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(54) **Glass antenna and window glass for vehicle**

Glasantenne und Fensterglas für Fahrzeuge

Antenne pour vitre et vitre de fenêtre pour véhicule

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(73) Proprietor: **Asahi Glass Company, Limited**
Chiyoda-ku
Tokyo 100-8405 (JP)

(72) Inventors:
• **Kagaya, Osamu**
Tokyo 100-8405 (JP)
• **Suenaga, Koutarou**
Tokyo 100-8405 (JP)

(74) Representative: **Müller-Boré & Partner**
Patentanwälte
Grafinger Straße 2
81671 München (DE)

(56) References cited:
EP-A- 1 643 587 **EP-A- 1 763 105**
WO-A-00/70708 **WO-A-03/034538**
WO-A1-2004/010529 **US-A1- 2006 132 361**
US-A1- 2008 158 075

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Description

BACKGROUND

1. Field of the Invention

[0001] The present invention relates to a glass antenna for a vehicle in which an antenna conductor and a feeding part are provided in a window glass for the vehicle. Also, the invention relates to a window glass for the vehicle having the glass antenna for the vehicle.

2. Description of the Related Art

[0002] As the prior art, a glass antenna for the vehicle capable of receiving the Digital Audio Broadcasting (DAB) is well known as described in JP-A-10-327009 and JP-A-2000-307321, for example. The DAB has two different frequency bands, including the band III (band 3) from 174 to 240 MHz and the L band from 1452 to 1492 MHz.

[0003] However, in the case where the frequency band is dual band such as DAB as described above, it is difficult to design and manufacture a glass antenna for the vehicle having a reception performance sufficient to support both the bands, because the bands are separated.

[0004] EP 1 643 587 A1 discloses a glass antenna with a feeding terminal and an L-shaped linear conductor.

[0005] WO 03/034538 A1 discloses a loaded antenna that features a similar behaviour through different frequency bands. A key point of the described antenna is the shape of the radiating element of the antenna, which consists of two main parts: a conducting surface and a loading structures. The conducting surface has a polygonal, space-filling or multilevel shape and the loading surface consists of a conducting strip connected to said conducting surface.

[0006] US 2006/0132361 A1 discloses a dual band antenna assembly including a radiating metal strip fabricated on a baseboard. The radiating metal strip includes a winding strip section having heading end and a tail end, a connected strip section having one connecting end coupled integrally to the tail end of the winding strip section and the other connecting end, a lump-like strip section having a first terminal end serving as a feeding pin and a section terminal end coupled integrally to the other connecting end of the connected strip section.

[0007] WO 00/70708 describes a glass antenna device for a vehicle which can receive AM and FM waves with high sensitivity without a choke coil and thus facilitates basic designing and adjustment of its antenna patterns. The described glass antenna device includes a dedicated AM antenna, a dedicated FM antenna and a defogging heater unit in the form of a printed conductor pattern.

[0008] EP 1 763 105 A1 describes a heating line pattern structure, in which the effect of the heating lines of a defogger on an antenna may be decreased. In partic-

ular, the defogger is structured by arranging heating lines between bus bars on both sides. The portions of the uppermost heating line in proximity to the monopole antenna is folded rectangularly at a regular interval to form a meander shape.

[0009] WO 2004/010529 A1 describes a vehicular screen antenna that includes a conductor extending on a dielectric, such as a window. The conductor is configured as a loop having entry and exit segments, the loop being positioned generally centrally on the dielectric. The entry and exit segments extend proximate each other from the loop towards a first edges of the dielectric and are oriented on the dielectric so as to extend generally vertically when the dielectric is fitted to a vehicle.

[0010] US 2008/0158075 A1 describes an antenna that includes a non-conductive pane, a ground plane disposed on the non-conductive pane, and radiating strip disposed on the non-conductive pane for operating in a plurality of frequency bands. The radiation strip defines a plurality of loops. A portion of the periphery of one of the loops coincides with at least a portion of a periphery of another of the loops. The radiating strip also includes at least one branch extending away from the periphery of one of the loops to allow tuning and shifting of the resonant frequencies of the antenna.

SUMMARY

[0011] It is an object of the invention to provide a glass antenna for a window glass for vehicle having the reception performance capable of supporting the dual band such as DAB.

[0012] This object is solved by a glass antenna for a vehicle having the features defined in claim 1. Preferred embodiments are defined in the dependent claims.

[0013] According to some features of the invention, there is provided a glass antenna for a vehicle, the glass antenna including: a feeding part; and an antenna conductor adapted to be disposed in or on a window glass for the vehicle, including: a loop element formed into a loop; a L-shaped element, including: a first antenna element, extending in a first direction from a first point of the loop element; and a second antenna element, extending in a second direction roughly perpendicular to the first direction from an end point of the first antenna element; and a connection element, connecting the feeding part with the second point of the loop element.

[0014] A conductor length of the second antenna element may be 75% or less compared with a summation of a conductor length of the first antenna element, a conductor length of the second antenna element, a conductor length of the connection element, a length of a virtual line segment between the first point and the second point with respect to the first direction, and a length of the virtual line segment with respect to the second direction.

[0015] Further, the window glass may be provided with a second conductor different from the antenna conductor including the loop element, the L-shaped element and

the connection element and a defogger of an energization heating type having a plurality of heater lines and bus bars for feeding power to the heater lines, the second antenna element extending in the blank area between the second antenna conductor and the defogger.

[0016] Further, the second direction may be the horizontal or almost horizontal direction in a state where the window glass for the vehicle is mounted on the vehicle, and the connection element may extend in the opposite direction to the first direction from the second point.

[0017] According to an aspect of the invention, there is provided a window glass for a vehicle, including the glass antenna according to the invention.

[0018] With the invention, it is possible to obtain a reception characteristic capable of supporting the dual band such as DAB.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawing which is given by way of illustration only:

Fig. 1 is a plan view of a glass antenna 100 for a vehicle according to one embodiment of the invention;

Fig. 2 is a plan view of a glass antenna 200 for the vehicle according to one embodiment of the invention;

Fig. 3 is a plan view of a glass antenna 300 for the vehicle according to one embodiment of the invention.

Fig. 4 is a first arrangement example of the glass antenna for the vehicle on the window glass;

Fig. 5 is a second arrangement example of the glass antenna for the vehicle on the window glass;

Fig. 6 is actual measurement data indicating the average value of antenna gain when the peripheral length of loop of the loop element 5 is varied;

Fig. 7 is actual measurement data indicating the average value of antenna gain when x_6 is varied;

Fig. 8 is a frequency characteristic of antenna gain for the glass antenna 100 when x_6 is 2.0 mm and 10.8 mm;

Fig. 9 is a frequency characteristic (band 3) of antenna gain when the arrangement of the loop element 5 is varied;

Fig. 10 is a frequency characteristic (L band) of antenna gain when the arrangement of the loop element 5 is varied;

Fig. 11 is a plan view of a glass antenna 400 for the vehicle according to one embodiment of the invention;

Fig. 12 is a pattern diagram where the AM glass antenna 20A in the basic shape of the AM glass antenna is arranged;

Fig. 13 is a pattern diagram where the AM glass antenna 20B is arranged;

Fig. 14 is a pattern diagram where the AM glass antenna 20C is arranged;

Fig. 15 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 according to each form of the AM glass antenna;

Fig. 16 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 with the pattern of Fig. 13 when the shortest distance w_{10} is varied;

Fig. 17 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 with the pattern of Fig. 14 when the shortest distance w_{10} is varied;

Fig. 18 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 when the length H_b of the right short-circuit line 29 is varied; and

Fig. 19 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 according to the length H_b of the right short-circuit line 29 and a difference in the arrangement location.

DETAILED DESCRIPTION OF THE INVENTION

[0020] The best mode for carrying out the present invention will be described below with reference to the drawings. In the drawings for explaining the mode, the direction denotes the direction on the drawing, unless otherwise stated. Also, these drawings are views from vehicle-exterior side (or views from vehicle-interior side) in the state where the window glass is mounted on the vehicle, and the lateral direction on the drawing corresponds to the horizontal direction. Also, in the case where the window glass is the backlite mounted at the rear part of the vehicle, for example, the lateral direction on the drawing corresponds to a width direction of the vehicle. The invention is not limited to the backlite, but may be also applied to the windscreen mounted at the front part of the vehicle or the side window mounted on the side of the vehicle.

[0021] Fig. 1 is a plan view of a glass antenna 100 for the vehicle according to one embodiment of the invention. The glass antenna 100 for the vehicle is one in which an antenna conductor and a feeding part are provided on a window glass 12 for the vehicle. The glass antenna 100 for the vehicle has a structure in which an antenna conductor includes a loop element 5 formed like a loop and a L-shaped element formed like a L-shape including an antenna element 1 of the first antenna element extending in a first direction roughly perpendicular to the horizontal direction, starting from a first point 5a that is a point on the loop element 5, and an antenna element 2 of the second antenna element extending in a second direction that is the direction roughly perpendicular to the first direction, starting from a first terminal portion 1g of the antenna element 1 extending in the first direction,

and a connection element 6 connected to a feeding part 18 at a connection point 6a, extending in a third direction (direction 180° opposite to the first direction in Fig. 1) that is the direction leaving away from the L-shaped element, starting from a second point 5b that is a point on the loop element 5. The L-shape also includes the bisymmetrical shape of the L-shape, and the angle may be bent with a curvature. Also, the terminal portion may be the end of the extending antenna element, or near the end of the conductor portion before the end.

[0022] The glass antenna 100 for the vehicle, which is a single pole (monopole) antenna, can pick up a reception signal obtained from the antenna conductor from the feeding part 18 on the positive pole side (hot side), whereby the reception signal is transmitted to a receiving apparatus (not shown). In the case of the single pole antenna, an opening portion of the vehicle body on which the window glass 12 is mounted or its neighborhood may be usable as the ground (capable of taking a so-called body earth). The glass antenna for the vehicle is in a suitable form if the feeding part 18 is disposed near the upper or lower marginal part of the opening portion of the vehicle body. In Fig. 1, it is disposed near the upper marginal part 15a of the opening portion of the vehicle body.

[0023] The feeding part 18 is a feeding point at which the feeder cable connected to the receiving apparatus is electrically connected. When an AV cable is employed as the feeder cable, the feeding part 18 is connected to an amplifier installed on the vehicle side, with the body earth taken on the ground of the amplifier. At this time, providing a structure of the feeding part 18 mounted with a connector for electrically connecting the AV cable and the feeding part 18, the AV cable can be more easily attached to the feeding part 18.

[0024] In the case where a coaxial cable is employed, an inner conductor of the coaxial cable is electrically connected to the feeding part 18, and an outer conductor of the coaxial cable is electrically connected to an earth part provided on the vehicle body or window glass 12. Providing a structure of the feeding part 18 mounted with a connector for electrically connecting the coaxial cable with the feeding part 18, the coaxial cable can be more easily attached to the feeding part 18.

[0025] In the case where an amplification circuit for amplifying the reception signal picked up from the feeding part 18 is contained in the connector mounted on the feeding part 18, it is necessary that the ground of the amplification circuit is electrically connected to a ground portion such as the outer conductor of the coaxial cable, the feeding part 18 is electrically connected to the input side of the amplification circuit, and the inner conductor of the coaxial cable is connected to the output side of the amplification circuit.

[0026] The shape of the feeding part 18 may be decided depending on the tip shape of the feeder cable directly attached to the feeding part 18 or the shape of the connection member for connecting the feeding part 18 and the feeder cable (e. g. , the shape of the mounting surface

or contact terminal of the connector). For example, the square shape like regular square, square, rectangle or oblong, or the polygonal shape is preferable in the respect of mounting. The circular shape like circle, rough circle, ellipse or oval may be also possible.

[0027] Fig. 1 shows the feeding part 18 of square shape. A connection point 6a with the connection element 6 is located on the lower side of the feeding part 18. The connection point 6a is the center point of the lower side of the feeding part 18 in Fig. 1, but may be any position on the lower side, or a point of intersection of the right side or left side and the lower side of the feeding part 18. The connection element 6, which is extended in the direction away from the feeding part 18, connects the feeding part 18 and the loop element 5.

[0028] The loop element 5 is the antenna conductor formed like a loop. Like a loop means in the shape of loop formed in same line width, or partly in greater line width to be looped. The shape of the loop element is circular like circle, rough circle, ellipse or oval, rectangular like regular square, square, rectangle, oblong, parallelogram, rough parallelogram, lozenge or rough lozenge, or polygonal. The shape of the loop element 5 of Fig. 1 is square. A connection point 5a with the antenna element 1 and a connection point 5b with the connection element 6 are located on a conductor part of the loop element 5. For a virtual line in the horizontal direction passing through the center of gravity of the loop element 5, the connection point 5a is located on the one side (lower side) and the connection point 5b is located on the other side (upper side). The connection points 5a and 5b of Fig. 1 are located on the straight line parallel to the first direction. Also, the connection point 5b is the center point of the upper side of the loop element 5 in Fig. 1, but may be any position on the upper side, or a point of intersection of the left side or right side and the upper side of the loop element 5 (see Figs. 2 and 3 that are the plan views of the glass antennae 200 and 300 for the vehicle according to the embodiment of the invention).

[0029] Also, the connection point 5b with the connection element 6 may be any position on the right side or left side of the loop element 5. Fig. 11 is a plan view of a glass antenna 400 for the vehicle according to one embodiment of the invention. The glass antenna 400 for the vehicle is in a suitable form if the feeding part 18 is disposed near the left or right marginal part of the opening portion of the vehicle body. In Fig. 11, it is disposed near the right marginal part 15b of the opening portion of the vehicle body.

[0030] It is required that the antenna element 1 extends in the lower direction (first direction), starting from the connection point 5a, with the terminal portion 1g as the end point. The connection point 5a is the center point of the lower side of the loop element 5 in Fig. 1, but may be any position on the lower side, or a point of intersection of the left side or right side and the lower side of the loop element 5 (see Figs. 2 and 3).

[0031] It is required that the antenna element 2 extends

in the left direction (second direction), starting from the terminal portion 1g, with a terminal portion 2g as the end point. It may extend in the right direction (i. e. , direction 180° opposite to the second direction). It is suitable that the direction (second direction) where the antenna element 2 extends is parallel or almost parallel to the horizontal direction in a state where the window glass 12 is mounted on the opening portion of the vehicle body because the antenna gain is better than unparallel.

[0032] It is preferred in the respect of improving the antenna gain that the conductor length x2 of the antenna element 2 is 75% or less (particularly 50% or less) of the total length of summing the conductor length x1 of the antenna element 1, the conductor length x2 of the antenna element 2, the conductor length x6 of the connection element 6, the length (Ly in Fig. 1) of the first direction component of a virtual line segment having the connection point 5a and the connection point 5b at both ends, and the length (zero in Fig. 1) of the second direction component of the virtual line segment.

[0033] In the invention, supposing that the wavelength in the air at a center frequency of a first broadcast frequency band is λ_{01} , the wavelength in the air at a center frequency of a second broadcast frequency band that is higher in band than the first broadcast frequency band is λ_{02} , the glass shortening coefficient of wavelength is k ($k=0.64$), $\lambda_{g1}=\lambda_{01}\cdot k$ and $\lambda_{g2}=\lambda_{02}\cdot k$, the antenna gain is improved by the total length ($x1+x2+x6+Ly$) being from $0.25\cdot\lambda_{g1}$ to $0.41\cdot\lambda_{g1}$, particularly from $0.27\cdot\lambda_{g1}$ to $0.39\cdot\lambda_{g1}$. The antenna gain is improved by the peripheral length ($Lx\times 2+Ly\times 2$) of loop of the loop element 5 being from $0.92\cdot\lambda_{g2}$ to $1.23\cdot\lambda_{g2}$, particularly from $0.98\cdot\lambda_{g2}$ to $1.17\cdot\lambda_{g2}$.

[0034] That is, the total length ($x1+x2+x6+Ly$) is set based on the length resonating in the band 3, and the peripheral length ($Lx\times 2+Ly\times 2$) of loop is set based on the length resonating in the L band.

[0035] For example, if the band 3 (174 to 240 MHz) is set as the first broadcast frequency band, the center frequency is 207 MHz, in which λ_{g1} at 207 MHz is 927.5 mm. Also, if the L band (1452 to 1492 MHz) is set as the second broadcast frequency band, the center frequency is 1472 MHz, in which λ_{g2} at 1472 MHz is 130.4 mm.

[0036] Accordingly, it is preferred in the respect of improving the antenna gain in the band 3 that the total length ($x1+x2+x6+Ly$) is specifically from 230 to 380 mm (particularly from 250 to 360 mm), and it is preferred in the respect of improving the antenna gain in the L band that the peripheral length ($Lx\times 2+Ly\times 2$) of loop of the loop element 5 is from 120 to 160 mm (particularly from 128 to 152 mm). If the shape of the loop element 5 is quadrilateral, one side corresponds to 30 to 40 mm (particularly 32 to 38 mm).

[0037] Also, it is preferred in the respect of improving the antenna gain in the L band that the relationship between the maximum lateral width Lx in the horizontal direction and the maximum longitudinal width Ly in the vertical direction orthogonal to the horizontal direction of the

loop shape of the loop element 5 is $Lx/Ly=0.17$ to 6.00 (particularly 0.27 to 3.67). More specifically, it is preferred in the respect of improving the antenna gain in the L band that Lx: 10 mm / Ly: 60 mm to Lx: 60 mm / Ly: 10 mm (particularly Lx: 15 mm / Ly: 55 mm to Lx: 55 mm / Ly: 15 mm).

[0038] For example, if the shape of the loop element 5 is rectangular, the maximum longitudinal width Ly and the maximum lateral width Lx correspond to the lengths of the short side and the long side of the rectangle. In Fig. 1, the shape of the loop element 5 is square, whereby $Lx/Ly=1$.

[0039] Also, in the invention, a first broadcast frequency band and a second broadcast frequency band that is higher in band than the first broadcast frequency band are provided, and when the wavelength in the air at a center frequency of the first broadcast frequency band is λ_{01} , the glass shortening coefficient of wavelength is k ($k=0.64$), and $\lambda_{g1}=\lambda_{01}\cdot k$, it is preferred in the respect of improving the antenna gain in the band 3 that the conductor length x6 of the connection element 6 is $0.16\cdot\lambda_{g1}$ or less, particularly $0.083\cdot\lambda_{g1}$ or less. More specifically, it is preferred in the respect of improving the antenna gain in the band 3 that the conductor length x6 is 141 mm or less, particularly 77 mm or less.

[0040] Further, it is preferred in the respect of improving the antenna gain near 200 MHz in the band 3 that the conductor length x6 of the connection element 6 is $0.011\cdot\lambda_{g1}$ or less, particularly $0.005\cdot\lambda_{g1}$ or less. More specifically, it is preferred in the respect of improving the antenna gain that the conductor length x6 is 10 mm or less, particularly 5 mm or less.

[0041] Fig. 4 shows an example in which the glass antenna according to the invention is arranged on the window glass 12. Four glass antennae are arranged on an upper left area, an upper right area, a lower left area and a lower right area of the window glass 12. Reference sign 15a denotes an upper side on an opening edge of the vehicle body, reference sign 15b denotes a right side on an opening edge of the vehicle body, reference sign 15c denotes a lower side on an opening edge of the vehicle body, and reference sign 15d denotes a left side on an opening edge of the vehicle body. In Fig. 4, if the window glass 12 is the backlite, a defogger (not shown) is formed in the central area. However, alternatively, it may be provided in at least one of the four areas. Also, it may be provided on a central upper area, a central lower area, a central left area or a central right area.

[0042] If the glass antenna in the upper right area is disposed in a state of Fig. 4, the glass antenna in the upper left area may be disposed in bilateral symmetry to the shape of the glass antenna in the upper right area in a state shown in the upper left area of Fig. 4.

[0043] In the case where a plurality of glass antennae are installed as described above, the diversity reception is performed, whereby the reception characteristic is favorably improved.

[0044] An auxiliary antenna conductor is not affixed to

the above glass antenna. However, additionally, an auxiliary antenna element in the shape of T-shape, L-shape or loop may be affixed via or not via a connection conductor to the antenna element for impedance matching, phase adjustment or directivity adjustment.

[0045] Also, the glass antenna may be constructed by providing a conductor layer of antenna conductor inside or on the surface of a synthetic resin film, and forming the synthetic resin film with the conductor layer on the surface of vehicle-interior side or surface of vehicle-exterior side of a window glass plate. Further, the glass antenna may be made by forming a flexible circuit board formed with the antenna conductor on the surface of vehicle-interior side or surface of vehicle-exterior side of the window glass plate.

[0046] A mounting angle of the window glass plate to the vehicle is preferably from 15 to 90° to the horizontal direction, and more preferably from 30 to 90°.

[0047] The antenna conductor is formed by printing and firing a paste containing conductive metal such as silver paste on the surface of vehicle-interior side of the window glass. However, instead of this forming method, the antenna conductor may be made by forming a filament or foil member made of conductive material such as copper on the surface of vehicle-interior side or surface of vehicle-exterior side of the window glass plate or pasting it on the window glass by adhesives. The antenna conductor may be formed into the window glass. The feeding part 18 is similarly treated.

[0048] Also, a masking film may be formed on the plane of the window glass, and part or all of the antenna conductor may be provided on the masking film. The masking film is made of ceramics, such as a black ceramic film. In this case, seeing the window glass from outside of the vehicle, part of the antenna conductor provided on the masking film is hidden from outside of the vehicle owing to the masking film, so that the window glass of excellent design is produced. In the illustrated configuration, if at least the feeding part and a part of the antenna conductor are formed on the masking film, only a slender line portion of the conductor is visible in view from vehicle-interior side, which is favorable in design.

[0049] Fig. 5 (view from vehicle-exterior side or view from vehicle-interior side) shows an upper right area of the backlite 12 in the arrangement in which the backlite 12 is provided with the glass antenna according to an embodiment of the invention. The backlite 12 is provided with a plurality of heater lines, a plurality of bus bars (only one shown in Fig. 5) for feeding power to the plurality of heater lines, in which a defogger 30 is composed of the plurality of heater lines and the plurality of bus bars. In Fig. 5, reference sign 30a denotes the highest level heater line, and reference sign 30b denotes the bus bar. Also, reference sign 40 denotes one example of the glass antenna for receiving the digital television broadcasting which is arranged in an upper marginal area of the defogger 30. Also, reference sign 20 denotes one example of the glass antenna for receiving the AM broadcasting

which is arranged in an upper marginal area of the defogger 30. Reference sign 20a denotes the lowest level antenna element of the AM glass antenna 20. It is preferred in the respect of improving the antenna gain that the glass antenna according to the invention is arranged so that the antenna element 2 may extend in a blank area between the antenna element 20a and the heater line 30a.

[0050] That is, in the invention, it is preferred in the respect of improving the antenna gain in the L band that the window glass 12 for the vehicle is provided with an independent conductor (AM glass antenna 20 in Fig. 5) not DC connected with the antenna conductor having the loop element 5, the antenna elements 1 and 2 and the connection element 6, in the blank area on the peripheral side of the window glass for the vehicle from the antenna element 2. Also, it is more preferred that the defogger (defogger 30 in Fig. 5) of the energization heating type having the plurality of heater lines and the bus bar for feeding power to the plurality of heater lines is provided and the antenna element 2 extends in the blank area between the independent conductor and the defogger.

[0051] In this case, a first broadcast frequency band and a second broadcast frequency band that is higher in band than the first broadcast frequency band are provided, and when the wavelength in the air at a center frequency of the second broadcast frequency band is λ_{02} , the glass shortening coefficient of wavelength is k ($k=0.64$), and $\lambda_{g2}=\lambda_{02}\cdot k$, it is preferred in the respect of improving the antenna gain that the minimum value of the second direction component in an interval between the antenna conductor and the independent conductor on the same horizontal plane is from $0.008\cdot\lambda_{g2}$ to $0.39\cdot\lambda_{g2}$, particularly from $0.008\cdot\lambda_{g2}$ to $0.23\cdot\lambda_{g2}$. More specifically, it is preferred in the respect of improving the antenna gain that the minimum value of the second direction component in the interval between the antenna conductor and the independent conductor on the same horizontal plane is from 1 mm to 50 mm, particularly from 1 mm to 30 mm.

[0052] It is preferred in the respect of providing reception ability for the frequency band of AM broadcasting that the independent conductor has a plurality of liner conductors running in parallel in the second direction and electrically connected to a second feeding part (e. g. , feeding part provided on the left end of the AM glass antenna 20, though not shown in Fig. 5) different from the feeding part 18. Also, the adjacent liner conductors of the plurality of liner conductors may have at least one short-circuit part connected by the short-circuit line, starting from the leading end of at least one of the adjacent liner conductors on the antenna conductor side.

[0053] In this case, it is preferred in the respect of improving the antenna gain in the band III that a first broadcast frequency band and a second broadcast frequency band that is higher in band than the first broadcast frequency band are provided, and when the wavelength in the air at a center frequency of the second broadcast

frequency band is λ_{02} , the glass shortening coefficient of wavelength is k ($k=0.64$), and $\lambda_{g2}=\lambda_{02}\cdot k$, a length with respect to the first direction of the short-circuit line connected to a leading end, which is disposed nearest to the peripheral edge of the window glass among leading ends of the plurality of liner conductors at the side of the antenna conductor, falls within a range from 0 to $0.19\cdot\lambda_{g2}$. Particularly, it is preferably from 0 to $0.15\cdot\lambda_{g2}$. More specifically, it is preferred in the respect of improving the antenna gain in the band III that the length with respect to the first direction of the short-circuit line connected to a leading end, which is disposed nearest to the peripheral edge of the window glass among leading ends of the plurality of liner conductors at the side of the antenna conductor, falls within a range from 0 to 25 mm, particularly from 0 to 20 mm. That is, the short-circuit line connected to the leading end nearest to the peripheral edge of the window glass for the vehicle is not provided or should be limited to the above length.

[0054] Further, in the invention, it is preferred in the respect of improving the antenna gain in the band III that there is at least one open end not connected by the short-circuit line between the leading end of at least one of the adjacent conductors of the plurality of liner conductors on the side of the antenna conductor and the paired liner conductor, and the total sum of the distance of the first direction component in the open end is 30% or more of the distance of the first direction component between the highest and lowest levels of the leading end of the plurality of liner conductors on the side of the antenna conductor. Particularly, it is preferably 60% or more.

[0055] Also, in the invention, it is preferred in the respect of improving the antenna gain that the independent conductor includes the plurality of liner conductors running in parallel in the second direction, in which all the leading end of the adjacent liner conductors of the plurality of liner conductors on the side of the antenna conductor are not DC connected, namely, open (open ended).

[Examples]

[Example 1]

[0056] For a high-frequency glass antenna for automobile fabricated by mounting a form of the glass antenna 100 as shown in Fig. 1 on the upper right side of the backlite in view from vehicle-interior side in the actual vehicle, varied the peripheral length of loop of the loop element 5, the antenna gain of the glass antenna 100 corresponding to each of them was measured with respect to each angles while the vehicle is turned 360 degrees, and the average antenna gain was calculated.

[0057] At this time, the dimension of each part of the glass antenna 100 as shown in Fig. 1 is,

x1 : 78 mm

(continued)

x2 : 164 mm
x6 : 2 mm

[0058] The conductor width of each antenna element for the glass antenna 100 is 0.8 mm.

[0059] The measurement of the antenna gain was made by radiating electric wave over the automobile in which the window glass is inclined by 15° to the horizontal direction, and rotating the automobile 360° for every angle of 2° . The electric wave was vertically polarized wave, and the frequency was varied for every 10 MHz in each range of the band 3 and the L band. The elevation angle between the originating position of electric wave and the antenna conductor was measured in the horizontal direction (the direction at elevation angle = 0° , assuming that the elevation angle is 0° on the plane parallel to the ground, and the elevation angle is 90° in the zenith direction). The antenna gain was normalized on the basis of a half wave dipole antenna (both the band III and the L band) so that the half wave dipole antenna might be 0dB.

[0060] Fig. 6 is actual measurement data indicating the average value of antenna gain acquired by the above method when the peripheral length of loop of the loop element 5 is varied. In Fig. 6, the antenna gain along the longitudinal axis indicates the average value of antenna gain for every 10 MHz in the range from 170 to 240 MHz as the frequency corresponding to the band 3 and the average value of antenna gain for every 10 MHz in the range from 1450 to 1490 MHz as the frequency corresponding to the L band.

[0061] As the peripheral length of loop is greater, the antenna gain increases, and when the peripheral length of loop is 140 mm, the antenna gain is maximum, as shown in Fig. 6. Accordingly, it can be found that the excellent antenna gain is obtained by making the peripheral length of loop from 120 mm to 160 mm (particularly from 128 mm to 152 mm).

[Example 2]

[0062] Subsequently, for a high-frequency glass antenna for automobile fabricated by mounting a form of the glass antenna 100 as shown in Fig. 1 on the upper right side of the backlite in view from vehicle-interior side in the actual vehicle, varied the position of the loop element 5 in the vertical direction without varying the total length ($x1+x2+x6+Ly$), the antenna gain of the glass antenna 100 corresponding to each of them was measured with respect to each angles while the vehicle is turned 360 degrees, and the average antenna gain was calculated.

[0063] At this time, the dimension of each part of the glass antenna 100 as shown in Fig. 1 is,

total length (x1+x2+x6+Ly) : 279 mm
 x2 : 164 mm
 Lx : 35 mm
 Ly : 35 mm

[0064] The conductor width of each antenna element for the glass antenna 100 is 0.8 mm. The measurement of the antenna gain was made by the same method as the example 1.

[0065] Fig. 7 is actual measurement data indicating the average value of antenna gain acquired by the above method when x6 is varied. In Fig. 7, the antenna gain along the longitudinal axis indicates the average value of antenna gain for every 10 MHz in the range from 170 to 240 MHz as the frequency corresponding to the band 3 and the average value of antenna gain for every 10 MHz in the range from 1450 to 1490 MHz as the frequency corresponding to the L band.

[0066] As x6 is smaller, the antenna gain increases, and when x6 is smaller from near 140 mm, the antenna gain has the high value, as shown in Fig. 7. That is, it can be found that the excellent antenna gain is obtained by shortening the connection element 6 (making the loop element 5 closer to the feeding part 18) especially in the band 3.

[0067] Fig. 8 is the frequency characteristic of antenna gain for the glass antenna 100 where x6 is 2.0 mm and 10.8 mm. In Fig. 8, the antenna gain along the longitudinal axis indicates the average value of antenna gain for every 10 MHz in the range from 170 to 240 MHz as the frequency corresponding to the band 3 and the average value of antenna gain for every 10 MHz in the range from 1450 to 1490 MHz as the frequency corresponding to the L band.

[0068] From the results of Fig. 7, though 2.0 mm and 10.8 mm indicate the high antenna gain as the average value, the antenna gain where x6 is 2.0 mm is better at a specific frequency (near 200 MHz) than the antenna gain where x6 is 10.8 mm, as shown in Fig. 8. Accordingly, it can be found that the antenna gain is excellent over the entire frequency band range of the band 3 by setting the connection element 6 to 10 mm or less. Since the antenna characteristic in the L band was hardly changed, the graph is omitted.

[Example 3]

[0069] Subsequently, for a high-frequency glass antenna for automobile fabricated by mounting each form of the glass antennae 100, 200 and 300 as shown in Figs. 1, 2 and 3, which are different from one another in the arrangement of the loop element 5, on the upper right side of the backlite in view from vehicle-interior side in the actual vehicle, the antenna gain for each glass antenna was measured with respect to each angles while the vehicle is turned 360 degrees, and the average an-

tenna gain was calculated.

[0070] At this time, the dimension of each part of the glass antennae 100, 200 and 300 is,

x1 : 78 mm
 x2 : 164 mm
 x6 : 2 mm
 Lx : 35 mm
 Ly : 35 mm

[0071] The conductor width of each antenna element for the glass antenna 100 is 0.8 mm. The measurement of the antenna gain was made by the same method as the example 1.

[0072] Fig. 9 is the frequency characteristic of antenna gain for the band 3 and Fig. 10 is the frequency characteristic of antenna gain for the L band where the arrangement of the loop element 5 is varied as shown in Figs. 1, 2 and 3. Even if the arrangement or orientation of the loop element 5 is varied, the equivalent antenna characteristic is obtained as shown in Figs. 9 and 10.

[Example 4]

[0073] Subsequently, a high-frequency glass antenna for automobile was fabricated by mounting a pattern in which the antenna element 2 extends in the blank area between the AM glass antenna and the defogger on the actual backlite.

[0074] Fig. 12 is a pattern diagram where an AM glass antenna 20A in the basic shape of the AM glass antenna is arranged. The basic dimension of each part of the AM glass antenna 20A is,

w1 : 375 mm
 w2 : 335 mm
 w3 to w7 : 20 mm
 w8 : 40 mm
 w9 : 20 mm
 w10 : 10 mm
 w11 : 1070 mm
 w12 : 150 mm

[0075] Where w1 is the distance in the width direction of the vehicle between an intermediate short-circuit line 28 short-circuiting a plurality of liner conductors 21 to 26 near the center of each liner conductor and a left short-circuit line 27 short-circuiting the plurality of liner conductors 21 to 26 at the leading end on the left side (leading end on the opposite side of the glass antenna 100) of each liner conductor; w2 is the distance in the width direction of the vehicle between the intermediate short-circuit line 28 and a right short-circuit line 29 short-circuiting the plurality of liner conductors 21 to 26 at the leading end on the right side of each liner conductor; w3 to w7 are the distances between each liner conductor;

w8 is the distance between the lowest level liner conductor 26 among the liner conductors of the AM glass antenna 20A and the highest level heater line 30a among the heater lines between the bus bars 30b and 30c of the defogger 30; w9 is the distance between the liner conductor 26 and the antenna element 2; w10 is the shortest distance in the width direction of the vehicle between the glass antenna 100 and the AM glass antenna 20A (the distance between the right short-circuit line 29 and the left side 5e of the loop element 5 in Fig. 12); w11 is the length of the heater line 30a; and w12 is the distance between the upper marginal part 15a of the opening portion of the vehicle body and the heater line 30a. The conductor width of each antenna element and the short-circuit line for the AM glass antenna 20A is 0.8 mm.

[0076] Also, as the other shapes of the AM glass antenna, a high-frequency glass antenna for automobile in the case of an AM glass antenna 20B as shown in Fig. 13 and a high-frequency glass antenna for automobile in the case of an AM glass antenna 20C as shown in Fig. 14 were fabricated.

[0077] The AM glass antenna 20B is formed with the open ends 41 to 45 opening in the width direction of the vehicle to the glass antenna 100 because the right leading end of the liner conductors 21 to 26 are not connected (i.e., by deleting the right short-circuit line 29 of Fig. 12). In the pattern of Fig. 13, the dimension and the left half form are omitted, but the same as the pattern of Fig. 12.

[0078] The AM glass antenna 20C is formed with two open ends 42 and 44 opening in the width direction of the vehicle to the glass antenna 100. That is, a short-circuit part 29b for short-circuiting the liner conductors 22 and 23 and a short-circuit part 29d for short-circuiting the liner conductors 24 and 25 are arranged at the positions displaced from the right leading end on the central part side of the AM glass antenna 20C in the width direction of the vehicle, thereby forming a meander shape at the right terminal portion of the AM glass antenna 20C. In the pattern of Fig. 14, the dimension and the left half form are omitted, but the same as the pattern of Fig. 12. In the case of the pattern of Fig. 14, the total sum of the vertical length of the right short-circuit lines 29a, 29c and 29e connecting the right leading ends (in other words, total length of the right short-circuit line 29 in Fig. 12) corresponds to 60% ($= (3/5) \times 100[\%]$) of the vertical distance between the right leading end of the highest level liner conductor 21 and the right leading end of the lowest level liner conductor 26. In the case of the pattern of Fig. 13, it corresponds to 0%. In this case, the total sum of the length between the open ends corresponds to 40% of the distance in the vertical direction between the right leading end of the highest level liner conductor 21 and the right leading end of the lowest level liner conductor 26.

[0079] Next, for a high-frequency glass antenna for automobile fabricated by mounting each pattern of Figs. 12, 13 and 14 on the actual backlite, which are different from one another in the form of the AM glass antenna, the antenna gain for each glass antenna was measured with

respect to each angles while the vehicle is turned 360 degrees, and the average antenna gain was calculated. The measurement of the antenna gain was made by the same method as the example 1.

[0080] Fig. 15 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 according to each form of the AM glass antenna. "Open" designates the pattern of Fig. 13; "Short" designate the pattern of Fig. 12; "Meander" designates the pattern of Fig. 14; and "Without-AM" designates the case where the AM glass antenna itself is not provided. As shown in Fig. 15, if the AM glass antenna corresponding to a independent conductor is provided for the glass antenna 100 on the upper side of the antenna element 2 and on the left side of the antenna element 1, the antenna gain in the L band improves while the antenna gain in the band 3 is kept high. Among these patterns, the pattern (pattern of Fig. 14) in which at least part of the right short-circuit line at the right end of the AM glass antenna is open ended (open) is excellent in the respect of improving the antenna gain of the glass antenna 100, and particularly the pattern (pattern of Fig. 13) in which all the right ends are open is more excellent.

[Example 5]

[0081] Subsequently, for each pattern of Figs. 13 and 14 for which the favorable results are obtained in the example 4, varied the shortest distance w2 between the AM glass antenna and the glass antenna 100, the antenna gain of the glass antenna 100 corresponding to each of them was measured with respect to each angles, while the vehicle is turned 360 degrees, and the average antenna gain was calculated. At this time, in the case where the AM glass antenna itself is not provided, it was calculated on the basis of the antenna gain of "Without-AM" so that the antenna gain of "Without-AM" might be 0dB.

[0082] Fig. 16 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 with the pattern of Fig. 13 when the shortest distance w10 is varied. Fig. 17 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 with the pattern of Fig. 14 when the shortest distance w10 is varied. In Figs. 16 and 17, the antenna gain along the longitudinal axis indicates the average value of antenna gain for every 10 MHz in the range from 170 to 240 MHz as the frequency corresponding to the band 3 and the average value of antenna gain for every 10 MHz in the range from 1450 to 1490 MHz as the frequency corresponding to the L band.

[0083] For both the pattern of Fig. 13 and the pattern of Fig. 14, as the shortest distance w10 is greater, the antenna gain increases, as shown in Figs. 16 and 17. Particularly, in the case of the pattern of Fig. 14, as the shortest distance w10 is greater, the antenna gain in the L band remarkably increases, as shown in Fig. 17. Accordingly, when the AM glass antenna is provided, the excellent antenna gain is obtained if the shortest distance

between the AM glass antenna and the glass antenna 100 in the width direction of the vehicle is 10 mm or more (particularly 20 mm or more).

[Example 6]

[0084] Subsequently, varied the length H_b of the right short-circuit line 29 for the AM glass antenna 20A of Fig. 12, the antenna gain of the glass antenna 100 corresponding to each of them was measured with respect to each angles while the vehicle is turned 360 degrees, and the average antenna gain was calculated in the same way as in the example 5. In this case, the length H_b of the right short-circuit line 29 is changed by gradually widening the width of the opening end provided on the right end of the AM glass antenna 20A from the upper side (gradually cutting off the right short-circuit line 29 from the upper side) without changing the position and length of the liner conductors 21 to 26.

[0085] Fig. 18 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 when the length H_b of the right short-circuit line 29 is changed. In Fig. 18, the antenna gain along the longitudinal axis indicates the average value of antenna gain for every 10 MHz in the range from 170 to 240 MHz as the frequency corresponding to the band 3 and the average value of antenna gain for every 10 MHz in the range from 1450 to 1490 MHz as the frequency corresponding to the L band. Also, when the length H_b is 100 mm, the shape of the pattern for the AM glass antenna 20A of Fig. 12 is indicated, and when the length H_b is 0 mm, the shape of the pattern for the AM glass antenna 20B of Fig. 13 is indicated.

[0086] As the length H_b is shorten by gradually cutting off the right short-circuit line 29 from the upper side, the antenna gain in the band 3 improves while the antenna gain in the L band is kept high, as shown in Fig. 18. Accordingly, when the AM glass antenna is provided, the total sum H_b of the length of the first direction component of the short-circuit line connecting the leading ends of the liner conductors 21 to 26 is 70% or less of the length H of the vertical direction component between the right leading end of the highest level liner conductor 21 and the right leading end of the lowest level liner conductor 26, whereby the excellent antenna gain is obtained. In other words, the width of the opening end provided at the right end of the AM glass antenna 20A is 30% or more (particularly 60% or more) of the length H of the vertical direction component between the right leading end of the highest level liner conductor 21 and the right leading end of the lowest level liner conductor 26, whereby the excellent antenna gain is obtained.

[0087] Fig. 19 is actual measurement data indicating the average value of antenna gain for the glass antenna 100 over the entire periphery of the vehicle according to a difference in the length H_b and the arrangement location of the right short-circuit line 29. The calculation of the antenna gain is made by the same method as the

example 5. The "20 mm short-circuit from the upper end" is the case where only the liner conductor 21 and the liner conductor 22 being proximate to the upper marginal part 15a of the opening portion of the vehicle body are connected by the right short-circuit line 29, with the liner conductors 22 to 26 open ended. The "20 mm opening from the upper end" is the case where only the liner conductor 21 and the liner conductor 22 being proximate to the upper marginal part 15a of the opening portion of the vehicle body are opened, with the liner conductors 22 to 26 connected with each other by the right short-circuit line 29.

[0088] It can be found that if the liner conductor 21 being proximate to the upper marginal part 15a of the opening portion of the vehicle body is connected with the right short-circuit line 29, the band 3 is worse even though the liner conductors 22 to 26 are open ended, as shown in Fig. 19. On the other hand, even if the liner conductors 22 to 26 are connected with the right short-circuit line 29 as the liner conductor 21 and the liner conductor 22 are open ended, the band 3 improves. That is, if the liner conductor 21 being proximate to the upper marginal part 15a of the opening portion of the vehicle body is connected with the right short-circuit line 29, it is preferred that the length of the right short-circuit line 29 is shortened.

[0089] Accordingly, a first broadcast frequency band and a second broadcast frequency band that is higher in band than the first broadcast frequency band are provided, and when the wavelength in the air at a center frequency of the second broadcast frequency band is λ_{02} , the glass shortening coefficient of wavelength is k ($k=0.64$), and $\lambda_{g2}=\lambda_{02}\cdot k$, it is preferred in the respect of improving the antenna gain that the length of the first direction component of the short-circuit line connected to the liner conductor 21 being proximate to the upper marginal part 15a of the opening portion of the vehicle body is from 0 to $0.19\cdot\lambda_{g2}$, particularly from 0 to $0.15\cdot\lambda_{g2}$, based on Fig. 19. More specifically, it is preferred in the respect of improving the antenna gain that the length of the short-circuit line is from 0 mm to 25 mm, particularly from 0 mm to 20 mm.

Claims

1. A glass antenna (100; 200; 300; 400) for a vehicle, the glass antenna (100; 200; 300; 400) being a monopole antenna comprising:

a feeding part (18); and
an antenna conductor adapted to be disposed in or on a window glass for the vehicle, including:

a L-shaped element, including:

a first antenna element (1), extending in a first direction; and
a second antenna element (2), extend-

ing in a second direction roughly perpendicular to the first direction from an end point (1g) of the first antenna element (1);

a loop element (5) formed into a closed loop shape, wherein the first antenna element (1) extends in the first direction from a first point (5a) of the loop element (5); and
a connection element (6), connecting the feeding part (18) with a second point of the loop element (5), **characterized in that**

a first broadcast frequency band and a second broadcast frequency band in which a marginal zone covers higher frequencies than a marginal zone of the first broadcast frequency band are provided, a wavelength in the air at a center frequency of the second broadcast frequency band is λ_{02} , a glass shortening coefficient of wavelength is k and λ_{g2} is defined as $\lambda_{g2} = \lambda_{02} \cdot k$, wherein the peripheral length ($Lx^2 + Ly^2$) of the loop element (5) falls within a range from $0.92 \cdot \lambda_{g2}$ to $1.23 \cdot \lambda_{g2}$, and a wavelength in the air at a center frequency of the first broadcast frequency band is λ_{01} and λ_{g1} is defined as $\lambda_{g1} = \lambda_{01} \cdot k$, wherein a summation of a conductor length (x1) of the first antenna element (1), a conductor length (x2) of the second antenna element (2), a conductor length (x6) of the connection element (6), a length of a virtual line segment between the first point (5a) and the second point (5b) with respect to the first direction, and a length of the virtual line segment with respect to second direction falls within a range from $0.25 \cdot \lambda_{g1}$ to $0.41 \cdot \lambda_{g1}$.

2. The glass antenna (100; 200; 300; 400) according to claim 1, wherein:

an inner circumferential length of a looped conductor portion of the loop element (5) falls within a range from 120 mm to 160 mm.

3. The glass antenna (100; 200; 300; 400) according to any one of claims 1 to 2, wherein a conductor length (x6) of the connection element (6) is less than or equal to $0.16 \cdot \lambda_{g1}$.

4. The glass antenna (100; 200; 300; 400) according to any one of claims 1 to 2, wherein a conductor length (x6) of the connection element (6) is less than or equal to 141 mm.

5. The glass antenna (100; 200; 300; 400) according to any one of claims 1 to 4, wherein a conductor length (x2) of the second antenna element (2) is 75% or less compared with a summation

of a conductor length (x1) of the first antenna element (1), a conductor length (x2) of the second antenna element (2), a conductor length (x6) of the connection element (6), a length of a virtual line segment between the first point (5a) and the second point (5b) with respect to the first direction, and a length of the virtual line segment with respect to the second direction.

6. The glass antenna (100; 200; 300; 400) according to any one of claims 1 to 4, wherein a summation of a conductor length (x1) of the first antenna element (1), a conductor length (x2) of the second antenna element (2), a conductor length (x6) of the connection element (6), a length of a virtual line segment between the first point (5a) and the second point (5b) with respect to the first direction, and a length of the virtual line segment with respect to second direction falls within a range from 230 to 380 mm.

7. The glass antenna (100; 200; 300; 400) according to any one of claims 1 to 6, further comprising an independent conductor (20), not DC connected with the antenna conductor, disposed on a blank area between a peripheral (15a) of the window glass and the second antenna element (2).

8. The glass antenna (100; 200; 300; 400) according to claim 7, wherein a minimum value of an interval between the antenna conductor and the independent conductor (20) with respect to the second direction falls within a range from 1 mm to 50 mm.

9. The glass antenna (100; 200; 300; 400) according to claim 7 or 8, wherein the independent conductor (20) includes:

a plurality of liner conductors (21, 22, 23, 24, 25, 26), aligned parallel to the second direction; and a short-circuit part, including a short-circuit line (29) connecting a pair of liner conductors of the plurality of liner conductors (21, 22, 23, 24, 25, 26) at a side of the antenna conductor and starting from a leading end of at least one of the pair of liner conductors being adjacent to each other.

10. The glass antenna (100; 200; 300; 400) according to claim 9, wherein a length of the short-circuit line with respect to the first direction for the short-circuit line connected to a leading end, which is disposed nearest to the peripheral edge of the window glass among leading ends of the plurality of liner conductors (21, 22, 23, 24, 25, 26) at the side of the antenna conductor, falls within a range from 0 to $0.19 \cdot \lambda_{g2}$.

11. The glass antenna (100; 200; 300; 400) according to claim 9, wherein

a length of the short-circuit line with respect to the first direction for the short-circuit line connected to a leading end, which is disposed nearest to the peripheral edge of the window glass among leading ends of the plurality of liner conductors (21, 22, 23, 24, 25, 26) at the side of the antenna conductor, falls within a range from 0 to 25 mm.

12. The glass antenna (100; 200; 300; 400) according to any one of claims 9 to 11, wherein:

the independent conductor (20) is provided with at least one open end, where leading ends of adjacent liner conductors of the plurality of liner conductors (21, 22, 23, 24, 25, 26) at the side of the antenna conductor are not connected by the short circuit line; and
a summation of the distance of the open end with respect to the first direction is 30% or more compared with a distance between highest and lowest levels of the leading edges of the plurality of liner conductors (21, 22, 23, 24, 25, 26) at the side of the antenna conductor.

13. The glass antenna (100; 200; 300; 400) according to claim 7 or 8, further comprising
a plurality of liner conductors (21, 22, 23, 24, 25, 26), aligned parallel to the second direction, in which leading edges of adjacent liner conductors of the plurality of liner conductors (21, 22, 23, 24, 25, 26) are not DC connected with each other at a side of the antenna conductor.

14. A window glass for a vehicle, comprising
the glass antenna (100; 200; 300; 400) according to any one of claims 1 to 13.

Patentansprüche

1. Scheibenantenne (100; 200; 300; 400) für ein Fahrzeug, wobei die Scheibenantenne (100; 200; 300; 400) eine Monopolantenne ist, umfassend:

ein Speise- bzw. Zuführungsteil (18); und
einen Antennenleiter, der angepasst ist, in oder an einer Fensterscheibe für das Fahrzeug angeordnet zu sein, enthaltend:

ein L-förmiges Element, enthaltend:

ein erstes Antennenelement (1), das sich in einer ersten Richtung erstreckt; und
ein zweites Antennenelement (2), das sich in einer zweiten Richtung ungefähr senkrecht zu der ersten Richtung von einem Endpunkt (1g) des ersten Anten-

nenelements (1) erstreckt;

ein Kreis- bzw. Schleifenelement (5), das in der Form eines geschlossenen Kreises bzw. Schleife gebildet ist, wobei sich das erste Antennenelement (1) in der ersten Richtung von einem ersten Punkt (5a) des Kreis- bzw. Schleifenelements (5) erstreckt; und
ein Verbindungselement (6), das das Speise- bzw. Zuführungsteil (18) mit einem zweiten Punkt des Kreis- bzw. Schleifenelements (5) verbindet,

dadurch gekennzeichnet, dass ein erstes Rundfunk- bzw. Sendefrequenzband und ein zweites Rundfunk- bzw. Sendefrequenzband vorgesehen sind, bei dem eine Randzone höhere Frequenzen abdeckt als eine Randzone des ersten Rundfunk- bzw. Sendefrequenzbands, eine Wellenlänge in der Luft bei einer Mittenfrequenz des zweiten Rundfunk- bzw. Sendefrequenzbands λ_{02} ist, ein Scheibenkürzungswellenlängenkoeffizient k ist und λ_{g2} als $\lambda_{g2} = \lambda_{02} \cdot k$ definiert ist, wobei die periphere Länge ($Lx^2 + Ly^2$) des Kreis- bzw. Schleifenelements (5) in einen Bereich von $0,92 \cdot \lambda_{g2}$ bis $1,23 \cdot \lambda_{g2}$ fällt, und eine Wellenlänge in der Luft bei einer Mittenfrequenz des ersten Rundfunk- bzw.

Sendefrequenzbands λ_{01} ist und λ_{g1} als $\lambda_{g1} = \lambda_{01} \cdot k$ definiert ist, wobei eine Summierung einer Leiterlänge ($x1$) des ersten Antennenelements (1), einer Leiterlänge ($x2$) des zweiten Antennenelements (2), einer Leiterlänge ($x6$) des Verbindungselements (6), einer Länge eines virtuellen Liniensegments zwischen dem ersten Punkt (5a) und dem zweiten Punkt (5b) bezüglich der ersten Richtung und einer Länge eines virtuellen Liniensegments bezüglich der zweiten Richtung in einen Bereich von $0,25 \cdot \lambda_{g1}$ bis $0,41 \cdot \lambda_{g1}$ fällt.

2. Scheibenantenne (100; 200; 300; 400) nach Anspruch 1, wobei:

eine Inneumfangslänge eines kreis- bzw. schleifenartigen bzw. geschlungenen Leiterabschnitts des Schleifenelements (5) in einen Bereich von 120 mm bis 160 mm fällt.

3. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 2, wobei
eine Leiterlänge ($x6$) des Verbindungselements (6) kleiner als oder gleich $0,16 \cdot \lambda_{g1}$ ist.

4. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 2, wobei

eine Leiterlänge (x6) des Verbindungselements (6) kleiner als oder gleich 141 mm ist.

5. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 4, wobei
eine Leiterlänge (x2) des zweiten Antennenelements (2) 75 % oder weniger verglichen mit einer Summierung einer Leiterlänge (x1) des ersten Antennenelements (1), einer Leiterlänge (x2) des zweiten Antennenelements (2), einer Leiterlänge (x6) des Verbindungselements (6), einer Länge eines virtuellen Liniensegments zwischen dem ersten Punkt (5a) und dem zweiten Punkt (5b) bezüglich der ersten Richtung und einer Länge des virtuellen Liniensegments bezüglich der zweiten Richtung beträgt. 5
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6. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 4, wobei
eine Summierung einer Leiterlänge (x1) des ersten Antennenelements (1), einer Leiterlänge (x2) des zweiten Antennenelements (2), einer Leiterlänge (x6) des Verbindungselements (6), einer Länge eines virtuellen Liniensegments zwischen dem ersten Punkt (5a) und dem zweiten Punkt (5b) bezüglich der ersten Richtung und einer Länge des virtuellen Liniensegments bezüglich der zweiten Richtung in einen Bereich von 230 bis 380 mm fällt. 20
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7. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 6, ferner umfassend
einen unabhängigen Leiter (20), der nicht mit dem Antennenleiter DC-verbunden ist, angeordnet an bzw. auf einem blanken bzw. leeren Bereich zwischen einer Peripherie (15a) der Fensterscheibe und dem zweiten Antennenelement (2). 30
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8. Scheibenantenne (100; 200; 300; 400) nach Anspruch 7, wobei
ein Minimalwert eines Intervalls zwischen dem Antennenleiter und dem unabhängigen Leiter (20) bezüglich der zweiten Richtung in einen Bereich von 1 mm bis 50 mm fällt. 40
9. Scheibenantenne (100; 200; 300; 400) nach Anspruch 7 oder 8, wobei der unabhängige Leiter (20) enthält:
eine Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26), die parallel zu der zweiten Richtung ausgerichtet sind; und
ein Kurzschlusssteil, das eine Kurzschlussleitung (29) enthält, die ein Paar Liner-Leiter der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an einer Seite des Antennenleiters verbindet und von einem führenden Ende zumindest eines des Paares von Liner-Leitern ausgeht, die angrenzend an bzw. benachbart zueinander sind. 45
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10. Scheibenantenne (100; 200; 300; 400) nach Anspruch 9, wobei eine Länge der Kurzschlussleitung bezüglich der ersten Richtung für die Kurzschlussleitung, die mit einem führenden Ende verbunden ist, das am nächsten an der peripheren Kante bzw. Rand der Fensterscheibe unter führenden Enden der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an der Seite des Antennenleiters angeordnet ist, in einen Bereich von 0 bis $0,19 \cdot \lambda_{g2}$ fällt. 5
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11. Scheibenantenne (100; 200; 300; 400) nach Anspruch 9, wobei eine Länge der Kurzschlussleitung bezüglich der ersten Richtung für die Kurzschlussleitung, die mit einem führenden Ende verbunden ist, das am nächsten an der peripheren Kante bzw. Rand der Fensterscheibe unter führenden Enden der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an der Seite des Antennenleiters angeordnet ist, in einen Bereich von 0 bis 25 mm fällt. 15
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12. Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 9 bis 11, wobei: 25
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der unabhängige Leiter (20) mit zumindest einem offenen Ende versehen ist, wo führende Enden von angrenzenden bzw. benachbarten Liner-Leitern der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an der Seite des Antennenleiters nicht durch die Kurzschlussleitung verbunden sind; und
eine Summierung des Abstands des offenen Endes bezüglich der ersten Richtung 30 % oder mehr verglichen mit einem Abstand zwischen einer höchsten und einer niedrigsten Ebene der führenden Kanten bzw. Ränder der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an der Seite des Antennenleiters beträgt. 40
45

13. Scheibenantenne (100; 200; 300; 400) nach Anspruch 7 oder 8, ferner umfassend
eine Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26), die parallel zu der zweiten Richtung ausgerichtet sind, bei denen führende Kanten bzw. Ränder von angrenzenden bzw. benachbarten Liner-Leitern der Mehrzahl von Liner-Leitern (21, 22, 23, 24, 25, 26) an einer Seite des Antennenleiters nicht miteinander DC-verbunden sind. 50
14. Fensterscheibe für ein Fahrzeug, umfassend
die Scheibenantenne (100; 200; 300; 400) nach einem der Ansprüche 1 bis 13. 55

Revendications

1. Antenne pour vitre (100 ; 200 ; 300 ; 400) pour un véhicule, l'antenne pour vitre (100 ; 200 ; 300 ; 400) étant une antenne unipolaire comprenant :

une partie d'alimentation (18) ; et
un conducteur d'antenne adapté à être disposé dans ou sur une vitre de fenêtre pour le véhicule, incluant :

un élément en L incluant :

un premier élément d'antenne (1) s'étendant dans une première direction ; et
un second élément d'antenne (2) s'étendant dans une section direction approximativement perpendiculaire à la première direction depuis un point d'extrémité (1g) du premier élément d'antenne (1) ;

un élément de boucle (5) formé en une forme de boucle fermée, dans laquelle le premier élément d'antenne (1) s'étend dans la première direction depuis un premier point (5a) de l'élément de boucle (5) ; et

un élément de connexion (6) connectant la partie d'alimentation (18) à un second point de l'élément de boucle (5), **caractérisée en ce que** une première bande de fréquence de diffusion et une seconde bande de fréquence de diffusion dans laquelle une zone marginale couvre des fréquences supérieures à une zone marginale de la première bande de fréquence de diffusion sont prévues, une longueur d'onde dans l'air à une fréquence centrale de la seconde bande de fréquence de diffusion est λ_{02} , un coefficient de raccourcissement de vitre de longueur d'onde est k et $\lambda_{g2} = \lambda_{02} \cdot k$, dans laquelle la longueur périphérique ($Lx^2 + Ly^2$) de l'élément de boucle (5) entre dans une plage de $0,92 \cdot \lambda_{g2}$ à $1,23 \cdot \lambda_{g2}$, et une longueur d'onde dans l'air à une fréquence centrale de la première bande de fréquence de diffusion est λ_{01} et λ_{g1} est défini comme $\lambda_{g1} = \lambda_{01} \cdot k$, dans laquelle une somme d'une longueur de conducteur (x1) du premier élément d'antenne (1), d'une longueur de conducteur (x2) du second élément d'antenne (2), d'une longueur de conducteur (x6) de l'élément de connexion (6), d'une longueur d'un segment de ligne virtuelle entre le premier point (5a) et le second point (5b) par rapport à la première direction et d'une longueur du segment de ligne virtuelle par rapport à la seconde direction entre dans une plage de $0,25 \lambda_{g1}$ à $0,41 \cdot \lambda_{g1}$.

2. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 1, dans laquelle :

une longueur circonférentielle interne d'une portion de conducteur en boucle de l'élément de boucle (5) entre dans une plage de 120 mm à 160 mm.

3. Antenne pour vitre (100; 200; 300; 400) selon l'une

quelconque des revendications 1 à 2, dans laquelle une longueur de conducteur (x6) de l'élément de connexion (6) est inférieure ou égale à $0,16 \lambda_{g1}$.

4. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon l'une quelconque des revendications 1 à 2, dans laquelle une longueur de conducteur (x6) de l'élément de connexion (6) est inférieure ou égale à 141 mm.

5. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon l'une quelconque des revendications 1 à 4, dans laquelle une longueur de conducteur (x2) du second élément d'antenne (2) est de 75 % ou moins par rapport à une somme d'une longueur de conducteur (x1) du premier élément d'antenne (1), d'une longueur de conducteur (x2) du second élément d'antenne (2), d'une longueur de conducteur (x6) de l'élément de connexion (6), d'une longueur d'un segment de ligne virtuelle entre le premier point (5a) et le second point (5b) par rapport à la première direction et d'une longueur du segment de ligne virtuelle par rapport à la seconde direction.

6. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon l'une quelconque des revendications 1 à 4, dans laquelle une somme d'une longueur de conducteur (x1) du premier élément d'antenne (1), d'une longueur de conducteur (x2) du second élément d'antenne (2), d'une longueur de conducteur (x6) de l'élément de connexion (6), d'une longueur d'un segment de ligne virtuelle entre le premier point (5a) et le second point (5b) par rapport à la première direction et d'une longueur du segment de ligne virtuelle par rapport à la seconde direction entre dans une plage de 230 à 380 mm.

7. Antenne pour vitre (100; 200; 300; 400) selon l'une quelconque des revendications 1 à 6, comprenant en outre un conducteur indépendant (20), non connecté en CC au conducteur d'antenne, disposé sur une zone vierge entre un périphérique (15a) de la vitre de fenêtre et le second élément d'antenne (2).

8. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 7, dans laquelle une valeur minimale d'un intervalle entre le conducteur d'antenne et le conducteur indépendant (20) par rapport à la seconde direction entre dans une plage de 1 mm à 50 mm.

9. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 7 ou 8, dans laquelle le conducteur indépendant (20) inclut :

une pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) alignés parallèlement à la seconde direction ; et
une partie de court-circuit, incluant une ligne de

- court-circuit (29) connectant une paire de conducteurs de chemise de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) sur un côté du conducteur d'antenne et partant d'une extrémité de tête d'au moins un de la paire de conducteurs de chemise qui sont adjacents l'un à l'autre. 5
10. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 9, dans laquelle une longueur de la ligne de court-circuit par rapport à la première direction pour la ligne de court-circuit connectée à une extrémité de tête qui est disposée au plus près du bord périphérique de la vitre de fenêtre parmi les extrémités de tête de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) sur le côté du conducteur d'antenne, entre dans une plage de 0 à $0,19 \cdot \lambda_{g2}$. 10 15
11. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 9, dans laquelle une longueur de la ligne de court-circuit par rapport à la première direction pour la ligne de court-circuit connectée à une extrémité de tête qui est disposée au plus près du bord périphérique de la vitre de fenêtre parmi les extrémités de tête de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) sur le côté du conducteur d'antenne, entre dans une plage de 0 à 25 mm. 20 25 30
12. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon l'une quelconque des revendications 9 à 11, dans laquelle :
- le conducteur indépendant (20) est pourvu d'au moins une extrémité ouverte, où des extrémités de tête de conducteurs de chemise adjacents de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) sur le côté du conducteur d'antenne ne sont pas connectées par la ligne de court-circuit ; et 35 40
- une somme de la distance de l'extrémité ouverte par rapport à la première direction est de 30 % ou moins par rapport à une distance entre des niveaux le plus élevé et le plus bas des bords de tête de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) sur le côté du conducteur d'antenne. 45
13. Antenne pour vitre (100 ; 200 ; 300 ; 400) selon la revendication 7 ou 8, comprenant en outre une pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) alignés parallèlement à la seconde direction, dans laquelle des bords de tête de conducteurs de chemise adjacents de la pluralité de conducteurs de chemise (21, 22, 23, 24, 25, 26) ne sont pas connectés en CC les uns aux autres sur un côté du conducteur d'antenne. 50 55
14. Vitre de fenêtre pour un véhicule comprenant l'antenne pour vitre (100 ; 200 ; 300 ; 400) selon l'une quelconque des revendications 1 à 13.

FIG. 1

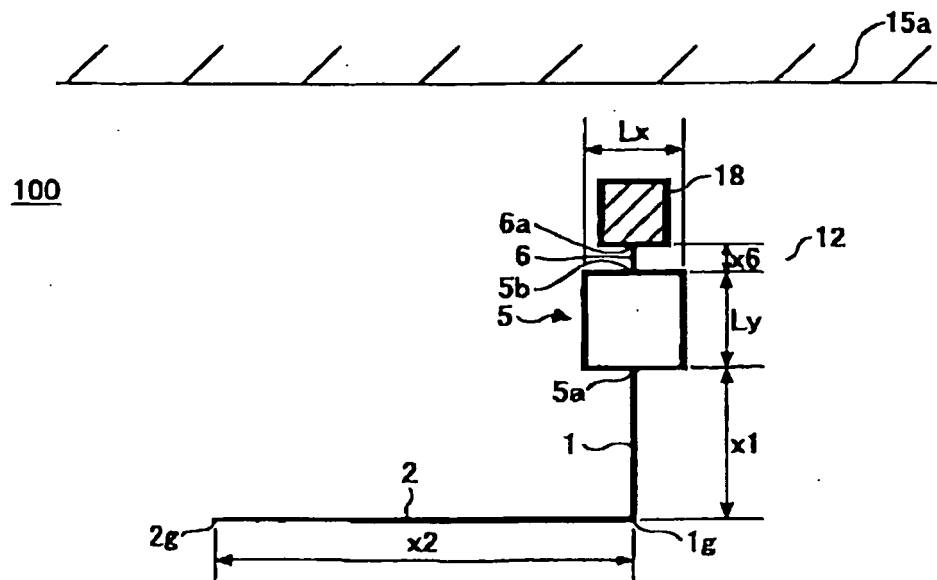


FIG. 2

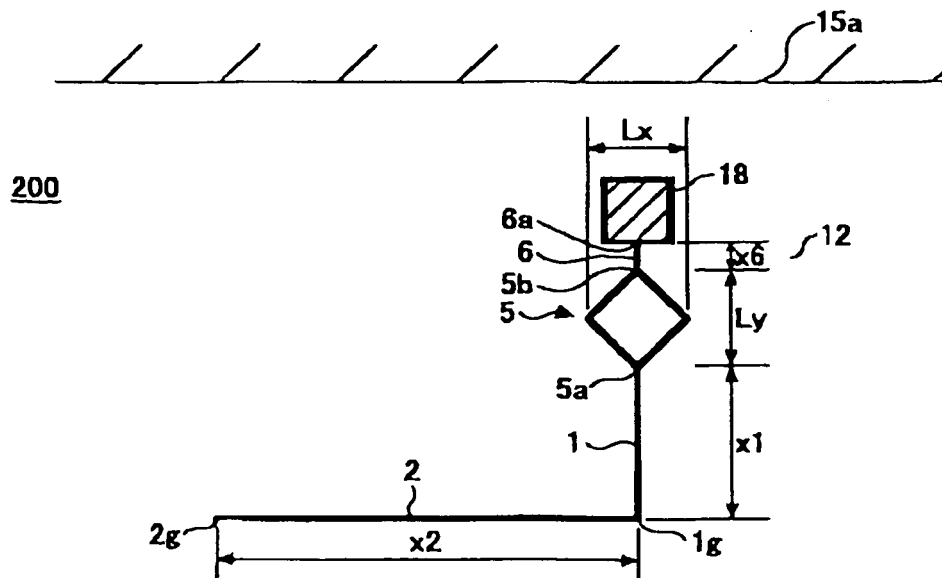


FIG. 3

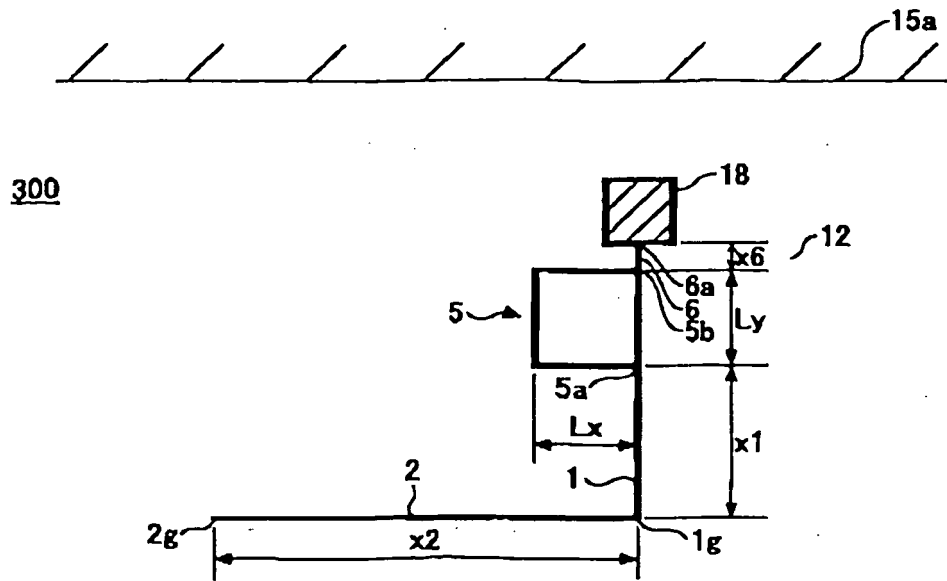


FIG. 4

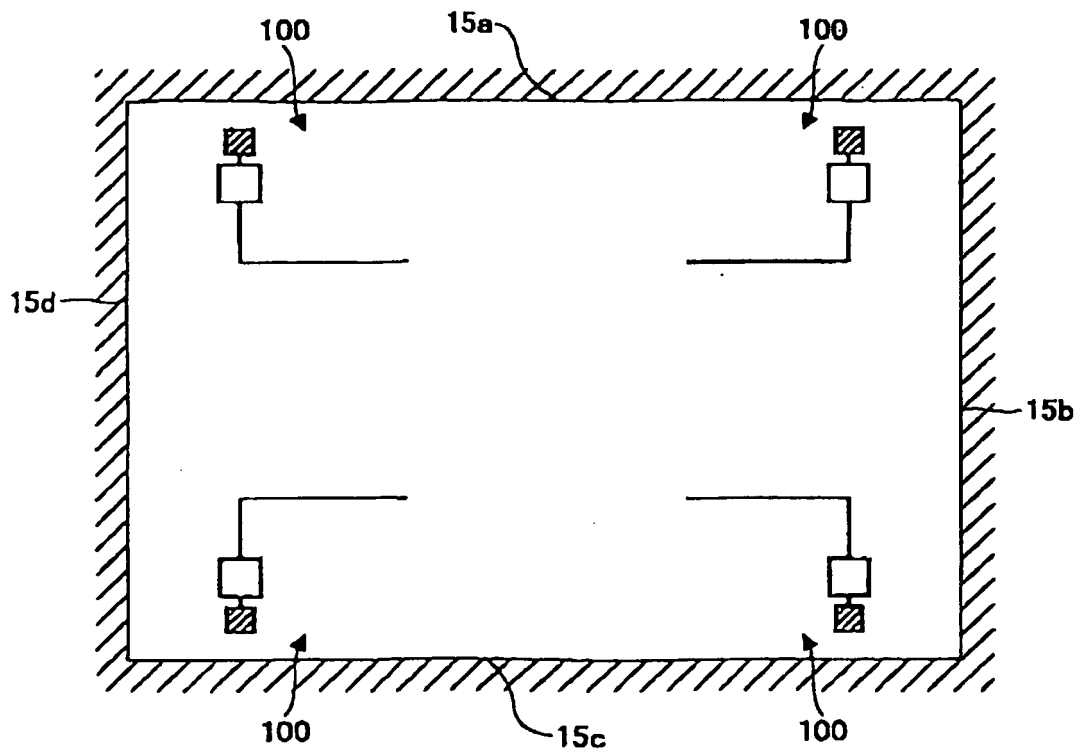


FIG. 5

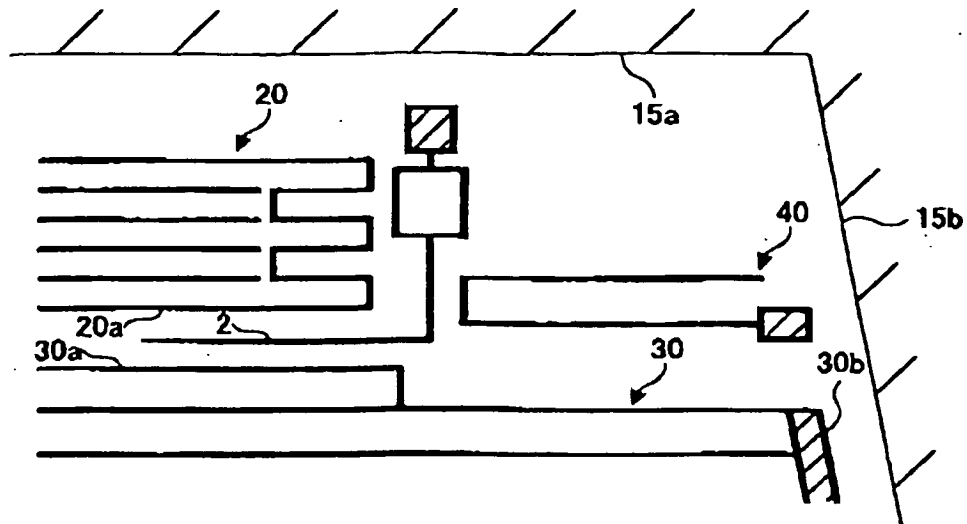


FIG. 6

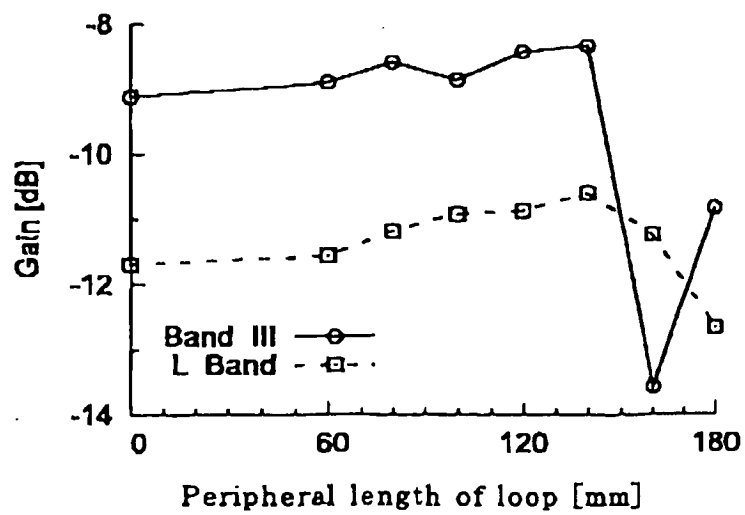


FIG. 7

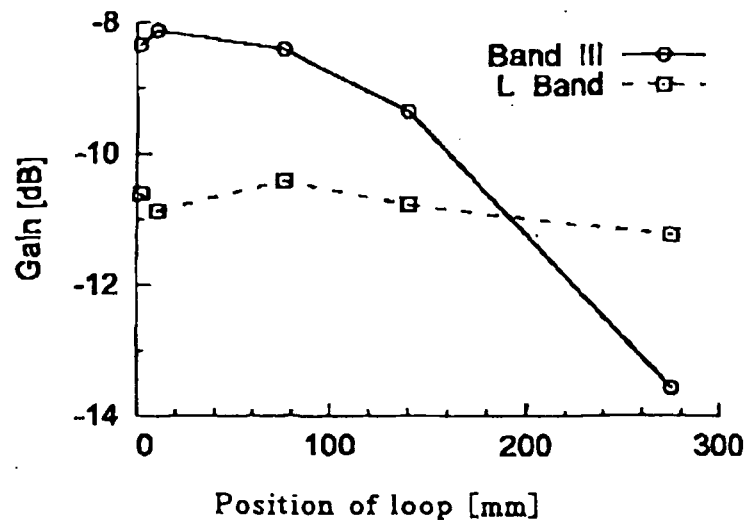


FIG. 8

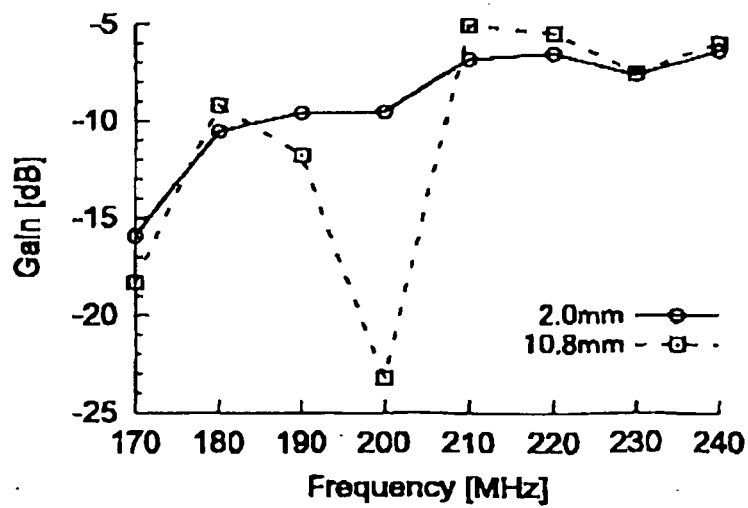


FIG. 9

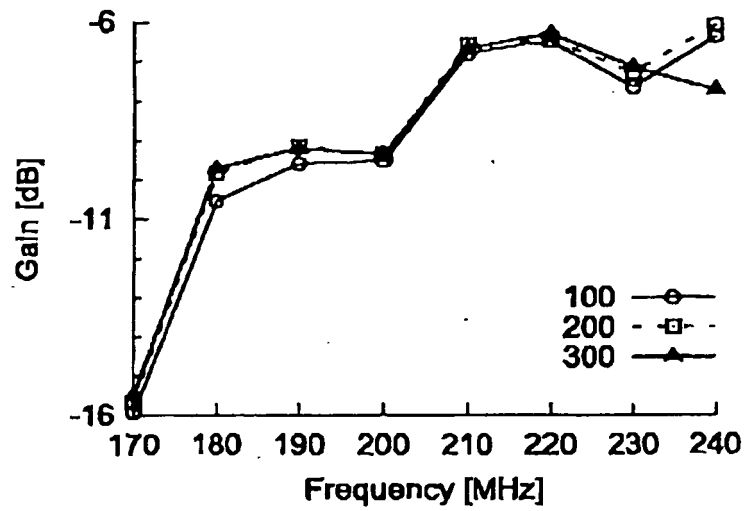


FIG. 10

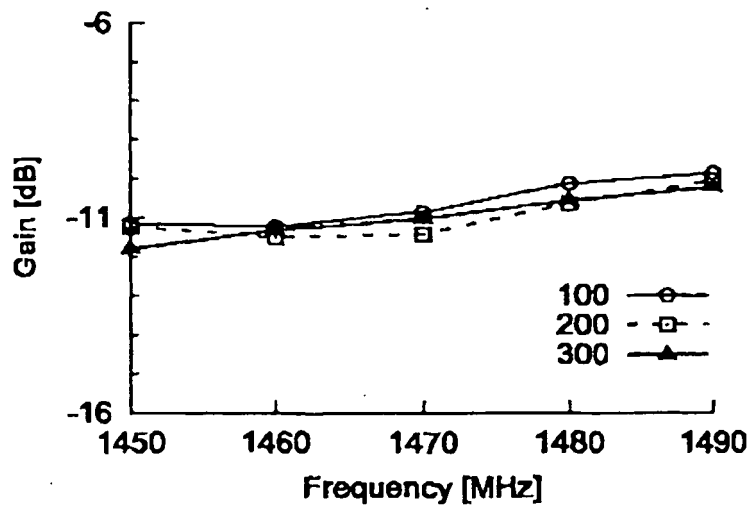


FIG. 11

400

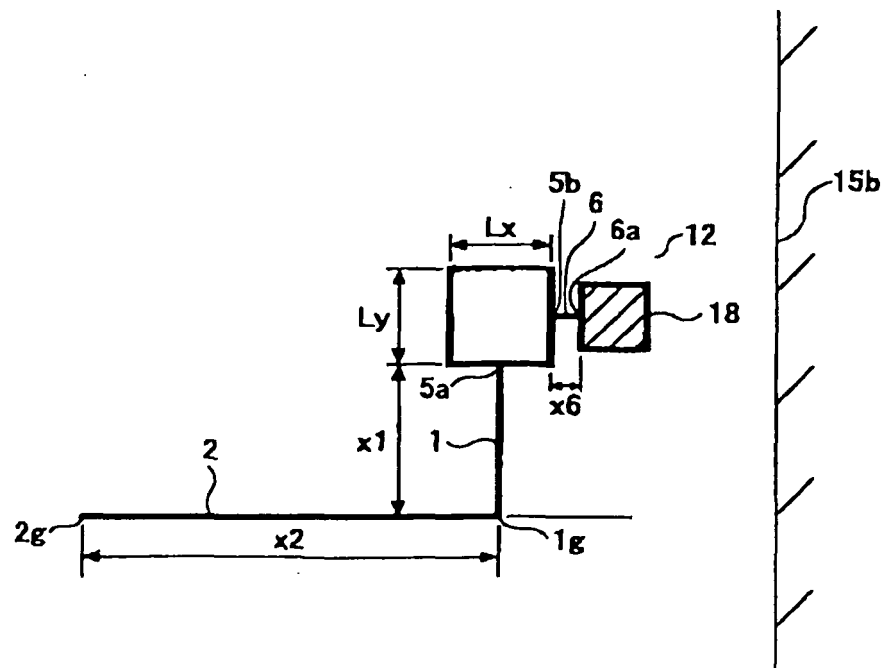


FIG. 12

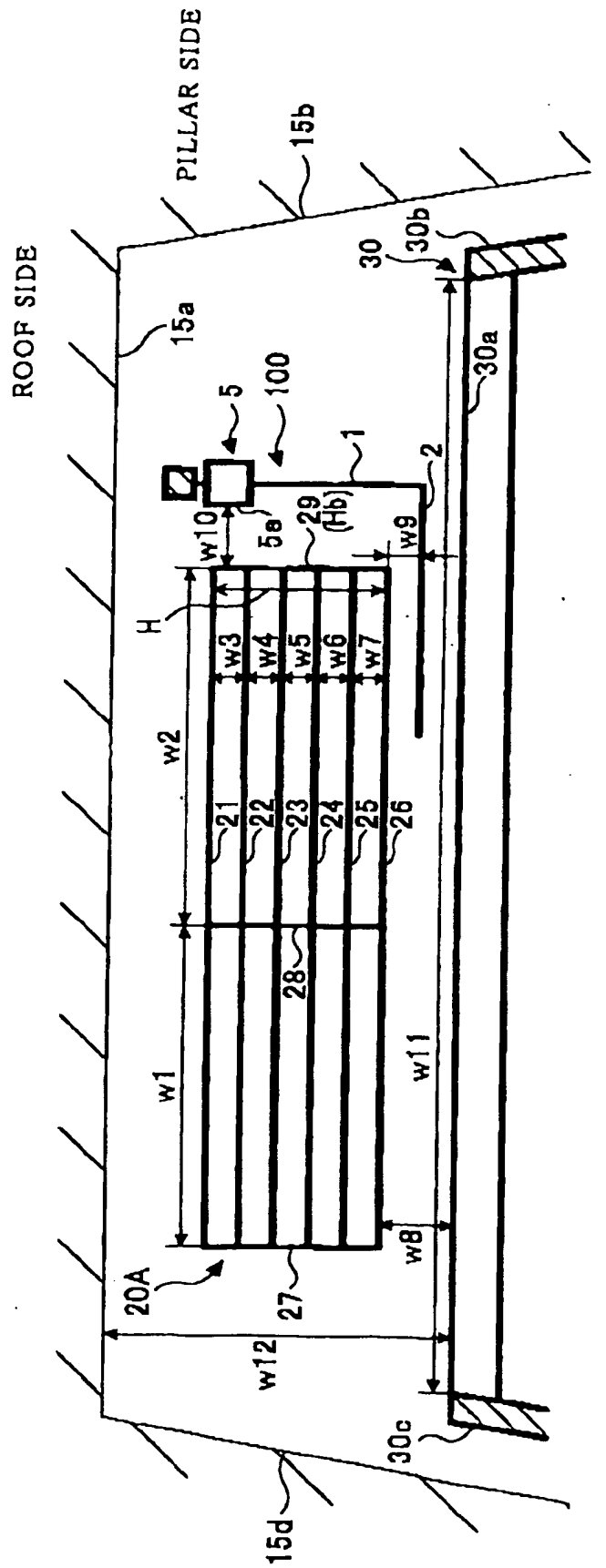


FIG. 13

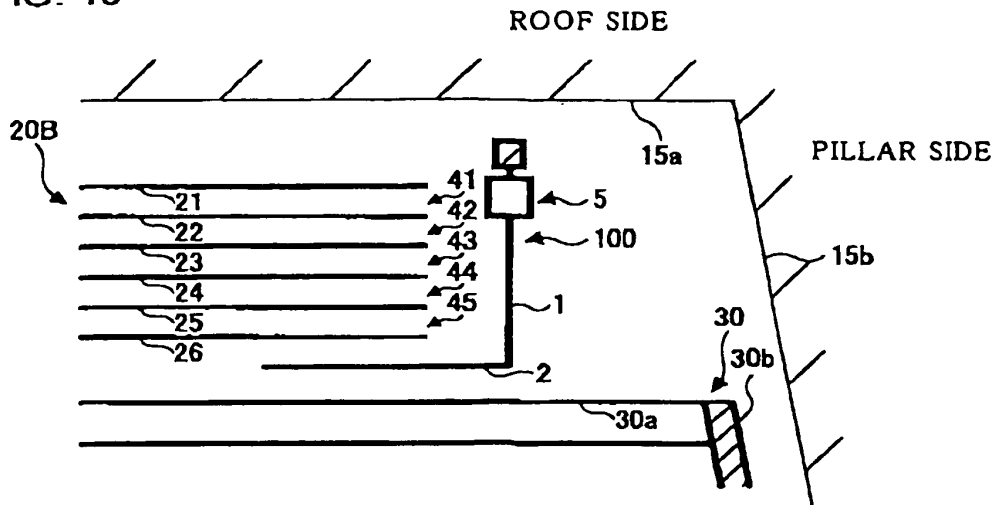


FIG. 14

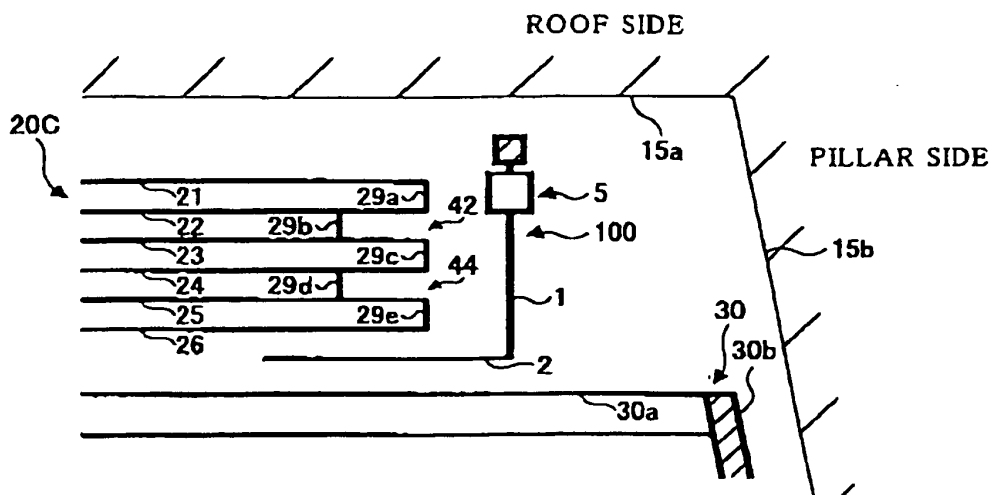


FIG. 15

	BAND III	L BAND
Open	-7.90	-9.81
Short	-9.91	-9.84
Meander	-8.60	-10.24
Without-AM	-8.87	-11.00

FIG. 16

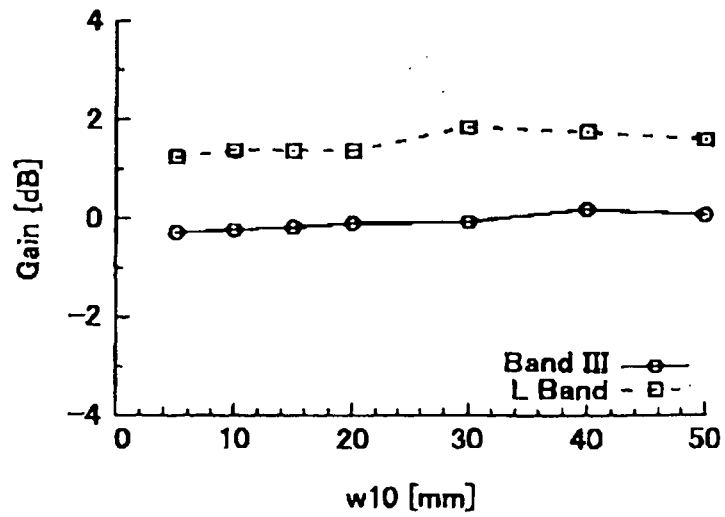


FIG. 17

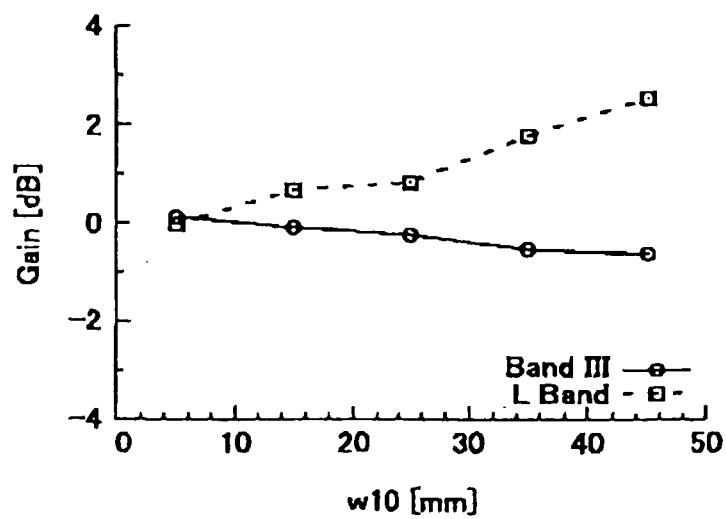


FIG. 18

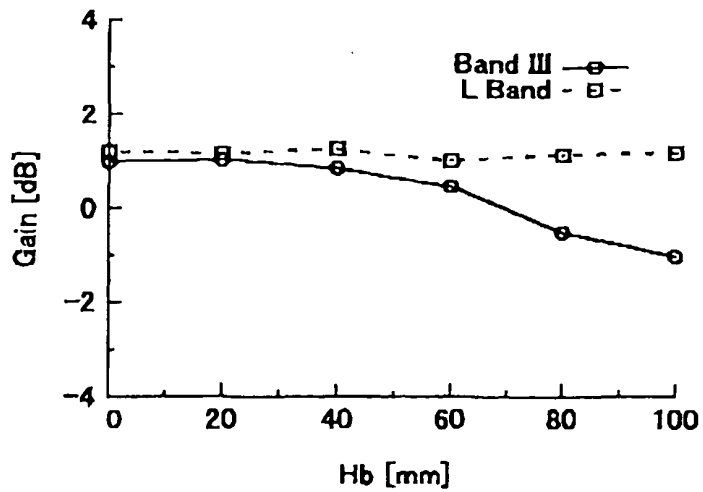


FIG. 19

	BAND III	L BAND
20 mm SHORT-CIRCUIT FROM UPPER END	-3.18	0.82
20 mm OPENING FROM UPPER END	-0.51	1.12

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 10327009 A [0002]
- JP 2000307321 A [0002]
- EP 1643587 A1 [0004]
- WO 03034538 A1 [0005]
- US 20060132361 A1 [0006]
- WO 0070708 A [0007]
- EP 1763105 A1 [0008]
- WO 2004010529 A1 [0009]
- US 20080158075 A1 [0010]