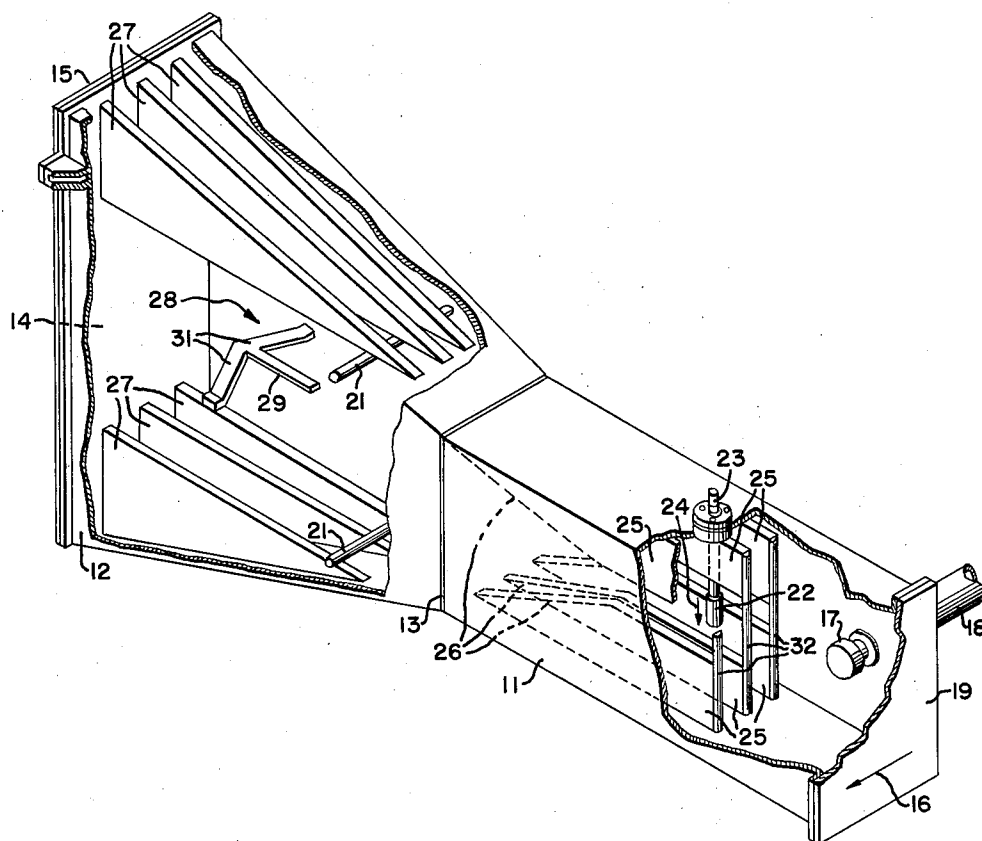


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DUAL FREQUENCY FEED HORN

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This invention relates generally to feed horns of the type generally employed for radiating or receiving electromagnetic energy in cooperation with a reflecting surface for the purpose of forming a shaped beam. More particularly the present invention relates to a feed horn which is arranged to radiate two different frequencies with cross polarization to obtain the desired illumination of a reflector surface for each frequency.

In many applications it is desirable to radiate independent signals on different UHF or microwave frequencies using the same antenna structure for each frequency. With ultra high frequencies or microwaves it is generally desirable to provide an antenna system which has a highly directional beam pattern which is adapted to obtain the maximum advantage according to the particular service for which the antenna is intended. Where the antenna is in the form of a feed horn and a curved reflecting surface it has heretofore been difficult to obtain the desired illumination distribution over the curved reflecting surface at more than one frequency for any particular feed horn used to illuminate the surface.

It is accordingly the primary object of the present invention to provide a feed horn capable of radiating widely different frequencies of electromagnetic energy with any desired energy distribution at each frequency.

A further object of the invention is to provide a feed horn capable of radiating frequencies which differ by a factor of two to one and obtain substantially uniform illumination of a reflecting surface for both frequencies.

A further object of the invention is to provide a dual frequency horn feed in which the sources supplying energy to the feed horn are effectively isolated from each other.

These and other objects of the invention will be apparent from the following detail description taken in conjunction with the accompanying drawing in which the single FIGURE is an isometric view of a feed horn in accordance with the invention with sections partly broken away for showing the structure.

In accordance with the present invention two different frequencies are radiated by the same horn structure by feeding the horn to produce TE_{01} mode energy with cross polarization to the input of the feed horn. The dimensions of the horn are chosen with respect to the lowest frequency radiated and modified for the higher frequency by the inclusion of one or more pairs of parallel conductive plates arranged relative to the polarization of the two energies radiated by the horn so as to alter the effective dimensions of the horn for the higher frequency while having substantially no effect on the horn dimensions for the lower frequency.

Referring now to the FIGURE a horn constructed in accordance with the present invention is shown to comprise a rectangular wave guide portion 11 connected to a tapered horn section 12 the junction therebetween being at the throat 13 of the horn 12. The end of the horn 12 forms the radiating aperture 14 which may be covered with fiberglass or other radome material 15.

The rectangular wave guide 11 may be supplied in any conventional manner with TE_{01} energy at the lower frequency to be transmitted polarized as indicated by the arrow 16. This energy mode at the lower frequency is excited in the disclosed embodiment by a conductive probe 17 connected to the inner conductor of a coaxial

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line 18. The wave guide 11 is terminated by conductive plate 19 with the result that TE_{01} energy introduced by the probe 17 is polarized with the electric vector in the direction of the arrow 16 and propagated down the wave guide 11 through the horn 12 to be radiated from the aperture 14 with any desired power distribution as required by a particular design. A pair of matching rods 21 may be provided in the horn 12 for the purpose of matching the horn in accordance with conventional practice.

In order to radiate a substantially higher frequency through the structure formed by the waveguide 11 and horn 12 it is necessary substantially to reduce the transverse dimensions of the structure in order to obtain the desired power distribution of the radiated energy and to suppress the propagation and radiation of higher order modes. In order to minimize the interaction between the two frequencies to be handled by the dual frequency horn structure of the present invention, the second frequency is introduced by means of a conductive probe 22 which is connected to the center conductor of a coaxial feed line 23, the axis of the coaxial line 23 being perpendicular to the plane containing the axis of the coaxial line 18. The probe 22 therefore introduces TE_{01} mode energy into the wave guide 11 with the electric vector polarized in the direction of the arrow 24. In order effectively to reduce the internal dimensions of the waveguide 11 with respect to the higher frequency energy introduced by the probe 22 one or more opposed pairs of parallel spaced conductive plates 25 are conductively attached to the inner walls of the waveguide 11 as shown. The plates 25 have substantially no effect on energy with the electric vector polarized in the direction of the arrow 16 but are spaced sufficiently close to appear as a waveguide below cutoff to energy polarized with the electric vector in the direction of the arrow 24. Accordingly the dimensions of the effective wave guide into which the probe 24 can propagate energy is substantially determined by the spacing between the opposed inner edges of the plates 25.

The plates 25 taper as at 26 to be flush with the inner surface of the waveguide 11 at the throat 13 of the horn 12. The opposed tapered edges 26 effectively form a tapered horn section for the high frequency energy radiated by the probe 22.

In order to reduce the radiating aperture for the high frequency energy propagated by the probe 22, the aperture 14 is effectively reduced by a plurality of spaced parallel plates 27 connected to the inner surface of the horn 12. The plates 27 are wedge shaped with an angle equal to the flare angle of the horn 12 such that in the assembled position shown the opposed edges of the plates 27 are parallel. The spacing between adjacent plates 27 may be substantially the same as that of plates 25 to act as waveguide below cutoff for the high frequency energy. The effective dimension to the high frequency energy from probe 22 is, therefore, the dimension between the opposed edges of the plates 27.

In order to suppress undesirable modes propagated from the probe 22 a mode suppressing structure may be employed. One form of structure which is effective to suppress the TM_{11} mode and at the same time provide additional matching between the horn 12 and aperture 14 comprises a transverse structure 28 made of conductive material. The mode suppressor 28 may be described as being in the form of a blunt arrow having a shaft 29 centrally positioned along the axis of the horn 12 and supporting members 31 connected at an obtuse angle and conductively connected to the inner walls of the horn 12 at opposed points on the opposite walls. The taper between the members 31 provides additional matching between the aperture 14 and the horn 12 at both of the

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operating frequencies and in addition serves as the structural support for the mode suppressing rod 29.

In order to terminate the high frequency waveguide structure composed of plates 25 and provide improved isolation between the feeds 22 and 17, the plates 25 are connected by conductive bars 32 which serve the purpose of closing the high frequency waveguide formed between the plates 25. The presence of the conductive bars 32 has no appreciable effect on the energy radiated from the probe 17 through the waveguide 11.

For matching purposes it may be found desirable effectively to bow the waveguide structure for the high frequency energy by making the central pair of the plates 25 narrower than the remaining plates 25. This structure, as shown, has the effect of providing a wider spacing between the opposed inner edges of the central pair of plates 25 giving in effect a bowed cross section to the effective waveguide form for the high frequency energy. This bowed effect is continued by the taper of the central pair of blades 25 up to the point where the taper merges with the inner surface with the guide 11 at the throat 13.

As a specific example of an embodiment of the invention an antenna for L band operation constructed to operate over a frequency range from 570 m.c. to 630 m.c. was used to illuminate a sixty foot reflector. A two degree beam width in the direction of polarization and a transverse beam width of 5.6° was attained. At the same time the higher frequency structure was energized with frequencies between 990 m.c. and 1130 m.c. and the corresponding beam widths were 1.5° and 5.5°. Thus the antenna structure gave substantially the same coverage at two frequency bands which were separated approximately by a factor of two-to-one and the isolation between the two probes 17 and 22 was sufficient to have negligible effect upon the apparatus connected to the lines 18 and 23 respectively.

While the embodiment of the antenna has been described particularly with reference to transmission it will be apparent that the operation is similar for reception and duplex operation and operation for transmission or reception or both is to be understood as encompassed by the language of the claims.

While a single embodiment of the invention has been disclosed showing the present preferred construction it will be apparent to those skilled in the art that modifications be made from the structure. For example any number of pairs of opposed plates may be used to alter the dimensions of the waveguide or horn for the higher frequency without departing from the spirit of the invention. Accordingly the invention is to be limited only by the scope of appended claims.

We claim:

1. A dual frequency antenna comprising a rectangular

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waveguide, a rectangular horn coupled to said waveguide and having at least two opposite side walls diverging, a set of spaced parallel conductive plates projecting inwardly from each divergent wall of said horn, said plates being wedge-shaped and positioned in planes parallel to the axis of propagation of said horn with the wide end of said wedges adjacent the aperture of said horn, a second set of spaced parallel conductive plates projecting inwardly from the walls of said waveguide and positioned in planes parallel with the planes of said plates in said horn, the plates of said second set being tapered to diverge at the end adjacent the junction of said waveguide and said horn with the angle of taper being approximately equal to the angle of divergence of said horn, means for coupling electromagnetic energy of a first frequency to said waveguide in the TE_{01} mode with the electric vector normal to said plates, and means for coupling electromagnetic energy of a second frequency higher than said first frequency to said waveguide in the TE_{01} mode orthogonal to said mode of said first frequency.

2. Apparatus according to claim 1 with additionally mode suppression means, said means comprising an elongated conductive element positioned on and aligned with the axis of propagation of said horn.

3. Apparatus according to claim 1 in which said plates in said waveguide extend from the region of the junction of said horn and said waveguide to an intermediate point in said waveguide, said means for coupling energy of a second frequency being located between said junction and said intermediate point and said means for coupling energy of a first frequency being located beyond said intermediate point.

4. Apparatus according to claim 3 in which the ends of said plates in said waveguide at said intermediate point are connected by rods in the plane of opposed pairs of said plates and extending across the space separating said pairs.

5. Apparatus according to claim 4 in which said plates include a centrally located opposed pair, the spacing between the opposed edges of said central pair being greater than the spacing between the opposed edges of adjacent pairs.

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