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LOW PROFILE OPEN-ENDED WAVEGUIDE ANTENNA WITH DIELECTRIC DISC LENS

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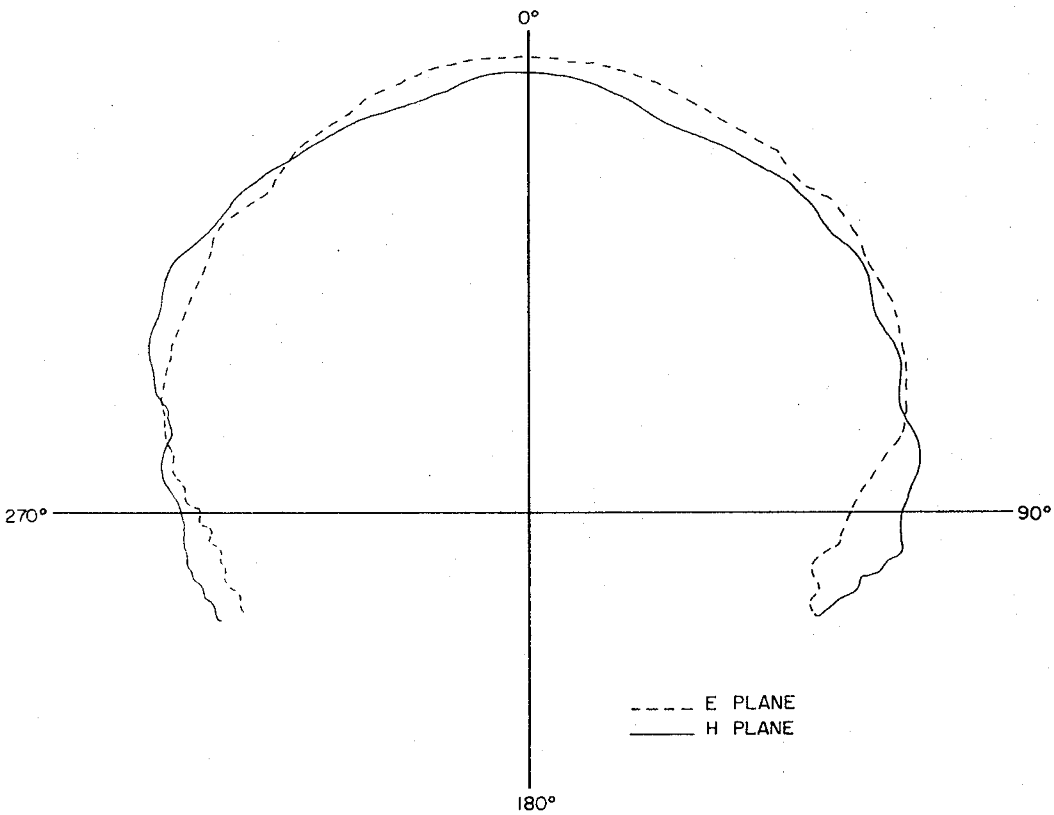

FIG. 2

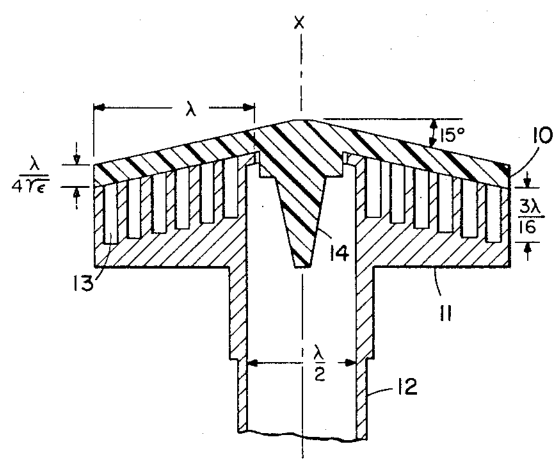

FIG. 1

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LOW PROFILE OPEN-ENDED WAVEGUIDE ANTENNA WITH DIELECTRIC DISC LENS

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ABSTRACT OF THE DISCLOSURE

This invention relates to a low-profile microwave antenna, with a dielectric surface-wave configuration. The antenna takes the form of a slightly conical, circular, dielectric disk in contact with a metallic ground plane. The ground plane is embedded with circular chokes.

There existed the need for a low-profile, (and consequently low aerodynamic drag), high-temperature, X-band antenna having a very wide omnidirectional beam, for use on the Nike-Zeus missile. The instant invention is the fulfillment of this need. A pair of antennae constructed as defined hereinafter will provide isotropic coverage, when properly mounted on a missile.

The invention takes the form of a slightly conical, circular, dielectric disk in contact with a metallic ground plane imbedded with circular chokes.

An object of the invention is to provide a novel low-profile microwave antenna.

Another object is to provide a novel, dielectric, surface-wave, microwave antenna.

Yet another object is to provide a novel, high-temperature microwave antenna.

Still another object is to provide a novel microwave antenna having a very wide omnidirectional response pattern.

These objects, and others which may be obvious from the following description, are best understood by reference to the drawings, in which:

FIGURE 1 is a full sectional view of the inventive antenna, and

FIGURE 2 is a response curve for the antenna of FIGURE 1.

Referring now to FIGURE 1, the antenna of the invention consists of a slightly conical dielectric disk **10** in contact with a metallic ground plane **11**. The disk **10** and ground plane **11** are mounted on the end of a circular waveguide **12**. It is to be understood that the antenna is a solid of revolution of the FIGURE 1 section about the longitudinal axis X—X of waveguide **12**.

Disk **10** is a high temperature dielectric such as alumina or fused quartz, having a dielectric constant designated ϵ.

The dimensions of the antenna elements, with respect to the desired wavelength of operation λ, are shown on FIGURE 1 of the drawings. As can be seen from FIGURE 1 of the drawings, the inside diameter of waveguide **12** is $\lambda/2$. The thickness of disk **10** is $\lambda/4\sqrt{\epsilon}$, and the radius of ground plane **11** from the inside of waveguide **12** to the outside of the ground plane is λ. Disk **10** is a shallow cone, the side of which is depressed 15° below a perpendicular to axis X—X of waveguide **12**.

Ground plane **11** has a plurality of grooves, such as **13**, in the surface thereof. These grooves act as wave traps or chokes, and reduce undesired lobes in the radiation pattern of the antenna. The depth of the grooves is $3\lambda/16$, and the width is ½ to ¼ the depth thereof.

Attached to disk **11** is a stepped matching element **14** to provide a match between the waveguide and antenna impedances.

The response pattern of the inventive antenna is shown in FIGURE 2, for the *e* plane and the *h* plane. For these response patterns, the dielectric constant $\epsilon=3.78$. As is obvious from inspection of FIGURE 2, the pattern is in the form of a very wide beam. The overall beam pattern is the surface of revolution of the shown pattern about the 0°–180° axis, and is thus omnidirectional. The 0°–180° axis corresponds to the X—X axis of FIGURE 1.

While a specific embodiment of the invention has been shown and described, other embodiments may be obvious to one skilled in the art, in light of this disclosure. The cone angle of disk **10** may be less than the 15° described, and may in fact, be 0°. Such a change in angle will produce a change in the radiation pattern to make it less broad, or more directional in the X—X direction in FIGURE 1 or the 0°–180° direction of FIGURE 2.

The designation of high temperature dielectrics such as alumina or fused quartz as the material for disk **10** is with high temperature requirements in mind. Obviously, other less rugged dielectrics could be used and would be within the scope of the invention, if less rugged conditions were specified for the antenna.

If desired, a skirt portion and a flange portion may additionally be provided for disk **10**, which skirt portion would cover the exposed side of ground plane **11**, and which flange portion would be coplaner with the bottom surface of the ground plane. The additional portions would give a smoother configuration to the antenna and would aid in reduction of stresses from thermal expansion of disk **10**. However, such additional portions would cause a disturbance in the radiation pattern of the antenna by providing an unwanted path for TM mode propagation. This disturbance could be minimized by making the additional portions together an electrical length an odd multiple of a quarter wavelength of λ, and metalizing them.

While the inventive antenna was designed for use on a missile, it would not be necessary to limit its use thereto. Obviously, the antenna could be used on any object desired.

I claim:

1. A microwave antenna for use at a wavelength λ, including a body of conductive material in the shape of a segment of a cylinder terminating in a cone, with an axial perforation through said cylinder and said cone; at least one groove on said cone, concentric with the axis of said cone; and with a sheet of dielectric material covering said cone, wherein said sheet is approximately $1\lambda/4\sqrt{\epsilon}$ thick.

2. The antenna as defined in claim **1** wherein both of said cylinder and said cone are right circular figures.

3. The antenna as defined in claim **2** wherein the radial dimension of said cone from said perforation to the wall of said cylinder is λ.

4. The antenna as defined in claim **2** wherein the side of said cone makes an angle of approximately 15° with a perpendicular to the axis of said cylinder.

5. The antennas defined in claim **2** wherein there are a plurality of grooves.

6. The antenna as defined in claim 5 wherein said grooves are approximately $3\lambda/16$ deep.

7. The antenna as defined in claim 6 wherein said the width of said grooves is approximately ½ to ¼ of the depth.

8. The antenna as defined in claim 2 wherein said sheet of dielectric includes a generally cone-shaped portion extending into said perforation.

9. The antenna as defined in claim 1 wherein said perforation is circular and has a diameter of $\lambda/2$.

References Cited

UNITED STATES PATENTS

2,742,640	4/1956	Cronin	343—772
2,921,309	1/1960	Elliott	343—786
2,761,138	8/1961	Sherman	343—783

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343—772, 783, 785