receiving main antenna, the FM radio receiving sub antenna, and DAB purpose antenna are disposed on the blank space at the upper part of the rear window glass and the respective antennae can suitably receive the electric waves at a desired frequency bandwidth.

[0009] The automotive glass antenna according to the present invention is a glass antenna disposed on an upper side of a defogger of a rear window glass of an automotive vehicle. This automotive glass antenna comprises: an FM first antenna receiving the FM broadcasting wave or both of the FM broadcasting wave and an AM broadcasting wave; an FM second antenna for performing a diversity reception of the FM broadcasting wave together with the FM first antenna; and a DAB purpose antenna for receiving the DAB broadcasting wave.

[0010] The FM first antenna is disposed in such a way that the blank space formed by the FM first antenna element and the end edge of a flange of the automotive vehicle is disposed on an upper part of the defogger when the rear window glass is attached to the automotive vehicle.

[0011] The FM second antenna and the DAB purpose antenna are disposed in the blank space. The FM second antenna includes: an FM second antenna feed point disposed on a side section of the rear window glass; and an FM second antenna element.

[0012] The FM second antenna element includes an FM second antenna first strip and an FM second antenna second strip. The FM second antenna first strip has one end connected to the FM second antenna feed point, is extended toward a direction away from the FM second antenna feed point, and has the other end connected to a tip of or a midway through the FM second antenna second strip.

[0013] In the automotive glass antenna according to the present invention, the FM second antenna second strip may be overlapped on the antenna element of the DAB purpose antenna. Or alternatively, the FM second

antenna first strip and the FM second antenna second strip can be overlapped on the antenna element of the DAB purpose antenna. It should be noted that, in this specification, the term of overlap is defined as a close lap of one strip of two strips of separate antenna elements over the other strip of the two strips thereof with a predetermined length and with a predetermined interval.

[0014] The automotive glass antenna according to the present invention is structured in such a way as described above. Hence, the antenna sensitivity of the DAB purpose antenna can be increased.

[0015] The automotive glass antenna according to the present invention, as the DAB purpose antenna, with the core wire side feed point and the ground side feed point provided, an antenna having a core wire side feed point connected to the core wire side feed point and a ground side antenna element connected to a ground side feed point may be used.

[0016] In the automotive glass antenna according to the present invention, a part or a whole of the ground side element of DAB purpose antenna may be placed in proximity of the FM second antenna strip of the FM second antenna to constitute a capacitive coupling. In addition, a part or a whole of the DAB purpose antenna may be placed in the proximity of the FM second antenna first strip of the FM second antenna and the FM second antenna second strip to constitute the capacitive coupling. Thus, the antenna sensitivity of DAB purpose antenna at the band III of DAB can be increased.

[0017] In the automotive glass antenna according to the present invention, the antenna element of the DAB purpose antenna and the antenna element of the FM second antenna has an overlapped interval of equal to or larger than 3mm but equal to or smaller than 10mm. By adjusting this range, the high antenna sensitivity can be obtained at band III of the DAB purpose antenna.

[0018] In the automotive glass antenna according to the present invention, the FM second antenna structure is as described above. Hence, the antenna sensitivity of the FM second antenna can be suppressed to be lower in the band III of DAB which is outside of the FM bandwidth. Therefore, even if the FM second antenna and the DAB purpose antenna are disposed at the blank space formed by the FM first antenna element and the flange end edge of the automotive vehicle, the DAB purpose antenna can obtain the favorable antenna sensitivity. Due to the difference in the antenna sensitivities, while two FM antennae and the DAB purpose antenna are coexistent on the blank space at the upper part of the defogger of the rear window glass, the respective antennae can provide the desired antenna sensitivities at desired bandwidths.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is an elevation view of a whole automotive glass antenna related to a first preferred embodiment according to the present invention.

Fig. 2 is an elevation expanded view of a surrounding of an FM second antenna and DAB purpose antenna of the automotive glass antenna related to the first preferred embodiment according to the present invention.

Fig. 3 is an elevation view of the whole automotive glass antenna related to a second preferred embodiment according to the present invention.

Fig. 4 is an elevation expanded view of a surrounding of an FM second antenna and DAB purpose antenna of the automotive glass antenna related to the first preferred embodiment according to the present invention.

Fig. 5 is an elevation view of the whole automotive glass antenna related to a third preferred embodiment according to the present invention.

Fig. 6 is an elevation expanded view of a surrounding of an FM second antenna and DAB purpose antenna of the automotive glass antenna related to the third preferred embodiment according to the present invention.

Fig. 7 is a graph representing an average antenna sensitivity for each frequency in an FM frequency bandwidth of the FM second antenna of the automotive glass antenna in an example 1 and in a comparative example

Fig. 8 is a graph representing an average antenna sensitivity for each frequency in a band III of DAB bandwidth of the FM second antenna of the automotive glass antenna in example 1 and in the comparative example.

Fig. 9 is a graph representing an average antenna sensitivity for each frequency in a band III of the DAB of the DAB purpose antenna of the automotive glass antenna in example 1 and in the comparative example.

Fig. 10 is a graph representing an average antenna sensitivity in a band III of the DAB purpose antenna when an interval of FM second antenna and DAB purpose antenna is varied.

Fig. 11 is a elevation view of the whole automotive vehicle glass antenna related to the comparative example.

Fig. 12 is an elevation expanded view of a surrounding of an FM second antenna and DAB purpose antenna of the automotive glass antenna related to the comparative example.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Hereinafter, a structure of an automotive glass antenna in a preferred embodiment according to the present invention will be described. It should be noted that upper, lower, right side (rightward), or left side (leftward) is used for the accompanied drawings but not prescribed for directions of actual articles.

[First embodiment]

[0021] Fig. 1 is an elevation view of the automotive glass antenna related to a first preferred embodiment according to the present invention.

[Whole structure]

[0022] The automotive glass antenna in the first embodiment is a glass antenna disposed on an upper part of a defogger 5 of a rear window glass 1. The glass antenna includes: an FM first antenna 2 disposed from a right side to left side of an upper part of a defogger 5 of a rear window glass 1; an FM second antenna 3 performing a diversity reception of an FM broadcasting wave together with FM first antenna 2; and a DAB purpose antenna 4 disposed at a left side of rear window glass 1. FM first antenna 2 may be the antenna receiving both of the FM broadcasting wave and AM (Amplitude Modulation) broadcasting wave.

[0023] Defogger 5 includes a pair of bus bars 51 longitudinally disposed at both side sections of rear window glass 1. A plurality of heating horizontal strips 52 are disposed between pair of bus bars 51 and both ends of heating horizontal strips 52 are connected to the pair of bus bars 51. A defogger vertical strip 53 may be disposed along a center line r of rear window glass 1. This defogger vertical strip 53 has its upper end connected to an uppermost heating horizontal strip 52, is connected to crossing all heating horizontal strips 52, and is connected to a lowermost heating horizontal strip 52.

[0024] FM fist antenna 2 serves as a main antenna and FM second antenna 3 serves as a sub antenna. The FM first antenna 2 is provided with an FM first antenna feed point 21 located at a right side section of rear window glass 1 at an upper section of defogger 5. Then, an FM first antenna element 22 is extended from FM first antenna feed point 21.

[0025] FM first antenna element 22 has all elements disposed on an inside of a flange end edge 6 of the automotive when rear window glass 1 is attached onto the automotive vehicle.

[0026] FM first antenna element 22 includes: an FM first antenna horizontal strip 221; an FM first antenna vertical strip 222; an FM first antenna first letter U shaped element 223; an FM first antenna second letter U shaped element 224; and an FM first antenna drawing strip 225.

[0027] FM first antenna horizontal strip 221 is disposed along the upper part of flange end edge 6 when rear window glass 1 is attached onto the automotive vehicle. In addition, FM first antenna first letter U shaped element 223 includes: an FM first antenna first letter U shaped element upper side horizontal strip 223a; an FM first antenna letter U shaped element lower side horizontal strip 223b; and a connection strip connecting left sides of both of horizontal strips 223a and 223b. Then, FM first antenna first letter U shaped element lower side horizontal strip 223b is disposed to be spaced apart from an uppermost heating horizontal strip 52.

[0028] FM first antenna vertical strip 222 is a strip disposed to be overlapped on a center line r of the rear window glass. An upper end of FM first antenna vertical strip 222 is connected to a midway section of FM first antenna horizontal strip 221 and a lower end of FM first antenna vertical strip 222 is connected to a midway section of FM first antenna first letter U shaped element upper section horizontal strip 223a.

[0029] An FM first antenna second letter U shaped element 224 is disposed at a right side of center line r of the rear window glass and is interposed between FM first antenna horizontal strip 221 and FM first antenna second letter U shaped element upper section horizontal strip 223a.

[0030] FM first antenna second letter U shaped element 224 includes: an FM first antenna second letter U shaped element upper section horizontal strip 224a; an FM first antenna second letter U shaped element lower section horizontal strip 224b; and a connection strip to connect left ends of both horizontal strips 224a and 224b.

[0031] A midway section of FM first antenna second letter U shaped element lower section horizontal strip 224b is connected to a connection strip connected to a rightward end of FM first antenna letter U shaped element upper section horizontal strip 223a. One end of FM first antenna drawing strip 225 is connected to FM first antenna feed point 21 and the other end of FM first antenna drawing strip 225 is connected to FM first antenna second letter U shaped horizontal strip 224a. A midway section of FM first antenna drawing strip 225 is extended toward the upper direction from feed point 21 and disposed between FM first antenna second letter U shaped horizontal strip 224a and FM first antenna horizontal strip 221.

[0032] On the left side of center line r of rear window glass 1, FM first antenna horizontal strip 221, FM first antenna vertical strip 222, FM first antenna letter U shaped element upper horizontal strip 223a, and the blank space 23 (denoted by a dot line) of FM first antenna element 22 enclosed with flange end edge 6 of the left side of rear window glass 1 are formed.

[0033] The shape of FM first antenna 2 is not limited to this. Blank space 23 formed by flange end edge 6 of the automotive vehicle and FM first antenna element 22 when rear window glass 1 is attached to the automotive vehicle has an area sufficient to include FM second antenna 3 and DAB purpose antenna 4.

[0034] FM second antenna 3 and DAB purpose antenna 4 are disposed on the blank space 23 of FM first antenna element 22.

[0035] In FM second antenna 3, an FM second antenna feed point 31 is disposed at the left side section of rear section window glass 1. An FM second antenna element 32 is extended from FM second antenna feed point 31.

[0036] DAB purpose antenna 4 is disposed at an upper section of FM second antenna 3. A ground side feed point 42 is disposed at a left side section of rear window glass

1. A core wire side feed point 41 is disposed above ground side feed point 42.

A ground side antenna element 44 is extended from ground side feed point 42. A core wire side antenna element 43 is extended from core wire side feed point 41. In the first embodiment, DAB purpose antenna 4 is disposed above FM second antenna 3. However, the present invention is not limited to this. DAB purpose antenna 4 may be disposed below FM second antenna 3.

[0037] Fig. 2 is an expanded view of FM second antenna 3 and DAB purpose antenna 4, both antennae being disposed on the blank space of FM first antenna element 22 shown in Fig. 1.

[0038] FM second antenna element 32 of FM second antenna 3 is extended from FM second antenna feed point 31. FM second antenna element 32 includes: an FM second antenna first strip 321 and an FM second antenna second strip 322.

[0039] One end of FM second antenna first strip 321 is connected to FM second antenna feed point 31 and FM second antenna first strip 321 is horizontally extended from FM second antenna feed point 31 toward center line r of rear window glass. A midway section of FM second antenna first strip 321 is bent toward the upper direction to form FM second antenna first strip connection section 321a. A tip of FM second antenna first strip connection section is connected to FM second antenna second strip 322.

[0040] FM second antenna second strip 322 is a strip extended in the horizontal direction. A tip of or midway through FM second antenna second strip 322 is connected to a tip of FM second antenna first strip 321 via FM second antenna first strip connection section 321a.

[0041] FM second antenna first strip 321 and FM second antenna second strip 322 are not always the horizontal strips as described in the first embodiment. For example, these strips may be bended or may be extended in an oblique upper direction or in an oblique lower direction.

[0042] By adjusting lengths of FM second antenna first strip 321 and FM second antenna second strip 322 and by adjusting connection positions between FM second antenna first strip 321 and FM second antenna strip 322, an antenna sensitivity of the DAB purpose antenna 4 in conformity to the vehicle body shape of various types of the automotive vehicles and in conformity to the shapes of the DAB purpose antenna can be obtained.

[0043] A ground side feed point 42 of DAB purpose antenna 4 is disposed at a left side section of the rear window glass. A core wire side feed point 41 of DAB purpose antenna 4 is disposed at the left side section of rear window glass located at the upper side of ground side feed point 42. A ground side antenna element 44 is extended from ground side feed point 42. A core wire side antenna element 44 is extended from core wire side feed point 41.

[0044] Ground side antenna element 44 includes a ground side first horizontal strip 441. One end of ground side first horizontal strip 441 is connected to ground side feed point 42 and ground side first horizontal strip 441 is a strip extended toward center line r of the rear window glass 1.

[0045] Core wire side antenna element 43 is constituted by a core wire side first horizontal strip 431, core wire side vertical strip 432, and core wire side second horizontal strip 433.

[0046] Core wire side first horizontal strip 431 has one end connected to core wire side feed point 41 and is a strip extended toward the direction of center line r of the rear window glass. Core wire side vertical strip 432 has one end connected to a midway section of core wire side first horizontal strip 431 and is a strip extended toward the lower direction. The other end of core wire side vertical strip 432 is connected to a midway of core wire side second horizontal strip 433. Core wire side second horizontal strip is a horizontal strip extended in the rightward and leftward directions at a lower side of core wire side first horizontal strip 431.

[0047] As described above, FM second antenna 3 and DAB purpose antenna 4 are disposed within the blank space 23 of FM first antenna element 22, both antennae of FM second antenna 3 and DAB purpose antenna 4 can obtain favorable antenna sensitivities at a desired bandwidth.

The reason of obtaining of the favorable antenna sensitivities is as follows: That is to say, since the structure of FM second antenna 3 takes a form of the first embodiment as described above, the antenna sensitivity of FM second antenna 3 can be lowered in the band III of DAB bandwidth which is an outside of FM bandwidth. Thus, DAB purpose antenna 4 can be prevented from interfering against FM second antenna 3 in the band III and the favorable antenna sensitivity can be obtained in the band III.

[0048] In addition, it is preferable that a part of FM second antenna second strip 322 of FM second antenna 3 is overlapped with a predetermined interval m with respect to ground side horizontal strip 441 of DAB purpose antenna 4 since the antenna sensitivity of DAB purpose antenna 4 in the band III can be increased.

[0049] In the automotive glass antenna in the first embodiment, part of FM second antenna second strip 322 is overlapped with respect to ground side horizontal strip 411 of DAB purpose antenna 4. However, a higher sensitivity can be obtained if FM second antenna second strip 322 is overlapped with respect to part of ground side horizontal strip 441 of DAB purpose antenna 4.

[0050] In the automotive glass antenna in the first embodiment, ground side element 44 of DAB purpose antenna 4 is disposed to be closer to FM second antenna element 32 than core wire side antenna element 43. However, core wire side antenna element 43 may be closer to FM second antenna element 32 than ground side element 44.

[0051] In addition, in the automotive glass antenna in the first preferred embodiment, DAB purpose antenna 4

is a non-ground type antenna including ground type feed point 42 and core-wire side feed point 41. However, the DAB purpose antenna 4 may be ground type antenna whose ground is provided at the vehicle body.

[0052] In the automotive glass antenna in the first preferred embodiment, blank space 23 of FM first antenna element 22 is disposed on the left side of an upper blank space of defogger 5. However, it is always necessary to be disposed on the left side. Depending on the structure of FM first antenna 2, the blank space of FM first antenna element 22 may be disposed on the center of an upper blank space of rear window glass 1 or the right side of the upper blank space of rear window glass 1, viz., a side on which FM first antenna feed point 21 of FM first antenna 2 is disposed.

[Connection of automotive glass antenna in the first embodiment to a receiver]

[0053] An amplifier (not shown) is disposed on a part of a vehicle body which is placed in proximity of FM first antenna feed point 21. A coaxial cable (not shown) is extended from a receiver (not shown) and is connected to the amplifier. The amplifier is grounded to the vehicle body and an outer sheath conductor wire is grounded to the vehicle body via the amplifier.

[0054] A feed terminal is soldered to FM first antenna feed point 21 and an AV (Low-voltage cables for Automobile and Vinyl) cable serves to connect this feed terminal 21 to the amplifier.

[0055] In general, a filter is disposed in the amplifier so as not to input waves other than a desired bandwidth. Thus, FM first antenna 2 has reduced interference of receiving the electric waves of the band III of DAB purpose antenna 4.

[0056] A grounding (or ground) point (not shown) is disposed on a part of the vehicle body placed in proximity of FM second antenna feed point 31. The coaxial cable (not shown) serves to connect the receiver (not shown) to the grounding point and outer sheath conductor of this coaxial cable is grounded. Then, the feed terminal is soldered to FM second terminal feed point 31 and the AV cable is connected between the feed terminal and the grounding point.

[0057] The feed terminals are soldered to ground side feed point 42 and core wire side feed point 41. The coaxial cable serves to connect the receiver and the grounding point (not shown). The core wire of the coaxial cable is connected to core wire side feed point 41 via the feed terminal. The outer sheath conductor is connected to ground side feed point 42 via the feed terminal. In addition, the amplifier may be disposed between the receiver and the feed terminal.

[Forming method of forming the automotive window glass in the first embodiment]

[0058] A generally available conductive ceramic paste in the same way as the forming of defogger 5 of rear window glass 1 can be used, the glass antenna can be printed in the same method as defogger 5, and can be baked by means of a heating furnace.

[0059] In addition, as far as DAB purpose antenna 4 is concerned, a film antenna printed in a conductive paste on a transparent film may be adhered onto the blank space of FM first antenna element 22 of rear window glass 1.

[Second embodiment]

[0060] Fig. 3 shows an elevation view of the automotive glass antenna related to a second preferred embodiment according to the present invention.

[0061] The automotive glass antenna in the second embodiment is the same as that in the first embodiment except the shapes of FM second antenna and DAB purpose antenna 4. Hereinafter, the structure of each of FM second antenna 3 and DAB purpose antenna 4 will be described on a basis of Fig.4 in which FM second antenna 3 and DAB purpose antenna 4 are formed on the blank space 23 of FM first antenna element 22.

[0062] FM second antenna 3 has FM second antenna element 32 extended from FM second antenna feed point 31. FM second antenna element 32 is provided with an FM second antenna first strip 321 and FM second antenna second strip 322.

[0063] FM second antenna strip 321 has one end connected to FM antenna feed point 31 and extended in the horizontal direction from FM second antenna feed point 31 to the direction of center line r of the rear window glass 1. Then, FM second antenna first strip 321 has the midway section bent in the upward direction to form FM second antenna first strip connection section 321a and has its tip connected to FM second antenna second strip 322.

[0064] FM second antenna second strip 322 is a strip extended in the horizontal direction. A tip of FM second antenna first strip 321 is connected to a tip of FM second antenna second strip 322. Then, FM second antenna second strip 322 is extended in the left side of rear window glass from the tip of FM second antenna second strip 322 at which FM second antenna first strip 321 is connected.

[0065] A ground side feed point 42 is disposed at the left side section of rear window glass 1 and a core wire side feed point 41 is disposed at the left side of rear window glass 1 and at the upper side of ground side feed point 42. Ground side antenna element 44 is extended form ground side feed point 42 and core side antenna element 43 is extended from core side feed point 41.

[0066] Core wire side antenna element 43 is constituted by a core wire side first horizontal strip 431.

[0067] Core wire side first horizontal strip 431 has one end connected to ground side feed point 41 and is a strip extended toward center line r of rear window glass 1.

[0068] Ground side antenna element 44 is constituted by a ground side loop shaped strip 442. Ground side loop

shaped strip 442 has one end connected to ground side feed point 42 and is extended in the direction of center line r of rear window glass 1 so as to enclose core wire side first horizontal strip 431 to form a ground side loop shaped strip 442a. Ground side antenna element 44 is further extended in the upward direction. A tip of ground side antenna element 44 extended toward the left side of the rear window glass 1 is opened.

[0069] FM second antenna 3 and DAB purpose antenna 4 can obtain preferable antenna sensitivities at desired bandwidths, respectively.

In addition, since FM second antenna second strip 322 of FM second antenna 3 and a part of ground side loop shaped strip 442a and DAB purpose antenna 4 are overlapped at an interval of m so that the antenna sensitivity of DAB purpose antenna 4 at band III can be increased.

[Third embodiment]

[0070] Fig.5 shows an elevation view of the automotive glass antenna in a third preferred embodiment according to the present invention.

[0071] The automotive glass antenna in the third embodiment is generally the same as the second embodiment except the shapes of FM second antenna 3 and DAB purpose antenna 4. Hereinafter, the structures of FM second antenna 3 and DAB purpose antenna 4 will be described on a basis of Fig. 6 which shows FM second antenna 3 and DAB purpose antenna 4 formed on a blank space 23 of FM first antenna element 22.

[0072] FM second antenna 3 in this embodiment is different from that in the second embodiment in that FM second antenna 3 includes an FM second antenna auxiliary strip 323.

One end of FM second antenna auxiliary strip 323 is connected to FM second antenna feed point 31. FM second auxiliary strip 323 is extended horizontally with a space provided for FM second antenna first strip 321 and the other end of FM second antenna auxiliary strip 323 is connected to FM second antenna first strip connection section 321a.

[0073] DAB purpose antenna 4 has different shape of ground side loop shaped strip 442 from the second embodiment and includes a ground side auxiliary strip 443.

[0074] Ground side loop shaped strip 442 of ground side antenna element 442 has one end connected to ground side feed point 42 and is disposed to enclose core wire side first horizontal strip 431. The tip of ground side loop strip 442 is opened.

Ground side loop shaped strip lower side section 442a is overlapped at an interval m with respect to FM second antenna second antenna second strip and is extended with an interval **q** with respect to FM second antenna first strip connection section 321. Then, ground side loop shaped strip 442 is connected to ground side auxiliary strip 443.

[0075] FM second antenna 3 and DAB purpose antenna 4 can obtain favorable antenna sensitivities at their respective bandwidths even in the structure described above.

[Example 1]

[0076] The automotive glass antenna in the first embodiment shown in Fig. 1 was mounted and fixed to the flange of an opening section of the automotive, a length and a positional relationship of each strip constituting FM first antenna element 22 were adjusted in order for FM first antenna 2 to obtain a favorable antenna sensitivity at the frequency bandwidth of 88MHz through 108MHz which is the frequency bandwidth of FM band of outside of Japan and the length and positional relationship of each of the strips constituting FM second antenna element 32 in order for FM second antenna 3 to obtain the favorable antenna sensitivity at the frequency bandwidth of 88MHz through 108MHz, and the length and positional relationship of each strip constituting DAB purpose antenna 4 in order for DAB purpose antenna 4 to obtain the favorable antenna sensitivity at the frequency bandwidth of 174MHz through 240MHz which is the band III of DAB were adjusted.

[0077] [Dimensions of and intervals between the respective antennae of FM second antenna and DAB purpose antenna of the automotive glass antenna related to the example 1]

The dimensions will be described using symbols shown in Fig. 2.

[Dimensions of DAB purpose antenna]

[0078] The dimensions of core wire side feed point 41 and ground side feed point 42 = 10 mm x 10 mm

Core wire side first horizontal strip 431 = 140mm

Core wire side vertical strip 432 = 25mm

Core wire side second horizontal strip 433 = 150mm

A distance **k** from core wire side feed point 41 to a junction point between core wire side first strip 431 and core wire side vertical strip 432 = 80mm

A part **g** from a junction point between core wire side vertical strip 432 and core wire side second strip 433 extended toward the left side section of rear window glass 1 of core wire side second strip 433= 90mm A part **h** from a junction point between core wire side vertical strip 432 and core wire side second strip 433 and extended toward the left side section of rear window glass = 60mm

Ground side horizontal strip 441 = 105mm

Interval **n** between core wire side vertical strip 433 and ground side horizontal strip 441 = 5mm

[Dimensions of FM second antenna]

[0079] Dimensions of FM second antenna feed point 31 = 12mm x 22mm

FM second antenna first strip 321 = 195mm

FM second antenna first strip connection section 321a = 25mm

FM second antenna second strip 322 = 245mm
A part **d** extended toward the left side section of rear window glass 1 from the junction point between FM second antenna first strip connection section 321a and FM second antenna second strip = 150mm
A part **e** extended from the junction point between FM second antenna first strip connection section 321a and the FM second antenna second strip toward the direction of a center line **r** of rear window glass =95mm

[Interval between FM second antenna and DAB purpose antenna]

[0080] An interval **m** between ground side horizontal strip 441 of DAB purpose antenna and FM second antenna second strip 322 of FM second antenna 3 = 5mm
An overlap length **p** between ground side horizontal strip 441 of the DAB purpose antenna 4 and the FM second antenna second strip 322= 100mm
It should be noted that each left side of FM second antenna feed point 31, core wire side feed point 41 of DAB purpose antenna 4, and ground side feed point 42 of DAB purpose antenna 4 is aligned on a vertical line.

[Method of forming each antenna]

[0081] FM first antenna 2, FM second antenna 3, and DAB purpose antenna 4 were printed using generally available conductive ceramic paste which is the same as the forming of defogger 5 of rear window glass 1, were printed in the same way as the defogger, and were baked through a heating furnace. Each width of the respective strips constituting all of antennae was 0.7mm.

[Connection method of each antenna to a receiver]

[0082] As far as FM first antenna 2 is concerned, an amplifier (not shown) was disposed on a part of the vehicle body which is placed in proximity of FM first antenna feed point 21. The amplifier was grounded on the vehicle body and an outer sheath conductor of a coaxial cable was grounded on the vehicle body via the amplifier.
[0083] In addition, the feed terminal was soldered to FM first antenna feed point 21 and the AV cable was connected between the feed terminal and the amplifier.
[0084] The filter was provided on the amplifier in order for the amplifier to input a signal other than the FM bandwidth.
[0085] As far as FM second antenna 3 was concerned, a ground point (not shown) is disposed on a vehicle body placed in the proximity of FM second antenna feed point 31.
The coaxial cable (not shown) was used to connect the receiver (not shown) to the ground point. The outer sheath conductor of the coaxial cable was grounded. The feed terminal is soldered to FM second antenna feed point 31 and the AV cable was used to connect the feed terminal to the ground point.
[0086] As far as DAB antenna 4 was concerned, the feed terminal was soldered to ground side feed point 42 and core wire side feed point 41. The coaxial cable (not shown) was used to connect from the receiver (not shown) to the feed terminal. The core wire of the coaxial cable was connected to core wire side feed point 41 via the feed terminal. The outer sheath conductor of the coaxial cable was connected to core wire side feed point 41 via feed terminal.

<Measurement result of the automotive glass antenna related to example 1>

[Influence of the shape of FM second antenna 3]

[0087] A comparative example in which only FM second antenna was altered from above-described example 1 (first embodiment) and the comparison of the antenna sensitivity of FM second antenna 3 and the comparison between the antenna sensitivities of DAB purpose antenna 4 in example 1 (first embodiment) and in the comparative example was carried out.
[0088] Fig. 7 shows average values of antenna sensitivities in respective frequencies in the frequency bandwidth of 88MHz through 108MHz which is the FM band outside of Japan in all directions (hereinafter, referred simply to as an average antenna sensitivity) in FM second antenna 3 in example 1 described above and related to FM second antenna 3 in the comparative example (which will be described later).
In Fig. 7, a solid line denotes the result of example 1 (first embodiment) and a dot line denotes the comparative example.
A unit of the lateral axis in Fig. 7 is a frequency and each value of the unit is MHz. A longitudinal axis of Fig. 7 denotes the average antenna sensitivity and one scale denotes 10dB.
[0089] It is appreciated from Fig. 7 that FM second antenna 3 in example 1 (first embodiment) obtained the approximately same high average antenna sensitivity as FM second antenna 3 in the comparative example in the frequency bandwidth of 88MHz through 108MHz which is the FM bandwidth of outside of Japan.
[0090] On the other hand, Fig. 8 shows the average antenna sensitivity in the 174MHz through 240MHz which is the bandwidth of band III of DAB which is outside of the FM bandwidth outside of Japan in the case of FM second antenna 3 in the embodiment and in the case of FM second antenna 3 in the comparative example. A solid line denotes example 1 (first embodiment) and a dot line denotes the comparative example. Even in Fig.8, the lateral axis denotes the frequency and unit of the lateral axis denotes MHz. The longitudinal axis of Fig. 8 denotes the average antenna sensitivity and one scale of the longitudinal axis is 10dB.
[0091] It is appreciated from Fig. 8, that FM second antenna 3 in example 1 (the first preferred embodiment) obtained the average antenna sensitivity lower than FM

second antenna 3 related to the comparative example in the frequency band of 174MHz through 240Mz which is band III of DAB purpose antenna 4.

[0092] Fig. 9 shows comparison results of the average antenna sensitivities of band III of DAB purpose antenna 4 in the case of example 1 (the first embodiment) and in the case of the comparative example.

DAB antenna is the same antenna shape between example 1 (first embodiment) and the comparative example. A solid line denotes example 1 (the first embodiment) and a dot line denotes the comparative example. In Fig. 9, the unit of the lateral axis is the frequency and the unit is MHz. The longitudinal axis of Fig. 9 denotes the average antenna sensitivities and one scale is 10dB.

[0093] As shown in Fig. 9, DAB purpose antenna 4 in example 1 obtained a higher average antenna sensitivity in band III of DAB than the comparative example even if the shape of DAB purpose antenna 4 is the same between example 1 and the comparative example and even if, in the comparative example, DAB purpose antenna 4 and FM second antenna 3 are disposed to be more separately than example 1.

[Influence of interval between the DAB purpose antenna and the FM second antenna]

[0094] Fig. 10 shows the variation in the average antenna sensitivity in band III of DAB of DAB purpose antenna 4 when interval **m** between ground side horizontal strip 441 and FM second antenna second strip 322 of FM second antenna 3 is varied.

[0095] In Fig. 10, the unit of the lateral axis is the frequency and the unit is MHz. The longitudinal axis in Fig. 10 denotes the average antenna sensitivities and one scale is 2dB. Triangle marks denote interval **m** = 5mm, square marks denote interval **m** = 10mm, and rhombus marks denote interval **m** =15mm.

As appreciated from Fig. 10, as interval **m** becomes narrower, the higher average antenna sensitivities could be obtained.

Especially, when interval **m** is narrower than 10mm, better average antenna sensitivities in band III of DAB were obtained by the DAB purpose antenna 4.

However, the automotive glass antenna according to the present invention is prepared by the print of generally available conductive paste. Hence, it is desirable to provide about 3mm for the interval between the strips. Hence, a desirable interval **m** is 3mm through 10mm.

[Comparative example]

[0096] In the automotive glass antenna related to the comparative example, the shape of FM second antenna 3 is different as shown in Figs. 11 and 12 and the others are the same as example 1.

The shape, the dimension of FM second antenna 3 and the positional relationship of FM second antenna 3 to DAB purpose antenna 4 will be described using Fig. 12.

[0097] FM second antenna 3 includes: FM second antenna feed point 31 disposed at the left side portion of the rear window glass; and FM second antenna element 32, FM second antenna element 32 being constituted by FM second antenna first strip 321.

[0098] FM second antenna first strip 321 is the horizontally extended strip and one end of FM second antenna first strip 321 is connected to FM second antenna feed point 31. FM second antenna first strip 321 is extended straightly toward the direction of center line r of the rear window glass and the length thereof is 500mm. Then, an interval **s** between FM second antenna first strip 321 and ground side horizontal strip 441 of DAB purpose antenna 4 is **s** = 30mm.

[0099] A ground point (not shown) is disposed on a part of the vehicle body which is placed in proximity of FM second antenna feed point 441. The coaxial cable is connected between receiver (not shown) and the ground point and outer sheath conductor of the coaxial cable is grounded. The feed terminal is soldered to FM second antenna feed point 31 and the AV cable is connected from the feed terminal and the ground point.

[0100] Various changes and modifications can be made without departing from the scope of the following claims.

Claims

1. A glass antenna disposed at an upper section of a defogger (5) of a rear window glass (1) of an automotive vehicle, comprising:

   an FM first antenna (2) receiving an FM broadcasting wave or both of the FM broadcasting wave and an AM broadcasting wave;
   an FM second antenna (3) performing a diversity reception of the FM broadcasting wave together with the first FM antenna; and
   a DAB purpose antenna receiving a DAB broadcasting wave, wherein the FM first antenna (2) is disposed in such a way that a blank space (23) formed by an FM first antenna element (22) and a flange end edge (6) of the automotive vehicle is disposed at an upper part of the defogger when the rear window glass is attached to the automotive vehicle, the FM second antenna (3) and the DAB purpose antenna (4) are disposed on the blank space (23), the FM second antenna (3) includes: an FM second antenna feed point (31) disposed at a side section of the rear window glass (1); and an FM second antenna element (32), the FM second antenna element (32) includes: an FM second antenna first strip (321); and an FM second antenna second strip (322), and FM second antenna first strip (321) has one end connected to the FM second antenna feed point (31), is extended in a direction away from

the FM second antenna feed point (31), and has the other end connected to a tip or to a midway section through the FM second antenna second strip (322).

2. The glass antenna as claimed in claim 1, wherein the FM second antenna second strip (322) of the FM second antenna (3) is overlapped on an antenna element (44) constituting the DAB purpose antenna (4).

3. The glass antenna as claimed in claim 1, wherein the FM second antenna first strip (321) and FM second antenna second strip (322) of the FM second antenna are placed in proximity of the element constituting the DAB purpose antenna and are overlapped on the element constituting the DAB purpose antenna.

4. The glass antenna as claimed in any one of the preceding claims 1 through 3, wherein the DAB purpose antenna (4) includes: a core wire side feed point (41); and a ground side feed point (42), a core wire side antenna element (43) is connected to the core wire side feed point (41), and a ground side antenna element (44) is connected to the ground side feed point (42).

5. The glass antenna as claimed in claim 4, wherein a part or whole of the ground side antenna element (44) of the DAB purpose antenna is placed in proximity to the FM purpose second antenna (322) of the FM second antenna (3) to constitute a capacitive coupling.

6. The glass antenna as claimed in claim 4, wherein a part or whole of the ground side element (44) of DAB antenna (4) is placed in proximity of the FM second antenna first strip (321) and FM second antenna second strip (322) to constitute a capacitive coupling.

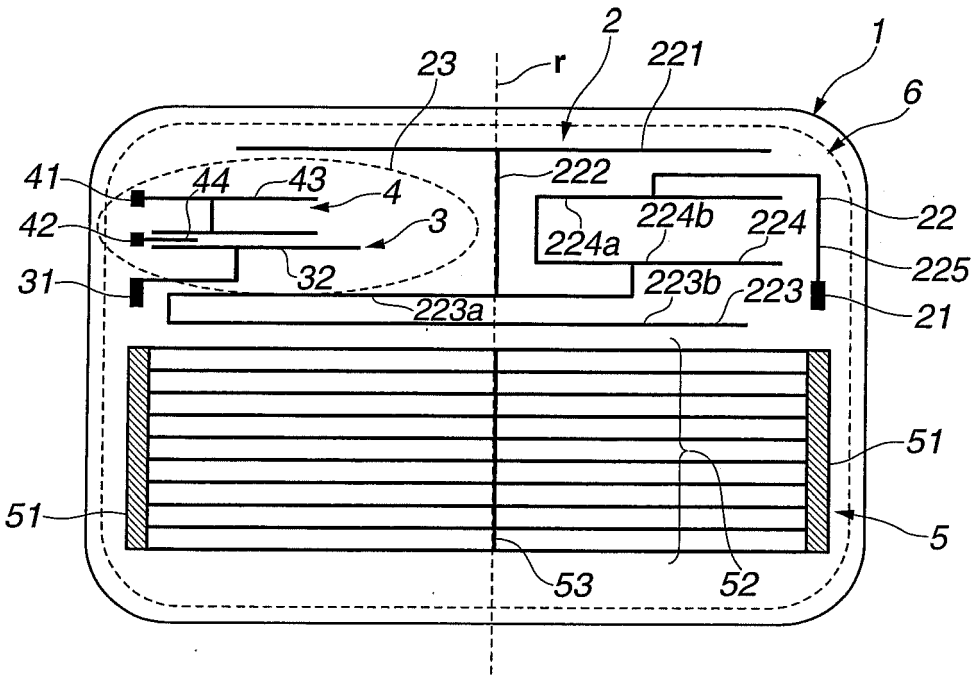
7. The glass antenna as claimed in any one of the preceding claims 2 through 6, wherein the antenna element constituting the DAB antenna (4) and the antenna element (32) constituting the FM second antenna (3) are overlapped to each other with an interval (m) of 3 mm or longer but 10mm or shorter.

8. The glass antenna as claimed in claim 2, wherein the antenna element of the DAB purpose antenna on which the FM second antenna second strip (322) is overlapped is a ground side antenna element (44) connected to a ground side feed point (42) of the DAB purpose antenna.

9. The glass antenna as claimed in claim 3, wherein the antenna element of the DAB purpose antenna on which the FM second antenna first strip (321) and the FM second antenna second strip (322) are overlapped is a ground side antenna element (44) connected to a ground side feed point (42) of the DAB purpose antenna.

10. The glass antenna as claimed in claim 4, wherein the FM second antenna feed point (31), the ground side feed point (42) of the DAB purpose antenna, and the core wire side feed point (41) of the DAB purpose antenna are vertically aligned on the rear window glass.

FIG.1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4
222
42
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32
223b
223
21
223a
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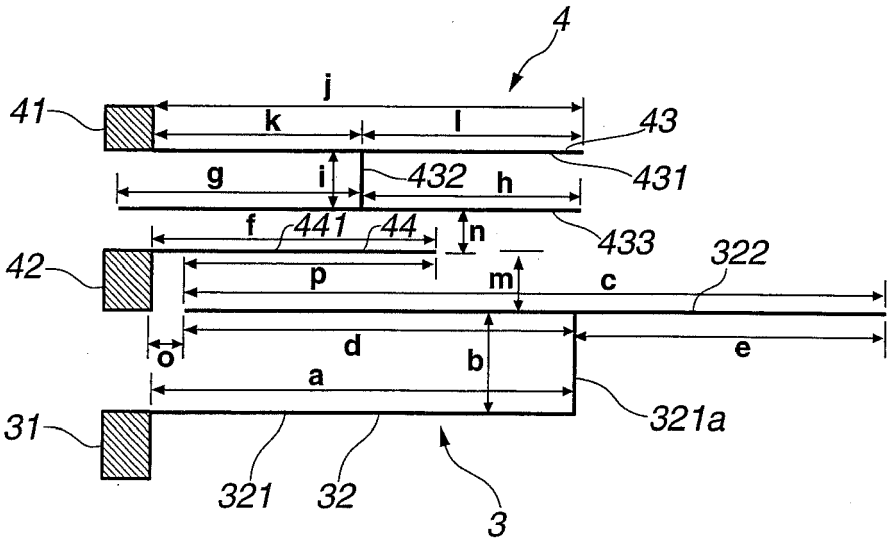
52

FIG.2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441
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3

FIG.3

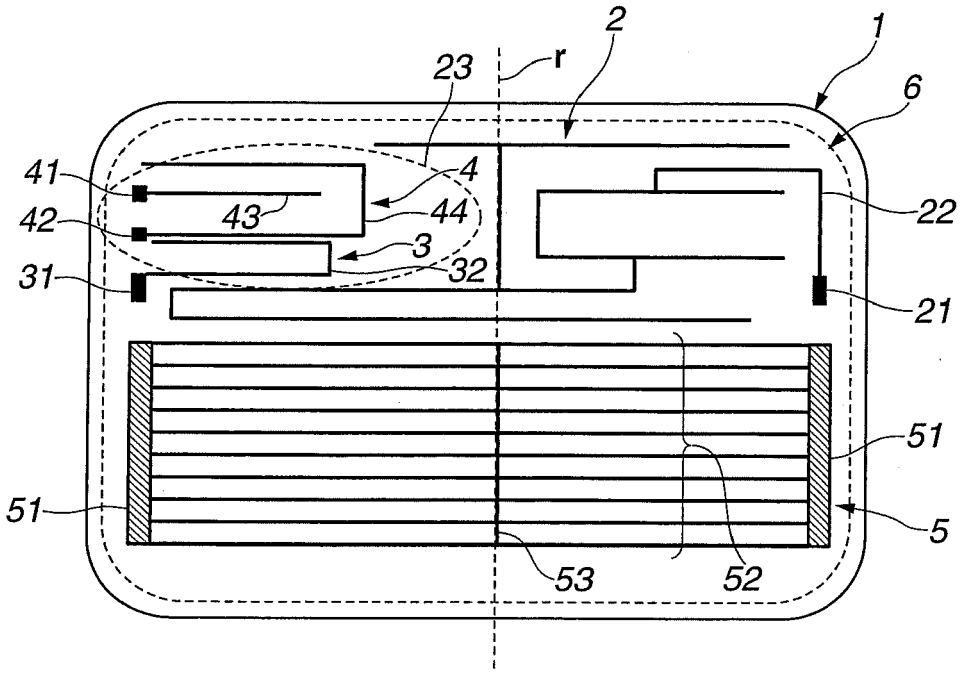
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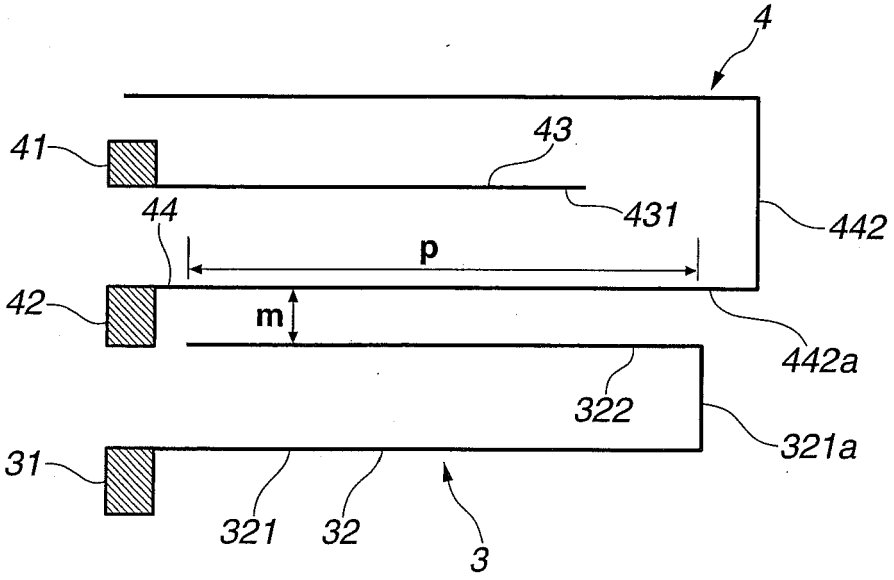
FIG.4


4
41
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p
42
m
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322
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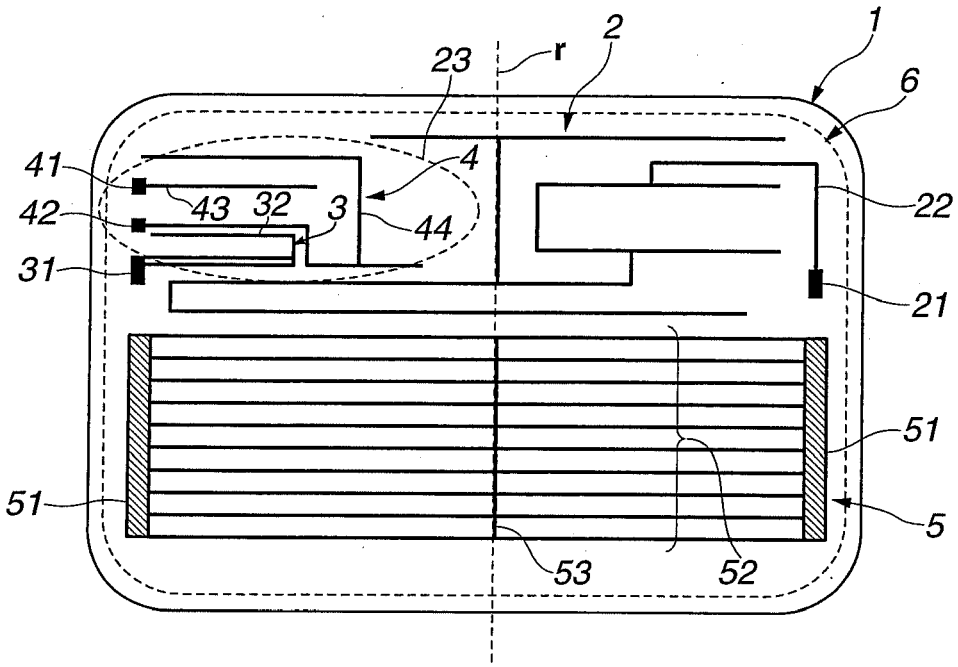
32
3

FIG.5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41
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42
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32
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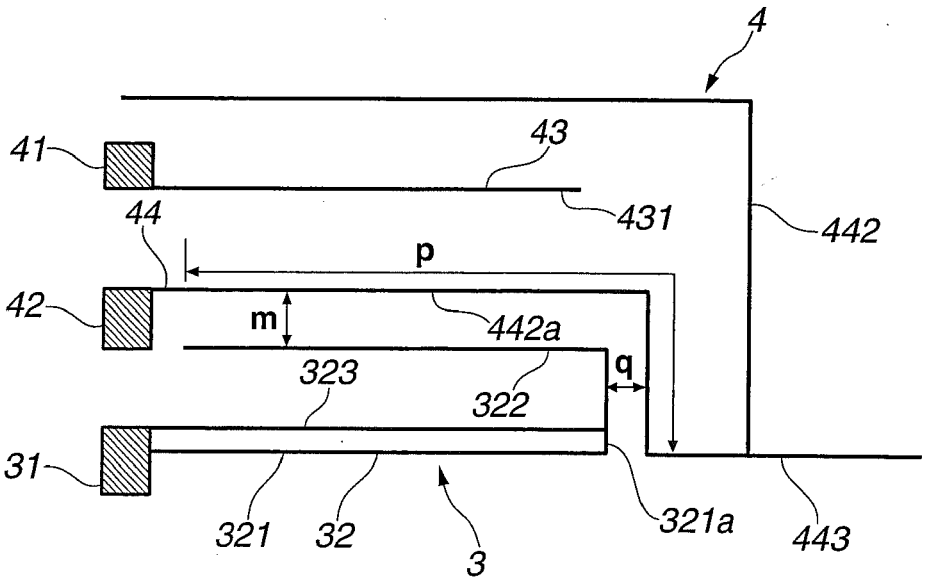
FIG.6


4
41
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44
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442
p
42
m
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323
q
322
31
321
32
3
321a
443

FIG.7

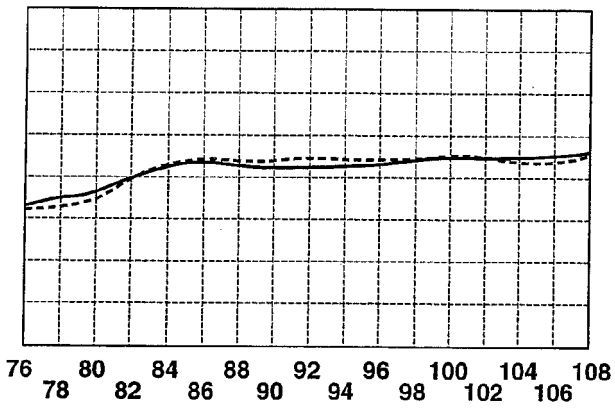


FIG.8

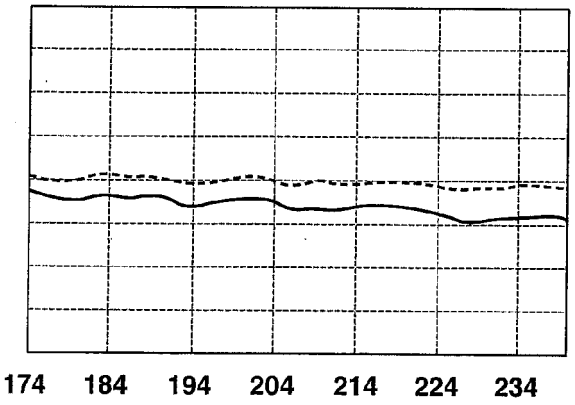


FIG.9

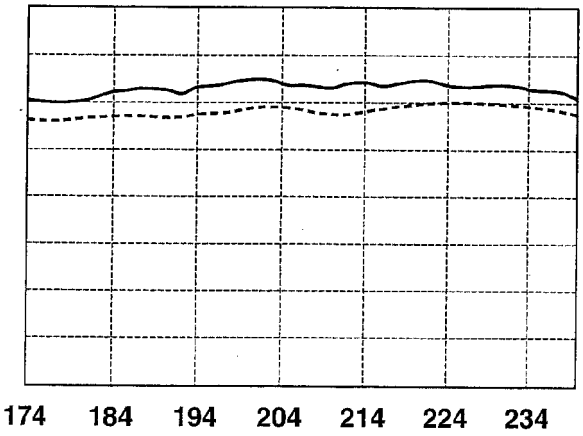


FIG.10

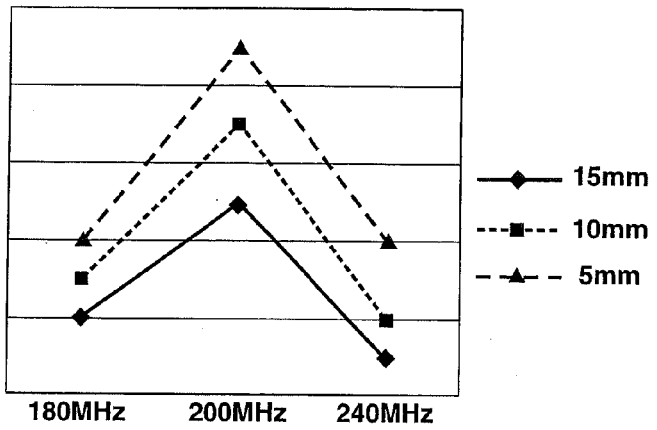


FIG.11

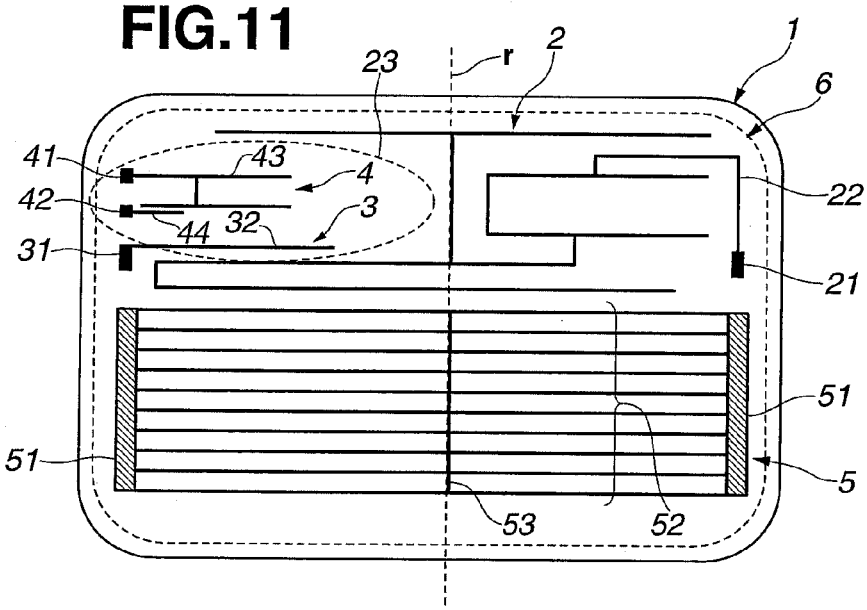
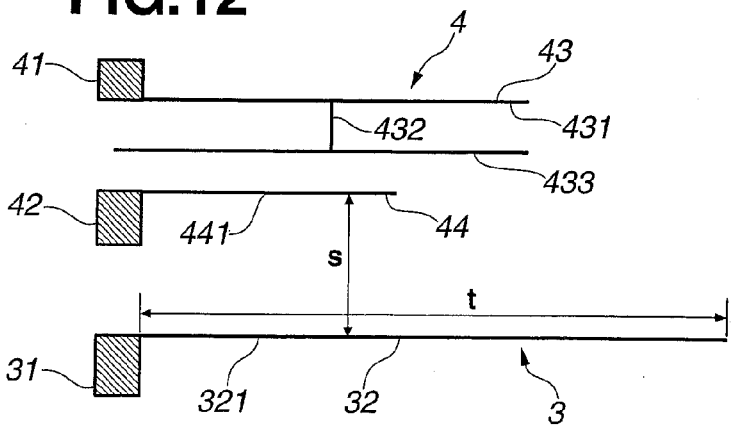


FIG.12



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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 1063

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	EP 2 485 325 A1 (CENTRAL GLASS CO LTD [JP]) 8 August 2012 (2012-08-08)	1-3	INV. H01Q1/12
Y	* paragraph [0015] * * page 10 * * page 32 * * figures 1, 2, 3 *	4-10	
Y	EP 2 581 983 A1 (CENTRAL GLASS CO LTD [JP]) 17 April 2013 (2013-04-17) * paragraph [0017] *	4-10	

TECHNICAL FIELDS SEARCHED (IPC)
H01Q

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

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2485325 A1	08-08-2012	CN 102668239 A	12-09-2012
		EP 2485325 A1	08-08-2012
		JP 5428847 B2	26-02-2014
		JP 2011135405 A	07-07-2011
		KR 20120080648 A	17-07-2012
		US 2012249382 A1	04-10-2012
		WO 2011077874 A1	30-06-2011
EP 2581983 A1	17-04-2013	AU 2011266380 A1	24-01-2013
		CN 102971907 A	13-03-2013
		EP 2581983 A1	17-04-2013
		JP 2012023707 A	02-02-2012
		WO 2011158602 A1	22-12-2011

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Patent documents cited in the description

- JP 2011135405 A **[0005]**
- EP 2485325 A1 **[0005]**