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(54) Multiband aerial

(57) A multiband aerial, especially suitable for a motor vehicle window, or for application to such window, said aerial comprising a single conductor wire which starts from a signal pickup position 1, and terminates in just the one free end 9, and which includes an FM aerial section 5 and an AM aerial section 3,4,6,7, with said sections being connected in series - therefore not requiring phasing - and being electrically isolated by means of an inductor 3, preferably of box rib pattern. The inductor 2 functions as an open circuit in the FM band and as a short circuit in the AM band. The series of vertical and horizontal segments 3,4,5,6 and 7 forming the sole aerial conductor wire can be of variable, but always asymmetric geometry.

Other embodiments disclose different configurations and dispositions for the pick up and end points.

The capacitance of the conductor 1-2-4-5-6-7 can be adjusted in relation to that of the output cable by varying the distance to the window edge.

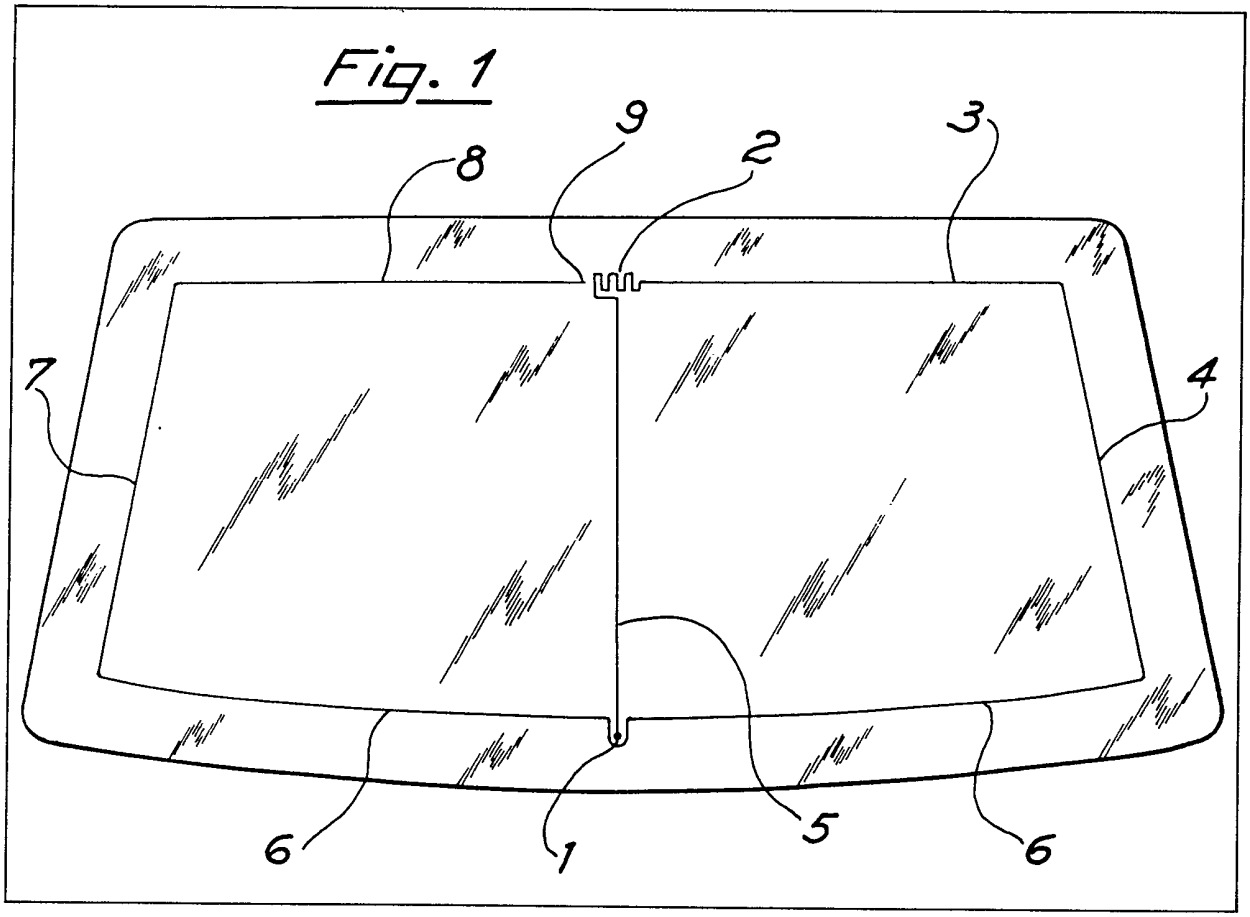

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Fig. 1

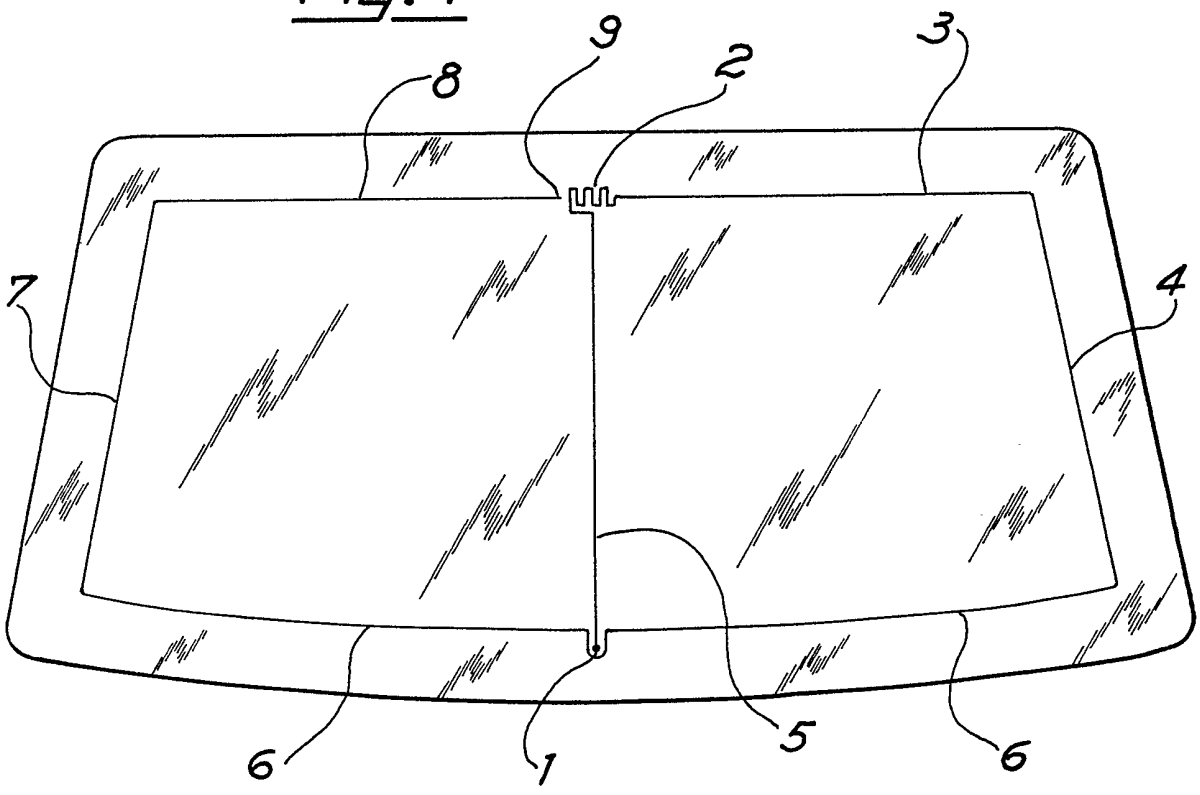


Fig. 2

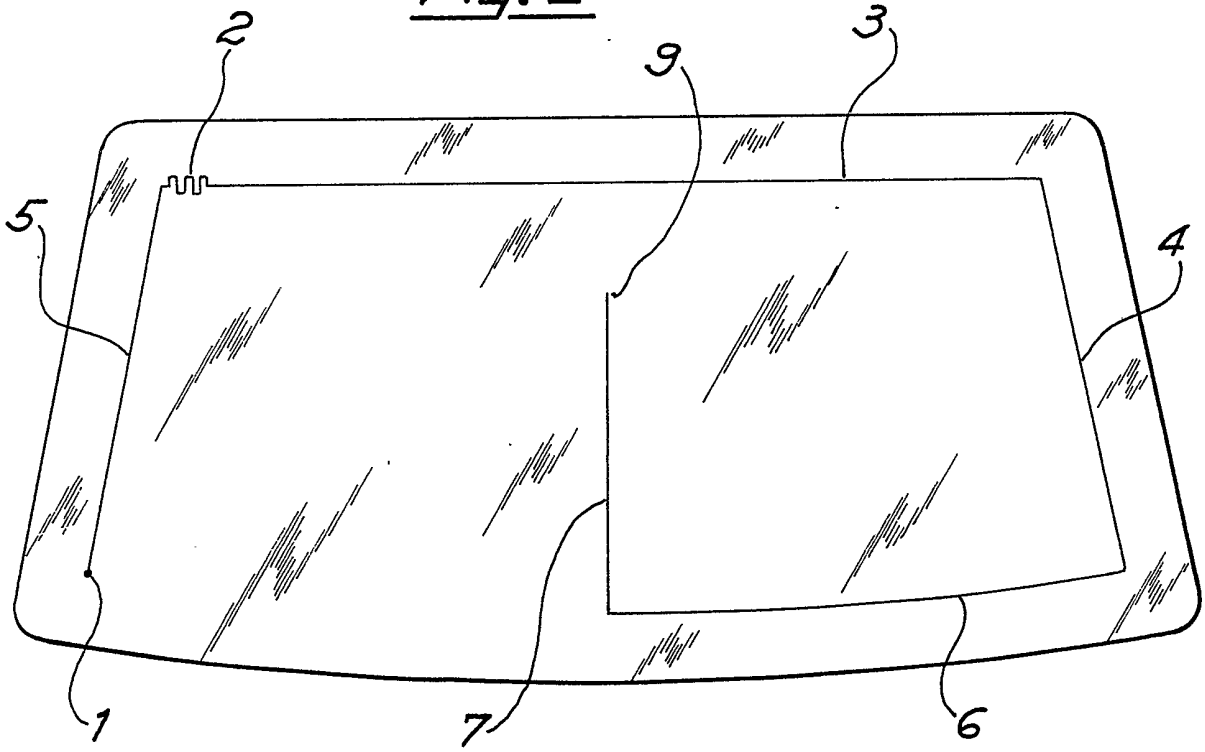


Fig. 3

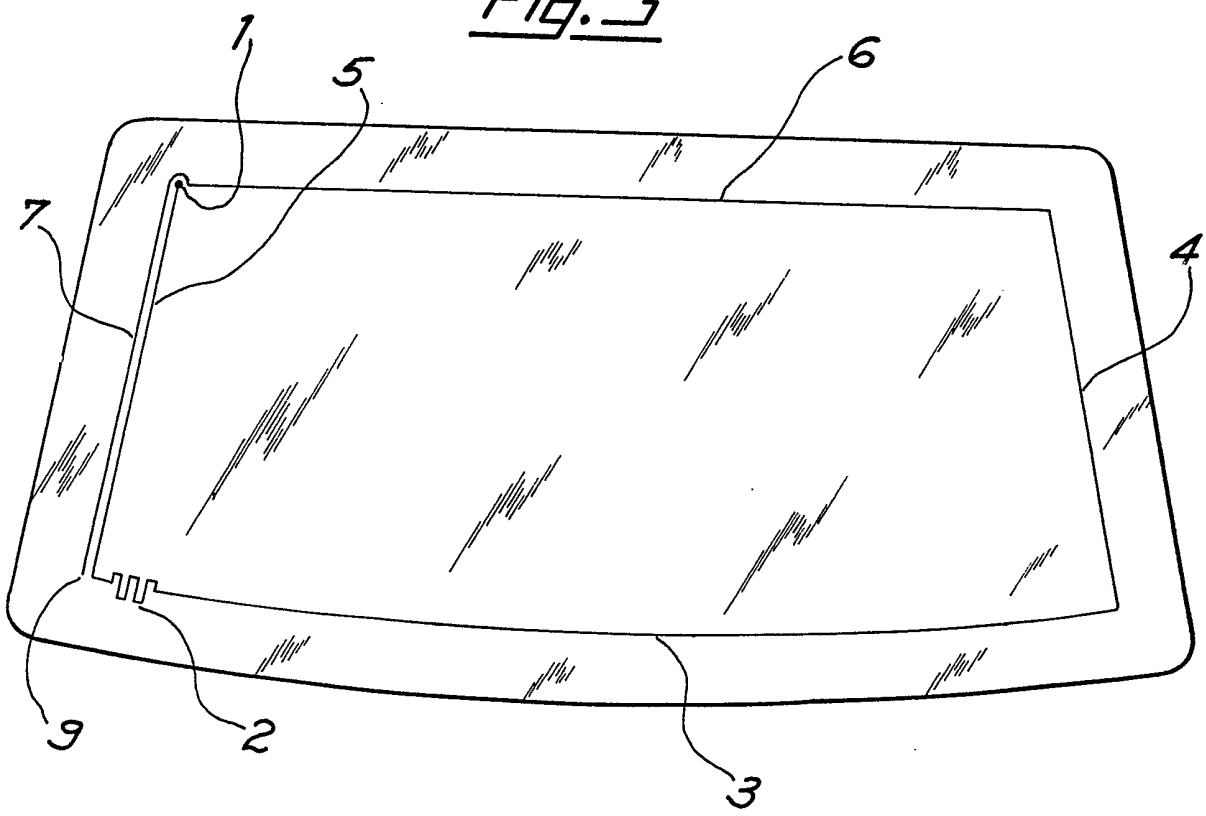
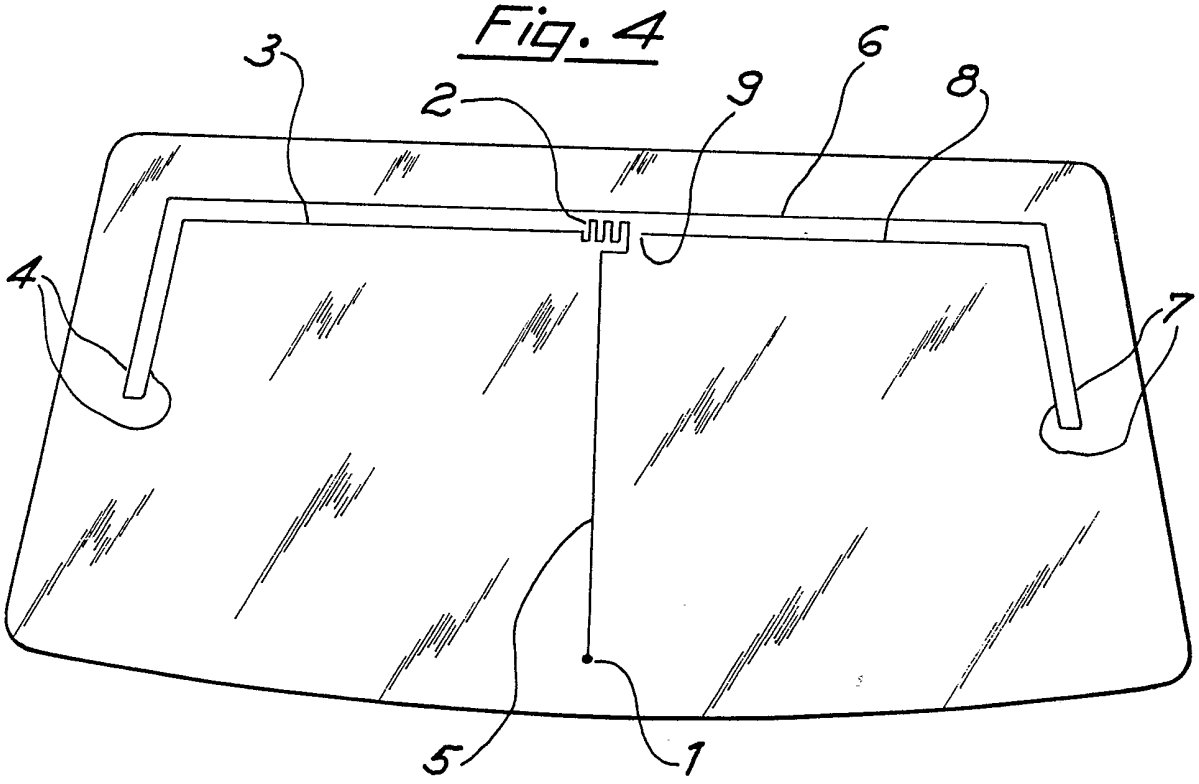


Fig. 4



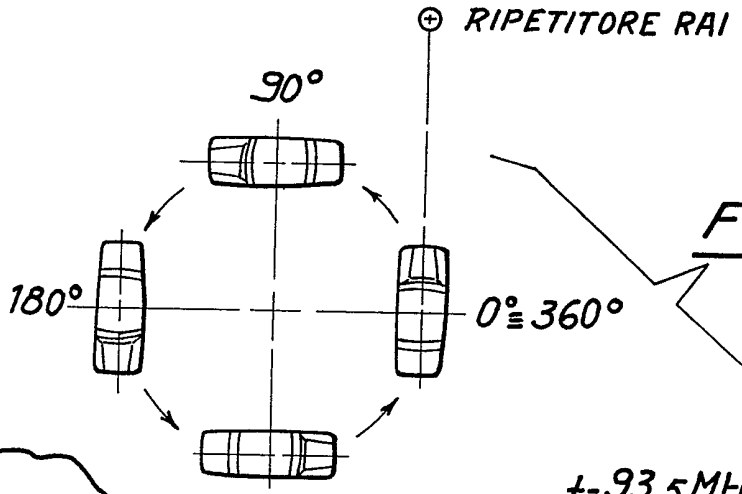


Fig. 5

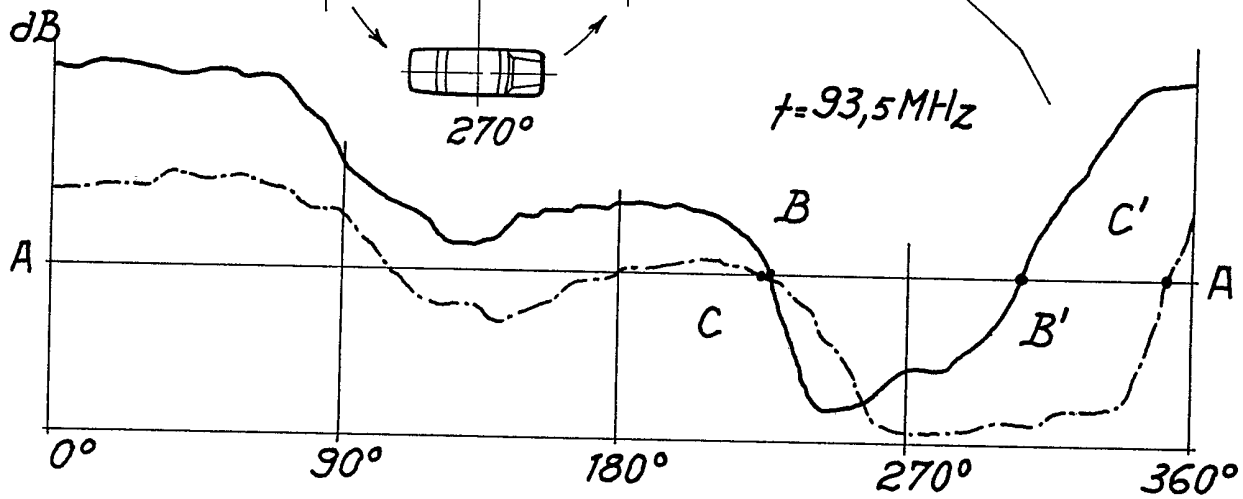


Fig. 6

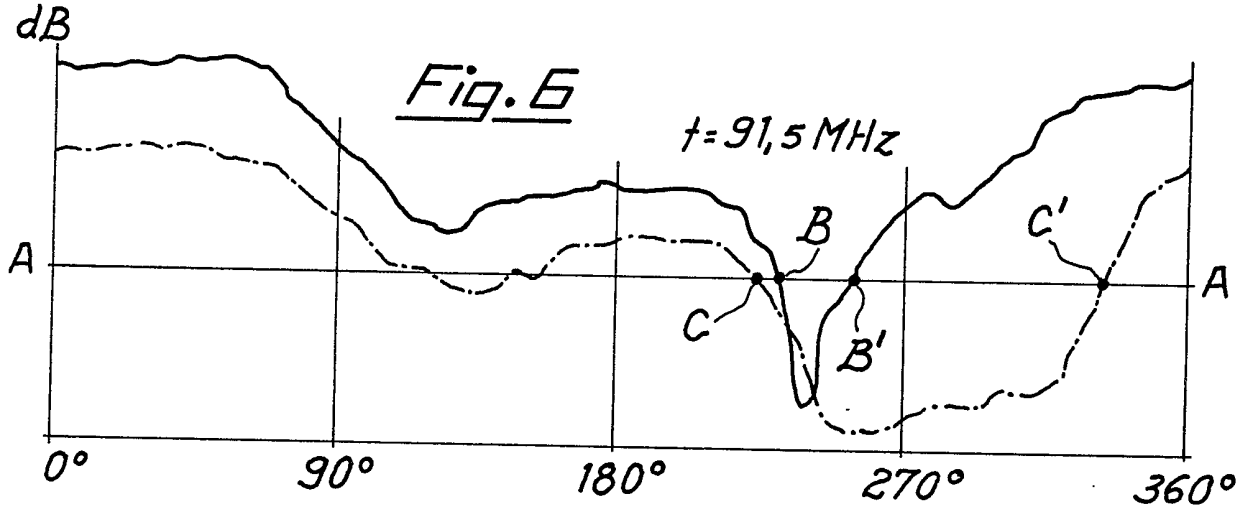
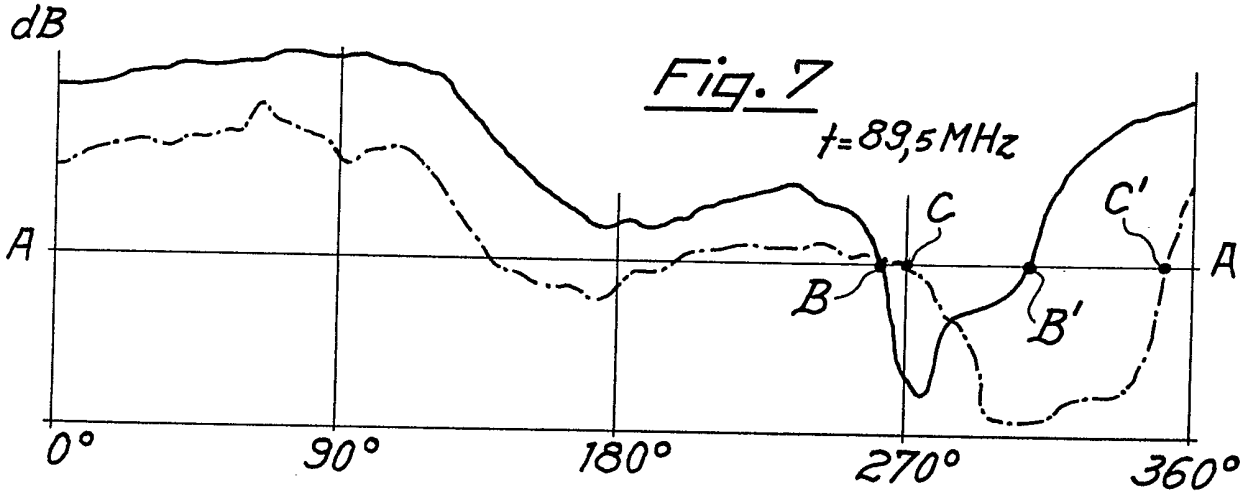


Fig. 7



SPECIFICATION

Multiband aerial, especially suitable for a motor vehicle window

This invention relates to a multiband aerial, especially suitable for application to a motor vehicle window or windscreen. The aerial assembly, or rather the aerial circuit, and the window on which said circuit is applied, is referred to herein as the "aerial window".

Multiband aerials for reception of signals both in the ultrashort wave band (FM), and in the short, medium and long wave band (AM) are already well known in many configurations, and are finding general application, replacing the rod aerials hitherto used on motor vehicles.

The circuits of said aerials are generally applied on the window by means of a silk screen printing process on a glass frit containing a metallic conductor, followed by annealing, or else the embedding of a conductor wire in a plastics film interposed between two glass panes.

The known aerial configurations normally consist of central elements for FM reception, and side elements, extending along the edge of the windscreen, for AM reception; these elements are then interconnected to the cable leading from the aerial to the radio receiver.

Particularly widely diffused, among the various aerial configurations adopted, are those described in Italian Patent No. 945.948 (to Saint Gobain) consisting of a vertical conductor of rod or T form for reception in the ultra short wave band (FM) arranged along the windscreen centre line, and of a conductor for reception in the short, medium and long wave band branching from the signal pick up point into two arms which follow the edge of the windscreen.

Also worthy of note, thanks to its special characteristics, is the aerial configuration described in Italian Patent Application No. 20387 A/79 (to Fabbrica Pisana S.p.A.) consisting of vertical segments interconnected to horizontal segments, wherein the latter are chiefly confined to the top part of the windscreen, and their horizontalness depends on the slope of the windscreen top edge.

Lastly mention should be made of the aerial configuration described in French Patent Application 7338052 (publication No. 2.205.755) (to Flachglas A.G. Delog-Detag). This aerial consists of double vertical and horizontal elements interconnected at the signal pickup point.

All known aerial configurations, including the above described ones, have the various conductors forming the aerial, that is for FM and for AM, converging on one or more points which are connected one to the other, and therefore "in parallel".

Hence in these configurations, the signal received from the central aerial segment is then summed in phase with that received from the peripheral aerial segments, in order to improve aerial performance in AM or FM.

These known aerial configurations possess two rather appreciable drawbacks: firstly, it is not possible in actual practice to vary the signal pickup position on the window, but at the same time keeping the configuration geometry unvaried, as the conductor element lengths are interdependent on ratios which are in relation to the wave lengths received; secondly, all the aerial configurations hitherto described are highly directional.

This means that the aerial receives in an acceptable degree only when it is oriented towards the transmitter within certain angles, and its reception properties are considerably diminished when the angle of orientation is over 180° and below 360°.

The present inventions seeks to provide a multiband aerial which remedies or reduces such drawbacks and represents appreciable progress in its particular industrial field by reducing the directivity of reception; hence it is possible to alter the position of the signal pickup point without this impairing reception properties. Consequently reception capability in the ultra-short waveband (FM) is appreciably increased.

In accordance with the invention there is provided a multiband aerial, for mounting on a window, said aerial comprising a single conductor wire, commencing from a signal pickup point and terminating in a single free end, and comprising an aerial section for FM and an aerial section for AM, wherein said sections are connected in series and are mutually electrically isolated by an inductor, which inductor functions as an open circuit for the FM band and as a short circuit for the AM band.

In an embodiment, the aerial comprises a single conductor which commences from the signal pickup position and continues with a series of vertical and horizontal segments of variable, but always asymmetrical geometry (for example, as represented in any one of the accompanying drawings), terminating in just the one free end.

Briefly, the aerial is based on two aerials (for FM and AM) connected in series and electrically isolated by means of an inductor. This inductor functions as an open circuit in the FM band and as a short circuit in the AM band; hence the entire wire of the circuit functions as just one single series aerial in the AM band.

The series connection differs from parallel connection hitherto adopted, in that it does not require phasing between the two aerials, which would on the one hand, cause a non-optimum utilisation, and on the other hand, impair the directivity in the FM band.

In order that the invention may be better understood an embodiment thereof will now be described by way of example only and with reference to the accompanying drawings in which:-

Figures 1 to *4* each show a different configuration of the aerial according to this invention shown mounted on a vehicle window; and

Figures 5 to *7* are graphs plotted to show the degree of reception available with each of the aerials at 3 different frequencies.

The configurations shown in Figures 1 to 4 consist of one single conductor in accordance with the invention, comprising the segments for FM reception and for AM reception respectively, which are connected in series and are electrically isolated by an inductor.

Referring to Figure 1, the aerial comprises a vertical aerial conductor 5 which commences in an upward direction from a signal pickup point 1, lying on the windscreen centre line. The vertical aerial conductor 5 is connected in series to a horizontal aerial conductor 3 by means of an inductor 2 of box rib pattern, whose dimensions are calculated in each individual case, in order to optimize the total length of the aerial elements for AM and FM reception.

The horizontal part of the aerial conductor continues in this configuration with vertical and horizontal sections, 4,6,7,8, which are interconnected in series and terminate in a free end 9. Hence, as already emphasised, the aerial only has two ends; one for the signal pickup point 1; and the other being terminal end 9.

The position of the signal pickup point 1 can be shifted to one side, and the segments can follow one another, being connected in series, as shown in Figure 2.

The position of the signal pickup point 1 need not necessarily be at the bottom of the window as in the previous examples, but can be at top left; also in this case, all aerial elements are connected in series, as shown in Figure 3.

In the configuration illustrated in Figure 4, the signal pickup point is still located at the bottom towards the centre as in the example shown in Figure 1, but all the other elements 2,3,4,5,6,7,8 are confined to the top part of the window and are connected in series, up to free end 9.

The Applicant has carried out a number of experiments by mounting a windscreen incorporating an aerial circuit of the type described above on a FIAT 132 car; in these experiments the car was driven along a closed loop path at constant speed for a distance of about 20 km from a RAI (Radio Televisione Italiana) transmitter. The graphs plotted in Figures 5,6,7 were obtained for frequencies of 93.5 MHz, 91.5 MHz and 89.5 MHz respectively.

In these graphs, the solid line represents reception with the windscreen aerial described herein, while the broken line represents reception with a windscreen aerial of conventional configuration.

The graphs clearly show the improved reception power of the aerial described above, which is about 40 to 60% higher.

Furthermore, these graphs show the clear decrease in amplitude of the angle between which reception is appreciably lowered due to the directivity.

In fact, suppose we trace a line of constant dB, corresponding to preset value A, we find that the length of segments B-B' is always shorter than the length of segments C-C'.

The graph in Figure 5 shows how said length is reduced by about 40%; in Figure 6 the reduction is even greater - about 80%; in Figure 7 reduction is about 50%.

Hence it is shown that the aerial described herein represents, as already stated, substantial technical progress in the field of hitherto known windscreen aerials, as it highly successfully overcomes the disadvantage in which reception is considerably reduced when the aerial forms angles of over 180° and below 360° with the transmitter.

In order to understand more clearly the manner of operation of the aerial the motorcar should be considered, electromagnetically speaking, to be a hollow metal body in communication with the outside through various openings, one of which is the windscreen; also the car dimensions are very small with respect to the incident wave (hectometric waves). Hence it is justifiable to adopt a quasi-static line of reasoning when dealing with the problem.

The motor car therefore be represented as a hollow metal body immersed in an electrical potential produced by the external field.

An elelctric charge is induced in the car and the car is then brought up to a spatially constant potential. In the openings, instead, there is spatial distribution of potential which can be calculated either numerically (method of moments) or analytically on simplified models of the system.

The wire 1-2-4-5-6-7 integrates this difference in potential and applies it to input terminal 1.

So a physical understanding of the phenomenon permits deduction of the most appropriate wire arrangement in order to maximize the voltage received.

However, in order to optimize the voltage transferred to the receiver, it is also necessary for the impedance at the aerial input, that is substantially the capacitance of wire 1-2-4-5-6-7, to be in relation to the capacitance of the cable connecting the aerial to the receiver.

This capacitance can be varied by varying the wire length and the distance of the wire from the windscreen edge.

In this way, full optimization of the aerial will be achieved.

CLAIMS

1. A multiband aerial, for mounting on a window, said aerial comprising a single conductor wire, commencing from a signal pickup point and terminating in a single free end, and comprising an aerial section for FM and an aerial section for AM, wherein said sections are connected in series and are mutually electrically isolated by an inductor, which inductor functions as an open circuit for the FM band and as a short circuit for the AM band.

2. A multiband aerial as claimed in claim 1 wherein the conductor wire forming the aerial comprises a series of vertical and horizontal segments arranged in a pattern having no axis of symmetry.

3. A multiband aerial as claimed in either one of claims 1 or 2 comprising a vertical segment for reception in the ultra-short wave band (FM) and commencing from the signal pickup point, said segment being arranged either along the central axis of the aerial, or at varying distances from either side of the axis.

4. A multiband aerial as claimed in any one of claims 1 to 3 wherein the signal pickup point from which commences the single conductor wire forming the aerial is positioned either at the top or at the bottom of the aerial.

5. A multiband aerial as claimed in claim 2 wherein the series of vertical and horizontal segments of the aerial for reception in the short, medium and long wave band (AM) are positioned in such a way that, when fitted to a window, the segments are close to either four edges of the window, or only to three of said edges, or only to part of them, and confined either to the top or bottom part of the window, and can finish either at the side or on the centre line as required.

6. A multiband aerial as claimed in one of the preceding claims wherein said inductor is of box rib pattern, and has dimensions which are calculated in each individual case.

7. A multiband aerial for mounting on a window, substantially as herein described and illustrated with reference to any one of Figures 1 to 4 of the accompanying drawings.

8. Windscreen or window of a motor vehicle when fitted with a multiband aerial as claimed in one of the preceding claims.

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