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(54) **VEHICLE EXTERIOR MIRROR WITH ANTENNA**

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(57) **ABSTRACT**

An exterior rear view mirror for a motor vehicle comprises a case containing a reflective member and an antenna, consisting of an electrically conductive layer on a surface of the case, for transmitting and/or receiving radio frequency electromagnetic radiation. The electrically conductive layer has at least one zone having its periphery shaped in accordance with the frequency of said electromagnetic radiation.

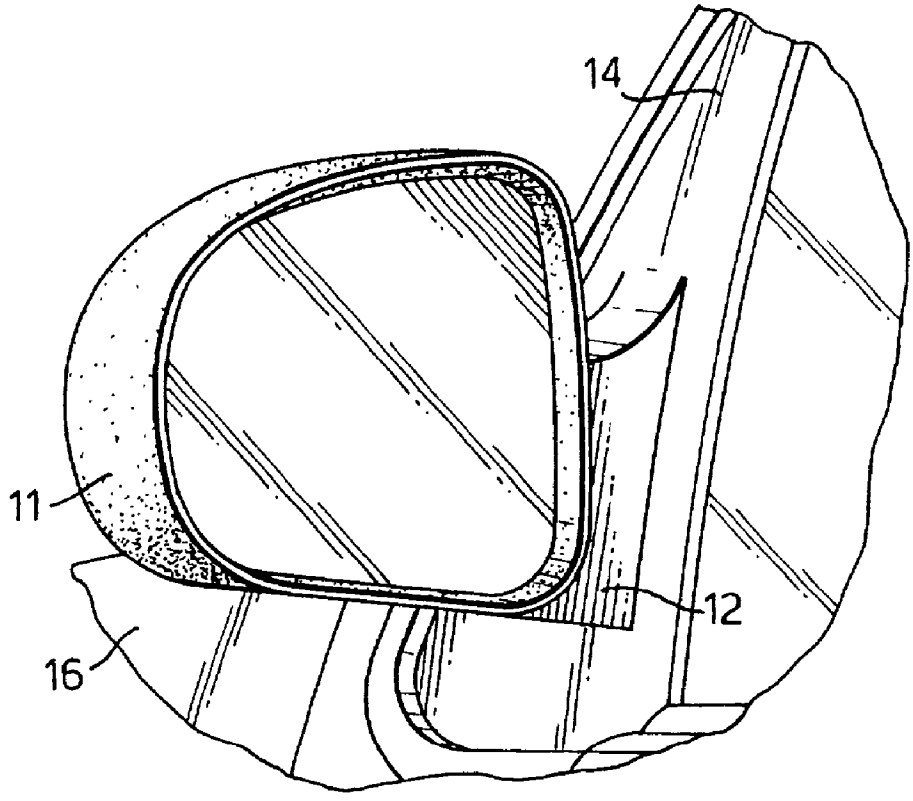


Fig.1.

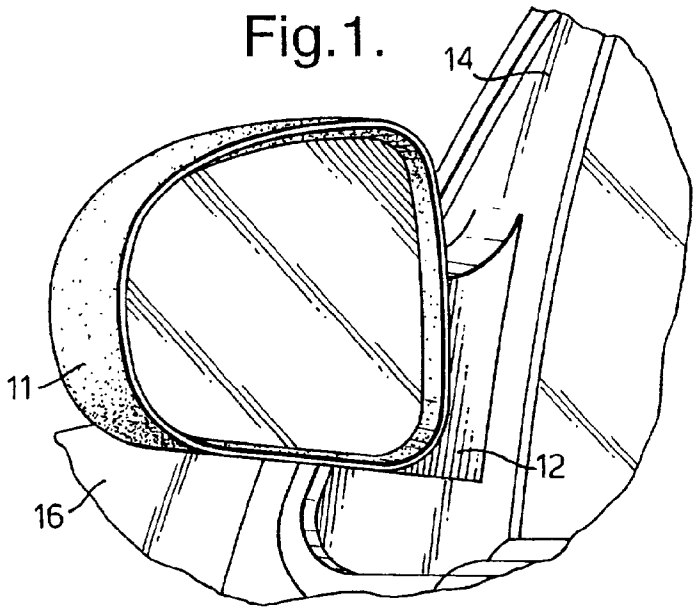


Fig.2.

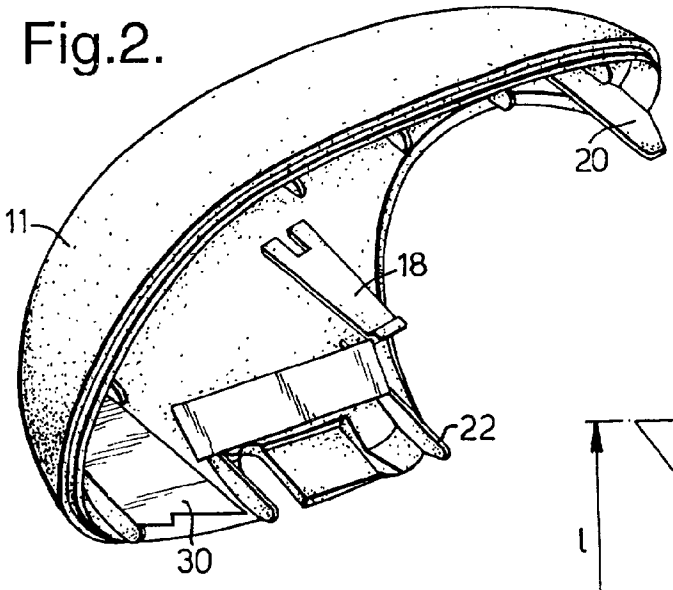


Fig.7.

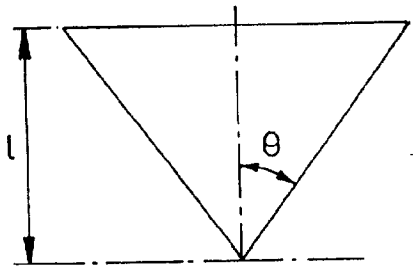


Fig.3.

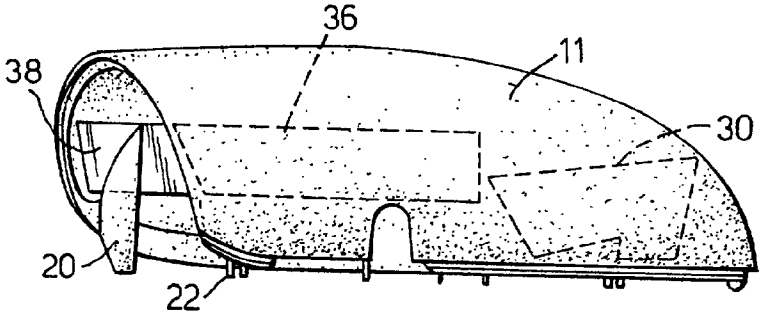


Fig.4.

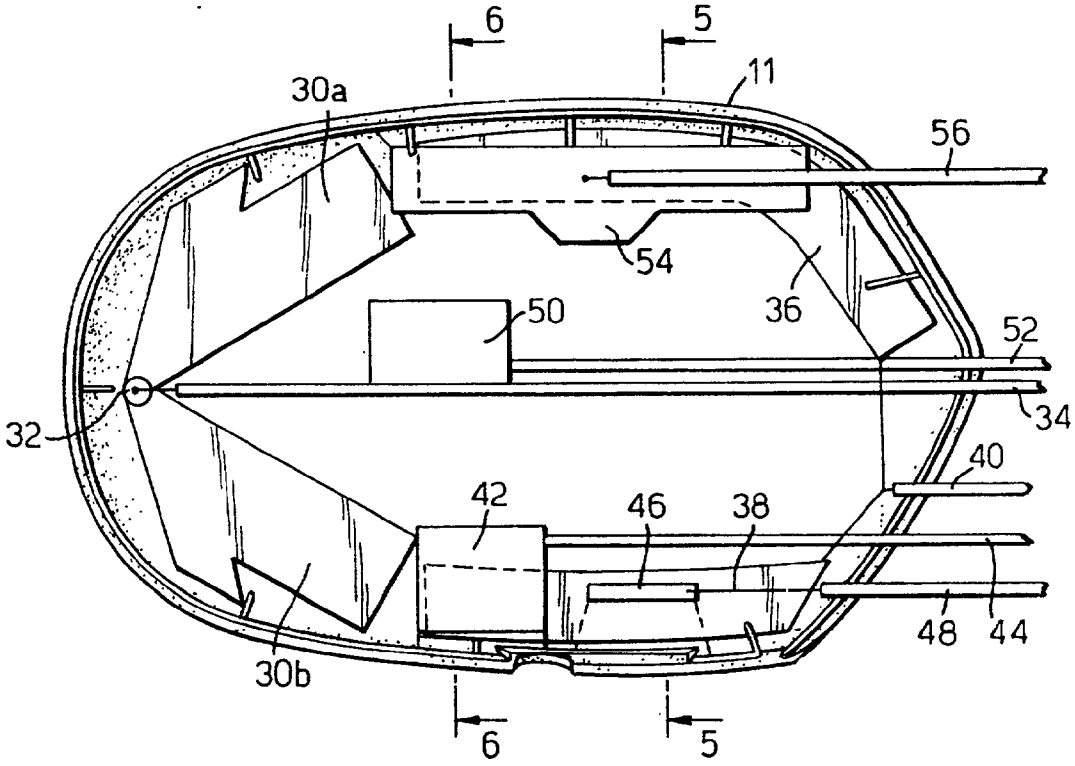


Fig.5.

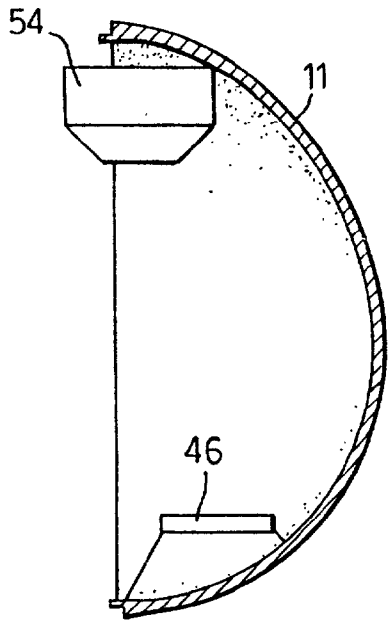
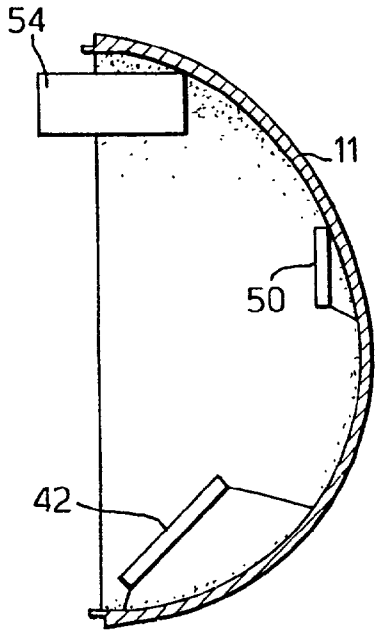


Fig.6.



VEHICLE EXTERIOR MIRROR WITH ANTENNA

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Ser. No. 09/404,101 filed Sep. 23, 1999.

FIELD

[0002] This invention relates to an exterior rear view mirror for a motor vehicle comprising a case containing a mirror glass or other reflective member and an antenna for transmitting and/or receiving radio frequency electromagnetic radiation comprising an electrically conductive layer on a surface of the case.

RELATED ART

[0003] An exterior mirror of this type is disclosed in GB-A-1590824. The case comprises a body moulded from plastics material having a bright copper layer deposited on substantially the whole of its outer surface for receiving a chromium-plated outer layer. The bright copper layer also serves as an antenna.

SUMMARY OF THE INVENTION

[0004] According to the invention, in a rear-view mirror assembly of the type described above, the antenna comprises an electrically conductive layer on a surface of a rigid member forming part of the mirror assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] **FIG. 1** is a perspective view of a vehicle exterior mirror in accordance with the invention;

[0006] **FIG. 2** is a perspective view of the case of the mirror shown in **FIG. 1**;

[0007] **FIG. 3** is a perspective view of the mirror case shown in **FIG. 2**, from a different angle;

[0008] **FIG. 4** is a view into the mirror case of **FIGS. 2 and 3** through the opening in which the mirror glass would be mounted;

[0009] **FIG. 5** is a cross-sectional view taken on the line **5-5** in **FIG. 4**;

[0010] **FIG. 6** is a cross-sectional view taken on the line **6-6** in **FIG. 4**; and

[0011] **FIG. 7** is a diagram illustration dimensions of a theoretical conical antenna.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] **FIG. 1** shows a vehicle rear-view mirror comprising a reflective member **10** fitted in a case **11**, which is mounted on a bracket **12**, which is secured to one of the front doors **14** of a motor car **16**. As can be seen from **FIG. 2**, the case **11** has a clip **18** and guides **20** and **22** by means of which it is secured to an internal frame member (not shown) of the mirror assembly. In accordance with the invention, a first metallic foil element **30** is secured by adhesive to the inside surface of the outboard end of the case **11**. As can best be seen from **FIG. 4**, the element **30** is formed in two symmetrical halves **30*a*** and **30*b*** interconnected by a link part **32** which is connected by a coaxial cable **34** to a mobile telephone (not shown). The two symmetrical halves **30*a*** and **30*b*** approximate to a conical antenna. **FIG. 7** shows a cone of half cone angle θ and length ⌊. Theoretically ⌊ should be equal to wavelength λ of the radio signals (i.e. the speed of light divided by the centre frequency). In practice, acceptable results are achieved if ⌊ is three tenths of the theoretical value.

[0013] The theoretical formula for the feed-point impedance (Zk) of a conical antenna is:

$$Zk=(Zo/\pi)\text{Ln cot } g(\theta/2)$$

[0014] where Zo is the free space impedance (377 ohms in air) and "Ln cot g" means "logarithmic cotangent". 30° is a realistic practical value for θ.

[0015] The relationship between the angle θ and the impedance of the antenna is linear. Good reception can be obtained if the actual feed-point impedance is between half and twice its optimum value. Provided this condition is met, it can be shown from FIGS. **8-15** on page 355 of John D. Kraus, "Antennas", published by McGraw Hill, ISBN 0-07-0354-22-7, that, because the curve is practically linear in the area used, a practical optimised value Zo for the actual feed-point impedance is:

$$Zo=1500(\lfloor/\lambda)-113\text{-}3$$

[0016] It follows that the length ⌊ of the foil elements **30*a*** and **30*b*** and the half-cone angle θ is:

$$(Zo/\pi)\text{Ln Cot } g\theta/2=1500(\lfloor/\lambda)-113\text{-}3$$

[0017] In practice, the length ⌊ of foil element may be about three tenths of the wavelength λ.

[0018] Two other foil elements **36** and **38** that are a mirror image of one another are secured by adhesive to the central and inboard parts of the interior surface of the case **11**. These foil elements **36** and **38** are connected by a cable **40** to a radio broadcast receiver, for example an FM radio receiver (not shown).

[0019] In addition to the above two antennae, a third antenna **42** is connected by a cable **44** to a transponder (not shown) for an automatic road toll charging system; a fourth antenna **46** is connected by a cable **48** to a controller for the central door locking system for the car **16**. Another antenna **50**, positioned in the centre of the mirror case **11** is connected by a cable **52** to a digital radio receiver (not shown) while a further antenna **54** is connected by a cable **56** to a GPS receiver (also not shown).

[0020] The antennae **42**, **46**, **50** and **54** are rigid antennae mounted within the case **11**. Although the various cables **34**, **40**, **44**, **48**, **52** and **56** are shown as parallel to one another, in practice they are gathered together so as to extend through the interior of the bracket **12** into the interior of the car **16**, where they are connected to their respective transmitters and/or receivers.

[0021] Antennae comprising metal inserts moulded into the case **11** may replace the foil antennae **30**, **36** and **38**. Another alternative is for the case or cover member to be formed as co-moulding of two different plastics material, only one of which will accept surface metallisation. A layer of metal is then deposited on this part to serve as the antennae.

[0022] If the case has a separate decorative exterior cover member of the type described in European Patent Applica-

tion No. 98302674.1, the electrically conductive layer may be formed either on the inner surface of such cover member or on that part of the outer surface of the mirror case which is enclosed by the cover member.

[0023] Alternatively or additionally one or more antennae may take the form of a conductive layer on part of the mounting for the mirror glass or other reflective member.

[0024] The mirror assembly may in addition incorporate other antennae for receiving GPS signals, remote operation of the car door locks and transponders for automatic road toll accounting systems. Some of these additional antennae may be formed as self-supporting rigid members.

1. An exterior rear view mirror for a motor vehicle comprising a case containing a reflective member and an antenna for transmitting and/or receiving radio frequency electromagnetic radiation comprising an electrically conductive layer on a surface of the case, characterized in that the electrically conductive layer comprises a first zone having its periphery shaped in accordance with the frequency of said electromagnetic radiation.

2. A rear view mirror according to claim 1, wherein the length of said first zone is substantially equal to about three tenths of the wavelength of said electromagnetic radiation.

3. A rear view mirror according to claim 2, wherein said first zone is formed on a curved part of the surface of the case so as to form a part-conical antenna, the half cone angle θ of which is related to the length ⌊, the feed-point impedance Zo and the wavelength λ by the formula:

$$(Zo/\pi)\mathrm{Ln}\ \mathrm{Cot}\ g\theta/2=1500(\lfloor/\lambda)-113{,}3$$

4. A rear view mirror according to claim 1, wherein the electrically conductive layer comprises a further zone for receiving electromagnetic radiation of a frequency different from that received by said first zone.

5. A rear view mirror according to claim 1, wherein the electrically conductive layer is located on the inside surface of the case.

6. A rear view mirror according to claim 1, wherein the case has an exterior cover member and the electrically conductive layer is applied to the inner surface of said exterior cover member.

7. A rear view mirror according to claim 1, wherein the case has an exterior cover member and the conductive layer is located on a part of the outer surface of the mirror case, which is enclosed by the cover member.

8. A rear view mirror according to claim 1, wherein the electrically conductive layer comprises foil secured by adhesive.

9. A rear view mirror according to claim 1, wherein the electrically conductive layer comprises an insert moulding formed as part of one of the case and the cover member.

10. A rear view mirror according to claim 1, wherein the case is formed as co-moulding of two different plastics material, only one of which is capable of accepting surface metallisation, and the conductive layer comprises metallisation deposited thereon.

11. A rear view mirror according to claim 1, wherein the electrically conductive mirror comprises first and second zones which are shaped so that the first zone is a mirror image of the second zone.

12. A rear view mirror according to claim 1, having at least one additional antenna formed as self-supporting rigid member located within the mirror case.

13. A rear view mirror according to claim 1, having an antenna for a mobile telephone.

14. A rear view mirror according to claim 1, having an antenna for FM radio reception

15. A rear view mirror according to claim 1, having an antenna for receiving GPS signals.

16. A rear view mirror according to claim 1, having an antenna for a remote operation of the car door locks.

17. A rear view mirror according to claim 1, having an antenna for a for an automatic road toll accounting system.

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