Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention.)
Description

[0001] The present invention relates to antenna systems used on motor vehicles and more particularly to antenna systems in which concealed antennas are employed.

[0002] Conventional fixed mast antennas mounted to and extending from vehicle bodies have generally been known to provide adequate gain for receiving radio signals. However, these antennas have drawbacks in that they are generally unsightly and also are vulnerable to bending and breakage. Concealed antennas, on the other hand, do not have the drawbacks associated with the conventional antennas in that typically they are flush mounted directly to a glass panel or an isolated section of sheet metal in the vehicle.

[0003] Nonetheless, concealed antennas do generally encounter a problem in that they are generally configured small in order to fit onto a particular window or body panel. This can be particularly true for some vehicles in that there may only be a very few small panels, such as windows or isolated body panels, available given the shape of the particular vehicle. Thus, these surfaces may be small relative to the wavelengths of the signals one wishes to receive. For example, signals in the AM frequency band. For these antennas, then, a concern arises with having good reception in the AM frequency band because of a lack of low frequency gain due to the small size of the antenna. To account for this, the systems generally require the use of an AM amplifier module to get sufficient gain to overcome cable and mismatch losses and still have an adequate signal.

[0004] While some have attempted to overcome this concern by mounting concealed antennas on multiple surfaces of the vehicle, they are generally more complex than desirable or require other amplification, filtering or switching components to provide enough gain for an adequate signal in the frequency ranges desired.

[0005] Thus a simple, concealed antenna system is desired that will provide adequate gain for both high and low frequencies, with the flexibility to configure the system for various vehicle designs.

[0006] JP-A-08265028 describes an antenna system for a motor vehicle in which a first antenna element on a glass pane includes a first conductor wire and a second conductor wire in the form of a loop. A first node connects the first and second conductors together. The first conductor is to receive FM radio waves and the second conductor is to receive AM radio waves. A second glass pane has a second antenna element to receive AM radio waves. The second antenna element is connected to the first antenna element.

[0007] The present invention provides an antenna system for a motor vehicle comprising:

- a first and a second panel, with the panels being electrically isolated from the vehicle;
- a first antenna element, mounted on the first panel, including a first conductor shaped as a generally vertical line and a second conductor generally shaped as a loop, with a first node connecting the first conductor and the second conductor, and with a second node on the second conductor spaced from the first node;
- a second antenna element, mounted on the second panel, including a third conductor having a third node; and
- a connection between the second node on the first antenna element and the third node on the second antenna element such that the first and the second elements are connected in series;

characterised in that;

the second antenna element comprises a heating conductor grid having a power source and a ground, a first inductor connected between the power source and the heating conductor grid and a second inductor connected between the heating conductor grid and the ground, and a capacitor included in the connection between the first antenna element and the second antenna element to isolate the first antenna element from the current used to power the heating conductor grid.

[0008] The present invention provides antenna elements which can be concealed in the windows or isolated panels of a vehicle. The overall gain of the antenna system is increased by coupling the multiple antenna elements in series such that good radio frequency reception is possible for a broad range of frequencies.

[0009] An advantage of the present invention is that it provides multiple aperture coupling of antennas for increased antenna gain at low radio frequencies while not interfering with gain at higher frequencies, without the need for a low frequency amplifier.

[0010] An additional advantage of the present invention is that the multiple antenna elements can be coupled together without the need for components that isolate the higher radio frequencies between antenna elements, thus improving lower radio frequency reception without degrading higher radio frequency reception.

[0011] The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic perspective view of a vehicle with the antenna system of the present invention;
Fig. 2 is a schematic view of two of the vehicle windows of Fig. 1;
Fig. 3 is a schematic view similar to Fig. 2, illustrating a second embodiment of the present invention;
Fig. 4 is a schematic view similar to Fig. 2, illustrating a third embodiment of the present invention; and
Fig. 5 is a schematic view similar to Fig. 2, illustrating a fourth embodiment of the present invention.
A first embodiment of the present invention is illustrated in Figs. 1 and 2. A vehicle 10 includes a radio frequency (RF) reception device 12, such as a conventional AM/FM radio mounted therein. Connected to an antenna input for this device 12 is a coaxial cable 14, which extends, preferably concealed, within the body of the vehicle 10 back to a multiple aperture concealed antenna system 16. The vehicle includes a rear window 19, a right side rear window 20 and a left side rear window 21 on which the antenna system 16 can be mounted.

For this first embodiment, the antenna system 16 includes a first antenna element 18 mounted on the right side rear window 20. The first antenna element 18 is affixed to the glass 20 by known techniques, which will not be discussed further herein. The first antenna element 18 includes a single, generally vertical conductive line 22 connected at a node 24, at about the top centre of the window 20, to a conductive loop 26 that extends around the periphery of the window 20 just inside of the edge. The coaxial cable 14 connects to the node 24 and includes a ground 28 at this location.

This first antenna element 18 will act as the primary antenna for reception of RF signals, with the single conductive line 22 for the higher RF reception (FM band). On the other hand, the loop 26 is a high impedance element for AM reception, coupled to the first (primary) antenna element 18. In this way, inductors are not required in order to isolate the FM frequencies from the second antenna element 30.

The wire 32 is connected to the node 36 on the defroster grid 38 via a capacitor 40, to isolate the first antenna 18 from the current used to power the defroster grid 38. A pair of inductors 42 are connected on either side of the grid 38, one before ground and the other to the lead connected to a conventional power source, not shown, for the defroster grid 38, in order to effectively isolate the defroster grid 38 from ground and from the power source to provide better gain and electromagnetic interference (EMI) immunity.

A second embodiment is illustrated in Fig. 3. In this embodiment, similar elements are similarly designated with the first embodiment, while changed elements are designated with 100 series numbers. The first antenna element 18 in the right rear side window 20 is the same, while the second antenna element 130 is no longer coupled to the rear defroster grid 138. The second antenna element 130 is formed by a conductive loop traced on the rear window 19 around the defroster grid 138. This better isolates the antenna assembly 116 from the defroster grid 138, but requires the additional trace on the rear window 19. The defroster grid 138 may still be coupled to the inductors 142 to provide better gain and EMI immunity, but are not necessary for this embodiment.

A third embodiment of the present invention is illustrated in Fig. 4. In this embodiment, similar elements are similarly designated with the first embodiment, while changed elements are designated with 200 series numbers. In this embodiment, the left side rear window 21 has a conductive trace of a loop printed on it to act as the second antenna element 230. The wire 232 now extends across the vehicle to couple the second antenna element 230 in series to the first antenna element 18. The point at which the wire 232 connects to the second antenna element 230 is generally chosen to be the most convenient assembly location. This second antenna element 230 performs the same function as the second antenna elements in the first and second embodiments, but may be more conveniently located for a particular vehicle design. A single loop is shown on the left side rear window 21, but, if desired, additional horizontal or vertical lines can be added to further improve the gain of the antenna.

In a fourth embodiment of the present invention, as illustrated in Fig. 5, both the rear window 19 and the left side rear window 21 are used as antenna elements. In this embodiment, similar elements are similarly designated with the first embodiment, while changed elements are designated with 300 series numbers. The second antenna element 330 is connected in
series with the first (still primary) antenna element 18 on the right rear side window 20 by the wire 332. This arrangement is generally the same as in the second embodiment, as discussed above. Further, a third antenna element 50, located on the left side rear window 21 is connected in series to the second antenna element 330 by a second wire 52. By having an additional antenna element connected in series, the aperture of the entire antenna system 316 is further increased, although the cost of the system also increases. This third antenna element 50 is shown as just a loop, but again, it can have additional horizontal or vertical lines. And, as discussed above, the second wire 52 can also be coaxial cable, but this is not necessary, as discussed above.

[0021] As a further alternative, the antenna elements can be mounted on isolated sheet metal or composite components and will produce results of the overall system similar to the glass mounted elements as discussed above. For example, a composite trunk lid, lift gate, etc. can be used for mounting an antenna element.

Claims

1. An antenna system for a motor vehicle comprising:

   a first and a second panel (20), with the panels being electrically isolated from the vehicle;
   a first antenna element (18), mounted on the first panel (20), including a first conductor (22) shaped as a generally vertical line and a second conductor (26) generally shaped as a loop, with a first node (24) connecting the first conductor (22) and the second conductor (26), and with a second node (34) on the second conductor (26) spaced from the first node (24); a second antenna element (30), mounted on the second panel (19), including a third conductor (38) having a third node (36); and a connection (32) between the second node (34) on the first antenna element (18) and the third node (36) on the second antenna element (30) such that the first and the second antenna elements (18, 30) are connected in series;

   characterised in that;

   the second antenna element (30) comprises a heating conductor grid (38) having a power source and a ground,
   a first inductor (42) connected between the power source and the heating conductor grid (38) and a second inductor (42) connected between the heating conductor grid and the ground, and
   a capacitor (40) included in the connection between the first antenna element (18) and the second antenna element (30) to isolate the first antenna element from the current used to power the heating conductor grid (38).

2. An antenna system as claimed in claim 1, wherein the first and second panels (20) are windows of the vehicle.

3. An antenna system as claimed in claim 1 or 2, wherein the first conductor (22) is sized to receive radio frequencies in the FM band range and the first node (24) is spaced from the second node (34) a distance (l) along the second conductor (26) of about one quarter of a wavelength at the FM band frequencies.

Patentansprüche

1. Antennensystem für ein Kraftfahrzeug, folgendes aufweisend:

   eine erste und eine zweite Platte (20), wobei die Platten elektrisch vom Fahrzeug isoliert sind;
   ein erstes Antennenelement (18), welches auf der ersten Platte (20) angebracht ist, mit einem allgemein in Form einer vertikalen Linie ausgebildeten ersten Leiter (22) und einem allgemein in Form einer Schleife ausgebildeten zweiten Leiter (26), mit einem den ersten Leiter (22) und den zweiten Leiter (26) miteinander verbindenden ersten Knoten (24), und mit einem auf dem zweiten Leiter (26) im Abstand von besagtem erstem Knoten (24) angeordneten zweiten Knoten (34);
   ein zweites Antennenelement (30), welches auf der zweiten Platte (19) angebracht ist, mit einem dritten Leiter (38) mit einem dritten Knoten (36); und
   eine Verbindung (32) zwischen dem zweiten Knoten (34) am ersten Antennenelement (18) und dem dritten Knoten (36) am zweiten Antennenelement (30), so daß das erste und das zweite Antennenelement (18, 30) in Reihe miteinander verbunden sind; dadurch gekennzeichnet, daß das zweite Antennenelement (30) von einem Heizleitergitter (38) mit einer Stromquelle und einem Masseanschluß gebildet wird, eine zwischen der Stromquelle und dem Heizleitergitter (38) angeschlossene erste Drosselspule (42) enthält, und eine zwischen dem Heizleitergitter und Masse angeschlossene zweite Drosselspule (42), und einen in der Verbindung zwischen dem ersten Antennenelement (18) und dem zweiten Antennenelement (30) eingebauten Kondensator (40), um so das erste Antennenelement gegen
den zum Betreiben des Heizleitergitters (38) verwendeten Strom zu isolieren.

2. Antennensystem nach Anspruch 1, in welchem die erste und zweite Platte (20) jeweils Fenster des Fahrzeugs sind.

3. Antennensystem nach Anspruch 1 oder 2, worin der erste Leiter (22) so bemessen ist, daß er Radiofrequenzen im FM-Bandbereich empfängt, und der erste Knoten (24) entlang des zweiten Leiters (26) in einem Abstand (l) vom zweiten Knoten (34) angeordnet ist, der etwa ein viertel der Wellenlänge der FM-Bandfrequenzen beträgt.

Revendications

1. Système d'antenne destiné à un véhicule à moteur comprenant :

   un premier et un second panneau (20), les panneaux étant électriquement isolés du véhicule,
   un premier élément d'antenne (18) monté sur le premier panneau (20) comprenant un premier conducteur (22) en forme d'une ligne généralement verticale et un second conducteur (26) en forme générale de boucle, un premier noeud (24) reliant le premier conducteur (22) et le second conducteur (26), et un second noeud (34) sur le second conducteur (26) éloigné du premier noeud (24),
   un second élément d'antenne (30), monté sur le second panneau (19), comprenant un troisième conducteur (38) comportant un troisième noeud (36), et une connexion (32) entre le second noeud (34) sur le premier élément d'antenne (18) et le troisième noeud (36) sur le second élément d'antenne (30) de sorte que les premier et second éléments d'antenne (18, 30) sont reliés en série,

   caractérisé en ce que,

   le second élément d'antenne (30) comprend une grille de conducteurs de chauffage (38) comportant une source d'alimentation et une masse,
   une première bobine d'inductance (42) reliée entre la source d'alimentation et la grille des conducteurs de chauffage (38) et une seconde bobine d'inductance (42) reliée entre la grille des conducteurs de chauffage et la masse, et
   un condensateur (40) inclus dans la connexion entre le premier élément d'antenne (18) et le second élément d'antenne (30) afin d'isoler le premier élément d'antenne du courant utilisé

2. Système d'antenne selon la revendication 1, dans lequel les premier et second panneaux (20) sont des fenêtres du véhicule.

3. Système d'antenne selon la revendication 1 ou 2, dans lequel le premier conducteur (22) est dimensionné pour recevoir des fréquences radio dans la gamme de la bande de modulation de fréquence FM et le premier noeud (24) est éloigné du second noeud (34) d'une distance (l) le long du second conducteur (26) d'environ un quart de longueur d'onde pour les fréquences de la bande FM.