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(54) Parasitic element antenna for vehicles and windscreen including said antenna

(57) A vehicle antenna (1; 100; 200; 300; 401; 501; 601; 701) is described, able to be coupled with a surface made of dielectric material (2; 102; 202; 302; 402; 502; 602; 702) and comprising at least a mainly longitudinally developed radio wave receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707). The antenna (1) comprises at least a parasitic element (3; 103; 203; 303; 403; 503; 603; 703), separated by said at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and with mainly longitudinal development, on a side of which said at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) is disposed. This at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and the at least a parasitic element (3; 103; 203; 303; 403; 503; 603; 703) consist of conductive material strips which define mutually substantially incident development axes.

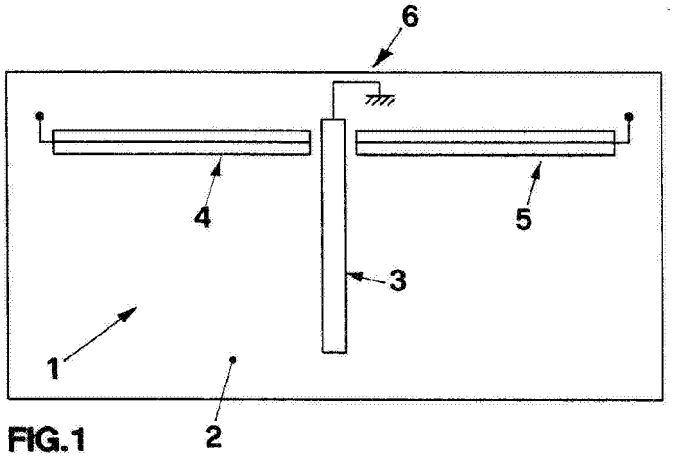

FIG.1

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Description

[0001] The present invention is about a vehicle antenna suitable in particular to be installed on a windscreen or on other dielectric surfaces of the vehicle.

[0002] The invention also concerns a windscreen including said antenna.

[0003] It is known that there is the need to equip the vehicles with antennas able to receive radio waves related to different applications like, for instance, FM radio, AM radio, digital radio (DAB) and television signals.

[0004] Several embodiments of vehicle antennas are known and, in particular, a type of antennas is known, consisting of essentially plane conductive structures disposed on a dielectric like, for instance, the front windscreen.

[0005] Such antenna structures comprise elements of adequate length to the radio wave frequency to be received and electrically connected to one or more electronic devices which process and demodulate the received signal.

[0006] Such antennas have some acknowledged inconveniences.

[0007] In particular, a first inconvenience is due to the arrangement of the receiving elements, on the dielectric material surface, which affects their capability to receive radio waves with horizontal and/or vertical polarization, obtaining, in some situations, a bad reception.

[0008] The cause of such inconvenience is explained hereinafter.

[0009] It is known that the stations transmitting radio waves can send signals either with horizontal or vertical polarization.

[0010] It is also known that the structure of a car, as well as buildings or all those elements that can act as a shield or an obstacle for radio signals around the car, can modify the polarization of the radio wave transmitted by the transmitting station.

[0011] The flat antennas belonging to the prior art are composed by substantially longitudinally developed receiving elements that can be horizontally, vertically or obliquely disposed on the dielectric surface which supports them.

[0012] It is evident that, if the receiving element is vertically or horizontally disposed, there is always the possibility to receive radio waves with orthogonal polarization with respect to that most suitable for the antenna.

[0013] In this situation, the reception of radiofrequency signals related to radio waves having a polarization in accordance with the arrangement of the receiving element/s is optimal, while the reception of radiofrequency signals having an orthogonal polarization with respect to the arrangement of the receiving element represents the worst case.

[0014] This aspect causes the aforementioned inconvenience in the antennas belonging to the prior art i.e., in other words, it introduces a risk factor in the radio signal reception since, for any provided antenna arrangement, it is much probable that said arrangement is not suitable for the polarization of the waves to be received.

[0015] A further inconvenience of known flat antenna embodiments is due to the fact that they are not omni directional, i.e. they are not able to correctly receive the radio wave for all the source directions.

[0016] This inability is related both to the geometrical extent of the receiving element and to its arrangement on the surface associated therewith.

[0017] Indeed, the very close presence of metallic parts can cause shield effects for some receiving angles of the radio wave, i.e. the angles according which said shielding parts are disposed aligned with respect to the receiving elements.

[0018] This effect defines "shadow areas" that can cause transmitted signal losses, and thus information losses, during the vehicle movement.

[0019] Some antenna embodiments are known in which at least a parasitic element has been added, parallelly disposed with respect to the receiving elements in order to amplify their reception using the parasitic element as a repeater. However, said embodiments still present the inconvenience of being not omni directional since they mainly receive the electromagnetic waves having a parallel polarization with respect to the direction defined by the receiving and parasitic elements.

[0020] The present invention intends to overcome all the aforementioned inconveniences.

[0021] In particular, it is an object of the present invention to provide for an antenna with essentially flat elements which is able to be disposed on a surface of a dielectric belonging to a vehicle and which maximizes the receptivity of its receiving elements, whatever it might be the polarization of the radio waves of the transmitting radio station.

[0022] It is another object of the present invention to provide for an antenna with essentially flat elements which has a substantially omni directional radiation diagram.

[0023] It is a further object of the present invention to provide for a windscreen which includes an antenna able to maximize the receptivity of its elements, whatever it might be the polarization of the radio signals of the transmitting radio station, and having a substantially omni directional radiation diagram.

[0024] The above mentioned objects are attained by a vehicle antenna which, according to the content of the main claim, is able to be coupled with a surface made of dielectric material, comprises at least a mainly longitudinally developed radio wave receiving element, and it is characterized by comprising at least a parasitic element, separated by said at least a receiving element and with mainly longitudinal development, on a side of which said at least a receiving element is disposed, said at least a receiving element and said at least a parasitic element consisting of conductive material strips which define mutually substantially incident development axes.

[0025] The above mentioned objects are also attained

by a vehicle windscreen characterized by comprising an antenna having at least a mainly longitudinally developed parasitic element, and at least a receiving element laterally disposed with respect to said parasitic element and separated therefrom, said at least a receiving element and said at least a parasitic element consisting of conductive material strips which define, on the plane defined by said windscreen, mutually substantially incident development axes.

[0026] According to a preferred executive embodiment, the parasitic element and the receiving elements define mutually substantially orthogonal axes on the surface coupled therewith and the parasitic element is galvanically connected to the vehicle mass.

[0027] Advantageously, since the receiving and parasitic elements are made of conductive material, they each provides for receiving elements particularly suited to receive electromagnetic waves with a polarization having the same direction defined by the elements themselves.

[0028] Still advantageously, since the parasitic element is disposed along a direction incident to the receiving elements, it is particularly suited to receive also electromagnetic waves with a polarization different from the polarizations mainly received by the receiving elements.

[0029] In this case, the parasitic element amplifies the receptivity of the electromagnetic waves received by the receiving elements and moreover it permits to obtain an antenna which is able to correctly receive also electromagnetic waves having a polarization different from the polarization that the receiving elements are particularly suited to receive.

[0030] In particular, with the parasitic element orthogonally disposed with respect to the receiving elements, the antenna of the invention is particularly suited to receive electromagnetic waves having mutual orthogonal polarizations, making the reception diagram of the antenna omni directional.

[0031] The above mentioned objects will be better highlighted in the description of preferred executive embodiments of the invention, given in an explanatory but not limiting way, and shown in the figures of the annexed drawings, wherein:

- Figure 1 is an axonometric view of the antenna according to the invention;
- Figures 2 to 4 show some executive embodiments of the antenna according to the invention;
- Figure 5 is an axonometric view of the windscreen according to the invention;
- Figures 6 to 8 show some executive embodiments of the windscreen according to the invention; and
- Figure 9 shows a utilization example of the windscreen according to the invention.

[0032] The vehicle antenna of the invention is shown in Figure 1, where it is generally indicated with numeral 1 and where one can see that it is disposed on a surface made of dielectric material **2** and it comprises a mainly longitudinally developed parasitic element **3** and two mainly longitudinally developed too receiving elements **4, 5,** disposed on both sides of the parasitic element **3.**

[0033] The parasitic element **3** is connected to the ground **6** through a galvanic connection.

[0034] According to an executive embodiment, the parasitic element is connected to the ground through a capacitive coupling.

[0035] According to a further executive embodiment, the parasitic element is insulated.

[0036] Concerning the receiving elements **4, 5,** they provide for a receiving structure connected to an electronic device, which manages the information content of the received radio signal through the interposition of an amplifier.

[0037] In different executive embodiments, not shown herein, the connection between the receiving elements of the antenna and the electronic device is a direct connection.

[0038] It should be pointed out that the preferred executive embodiment described hereby corresponds to an antenna whose utilization provides for the two receiving elements working in a complementary way.

[0039] There are further embodiments, such as the phase diversity, according which both elements receive the same signal, therefore it should be more correct, from a lexical point of view, to mention them as an antenna array and not as an antenna.

[0040] However, for simplifying purposes, it has been chosen to make reference to the invention as an antenna hereinafter, although it is an antenna array in some embodiments.

[0041] In the preferred executive embodiment, the receiving elements 4, 5 and the parasitic element 3 consist of a wire made of conductive material inserted in the dielectric.

[0042] In different executive embodiments, the receiving elements and the parasitic element consist of a strip made of conductive material laid on the dielectric.

[0043] Furthermore, as one can see in Figure 1, the receiving elements 4, 5 and the parasitic element **3** define substantially mutually orthogonal directions.

[0044] Advantageously, currents induced by radio waves with components orthogonal to the radio wave components, which induce currents in the parasitic element 3, are thus formed in the receiving elements 4, 5.

[0045] In different executive embodiments, the receiving elements and the parasitic element define mutually incident but not orthogonal directions.

[0046] However, it must be noted that there is no overlap among the elements.

[0047] Concerning the radiofrequency operation of the receiving elements 4, 5 and the parasitic element **3,** one can see that their length and the dielectric on which they are disposed define an equivalent resulting length which, in the preferred executive embodiment, is equal to a quarter of the wavelength of the radio signal that the antenna 1 is able to receive.

[0048] Concerning the dielectric material 2 on which the antenna 1 is supported, it is glass in the preferred executive embodiment.

[0049] In different executive embodiments, the dielectric material can be a plastic material or a plastic material reinforced by fiber glass.

[0050] According to another executive embodiment, shown in Figure 2, the antenna **100** is provided with a single receiving element **104.**

[0051] As one can see, the parasitic element **103** coupled with the element **104** is still disposed in a substantially centred position with respect to the dielectric material surface **102** on which these elements are disposed.

[0052] In a further executive embodiment, shown in Figure 3, the antenna **200** according to the invention is still composed by a single parasitic element **203,** disposed in a substantially centred position with respect to the dielectric material surface **202,** while the receiving elements **204** are three in number.

[0053] In still another executive embodiment, shown in Figure 4, the antenna **300** is composed by four receiving elements, generally indicated with numeral **307,** laterally disposed with respect to the parasitic element **303.**

[0054] All the executive embodiments described so far are given by way of example, and therefore they should not be considered as a restriction for further executive embodiments.

[0055] For instance, these embodiments could provide for a different number of receiving elements and/or a substantially oblique position with respect to the parasitic element, or such a position that the receiving elements and the parasitic element define each an incident direction with respect to the others.

[0056] As mentioned hereinbefore, the invention also relates to a windscreen that, in its preferred executive embodiment, is shown in Figure 5, where it is generally indicated with numeral **400** and where one can see that it comprises a generally made of glass surface **402** on which a parasitic element **403** and two receiving elements **404** and **405** are disposed, said receiving elements being disposed on both sides of the parasitic element **403.**

[0057] As one can see in Figure 5, the parasitic element **403** is substantially disposed in the center of the windscreen **400** surface.

[0058] Advantageously, since the windscreen **400** is inserted in the structure of a car, and being said structure made of metallic material and thus forming a shield for radio waves coming from their direction, the parasitic element **403** is in the best position for being affected as little as possible from said shield.

[0059] As one can see, the receiving elements **404** and **405** and the parasitic element **403** define mutually orthogonal directions.

[0060] The parasitic element **403** is galvanically connected to the vehicle mass **406.**

[0061] In a different executive embodiment of the windscreen according to the invention, not shown in the drawings, the parasitic element and the receiving elements define each a substantially incident direction with respect to the others.

[0062] In further executive embodiments, the parasitic element is connected to the ground through a capacitive coupling or it is insulated.

[0063] In Figures 7 to 9 some executive embodiments of the windscreen according to the invention are shown, which are different from that described hereinbefore by the presence of a different number of receiving elements.

[0064] A more detailed description of these elements is omitted because is fully equivalent to that related to the embodiments of the antenna according to the invention shown in Figures 2 to 4.

[0065] Operatively, the manufacture of the support surface, i.e. the windscreen **402,** in which wires of conductive material forming the parasitic element **403** and the receiving elements **404** and **405** are inserted, should be performed.

[0066] According to some executive embodiments, the windscreen glass has to be manufactured at first, and subsequently conductive material strips forming the parasitic element and the receiving elements are laid on it.

[0067] As one can see in Figure 9, two electric connections **415, 416** linked to the car radio set through the interposition of an amplifier and an electric connection **417** linked to a bolt **418** are taken from the receiving elements **404, 405.**

[0068] The bolt is coupled with the body of the vehicle **A** in order to form a galvanic connection to the ground for the parasitic element 403.

[0069] As one can see in the Figure 9, when the radio waves hit the antenna **401** of the windscreen **400** they induce the currents **420, 421** and **422** on the receiving elements **404, 405** and on the parasitic element 403.

[0070] The currents **420, 421** and **422** are of different entity due to the different arrangement of the parasitic element **403** with respect to the receiving elements **404, 405.**

[0071] In any case, on the parasitic element **403** currents **422** are developed, generated in particular by radio wave components coherent with its arrangement and not able to be developed instead in an optimal way on the receiving elements **404, 405.**

[0072] The currents **422** flowing on the parasitic element **403** generate an electric field **425** which induces in its turn additional currents on the receiving elements **404** and **405.**

[0073] Therefore, these additional currents obtain the effect to increase the induced current value on the receiving elements 404, 405, and thus to increase the radio signal quality received by the car radio set.

[0074] On the basis of the aforesaid description, the antenna and the windscreen of the invention achieve the intended objects.

[0075] In particular, an essentially flat antenna has been provided, able to be disposed on a dielectric material surface, which maximizes the receptivity of its receiv-

ing elements, whatever it might be the polarization of the radio waves transmitted by the transmitting radio station.

[0076] Moreover, an antenna with essentially flat elements has been provided, having a substantially omni directional radiation diagram.

[0077] Furthermore, a windscreen has been provided, including the flat antenna of the invention and obtaining the same advantages.

[0078] In the executive stage, further variations, although not described and not shown in the drawings, to the antenna and the windscreen of the invention could be provided but, if they fall within the scope of protection of the following claims, they should all be intended as protected by the present patent.

Claims

1. A vehicle antenna (1; 100; 200; 300; 401; 501; 601; 701), able to be coupled with a surface made of dielectric material (2; 102; 202; 302; 402; 502; 602; 702) and comprising at least a mainly longitudinally developed radio wave receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707), **characterized by** comprising at least a parasitic element (3; 103; 203; 303; 403; 503; 603; 703), separated by said at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and with mainly longitudinal development, on a side of which said at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) is disposed, said at least a receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and said at least a parasitic element (3; 103; 203; 303; 403; 503; 603; 703) consisting of conductive material strips which define mutually substantially incident development axes.

2. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 1), **characterized in that** said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) is connected to the ground (6; 106; 206; 306; 406; 506; 606; 706).

3. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 1), **characterized in that** said receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) define mutually substantially orthogonal axes on the surface coupled therewith.

4. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 1), **characterized in that** said receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) consist of wires made of conductive material.

5. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 2), **characterized in that** said ground connection of said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) is a galvanic connection.

6. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 2), **characterized in that** said ground connection of said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) is a capacitive coupling.

7. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 1), **characterized in that** said receiving element (4, 5; 104; 204; 307; 404, 405; 504; 604; 707) and said parasitic element (3; 103; 203; 303; 403; 503; 603; 703) have the same length.

8. The antenna (1; 100; 200; 300; 401; 501; 601; 701) according to claim 1), **characterized in that** said dielectric material is glass.

9. The antenna (1; 100; 200; 300) according to claim 1), **characterized in that** said dielectric material is a plastic material.

10. The antenna (1; 100; 200; 300) according to claim 1), **characterized in that** said dielectric material is a plastic material reinforced by fiber glass.

11. A vehicle windscreen (400; 500; 600; 700) **characterized by** comprising an antenna (401; 501; 601; 701) having at least a mainly longitudinally developed parasitic element (403; 503; 603; 703) and at least a receiving element (404; 405; 504; 604; 707) laterally disposed with respect to said parasitic element (403; 503; 603; 703) and separated therefrom, said at least a receiving element (404; 405; 504; 604; 707) and said at least a parasitic element (403; 503; 603; 703) consisting of conductive material strips which define, on the plane defined by said windscreen (400; 500; 600; 700), mutually substantially incident development axes.

12. The windscreen (400; 500; 600; 700) according to claim 11), **characterized in that** said parasitic element (403; 503; 603; 703) is connected to the ground (406; 506; 606; 706).

13. The windscreen (400; 500; 600; 700) according to claim 12), **characterized in that** said ground connection is a galvanic connection.

14. The windscreen (400; 500; 600; 700) according to claim 12), **characterized in that** said ground connection is a capacitive coupling.

15. The windscreen (400; 500; 600; 700) according to

claim 11), **characterized in that** said parasitic element (403; 503; 603; 703) is disposed in a substantially centred position with respect to the plane formed by said windscreen (400; 500; 600; 700).

16. The windscreen (400; 500; 600; 700) according to claim 11), **characterized in that** said receiving element (404; 405; 504; 604; 707) and said parasitic element (403; 503; 603; 703) define mutually substantially orthogonal axes on the plane formed by said windscreen (400; 500; 600; 700).

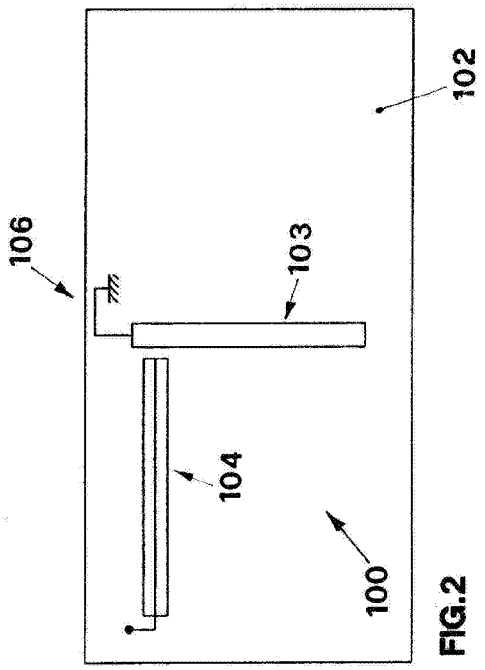

FIG.2

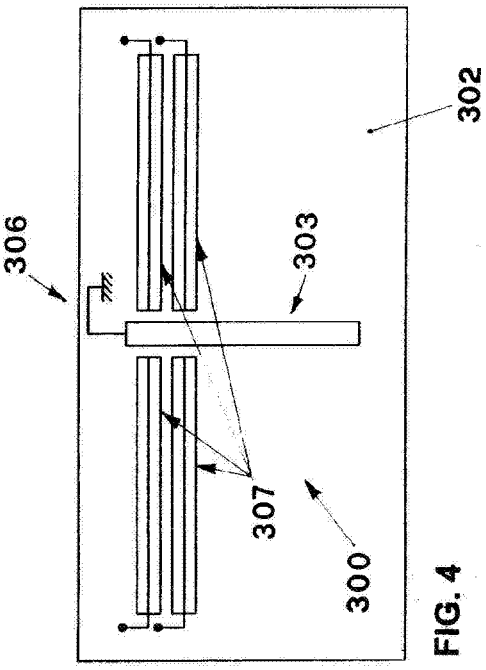

FIG. 4

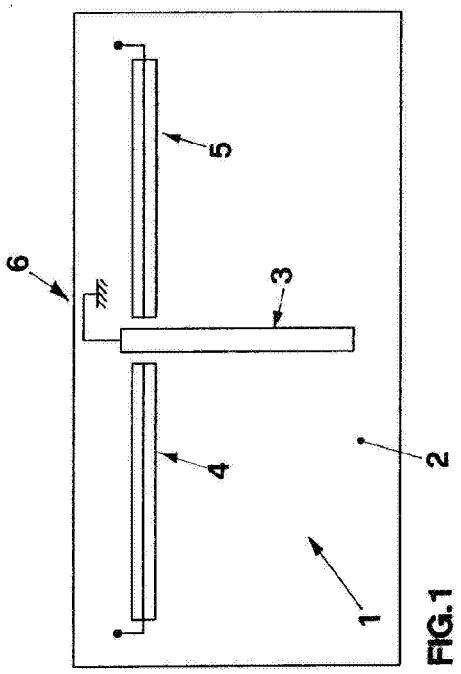

FIG.1

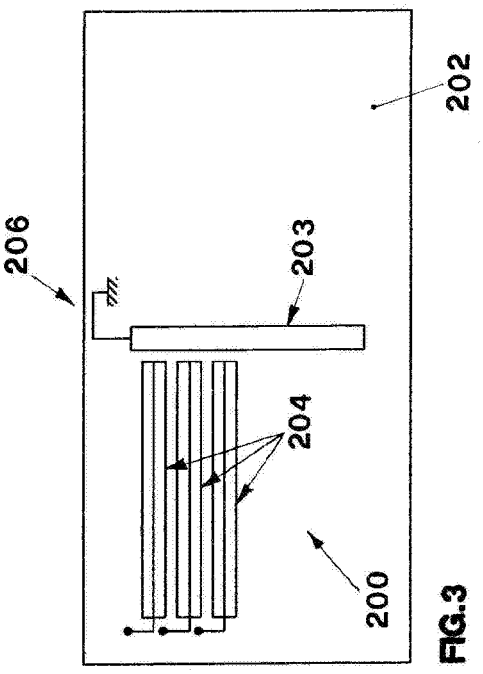

FIG.3

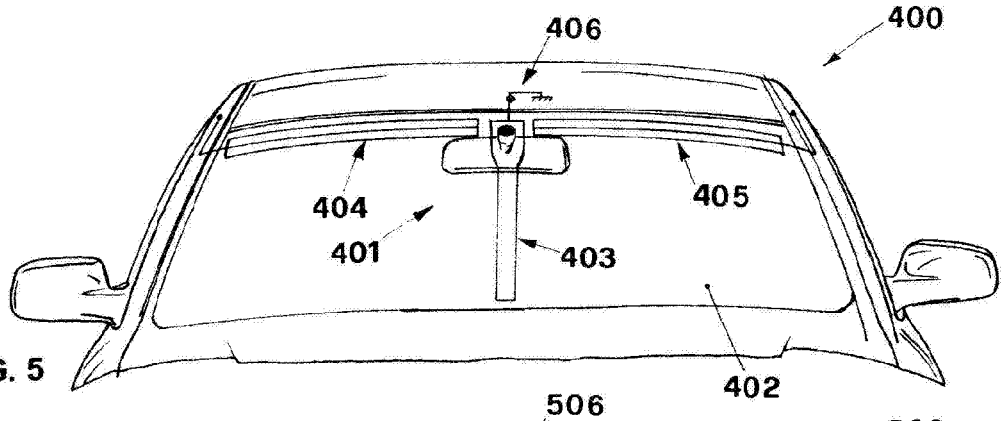

FIG. 5

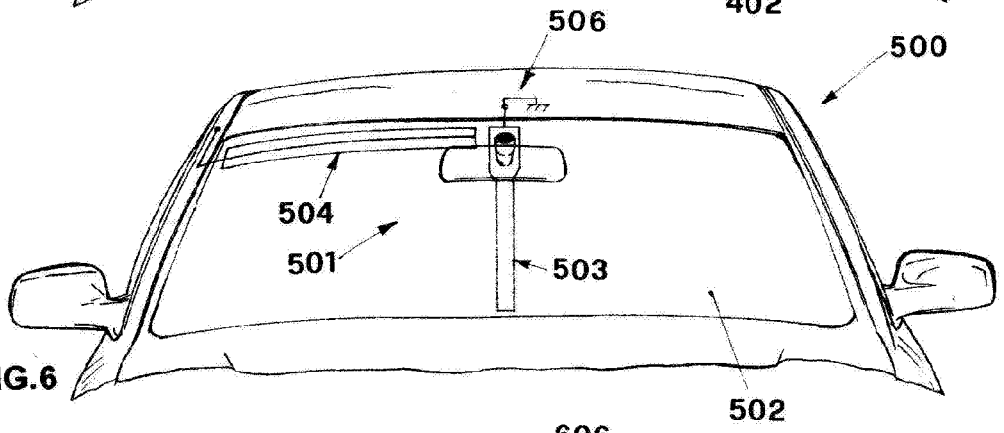

FIG.6

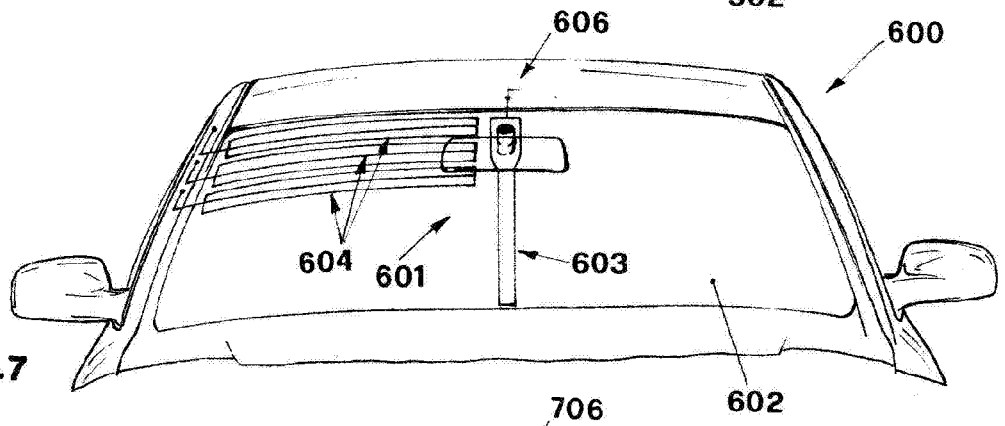

FIG.7

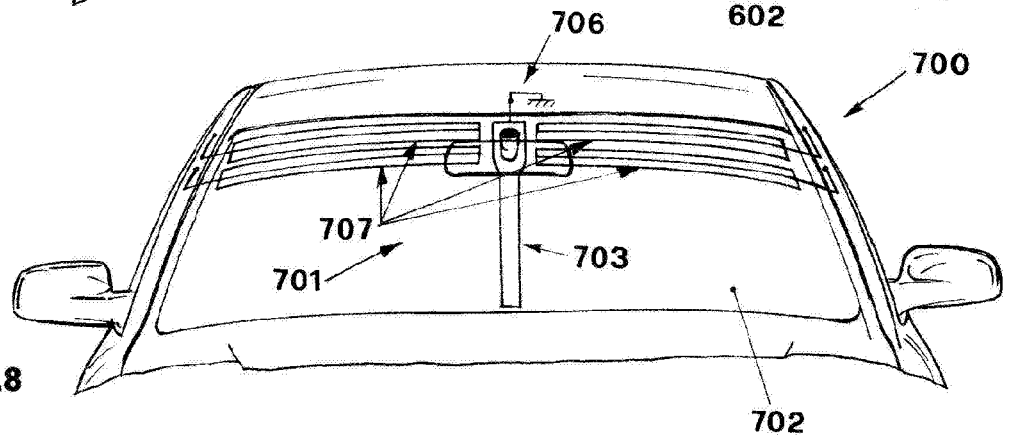

FIG.8

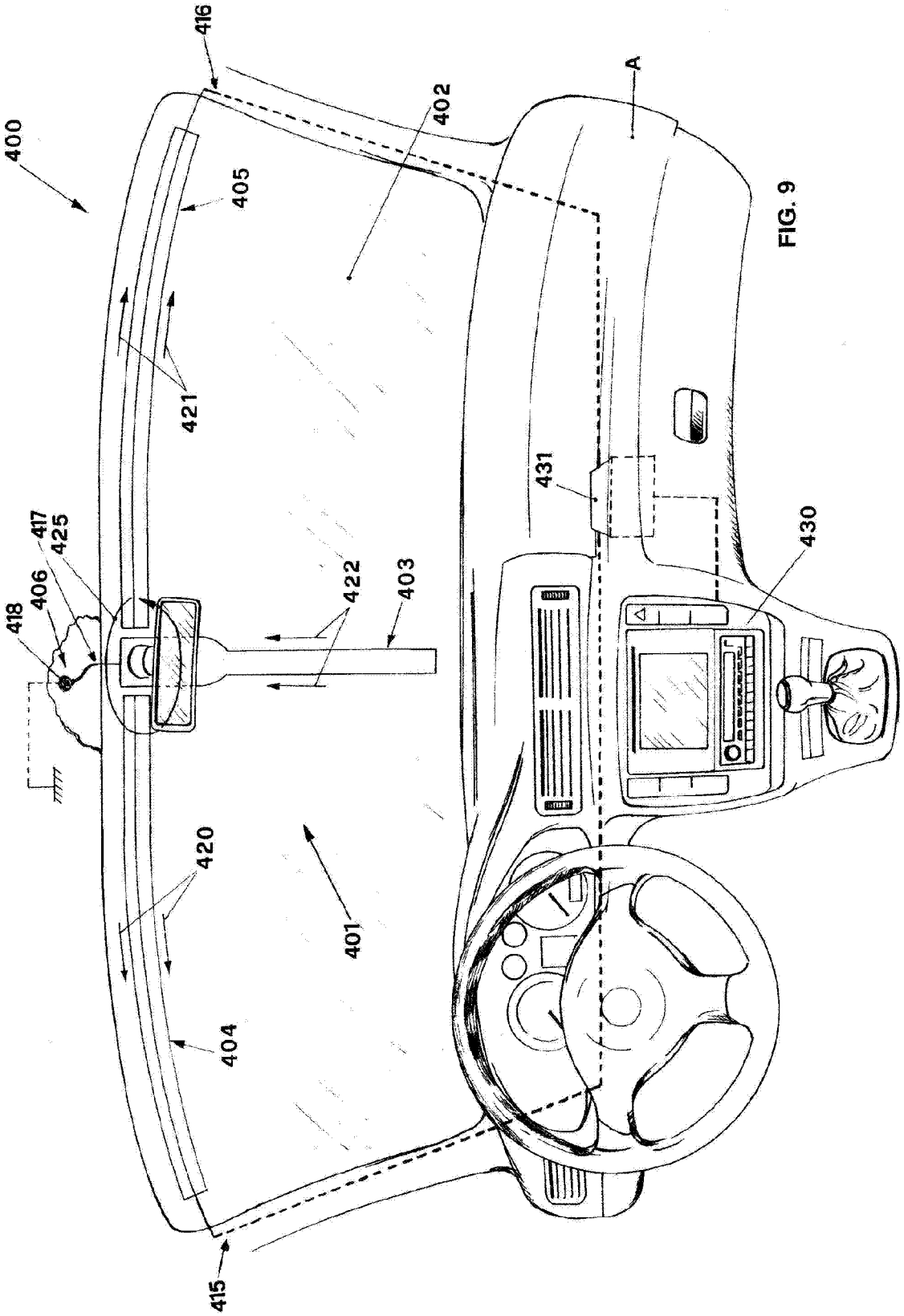
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FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 06 10 0996

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X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2005 026905 A (CENTRAL GLASS CO LTD), 27 January 2005 (2005-01-27) * abstract; figure 4 * -----	1-4, 8-12,15, 16	
			TECHNICAL FIELDS SEARCHED (IPC) H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 April 2006	Moumen, A

CATEGORY OF CITED DOCUMENTS

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13-04-2006

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