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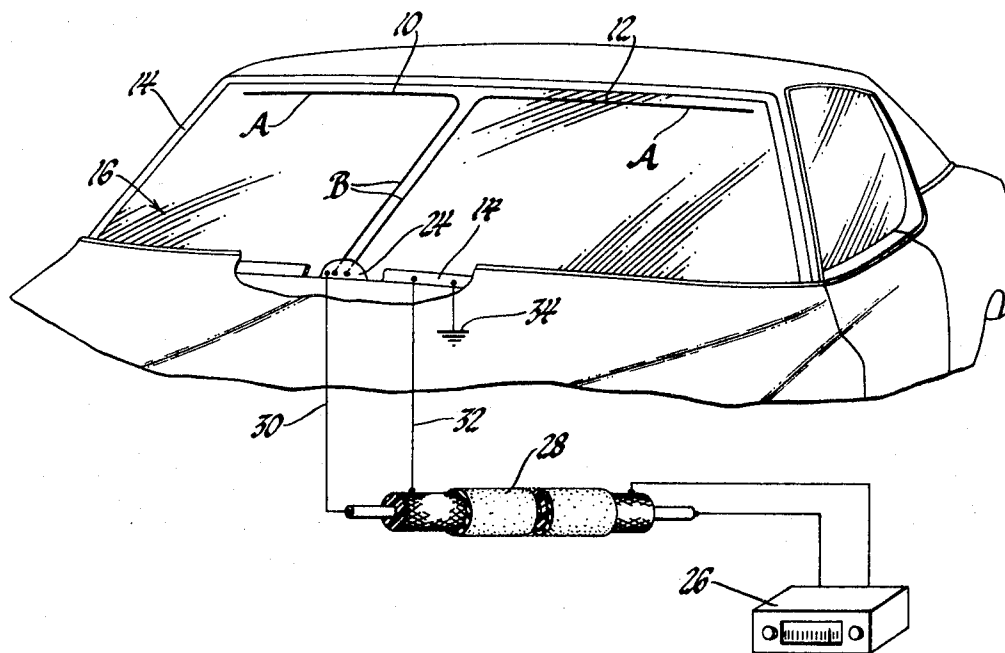
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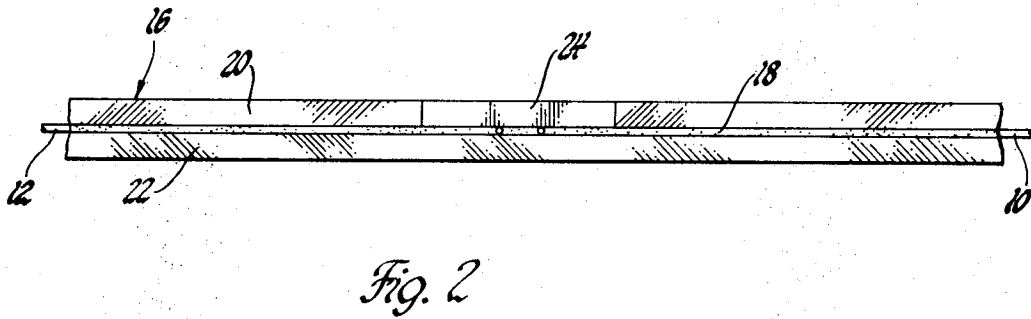
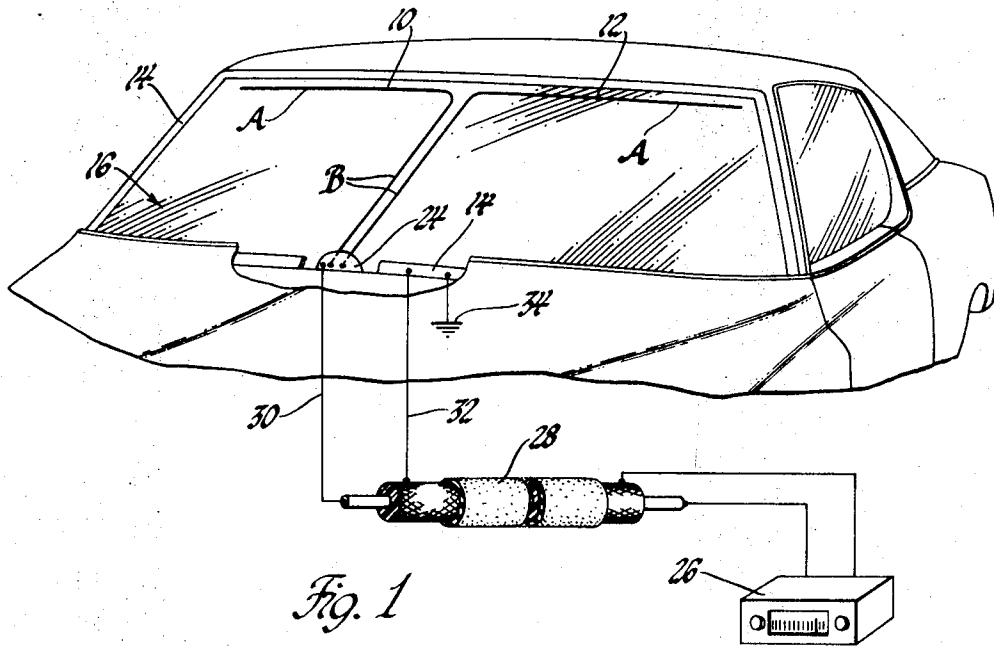
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[54] **CONCEALED WINDSHIELD BROADBAND ANTENNA**
6 Claims, 2 Drawing Figs.

[52] **U.S. CL.**..... **343/712,**
343/830, 343/873
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 [50] **Field of Search**..... **343/705,**
708, 711, 720; 343/712, 830, 873

ABSTRACT: An AM-FM antenna for vehicular radio receivers comprising a pair of L-shaped fine wire conductors disposed between the laminates of a windshield in reversely symmetrical relation and connected to a receiver by way of a coaxial lead. Spacings between the conductors and the vehicle body portion bounding the windshield are chosen to capacitively load the antenna for AM reception and to resonate the antenna for FM reception.





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CONCEALED WINDSHIELD BROADBAND ANTENNA

INTRODUCTION AND SUMMARY OF THE INVENTION

This invention relates to antennae for vehicular radio receivers and more particularly to a broadband antenna which includes conductors disposed within a vehicle window opening such as the windshield aperture.

In accordance with the present invention a highly inconspicuous antenna for vehicle radio receivers is provided. This is accomplished by placing conductors such as fine wires within a window opening in the vehicle body. So disposed, the conductors may be supported by the glass in the window. In a specific and preferred embodiment, the conductors are placed in the windshield aperture between the glass laminates so as to be fully supported in a fixed position relative to the body.

The present invention also provides an antenna of a configuration which exhibits broadband reception characteristics so as to accommodate both AM and FM signal reception. In general, this is accomplished through the use of two separate conductors of reversely symmetrical disposition each of which includes a portion which is relatively close to a metallic body element and a portion which is relatively remote from the metallic body. The conductor portions which are relatively remote from the body intercept the incident radio waves and the conductor portions which are relatively close to the body act to condition the antenna for broadband reception. In the AM band, the conductor portions relatively close to the body form capacitor elements which load the remote portions for proper antenna impedance characteristics. In the FM band, the relatively close conductor portions act to resonate the antenna conductors for maximum response in the standard FM frequency band.

Further features and advantages of the invention will become apparent upon reading the following specification which is to be taken with the accompanying drawings of which:

FIG. 1 is a plan view of a vehicle windshield incorporating an embodiment of the present invention; and

FIG. 2 is a bottom view of the vehicle windshield showing more of the nature of the connection means.

In FIG. 1, the illustrative embodiment of the antenna comprises a pair of L-shaped fine wire conductors 10 and 12 having terminal ends and being disposed in reversely symmetrical fashion within a vehicle windshield aperture defined by a surrounding metallic body molding 14. While the molding 14 is shown as one piece, it may also consist of several connected sections. Conductors 10 and 12 are supported in the position shown by the windshield glass 16. This may be accomplished by placing the conductors 10 and 12 in the thermoplastic layer 18 between laminates 20 and 22 shown in FIG. 2. Alternatively, the conductors may be disposed on the surface of glass 16 by means of a transparent plastic tape.

As shown in FIG. 1 with reference to conductor 10, each of the reversely symmetrical conductors 10 and 12 includes a transverse portion A which is relatively closely adjacent the body molding 14. Each conductor also includes a longitudinal portion B which is near the centerline of windshield glass 16 and thus is relatively remote from the body molding 14.

The longitudinal portions B of conductors 10 and 12 extend in parallel fashion to a point in the bottom center of the windshield glass 16. At this point conductors 10 and 12 are electrically connected to a copper foil contact 24. As shown in the FIGS., contact 24 extends between the laminates 20 and 22 to the bottom periphery where it wraps around the interior laminate 20.

The antenna comprising conductors 10 and 12 is connected to a radio receiver 26 by means of a coaxial conductor cable 28. The center conductor of cable 28 is connected by a short lead 30 to the foil contact 24. The outer conductor of cable 28 is connected to the body molding 14 by a conductor

represented at 32. The body molding 14 is grounded as indicated at 34.

It will be understood that receiver 26 may be equipped for either AM or FM broadcast reception or, alternatively, it may be equipped for both AM and FM reception as is often the case. The antenna represented by conductors 10 and 12 in the windshield aperture defined by molding 14 is effective to abstract energy from passing radio waves in both AM and FM frequency bands. Accordingly, the antenna is particularly suitable for broadband applications.

In the AM band of 550 to 1,600 kc., the conductors 10 and 12 constitute a capacitively loaded, two-conductor antenna. To abstract maximum energy from a passing AM frequency radio wave, it is desirable to match the reactance of the load with a reactive component of antenna impedance of opposite type or sign. The transverse conductor portions A of conductors 10 and 12 are capacitively coupled to the adjacent grounded body molding 14. Accordingly, the capacitances produced by the transverse portions are in series with the longitudinal conductor portions B and serve to at least approximate the desired reactance match. It has been found that with the antenna conductor disposed within the laminates 20 and 22, a satisfactory capacitance value of more than 40 pf. can be achieved at 900 kc. Of course, it will be understood that wire size, length and spacing may affect this value, as well as the dielectric constant of the material between the conductors 10 and 12 and the body molding 14.

For FM broadcast reception, the transverse portions A adjacent body molding 14 may be considered to function as an open wire transmission line having distributed inductive and capacitive impedance characteristics. The longitudinal portions B again act as a short vertical antenna. Like all transmission lines, the conductors 10 and 12 act as a resonant circuit. Antenna resonance occurs when the open circuit impedance of the top sections formed by transverse portions A and the reactance of the longitudinal portions B cause zero total reactance. It has been found that by proper choice of wire size, length and spacing, this resonant circuit may be made resistive, that is, resonant, at approximately the center of the FM band, 100 mc. Thus the antenna presents a relatively constant impedance to the receiver 26 over the FM band.

Although not to be understood as limiting the present invention, the following design parameter numbers have been found to give good performance in both the AM and FM bands:

Wire diameter.....	in.—0.003
Transverse conductor length.....	in.—22.5
Longitudinal conductor length.....	in.—20.0
Transverse conductor spacing to body molding.....	in.—1
Spacing between longitudinal portions.....	in.—0.5
Antenna capacitance.....	pf.—40.8
Open circuit transmission line impedance.....	¹ 210

¹ Ohms at 100 mc.

The transverse conductor portions A may be of the same length as indicated above to produce a purely resistive, or resonant, condition at a frequency at or approximately at the center of the FM band. Alternatively, the portions A may be made of dissimilar length or dissimilar spacing relative to the molding 14. Changes in the conductor length and spacing result in changes in the distributed impedance quantities and thus alter the resonant frequency. Since the conductors 10 and 12 are physically separate, it is possible to resonate one conductor at a frequency of less than 100 mc. and the other conductor at a frequency of more than 100 mc. For example, resonant frequencies of 92 mc. and 108 mc. are obtainable with changes in conductor length of 10 percent or less.

It has been found that a change in the spacing between conductor portions A and the body molding 14 produces a less proportional shift in resonance than does a change in wire length. Accordingly, it may ordinarily be preferable to vary antenna characteristics by changing conductor length where such change is desired.

It has also been found that the window opening defined by body molding 14 exhibits a resonant cavity characteristic which results in antenna sensitivity to signals of frequencies in bands other than AM and FM. For example, the combination of the conductors 10 and 12 in a typical windshield opening exhibits a resonance at approximately 27 mc. which is within the Citizens Band. Accordingly, the antenna may also serve additional special purpose receivers.

It is to be understood that the foregoing description refers to an illustrative embodiment of the invention and is not to be construed in a limiting sense.

I claim:

1. An AM-FM broadband radio antenna for a vehicle-mounted receiver comprising in combination: a metallic vehicle body element defining a window opening, a window disposed in the opening, first and second conductors having terminal ends, the conductors being disposed in the opening in reversely symmetrical relation and supported by the window, each of the conductors having a portion relatively closely adjacent but spaced from the metallic body element and a portion relatively remote from the metallic body element, the relatively remote portions serving to develop electrical radio signals in response to intercepted electromagnetic radio waves, the relatively adjacent portions providing a capacitance determined as a function of the length of the relatively adjacent portions and as a function of the spacing of the relatively adjacent portions from the metallic body element, the capacitance having such a value that the relatively adjacent portions serve to tune the relatively remote portions for maximum performance in both the AM band and the FM band, and means electrically connecting the terminal ends of the remote conductor portions and the body element to a receiver in the vehicle.

2. An AM-FM broadband radio antenna for a vehicle-mounted receiver comprising in combination: a metallic vehicle body element defining a windshield opening, a windshield disposed in the opening, first and second conductors having terminal ends, the conductors being disposed in the opening in reversely symmetrical relation and supported by the windshield, each of the conductors having a first portion extending transversely of the windshield and relatively closely adjacent but spaced from the body element and a second portion extending longitudinally of the windshield and relatively remote from the metallic body element, the second conductor portions serving to develop electrical radio signals in response to intercepted electromagnetic radio waves, the first conductor portions providing a distributed inductance and a distributed capacitance, the distributed inductance determined as a function of the length of the first conductor portions, the distributed capacitance determined as a function of the length

of the first conductor portions and as a function of the spacing of the first conductor portions from the metallic body element, the distributed inductance and the distributed capacitance having such values that the first conductor portions serve to tune the second conductor portions for proper impedance matching in the AM band and for maximum resonant response in the FM band, contact means electrically connecting the terminal ends of the second portions, and means electrically connecting the contact means and the body element to a receiver in the vehicle.

3. A broadband radio antenna for a vehicle-mounted receiver comprising in combination: a windshield aperture in the vehicle defined by a metallic body element, a laminated windshield of known dielectric constant disposed within the aperture, first and second conductors disposed between the laminates of the windshield, and having transverse portions adjacent but spaced from the body element bounding the upper periphery of the windshield and longitudinal portions extending in spaced parallel fashion along the centerline of the windshield, an antenna lead comprising coaxial center and outer conductors for connecting the first and second conductors to a radio receiver, means adjacent the bottom periphery of the windshield for electrically connecting the longitudinal portions of the first and second conductors to the center conductor, means connecting the body element to the outer conductor, the first and second conductors being constructed and arranged to operate as a capacitively loaded dipole antenna in the AM band and a resonant antenna in the FM band.

4. A broadband radio antenna as defined in claim 3 wherein the transverse portions are of effectively dissimilar length to resonate the antenna at spaced frequencies in the FM band.

5. An AM-FM antenna for vehicular radio receivers comprising in combination: a windshield aperture defined by a metallic vehicle body element, a laminated windshield of known dielectric constant disposed within the aperture, first and second L-shaped fine wire conductors disposed between the laminates of the windshield in reversely symmetrical relation, each of the conductors having a transverse portion adjacent but spaced from the body element bounding the top periphery of the windshield, and a longitudinal portion extending in spaced parallel fashion along the centerline of the windshield to points adjacent the bottom periphery thereof, an antenna lead comprising coaxial center and outer conductors for connecting the first and second conductors to a radio receiver, means connecting the first and second conductors to the center conductor at said points, and means connecting the body element to the outer conductor, the first and second conductors being constructed and arranged such that in the AM band the transverse portions operate as capacitors loading the longitudinal portions, and in the FM band the transverse portions operate as a transmission line with the adjacent body element to resonate the conductors.

6. A broadband radio antenna as defined in claim 5 wherein the transverse portions are of dissimilar length to resonate the first and second conductors at spaced frequencies in the FM band.

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