

[54] SUPPRESSED SIDELOBE EQUAL  
BEAMWIDTH MILLIMETER HORN  
ANTENNA

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343/786, 909, 911

[56] References Cited

FOREIGN PATENTS OR APPLICATIONS

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[57] ABSTRACT

A millimeter horn antenna apparatus for providing mil-  
limeter wave frequencies with suppressed sidelobes and  
equal beamwidths in the orthogonal electric and mag-  
netic planes.

3 Claims, 3 Drawing Figures

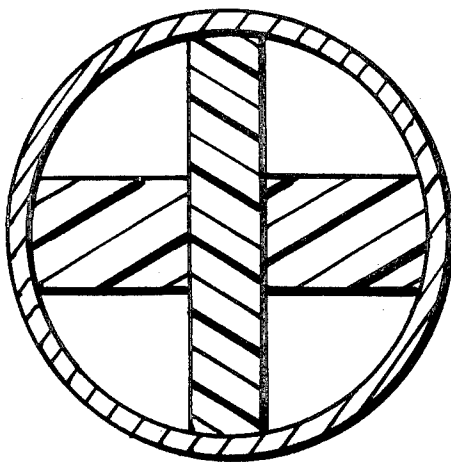


FIG. 2

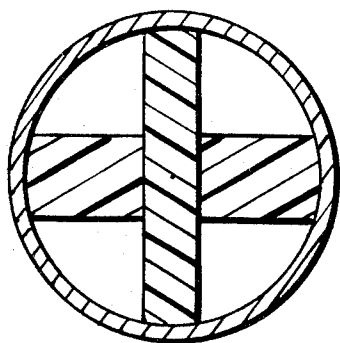
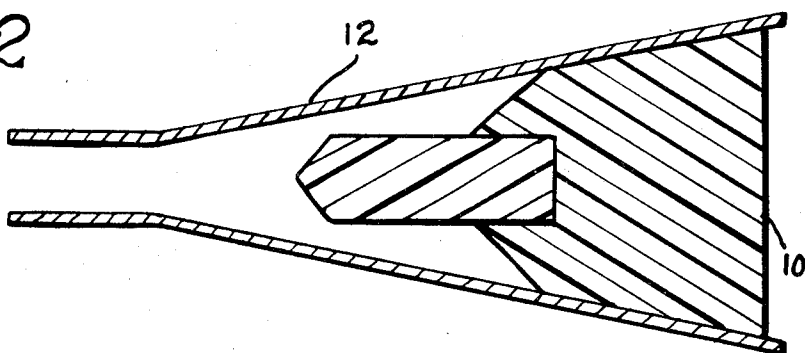


FIG. 3

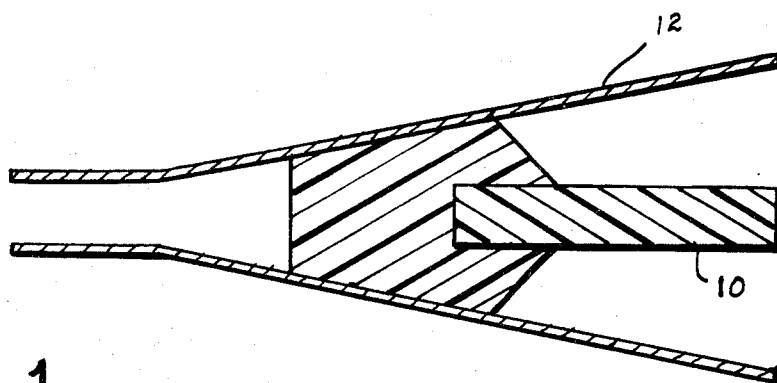


FIG. 1

# SUPPRESSED SIDELobe EQUAL BEAMWIDTH MILLIMETER HORN ANTENNA

## BACKGROUND OF THE INVENTION

The present invention relates broadly to millimeter horn antennas and in particular to a dielectric wedge apparatus for focusing and phase shifting the energy in the orthogonal planes.

In the field of radio communication, a great advantage of microwaves lies in the immense spaciousness of useful frequencies. For example, the frequency difference between the S-band and the K-band is approximately 20,000 MHz/sec. This frequency difference is about 100 times the combined frequency range of the present-day radio broadcasting, communication, and television. The use of microwaves provides another advantage which is related to the high directivity and resolving power of microwave wavelengths. Narrow microwave beams can be readily formed by antennas of physically convenient sizes. The superiority of microwaves over waves of much longer wavelengths, with respect to radiation directivity, may be clearly seen by the fact that very large antenna structures are necessary for beam transmission at longer wavelength. Similarly, the resolving power, as measured by the ability of a wave to differentiate one reflecting object from another, is larger for microwaves than for longer waves. However, the prior art antenna systems require external corrective and focusing devices such as lenses and restrictive apertures in order to obtain beamwidth and phase coincidence over relatively large arguments of the axial scan angle. There is also a requirement of extremely accurate tolerance in the antenna system in order to operate at the desired frequency. The present invention provides a low loss, low dielectric constant wedge to focus the electric and magnetic plane engines of a conical horn to produce equal beamwidths, suppressed sidelobe, and coincident phase centers in the radiation patterns.

## SUMMARY

The present invention utilizes a dielectric wedge which is positioned in a tapered conical horn between the throat and the aperture to focus and phase shift the energy in the orthogonal planes. The dielectric wedge is configured to provide a pair of plane surfaces which are perpendicular to one another and is shaped and dimensioned to fit snugly with the abutting surface of the tapered conical horn.

It is one object of the invention, therefore, to provide an improved conical millimeter horn antenna apparatus with suppressed sidelobes, equal beamwidths and coincident phase centers in the radiation patterns.

It is another object of the invention to provide an improved conical millimeter horn antenna apparatus to focus and phase shift the electric and magnetic energy in the orthogonal planes

It is yet another object of the invention to provide an improved conical millimeter horn antenna apparatus having coincident electric and magnetic plane power patterns and coincident phase fronts which are associated with these orthogonal planes.

It is still another object of the invention to provide an improved conical millimeter horn antenna apparatus which eliminates the need for external corrective and focusing devices.

These and other advantages, objects and features of the invention will become more apparent from the following detailed description when taken in conjunction with the illustrative embodiment in the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the conical millimeter horn antenna apparatus in accordance with this invention,

FIG. 2 is a top view of the conical millimeter horn antenna apparatus, and

FIG. 3 is a front view of the conical millimeter horn antenna apparatus illustrating the dielectric wedge in orthogonal planes with respect to the horn.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a dielectric wedge 10 which is inserted in the conical horn 12 between the throat and the radiating aperture. The wedge 10 may be constructed from either several separate pieces of dielectric material or form a single section of dielectric material. The material from which the wedge 10 may be constructed is any low-loss, low dielectric constant material, such as a dielectric material having a dielectric constant  $E$  of 1.02. The wedge 10 is constructed to provide a pair of orthogonal planes with respect to one another. The edges of the wedge 10 are tapered so as to snugly contact the inner surface of the conical horn 12 and thereby be held firmly in place. The dimensions of the wedge 10 and its position within the conical horn 12 are selected such that the correct phasing for suppressed sidelobes and coincident phase centers is obtained. The result of having a wedge with a pair perpendicular plane surfaces with respect to one another is a technique for obtaining equal beamwidths, coincident phase centers and equal phase fronts in the orthogonal electric and magnetic planes of a radiating conical horn antenna. Since the dielectric constant is so low, the matching of the conical horn 12 to a waveguide system presents little or no problem.

There is shown in FIG. 2 a top view of FIG. 1. The shape of the orthogonal planes of wedge 10 are each clearly defined when FIGS. 1 and 2 are viewed in conjunction to one another. It may be clearly noted that the edges of wedge are dimensioned to match the taper and slope of the conical horn antenna 12 interior walls. There is shown in greater detail in FIG. 3 the perpendicular arrangement of the orthogonal planes of the dielectric wedge 10. The correct operation is obtained when the wedge 10 which is comprised of a pair of plane sections that lie in orthogonal planes and thus, focus and phase shift the energy in each plane relatively independent of each other. Some typical results which were obtained for the wedge-corrected horn in both the electric and magnetic planes, is the coincidence of the power patterns for the orthogonal planes to  $\pm 7.0^\circ$  about the axis and sidelobe suppression is quite evident. Tests were also conducted to show power pattern coincidence in both angle and power.

In general, the energy in a particular plane, either the electric or magnetic plane, is fairly symmetric with respect to the axis of rotation. However, the beamwidths, phase centers, radii of curvature and energy distribution with respect to axial angle are not equal for the orthogonal electric and magnetic planes. By varying the path length of the energy in the electric and magnetic

planes by means of a low loss dielectric, a controlled focusing action can be obtained in each of the two orthogonal planes which is almost independent of the other plane. The action of the dielectric may be compared to the focusing properties of an optical lens which focuses light rays. By proper choice of dimensions (length, width and taper) of that portion of the dielectric wedge affecting the plane of interest, the beamwidth may be altered or focused, within limits, to obtain the desired response. The beamwidth and sidelobe level are not independent quantities and a compromise must be made depending on which criterion is more important for a particular application. The position of the orthogonal vanes of the dielectric wedge relative to each other is a factor which strongly affects the phase center coincidence of the energies in the electric and magnetic planes. Thus by proper choice of length, taper, thickness and relative position of the wedge vanes, coincident phase centers, radii of curvature, and almost coincident patterns may be obtained in the far field of the radiating horn antenna.

The present invention centers about the low dielectric constant corrective wedge which focuses and phase shifts the energy in the orthogonal electric and magnetic planes of a radiating conical horn antenna. The essential features of the corrective wedge are that wedge planes be orthogonal to one another, the material that is used for the wedge be of a low dielectric constant and that the overall wedge be configured so as to fit snugly within the circular radiating horn which is used. The taper and dimensions of the corrective wedge can only be defined in terms of the conical radiating horn antenna since this is the varying and controlling factor of the frequency at which one may be working. Ideally, a particular conical horn antenna configuration will provide the best radiating results only over a particular frequency range. Therefore, to provide the best theoretical results the horn antenna configuration

should be maximized for the particular frequency which is utilized. Thus, the corrective wedge will vary in direct relation to the conical radiating horn antenna.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

I claim:

1. A suppressed sidelobe equal bandwidth millimeter horn antenna apparatus comprising in combination:

a conical radiating horn antenna for radiating a millimeter wave frequency, said millimeter wave frequency providing a radiation pattern, said radiation pattern having orthogonal electric and magnetic energy planes, said conical radiating horn antenna having a throat and a radiating aperture, said conical radiating horn antenna being tapered between said radiating aperture and said throat, and

a wedge to focus and phase shift said orthogonal electric and magnetic energy planes to produce suppressed sidelobes and equal beamwidths, said wedge being positioned within said conical radiating horn antenna between said radiating aperture and said throat, said wedge comprising a pair of wedge vanes, said wedge vanes being plane surfaces, said pair of wedge vanes being in an orthogonal relationship to one another.

2. A suppressed sidelobe equal bandwidth millimeter horn antenna apparatus as described in claim 1 wherein said wedge is constructed from a one piece, low-loss, low-dielectric material.

3. A suppressed sidelobe equal bandwidth millimeter horn antenna apparatus as described in claim 1 wherein said wedge is constructed from a plurality of low-loss, low dielectric material sections.

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