United States Patent

Robinson, Jr. et al.

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[54] HORN-REFLECTOR ANTENNA

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[52] **U.S. Cl.**.....**343/781,** 343/784, 343/840

[51] **Int. Cl.**.....**H01q 19/14,** H01q 19/12

[58] **Field of Search**.....343/772, 781, 786, 840, 912, 343/915, 784, 840

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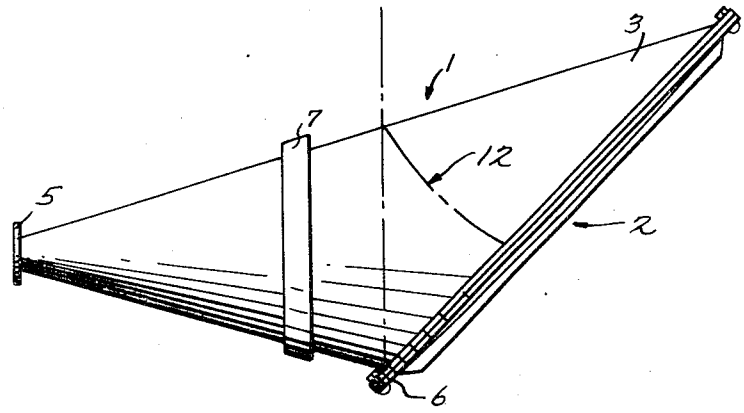
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[57] **ABSTRACT**

The present invention relates to a horn-reflector antenna and a method of making it. More particularly, it relates to a horn-reflector antenna consisting of a hollow cone composed of a microwave transparent material, lined in part with a microwave reflective material and a paraboloidal reflecting section which intersects with and is secured to the open end of the cone, the cone being unlined adjacent the paraboloidal reflecting section so that a portion of the cone functions as the radome.

5 Claims, 5 Drawing Figures



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SHEET 1 OF 2

Fig. 1.

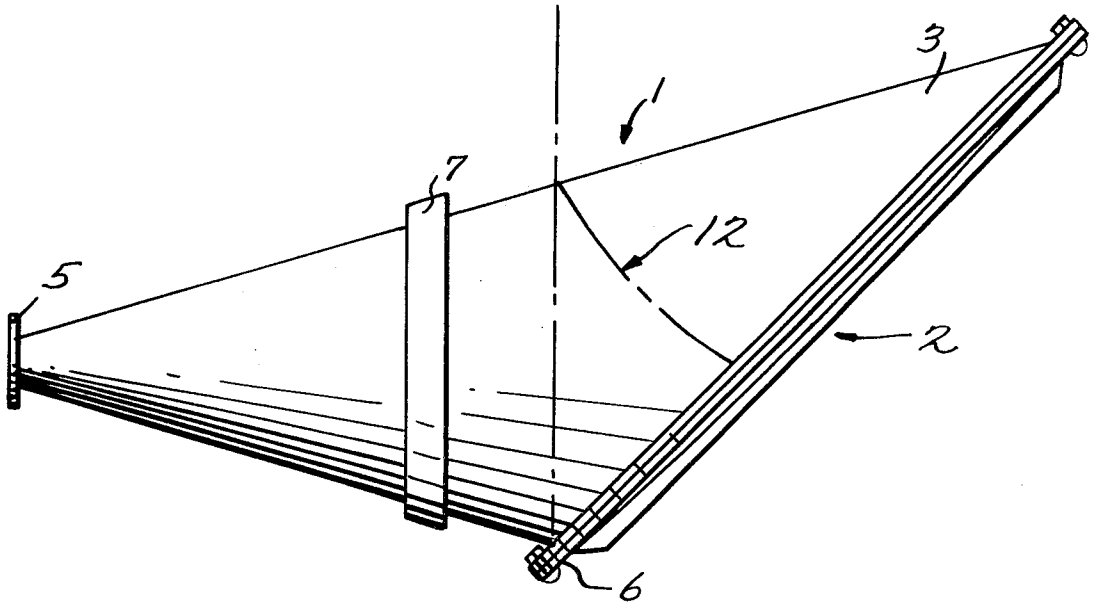
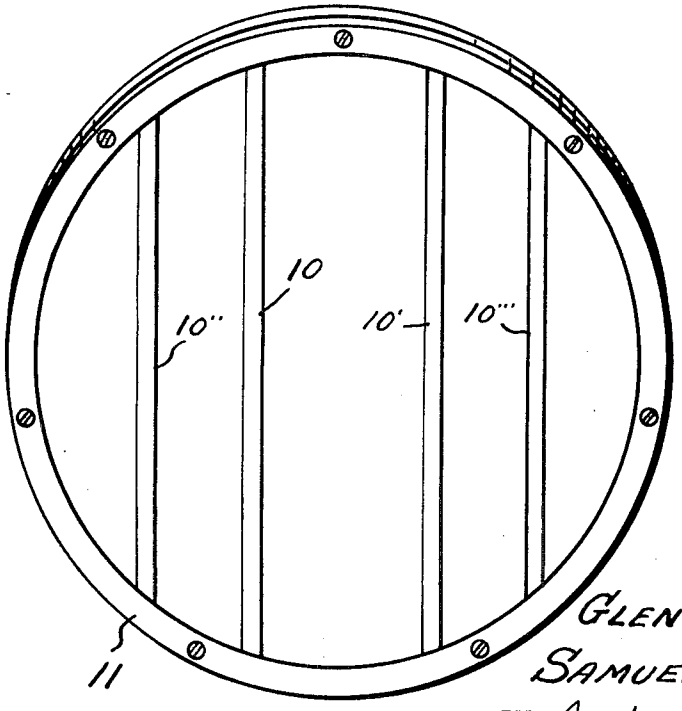


Fig. 2.



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Fig. 3.

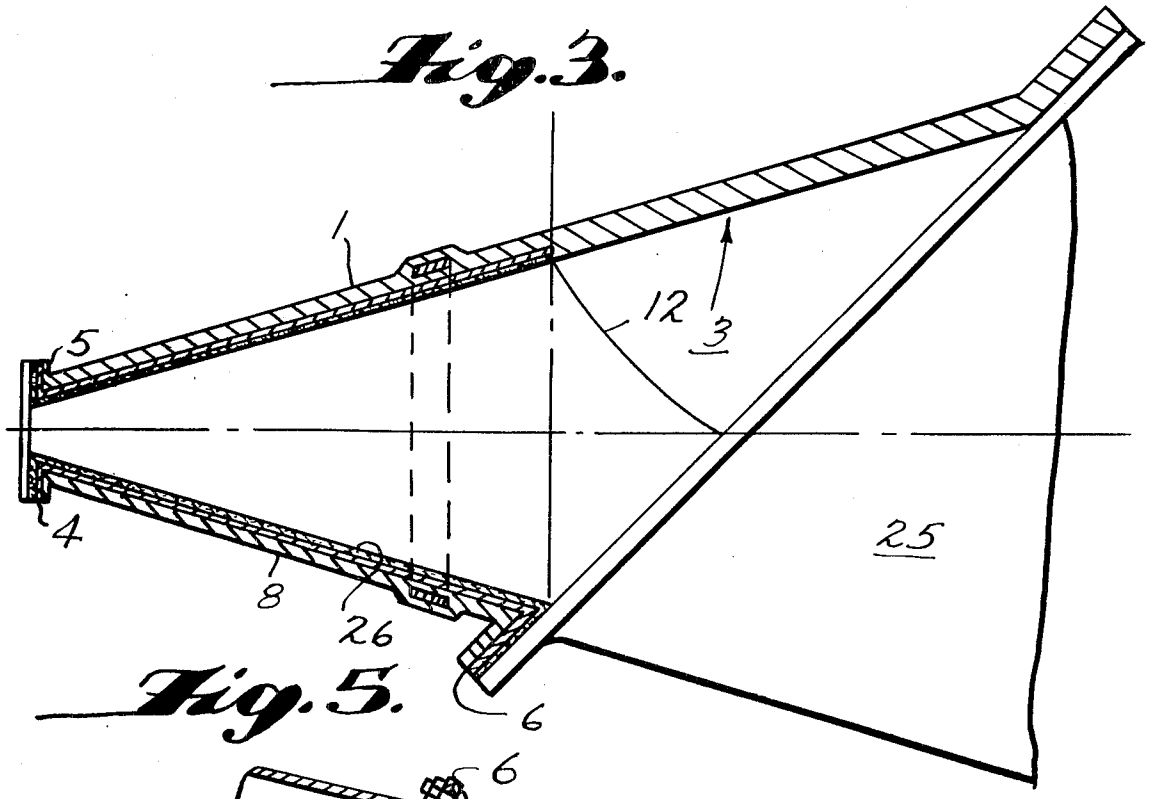
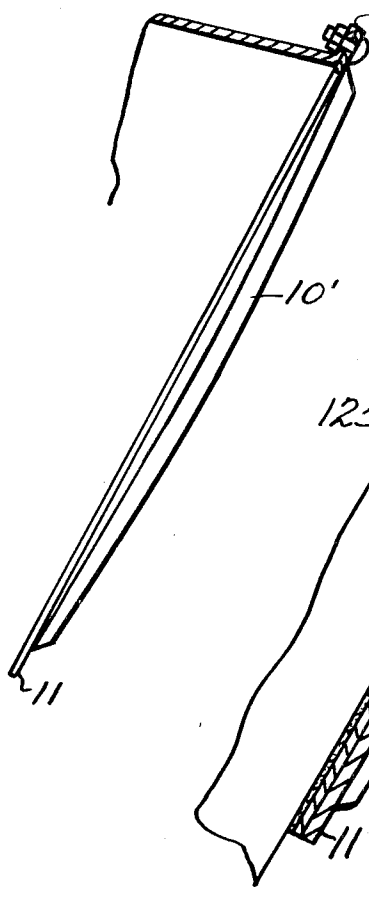


Fig. 5.



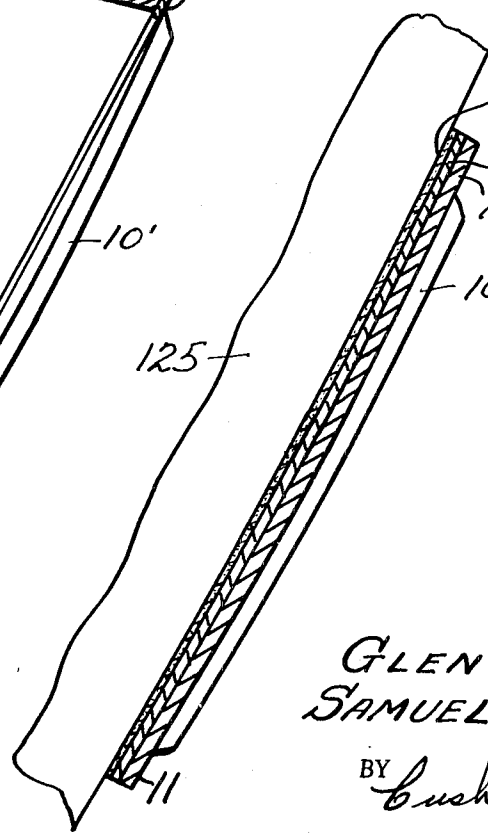


Fig. 4.

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HORN-REFLECTOR ANTENNA

A horn-reflector antenna is comprised of a pyramidal or conical electromagnetic horn and a reflector which is a sector of a paraboloid of revolution, the apex of the horn coinciding with the focus of the paraboloid of revolution and the axis of the horn being perpendicular to the axis of the paraboloid. The antenna design is based on geometrical optics and has no frequency-sensitive elements; therefore, it is extremely broadband. It is not polarization-sensitive and can be used in any linear or circular polarization. Because of the design, very little energy incident on the reflector is returned into the feed, so that impedance mismatch problems are avoided. Also, because of the shielding effect of the born, side and back lobes are minimized. Therefore, this type of antenna is quite useful for microwave communications and has been used extensively for communications networks on earth as well as in ground stations for satellite communications.

A commonly constructed form of horn-reflector antenna includes means completely enclosing the junction of the horn and the paraboloidal reflector including a radome, i.e., a plastic housing through which energy is reflected from the reflector. Enclosing the antenna permits pressurization of the interior, reduces wind loading and generally protects the interior of the horn and the surface of the reflector. However, the radome and the means used to fasten it in place increase the complexity and cost of the antenna and increase wind loading.

Principal objects of the present invention are to provide a horn-reflector antenna having a radome of simplified configuration and to provide a method of making the antenna which, taking advantage of the simplified configuration, reduces the cost of manufacture. The way in which the invention achieves these objectives will be understood best by considering the following detailed description of a preferred embodiment, in which reference will be made to the drawings, wherein:

FIG. 1 is a side elevation of the antenna;

FIG. 2 is a top view of the antenna;

FIG. 3 is a vertical section through the horn while being made on a mandrel;

FIG. 4 is a section through the reflector; and

FIG. 5 is a side view of the reflector, partially in section to show its attachment to the horn.

Referring to FIG. 1, the antenna comprises a conical horn, indicated generally at 1, and a reflector 2. The conical horn 1, which has a flare angle of 31.5°, is constructed of a plastic which is substantially transparent to microwaves. A preferred material is a thermosetting, water-resistant plastic such as epoxy resin or polyester resin, reinforced with glass mat, cloth or other reinforcing fibers. The innner surface of the horn, except for the radome area 3, is lined with a metallic layer preferably comprising aluminum and/or zinc which is microwave reflective. The aluminum and/or zinc may be applied by the technique known as metallizing with a flame spray gun. The conical horn 1 terminates, at the end near the apex, with a circular opening perpendicular to the axis of the horn and there is a flange 5 extending laterally outwardly from this opening for bolting or otherwise securing a wave guide feed to the conical horn. At the large end, the conical horn 1 terminates at a plane where it intersects the paraboloid of which the reflector is a section. At this end there is a flange 6 which extends laterally outwardly from the horn for bolting to a corresponding flange on the reflector. As additional reinforcement, there is a ring 7 extending laterally outwardly at about the middle of the horn.

As shown in FIG. 3, the horn 1, in cross section, comprises an outer shell 8 and an inner lining 4, except the portion 3 which has no inner liner. The outer shell is a microwave transparent material and preferably is a moldable plastic. Since considerable physical strength is required, it is desirable to reinforce the plastic, e.g., by embedding in it a glass fiber batting, cloth, or other reinforcing fibers, and the plastic may conveniently be a thermosetting resin which becomes permanently hardened such as epoxy or polyester resin.

The inner lining is a microwave reflective electrical conductor, preferably a metal such as aluminum and/or zinc. The lining may be in the form of a coating material, such as aluminum paint, or flame sprayed metal. It may be overcoated with a thin protective layer to reduce corrosion, as is well known.

As seen in FIGS. 1 and 4, the reflector 2 also is constructed of a reinforced plastic outer layer 108 with a microwave reflective inner layer 104 as described in connection with the conical horn. Reinforcing ribs 10, 10', 10'', and 10''' are provided extending outwardly from the reflector and there is a laterally outwardly extending flange 11 around the periphery of the reflector for bolting to flange 6.

The portion of the conical horn which is lined is substantially all of the horn except the area 3 against which radiation is reflected from the reflector 2. As will be appreciated, the coincidence of the focus of the paraboloid and the apex of the conical horn results in the reflector projecting a beam parallel to the axis of the paraboloid. By drawing lines parallel to that axis from the outer edges of the reflector and through the conical horn, the upper edge 12 of the inner lining is established along the curved line where those parallel lines intersect the horn. Slight departure from this curved line may be desirable because of slight scattering at the reflector, but it is undesirable that a substantially larger area be covered by the inner lining because this will reduce the energy transmitted and/or received by the antenna. Similarly, the lining should not cover a substantially smaller area because this may result in spillover of energy transmitted through the apex of the horn.

The horn preferably is manufactured on a conical mandrel 25, as seen in FIG. 3, and the simplicity of this manufacturing process is one of the principal advantages of the invention. Preferably the mandrel is provided first with a thin release coating 26 to facilitate removal of layers subsequently applied. Then metallic layer 4 is applied to the release coating in the area except that corresponding to the portion 3. For example, aluminum or zinc metal may be flame sprayed onto the release coating. Next, frame members may be mounted in place to provide reinforcement for the flange ring 7. These may be, e.g., wood. Then the entire area corresponding to the cone is covered with glass-fiber-reinforced thermosetting resin, which also may be applied over the frame members to make them an integral part of the horn. The resin is allowed to harden and the completed horn is removed from the mandrel. The reflector, as seen in FIG. 4, is made in the same way, by applying successively a release coating 126, a metallic layer 104 and glass-fiber-reinforced resin 108 to a mold 125. Then the completed reflector and horn are bolted together.

The dimensions of the horn and reflector are essentially as already well known. For example, the dimensions of a conical horn-reflector antenna are described by Hines, Li and Turrin in "The Bell System Technical Journal," Volume 42, July 1963, pages 1,187–1,211, and those of a pyramidal horn by Crawford, Hogg and Hunt in "The Bell System Technical Journal," Volume 40, July 1961, pages 1,095–1,116. In the case of a conical horn, the variable dimensions are the focal length and the flare angle of the cone. Since the focus of the paraboloid of which the reflector is a section coincides with the apex of the cone, and the axis of the cone is perpendicular to the axis of the paraboloid, all other dimensions are automatically determined. The preferred flare angle is known to be 31.5° (the angle α_0 in the aforesaid Hines et al. paper is 15.75°) and the focal length of the paraboloid is typically 3 to 30 feet.

The invention has been described in connection with a preferred embodiment, but no limitation thereto is intended. For example, while a conical horn-reflector antenna has been described, the invention can be applied to a pyramidal horn-reflector antenna, although a conical horn is preferred because less reinforcement is required. While a glass-fiber batting has been mentioned, it is possible to spray a mixture of fibers and resin to form the outer shell 8. Similarly, while a metal-coated plastic reflector has been described, it may be

solid metal. Therefore, it will be appreciated that the invention is not limited in regard to details of construction and mode of operation as described by way of example.

What is claimed is:

1. A horn antenna comprising a hollow cone the cross section of which, in a plane perpendicular to the axis, is circular, a concave reflector which is a sector of a paraboloid of revolution and means connecting said cone and said reflector, the wide end of the cone being sectioned at an angle to the axis of the cone where it intersects said reflector and the apex of said cone coinciding with the focus of said paraboloid of revolution, said reflector and said cone together forming a substantially closed volume, a first portion only of said cone comprising a microwave reflective material and a second portion of said cone adjacent said reflector being transparent to microwaves and providing a radome, whereby energy introduced into said cone at its apex is reflected from said reflector and through said radome, said first portion comprising substantially all of said horn except the portion against which energy introduced at said apex is reflected from said reflector.

2. A horn antenna as set forth in claim 1 including flange means adjacent the apex of said cone for coupling to a waveguide.

3. A horn antenna as set forth in claim 1 in which said cone is comprised of a microwave transparent material and in the microwave reflective portion of said cone the microwave transparent material is lined with a microwave reflective material.

4. A horn antenna as set forth in claim 3 in which the microwave transparent material is a plastic.

5. A horn antenna as set forth in claim 4 in which the plastic material is fiber glass reinforced plastic.

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